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Member of the SNC-Lavalin Group

South East Strategic Reservoir Option Gate 1 submission – Technical Annex B1

Environmental Assessment Report

Thames Water Utilities Ltd

28 June 2021

5201137-006

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Document history

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		3	FW	AF	CB	PMU	
		4	GW	KS	PMU	PMU	
		5	LB	AH	PMU	PMU	
		6	MT	AF	VJ	PMU	
		7	SD	NL	PMU	PMU	
		8	SD	NL	PMU	PMU	
		9	JJ	PS	CB	PMU	
		10	PW	CW	PMU	PMU	
		11	CS, JN	LB, RE	CB	PMU	
		12	CW, KS	PW	CB	PMU	
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Client signoff

Client	Thames Water Utilities Ltd
Project	South East Reservoir Strategic Option (SESRO)
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1. Introduction

1.1. Purpose of report

Atkins, a member of the SNC Lavalin group, has been appointed by Thames Water to carry out the Environmental Services for the South East Strategic Reservoir Option (SESRO). SESRO has been identified as one of the Strategic Resource Options (SROs) in Ofwat's PR19 Final Determination. Located west of Abingdon, the SESRO design is based on the abstraction of water from the River Thames at Culham, to be stored in a non-impounding reservoir during wetter months (when the reservoir is not already full). This water would then be released back into the River Thames at Culham so that it would be available for abstraction downstream.

This Technical Annex supports the regulatory assessment of environmental effects of the SESRO SRO in accordance with the WRSE ACWG Guidance[1]. The findings of the EAR have fed into the Habitats Regulations Assessment (HRA) (Technical Annex B2), Water Framework Directive (WFD) assessment (Technical Annex B3) and the Strategic Environmental Assessment (SEA) (Technical Annex B4). It has also fed into Section 5 of the Mott MacDonald 2021 Conceptual Design Report (CDR) (Technical Annex A2). This report has been structured as follows:

The remaining chapters in Section 1 provide an overview of the scheme and the main assessment assumptions.

Section 2 covers landscape and visual.

Section 3 covers the historic environment.

Section 4 covers the geomorphology (shape and form) of the aquatic environment.

Section 5 covers the hydrology (flow) conditions of the aquatic environment.

Section 6 covers water quality in the reservoir and the aquatic environment.

Section 7 covers fisheries and Section 8 covers 'other' aquatic ecology – i.e. macroinvertebrates, macrophytes, diatoms, phytoplankton and zooplankton.

Section 9 covers Invasive and Non-Native Species (INNS).

Section 10 covers the terrestrial environment.

Section 11 provides an overview of Natural Capital Accounting (NCA) and wider benefits assessments.

Section 12 provides results of the Biodiversity Net Gain (BNG) assessments.

Section 13 provides a summary of the main findings for each topic area.

1.2. Scheme description

1.2.1. SESRO options

There are currently six main size options[2] for SESRO, including four single phase construction options and two dual phase construction options. These are:

- 150 Mm^3 capacity reservoir;
- 125 Mm^3 capacity reservoir;
- 100 Mm^3 capacity reservoir;
- 75 Mm^3 capacity reservoir;
- 30+100 Mm^3 capacity, two-phase construction reservoir; and,
- 80+42 Mm^3 capacity, two-phase construction reservoir.

Technical Annex A2, Appendix A.1.1 - A1.1.6 and Technical Annex B1: EAR Figures, Figure 1.1 provides further detail of the reservoir in its environs, showing both similarities and differences with regard to the scheme's red line boundary, the reservoir's construction and operational footprint between the six different options[3].

[1] wrse_file_1347_wrse-regional-plan-environmental-assessment-methodology-guidance.pdf
[2] The options are sized by million cubic megalitres (Mm^3)
[3] Using WRMP24 designs issued to Atkins on 28/01/21.

Technical Annex A2, Sections 2.1.1 – 2.1.13 provides a detailed description of scheme elements including similarities and differences. Each of the six scheme options has provisions for:

- River Intake / Outfall Structure and Shaft;
- Conveyance Tunnels;
- Pumping Station;
- Bunded Reservoir, including Reservoir Inlet and Outlet Towers;
- An Air Diffuser Network within the Reservoir itself;
- Two Watercourse Diversions;
- Habitat creation to provide biodiversity net gain;
- An Auxiliary Drawdown Channel;
- Replacement Floodplain Storage;
- Rail Siding and Materials Handling Area;
- Recreation;
- Roads and Car Parking; and,
- Other Enabling Infrastructure.

1.2.2. Reservoir footprint and River Ock catchment

The site is in a lowland landscape primarily used for arable agriculture (mostly Grade 3 & 4) with some pasture, some woodlands, hedgerows, ponds and two large solar panel farms. The topography of the landscape is flat with subtle variation associated with catchment boundaries.

There are various watercourses of differing size and form within the boundary of the project, including Main Rivers as well as Ordinary Watercourses. The position of these watercourses is shown in Technical Annex B1: EAR Figures, Figure 1.2, these are labelled with their names where known, if unknown a code has been given to them. Main Rivers within or near to the scheme's boundary including Cow Common Brook, Portobello Ditch, Mere Dyke, Childrey Brook and River Ock. There are also a large number of ditches that follow field boundaries, some of these are previously straightened channels and flow pathways, others appear man-made amendments to assist land drainage. The geology of the area within the footprint of the reservoir is Ampthill Clay Formation and Kimmeridge Clay Formation (undifferentiated) - Mudstone.

There will be no active discharge into the River Ock catchment from the reservoir. Any reservoir drawdowns (emergency or maintenance) would be through the auxiliary drawdown channel, which would flow west to east joining the River Thames around the proposed combined intake/discharge structure. The channel would cross the Oday Ditch network, which flow into the River Thames just upstream of the Ginge Brook catchment and forms part of the Thames (Evenlode to Thame) WFD waterbody.

1.2.3. Combined intake/discharge structure and River Thames catchment

The River Thames flows north to south to the east of the position of SESRO and the River Ock. The combined intake and outfall structure (as originally designed by Jacobs in 2006[4]) will be located on the right-hand bank of the River Thames around Culham. The structure would be downstream of the River Ock, the town of Abingdon-on-Thames and Anderson Island, upstream of Culham Bridge and upstream of a section of the River Thames where flows are split between the Culham Cut (which is navigable) and a section which is not designated as navigable and includes the Sutton Pools weir pool and a local hydropower scheme. The approximate grid reference of the combined intake/discharge structure is [redacted]

It is noted that the location and orientation of the combined intake/discharge structure as shown in the 2021 CDR is deliberate, i.e. it faces in a south easterly direction which would mean that any releases would be into the main river flow within this section rather than directed at the opposite river bank and prevent bank erosion.

Re-abstraction of water released by SESRO would take place at one or more downstream intakes. Although the SESRO project takes the lead on describing any possible changes to the River Thames as a result of the operation (intake and discharge) of SESRO, selecting the most appropriate intake option(s) is part of other work packages namely the Thames to Southern Transfer (T2ST) SRO, the Thames to Affinity Transfer (T2AT) SRO and the London Reuse SRO. It is anticipated that multiple of these locations may take water in future. From upstream to downstream different River Thames intake options comprise:

[4] Thames Water (2018). Abingdon Reservoir Conceptual Design Report. October 2018.

- A potential new intake option to be located between Pangbourne and Reading (part of the T2ST SRO) [5];
- A potential new intake option to be located between Hambleden Lock (near Medmenham) and Bray Lock (near Maidenhead) (part of the T2AT SRO);
- An existing Thames Water intake at Datchet (part of the T2AT SRO);
- Existing Affinity Water intakes at Sunnymeads, Chertsey, Egham and Desborough Island (all part of the T2AT SRO);
- Existing Thames Water intakes at Walton-on-Thames, Hampton and Surbiton (part of the London Reuse SRO); and,
- A potential new intake option upstream of Teddington Weir (part of the London Reuse SRO).

1.3. Description of study reaches

A total of 13 different study reaches have been identified, covering the River Ock catchment that would contain the reservoir; and the River Thames catchment which will interact with SESRO in terms of abstraction and discharge. These are listed in Table 1-1 below and shown in Technical Annex B1: EAR Figures, Figure 1.3.

As described in Section 1.2.3, it is currently unknown exactly which River Thames intakes may abstract water released by SESRO. As such, it is recognised that discharges from SESRO may affect the River Thames all the way down to Teddington Weir (which forms the tidal limit and at which point pass forward flows will be abstracted using the principles set out by the Lower Thames Control Diagram). This is reflected in Environment Agency feedback[6]. For consistency in approach the assessments undertaken as part of the SESRO SRO will, therefore, cover the whole fluvial Thames between SESRO and Teddington Weir. To aid with assessment, study sections for the River Thames have been set between each of the intakes described in Section 1.2.3.

With regard to Reach 3 (River Thames upstream of SESRO), this reach has been included as a study reach as, in future, benefits to this reach may be possible as a result of selecting multiple linked and/or joint options, for example augmentation upstream of Farmoor, a piped transfer to Farmoor reservoir or a treatment plant at SESRO with an equivalent reduction in the Farmoor abstraction. This is however not part of the SESRO Gate 1 assessment and report.

Table 1-1 – SESRO study reaches

Reach no.	Watercourse	Reach	WFD waterbody	Consideration of potential SESRO effects in relation to:	
				SESRO Construction activities	SESRO Operation
1	Cow Common Brook Portobello Ditch Landmead Ditch Mere Dyke	Watercourses within the reservoir footprint	*Cow Common Brook and Portobello Ditch (GB106039023360)*	Reservoir construction Tunnel construction Watercourse diversion	None, no discharge in the River Ock catchment
	Childrey Brook Hanney Ditch		*Childrey Brook and Norbrook at Common Barn (GB106039023380)*	Reservoir construction Canal Access road Watercourse diversion	None
2	Mere Dyke River Ock	Watercourses between the reservoir footprint and the River Thames	*Ock and tributaries (Land Brook confluence to Thames) (GB106039023430)*	Reservoir footprint Access road Watercourse diversion	None
	Sandford Brook		*Sandford Brook (source to Ock) (GB106039023410)*	Access road construction (from A415 to Reservoir)	None

[5] It is noted an alternative set of options for T2ST includes a direct connection into SESRO.
[6] Environment Agency (2020) Strategic transfer schemes – Thames area ecology workshop. 16 March 2020. 9pp.

Reach no.	Watercourse	Reach	WFD waterbody	Consideration of potential SESRO effects in relation to:	
				SESRO Construction activities	SESRO Operation
3	Ginge Brook Mill Brook	Watercourses east of the A34 within the pipeline and intake/discharge structure red line boundary	*Ginge Brook and Mill Brook (GB106039023660)*	Railway sidings, materials handling Watercourse diversion	None
4	River Thames	Upstream of SESRO (Farmoor to Culham) Reach length - 27.3 km (along main branch of the Thames)	*Thames (Evenlode to Thame) (GB106039030334)*	None	None
5	River Thames	Immediately downstream of SESRO combined intake/discharge structure up to the River Thame confluence Reach length - 13.2 km		Construction of combined intake/discharge structure Auxiliary drawdown channel connection to the River Thames Tunnel between SESRO and the intake structure.	Yes, according to Thames Water hydrological modelling[7] the main zone of hydrological influence is the reach of the River Thames between the proposed SESRO intake/discharge structure and the River Thame.
6	River Thames	Between River Thame and Thames Water Datchet intake Reach length – 87.3 km	*Thames Wallingford to Caversham (GB106039030331)* *Thames (Reading to Cookham) (GB106039023233)* *Thames (Cookham to Egham) (GB106039023231)*	No construction activities	Yes, potential impacts or benefits as a result of the abstraction and discharge regime
7	River Thames	Between Thames Water Datchet intake and Affinity Water Sunnymeads intake Reach length – 2.8 km	*Thames (Cookham to Egham) (GB106039023231)*	No construction activities	See Reach 6
8	River Thames	Between Affinity Water Sunnymeads and Affinity Water Egham intake Reach length – 6.4 km		No construction activities	See Reach 6

[7] Thames Water (2007) Reservoir Operating Regime and Implications for Aquatic Ecology in the River Thames v2.0. Briefing note prepared by Cascade Consulting.

Reach no.	Watercourse	Reach	WFD waterbody	Consideration of potential SESRO effects in relation to:	
				SESRO Construction activities	SESRO Operation
9	River Thames	Between Affinity Water Egham and Affinity Water Chertsey intake Reach length – 6.9 km	*Thames (Cookham to Egham) (GB106039023231)* *Thames (Egham to Teddington) (GB106039023232)*	No construction activities	See Reach 6
10	River Thames	Between Affinity Water Chertsey intake and Affinity Water Walton (Desborough Island) intake Reach length – 7.3 km	*Thames (Egham to Teddington) (GB106039023232)*	No construction activities	See Reach 6
11	River Thames	Between Affinity Water Walton and Thames Water Walton intake Reach length – 4.1 km		No construction activities	See Reach 6
12	River Thames	Between Thames Water Walton and Thames Water Hampton intake Reach length – 2.2 km		No construction activities	See Reach 6
13	River Thames	Between Thames Water Hampton intake and Teddington Weir (tidal limit) Reach length - 9.5 km		No construction activities	See Reach 6

1.4. Linked and/or joint options

This report does not cover so-called ‘linked’ and/or ‘joint’ options nor the influence that other SRO and non-SRO options may have on SESRO. The following are worthy of note:

- Severn Thames Transfer (STT), which may in future link into SESRO and provide water for storage in the reservoir or for release into the River Thames at Culham;
- T2ST, which has an option to take water directly from SESRO as well as from the River Thames between Pangbourne and Reading; and/or the,
- Farmoor supply option, which would constitute building a pipeline between SESRO and Farmoor Reservoir, located to the north of SESRO and west of the City of Oxford. This option would provide the opportunity to reduce abstraction at Farmoor at times water is being transferred from SESRO to Farmoor which is likely to provide benefits to a number of watercourses flowing through Oxford.

Downstream from Reach 11, cumulative impacts between the London Reuse and SESRO SROs need to be considered as part of future gates, as the London Reuse SRO also propose a new discharge in this reach for re-abstraction before Teddington Weir.

2. Physical environment – Landscape

2.1. Introduction/explanation of topic area

The proposal site is located in the Vale of White Horse comprising open undulating clay lowland farmland that contrasts with enclosed pastures along watercourses. The A34 links the settlements of Abingdon, Drayton, Steventon and Harwell to the east, and the A338 links the settlements of East Hanney, Grove and Wantage to the west. Numerous public rights of way including The Vale Way cross the Vale as well as local roads and access tracks that link individual and small groups of residential and mainly farm buildings, solar farms and a depot. Other infrastructure includes the Great West Rail Line, and transmission lines. The wooded Corallian limestone ridge lies to the north whilst to the south the Hendred Plain forms a low ledge of lower chalk that separates the clay vale from the high chalk downs forming the North Wessex Downs Area of Outstanding Natural Beauty. Long distance views overlook the vale from vantage points.

As part of Gate 1, potentially significant issues were identified in consultation with Environment Agency due to the proposed location of SESRO in relation to the North Wessex Downs AONB. This was also flagged in a representation by Natural England on Thames Water's WRMP19.

The assessment framework described in Chapter 2 will form the brief for the Landscape and Visual Impact Assessment (LVIA) to be undertaken at Gate 2 of the proposed location of SESRO in relation to the North Wessex Downs AONB. The LVIA will be undertaken as an initial high-level appraisal in accordance with GLVIA3[8] at Gate 2 that will used as the basis to inform more formal evaluation and to support future scheme promotion or EIA.

An LVIA consists of two separate but related sections:

- Landscape assessment is the systematic description and analysis of the physical landscape features and elements within the landscape (collectively referred to as the 'landscape resource') and of the landscape character, followed by an assessment of the effects of the proposed development on this landscape resource and character. The landscape resource would include elements such as landform, vegetation cover, settlement and transport patterns, land use, building styles and historical and cultural components; and,
- Visual assessment is the description and analysis of specific views of the landscape and the general visual amenity of the area as experienced by people residing, visiting and travelling through the landscape, followed by an assessment of the effects of a proposed development on these views and visual amenity.

2.2. Datasets reviewed

2.2.1. Legislation and planning policy associated with the North Wessex Downs AONB

2.2.1.1. National Legislation

The Countryside and Rights of Way Act 2000 (CROW Act) provides the legal framework for AONB and defines within Section 85 a general duty of care for public bodies to have regard to the purpose of conserving and enhancing the natural beauty of AONBs.

2.2.1.2. National Planning Policy Framework (NPPF)

Paragraph 172 in NPPF 2019 includes policy guidance for AONBs:

> **15.Conserving and enhancing the natural environment[9]**
>
> *172. Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks, the Broads and Areas of Outstanding Natural Beauty, which have the highest status of protection in relation to these issues. The conservation and enhancement of wildlife and cultural heritage are also important considerations in these areas and should be given great weight in National Parks and the Broads. The scale and extent of development within these designated areas should be limited. Planning permission should be refused for major development other than in*

[8] Guidelines for Landscape and Visual Assessment Edition 3 Page 26 Para 3.2 and Table 3.1.
[9] https://www.gov.uk/guidance/areas-of-outstanding-natural-beauty-aonbs-designation-and-management

exceptional circumstances, and where it can be demonstrated that the development is in the public interest. Consideration of such applications should include an assessment of:

(a) the need for the development, including in terms of any national considerations, and the impact of permitting it, or refusing it, upon the local economy;

(b) the cost of, and scope for, developing outside the designated area, or meeting the need for it in some other way; and,

(c) any detrimental effect on the environment, the landscape and recreational opportunities, and the extent to which that could be moderated.

2.2.1.3. Other relevant planning policy guidance

Natural England are responsible for advising the local planning authorities on development proposals in an AONB. Natural beauty criterion for the designation of AONB include a combination of factors:

- landscape quality, where natural or man-made landscape is good quality;
- scenic quality, such as striking coastal landforms;
- relative wildness, such as distance from housing or having few roads;
- relative tranquillity, where natural sounds, such as streams or birdsong are predominant;
- natural heritage features, such as distinctive geology or species and habitat; and,
- cultural heritage, which can include the built environment that makes the area unique, such as archaeological remains or historic parkland[10].

Local Planning authorities are responsible for ensuring under the CROW Act that '*all decisions have regard for the purpose of conserving and enhancing the natural beauty of the AONB*'.

The AONB conservation board is established by the Secretary of State to manage the AONB and to create a management plan that delivers a number of requirements including an assessment of the special quality of the AONB, such as a landscape character assessment that includes its condition and vulnerability to change. Management plans are prepared for each AONB that set out the strategic context providing information relation to value and special qualities to help shape local plans and inform decisions on development proposals.

Each plan includes:

- an assessment of the special quality of the AONB, such as a landscape character assessment that includes its condition and vulnerability to change;
- cross reference to existing plans, such as local transport plans or biodiversity action plans;
- a strategy, such as a 5-year plan, of how you'll manage change;
- other special sites that exist in the AONB, such as scheduled ancient monuments or sites of special scientific interest;
- an action plan, for example who's doing what, why and by when; and,
- a monitoring plan to show how you'll measure the AONB's condition and effectiveness of management[10].

2.2.1.4. Vale of White Horse District Council Local Plan 2016

The Vale of White Horse District Council Local Plan adopted in 2016 includes core policy 44 that is designed to protect the landscape of the district with the requirement to respect, retain and enhance the local character and distinctiveness of the landscape of the Vale.

Landscape policy CP44 states:

The key features that contribute to the nature and quality of the Vale of White Horse District's landscape will be protected from harmful development and where possible enhanced, in particular:

- *features such as trees, hedgerows, woodland, field boundaries, watercourses and water bodies*
- *important landscape settings of settlements*
- *topographical features*
- *areas or features of cultural and historic value*
- *important views and visually sensitive skylines, and*
- *tranquillity and the need to protect against intrusion from light pollution, noise, and motion.*

[10] https://www.gov.uk/guidance/areas-of-outstanding-natural-beauty-aonbs-designation-and-management

Where development is acceptable in principle, measures will be sought to integrate it into the landscape character and/or the townscape of the area. Proposals will need to demonstrate how they have responded to the above aspects of landscape character and will be expected to:

- *incorporate appropriate landscape proposals that reflect the character of the area through appropriate design and management.*

preserve and promote local distinctiveness and diversity and, where practical, enhance damaged landscape areas.

High priority will be given to conservation and enhancement of the natural beauty of the North Wessex Downs AONB and planning decisions will have regard to its setting. Proposals that support the economy and social wellbeing of communities located in the AONB, including affordable housing schemes, will be encouraged, provided they do not conflict with the aims of conservation and enhancement.

2.2.1.5. Vale of White Horse District Council Design Guide 2015

The Vale of White Horse Design Guide 2015 is identified in the local plan as a key document informing development proposals requiring a developer to *assess 'the context and character of their site to ensure that new development will respect, respond to and enhance the unique characteristics of the Vale'*. The design guide includes the following design guide principles:

Principle DG1: Designations

Applicants should clearly identify whether the site lies within or in the setting of any statutory or non-statutory designation. Any development proposals within or in the setting of one or more of these designations will be required to demonstrate how the proposals respond to national and local policies relevant to that particular designation.

Principle DG2: AONB

Applicants with sites within and/or abutting the North Wessex Downs AONB must accord with relevant criteria set out in the AONB Management Plan and Paragraphs 115–116 of the NPPF. Proposals outside the AONB should not adversely affect its setting.*

*It is noted that paragraphs 115 and 116 in NPPF 2012 are superseded by paragraph 170 in NPPF 2019 (See Section 2.3.1.2 above).

The design guide also includes a landscape character assessment in Appendix E Vale of White Horse Settlement and Landscape Character. The SESRO is located in Zone 2 Clay Vale: 2B Central Clay Vale – Central Alluvial Island Villages whilst the North Wessex Downs AONB corresponds to Zone 3 Upper Greensand Ledge and Lower Chalk – Rolling Farmland Villages and Zone 5 Upper Chalk Downs.

2.2.1.6. Vale of White Horse District Council – other relevant documents

Both the Local Plan 2016 and Design Guide 2015 refer to the following as relevant reference documents in the consideration of development:

- Vale of White Horse Landscape character assessment September 2017.
- Oxfordshire Wildlife and Landscape Study.
- Oxfordshire historic landscape characterisation.

Planning advisory notes including the Landscape Strategy, and the North Vale Corallian Limestone Ridge, form part of the 2016 local plan (Refer Section 2.2.1.4 above). Whilst these planning advisory notes can no longer be considered as supplementary planning guidance, they are still considered relevant and useful in the consideration of developments and planning applications.

2.2.2. Published Landscape Character Assessments

The published assessments provide a hierarchical appraisal of landscape character through a recognised process. Landscape character is described in published national, county, district and local Landscape Character Assessments (LCA).

2.2.2.1. National Character Areas

National Character Areas defined by Natural England that are relevant to the North Wessex Downs AONB and SESRO include:

- 109 Midvale Ridge

- 108 Upper Thames Vale
- 116 Berkshire and Marlborough Downs

2.2.2.2. Vale of White Horse District Landscape Character Assessment 2016

The LCA 2016[11] divides the Vale into the landscape character types and then into landscape character areas identifying key characteristics, key positive landscape attributes, forces for change/sensitivities/pressures, landscape strategy guidance, and landscape guidelines on land management and built development.

The landscape character types and landscape character areas relevant to North Wessex Downs AONB and SESRO include:

- LM Corallian Limestone Ridge with Woodland
  - LM15 Marcham Corallian Limestone Ridge with Woodland
- RF River Floodplain
  - RF11 Garford to Abingdon Ock River Floodplain
- VL Lower Vale Farmland
  - VL2 Grove to Steventon Lower Vale Farmland
  - VL3 East Hanney to Abingdon Lower Vale Farmland
- FS Downs Footslopes
  - FS3 Spring Line Villages Downs Footslopes
  - FS4 Wantage to Milton Heights Downs Footslopes
- DS Downs Scarp
  - DS1 Idstone to Chilton Downs Scarp.

Relevant issues highlighted for consideration:

- Siting of 'any new large mass of development or bulky structures where they would affect the northern setting of the Downs, and subject any development to rigorous landscape and visual impact assessment, site carefully, and design to minimise impact, particularly regarding issues of intrusive colour and glare, and integrate with the area's rural context'.
- 'Development within the Vale effecting views from the Downs and it's wider setting'.
- 'North Wessex Downs AONB, the objectives and policies set out in the current AONB management plan'.
- Open panoramic views from viewpoints on the scarp and ridge, 'where unimpeded by woodland, over the footslopes and Vale to the north, towards the Corallian Limestone Ridge on the horizon'.

2.2.2.3. North Wessex Downs AONB Integrated Landscape Character Assessment 2002

The North Wessex Downs AONB Integrated LCA 2002[12] identifies Landscape character types and then landscape character areas. The landscape character types and landscape character areas relevant to SESRO include:

Downs Plain and Scarp

5c Hendred Plain[13]

> *'The Hendred Plain forms a low ledge of Lower Chalk extending in front of the Liddington–Letcombe Open Scarp that runs along the northern edge of the AONB. It is a comparatively small area but has a very distinct character forming a transition between the high downs and the clay lowlands of the Vale of White Horse'.*

2.2.3. North Wessex Downs AONB Management Plan 2019–2024

The North Wessex Downs AONB Management Plan 2019–2024 includes eight themes relating to: Landscape; Rural Land Management; Biodiversity; Historic Environment; Natural Resources; Development; Communities; and, Tourism Leisure and Access.

Each theme includes AONB strategic aims and objectives and policies that are included for landscape below:

[11] 19. Landscape Character Assessment (whitehorsedc.gov.uk)
[12] LUC Standard Report Template-London (northwessexdowns.org.uk)
[13] LUC Standard Report Template-London (northwessexdowns.org.uk)

S.01 Maintain and enhance the tranquillity and distinctive landscape character of the North Wessex Downs and its setting with a focus on the contribution from agriculture and forestry, development and infrastructure.

S.02 Promote understanding, appreciation and participation in the AONB by local communities, visitors and those making decision affecting its distinctive character.

2.38 AONB Policies: the Landscape	
LA 01	Encourage all partners and other stakeholders to have regard for AONB purposes across all relevant policies, programmes and activities.
LA 02	Seek to identify and address the main factors that threaten the special qualities of the AONB landscape, e.g. water abstraction, agricultural practices including diffuse pollution of watercourses, lack of woodland management, damage to historic sites, and built development.
LA 03	Use the North Wessex Downs Integrated Landscape Character Assessment to inform policy and decision making across the AONB and its setting.
LA 04	Support and promote good practice across all sectors that conserves and enhances the character and qualities of the North Wessex Downs landscape.
LA 05	Support and encourage efforts to conserve and explain the rich heritage of the North Wessex Downs, including archaeological sites.
LA 06	Ensure that all development in or affecting the setting of the AONB conserves and enhances the character, qualities and heritage of the North Wessex Downs landscape.
LA 07	Raise the policy profile of the North Wessex Downs locally, regionally and nationally to secure the co-ordination and resourcing of policies and programmes for the benefit of the AONB.

Source: North Wessex Downs AONB Management Plan 2019–2024

For landscape character area 5c Hendred Plain as identified in the North Wessex Downs AONB Integrated LCA 2002 (See Section 2.2.2.3 above), the management plan states the following:

'The Downs Plain is characterised by vast arable fields, lack of surface water and a general absence of settlement. Conversely the dramatic scarp slope, cut by springs, creates a convoluted edge alternately under woodland and pasture, including significant areas of remnant chalk grassland. This is a landscape that feels as though it has hardly changed over the centuries, although it is increasingly affected by development at its foot, outside the AONB boundary'.

2.3. Gate 1 proportional assessment methodology

Natural England defines landscape character as 'a distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another, rather than better or worse'[14]. Some landscapes are special because they have a particular amenity value, such as those nationally designated Areas of Outstanding Natural Beauty (AONB). Others may have an intrinsic value as good examples or be the only remaining examples of a particular landscape type. Some landscapes are more sensitive to development whereas others have a greater capacity to accommodate development. Assessments of landscape character and landscape sensitivity enable decisions to be made about the most suitable location of development to minimise impacts on landscapes.

At Gate 1, the baseline assessment took into account the landscape character of the study area for the reservoir options and wider context with reference to the National Character Areas (NCAs): 108 Upper Thames Vale NCA; 109 Midvale Ridge NCA; and, 116 Berkshire and Marlborough Downs NCA. In addition, the proximity of nationally designated areas, Areas of Outstanding Natural Beauty, National Parks and Green Belt in the Thames Water Supply Area was also considered. The future baseline of the NCAs and nationally designated areas was also considered and used to inform the identification of key sustainability issues in terms of landscape character and visual amenity:

- The need to protect and improve the natural beauty of the North Wessex Downs AONB
- The need to protect and improve the character of landscapes and townscapes.

[14] An Approach to Landscape Character Assessment Version 2 2018 Natural England landscape-character-assessment.pdf (publishing.service.gov.uk)

The assessment considered the baseline which is the same for all of the reservoir options against SEA core objective 'To conserve, protect and enhance landscape and townscape character and visual amenity'.

2.4. Outputs/findings

2.4.1. Assessment

The landscape character of the Vale of White Horse is distinctive comprising open undulating clay lowland farmland that contrasts with enclosed pastures along watercourses. The reservoir is in close proximity to the Oxford Greenbelt and is located within the northern setting of the North Wessex Downs AONB. Long distance views overlook the vale from vantage points.

A new reservoir will result in a permanent change to landscape and visual amenity, however as described in the CDR (2021), design principles will be identified and a landscape-led design and mitigation strategy developed to ensure embedded mitigation, good environmental design integration, and an environmentally sustainable development that will likely contribute to an overall improvement in the landscape surrounding the reservoir. The design and mitigation strategy will aim to connect the reservoir design into the landscape, protecting the landscape character and identifying opportunities for landscape improvements and enhancements, whilst taking into account the views and visual amenity of key receptors. A new valued landscape will result that is used by people with significant beneficial effects associated with the commitments to landscaping and creation of aquatic and grassland.

Whilst the construction of the reservoir would result in landscape, visual and habitat impacts, mitigation measures as described in the CDR (2021), will be implemented to avoid, reduce and minimise loss or disturbance through the design and planning of construction activities resulting in a significant (moderate) adverse effect that will reduce to less significant (minor) adverse effects during operation.

2.4.2. Consultation

As part of Gate 1 potentially significant issues were identified in consultation with Environment Agency due to the proposed location of SESRO in relation to the North Wessex Downs AONB.

This was also flagged in a representation by Natural England on Thames Water's WRMP19 which stated:

> *'If the Abingdon Reservoir option[15] is pursued, Thames Water will need to undertake a full Landscape and Visual Impact Assessment (LVIA) at the project stage.*
>
> *'We advise that Thames Water works with relevant parties (including Natural England and the AONB Board) in the option development in order to make sure that, despite the scale of impact, the option is designed to be as sensitive to its setting as possible and that the most appropriate landscape mitigation is selected. There are opportunities for landscape improvements, and careful design would be essential to ensure local landscape character is not just protected, but also enhanced.'*

2.5. Conclusions

Taking into account the findings of the Gate 1 assessment and the feedback from the consultation with the Environment Agency and Natural England on the Thames Water's WRMP19 the requirement for and the scope of an LVIA for the proposed location of SESRO in relation to the North Wessex Downs AONB, was subsequently considered to be undertaken at Gate 2.

It was established that an LVIA undertaken at Gate 2 of the proposed location of SESRO would need to assess the potential scale of impact on the landscape, and the visual impact of the proposed location of SESRO in relation to the setting of the North Wessex Downs AONB (See Figure 2.1 Location Plan in Technical Annex B1: EAR Figures).

The LVIA would be undertaken as an initial high-level appraisal in accordance with GLVIA3[16], at Gate 2 that will used as the basis to inform more formal evaluation and to support future scheme promotion or EIA. For clarification, it would focus on the AONB and would not be a full LVIA that considers all landscape and visual effects within the study area of the reservoir proposal site.

Section 2.6 describes the proposed assessment framework for a high level LVIA to be undertaken at Gate 2.

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[15] It is noted that historic pertaining to SESRO have previously been referred to as the Upper Thames Major Reservoir Development (UTRMD), Upper Thames Reservoir or Abingdon Reservoir.
[16] Guidelines for Landscape and Visual Assessment Edition 3 Page 26 Para 3.2 and Table 3.1.

The findings of the high-level assessment will be used to inform design principles and the careful development of the landscape-led design and mitigation strategy during scheme optimisation at Gate 2, to ensure good design integration and an environmentally sustainable development. This design and mitigation strategy will take account of the setting of the AONB including *'long views from and to the designated landscape are identified as important, or where the landscape character of land within and adjoining the designated area is complementary'* to minimise impacts, whilst protecting the landscape character and identifying opportunities for landscape improvements and enhancements.

2.6. Assessment framework towards Gate 2

The assessment framework describes below sets out the broad principles of the proposed approach to the LVIA to inform discussions with Natural England and other relevant stakeholders including AONB Conservation Board, Vale of White Horse District Council. The LVIA will be undertaken as an initial high-level appraisal in accordance with GLVIA3[17] at Gate 2 that will used as the basis to inform more formal evaluation and to support future scheme promotion.

2.6.1. Toolkit

The proposed LVIA for Gate 2 will be based on GLVIA3 and reference other relevant best practice guidance.

2.6.2. Definition of landscape and the role of landscape and visual impact assessment

GLVIA3 adopts the following definition adopted by the European Landscape Convention 2002:

> *'Landscape is an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors'.*

This definition encourages consideration of the landscape as resource that provides an integrated framework to consider a wide range of environmental, land use and development issues in the surrounding context.

The LVIA considers the effect of a proposed development on the landscape as a resource 'in its own right' through the consideration of the landscape character (See Section 2.2.2 above) and assessment of landscape effects.

> *'Character is not just about the physical elements and features that make up the landscape, but also embraces the aesthetic, perceptual and experiential aspects of the landscape that make different places distinctive.'*[18]

The LVIA also considers the effect on specific *'views that people have and their visual amenity – meaning the overall pleasantness of the views they enjoy of their surroundings'.*[18] informing the assessment of visual effects.

2.6.3. Competent expert

Professional judgement is an important part of the LVIA, and it is proposed that the LVIA for Gate 2 will be undertaken by a suitably qualified team and led by a Chartered Landscape Architect.

2.6.4. Baseline Study

A desk-based exercise will be undertaken to identify background information (See Section 2.6.4.2 below) on the key landscape resource and sensitive visual receptors that will inform the LVIA and that will be in addition to what has already been collated and described in Section 2.2 above.

2.6.4.1. Study Area identification

The proposed study area for the LVIA to consider the impact of the SESRO on the landscape setting on the North Wessex Downs AONB will be based on the zone of visual influence (ZVI) informed by desk study, a site visit and if available a 3D model and GIS used to identify the zone of theoretical visibility based on a terrain model.

[17] Guidelines for Landscape and Visual Assessment Edition 3 Page 26 Para 3.2 and Table 3.1.
[18] Guidelines for Landscape and Visual Impact Assessment (GLVIA3) Third Edition Page 36 Para 3.2 Table 3.1.

2.6.4.2. Evidence gathering – designations and other information (including relevant mapping where available)

Background information that will be considered within the setting of the North Wessex Downs AONB:

- Other relevant nationally designated areas and features assessed by other environmental topics, including conservation areas, sites of special scientific interest etc and other sensitive sites;
- Green infrastructure i.e. networks of greens spaces, watercourses and water bodies, and key connections between the SESRO, the Vale of White Horse and North Wessex Downs AONB;
- Landscape character assessments, landform, landcover, key characteristics, features, and sensitivities, and what is valued in terms of landscape quality (condition), scenic quality, rarity, representativeness, conservation interest, recreational value, perceptual aspects, and associations[18];
- Representative vantage points, including long views to and from, will also be identified in consultation with the AONB Conservation Board and Vale of White Horse District Council; and,
- Other sources identified by stakeholders.

2.6.4.3. Site Visit

A high-level assessment will be undertaken on site to confirm the features or elements that contribute to the character of the landscape (as described by published documents) and to review the ZVI to determine the potential visibility of SESRO. A site photographic record will be collated post visit.

Photographs will be taken with a digital camera with a 35 mm fixed focal length lens. These will be presented as a series of panoramic photographs to illustrate landscape character in the area and also as representative viewpoints identified in consultation with the AONB Conservation Board and Vale of White Horse District Council and corresponding to publicly accessible locations and nearby visual receptors. These will be used to inform the assessment of potential landscape impacts and visual impacts in relation to the setting of the North Wessex Downs AONB, and long views to and from the SESRO and AONB.

2.6.5. Assessment

The LVIA at Gate 2 will involve:

- identifying the nature of the proposed change or development;
- describing the existing landscape resource and the views and visual amenity affected, and evaluating susceptibility of the resource/receptor to the SESRO in combination with its value to determine its sensitivity; and,
- predicting potential impacts/magnitude of change to the receptor as a result of SESRO although not their significance and considering opportunities for how these effects might be mitigated through the design process.

2.6.6. Reporting

The findings of the assessment will be presented in an appraisal report that will include the following:

- Introduction – setting out the purpose of the LVIA described in the appraisal report;
- Legislative and policy framework – describing the national legislation and policy context;
- Assessment methodology – describing the approach to LVIA to inform the Gate 2 appraisal report;
- Project description – describing the proposed development, identifying the main features and parameters available and relevant to the LVIA, as well as, assumptions and limitations associated with Gate 2;
- Study Area and Baseline studies – describing the existing landscape resource and visual environment in the study areas with an indication of value informed by desk study, site visit and stakeholder consultation;
- Identification and description of potential impacts – identifying and describing potential impacts in relation to the setting of the AONB; and,
- Mitigation – considering opportunities for design and mitigation, enhancement/improvement.

3. Historic environment

3.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO, including impacts to designated heritage assets, historic landscape and unknown below ground archaeology. For this chapter a gap analysis was undertaken to determine our current understanding of the historic environment within the red line boundary.

No designated heritage assets have been identified within the scheme footprint and no designated heritage assets within the Study Area will experience a change in their setting sufficient to change their significance. Archaeological remains are expected to be present on the Scheme. The most significant impact would be during construction on below ground archaeological remains. A programme of archaeological evaluation and investigation will be undertaken prior to construction to locate and record any other archaeological remains. Table C1. of the SEA outlines the proposed approach.

3.2. Datasets reviewed

For the purpose of this gap analysis the following datasets were consulted:

- Oxfordshire Historic Environment Record (HER);
- Oxford Archaeological Research Frameworks; and,
- Archaeology Data Service.

Engagement with Oxford County Council [redacted] and Historic England [redacted] took place on the 26/11/2020. As part of these discussions, a gap analysis of the reports and Written Scheme of Investigation (WSI) for the Desk Based Assessment (DBA) was agreed upon. Further engagement was held on 17/02/2021 where methodology for DBA was detailed. Oxford County Council as part of this consultation on 17/02/21 provided their standard brief for desk-based assessment, which details their expectations. This brief will be followed in the production of the DBA.

3.3. Gate 1 proportional assessment methodology

Archaeological remains are expected to be present on the Scheme. The most significant impact would be during construction on below-ground archaeological remains. A programme of archaeological evaluation and investigation will be undertaken prior to construction to locate and record any other archaeological remains.

In addition to a thorough review of the available literature (and associated data/analyses), this review has considered the latest design for the proposed reservoir. It is noted that all options are considered to have the same impacts on archaeological remains, with only a slightly smaller area being affected by the 75 Mm^3 option whereas all the other five options have the same/similar footprint.

Using the literature/data available, this review has used expert judgement to yield qualitative judgements in respect of the impacts of the proposed reservoir on the historic environment baseline. The historic environment analysis including an overview of the chronology of surveys, potential gaps in evaluation and measures to address the potential gap.

Historic environment information was gathered within 1 km radius of the Scheme for designated assets and non-designated assets. Information on key designated heritage assets outside the study area have also been included where there was the potential for impacts to their setting. The size of the study area is considered sufficient to compile a comprehensive baseline, identifying designated and non-designated heritage assets. This will allow a full understanding of the setting of any heritage assets within the study area and allow an assessment of the archaeological potential of the Scheme. In addition, the potential impacts on designated assets beyond the boundaries of the study area were assessed, where there was a clear relationship between these assets and the assets within the study area which may be affected by the Scheme.

Assumptions and limitations tor the assessment for this chapter are given below:

- The assessment is based on an illustrative design. Full details of the appearance of structures, size and type of planting, drainage etc have not been available; and,
- Outline mitigation measures have been incorporated into the chapter where possible, however, given the time constraints, detailed mitigation design has not been possible.

3.4. Outputs/findings

3.4.1. Heritage assets

The review of the HER data shows that there are 388 designated heritage assets with a 1 km study area comprising of

- 8 Scheduled Monuments
- 380 Listed Buildings:
  - 7 Grade I Listed Buildings
  - 31 Grade II* Listed Buildings
  - 342 Grade II Listed Buildings

There are 354 non-designated heritage assets in the 1 km study area with many of the assets focus on settlement activity during the prehistoric periods with evidence suggesting the area within the study area has been occupied since at least the Neolithic period. No designated heritage assets will be physically impacted.

3.4.2. Archaeological investigations

A review of the HER data/grey literature within the red line boundary suggests there have been at least *c.*300 archaeological investigations. A list of the reports which were recovered has been provided in Technical Annex B1, Appendix A3.3.1. A total of 86 reports could not be located, but a brief summary provided by HER has been provided and can also be found in Technical Annex B1, Appendix A3.3.1

3.5. Conclusions

No designated heritage assets have been identified within the Scheme footprint and no designated heritage assets will experience a change in their setting which will materially affect their significance.

The review of the current grey literature highlights that there is a very high potential for archaeological remains within the red line boundary, particularly for the prehistoric periods. The Scheme would therefore result in a complete loss and disturbance to a number of non-designated assets and potential loss to hitherto unknown archaeological remains. Further impacts such as changes to settings of a number of designated heritage assets are also anticipated.

Consultation with the Oxford County Council archaeologist was carried out who agreed with the proposed general framework set out in Section 3.6 including the desk-based assessment with the standards and guidance of the Chartered Institute for Field Archaeologists. The works will need to include the agreement of a WSI for the assessment. This WSI will not only need to set out the scope of the assessment but also detail how the data sources will be used, processed and incorporated into the assessment. The WSI can be viewed in Annex B1 Appendices: Historic Environment, A3.1.

3.6. Assessment framework towards Gate 2

In discussions with the Oxford County Council archaeologist and Historic England, the archaeological sensitivity of the area, and the consequent need for a robust quantification and qualification of known and potential remains and their significance has been highlighted along with reservations as to the degree of survey coverage so far undertaken for previous scheme iterations.

It is agreed that ahead of any determination of the scheme an extensive and staged programme of archaeological evaluation will be required, the details of the expectations of this programme of works are outlined in Table C1 of the SEA. The first step will be delivery of a detailed desk-based assessment at the Gate 2 stage.

- The following measures have therefore been proposed as being appropriate for Gate 2:
- A detailed desk-based assessment would be required to establish an understanding of the historic environment, ideally this would include the results of the following:
  - A full spectrum of targeted geophysical survey; Potentially including mixed approaches suitable for informing both near surface archaeology and underlying, deeper palaeodeposition.
  - Development of a geoarchaeological Deposit model to map underlying palaeohydrology and palaeo-environmental potential as well as aiding in predictive archaeological modelling; and,
  - Archaeological surveys of any areas of pasture, and flood plain (LiDAR, aerial photography complemented by walk-over survey) during Gate 2.

4. Physical Environment – Fluvial Geomorphology

4.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO, including changes to fluvial geomorphology within the River Ock catchment; and the River Thames around and downstream of the combined intake/discharge structure.

4.2. Datasets reviewed

Three principal publications have been reviewed, all three of which relate directly to the historical evolution of the way in which watercourses could be managed in respect of previous plans for the proposed reservoir. As such these documents form an excellent starting point for understanding the fluvial geomorphological baseline conditions:

- Cascade (2006): Geomorphic Regime Analysis;
- Nottingham University Consultancy Limited (NUCL) Report (2007): River Ock Floodplain Morphological Modelling – CAESAR Model; and,
- NUCL Report (2008) Geomorphic Design Templates for Watercourse Diversions.

All of the above reports were written in respect of former iterations of the proposed reservoir design and were led by Nottingham University Consultants Ltd (NUCL).

Two publications were not available for review, but are worthy of flagging here, as they contain additional historical baseline information that will need to be incorporated as the project progresses:

- Bromley, C. 2005. Fluvial Geomorphology of the Ock Catchment: 2005 Resurveys; and,
- NUCL 1999. Geomorphic design guidance for re-routed channels. Thames Water Abingdon Reservoir Proposal.

In addition to the data/literature, this review has also examined aerial photography, and Google StreetView photography of the watercourses in the study area. WFD data have been derived from the Environment Agency's Catchment Data Explorer[19], the principal source of baseline information in respect of the quality of the water environment around the proposed reservoir as reflected in the Thames River Basin Management Plan.

4.3. Gate 1 proportional assessment methodology

In addition to a thorough review of the available literature (and associated data/analyses), this review has considered the latest design for the proposed reservoir. Using the literature/data available, this review has used expert judgement to yield qualitative judgements in respect of the impacts of the proposed reservoir on the fluvial geomorphology baseline.

[19] https://environment.data.gov.uk/catchment-planning/

4.4. Outputs/findings

4.4.1. Design constraints and implications

4.4.1.1. Introduction and general description of alterations to the watercourse network

The original investigation into the geomorphological impacts of the proposed reservoir was undertaken by Cascade in 2006, using subconsultants from Nottingham University Consultants Ltd (NUCL). At a high-level, the investigation separated the project into two main watercourse diversions, termed the East Watercourse Diversion (EWD) and the West Watercourse Diversion (WWD), both of which involve the re-routing of the existing drainage around the proposed reservoir (therefore creating space for its footprint). Notwithstanding any live revisions on general design optioneering, this approach is assumed to still be valid in respect of the present-day proposals. Both diversions involve several watercourses, all of which ultimately serve as tributaries of the River Ock. The length of new watercourse created has been provided in Annex A1 CDR: Section 2.1.7.2, Table 2-13. The resultant loss of catchment area may be on the order of 6.6 km^2. However, there are six different reservoir capacity options (as described in Section 1.2.1) that have implications for the reservoir footprint and therefore the red line boundary. The length of river network that falls within the red line boundary of each option is provided in Table 4-1 below.

Table 4-1 – Length of watercourse network within the red line boundary of each reservoir option and the estimated river condition.

River condition is noted for each reach (see next Section for details). The reconfiguration of WFD water bodies and watercourses is presented in Technical Annex B1: EAR Figures, Figure 1.3.

River Name	WFD water body 'blue line' (✓)[20]	Estimated river condition[21]	Total length of river within each reservoir option boundary (km)			
			150 Mm^3 30+100 Mm^3 84+42 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3
Cow Common Brook u/s Portobello Road confluence		Fairly good	1.05	1.05	1.05	0.28
Cow Common Brook u/s Hanney Road	✓	Fairly good	0.99	0.99	0.99	0.97
Cow Common Brook d/s Hanney Road	✓	Fairly poor	2.86	2.86	2.86	2.86
Hanney Ditch		Fairly poor	2.09	2.09	1.86	1.51
Landmead Ditch		Fairly poor	0.73	0.73	0.73	0.73
Mere Dyke		Fairly poor	2.58	2.58	2.58	2.58
Oday Ditches on WFD blue line	✓	Fairly poor	0.34	0.34	0.34	0.34
Oday Ditches outside WFD blue line		Fairly poor	0.25	0.25	0.25	0.25
Portobello Ditch	✓	Fairly poor	1.14	1.14	0.53	0.23
River Ock	✓	Fairly good	0.12	0.12	0.12	0.12

[20] The WFD 'blue line' refers to the WFD reporting river network as presented on Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/

[21] For a description of how 'estimated river condition' has been derived, please see Section 12 of this report. In summary, in the absence of Modular River Survey (MoRPh) field surveys that record the extent of a range of geomorphological features that reflect the functioning of a river reach, river condition was estimated by visual inspection of satellite imagery of the river on Google Earth and using Habitat Modification Scores from available River Habitat Surveys (RHS) conducted previously on the rivers impacted by the Scheme. See section 12.3.2 and Table 12-1 for further details.

River Name	WFD water body 'blue line' (✓)[20]	Estimated river condition[21]	Total length of river within each reservoir option boundary (km)			
			150 Mm^3 30+100 Mm^3 84+42 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3
Sandford Brook	✓	Moderate	0.76	0.76	0.76	0.76
		Total km:	**12.93**	**12.93**	**12.09**	**10.63**

The EWD would involve the diversion of watercourses (predominantly ditches) to the south of the reservoir so that they flow around it to the east. It would drain the area between the reservoir and the existing railway. The watercourse diversion would join the Steventon Ditch East at Steventon and from here follow the present alignment of the remaining Steventon Brook East and thence the Mere Dyke to the north. The catchment area captured by the reservoir from this eastern catchment would be approximately 3.3 km^2. The Orchard Farm Ditch, Goose Willow Ditch, Steventon Ditch West and Mere Dyke West would be largely lost to the reservoir footprint. A small section of the Mere Dyke, to the west of Drayton, would also have to be moved to accommodate the proposed reservoir footprint.

The WWD would commence to the south of the reservoir and would involve the Cow Common Brook being diverted to the west. It would flow to the west intercepting the Portobello Ditch and the area between the proposed reservoir and the existing railway. The watercourse diversion will make allowance for a future extension of the Wilts & Berks Canal by flowing underneath this (the type of structure has yet to be decided) before joining the Hanney Ditch and passing in a further culvert beneath the proposed East Hanney–Steventon Road Diversion, to the south east of East Hanney. The combined watercourse would then be routed north where the preference is to connect into the current Hanney Ditch just to the north of the proposed canal. The catchment area captured by the reservoir from this western catchment would be approximately 3.3 km^2. The Cow Common Brook would be largely lost to the reservoir footprint.

The geomorphological impacts of the proposed reservoir are expected to be experienced almost wholly within the Ock catchment. Whilst there will be alterations to the flow and sediment regime in the downstream River Thames, both are expected to be negligible downstream of the River Thame confluence (beyond Reach 5). Any changes are expected within Reach 5.

4.4.1.2. Baseline description of the existing River Ock watercourse network

With respect to the existing geomorphology baseline (of the watercourses), the Cascade (2006) report identified:

- heavy supply of fine-grained sediment from an intensively-farmed, low-relief catchment, leading to some in-channel deposition, and localised destabilisation;
- a dense network of ditches, with little variability, generally stable planform over time, and generally monotonous trapezoidal cross sections – less than 5% of channels were 'natural', only the Ock, Childrey Brook and Letcombe Brook generally present any appreciable geomorphological diversity cohesive banks, with limited relief variability (height, slope etc.);
- Cow Common Brook, the only site of localised marginal gravel supply, did support "some riffle-pool and low incipient sinuosity"; and,
- reference conditions (in terms of flow/form relationships) may be suitable for investigation on the Childrey Brook, downstream of the confluence with Hanney Ditch.

4.4.1.3. Geomorphological principles for river design:

The Cascade (2006) report emphasises the need for appropriate baseline monitoring to understand the prevailing geomorphological conditions, and how they ned to be factored into channel design, which is recommended to be based on 'regime-type' analysis of channel dimensions. Such data build a solid platform for design optioneering and detailed design of new/modified river channels, utilising knowledge on (i) river flow and its variability, and (ii) the availability and characteristics of river sediments and how these are transferred. Both factors influence the resultant channel morphology.

Key to this approach is understanding the baseline and future stream power of all watercourses as a key component influencing the response of river systems to diversion and/or restoration activities. For example, a suggested distinction between high energy streams (stream power >35 Wm^{-2}) and low energy streams

(<35 Wm^{-2}) has been suggested in the literature. In the context of the proposed project, the low energy streams that would need to be diverted to create the reservoir footprint would clearly require assistance to develop their morphology, and this needs to be a key factor in the design. It is generally acknowledged that these types of watercourses are not able to transport excess sediment, erode their bed and banks, or to develop natural long-profile and planform patterns and transport the material necessary to build and maintain in-channel the sediment features (such as bars and riffles) characteristic of an alluvial stream. These assertions stem from the review and findings of Brookes (1992) but are also supported by a wide body of observation and experience. Crucially, modification of low-energy watercourses can have the effect of facilitating excess deposition (siltation), resulting in the build-up of the river bed levels and a subsequent requirement for in-channel maintenance to restore the 'desired' river bed profile. As a result, the Cascade (2006) report highlights that, in the context of the rerouted watercourses considered necessary to deliver the proposed reservoir, it would be inappropriate to replace the present, heavily engineered drainage channels with 'natural' watercourses; they will require specific design attention for them to have a natural function in light of their modified characteristics and functions.

Of key importance, however, is that for both the EWD and WWD designs considered in the Cascade (2006) report, the maximum high-stage (Q_5) design flows yielded very low stream power values of 4.7 W/m^2 and 7.2 W/m^2 respectively, even using upper/optimistic estimates. This is significant in respect of flagging the resultant risks of high rates of sediment deposition (siltation), and therefore potential need of maintenance, but also a low risk of channel instability/erosion issues.

The above constraints limit the use of 'regime-type analysis'[22] as the basis for diversion channel design. Further progress will also rest on the use of reference reaches, experience gained from stream restoration/re-routing projects in other catchments with similar environmental attributes, ecological considerations and targets and hydraulic/sediment transport analysis to design rerouted channels capable of meeting these multiple goals. Therefore, further site visits and liaison with scientists and engineers will be required in completing the design process for the rerouted channels. It is suggested that reference conditions (in terms of flow/form relationships) may be suitable for investigation on the Childrey Brook, downstream of the confluence with Hanney Ditch or a small sinuous section of Cow Common Brook which would be lost under the proposed scheme. On Childrey Brook, flow gauge data are available, together with modelling results and information on channel geometry. It is possible, therefore, to compare the flow and flood statistics for the current situation with existing channel dimensions and thus provide an indication of the local applicability of regime equation based on the flow statistics available. This, however, requires further consideration.

4.4.1.4. Suggested design criteria

Given considerations of sedimentation, water quality and ecology it would be helpful to vary the channel design to incorporate the following:

- Zones of lower gradient and greater width to act as sediment retention areas, possibly with the promotion of marginal vegetation;
- Capacity to generate or at least alter a range of within-channel bed (bar) forms. Generally, on straighter sections these would be alternate and diagonal bars, which could be 'seeded' using coarser sediment, and/or 'induced' via the incorporation of a sinuous planform. In meanders, point bars would be needed. The combined effect would be a variant of the riffle-pool sequence;
- A buffer area between channel and marginal agricultural areas – as wide as possible to mimic the functions of a natural 'floodplain' (noting the SESRO red line boundary will be within this floodplain); and,
- The incorporation of cross-sectional forms with alternate (and alternating degrees of) asymmetry, including shallow marginal areas, and possible natural coarser sediment sources.

Given the above concerns in respect of siltation, further work was subsequently undertaken to better quantify the rates and patterns of sediment transfer within the affected watercourse network (NUCL 2007). The 'Cellular Automaton Evolutionary Slope And River' (CAESAR)[23] floodplain morphological model was used to simulate

[22] Regime analysis is based upon specific data sets where conditions of flow, morphology and sediment transport are known to a reasonable degree, and where a degree of physical reasoning is employed to derive regime equations in order to derive appropriate channel dimensions.

[23] CAESAR is a cellular model that uses a regular mesh of grid cells to represent the river catchment studied. Every cell has properties of elevation, water discharge and depth, vegetation cover, depth to bedrock and grain size. The model uses an hourly rainfall record as the input for a hydrological model, which may be altered to represent hydrological variations over time (and different vegetation covers) to simulate the morphological response to such new conditions. For further details

existing and future baseline conditions, which allows the simulation of erosion and deposition patterns, and predicts the associated morphological changes, over periods of decades.

The CAESAR modelling results concluded the following points:

- Current rates of erosion and sedimentation within all of the current watercourses modelled are low;
- The great majority of fluvially-transported sediment arriving in the study area (>96%) is transferred *through* the River Ock system and, as such, any changes in sediment inputs from upstream as a result of SESRO are likely to be transferred downstream to the River Thames.
- Climate change is likely to have limited effects on erosion and deposition patterns in and around the River Ock in the vicinity of the SESRO.
- The presence of the proposed reservoir would also have very little impact on both erosion and deposition patterns in and around the River Ock and sediment delivery to the Thames.
- Long-term sediment-related effects due to the presence of the Upper Thames reservoir fall well within the error band for future behaviour of the system that is associated with uncertainty concerning local climate change impacts in the Ock basin.

The overall conclusion of this work is that the predicted localised morphological effects, following construction of the proposed reservoir are not considered to be significant in terms of sediment transport, and can be managed through appropriate, ongoing geomorphological monitoring and adaptive management within the lower Ock catchment.

Further to the CAESAR modelling, additional design analyses were undertaken by NUCL (2008), attempting to provide detailed advice to the engineering team on channel dimensions for both the EWD and the WWD. Repetition of these data is beyond the scope of this review and, furthermore, would need to be revisited in light of the progression on practical approaches to river design and restoration over the past decade that has arisen especially in light of the requirements of the hydromorphology component of the Water Framework Directive (WFD). Such constraints and opportunities are largely compatible with the analysis set out above, but further considerations are provided in the following sections.

4.4.2. Construction and Operation Impacts

The proposed design will involve an appreciable amount of catchment modification in order to provide the required space for the reservoir footprint. The descriptions of the EWD and the WWD in section 4.3 of this chapter remain valid; the original watercourse catchment areas that will be ‘lost’ will require the re-routing of drainage between the adjacent watercourses. The impacts of this, in respect of the geomorphological aspects of WFD, are described in Table 4-2 below.

see: Coulthard, T.J., Macklin, M.G. and Kirkby, M.J., 2002. A cellular model of Holocene upland river basin and alluvial fan evolution. *Earth Surface Processes and Landforms*, *27*(3), pp.269–288.

Table 4-2 – Geomorphology baseline and potential impacts (construction and operation).

The reconfiguration of WFD water bodies and watercourses is presented in Technical Annex B1: EAR Figures, Figure 1.3 and Table 4-1

Reach no.[24]	WFD Water body[25]	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
1	*Cow Common Brook and Portobello Ditch* GB106039023360	• Cow Common Brook and Portobello Ditch is not designated as An Artificial or Heavily Modified Water Body. Hydrological Regime is 'high' and Morphology 'supports good'. • However, the majority of the watercourses within this lowland catchment have been substantially modified from a geomorphological perspective. There is also a large network of agricultural drainage ditches that ultimately flow into the arterial watercourses, most notably Cow Common Brook. • Pill Ditch, Portobello Ditch, and much of the Cow Common Brook (downstream of Steventon Road/ Hanney Road and upstream of the railway) have experienced extensive planform modification, with most reaches being straightened to create space for the adjacent agricultural land use. These reaches do generally retain a thin strip of intermittent riparian vegetation. Whilst not confirmed, these reaches may have also been over-deepened and therefore disconnected from their floodplains in all but high flows. There is no evidence of hard bed or bank reinforcement. • Between the railway and Steventon Road/ Hanney Road, the Cow Common Brook	• Loss of between **39.1 and 44.8 km** of total watercourse (length) and associated riverine habitat[26]. • **Between 3.6 and 4.5 km** of this loss is associated with the WFD river network **(35 to 45%** of this 10.031 km water body, by length). • The total length lost is split into Main River and Ordinary Watercourse. The length of Main River lost is between **4.4 and 6.2 km.** • The remaining losses are associated with Ordinary Watercourses (Mere Dyke, Old Canal, Orchard Farm Ditch, Steventon Ditch, and a number of unnamed drainage ditches). **A total of between 34.7 and 44.8 km of Ordinary Watercourse would be lost.** • Between **7.2 (100Mm³) and 10.5 km (84_42Mm³)** of new watercourse gained as a result of EWD, WWD and Auxiliary Drawdown Channel. Length differs for each of the size options: See Annex A1, CDR: Section 2.1.7.2, Table 2-13.	• The proposed diversion of watercourses around the reservoir footprint will result in a loss of the baseline watercourse network (and its associated habitat) within this water body. This will require assessment in light of the design standard of the newly created diversion channels (EWD and WWD), and also offset mitigation (e.g. river restoration) elsewhere in the catchment (i.e. the creation of new river channel habitat). • Appropriate precautions will be taken when working in the channels of watercourses, to appropriately manage flood risk and the potential for deposition of silt or release of other forms of suspended material or pollution within the water column. • All measures will be in line with the requirements set out within the Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG5: Works and maintenance in or near water).

[24] The reaches in this column are the same as the study reaches set out in Table 1-1
[25] WFD water body data references within the table are all derived from Catchment Data Explorer: https://environment.data.gov.uk/catchment-planning/
[26] All calculations of length of watercourse lost in this column are based on the reservoirs with the shortest and longest lengths of watercourse lost. The option with the shortest length is 75Mm³ and the one with the longest length is 84_42Mm³. Any exception to this stated in the text. Total lengths (all WFD waterbodies combined) are presented in Technical Annex B3 (Water Framework Directive), Table 4-2.

Reach no.[24]	WFD Water body[25]	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
		presents a relatively natural planform. A sinuous course is accompanied by relatively thick and mature riparian vegetation coverage. Furthermore, the NUCL 2006 report indicates the local presence of a gravel supply (presumably from the channel banks) and the subsequent development of bedforms within the channel.		
1	*Childrey Brook and Norbrook at Common Barn* GB106039023380	• Childrey Brook and Norbrook at Common Barn is not designated as An Artificial or Heavily Modified Water Body. Hydrological Regime and Morphology both 'support good'. • Childrey Brook retains a sinuous planform through most of its course (within this water body), however downstream of the A338 displays limited in-channel morphological or flow diversity, and only sparse riparian vegetation coverage. • The planform of Nor Brook has been significantly modified, with multiple straightened sections, joined by abrupt/acute changes in course. Whilst there is a reasonable coverage of riparian vegetation buffering the channel, there appears to be limited in-channel flow or morphological diversity. • There is also a large network of agricultural drainage ditches that ultimately flow into the arterial watercourses. The most notable of these watercourses is Hanney Ditch, a largely straightened ditch flowing from south-north and joining the Childrey Brook adjacent to Common Barn.	• Loss of between 0 and **6 km** of watercourse (length) and associated riverine habitat. This includes both Main River and Ordinary Watercourses. • **0 km** of this loss is associated with the WFD river network. • The total length lost is split into Main River and Ordinary Watercourse. The length of Main River lost is **between 0 and 2.1 km** (Hanney Ditch up to Steventon Road), • The remaining losses (between 0 and **3.9 km**) are associated with Ordinary Watercourses. • Between **0 (75Mm³) and3 km (150Mm³, 84_42Mm³ and 100_30Mm³)** of new watercourse gained as a result of WWD. Length differs for each of the size options**:** See Annex A1, CDR: Section 2.1.7.2, Table 2-13. • The realigned Hanney Ditch, and any newly designed interconnecting sections, as well as the Childrey Brook downstream of its confluence with Hanney Ditch will require in-channel works to accommodate the increase in flow and sediment regime that will be	• The proposed diversion of watercourses around the reservoir footprint will result in a loss of the baseline watercourse network (and its associated habitat) within this water body. This will assessment in light of the design standard of the newly created diversion channels (EWD and WWD), and also offset mitigation (e.g. river restoration) elsewhere in the catchment (i.e. the creation of new river channel habitat). • Modification of Hanney Ditch and Childrey Brook will need to ensure not only that they increase conveyance capacity (to accommodate increased flow volumes as a result of the diversion from Cow Common Brook), but also such that hydromorphological processes and forms preserved and/or enhanced relative to the baseline. • Appropriate precautions will be taken when working in the channels of watercourses, to appropriately manage flood risk and the potential for deposition of silt or release of other forms of suspended material or pollution within the water column.

Reach no.[24]	WFD Water body[25]	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
			experienced as a result of diversion of flow from the Cow Common Brook catchment. Such in-channel works will result in hydromorphological modification relative to the baseline.	All measures will be in line with the requirements set out within the Environment Agency's PPGs (PPG1: General Guide to Prevention of Pollution; PPG5: Works and maintenance in or near water).
2	*Ock and tributaries (Land Brook confluence to Thames)* GB106039023430	• The Ock and tributaries (Land Brook confluence to Thames) is not designated as An Artificial or Heavily Modified Water Body. Hydrological Regime and Morphology both 'support good'. • The section of the River Ock downstream of its confluence with the Childrey Brook but upstream of Caldecott (that overlaps with the assessment area) is characterised by a mildly sinuous planform, punctuated by some locally straightened reaches (e.g. adjacent to the A34). Riparian vegetation coverage is intermittent, but in places is dense. There appears to be a limited degree of flow or morphological diversity.	The River Ock will experience an increase in flow volume between its confluence with the realigned Hanney Ditch and the existing confluence with Cow Common Brook. The magnitude of this increase will depend on the relative flow splits between the EWD and the WWD. This will require in-channel works to accommodate the increase in flow and sediment regime. As part of this, changes to flood risk must be managed due to the existing enhanced conveyance of water in the catchment. Such in-channel works will result in hydromorphological modification relative to the baseline. However, there would be no loss of watercourse network within this water body.	Modification of the River Ock will need to ensure not only an increase in conveyance capacity, but also that hydromorphological processes and forms preserved and/or enhanced relative to the baseline.
4	*Thames (Evenlode to Thame)* GB106039030334	• The Thames (Evenlode to Thame) is not designated as An Artificial or Heavily Modified Water Body. Hydrological Regime and Morphology both 'support good'. • This reach contains Sutton Pools downstream of the proposed combined intake/discharge structure, which is a diverse section of habitats off the main navigation. • The section of the Thames adjacent to and immediately downstream of Caldecott is characterised by a mildly sinuous planform, with relatively low levels of in-channel hydromorphological pressure. However, there are a number of offtakes including Abingdon	The River Thames will be subject to variations in flow regime associated with the reservoir auxiliary drawdown channel. At present it is unclear to what extent flows down this channel will impact on the River Thames, but flow-sensitive features within the Thames (Evenlode to Thame) e.g. weir pools may experience associated morphological changes. • Loss of **2.4 km** of watercourse (length) and associated riverine habitat for all options. This includes both Main River and Ordinary Watercourses.	Flow sensitive features require identification and assessment in Gate 2 once the full extent of hydrological impacts across the whole flow regime is better understood. The subsequent assessment will need to demonstrate whether there will be any geomorphological impacts as a result of the changed in flow regime and sediment supply. However, the geomorphological impacts of the proposed reservoir are expected to be experienced almost wholly within the directly affected portions of the Ock catchment. Whilst there will be alterations to the flow and sediment regime in the River Thames. Based

Reach no.[24]	WFD Water body[25]	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
		Marina (upstream of the Thames-Ock confluence) and Culham Cut (downstream of the Thames-Ock confluence), relatively low levels of riparian vegetation coverage, and additional bankside hydromorphological pressures associated with the use of the river for water sports. • Roads and footpaths are also located very close to the channel banks.	• **Less than 0.1 km** of this loss is associated with the WFD river network for all options (**less than 0.01% of this 63.863 km water body by length**). • The total length lost is split into Main River and Ordinary Watercourse. The length of Main River lost is **0.1 km for all options.** • The remaining losses (just over **2.2 km for all options**) are associated with Ordinary Watercourses. • **2.6 km** of new watercourse gained as a result of the Auxiliary Drawdown Channel for all options between the Reservoir site and the River Thames.	on a review of work to date, these are expected to be confined to Reach 5 and expected to be negligible in respect of their impacts on the formation and maintenance of geomorphological features of interest (e.g. weir pools) within such a large catchment as the Thames. For these reasons, waterbodies in Reaches 6–13 downstream of the River Thame are not considered further in this assessment.

4.5. Conclusions

There will be a loss of baseline watercourse network within the project area, which has been quantified for each of the six different options. This will result in the requirement for multiple river diversions and therefore reorganisation of the river and ditch network south of the River Ock. This introduces two principal constraints.

Firstly, there is a design constraint in respect of the fact that all watercourses present very low stream power values, a function of relatively small catchment areas, low discharge, and low gradient. From an engineering geomorphology perspective, therefore, the scheme is unlikely to introduce an erosion/stability risk, provided that diversion channel dimensions are designed appropriately. However, careful consideration will be needed to ensure that these low energy river channels are not subject to high rates of fine-grained sediment supply, and therefore susceptible to excess sediment deposition (siltation). This will require attention in the progression to Gate 2.

Secondly, from a WFD/habitat perspective, the project is likely to result in the net loss of riverine habitat as a direct consequence of the loss of the baseline watercourse network. This carries with it a consenting risk, introducing implications in respect of an appropriate quantity of mitigation (which is also linked to the requirements for Biodiversity Net Gain, as presented in Section 12 of this report), and in respect of the provisions of Article 4.7 of the WFD (now known as Regulation 19 in the Water Framework Directive Regulations which have hitherto not been considered). Both areas require further attention in the progression to Gate 2.

The geomorphological impacts of the proposed reservoir are expected to be experienced almost wholly within the Ock catchment. Whilst there will be alterations to the flow and sediment regime in the downstream River Thames. Based on a review of work to date, these are currently expected to be confined to Reach 5 only but expected to be negligible in respect of their impacts on the formation and maintenance of geomorphological features of interest (e.g. weir pools) within such a large catchment as the Thames. For these reasons, water bodies downstream of Thames (Evenlode to Thame) are not considered further in this assessment.

4.6. Assessment framework towards Gate 2

Baseline conditions need to be assessed using appropriate desk- and site-based methodologies, as agreed with the Environment Agency. This will inform the best possible understanding of the implications of the project in respect of WFD compliance and the required levels of mitigation. Gate 2 work is likely to include, but is not limited to, the following investigations:

- Fluvial geomorphology walkover surveys of all principal watercourses within the red line boundary that may be impacted by a change in flow, along with a more rapid and targeted walkover survey of the drainage ditch network (some of which are likely to be ephemeral). These surveys will determine the current baseline geomorphological conditions.
- River Thames weir pool surveys to determine the baseline status of any such downstream locations that could be sensitive to changes in hydrology and sediment supply as a result of the proposed reservoir. Locations of these features have not yet been identified. However, data gathered through bathymetric surveys and hydrometric surveys of sensitive locations may be correlated with hydrological models (2D/3D) in order to ascertain any likely impacts on weir pool morphology as a result of the proposed reservoir.
- MoRPh surveys at an appropriate spatial resolution (to be agreed with the Environment Agency). These data will be used to determine the habitat quality of the watercourse network that is being lost and, therefore, contribute to the Biodiversity Net Gain metric in respect of mitigating for this loss (see also Section 12 of this report).
- Geomorphological principles need to be embedded into the project design where new watercourses are to be created and where existing watercourses require modification. These principles should be aimed at working with natural geomorphological processes as far as practicable in order to ensure that the ultimate channel designs provides an appropriate degree of habitat heterogeneity (e.g. in channel width, depth, slope, substrate, cross-section etc.) and therefore support the objectives of WFD.

Once appropriate baseline characterisation is underway, and geomorphological principles are embedded into the design process, the Gate 2 assessment can focus on making informed evidence-based conclusions to support the EIA and WFD compliance processes.

5. Physical Environment – Hydrology

5.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO, including changes to river flows in the River Ock downstream of SESRO; and the River Thames downstream of the proposed discharge point near Culham.

5.2. Datasets reviewed

Various data and reports were used to gain an understanding of previous investigations, including:

- Cascade, 2006a. Upper Thames Major Resource Development (UTMRD) – TW/EA Water Resources & Operating Regime TWG briefing note on Abstraction Regime Investigation. PU002-7LTC/E2, 5 July 2006.
- Cascade, 2006b. Upper Thames Major Resource Development (UTMRD) – TW/EA Water Resources & Operating Regime TWG briefing note on Release Regime Investigation. PU002-7LTC/E2, 5 July 2006.
- Thames Water, 2008. Briefing note on Release Regime Investigation – Draft Water Resource Management Plan Operating Regime. V2.1, 5 December 2008.

The reports provide an insight into previous iterations of assessment of the SESRO scheme. A comparison of the approach and variations are outlined in Section 5.3.1.2. The input data (including inflow timeseries datasets) used to input into the model are:

- Gauged natural inflow data for Thames at Sutton Courtenay (39046) downloaded from the National River Flow Archive (NRFA)[27]. Available between 1973 to 2019.
- Gauged natural inflow data for Thames at Teddington (39001) downloaded from the NFRA[28]. Available between 1883 to 2019.
- Modelled natural inflow data for Thames at Sutton Courtenay provided by Thames Water. Available between 1920 to 2013.
- Release Trigger Timeseries' including reservoir storage volumes and Lower Thames Control Diagram (LTCD) ‘DEL1’ thresholds between 1989 to 2020. Provided by Thames Water.
- Gauged natural inflow data for Ock at Abingdon (39081) downloaded from the NRFA[29]. Available between 1962 to 2019.

The locations of the gauging stations are illustrated in Technical Annex B1: EAR Figures, Figure 5.5.

[27] NRFA Station Data for 39046 - Thames at Sutton Courtenay (ceh.ac.uk)
[28] NRFA Station Data for 39001 - Thames at Kingston (ceh.ac.uk)
[29] NRFA Station Mean Flow Data for 39081 - Ock at Abingdon (ceh.ac.uk)

5.3. Gate 1 proportional assessment methodology

5.3.1. Reservoir and River Thames

5.3.1.1. Overview of conceptual model

As described above, an excel-based conceptual model was developed to replicate the operational regime(s) of the reservoir. This was set up to specifically cover study reach 5, as hydrological modelling work carried out by Thames Water[30] concluded that the primary zone of influence of the SESRO operating regime would extend no further than the confluence with the River Thame. A conceptual model of the reservoir is illustrated in Technical Annex B1: EAR Figures, Figure 5.1.

The input is based on modelled flows in the River Thames at Sutton Courtenay (immediately downstream from the discharge point) which informs how much potential water is (or is not) available for abstraction. The other two inputs are from the River Thames at Teddington and London Reservoir Storage Levels which form the two triggers for discharge from the reservoir. These modelled flows cover a period from 1920 to 2010 (see Section 5.3.1.2), although it is noted that this needs updating in the future as further modelled runs become available.

The Hands-off Flow (HoF) and maximum abstraction rates are the same for all options, set at 1,450 Ml/d (Q_{50}) and 1,000 Ml/d respectively at Sutton Courtenay, as specified in the Thames Water (2008) report (see Section 5.2). Other parameters, such as reservoir volume (and useable capacity) and discharge release rates vary per option. Most of these input parameters were provided by Thames Water, others (shown in italics in the table below) were interpolated from those provided. Option 4 (150 Mm^3) has been split into two further sub-options to account for the potential maximum permissible discharge rate. Option 4a uses the rate calculated as being sustainable during the most extreme drought on record (321 Ml/d), whereas Option 4b uses the maximum outflow rate technically possible for energy recovery through the two Kaplan turbines and therefore the highest discharge rate possible (600 Ml/d) (see Appendix A1, CDR: Section 2.1.3.4). Option 4b does not reflect the true operational regime (which is more likely to have discharges between ~165Ml/d and ~321Ml/d depending on the size selected) and as such, findings for this option should be regarded with caution. As stated in Section 1.2.1, Option 6 and Option 5 would be delivered in two construction phases, i.e. 30+100 Mm^3 for Option 5 and 80+42 Mm^3 for option 6. However, for ease we have assessed the final size (i.e. combined volume) of these options. See Table 5-1.

Table 5-1 – Model input variables for each option (in size order*)

Options	Reservoir volume (Mm^3)	Minimum volume to remain within reservoir for safety purposes (Mm^3)	Maximum abstraction rate (Ml/d)	Maximum release rate (Ml/d)	Stepped (ramp-up) flow release rate (Ml/d)**	River Thames Hands-off Flow (Ml/d)
Option 1	75	4.0	1,000	165	*77*	<1,450
Option 2	100	5.6	1,000	219	*102*	<1,450
Option 6	122	*7.1*	1,000	*264*	*123*	<1,450
Option 3	125	*7.3*	1,000	*270*	*126*	<1,450
Option 5	130	*7.6*	1,000	*280*	*131*	<1,450
Option 4a	150	9.0	1,000	321	150	<1,450
Option 4b	150	9.0	1,000	600	*280*	<1,450

* The option sizes are expressed by volume in million cubic megalitres (Mm^3), where 1 Mm^3 = 1 Ml, and flow rates are expressed as megalitres per day (Ml/d)
** approximately 47% of the maximum release rate; Interpolated values in italics

[30] Thames Water (2007) Reservoir Operating Regime and Implications for Aquatic Ecology in the River Thames v2.0. Briefing note prepared by Cascade Consulting

When daily inflows are below the HoF threshold no abstraction can take place. When inflows are greater than the HoF then abstraction can occur up to the maximum abstraction rate, assuming the HoF can be maintained. Daily inflows exceeding both the HoF and the maximum abstraction rate (i.e. >2,450 Ml/d) will not be abstracted and will instead continue to the River Thames. In addition, if the reservoir is at capacity no further abstraction can take place and all flows continue downstream along the River Thames.

The commencement of discharge from the reservoir is determined by two triggers (Drought Event Level 1 or DEL1) based on the amount of water stored in London's reservoirs and flows within the Thames at Teddington. If either reach a critical threshold then discharge from the reservoir will begin. The triggers are:

- If the volume of water in London reservoirs fall below the LTCD; or,
- If the flow at Teddington Weir (based on a five-day average) falls below 3,000 Ml/day.

When either one or both thresholds are met, discharge from the reservoir will commence. Discharge will begin with three days of reduced 'ramp-up' flows before the maximum discharge release rate is activated. Discharge ceases when storage and river levels recover, or when the usable capacity of the reservoir has depleted with only dead water remaining.

Based on the above conditions, abstraction and discharge would not be active at the same time.

5.3.1.2. Assumptions and limitations

As described in Section 5.2, several gauged ("actual") datasets are available for input as inflows at Sutton Courtenay and Teddington, as well as recorded reservoir storage levels in London. A modelled flow timeseries was also provided by Thames Water and used as part of a deployable output (DO) analysis. Following a comparison of these datasets across overlapping dates (1989 to 2010) the inflows appear relatively comparable (see Technical Annex B1: EAR Figures, Figure 5.2 and Figure 5.3).

The modelled reservoir storage levels in London are less consistent (Technical Annex B1: EAR Figures, Figure 5.4). We understand from Thames Water that any differences can be explained by the modelled data being over-optimistic with the efficiency by which water is captured and stored. In reality, the drawdown(s) are likely to occur more often; this is reflected in the recorded storage levels data.

However, taking this into account, the modelled timeseries covers a much longer time period from 1920 to 2010, and would enable a much broader analysis of the data (albeit that this timeseries does not cover recent years and will need to be updated and re-assessed at Gate 2). Therefore, taking the above into account, the longer modelled timeseries has been used to represent the inflows.

Previous studies have demonstrated when flow falls below 3,000 Ml/d at Teddington for more than ten consecutive days, there is insufficient flow in the river to meet London's demand and the reservoir storage levels begins to decline (Thames Water, 2008). It is estimated that it will take approximately four days for the discharge from SESRO to be experienced in the Lower Thames. Therefore, a five-day average of flows at Teddington is used to determine when to trigger release and ensure demand is met (Thames Water, 2008). It is also assumed that any flow released from SESRO will have no impact on the overall flows at Teddington, accepting that it would be re-abstracted into the London reservoir storage before this point.

Thames Water undertook a series of similar modelling exercises in 2006/08 (see Section 5.2). A comparison of approaches is provided in Table 5-2. Overall, the two approaches are comparable, with most variations a result of difference in the operating parameters for each option. The primary deviations are the lack of inclusion of London storage level triggers in the previous model and the omission of transfer losses and sweetening flows in the current model.

Table 5-2 – Model comparisons

	Thames Water, 2008		Atkins, 2021	
Parameter	Included	Criteria	Included	Criteria
Reservoir volume/ useable capacity	**Yes**	150 Mm^3 including 9 Mm^3 emergency storage	Varies	Varies depending on the option (see Table 5-2)
River transfer losses	**Yes**	2%	No	Not included (currently being investigated as part of a different study)
Hands-off Flow	**Yes**	1,450 Ml/d at Sutton Courtenay Weir (Q_{50} exceedance flow)	**Yes**	Included with same criteria

	Thames Water, 2008		Atkins, 2021	
Parameter	Included	Criteria	Included	Criteria
Maximum abstraction levels	**Yes**	Maximum abstraction 1,000 Ml/d in a single day	**Yes**	Included with same criteria
DEL1 trigger – River Thames at Teddington Weir	**Yes**	Five consecutive days of flow at Teddington below 3,000 Ml/d	*Varies*	Same principal, but uses a five-day average as opposed to absolute values
DEL1 trigger – London Reservoir Storage	No	Not included	**Yes**	When London reservoir storage falls below LTCD
Abstraction pumping rate and its variability	**Yes**	Stepped pumping arrangements – no ramping other than to maintain HoF	**Yes**	No ramping of abstraction.
Maximum discharge release rate	**Yes**	Maximum release 255 Ml/d in a single day	*Varies*	Maximum release rate varies (see Table 5-2)
Variability of flow release	**Yes**	Three days at 120 Ml/d then maximum rate	*Varies*	Included, but ramp-up release rate varies depending on option (see Table 5-2)
Threshold for terminating release	**Yes**	Five consecutive days of naturalized flow at Teddington Weir of at least 3,000 Ml/d	*Varies*	Termination when flow at Teddington is >3,000 Ml/d and London reservoir storage above LTCD
Time of travel	**Yes**	Assumes four days for flow from Culham to affect London flow levels	**Yes**	Same assumption
Reservoir water level management	**Yes**	Surface evaporation and rainfall included; Tunnel sweetening flow of 5 Ml/d	No	Not included at this stage, subject to further design as part of Gate 2

5.3.1.3. Model runs

The model was run across four different historical time periods for each option (these periods were also used as part of earlier investigations, see Cascade 2006a and 2006b in Section 5.2). The time periods were selected to represent and assess how the reservoir may have operated under different conditions, and what the potential impacts on the flows in the River Thames might have been. The average daily flows per year are illustrated in Technical Annex B1: EAR Figures, Figure 5.6, from small (bottom-right) to large (top-left). The chosen conditions include:

- All years – 1920 to 2013
- A typical non-drought period – 1986 to 1988 (in blue)
- A typical drought period – 1996 to 1998 (in red)
- An extreme drought – 1933 to 1934 (in yellow)

However, the model is flexible and allows for a variety of different periods to be examined. Alternative periods of time can be selected within the range of years currently assessed (1920–2010). The model is retrospective and based on synthetic data derived from historical records, therefore it should be considered as an indicative operational regime and not a forward-looking prediction of what might happen in the future. This is especially true given that it does not account for climate change. That said, additional or alternative inflow timeseries data can be input and used against the same operation regime; this includes the WRSE regional modelling exercise.

5.3.2. River Ock

This work has primarily focused on the impacts to the River Thames at source, i.e. within the immediate reach downstream of the abstraction/discharge point. However, there are also direct (physical) impacts in the River

Ock catchment, where the proposed reservoir is to be constructed. This will not include additional discharge into the River Ock system from the proposed reservoir, but the impacts include:

- The diversion of existing channels to the west and east around the reservoir footprint to maintain flow connectivity;
- Loss of watercourse(s) and catchment area underneath reservoir footprint;
- Surface water run-off originating from the reservoir bund;
- An increase in flood risk from a reduction in flood storage capacity within the floodplain; and,
- Construction activities potentially adversely affecting the watercourses and wetlands, for example via increased fine sediment input and pollution runoff.
- At present, for the purposes of Gate 1, the analysis of these impacts has been limited to higher flow (flood) modelling being undertaken by Mott MacDonald (see Technical Annex A1, Appendix E.1). For Gate 2, changes to flows will also require environmental assessments to understand how flow may change within study reaches 1, 2 and 3 in particular.

5.4. Outputs/findings

5.4.1. Reservoir and River Thames in immediate reach

5.4.1.1. Reservoir operations

Reservoir storage and operational models for each option across each time period are provided in Technical Annex B1: EAR Figures, Figure 5.11. Table 5-3 summarises these outputs around key descriptors, e.g. the frequency and duration of abstractions and discharges.

Please note, the options are ordered in ascending reservoir volume (i.e. size), from smallest (option 1) to largest (options 4a and 4b).

Abstraction

The data presented in Table 5-3 suggest that the frequency of abstraction increases with the size of the reservoir. Active daily abstraction across the 'All years' record (1920–2010) increases from 6% for option 1 to 11% for option 4a, and jumps up to 17% for option 4b. This is likely because larger reservoirs take much longer to fill because of the larger volume of water required (see Technical Annex B1: EAR Figures: Figure 5.11).

Abstraction during the typical drought period (1996–98) occurs more than twice as frequently than during the typical non-drought period (1986–88), and this appears to be driven by how often the reservoir is at capacity, which dictates whether there is capacity for further abstraction. The reservoir is likely to be at capacity between 65% and 69% of the time during the typical non-drought period, and 28% to 38% during the typical drought period.

Abstraction during the extreme drought period (1933–34) is significantly reduced to almost inactive (<1%), driven by an overall reduction in the availability of flow in the Thames (i.e. flow less than HoF). The reservoir is at capacity for approximately 22% of the time across all options; this is in fact at the beginning of the drought and does not recover for almost two and a half years in 1936.

Discharge

With regard to the reservoir discharging, there is very little difference between the options across all periods, likely because the DEL1 triggers are independent of the reservoir option. The proportion of time varies by a mere 0.1% across the 'All years' record (1920–2010), increasing with reservoir size. This suggests in all options the reservoir rarely empties (see Technical Annex B1: EAR Figures, Figure 5.11) with the exception of option 4b, which discharges approximately 3% less frequently compared to the other options. This option would likely have drawn down more often due to its higher discharge rate.

Across the other time periods, the frequency of discharge appears to increase in line with demand (in the Thames). During the typical non-drought period (1986–88) the frequency is approximately 12.5% across all options, whereas during the typical drought period (1996–98) the frequency is almost four times greater; approximately 45% across all options. During the extreme drought, the demand is clearly even greater and varies marginally between 63% to 64%. For both the drought periods option 4b is likely to discharge significantly less – around 30–40% less – driven (as above) by the reservoir being close to or at emergency water levels due to its higher discharge rate.

This pattern also corresponds with the longest, continuous period of discharge, increasing from 24 days during the typical non-drought period to 175 days during the typical drought period, and 305 days during the extreme drought. The longest on record was 331 days, occurring in the 1920s. Option 4b has slightly reduced periods of discharge during drought periods due to the reservoir being close to or at emergency water levels due to its higher discharge rate.

On average across the 'All years' record, the reservoir correspond to a typical pattern of increased abstraction during the wet winter months and discharge due to demand in drier summer months. The storage levels also correspond to the demand with the reservoir typically being at capacity by May and drawn down by October/November (see Technical Annex B1: EAR Figures, Figure 5.12).

Table 5-3 – SESRO options comparison All years and all options (arranged by reservoir size)

Descriptor	Period	Number of days and % against total number of days in record						
		Option 1 75 Mm^3	Option 2 100 Mm^3	Option 6 122 Mm^3	Option 3 125 Mm^3	Option 5 130 Mm^3	Option 4a 150 Mm^3	Option 4b 150 Mm^3
Number of daily records	All years	33,238						
	1920–2010							
	Non-drought	1,096						
	1986–1988							
	Drought	1,096						
	1996–1998							
	Extreme drought	730						
	1933–1934							
Abstraction active	All years	1,939	2,480	2,952	3,039	3,145	3,620	5,554
	1920–2010	5.8%	7.5%	8.9%	9.1%	9.5%	10.9%	16.7%
	Non-drought	36	44	47	49	50	54	80
	1986–1988	3.3%	4.0%	4.3%	4.5%	4.6%	4.9%	7.3%
	Drought	90	121	161	166	171	201	286
	1996–1998	8.2%	11.0%	14.7%	15.1%	15.6%	18.3%	26.1%
	Extreme drought	3	4	4	4	4	5	9
	1933–1934	0.4%	0.5%	0.5%	0.5%	0.5%	0.7%	1.2%
Abstraction at max 1,000 Ml/d	All years	1,116	1,510	1,813	1,858	1,922	2,188	367
	1920–2010	3.4%	4.5%	5.5%	5.6%	5.8%	6.6%	1.1%
	Non-drought	11	16	17	18	18	19	11
	1986–1988	1.0%	1.5%	1.6%	1.6%	1.6%	1.7%	1.0%
	Drought	73	104	123	128	133	149	8
	1996–1998	6.7%	9.5%	11.2%	11.7%	12.1%	13.6%	0.7%
	Extreme drought	3	3	4	4	4	4	9
	1933–1934	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	1.2%
	All years	8,551	8,550	8,556	8,557	8,558	8,560	7,685

Descriptor	Period	Number of days and % against total number of days in record						
		Option 1 75 Mm^3	Option 2 100 Mm^3	Option 6 122 Mm^3	Option 3 125 Mm^3	Option 5 130 Mm^3	Option 4a 150 Mm^3	Option 4b 150 Mm^3
Reservoir discharging	1920–2010	25.7%	25.7%	25.7%	25.7%	25.7%	25.8%	23.1%
	Non-drought	137	137	137	137	137	137	137
	1986–1988	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
	Drought	493	493	493	493	493	493	346
	1996–1998	45.0%	45.0%	45.0%	45.0%	45.0%	45.0%	31.6%
	Extreme drought	458	457	462	462	463	465	267
	1933–1934	62.7%	62.6%	63.3%	63.3%	63.4%	63.7%	36.6%
Longest number of consecutive days discharging	All years	331	331	331	331	331	331	237
	1920–2010	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.7%
	Non-drought	24	24	24	24	24	24	24
	1986–1988	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
	Drought	175	175	175	175	175	175	175
	1996–1998	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
	Extreme drought	305	305	305	305	305	305	233
	1933–1934	41.8%	41.8%	41.8%	41.8%	41.8%	41.8%	31.9%
Average number of consecutive days discharging	All years	29	29	29	29	29	29	10
	1920–2010	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%
	Non-drought	12	12	12	12	12	12	1
	1986–1988	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	0.1%
	Drought	55	55	55	55	55	55	17
	1996–1998	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	1.5%
	Extreme drought	76	76	77	77	77	58	37
	1933–1934	10.5%	10.4%	10.5%	10.5%	10.5%	8.0%	5.1%

Colour scheme: green (lowest within a scenario) to red (highest within a scenario) per descriptor

5.4.1.2. Changes in flows in the River Thames

Based on the potential outputs from the reservoir operational model, a series of Flow Duration Curves (FDCs) has been produced for the Sutton Courtenay Gauge for all options across each time period. The potential deviation (increase or decrease) in flows is based on the exceedance probability[31]. The FDC's are illustrated in Technical Annex B1: EAR Figures, Figure 5.7 to Figure 5.10, and key flow statistics Table 5-4. Higher flows are Q_5, Q_{10} and Q_{25}, and low flows being Q_{70}, Q_{90} and Q_{95}. The HoF, as discussed above, is equivalent to Q_{50} (median) across the 'All years' record. These are discussed further below.

All years – 1920–2010

The FDC is illustrated in Technical Annex B1: EAR Figures, Figure 5.7. The FDC for 'All years' is a good average of flow conditions, considering the extreme driest and wettest years. As shown in Technical Annex B1: EAR Figures, Figure 5.7, flows are generally lower than the baseline during higher (less frequent) flow conditions, albeit by <5%. This is largely a result of more available flow within the Thames for abstraction, i.e. when flow is above HoF (approximately Q_{50}) and demand is low. Overall, there is little difference between the options.

The flows for all options converge with the baseline around Q_{50}, coinciding with the HoF threshold. After this the flow in the Thames is much greater than the baseline at low flow, varying with each option but broadly increasing with the size of the proposed reservoir. There is potentially up to a 45% increase at Q_{95} for option 1 and an 81% increase for option 4a. When flow is less than the HoF threshold, it can be assumed demand in the River Thames catchment is higher and is therefore supplemented by the reservoir(s) discharging. The bigger the reservoir option, the higher the rate and available volume of water to discharge, hence the larger deviation and increase in flows compared with the baseline.

For option 4b the increase in low flows is much starker, but then tails off significantly around Q_{90}, presumably as the reservoir empties.

Typical non-drought years – 1986–1988

The FDC is illustrated in Technical Annex B1: EAR Figures, Figure 5.8. Despite the pattern of flow during the typical non-drought years appearing visually similar, it is less defined compared with the 'All years' flow record above. This is almost certainly because the reservoir options are likely to be at capacity for long periods of time, and therefore unable to abstract flow from the Thames and flow continues downstream. Across this period downstream demand is also likely to be less overall.

There is likely to be little or no change in flows from the baseline for the very high flows (Q_5 and Q_{10}), and only minor reductions (<1%) at Q_{25} flows. There is however some decrease in flows at Q_{50}, between 6% and 9%, increasing with the reservoir option size. However, the Q_{50} across this period is slightly higher than the HoF threshold, at 1,680 M//d. HoF during this period is equivalent to Q_{52} to Q_{54}.

There is little or no change in flows at Q_{70} for all options, apart from option 4b with a 1.4% increase in flows. Flow increases are more pronounced at Q_{90}/Q_{95}, with flows increasing between 20% and 40% compared to the baseline. Interestingly, the deviation from the baseline increases for the smaller options (75 Mm^3, 100 Mm^3 and 122 Mm^3) between Q_{90} to Q_{95}, and yet reduces for the three larger options (125 Mm^3, 130 Mm^3, and 150 Mm^3), albeit the difference is nominal and all options are still much higher compared the baseline.

Low flows for option 4b are markedly higher compared the other options and, although it does decline, remains comparable with other options at the extreme low flows, e.g. Q_{99}.

Typical drought years – 1996–1998

The FDC is illustrated in Technical Annex B1: EAR Figures, Figure 5.9. The greatest deviation from the baseline (at both high and low flows) is observed during the typical drought period, compared to the other periods examined. At higher flows, this is likely because during a typical drought the reservoirs are rarely at capacity for all options (although unlikely to reach emergency water levels) and therefore have the capacity to abstract more often. This varies between 3% and 10% decreases at Q_5 and Q_{10}, and 8% and 13% at Q_{25} compared with the baseline. Again, the larger the reservoir the greater the deviation.

HoF is comparable to Q_{40} during this period. The Q_{50} is much lower (955 Ml/d) compared to the 'All years' record and the flows across the options are approximately 7% to 16% higher against the baseline at Q_{50}. This deviation (increase) from the baseline gets significantly larger as demand increases during low flows. The typical drought baseline Q_{95} value is comparable with the 'All years' baseline value, i.e. 332 Ml/d compared with

[31] Exceedance probability is the percentage of time a given flow is equalled or exceeded, e.g. Q_{95} exceeded 95% of the time.

334 Ml/d respectively. During this period the reservoir is unlikely to be close to or at emergency water levels, demand is more acute and the supplementary flows from the reservoir discharge have a much greater affect. This equates to an approximate increase of 50% for option 1 at Q_{95} and 96% for option 4a, much higher than across the 'All years' flow record.

Again, flows for option 4b are markedly higher compared to other options and they begins to decline around Q_{80} and return to the baseline around Q_{98}, presumably as the reservoir empties.

Extreme drought years – 1933–34

The FDC is illustrated in Technical Annex B1: EAR Figures, Figure 5.10. Visually there appears little deviation from the baseline for the very "high flows", i.e. above Q_{20}. However, there is some slight increase in flow by around 1% to 2% at Q_{10} (see Table 5-4). This is because the timing of these peak flows coincides with the period prior to the drought occurring, and the reservoir being at capacity and not abstracting as would be the case during other periods (see Technical Annex B1: EAR Figures, Figure 5.11).

The HoF is equivalent to Q_{23}/Q_{24} during this period and coincides with the deviation from the baseline being more pronounced at "higher flows", although these are of course much lower when compared with 'All years' record. These steadily continue to increase, peaking at Q_{89} with flows between 55% and 113% above baseline, again increasing with the size of the reservoir option. Although still higher than the baseline, the deviation then reduces at the very low flows, between 11% and 13% at Q_{95}. This pattern is representative of a massive demand for water and an increase in discharge from the reservoir options throughout almost 75% of the time. The fall off towards the end of the FDC is likely due to the reservoir being drawn down quicker compared to other periods, although it is still artificially higher than the baseline due to input from discharge overall.

During the extreme drought, option 4b is still much higher during lower flows than the other option, but declines much sooner, around Q_{60} and returns to the baseline at $Q_{80,}$ therefore it has a much-reduced benefit during low flows.

Table 5-4 – Exceedance probability per option All years and all options

Exc (Q)	Period	Flow (Ml/d) and % difference from baseline							
		Baseline	Option 1 75 Mm^3	Option 2 100 Mm^3	Option 6 122 Mm^3	Option 3 125 Mm^3	Option 5 130 Mm^3	Option 4a 150 Mm^3	Option 4b 150 Mm^3
95	All years	334	485	529	564	569	577	605	616
	1920–2010		45.4%	58.5%	69.2%	70.6%	73.0%	81.5%	84.5%
	Non-drought	451	569	594	606	608	608	611	633
	1986–1988		26.1%	31.7%	34.4%	34.7%	34.8%	35.4%	40.3%
	Drought	332	496	550	595	601	611	650	382
	1996–1998		49.6%	65.9%	79.3%	81.2%	84.3%	95.9%	15.2%
	Extreme drought	255	282	282	284	284	286	287	255
	1933–1934		10.9%	10.9%	11.6%	11.6%	12.1%	12.5%	0.0%
90	All years	400	544	584	617	621	628	658	767
	1920–2010		35.8%	45.9%	54.0%	55.2%	57.0%	64.5%	91.5%
	Non-drought	507	614	656	681	687	695	707	737
	1986–1988		21.1%	29.3%	34.3%	35.4%	37.0%	39.5%	45.3%
	Drought	357	521	575	619	625	635	673	657
	1996–1998		46.1%	61.1%	73.5%	75.0%	77.9%	88.4%	84.1%
	Extreme drought	262	382	389	410	417	417	441	262
	1933–1934		46.0%	48.5%	56.5%	59.1%	59.1%	68.5%	0.0%
70	All years	755	806	822	841	843	848	870	1,034
	1920–2010		6.8%	8.9%	11.4%	11.7%	12.3%	15.2%	36.9%
	Non-drought	894	894	894	894	894	894	906	1,043

Exc (Q)	Period	Flow (Ml/d) and % difference from baseline							
		Baseline	Option 1 75 Mm^3	Option 2 100 Mm^3	Option 6 122 Mm^3	Option 3 125 Mm^3	Option 5 130 Mm^3	Option 4a 150 Mm^3	Option 4b 150 Mm^3
	1986–1988		0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	16.7%
	Drought	596	718	752	781	786	792	827	967
	1996–1998		20.4%	26.0%	30.9%	31.8%	32.8%	38.6%	62.1%
	Extreme drought	355	503	554	598	604	614	649	527
	1933–1934		41.5%	55.9%	68.4%	70.1%	72.7%	82.5%	48.2%
50	All years	1465	1,450	1,450	1,450	1,450	1,450	1,450	1,450
	1920–2010		−1.0%	−1.0%	−1.0%	−1.0%	−1.0%	−1.0%	−1.0%
	Non-drought	1680	1,570	1,565	1,561	1,561	1,557	1,533	1,522
	1986–1988		−6.5%	−6.8%	−7.1%	−7.1%	−7.3%	−8.7%	−9.4%
	Drought	955	1,023	1,055	1,079	1,083	1,091	1,104	1,216
	1996–1998		7.1%	10.5%	13.0%	13.3%	14.2%	15.6%	27.3%
	Extreme drought	485	639	679	722	728	736	774	961
	1933–1934		31.7%	40.0%	48.8%	50.0%	51.7%	59.4%	98.1%
25	All years	3179	3,111	3,088	3,066	3,064	3,059	3,044	2,930
	1920–2010		−2.2%	−2.9%	−3.6%	−3.6%	−3.8%	−4.3%	−7.9%
	Non-drought	3141	3,134	3,122	3,115	3,115	3,115	3,113	3,103
	1986–1988		−0.2%	−0.6%	−0.8%	−0.8%	−0.8%	−0.9%	−1.2%
	Drought	2389	2,198	2,166	2,137	2,137	2,114	2,071	1,954
	1996–1998		−8.0%	−9.3%	−10.5%	−10.5%	−11.5%	−13.3%	−18.2%
	Extreme drought	1153	1227	1,263	1,305	1,309	1,318	1,358	1,377

Exc (Q)	Period	Flow (Ml/d) and % difference from baseline							
		Baseline	Option 1 75 Mm^3	Option 2 100 Mm^3	Option 6 122 Mm^3	Option 3 125 Mm^3	Option 5 130 Mm^3	Option 4a 150 Mm^3	Option 4b 150 Mm^3
	1933–1934		6.4%	9.5%	13.2%	13.6%	14.3%	17.8%	19.4%
10	All years	5929	5,840	5,803	5,776	5,773	5,768	5,741	5,607
	1920–2010		−1.5%	−2.1%	−2.6%	−2.6%	−2.7%	−3.2%	−5.4%
	Non-drought	5444	5,444	5,444	5,444	5,444	5,444	5,444	5,339
	1986–1988		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	−1.9%
	Drought	4139	3,989	3,865	3,725	3,725	3,725	3,692	3,451
	1996–1998		−3.6%	−6.6%	−10.0%	−10.0%	−10.0%	−10.8%	−16.6%
	Extreme drought	3767	3,840	3,809	3,809	3,809	3,809	3,847	3,847
	1933–1934		2.0%	1.1%	1.1%	1.1%	1.1%	2.1%	2.1%
5	All years	8130	8,092	8,051	8,017	8,013	8,004	7,997	7,872
	1920–2010		−0.5%	−1.0%	−1.4%	−1.4%	−1.6%	−1.6%	−3.2%
	Non-drought	7389	7,389	7,389	7,389	7,389	7,389	7,389	7,102
	1986–1988		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	−3.9%
	Drought	5887	5,711	5,519	5,388	5,388	5,388	5,317	4,995
	1996–1998		−3.0%	−6.3%	−8.5%	−8.5%	−8.5%	−9.7%	−15.1%
	Extreme drought	5516	5,408	5,433	5,381	5,381	5,381	5,381	5,381
	1933–1934		−1.9%	−1.5%	−2.5%	−2.5%	−2.5%	−2.5%	−2.5%

Colour Scheme: Green (low <0) to red (high >0)
N.B. The above assessment shows the full impact of the phased options (i.e. 80+42 and 30+100) and not the two phases separately

5.4.2. Flow changes – River Ock catchment

As described in Section 5.3.2, the proposed reservoir – regardless of the chosen option – would be situated within the River Ock catchment, which flows into the River Thames at Abingdon.

Mott MacDonald's flood modelling had broadly determined the reservoir scheme would likely not affect the workings of the upper catchment areas. This is largely due to the assumption that all incoming channels which are cut off as a result of the construction of the reservoir would be diverted around the reservoir to the east and west (see Section 4.4.2 in the Geomorphology chapter). However, a more detailed analysis of the impact(s) of these realignments on the affected watercourses, as well as the receiving watercourses, will be required at Gate 2 to understand the changes in flow within each river section. This includes three associated water body catchments:

- Cow Common Brook and Portobello Ditch – *c.*40 km of lost watercourse and realignment around the reservoir;
- Childrey Brook and Norbook at Common Barn – *c.*4 km lost watercourse and requirement for increased capacity to carry diverted watercourses, e.g. Hanney Ditch which would potentially carry more flows from Cow Common Brook and Portobello Ditch; and,
- Ock and tributaries (Land Brook confluence to Thames) – to investigate any changes to flow within the River Ock catchment.

The only existing gauge is downstream on the River Ock and immediately prior to its confluence with the River Thames (39081[32], see Technical Annex B1: EAR Figures, Figure 5.5). The River Ock at this point accounts for approximately 5% to 8% of the flow to the Thames as measured at the gauge at Sutton Courtenay, see Table 5-5.

Table 5-5 – Selected flow statistics for the River Ock at Abingdon and River Thames at Sutton Courtenay (without Scheme)

Exc (Q)	Gauged flows on River Thames – Without Scheme (Ml/d)	Gauged flows on River Ock – Without Scheme (Ml/d)	River Ock % flow contribution to River Thames
95	334	27	8.2%
90	400	33	8.3%
70	755	48	6.3%
50	1,465	76	5.2%
25	3,179	159	5.0%
10	5,929	304	5.1%
5	8,130	452	5.6%

Further work will be required to understand the baseline flows in each affected watercourse, their relative contribution to the overall River Ock flows and how these will change with the proposed scheme. It is proposed that this is through a semi-quantitative conceptual model, allowing the description of changes in flow at different centiles at key nodes within the River Ock catchment.

5.4.3. Flow changes – River Thames downstream of River Thame

As set out in Section 1.2.3, the assessment of the benefits and impacts of SESRO releases includes the fluvial River Thames down to Teddington Weir. As set out in Table 5-1, the SESRO discharge volume is dependent on the size of each SESRO option. The volume of water released by SESRO will be re-abstracted by one or more existing or new intakes and the size of SESRO effectively sets the 'cap' for the amount of re-abstraction which can occur by one or more intakes.

Table 5-6 below sets out the key existing and proposed (new) public water supply intakes along the fluvial River Thames which are being considered as part of the T2ST, T2AT and London Reuse SROs. Further work is needed as part of Gate 2 to set out the hydrological linkages between SESRO and different intakes described below.

[32] NRFA Station Mean Flow Data for 39081 - Ock at Abingdon (ceh.ac.uk)

Table 5-6 – Key existing and proposed (new) public water supply intakes from the fluvial River Thames from upstream to downstream

Existing or proposed (new) intake	Company	Intake name	Approx. grid reference for existing intakes	Licence reference for existing intakes	Licenced volume for existing intakes	Proposed change in volume (Gate 1)	SRO/scheme
New	Southern Water	Between Pangbourne and Reading	N/A	N/A	N/A	Proposed volume is 50, 80 or 120 Ml/d	T2ST
New	Affinity Water	'Maidenhead' Option (Between Hambleden Lock and Bray Lock)	N/A	N/A	N/A	Proposed volume is either 50 Ml/d or 100 Ml/d	T2AT
Existing	Thames Water	Datchet	[redacted]	28/39/M/2	Set across all six intakes on licence 28/39/M/2: 5,455 Ml/day, 663570 Ml/year	None	None, no change proposed
Existing	Affinity Water	Sunnymeads (Iver)	[redacted]	28/39/27/64	227.3 Ml/day (max daily, annual average)	Proposed volume is either 50 Ml/d or 100 Ml/d	T2AT
Existing	Thames Water	Hythe End/Staines/ Wraysbury	[redacted]	28/39/M/2	See Datchet	None	None, no change proposed
Existing	Thames Water	Laleham	[redacted]	28/39/M/2	See Datchet	None	None, no change proposed
Existing	Affinity Water	Chertsey	[redacted]	28/39/M/6	55 Ml/d (max daily) 36.44 Ml/d (annual average)	Proposed volume is either 50 Ml/d or 100 Ml/d	T2AT
Existing	Affinity Water	Egham	[redacted]	28/39/M/6	182 Ml/d (max daily) 146.03 Ml/d (annual average)	Proposed volume is either 50 Ml/d or 100 Ml/d	T2AT
Existing	Affinity Water	Desborough/Walton	[redacted]	28/39/M/6	55 Ml/d (max daily) 45 Ml/d (annual average)	Proposed volume is either 50 Ml/d or 100 Ml/d	T2AT

Existing	Thames Water	Walton*	[redacted]	28/39/M/2	See Datchet	Proposed volume 50, 100, 150, 200 Ml/d	London Reuse
Existing	Thames Water	Hampton (to the River Lee system via Thames-Lee-Tunnel)*	[redacted]	28/39/M/2	See Datchet		London Reuse
Existing	Thames Water	Surbiton*	[redacted]	28/39/M/2	See Datchet		London Reuse
New	Thames Water	Teddington*	N/A	N/A	N/A	Proposed volume is 50, 75 or 150 Ml/d (London Reuse); or 50 or 100 Ml/d (T2AT)	T2AT London Reuse

*It is our understanding that the London Reuse SRO is considering an additional discharge from Mogden Sewage Treatment Works (STW) around Walton-on-Thames which may provide additional flow to the lowermost River Thames intakes. The maximum discharge volume considered is 200 Ml/day.

We propose that the Gate 2 work involves a conceptual model of the River Thames, using the same approach as previously completed as part of the AMP5 Lower Thames Operating Agreement (LTOA) hydrological work and AMP6 Lower Lee flow investigation. This would involve showing the River Thames as a line running from upstream to downstream (e.g. from left to right), clearly highlighting the distance from SESRO where:

- Measured flow data are available (using gauged datasets);
- There are flow contributions from key tributaries that join the River Thames such as the River Thame, River Kennet, River Wye, River Wey, River Mole, etc.;
- There are flow contributions from existing large discharges such as STW; and
- There are reductions in flow as a result of existing intake discharges (using recent actual data).

The conceptual model will be displayed at different flow centiles such as Q_{90}, Q_{50} and Q_{10}. In turn, this will provide a baseline to highlight changes to river flows in key reaches as a result of the different scheme options. The conceptual model work will also form an important part of the Gate 2 hydrodynamic model proposed for the fluvial River Thames (see Section 6.6). It is noted that the conceptual work will need to take account of any projected losses along the River Thames, which is currently being investigated as part of a different work package.

5.5. Conclusions

Abstraction is primarily determined by the SESRO HoF threshold, 1,450 Ml/day at Sutton Courtenay, which is approximately Q_{50} across the 'all years' record. However, during other acute periods of time this varies and therefore the amount of time the reservoir can abstract also varies. For instance, in typical non-drought years the HoF threshold is met more frequently, albeit only slightly, and therefore abstraction can occur more often. However, abstraction is also influenced by reservoir capacity, i.e. how often the reservoir options are at capacity. The abstraction rate is a constant, therefore reservoir(s) fill up quicker in non-drought periods; even more so in smaller reservoir options. So, the abundant amounts of water available are offset by the capacity of the reservoir and this results in a reduced impact on higher flows.

In typical drought years, whilst the HoF threshold is met less frequently, the reservoir options are also at capacity less often and therefore the capacity for abstraction increases. Consequently, this has a bigger impact on higher flows than during the non-drought years.

During extreme droughts, the HoF is met even less frequently and the abstraction is hindered by availability. In fact, abstraction rarely occurs during this period.

Discharge is determined by the downstream demand and again by reservoir capacity, i.e. availability of supply. Unlike the abstraction rate, the discharge rate varies with the option; i.e. smaller reservoirs discharge at a lower rate than the larger reservoir options. A stepped increase in the discharge has been included as a key mitigation measure to avoid a sudden change in flows. The biggest change in flows as a result of the discharge (which can be positive or negative) is, like abstraction, experienced during typical drought periods, where abstraction can still occur to top up the reservoir(s), but the demand is still high requiring more frequent discharge. Clearly the increase in flows compared against the baseline is higher for the bigger reservoirs due to higher discharge rate. During the typical non-drought period demand is lower which reduces the impact, whereas during an extreme drought the supply is spent due to high demand.

Option 4b assessed is the largest reservoir option (along with option 4a) with the maximum permissible (technically feasible) discharge of 600 Ml/d. Broadly, access to larger discharges has a benefit to meet rapid changes in demand, but this is more likely to be a short-term or temporary measure and unlikely to be a sustainable discharge to reduce risk to reservoir storage. Nevertheless, depending on timing, such increased flows could have a marked impact on more sensitive ecology features such as larval/juvenile fish, phytoplankton[33] and zooplankton, and may require an extended ramp-up flow period increase flows incrementally (over two or more flow stages).

The impacts on the River Ock catchment are less clear at this stage. It is acknowledged that there will be a loss of catchment area and a need to realign and consolidate flows from multiple channels from the construction of the reservoir. Further work is needed at Gate 2 to assess the hydrological impact on these watercourses and it

[33] Plants or animals are considered 'plankton' if they are not able to swim independent of prevailing currents. There are a number of different types of plankton groups: Phytoplankton includes plant/algal groups; zooplankton includes animal groups like small crustaceans whilst ichthyoplankton refers to larval fish stages where some species are planktonic for a very short time.

is proposed that this is not through a formal hydrodynamic model, but that this is derived through a semi-quantitative conceptual model.

Further work is also needed to determine the effect on hydrology on the main River Thames around each of the current and proposed intakes.

5.6. Assessment framework towards Gate 2

There is further work to be undertaken at Gate 2, which should include:

- Further clarification/review of the input data that is being used to run the model (especially for datasets derived from modelling) to ensure all datasets are accurate (within reason) and consider using actual gauged data to ground truth and extend the input data to cover more recent periods of flow from 2010 as well as further downstream (using the 1D hydrodynamic model);
- The potential impacts from climate change should also be discussed at Gate 2 to consider the extent of impact and how this is best captured as part of the model;
- Alignment of the hydrological conceptual model and subsequent assessments with any cross-SRO WRSE water resources model outputs to allow 'like-for-like' simulation of the proposed system;
- Further assessment of the impact of the maximum permissible discharge (600 Ml/d) and investigation of the potential for additional ramp-up flow stages;
- Further detailed hydrological modelling to account for more reservoir storage losses, such as evapotranspiration, transfer losses and sweetening flows;
- Further work on River Thames losses;
- Further detailed assessment of the hydrological impacts on the Lower Thames and on the River Thame downstream of the abstraction/discharge point, both through a semi-quantitative conceptual model and a 1D hydrodynamic water quality model (see Section 6.6); and,
- More detailed assessment of the hydrological impacts River Ock catchments, including assessing the baseline flow conditions and changes in the timing of peak flows for the affected catchments through a conceptual model and consideration of flow gauging of any channels without flow information.

6. Water Quality

6.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO, including and changes to water quality in the River Ock downstream of SESRO; and the River Thames downstream of the proposed discharge point near Culham.

This section does not contain risks to drinking water safety, which are included in Technical Annex C.

6.2. Datasets reviewed

Thames Water and Environment Agency data were collated for the River Thames, from Farmoor Reservoir to Teddington, and for the River Ock to determine baseline water quality conditions.

A list of previous documents and datasets that have been reviewed as part of this study includes:

- Thames Water WRMP19 Resource Options: Abingdon Reservoir Conceptual Design Report (2018);
- SESRO_Reservoir and River Modelling Review. Rev1.0. Doc. No. 5201137.001. (Atkins, 2020);
- Cascade and HR Wallingford (2016) Thames Water Utilities Ltd Severn Thames Transfer: Water Quality and Ecology Assessment – Phase 2 Main Project Report. Version 2.1;
- Cascade (2008) Upper Thames Reservoir Assessment CFD Modelling Report, Version 0.2;
- Cascade and APEM (2005) Upper Thames major resource development: eutrophication & algal development control;
- Cascade (2005) Water quality strategy: Water quality technical working group;
- Cascade (2007a) Phytoplankton baseline report 2007–06;
- Cascade (2007b) Water quality modelling evaluation;
- Various E2 Rp Water Quality Trends P1 (Cascade Consulting, 2005);
- WFD chemical status for the 2015 and 2019 cycles including break down of Ammonia, DO, Phosphate and BOD; and,
- Environment Agency Water Quality Data Archive Available at: Open WIMS data for the period between 2010 and 2021.

6.3. Gate 1 proportional assessment methodology

6.3.1. Reservoir

This section sets out the baseline conditions for reservoir and river water quality ahead of more detailed hydrodynamic water quality modelling proposed for the reservoir and River Thames as part of Gate 2.

An independent review of reservoir water quality modelling previously undertaken for this scheme was completed in 2020[34]. With no changes to the proposed reservoir design, no further assessment of potential changes to reservoir water quality has been undertaken as part of Gate 1. As such, the work also determined if mitigation measures specified in the 2018 CDR remain valid or require updating.

The Gate 1 work has presented the main findings of an independent reservoir modelling paper undertaken by Atkins as part of a standalone technical note shared with the Environment Agency on 18/12/2020. Comments were received on 09/02/2021 and a workshop with national modelling specialists was held on 18/02/2021. During the workshop, it was agreed that future hydrodynamic reservoir modelling should focus on the use of 3D models; and that Atkins' recommendation for use of a Phytoplankton RespOnses To Environmental CHange (PROTECH) model for algae was appropriate.

6.3.2. River Ock and River Thames

As part of our approach, Atkins has summarised the previous river water quality modelling work, as well as Water Framework Directive (WFD) status and Environment Agency monitoring data to identify any potential changes to water quality since that work was undertaken.

[34] Atkins (2020) SESRO Reservoir and River Modelling Review (Task 3 & 6). Technical Note. Issued 17 December 2020.

As part of the baseline reporting, we outlined the WFD Chemical status for the 2015 River Basin Management Plan 2 (RBMP2) as well as the interim Chemical status for 2019. The 2019 status was included for water quality because new determinands were introduced for a large proportion of the catchments, resulting in changes to the Chemical Status. The results of this review have been presented in Technical Annex B1, Appendix A6.1.

In addition, Gate 1 work has included running a SAGIS-SIMCAT model for the River Ock and River Thames. Representation of the operation of SESRO was incorporated into the existing Environment Agency SAGIS-SIMCAT model and model runs were undertaken to compare water quality with and without SESRO for a range of nutrients, sanitary chemicals, metals and organic chemicals to assess risks to WFD compliance and drinking water (further detailed information on this work is provided in Appendix A6). The aim of this work was to provide an initial assessment of water quality impacts of abstraction and releases of water from the reservoir on the River Ock at Abingdon, the River Thames at Culham and the River Thames at Datchet. The results of the SIMCAT modelling has been presented in Technical Annex B1, Appendix A6.2.

Findings of the River Thames model review report and proposed approach for Gate 1 SIMCAT work were sent to the Environment Agency on 18/12/2020 and comments were received on 09/02/2021. A workshop with national modelling specialists was held on 18/02/2021. During the workshop, it was agreed that Atkins' proposed approach to a single 1D hydrodynamic model covering multiple SROs along the whole fluvial Thames between Lechlade-on-Thames and Teddington was the right approach; and that the SIMCAT work for Gate 1 was also fine to proceed.

6.4. Outputs/findings

6.4.1. Construction

6.4.1.1. Reservoir

There expected to be no water quality impacts on the reservoir during the construction phase as no water is expected to be stored in the reservoir until construction is completed. Potential construction impacts to the watercourses within the reservoir footprint are presented below.

6.4.1.2. River

Construction works have been highlighted as having the potential to impact reaches 1 to 3, as noted in Section 1.3, Table 1-1. The baseline data for these reaches have been gathered and presented below in Table 6-1.

In the 2015 WFD classification, all river water bodies achieved Good Chemical status. However, in the 2019 interim classification, all waterbodies considered were classified as failing with regards to the WFD Chemical status. This was because of polybrominated diphenyl ether (PBDE) and mercury concentrations failing to meet the required standards at all water bodies considered. Additionally, there was failure to meet the required standards at *Ginge Brook and Mill Brook* and *Ock and tributaries (Land Brook confluence to Thames)* due to perfluoro-octane sulphonate (PFOS) levels and *Childrey Brook and Norbrook at Common Barn* due to cypermethrin (a priority hazardous substance) levels.

DO levels were classified as High in 2015 and 2019 for three water bodies: *Childrey Brook and Norbrook at Common Barn*, *Sandford Brook (source to Ock)* and *Ginge Brook and Mill Brook. Ock and tributaries (Land Brook confluence to Thames)* achieved Good status for DO, whereas *Cow Common Brook and Portobello Ditch* achieved Bad status for both 2015 and 2109.

Reactive phosphorus did not attain Good status in any of the water bodies in 2015 or 2019 except for *Sandford Brook (source to Ock)* which achieved High. The WFD status with regards to total ammonia was classified as High in all water bodies for both 2015 and 2019. BOD was not assessed for any of these water bodies in 2015 or 2019.

There is a risk of reduced water quality in waterbodies as a result of construction work. The following mitigation measures have been identified to reduce this risk or mitigate effects:

- Provision for the development of a surface water management plan for the construction work, including management of water which would enter the construction site from upstream; management of rainfall which would fall within the (reservoir) excavation site; and any dewatering. This has, so far, included consideration of the timing of watercourse diversions (which would be required prior to starting excavation work); and the provision of temporary settlement ponds to the north-east corner of the site which would form part of the site's overall surface water management plant.
- The plan will make sufficient allowance to allow (peak) flows to be attenuated whilst testing of water quality would be required before release back into the River Thames / River Ock.

- Further mitigation through implementing standard good practice for construction, for example:
- Appropriately manage the potential for deposition of silt or release of other forms of suspended material or pollution within the water column, e.g. through adherence to Guidance for Pollution Prevention (GPP), Pollution Prevention Guidance (PPG) and CIRIA guidance documents in relation to work in or near water, e.g. GPP1, GPP5, GPP21, PPG3, PPG5, PPG6 and CIRIA C648.
- A dividing bund around the perimeter of the earthworks footprint can be incorporated into the construction methodology.
- Measures can be taken to protect any temporary exposure of bare soil from runoff during heavy rainfall events.
- All vehicles and any chemical / oil storage to be fully bunded to prevent any accidental pollution of groundwater or watercourses and any storage/refuelling to be undertaken away from watercourses.

The mitigation measures will be set out in applications for Environmental Permits, which are required for any river construction works and any discharges to controlled waters.

Table 6-1 – Water quality construction impacts

Reach	WFD Water body	Baseline description		Potential impact pathway	Gate 1 proportional initial assessment findings
		WFD classification (2015)	Interim status (2019)		
1	*Cow Common Brook and Portobello Ditch*	Good Chemical Status	Chemical 'Fail' (PBDE and Mercury and Its Compounds)	Temporary works may increase sediment loads, pollutant spills and polluted runoff which could be carried downstream	A Construction Environment Management Plan (CEMP) should be undertaken to prevent impacts form sediment and chemical pollution from construction activities. Many of these measures are likely to be associated with good site practice and the preparation of robust method statements (e.g. Pollution Prevention and Incident Control Plan Pollution Prevention Guidelines (PPGs) (Environment Agency, 2013[35]).
		DO 'Bad'	DO 'Bad'		
		Phosphate 'Poor'	Phosphate 'Poor'		
		Ammonia 'High'	Ammonia 'High'		
		BOD N/A*	BOD N/A		
	Childrey Brook and Norbrook at Common Barn	Good Chemical Status	Chemical 'Fail' (PBDE, Cypermethrin and Mercury and Its Compounds)	Temporary works may increase sediment loads, pollutant spills and polluted runoff which could be carried downstream	
		DO 'High'	DO 'High'		
		Phosphate 'Poor'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High'		
		BOD N/A	BOD N/A		
2	*Ock and tributaries (Land Brook confluence to Thames)*	Good Chemical Status	Chemical 'Fail' (PBDE, PFOS and Mercury and Its Compounds)	Potential increase in sediment loads, pollutant spills and polluted runoff during construction may reduce water	A Construction Environment Management Plan (CEMP) should be undertaken to prevent impacts form sediment and chemical pollution from construction activities. Many of these measures are likely to be associated with good
		DO 'Good'	DO 'Good'		

[35] Pollution Prevention Guidelines (PPGs) with particular reference to PPG1 (general guide to the prevention of water pollution), PPG3 (use and design of oil separators in surface water drainage systems), PPG5 (works near or liable to affect watercourses) and PPG6 (working at construction and demolition sites). The PPGs contain a mix of regulatory requirements and good practice advice. They have been withdrawn by the Environment Agency but are still considered good practice advice to avoid pollution of watercourses. All of the PPGs are available from http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx

Reach	WFD Water body	Baseline description		Potential impact pathway	Gate 1 proportional initial assessment findings
		WFD classification (2015)	Interim status (2019)		
		Phosphate 'Poor'	Phosphate 'Poor'	quality in these downstream watercourses.	site practice and the preparation of robust method statements (e.g. Pollution Prevention and Incident Control Plan Pollution Prevention Guidelines (PPGs) (Environment Agency, 2013).
		Ammonia 'High'	Ammonia 'High'		
		BOD N/A	BOD N/A		
	Sandford Brook (source to Ock)	Good Chemical Status	Chemical 'Fail' (PBDE, Mercury and its compounds)	The proposed new access road crossing the Sandford Brook watercourse may cause deterioration to water quality due to increased volumes of road runoff and pollution.	A Construction Environment Management Plan (CEMP) should be undertaken to prevent impacts form sediment and chemical pollution from construction activities. Many of these measures are likely to be associated with good site practice and the preparation of robust method statements (e.g. Pollution Prevention and Incident Control Plan Pollution Prevention Guidelines (PPGs) (Environment Agency, 2013).
		DO 'High'	DO 'High'		
		Phosphate 'High'	Phosphate 'High'		
		Ammonia 'High	Ammonia 'High'		
		BOD N/A	BOD N/A		
3	*Ginge Brook and Mill Brook*	Good Chemical Status	Chemical 'Fail' (PBDE, PFOS and Mercury and its compounds)	No impacts expected on the assumption that no hydrological connectivity or lost watercourse.	A Construction Environment Management Plan (CEMP) should be undertaken to prevent impacts form sediment and chemical pollution from construction activities. Many of these measures are likely to be associated with good site practice and the preparation of robust method statements (e.g. Pollution Prevention and Incident Control Plan Pollution Prevention Guidelines (PPGs) (Environment Agency, 2013).
		DO 'High'	DO 'High'		
		Phosphate 'Moderate'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High''		
		BOD N/A	BOD N/A		

* BOD was not assessed at part of the 2019 interim classification and was only considered within the Thames water bodies in the 2015 cycle.

6.4.2. Operation

6.4.2.1. Reservoir

A review of the reservoir modelling carried out during the period 2005–2010 for Thames Water was undertaken to inform further Gate 2 modelling requirements. The previous reservoir modelling work included the development of hydrodynamic model using SULIS and a phytoplankton model (PROTECH). The former assessed reservoir mixing and requirements for artificial aeration to reduce stratification and the latter provided an estimate of likely algal biomass and speciation in the reservoir.

Whilst the overall modelling strategy developed in the previous work is still relevant and useful, this will need to be updated to include revised modelling components such as a more up to date hydrodynamic reservoir (the Environment Agency have recommended a 3D modelling approach) and algal modelling systems.

Key studies (Cascade, 2008) identified the potential water quality issues in the proposed reservoir as a risk. The previous modelling work described in this report identified that there was a risk of very high phytoplankton populations in the new reservoir and this issue was one of primary concern in relation of water quality in the reservoir and impacts downstream, particularly in relation to drinking water.

In addition, the previous work demonstrated that additional mitigation should be considered to ensure no deterioration to downstream water bodies. This included “engineered” algal control options as follows:

- Artificial mixing;
- Intermittent artificial mixing;
- Microfiltration & Surface Skimmers;
- Draw-off Control (Variable Draw-off); and,
- Sonication.

Further potential impacts during operation are expected to be the same as those presented as part of the 2018 CDR, therefore, the proposed mitigation measures listed below are expected to still be appropriate:

- Water stored in and released from the reservoir will be subject to regular testing to avoid releasing poor quality water back to the river;
- Drainage water from the operational site will be subject to treatment as required to avoid pollution of watercourses (e.g. from visitor centre, equestrian centre, car park/road drainage);
- Discharge from the reservoir to the River Thames to regulate river flows will be subject to a discharge permit granted by the Environment Agency;
- Watercourse diversions are to be designed using a ‘naturalised’ form to enhance water quality;
- An overflow from the site could potentially be connected to the Reservoir Auxiliary Drawdown channel. Water from the treatment works could also be released via this overflow back to the river provided it has not been chlorinated; and,
- Emergency shutdown valves should be included in the plant in order to stop operation.

In addition, initial SAGIS-SIMCAT modelling provides initial outputs on reservoir quality for a range of nutrients, metals and organic chemicals (further information is provided in Technical Annex B1, Appendix A6).

6.4.2.2. River Thames

The SESRO design was based on the abstraction of water from the River Thames at Culham during periods of high flow (when the reservoir is not already full). This water would then be released back into the River Thames at Culham so that it would be available for abstraction downstream. The release of reservoir water during times of low river flow results in the potential for water quality impacts on downstream water bodies and abstractions during these low flow periods.

Previous water quality assessments have been undertaken to determine the impacts of the proposed reservoir on the downstream water bodies. The Atkins (2020) Reservoir and River modelling review has summarised the findings of the Cascade reports (2007a, 2007b, 2005) looking into eutrophication and algal development control, Phytoplankton baseline, Water quality strategy and water quality modelling evaluation. The findings of the Atkins (2020) review are presented below.

A specialist algal model was used in conjunction with a River Thames ISIS model to understand water quality impacts from the proposed reservoir. The key findings of the modelling are outlined below:

During calibration, using 2003 and 2004 observed data, the quality of outputs was good for some determinands but had significant limitations for key water quality parameters; including regulatory determinands of BOD and ammonia.

Algal modelling determined that there may be differences in algal biomass between the reservoir and the River Thames, however, this is unlikely to cause significant impacts due to limiting factors such as day length and solar radiation. Additional work will be required to understand any changes to temperature, nutrient availability and/or changes to velocities.

Baseline information for the reaches which are expected to have potential operational impacts (as highlighted in Section 1.3, Table 1-1) are presented below. The baseline data have been gathered and is presented below in Table 6-2.

In the 2015 WFD classification, *Thames (Evenlode to Thame)* is the only water body (of those considered in this report) to not achieve Good Chemical status. This changes in the 2019 interim classification due to the addition of determinands, which meant that all water bodies failed to meet the required Chemical status standards (with PBDE and PFOS causing failure in all cases).

Four of the Thames water bodies achieved High status for DO in the 2019 classifications: *Leach to Evenlode, Evenlode to Thame, Wallingford to Caversham and Cookham to Egham*. The remaining water bodies achieve Good status in 2019. Two of the water bodies see a change in DO classification between 2015 and 2019; the *Thames (Leach to Evenlode)* moves from Moderate to High and the *Thames (Egham to Teddington)* water body moves from High to Good, with the remaining having the same status in 2015 as in 2019.

Phosphate classifications remain unchanged between the 2015 and 2019 classifications and are Moderate in all water bodies other than the *Ock and Tributaries (Land Brook confluence to Thames),* where concentrations are classified as Poor (2015 and 2019).

Ammonia concentrations are consistently classified as corresponding to High status in all water bodies in 2015 and 2019.

BOD was not assessed at part of the 2019 interim classification. However, BOD was monitored in the Thames water bodies in 2015 and is classified as corresponding to High status in all water bodies where monitored except for the *Thames (Reading to Cookham)* water body, where it achieves Moderate status and *Thames (Egham to Teddington)* water body where it achieves Good status.

Considering the current baseline, potential impacts during operation are expected to be the same as those presented as part of the 2018 CDR, however, the Atkins River and Reservoir Modelling Review undertaken in 2020 demonstrated that additional mitigation should be considered to ensure no deterioration to downstream water bodies (see Section 6.4.2.1).

Table 6-2 – Water quality operational impacts

Reach	WFD Water body	Baseline description		Potential impact pathway	Gate 1 proportional initial assessment findings
		WFD classification (2015)	Interim status (2019)		
5	*Thames (Evenlode to Thame)*	Chemical 'Fail' (Tributyltin Compounds)	Chemical 'Fail' (PBDE, PFOS and Mercury and Its Compounds)	Poor reservoir water quality has the potential to impact the WFD status of DO (High) and Ammonia (High). Increased runoff and pollution from impermeable infrastructure not only has the potential to deteriorate these determinands but chemical status more generally.	SIMCAT modelling outputs indicate that a slight reduction in concentration of WFD chemicals will occur but insufficient to change status.
		DO 'High'	DO 'High'		
		Phosphate 'Moderate'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High'		
		BOD 'High'	BOD N/A		
6–8	*Thames Wallingford to Caversham*	Good Chemical Status	Chemical 'Fail' (Cypermethrin, PBDE, PFOS, Benzo(b)fluoranthene and Benzo(g-h-i)perylene)	Poorer reservoir water may change water quality in this reach, specifically in context of WFD status for DO (High) and Ammonia (High). At this stage, the relative influence of the discharge on water quality is expected to decrease with an increasing distance away from the SESRO discharge location.	SIMCAT modelling outputs indicate that a slight reduction in concentration of WFD chemicals will occur but insufficient to change status.
		DO 'High'	DO 'High'		
		Phosphate 'Moderate'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High'		
		BOD 'High'	BOD N/A		
	Thames (Reading to Cookham)	Good Chemical Status	Chemical 'Fail' (Cypermethrin (Priority hazardous), PBDE, PFOS,	Poorer reservoir water may change water quality in this reach, specifically in context of	SIMCAT modelling outputs indicate that a slight reduction in concentration of WFD chemicals will

Reach	WFD Water body	Baseline description		Potential impact pathway	Gate 1 proportional initial assessment findings
		WFD classification (2015)	Interim status (2019)		
			Benzo(b)fluoranthene and Benzo(g-h-i)perylene)	WFD status for DO (Good) and Ammonia (High). At this stage, the relative influence of the discharge on water quality is expected to decrease with an increasing distance away from the SESRO discharge location.	occur but insufficient to change status.
		DO 'Good'	DO 'Good'		
		Phosphate 'Moderate'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High'		
		BOD 'Moderate'	BOD N/A		
	Thames (Cookham to Egham)	Good Chemical Status	Chemical 'Fail' (PBDE and PFOS)	Poorer reservoir water may change water quality in this reach, specifically in context of WFD status for DO (High) and Ammonia (High). At this stage, the relative influence of the discharge on water quality is expected to decrease with an increasing distance away from the SESRO discharge location.	SIMCAT modelling outputs indicate that a slight reduction in concentration of WFD chemicals will occur but insufficient to change status.
		DO 'High'	DO 'High'		
		Phosphate 'Moderate'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High'		
		BOD 'High'	BOD N/A		
		DO 'High'	DO 'Good'		
		Phosphate 'Moderate'	Phosphate 'Moderate'		
		Ammonia 'High'	Ammonia 'High'		
		BOD 'Good'	BOD N/A		

Reach	WFD Water body	Baseline description		Potential impact pathway	Gate 1 proportional initial assessment findings
		WFD classification (2015)	Interim status (2019)		
9	*Thames (Egham to Teddington)*	Good Chemical Status	Chemical 'Fail' (Cypermethrin, PBDE, PFOS and Tributyltin Compounds)	Poorer reservoir water may change water quality in this reach, specifically in context of WFD status for DO (Good) and Ammonia (High). The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	SIMCAT modelling outputs indicate that a slight reduction in concentration of WFD chemicals will occur but insufficient to change status.
10		DO 'High'	DO 'Good'		
11		Phosphate 'Moderate'	Phosphate 'Moderate'		
12		Ammonia 'High'	Ammonia 'High'		
13		BOD 'Good'	BOD N/A		

* BOD was not assessed at part of the 2019 interim classification and was only considered within the Thames water bodies in the 2015 cycle

Environment Agency water quality sampling data were obtained and presented for five representative sites within the study reach (see Technical Annex B1: EAR Figures, Figure 6.1). Data for DO (% Saturation), total ammonia (as ammoniacal nitrogen as N), orthophosphate (reactive as P)[36] and BOD (ATU) have been presented in Technical Annex B1, Appendix 6.1. The WFD status classification thresholds[37] for each site and determinand are also presented on the plots and referred to below as benchmark to facilitate the interpretation of the data and the implications of potential changes in water quality.

DO% saturation

Overall DO% levels remained largely above the High status threshold at all of the selected sites. The three sites in the middle section of the reach (*Thames at Clifton Hampden Bridge, Thames at Days Lock and Thames at Windsor Leisure Centre*) had the least variable DO% results, with some outliers in 2015 (c. 140% saturation). *Thames at Donnington Bridge, Oxford* showed slightly more variable DO% levels than the three aforementioned sites, with two samples (2012 and 2019) dropping below the WFD classification of High (70%). The most downstream site (*Thames at Teddington Weir*) had the most variation with three results dropping below the WFD High status classification threshold.

Total ammonia

Overall ammoniacal nitrogen levels remained largely above the High status threshold at all of the selected sites. The most upstream sampling site (*Thames at Donnington Bridge, Oxford*) showed the least variation in ammoniacal nitrogen levels with only two results higher than 0.05 mgN/l since 2010. Both *Thames at Days Lock* and *Thames at Windsor Leisure Centre* had consistent ammoniacal nitrogen results below 0.15 mgN/l. Results at *Thames at Clifton Hampden bridge* varied slightly more with three samples in 2011 and 2012 recording levels above 0.15 mgN/l. The most downstream sampling site (*Thames at Teddington Weir*) had the greatest variation in ammonia concentrations with two results higher than 0.03 mgN/l (threshold for High WFD status (2015)) since 2010. These results overall suggest that ammonia levels increased in variability as we move downstream this system.

Orthophosphate

There was a similar amount of orthophosphate variability between the five sites. Most samples in all the Thames WFD water bodies reported orthophosphate concentrations corresponding below Good status. The most upstream site (*Thames at Donnington Bridge, Oxford*) had the largest proportions (23%) of samples having a concentration corresponding to achieving above Good status. The most downstream site (*Thames at Teddington Weir*) had the smallest proportion of samples (4%) having a concentration corresponding to achieving above Good status.

BOD

BOD data were collected up to 2008 only at all sites and they largely remained above the High status threshold at all selected sites. The three upstream sites (*Thames at Donnington Bridge, Oxford, Thames at Clifton Hampden Bridge and Thames at Days Lock*) all had very few sampling results corresponding to below Good status (1, 2 and 1 respectively). The months of April and May of 2003 and June and July 2009 consistently gave higher levels of BOD at these locations. The two downstream locations *Thames at Windsor Leisure Centre* and *Thames at Teddington Weir* had slightly more variable BOD results with six and nine samples respectively being below Good WFD (2015) status threshold. This suggests BOD was more stable in the upper reaches with variability of results increasing downstream.

Initial SAGIS-SIMCAT model outputs (Technical Annex B1, Appendix B.2) indicate that SESRO would have small but beneficial impact on downstream river quality and reduce the risk of WFD non-compliance and the risk to drinking water.

[36] Although the WFD Catchment data explorer reports on Phosphate, Environment Agency sampling data refers to Orthophosphate (reactive as P). Note the WFD regulations refer to reactive phosphorus. Due to these inconsistencies, the terms are used interchangeably within this chapter.
[37] Environment Agency (2015) WFD 2015 River Canal Physchem C2Pstds 150622. And Environment Agency, 2015; The Water Framework Directive (Standards and Classification), 2015

6.5. Conclusions

During construction, there is potential for water quality impacts within the River Ock catchment. Potential impacts could occur due to increase sediment loads from surface water runoff within the construction site and potential increased pollution from construction machinery and accidental spillages. Proposed mitigation, following good practice pollution prevention guidelines is expected to be adequate for the management of these potential impacts to a level where impacts are minimal. SIMCAT modelling indicates that water quality is the River Ock will show a slight improvement for ortho-phosphate, nitrate and BOD due reduced flows and increased travel times but a small increase in ammonia due to reduced dilution.

During operation, there is potential for water quality impacts to the reservoir. Current nutrients levels in the River Thames are likely to result in algal growth within SESRO. In addition there is a further risk of nutrients added by wildfowl. Engineered mitigation measures such as artificial mixing, Intermittent artificial mixing, Microfiltration & Surface Skimmers, Draw-off Control (Variable Draw-off) and sonification should be considered.

Operational releases from the reservoir have the potential to impact water quality in the River Thames during periods of low flow. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.

Potential impacts could result in the deterioration of some elements of WFD status or prevention of the water bodies achieving Good status in the future but SIMCAT modelling suggests that, in general, improvements in quality are likely to occur except for pesticides. The release of algae and their associated metabolites and toxins may be further cause of concern. Previous reports have also highlighted a potential risk of changes to dissolved oxygen levels and temperature in the River Thames. This needs verification through a 1D hydrodynamic model.

If effects are identified, additional mitigation measures should be considered within the reservoir to ensure no deterioration to the River Thames water quality, impact to the WFD status or drinking water.

6.6. Assessment framework towards Gate 2

Atkins have carried out a thorough and objective review of the river and reservoir modelling software previously applied to the SESRO projects, based on information provided by Thames Water. This was done along with an assessment of the available modelling software against a number of key criteria to ensure that the selected model platform is technically suitable and meets programme, SRO interfacing and risk considerations. We have recently updated this initial work, following receipt of the latest river model report for STT (InfoWorks RS) and feedback from other SROs regarding their programme constraints and aspirations. Table 6-3 below provides an overview of our assessment of different modelling options towards Gate 2.

Although the right modelling package is yet to be selected, it is proposed that the reservoir modelling work should include the use of a three-dimensional model such as Computational Fluid Dynamics (CFD) to take account of any revised reservoir designs. This would be used alongside PROTECH-D to model algal communities in the reservoir.

Each software platform was scored from one to five on a range of criteria relevant to the delivery of technically acceptable outputs within the required SESRO programme. In the analysis presented above, each category is given an equal weighting. Following the review of the latest reports and inclusion of programme and SRO interfacing considerations, the leading platforms are Mike, Questor and InfoWorks. In most technical aspects, Mike was assessed as having a slight advantage, particularly when considering the flexibility offered through its customisable, modular ECOLab system.

However, when considering programme and SRO interfacing aspects, InfoWorks emerges as the most suitable choice for this work. The use of the latest InfoWorks model for the study area affords the possibility to do this as the recently updated models provides an accelerated starting point in comparison to all other platforms, with model access and initial results available even before any updates or improvements are made. Additionally, it is aligned with the STT recommendation of using an InfoWorks model for the River Avon and River Severn, ensuring consistency and improved compatibility if required. It was therefore proposed to retain the existing InfoWorks modelling platform for this work going forward, updating the existing model using the latest data.

This new model of the River Thames will be developed primarily to inform the impact assessment required by the SESRO scheme. However, it is proposed that for consistency, all Thames Water SROs will use this model as their principal assessment methodology for water quality compliance on the Thames. Key (WFD) parameters of interest include: flow, level, temperature, dissolved oxygen, BOD, ammonia, nitrate, nitrite, soluble reactive phosphorus, total phosphorus and suspended solids.

These include:

- STT SRO;
- T2ST SRO;
- T2AT SRO; and the
- London Reuse SRO.

To serve all these requirements, the geographic extent of the model would likely be from Lechlade-on-Thames in the upper Thames catchment to Teddington Weir at the tidal limit. We have also considered that the river model will be interacting with the reservoir model.

This approach was discussed with the Environment Agency technical teams on 18 February 2021 where the cross-SRO approach and the use of a 1D hydrodynamic model like InfoWorks was endorsed.

Table 6-3 – Water quality operational impacts

Criteria	SAGIS-SIMCAT	QUAL2K	INCA	Questor	Flood Modeller	MIKE	InfoWorks
Dimensions	0D	1D	0D	0D	1D	1D/2D/3D	1D/2D
Type	Stoch	Deter	Deter	Deter/ Stochastic	Deter	Deter	Deter
Flow State	Steady State	Steady State	Dynamic	Dynamic/ Steady State	Dynamic	Dynamic	Dynamic
Track record	2	2	2	4	1	5	4
Determinands simulated	2	2	5	5	5	5	5
Processes simulated	2	4	5	5	4	5	4
Compatibility with standards	3	3	3	3	5	5	5
One model/ integrated approach	4	2	3	4	3	4	4
Scenario set-up	5	5	5	5	3	3	3
Flexibility	2	2	2	5	3	5	3
Ability to meet required SESRO programme	5	4	3	3	1	1	5
Compatibility with other SROs	2	3	1	2	3	3	5
Total Score	**27**	**27**	**29**	**36**	**28**	**36**	**38**

Stoch = Stochastic; Deter = Deterministic

7. Fisheries

7.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO on fish, including changes to fish communities in the River Ock underneath and downstream of the SESRO footprint; and in the River Thames downstream of the proposed discharge point near Culham.

7.2. Datasets reviewed

A review has been undertaken to identify fish records within the reaches outlined in Table 1-1. Previous documents and datasets that have been reviewed as part of this study are:

- Environment Agency Fish Data[38];
- Environment Agency WFD Ecological status for the 2015 and 2019 cycles[39];
- Thames Water Fisheries Baseline Survey (2009)[40];
- Thames Water fish surveys undertaken by Atkins in 2020; and,
- Thames Water WRMP19 Resource Options: Abingdon Reservoir Conceptual Design Report (2018).

7.3. Gate 1 proportional assessment methodology

Publicly available Environment Agency fish data have been reviewed along with historical project data sources (as listed above in Section 7.2) to determine a fisheries baseline for the study reaches outlined within Table 1-1. The Environment Agency data review was limited to records obtained within the last 10 years. Using the literature/data available, this review has used expert judgement to yield qualitative judgements in respect of the impacts of the proposed reservoir on the fisheries baseline.

7.4. Outputs/findings

The findings of the fisheries baseline data review are presented below. Watercourses have been split into 13 reaches to assess specific impacts of the reservoir and its associated infrastructure. The WFD Ecological status for 2015 and 2019 cycles are presented in Table 7-1. For most WFD water bodies within the 13 study reaches the fish element is not currently classified. This is likely due to the sensitivity of this element to the heavily modified nature of the water bodies and the potential for this to skew overall status. The findings of the Environment Agency and historical project data review are presented in Table 7-2. This includes baseline descriptions of fish species present within each reach. Potential impact pathways caused by the construction and operation of the reservoir are also presented in Table 7-2 along with a summary of the Gate 1 proportional findings which outline gaps in the data and identify where further surveys are needed. Recommendations for the Gate 2 monitoring assessment approach to provide an in-depth impact assessment associated with the reservoir construction and operation phases are stated.

Monitoring locations presented in Table 7-2 are provided in Technical Annex B1: EAR Figures, Figure 7.1.

[38] Principally the National Fish Populations Database reviewed on the Environment Agency's Ecology and Fish Data Explorer website: https://environment.data.gov.uk/ecology-fish/. Accessed: January 2020.
[39] WFD status information obtained from the Environment Agency Catchment Data Explorer website: https://environment.data.gov.uk/catchment-planning/. Accessed: January 2020.
[40] Cascade Consulting and APEM (2009) Upper Thames Reservoir: Fisheries Baseline Survey Report on behalf of Thames Water.

Table 7-1 – WFD Ecological status and fish classification for each reach.

Reach	WFD Waterbody	WFD Status and Class (2015)	WFD Interim Status and Class (2019)
1	*Cow Common Brook and Portobello Ditch*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Fish elements 'Not Classified'	Fish elements 'Not Classified'
2	*Childrey Brook and Norbrook at Common Barn*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Fish elements 'Not Classified'	Fish elements 'Not Classified'
3	*Ginge and Mill Brook*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Fish 'Poor'	Fish 'Poor'
4	*Thames (Evenlode to Thame)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Fish 'Moderate'	Biological elements 'Moderate'
		Fish 'Moderate'	Fish 'Good'
5	*Thames Wallingford to Caversham*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Moderate'	Biological elements 'High'
		Fish 'Not classified'	Fish 'Not classified'
	Thames (Reading to Cookham)	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'High'	Biological elements 'Good'
		Fish 'Not classified'	Fish 'Not classified'
	Thames (Cookham to Egham)	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'High'	Biological elements 'High'
		Fish 'Not classified'	Fish 'Not classified'
6	*Thames (Cookham to Egham)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'High'	Biological elements 'High'
		Fish 'Not classified'	Fish 'Not classified'
7	*Thames (Cookham to Egham)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'High'	Biological elements 'High'
		Fish 'Not classified'	Fish 'Not classified'
8	*Thames (Cookham to Egham)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'High'	Biological elements 'High'
		Fish 'Not classified'	Fish 'Not classified'

Reach	WFD Waterbody	WFD Status and Class (2015)	WFD Interim Status and Class (2019)
	Thames (Egham to Teddington)	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Fish 'Not classified'	Fish 'Not classified'
9 10 11 12 13	*Thames (Egham to Teddington)*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Fish 'Not classified'	Fish 'Not classified'

Table 7-2 – Baseline fish data and potential impact pathways

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
1	**Cow Common Brook:** two sites on the Cow Common Brook were surveyed in 2008 for Thames Water (sites 11 and 12). Five species were found across both sites. Most abundant species were stone loach (*Barbatula barbatula)*, 3-spined stickleback (*Gasterosteus aculeatus*) and minnow (*Phoxinus phoxinus*), all species associated with oxygen rich, flowing streams with gravel/cobble beds. The Habitats Directive Annex II species bullhead (*Cottus gobio*) was recorded at one of the sites (site 11). No invasive fish taxa were recorded. No Environment Agency data available for this watercourse post 2010.	Direct loss of approximately 3–4 km of potential habitat for fish in the Cow Common Brook. This may include habitat for spawning, rearing and general feeding for various life stages. Reduction in flow in the retained reach of Cow Common Brook downstream of the reservoir resulting from the loss of upstream watercourses and changes to overall catchment hydrology due to loss under the reservoir footprint. This may further reduce habitat availability for fish within this watercourse.	The fish community present on the Cow Common Brook will be sensitive to direct habitat loss under the footprint of the reservoir and mitigation will be required. Although the data available provide some information on fish species present within Reach 1, there is a limited spatial spread in the data (all surveys on main stem of the Cow Common Brook and Childrey Brook). Moreover, the data are over 10 years old and therefore may not be representative of the current baseline condition. As such, further surveys are required within the reach to inform a robust impact assessment and to provide detailed understanding of the habitat provided by these watercourses to ensure appropriate mitigation can be designed.
	Childrey Brook: four sites on the Childrey Brook were surveyed in 2008 for Thames Water (sites 6,7, 8 and 10). Nine species of fish were found across these sites. The most common species were minnow, roach (*Rutilus ruitlus*) and gudgeon (*Gobio gobio*), all of which are typically tolerant to moderate environmental changes. The Annex II species bullhead was recorded at one of the sites (site 8).	Childrey Brook is on the edge of the red line boundary and there are no scheme components overlapping it. It will however be affected by the additional flow diverted to the watercourse from the Cow Common Brook diversion. There is a possibility this is a positive change for a short section. Additionally, there is potential for general construction related pollution and sediment entrainment impacts.	
	There are no available data for watercourses such as **Portobello Ditch**, **Landmead Ditch** and **Hanney Ditch** that are within the redline boundary for this scheme.	For all options, there is a total loss of between 22 km and 35 km of watercourse under the footprint of the reservoir (this includes the loss of Cow Common Brook stated above, approximately 2 km of Portobello Ditch and several minor ditches). It	There are no data available for these watercourses, however the larger channels are likely to have commonality in species composition with Cow Common Brook as they are situated within the same catchment.

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
		is uncertain as to how much of this habitat is suitable for fish.	Further surveys are required to determine a baseline and complete future impact assessments for the Scheme. It is recommended that an assessment of fish habitat is undertaken for all watercourses within the reservoir footprint. For those identified as having suitable habitat for fish, detailed fish surveys should be completed.
2	**River Ock:** five sites (sites 1–5) on the River Ock were surveyed in 2008 for Thames Water. 11 species of fish were recorded. The River Ock appears to support a diverse fish community including lithophilic species, such as brown trout and dace. Bullhead were present at each one of the five sites located on the River Ock and dominated the fish community in sites 1 and 4. The number and size range of bullhead recorded within the River Ock during the 2008 surveys suggest that there is a healthy self-sustainable population of this species, confirming the presence of areas of well oxygenated water flowing over a coarse substrate of gravel and cobbles. The results of these surveys highlight the potential importance of the River Ock and its catchment for species with specialist spawning requirements and with the information to date, the River Ock may be considered as being particularly ecologically sensitive to the impacts of reduced flows. There were no available Environment Agency data for Mere Dyke.	All options include a crossing of the River Ock for an access road. This may cause a barrier to fish movement reducing connectivity and could result in direct habitat loss depending on the type of structure proposed. The watercourse diversion of the Cow Common Book into the Childrey Brook will result in an increase in flow within the River Ock between its confluences with these two watercourses. This may affect shallow/flow sensitive habitats in this reach which could provide spawning and rearing opportunities for fish. All options have a potential reduction of upstream recruitment/rearing habitat associated with the loss of watercourses under the reservoir footprint. This may potentially affect overall population size and community structure. Additionally, there is potential for general construction related pollution and sediment entrainment impacts.	The fish community present on the River Ock contains species indicative of better flows and good flows. These species are likely to be sensitive to habitat loss and habitat severance if there is no mitigation. The loss of upstream habitat may reduce community viability and may result in changes in flow regime associated with watercourse diversions if no mitigation is in place. Although the data available provide some information on fish species present within Reach 2, there is a limited spatial spread in the data (all surveys were undertaken on main stem of the River Ock). Moreover, the data are over 10 years old and therefore may not be representative of the current baseline condition. As such, further surveys are required on the Mere Dyke in particular to complete a relevant impact assessment.

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	There were no available data for **Sandford Brook.**	All options include a crossing of the Sandford Brook for an access road. This may cause a barrier to fish movement reducing connectivity and could result in direct habitat loss depending on the type of structure proposed. Additionally, there is potential for general construction related pollution and sediment entrainment impacts.	This watercourse is likely to have commonality in species composition with the River Ock as Sandford Brook is a tributary of the River Ock. As such, further surveys are required to complete a relevant impact assessment.
3	There were no available project or Environment Agency data for the **Ginge Brook or Mill Brook.**	Potential loss of headwater channels for all options associated with proposed railway sidings and a material handling area. At this stage, it is unclear whether there are any channels likely to be impacted due to a lack of baseline survey. However, it is unlikely that these channels will provide optimum habitat for fish due to the modified nature of their planform (as inferred by review of mapping). If impacts to headwaters are confirmed, there will be potential for general construction related pollution and sediment entrainment impacts to downstream watercourses.	There are no data available for these watercourses. The main stems of these watercourses are likely to have commonality in species composition with Cow Common Brook. Further surveys are required to provide an up to date baseline in order to complete a robust impact assessment.
4	**River Thames:** 17 Environment Agency sites were found that have been surveyed 83 times since 2010, the most recent being from 15 July 2019 to 21 July 2019. A total of 14 species were recorded with commonality of assemblages across the sites. The most abundant species were coarse species, roach and bleak (*Alburnus alburnus*). These are indicative of slow flowing enriched waters and is likely to be relatively tolerant to moderate environmental changes. Low numbers of the notable species European eel (*Anguilla anguilla*), which is	The majority of this reach lies upstream of direct impacts. However, it is recognised that impacts to fish within downstream reaches of the River Thames and other watercourses within the local area could result in alterations to community composition within this reach given the inter-connected nature of the system and potential for recruitment from elsewhere in the catchment.	The fish assemblages within this reach are dominated by coarse species associated with deep, slow flowing water. Although the data available provide some information on fish species present within Reach 4, there are limited habitat descriptions in the data. Recent Environment Agency data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, survey of potentially sensitive habitats (e.g. marginal vegetation) immediately surrounding/downstream of the intake

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	listed as Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species were also recorded. There was one survey conducted by Atkins in 2020. There was a commonality in the species assemblages found here with historical Environment Agency data, with coarse fish species such as roach dominating.		discharge structure is recommended to ensure potential impacts associated with the construction and operation of the intake discharge structure can be fully assessed.
5	**River Thames:** eight Environment Agency sites were found that have been surveyed 48 times, the most recent of which were from 22 to 24 July 2019 across five sites (Site IDs: 8231, 8284, 30712, 30726, 30727). A total of 12 species were found, and there was a commonality of assemblages across the sample sites. Notable species included European eel (elvers) and the invasive species Zander (*Sander lucioperca*). The species assemblage is indicative of slow flowing enriched waters and is likely to be relatively tolerant to moderate environmental changes. Between the SESRO discharge and River Thame, two weir pools (Sutton Pool and Clifton Hampden) are present and have been noted to provide otherwise rare spawning habitat between impounding structures. These are located within the area of greatest hydrological influence. Previous data supplied by Thames Water from 2005/2006 identified Sutton pools within this reach as important spawning	The main hydrological change in this reach is changes to velocity and depth during releases from the discharge structure which may result in adverse impacts on fish (particularly juvenile fish), through direct harm or mortality or reduction in suitable available habitat. The main area of hydrological influence is considered to be up to the River Thame confluence, meaning any effects would be greatest in Reach 5. Increased velocity immediately downstream of the new discharge may exert an additional environmental stressor to those fish moving upstream to spawn. As described in Table 5-1, the discharge will be 'stepped' as a way of dissipating the flow before it enters the channel, as a way of reducing the impact of higher energy flows. However, alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deeper-water habitat availability. At the same time, this may	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages e.g. within spawning sites such as Sutton Pools. Recent Environment Agency data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed.

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	sites for perch and roach, although the early emigration of larval perch from Sutton Pools to the main river suggests that such off-river habitats may not provide optimum nursery conditions for developing perch fry. Follow-up surveys were completed by Atkins in this reach at Sutton Pools and Clifton Weir in 2020. Environment Agency monitoring site (Site ID: 60763) is located within Sutton Pools. The most recent survey from 7 October 2014 indicate that roach were abundant during this season; however, perch had lower numbers, supporting the previous findings. Bleak were the most abundant species recorded during this survey.	result in a loss of 'low flow years' which may be more important for recruitment for some species and could lead to subtle community changes over time. Noting the scheme is most likely to discharge June to November, there may also be an effect on foodwebs (phytoplankton & zooplankton) if there is a risk these are displaced at key times of the year (see Section 8.4.4.2).	
6	**River Thames:** 53 Environment Agency sites were found that have been surveyed over 200 times, the most recent of which was between 12 September and 13 September 2019 across nine sites (Site IDs: 7672, 7680, 7694, 7697, 7698, 7700, 8071, 12216, 27759). A total of 15 species were found, and there was commonality of assemblages across the sites. The assemblages here were composed primarily of coarse species, with roach and bleak typically in highest abundance. Atkins undertook a fish survey at Hambleden Weir and Odney Weir in 2020. The species assemblage in the reach is indicative of slow flowing enriched waters and is likely to be relatively tolerant to moderate environmental changes.	As in Reach 5, increased velocity during discharge may result in adverse effects on juvenile fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases. As described in Table 5-1, the discharge will be 'stepped' as a way of dissipating the flow before it enters the channel, as a way of reducing the impact of higher energy flows. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deeper-water habitat availability.	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	Notable species included European eel (elvers).		associated with the operation of the intake discharge structure can be fully assessed.
7	**River Thames:** one Environment Agency site was found that has been surveyed five times, the most recent of which was on 13 September 2019 (Site ID: 16092). Two species were recorded, roach and bleak, and are indicative of slow flowing enriched waters. Previous records show the presence of the notable species, European eel. There was one survey undertaken by Atkins within the Ham Loop in 2020. There was a commonality in the species assemblages found with the Environment Agency surveys. With species dominated by coarse fish, such as roach.	As in Reach 6, increased velocity during discharge may result in adverse effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deep-water habitat availability.	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data and other survey data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed.
8	**River Thames:** five Environment Agency survey sites were found, that have been sampled 42 times, the most recent of which was on 14 September 2019 at two sites (Site IDs: 8073, 28120). Nine species were recorded here, and primarily composed of coarse fish, where roach and bleak that were present in high numbers, species that tolerant of environmental change. This indicates slow flowing, enriched waters. These also included ruffe (*Gymnocephalus*	As in reaches 6 to 7, increased velocity during discharge may result in adverse effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	cernuus), which is invasive. Key species included European eel elvers. There was one survey undertaken by Atkins at Bell Lock Weir Pool in 2020. There was a commonality in the species assemblages found here, dominated by coarse fish species such as roach. In total, 17 different species have been previously recorded through Environment Agency surveys at this site, including barbel, bullhead and European eel.	Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deep-water habitat availability.	the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data and other survey data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed.
9	**River Thames:** seven Environment Agency were found that have been sampled 58 times since 2010, the most recent of which was on 14 September 2019, across two sites (Site IDs: 8078 and 8079). Ten species were found, with commonality of assemblages across the sites. The species assemblages are mainly composed of coarse fish, in particular roach and bleak were present in high numbers. These species are tolerant to environmental change, and indicate slow flowing, enriched waters. Key species included European eel elvers. There were no Atkins surveys in this reach in 2020.	As in reaches 6–8, increased velocity during discharge may result in adverse effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deep-water habitat availability.	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data and other survey data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed.
10	**River Thames:** nine Environment Agency sites were found, that have been surveyed	As in reaches 6 to 9, increased velocity during discharge may result in adverse	The fish population within the River Thames may be sensitive to increased flows associated with the

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	48 times since 2010, most recent of which was on 15 September 2019 at two sites (Site IDs: 8082 and 8083). Nine species were found, with the majority found at Site 8082. Species assemblages were primarily composed of coarse species, in particular roach and bleak were present in high numbers and are tolerant to environmental changes. These species are indicative of slow flowing, enriched waters. No notable or invasive species were recorded here. There was one survey undertaken by Atkins at Desborough Loop in 2020. There was a commonality in the species assemblages found here compared to the Environment Agency monitoring site, with the community dominated by coarse fish species such as roach. Other species previously recorded through Environment Agency surveys at this site include bream, ruffe and barbel.	effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deep-water habitat availability.	SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data and other survey data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed.
11	**River Thames:** seven Environment Agency sites were found, and have been sampled 16 times since 2010, the most recent of which was on 16 September 2019 (Site ID: 13568). Eight species were found at this site. Species assemblages were primarily composed of coarse species, in particular roach and bleak were present in high numbers and are tolerant to environmental changes. These species are indicative of slow flowing, enriched waters. European eel elvers were also present. There was one survey undertaken by Atkins at Sunbury Weir Pool in 2020. Survey yielded nine species of fish where the assemblage was dominated by coarse fish	As in reaches 6 to 10 increased velocity during discharge may result in adverse effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data and other survey data are available for this reach, so further species

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	species such as chub, dace, roach, gudgeon, perch, pike and minnow. At total of 15 different species have been previously recorded through Environment Agency surveys at this site, including silver bream, European eel, Atlantic salmon and barbel.	providing additional deep water habitat availability.	surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed. In-combination assessments are also recommended for SESRO and London Reuse.
12	No available Environment Agency data available post 2010. No Thames Water/Atkins data for 2020.	As in reaches 6 to 11 increased velocity during discharge may result in adverse effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deep water habitat availability.	No data available. Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent survey data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed. In-combination assessments are also recommended for SESRO and London Reuse.
13	**River Thames:** eight Environment Agency sites were found that have been sampled 27 times since 2010, the most recent of which was 16 September 2019 at two sites (Site IDs: 8084 and 8085). 14 species were found here, and there was commonality in assemblages across the sites. Species	As in reaches 6 to 12 increased velocity during discharge may result in adverse effects on fish. As this reach is downstream from the intake discharge structure adverse effects are most likely to be associated with changes in habitat suitability rather than direct mortality and harm. The impacts	The fish population within the River Thames may be sensitive to increased flows associated with the SESRO discharge, as assemblages are dominated by coarse species with preferences for deep, slow flowing water. Early life stages will be particularly vulnerable.

Reach	Baseline description	Potential impact pathway	Gate 1 proportional initial assessment findings
	assemblages were primarily composed of coarse species, in particular roach and bleak were present in high numbers. These species are indicative of slow flowing, enriched waters and are typically tolerant to moderate environmental change. Key species included European eel, in addition to Atlantic salmon (*Salmo salar*) and brown/sea trout (*Salmo trutta*). There was one survey undertaken by Atkins at Lower Ham Road in 2020. The survey recorded perch, pike, roach and ruffe. No comparable Environment Agency survey data for this site is currently on record.	associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures. Alterations to the hydrological regime as a result of the operation of the intake discharge structure, could also result in potential benefits, such as increased summer flows providing additional deep-water habitat availability.	Further consideration is needed to fully determine the impacts of the operation of the intake discharge structure on the River Thames particularly in relation to potential impacts of these changes on the flow regime and what effects this may have on flow sensitive habitats and life stages. Recent Environment Agency data and other survey data are available for this reach, so further species surveys may not be necessary to provide an up to date baseline of species presence. However, up to date survey of flow sensitive habitats (e.g. marginal vegetation and weir pools) is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed. In-combination assessments are also recommended for SESRO and London Reuse.

7.5. Conclusions

Fish are a key component of the riverine ecosystem and will feature as an important component of future environmental assessments for SESRO. Various programmes of fisheries surveys have been undertaken within the reaches of the Upper River Thames in the past including targeted surveys for juvenile and adult fish and routine Environment Agency monitoring.

Previous surveys undertaken for Thames Water encompassed larval, juvenile and adult fish surveys, as well as additional targeted surveys, such as lamprey and bullhead surveys, a fish health assessment and assessments of angling data to provide information on fish communities within the main River Thames, weir streams between Sandford and Shillingford, the River Ock, Childrey Brook and Cow Common Brook.

For reaches 1, 2 and 3, there were no available Environment Agency fish monitoring data less than 10 years old. Previous surveys undertaken for Thames Water along the Cow Common Brook, Childrey Brook and River Ock within reaches 1 and 2 indicate that these were dominated by cyprinid species. The reaches also provided habitat for lower densities of salmonids. The River Ock was recorded as having suitable habitat in terms of fast flowing water and benthic refugia for the Annex II species bullhead. This habitat appears to be limited elsewhere within the study reaches, particularly on the main stem of the River Thames. No surveys have been undertaken on the Ginge Brook or Mill Brook, so little information is known about the fisheries baseline in Reach 3.

For Reaches 2 and 3, mitigation measures will need to be developed for SESRO's construction activities to avoid significant effects on fish populations. These should include best practice pollution prevention measures such as those specified in Section 6.4.1.2.

There will be a direct loss of habitat as a result of the reservoir footprint within Reach 1. Reach 2 is also likely to be impacted, through changes in hydrological regime associated within the diversion of the Cow Common Brook, as well as potential reductions in upstream recruitment/rearing habitat and loss of habitat associated with construction of an access road crossing. There are limited impacts anticipated for Reach 3, however further assessment will be required to determine the baseline habitat conditions within the Scheme footprint to assess the relative risks of the Scheme on fish in this reach.

The River Thames was dominated by coarse fish species with typical preferences for deep, slow flowing water. For the River Thames (reaches 4 to 13) regular Environment Agency fish monitoring data are available along with 2020 fish survey data undertaken by Atkins on behalf of Thames Water. This provides a fairly comprehensive understanding of fish species present, which includes notable species such as European eel, Atlantic salmon and brown trout (albeit at lower densities than other species). The invasive species zander has also been recorded in reach 5, but it is considered likely that this species is present in other reaches also.

The main potential impact on the River Thames reaches (reaches 4–13) are associated with the operation of the intake discharge structure near Culham. There is potential for changes in velocity to affect sensitive habitats which are important nursery grounds for larval and/or juvenile fish which if not mitigated could have implications on the success of future populations. There is also a risk that food sources (phytoplankton, zooplankton) could be moved downstream if larger discharges result in increases in velocity at times these groups are abundant. These effects are most likely to be seen in Reach 5 where hydrological changes will be most pronounced and may affect sensitive spawning and larval/juvenile fish rearing habitats, such as Sutton Pools are known to exist.

As Table 5-1 shows, flows and velocities released from SESRO are expected to increase with larger reservoir sizes. A key mitigation measure is that the discharge will be 'stepped' as a way of dissipating the flow before it enters the channel, as a way of reducing the impact of higher energy flows on fish and other aquatic biota. These impacts will lessen as distance from the new intake/outtake structure increases. A further two-stepped approach may be appropriate for option 4b along with additional creation of marginal habitats (if this is considered to be needed or appropriate). As the scheme is expected to be mostly operational between June and November, there may also be a possibility that some of the highest discharge volumes avoid sensitive time periods.

7.6. Assessment framework towards Gate 2

The fish surveys summarised in this assessment are from 2005 to 2008 and (for the River Thames) 2020. Most recent Environment Agency records were typically from 2019. Given the age of some of these data, particularly from Reaches 1 and 2 in the River Ock catchment, it is possible that the habitats, species and species distribution within the Scheme boundary have changed over time. Species that were abundant in specific reaches may no longer be as prevalent and changes in overall population dynamics may have occurred.

Therefore, it is recommended that additional fish surveys be conducted to provide a more recent baseline and inform the mitigation requirements for the Scheme.

There were no fish data available for Mere Dyke in Reach 2, the Sandford Brook within Reach 2 and Oday Ditches in Reach 3. Therefore further investigation will be needed. It is recommended that fish surveys are undertaken within Mere Dyke, Sandford Brook and Oday Ditches to provide an adequate baseline to determine potential significance of effects arising from the Scheme and to inform any mitigation requirements.

In addition to fish surveys on reaches 1–3, habitat condition surveys are recommended in areas that are likely to be most affected by the Scheme, for example where direct loss of habitat occurs, and reaches that will experience the most environmental stress. This information could be used to inform design of the proposed watercourse diversion, as well as help inform assessment of impacts.

For the River Thames around the proposed outfall (reaches 4 and 5), habitat and species-specific information must be used to assess the impacts associated with discharge and intake activities. An investigation into how the operation of the intake discharge structure will affect depth and velocity at sensitive locations (e.g. channel margins and weir pools) in order to determine how this will affect the fish population will be required. Habitat condition surveys are recommended along these reaches to identify and map flow sensitive habitats as well as marginal habitats, which can provide shelter for younger life stages, including but not limited to Sutton Pools. Juvenile fish data will need to be reviewed in particular to identify which species groups may be present, where they reside within Reach 5 and how their abundance is related to available habitats.

Recent Environment Agency data are available for Reaches 4 and 5. Where there is spatially diverse data, e.g. River Thames hydroacoustics, this needs to be reviewed to understand where different species reside in the River Thames system, particularly within Reach 5. Additional surveys of species utilising sensitive habitats (e.g. marginal vegetation) immediately surrounding and downstream of the intake discharge structure are recommended to ensure potential effects on fish can be fully assessed. This would include surveying for juvenile life stages. This may also include reviewing the presence of fish passes within the immediate area in order to assess the potential effects of increased or decreased flow on these. A survey programme should be set up to allow for aging of the fish and life cycle analysis (particularly for key species such as Atlantic salmon, European eel and brown trout) in order to determine potential impacts on population dynamics and wider conservation status. This will allow for an understanding of the relative sensitivities of different species utilising these reaches.

For Reaches 6 to 13, there is a fairly comprehensive historical data set especially in context of how the scheme is expected to affect these reaches. However, similarly, to reaches 4 and 5, identification of some of the flow sensitive habitats is recommended to ensure potential impacts associated with the operation of the intake discharge structure can be fully assessed. This may also include reviewing the presence of fish passes within the area in order to assess the potential effects of increased or decreased flow on these. However, it is recommended that this is only undertaken if the hydrological or hydrodynamic modelling work suggests there is a significant difference in level or flow as a result of the scheme.

For all reaches, where data are available, life cycle analysis for key fish species should be undertaken for priority species such as Atlantic salmon, European eel and brown trout in order to determine potential impacts on population dynamics and the wider conservation status of these species. Species-specific surveys are however not recommended.

All surveys should be conducted so that the data collated is comparable with other reaches, using standardised survey methods and ideally should be conducted within the same survey window. This will provide a good overall understanding of the processes that will be affected by the Scheme.

With regard to the reservoir itself, as European eel are recorded in the main River Thames suitable screening needs to be agreed for the raw water intake in accordance with the Eel Regulations (England and Wales) 2009. Screening for other fish species may also be required, but requires review as part of Gate 2.

8. Other Freshwater Ecology

8.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO on freshwater ecology (excluding fish), including changes to macrophytes and phytobenthos, macroinvertebrate, diatom and phytoplankton communities in the River Ock underneath and downstream of the SESRO footprint; and in the River Thames downstream of the proposed discharge point near Culham.

The following section summarises previous project macrophytes and phytobenthos, macroinvertebrate, diatom and phytoplankton survey data, Water Framework Directive (WFD) biological status and Environment Agency monitoring data to establish whether there are gaps in baseline datasets and identify any potential for changes to aquatic species assemblages arising from the Scheme.

8.2. Datasets reviewed

A review has been undertaken to identify ecological records to obtain baseline information on the aquatic receptors associated with the reservoir. Review of Environment Agency data has been limited to records obtained within the last 10 years within the 13 study reaches, as a way of providing an appropriate spatial and temporal baseline for the local communities. Other sources have been used to provide baseline information where Environment agency data was not available.

Previous documents and datasets that have been reviewed as part of this study are:

- Environment Agency Data[41,42,43];
- Data catchment explorer (WFD Ecological status for the 2015 and 2019 cycles);
- Thames Water: Upper Thames Reservoir Fisheries Baseline Survey (2009);
- Thames Water WRMP19 Resource Options: Abingdon Reservoir Conceptual Design Report (2018);
- Thames Water Utilities Ltd: Water Quality Technical Working Group: Phytoplankton Baseline Report (2007);
- Thames Water: Upper Thames Reservoir Midges and Mosquitos Review (2009);
- Thames Water: Upper Thames Reservoir Aquatic Macroinvertebrate Survey (2009);
- Thames Water: Upper Thames Reservoir Riverine Plankton and Diatom Survey (2009);
- Thames Water macrophyte surveys undertaken by Atkins in 2020; and,
- Thames Water macroinvertebrate surveys undertaken by Ricardo in 2020.

8.3. Gate 1 proportional assessment methodology

Publicly available Environment Agency aquatic species data have been reviewed along with historical project data sources (as listed above in Section 8.2) to determine a baseline for the study reaches outlined within Table 1-1. The Environment Agency data review was limited to records obtained within the last 10 years. Using the literature/data available, this review has used expert judgement to yield qualitative judgements in respect of the impacts of the proposed reservoir on the aquatic species baseline.

8.4. Outputs/findings

8.4.1. WFD status review

The WFD Ecological status for 2015 and 2019 cycles are presented in Table 8-1. The findings are presented below for macrophytes (Table 8-2), macroinvertebrates (Table 8-3) and diatoms (Table 8-4). These include a baseline description of macrophytes, macroinvertebrates, phytoplankton and diatoms for each reach, and the potential impact pathway caused by the construction and operation of the reservoir. Gate 1 proportional findings outline whether there are gaps in the data and ways to improve certainty. Gate 2 monitoring

[41] https://data.gov.uk/dataset/49e61441-82e8-4858-8d47-136db132df5a/freshwater-river-macrophyte-surveys-biosys
[42] https://data.gov.uk/dataset/3faf10d7-04bc-49e0-8377-61f75186d21d/freshwater-river-macroinvertebrate-surveys-biosys
[43] https://data.gov.uk/dataset/19cfcc06-13e8-4afc-9f61-d76f93be9a66/freshwater-river-diatom-surveys-biosys

assessment approach relates to an in-depth impact assessment associated with the reservoir construction and operation phases.

Table 8-1 – Ecological baseline description and WFD status

Reach	WFD Waterbody	Baseline description (2015)	Interim status (2019)
1	*Cow Common Brook and Portobello Ditch*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Macrophytes and Phytobenthos elements 'Poor'	Macrophytes and Phytobenthos elements 'Poor'
		Invertebrates 'Moderate'	Invertebrates' 'Poor'
	Childrey Brook and Norbrook at Common Barn	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Macrophytes and Phytobenthos 'Poor'	Macrophytes and Phytobenthos 'Poor'
		Invertebrates 'High'	Invertebrates 'High'
2	*Ock and tributaries (Land Brook confluence to Thames)*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Macrophytes and Phytobenthos elements 'Good'	Macrophytes and Phytobenthos elements 'Good'
		Invertebrates 'High'	Invertebrates 'High
3	*Thames (Leach to Evenlode*)	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor
		Macrophytes and Phytobenthos 'Not classified'	Macrophytes and Phytobenthos 'Not classified'
		Invertebrates 'Moderate'	Invertebrates 'Moderate'
4	*Thames (Evenlode to Thame)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Moderate'	Biological elements 'Moderate'
		Macrophytes and Phytobenthos 'Not classified'	Macrophytes and Phytobenthos 'Not classified'
		Invertebrates 'Moderate'	Invertebrates 'Moderate'
5	*Thames Wallingford to Caversham*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Moderate'	Biological elements 'High'
		Macrophytes and Phytobenthos 'Good'	Macrophytes and Phytobenthos 'Not classified'
		Invertebrates 'Moderate'	Invertebrates 'High'
	Thames (Reading to Cookham)	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'High'	Biological elements 'Good'
		Macrophytes and Phytobenthos 'Not classified'	Macrophytes and Phytobenthos 'Not classified'

Reach	WFD Waterbody	Baseline description (2015)	Interim status (2019)
		Invertebrates 'High'	Invertebrates 'High'
	Thames (Cookham to Egham)	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Good'	Biological elements 'Good'
		Invertebrates 'Good'	Invertebrates 'Good'
		Macrophytes and Phytobenthos 'Not classified'	Macrophytes and Phytobenthos 'Not classified'
6 7	*Thames (Cookham to Egham)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Good'	Biological elements 'Good'
		Invertebrates 'Good'	Invertebrates 'Good'
		Macrophytes and Phytobenthos 'Not classified'	Macrophytes and Phytobenthos 'Not classified'
8	*Thames (Cookham to Egham)*	Ecological classification 'Moderate'	Ecological classification 'Moderate'
		Biological elements 'Good'	Biological elements 'Good'
		Invertebrates 'Good'	Invertebrates 'Good'
		Macrophytes and Phytobenthos 'Not classified'	Macrophytes and Phytobenthos 'Not classified'
	Thames (Egham to Teddington)	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Invertebrates 'Good'	Invertebrates 'Good'
		Macrophytes and Phytobenthos 'Poor'	Macrophytes and Phytobenthos 'Poor'
9 10 11 12 13	*Thames (Egham to Teddington)*	Ecological classification 'Poor'	Ecological classification 'Poor'
		Biological elements 'Poor'	Biological elements 'Poor'
		Invertebrates 'Good'	Invertebrates 'Poor'
		Macrophytes and Phytobenthos 'Poor'	Macrophytes and Phytobenthos 'Poor'

Monitoring locations presented in Table 8-2, Table 8-3 and Table 8-4 are provided in Technical Annex B1: EAR Figures, Figure 7.1.

8.4.2. Macrophytes and Phytobenthos

8.4.2.1. Gate 1 proportional assessment findings

Most recent macrophyte and phytobenthos data are presented below in Table 8-2. Biological metrics were reviewed to assess community and habitat conditions. These indices principally comprise the River Macrophyte Nutrient Index (RMNI), which categorises a macrophyte community's preference to nutrient levels, and River Macrophyte Hydraulic Index (RMHI[44]), which describes a macrophyte community's preference for flow/level conditions. In addition, species richness was reviewed to assess the diversity of each reach.

[44] It is noted that RMHI is not a commonly used metric by the EA and should not be considered further (personal communication, Glen Meadows & Patrycja Meadows, Environment Agency.

Table 8-2 – Baseline macrophyte data and potential impact pathways

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
1	**Cow Common Brook:** one Environment Agency site was found that was surveyed on the 19 August 2013 (Site ID: 73641). Biological metrics were indicative of macrophyte assemblages that have a preference of enriched, slow flowing streams (RMNI: 8.49; RMHI: 8.08). The number of taxa (15) is indicative of a diverse habitat with 14 of these species being flowering plants. No notable or invasive species were recorded. **Childrey Brook:** one Environment Agency site was found and was surveyed on the 14 August 2012 (Site ID: 160540). Biological metrics are indicative of macrophyte assemblages with a preference for enriched (RMNI: 8.33), slow flow conditions (RMHI: 7.97). The number of taxa (16) indicates a diverse habitat, with 14 of these being flowering plants. No notable species were recorded, however there was one invasive species present, *Cladophora glomerata/Rhizoclonium hieroglyphicum*. No historical project data are available for macrophytes.	Direct loss of 3–4 km of habitat for macrophyte communities within the Cow Common Brook through construction of the Scheme. Reduction in flow in the retained reach of Cow Common Brook downstream of the reservoir resulting from the loss of upstream watercourses and changes to overall catchment hydrology due to loss under the reservoir footprint. This may further reduce habitat availability for macrophytes within watercourses. Additional flow diverted to the Childrey Brook from the Cow Common Brook diversion may affect water levels across specific habitat features, such as berms. It is currently uncertain whether this would result in a negative or positive effect on the macrophyte community within Childrey Brook. Additionally, there is potential for general construction related pollution and sediment entrainment impacts within retained reaches which could result in habitat degradation if unmitigated. There is also potential positive impacts through the creation of standing water (lentic) habitat within the reservoir itself, which may facilitate macrophyte growth particularly around the reservoir margins.	Although the data available provide some information on macrophyte species present within Reach 1, there was limited spatial spread in the data (all surveys on main stem of the Cow Common Brook and Childrey Brook). There are no available data for watercourses such as Portobello ditch, Landmead Ditch and Hanney Ditch within this reach. The data available are over seven years old and therefore may not be representative of the current baseline condition. As such, further surveys are required within the reach to inform a robust impact assessment and to provide detailed understanding of the habitat provided by these watercourses to ensure appropriate mitigation can be designed.
2	**Sandford Brook:** there was one Environment Agency site that has been sampled three times since 2010, the most recent was on the 27 July 2018 (Site ID: 35273). Biological metrics are indicative of macrophyte	All options include new crossings of Sandford Brook and River Ock for an access road. This may result in direct loss of habitat for macrophytes. Extent of loss will depend on	Although the data available provide some information on macrophyte species present within Reach 2, there is a limited spatial spread in the data. Moreover, the data is

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	assemblages that prefer enriched (RMNI: 8.25), slow flow conditions (RMHI: 8.38). Seven species were found here, indicating fair diversity. All species here were flowering plants. No notable or invasive species were found. **River Ock:** one Environment Agency sample site was found, and has been sampled once since 2010, on 26 July 2012 (Site ID: 35982). Biological metrics are indicative of macrophyte assemblages that prefer enriched (RMNI: 7.79), slow flow conditions (RMHI: 7.65). A total of 17 species were found, indicating good diversity, of which 12 species were flowering plants. No notable or invasive species were recorded. No historical project data are available for macrophytes.	the type of structure proposed, however shading effects are likely whether a bridge or culvert is adopted. The watercourse diversion of the Cow Common Book into the Childrey Brook will result in an increase in flow within the River Ock between its confluences with these two watercourses. This may also affect water quality. Changes to hydrology within this reach may alter the habitat typology available for macrophytes which could result in a shift in community composition. Additionally, there is potential for general construction related pollution and sediment entrainment impacts within retained reaches which could result in habitat degradation if unmitigated. During operation, a deterioration in water quality may be attributable to increased run off and pollution from impermeable infrastructure, affecting taxa that have high sensitivity to environmental change if unmitigated.	typically over three years old and therefore may not be representative of the current baseline condition. As such, further surveys are required within the reach to inform a robust impact assessment and to provide detailed understanding of the habitat provided by these watercourses to ensure appropriate mitigation can be designed.
3	**Ginge Brook:** one Environment Agency site was found, that has been sampled twice since 2010, the most recent of which was on the 15 July 2015 (Site ID:36117). Biological metrics are indicative of macrophyte assemblages that prefer enriched (RMNI:7.87), slower flow conditions (RMHI: 7.46). A total of 20 species were identified, indicating a diverse habitat, of which 15 were flowering plants. No notable or invasive species were recorded. **Mill Brook:** no Environment Agency data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will	Potential loss of headwater channels for all options associated with proposed railway sidings and a materials handling area. At this stage, it is unclear whether there are any channels likely to be impacted due to a lack of baseline survey. However, it is unlikely that these channels will provide optimum habitat for macrophytes due to the modified nature of their planform (as inferred by review of mapping). Potential loss of headwaters may reduce flow, thus water quality. This may also facilitate sedimentation which may lead to changes in	Although the data available provide some information on macrophyte species present within Reach 3, there is a limited spatial spread in the data (all surveys on main stem of the Ginge Brook). Moreover, the data are over six years old and therefore may not be representative of the current baseline condition. As such, further surveys are required to complete a robust impact assessment and inform any mitigation design.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	be commonality in the assemblages and metrics found across the study area. No historical project data are available for macrophytes.	habitat availability and result in a shift in community composition. If impacts to headwaters are confirmed, there will be potential for general construction related pollution and sediment entrainment impacts to downstream watercourses which could result in habitat degradation if unmitigated. During operation, a deterioration in water quality may be attributable to increased run off and pollution from impermeable infrastructure, affecting taxa that have high sensitivity to environmental change if unmitigated.	
4	**River Thames:** two Environment Agency sites were found, the most recent sampled was on 3 September 2019 (Site ID: 184225). Biological metrics are indicative of macrophytes assemblages that prefer enriched (RMNI: 7.93), slow flow conditions (RHMI: 8.05). Typical of lowland rivers of this nature. A total of 28 species was found here, indicating good habitat diversity, of which 23 were flowering plants. No notable species were recorded here, however two invasive species were found; Nuttall's waterweed (*Elodea nuttallii*) and Himalayan balsam (*Impatiens glandulifera)*. Atkins undertook one survey upstream of the intake/discharge point in 2020 and found the community typical of a large base-rich, lowland river and included reed sweet-grass, Nuttall's waterweed, yellow water-lily (*Nuphar lutea*) and blanketweed (*Cladophora glomerate/Rhizoclonium hieroglyphicum agg*) and indicative of 'Poor' WFD status.	This reach is upstream of direct impacts.	Although survey data in this reach are recent, there is limited spatial spread. Further survey is required to identify flow sensitive habitats. By undertaking macrophyte surveys in conjunction with other reaches the data should be comparable.
5	**River Thames:** no Environment Agency data available for this reach post 2010.	There is potential for the operation of the intake discharge structure to affect	Further investigation is needed to determine the level of impact that will be experienced by

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	No historical project data are available for macrophytes. Atkins undertook two macrophyte surveys in 2020, at Sutton Pools and Clifton Weir Stream. At Sutton Pools, the community contained 9 species and was typical of a large base-rich, lowland river and overall indicative of 'Poor' WFD status. At Clifton Weir Stream, macrophyte diversity was very low with only three species recorded including great yellow-cress and yellow water-lily. No protected or notable species were recorded. Nuttall's waterweed was the dominant species at Sutton Pools, covering over 75% of the survey stretch and may have been outcompeting other taxa. Himalayan balsam was present at Clifton Weir Stream.	macrophytes within this reach. However, given the observed low diversity the sensitivity of the communities observed to these changes is likely to be low. It is considered unlikely that SESRO's abstraction regime would impact the macrophyte community in this reach as most aquatic species are already adapted to a relatively stable flow and level regime. The discharge from SESRO may provide some flow and water quality benefits to the community in this reach. The main effect identified, if any, is that the change to the flow regime could affect the availability of marginal macrophyte habitat. The main area of hydrological influence is considered to be up to the River Thame confluence meaning any effects would be greatest in Reach 5.	marginal habitats and macrophyte species for appropriate mitigation measures to be put in place.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
6	**River Thames:** six Environment Agency sites were identified that have been sampled since 2010, the most recent of which was sampled 18 July 2016 (Site ID: 165823). Biological metrics are indicative of macrophyte assemblages that prefer enriched (RMNI: 7.87), slow flow conditions (RMHI: 7.94). A total of 25 species were recorded, indicating good habitat diversity, 20 of which were flowering plants. No notable species were recorded; however, one invasive species, least duckweed (*Lemna minuta)*, was present. A macrophyte survey undertaken by Atkins at Medmenham found eight different species typical of a large, base-rich, lowland river including yellow water-lily and common club-rush. The community was indicative of 'Good' WFD status. A macrophyte survey undertaken by Atkins at Odney Weir found eight different species typical of a large, lowland river including perfoliate pondweed, arrowhead and Kneiff's feather moss (*Leptodyctium riparium (Amblystegium riparium*). The community was indicative of 'Good' WFD status.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The magnitude of impact will lessen as distance from the structure increases.	Although the data is informative, more recent data is required to complete a robust impact assessment, as there may have been changes in community assemblages since 2016, in addition to being comparable with other sites within the reaches. Further investigation is needed to determine the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation measures to be put in place.
7	**River Thames:** there is no available Environment Agency data post 2010 for this reach of the river. A macrophyte survey undertaken by Atkins at Ham Island found 10 different species typical of a large lowland river including great yellow-cress (*Rorippa amphibia*) and Kneiff's feather moss. The invasive species monkey flower (*Mimulus* sp.) was also recorded. The community was indicative of 'Good' WFD status.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
		discharges, lock structures and land use pressures.	
8	**River Thames:** one Environment Agency site was found, that has been sampled three times since 2010, the most recent of which was on 30 September 2014 (Site ID: 35862). Biological metrics were indicative of macrophyte assemblage's preference for enriched (RMNI: 7.57), slow flow conditions (RMHI: 7.51). A total of 22 species were identified, indicating good habitat diversity, of which 17 were flowering plants. No notable species were recorded; however, one invasive species was recorded. A macrophyte survey undertaken by Atkins at Bell Weir found 19 species typical of a large lowland river including spiked water-milfoil (*Myriophyllum spicatum*) and yellow water lily which are indicative of slow flowing habitats. The Invasive species Nuttall's waterweed and least duckweed were also recorded. The community was indicative of 'Moderate' WFD status.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.
9	**River Thames:** one Environment Agency site was found that has been sampled four times, the most recent of which was 17 August 2017 (Site ID (35919). Biological metrics are indicative of the macrophyte assemblage's preference for enriched (RMNI: 7.83), slower flow conditions (RMHI: 7.87). A total of 42 species were recorded, indicating good habitat diversity, of which 32 were flowering plants. No notable species were recorded, however there were four invasive species present. No historical project data were available for macrophytes.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
10	**River Thames:** no available Environment Agency data post 2010. Due to the proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. A macrophyte survey undertaken by Atkins at Desborough Loop found 10 species typical of a large lowland river including spiked water-milfoil and yellow water lily which are indicative of slow flowing habitats. The Invasive species Nuttall's waterweed, least duckweed and floating pennywort (*Hydrocotyle ranunculoides*) were also recorded. The community was indicative of 'Moderate' WFD status.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.
11	**River Thames:** one Environment Agency site was found, that was sampled on 9 September 2019 (Site ID: 197072). Biological metrics are indicative of the macrophyte assemblage's preference for enriched (RMNI: 7.35), slow flow conditions (RMHI: 7.37). A total of 11 species were recorded, indicating moderate habitat diversity. One notable species was recorded, common mouse-ear (*Cerastium fontanum*). Two invasive species were also recorded; Nuttall's waterweed and least duckweed. A macrophyte survey undertaken by Atkins downstream of the Affinity Water Walton intake recorded seven different macrophyte taxa typical of a large base-rich, lowland river and included common water-moss, yellow water-lily and the non-native Canadian Pondweed and Nuttall's waterweed. The assemblage was indicative of WFD 'Good' status.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
12	**River Thames:** no available Environment Agency data post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. A macrophyte survey undertaken by Atkins downstream of the Thames Water Walton intake recorded ten different macrophyte taxa typical of a large base-rich, lowland river and included blue water-speedwell, arrowhead , yellow water-lily and the non-native Nuttall's waterweed. The assemblage was indicative of WFD 'Moderate' status.	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.
13	**River Thames:** one Environment Agency site was found, which has been sampled three times since 2010, the most recent being on 17 August 2017 (Site ID: 35900). Biological metrics are indicative of macrophyte assemblage's preference for enriched (RMNI: 7.71), slow flow conditions (RMHI: 7.6). A total of 26 species were recorded, indicating good habitat diversity. No notable species were recorded; however, three invasive species were present. These were Nuttall's waterweed, least duckweed and floating pennywort (*Hydrocotyle ranunculoides*). A macrophyte survey undertaken by Atkins downstream Hampton intake recorded seven different macrophyte taxa typical of large base-rich, lowland river including sweet-flag, rigid hornwort and Nuttall's waterweed. The assemblage was indicative of WFD 'Good' status. No notable species or INNS were recorded. A macrophyte survey undertaken by Atkins downstream the Surbiton intake recorded five different	There is potential for the operation of the intake discharge structure to impact macrophytes within the River Thames within this reach due to inundation and exposure respectively which may alter macrophyte community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	Due to the nature of the community recorded, it is considered unlikely that macrophyte communities in this each would be negatively affected by changes in the abstraction and discharge regime. Although the Gate 1 SIMCAT modelling suggests some minor benefit in phosphate levels, it is considered unlikely that this will noticeably benefit the macrophyte communities in this reach.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	macrophyte taxa. The macrophyte assemblage was limited in terms of true hydrophytes, likely due to artificial concrete banks and boat traffic. Species at the site included willow moss, alpine water-moss and unbranched bur-reed. The assemblage was indicative of WFD 'high' status. No notable species or INNS were recorded. A macrophyte survey undertaken by Atkins at Lower Ham Road found eight submerged taxa, with no marginal or emergent taxa recorded. Species included water starwort *Callitriche stagnalis/platycarpa*, willow moss and fat duckweed. Non-native species included Nuttall's waterweed and floating pennywort The assemblage was indicative of WFD 'Good' status.		

8.4.2.2. Conclusions

As would be expected, all the study reaches that have available data appear to have macrophyte communities that are indicative of slow flowing, enriched conditions, which are typical of lowland watercourses with shallow gradients and impounding structures. In addition, communities in the main River Thames can be affected by navigation. For all reaches, the available Environment Agency data were either not recent or had gaps in spatial spread, however the 2020 surveys have meant that almost all River Thames study reaches have recent (2020) datasets.

Given the age of the datasets for reaches 1 and 2, it is possible that the habitats, species and species distribution have changed over time. Species that were abundant in specific reaches may no longer be as prevalent and changes in overall population dynamics may have occurred. Therefore, it is recommended that additional macrophyte and habitat condition surveys be conducted to provide a more recent baseline for the Scheme and inform any mitigation requirements. For reaches 1, 2, and 3 habitat loss is the primary impact pathway, in addition to changes in flows and potential reduction in water quality resulting from construction works. Watercourse habitat loss will result in a reduction in abundance of marginal habitats within watercourses and potential changes to community composition if particularly rare or sensitive habitats are removed. However, it is also recognised that the reservoir itself, could provide significant opportunities for new macrophyte habitat establishment.

For all other reaches, the operation of the intake discharge structure may impact marginal habitats due to inundation and exposure respectively which could have both a positive and negative effect dependant on specific habitat and species water level requirements. For macrophytes, the magnitude of hydrological impacts within the River Thames is likely to be limited to Reach 5 only but the data collected to date suggests that there are no sensitive macrophyte species in this reach which would warrant specific mitigation. If the fisheries impact assessment concludes there is a requirement for (further) marginal or backwater habitats than this would also provide a benefit to macrophyte communities in the River Thames.

For Reaches 2 and 3, mitigation measures will need to be developed for SESRO's construction activities to avoid significant effects on macrophytes. These should include best practice pollution prevention measures such as those specified in Section 6.4.1.2. There are also opportunities to create ecologically sensitive realignment designs that presents morphological improvement and habitat creation for the realigned channel and ecological design of the reservoir itself to create new lentic habitat provision.

8.4.2.3. Assessment framework to Gate 2

A full updated desk study will be required, including a review of all available Environment Agency and NBN data in the River Ock catchment to identify any new records that can inform the macrophyte baseline for the Scheme.

Given the age of some of the available data, particularly from the Childrey Brook and Cow Common Brook in Reach 1 and River Ock in Reach 2, and some of the River Thames reaches, it is possible that the habitats, species and species distribution in these areas have changed over time. Species that were abundant in specific reaches may no longer be as prevalent and changes in overall population dynamics may have occurred. Therefore, it is recommended that for all reaches and watercourses, macrophyte surveys will need be to be conducted to provide a recent baseline to inform future environmental assessments of SESRO and any mitigation strategies. As well as the key watercourses listed above, surveys should target additional aquatic habitats within these reaches, such as minor ditches within the reservoir footprint, as there is currently no available baseline data for these.

All surveys should be conducted so that the data collated are comparable with other reaches, using standardised survey methods and ideally should be conducted within the same survey window. This will provide a good overall understanding of the processes that will be affected by the Scheme.

It is proposed that the 2020 surveys in the River Thames are repeated to obtain three full years of data. No further detailed assessment is proposed for the River Thames.

8.4.3. Macroinvertebrates

8.4.3.1. Gate 1 proportional assessment findings

Most recent macroinvertebrate data are presented below in Table 8-3. Biological metrics were reviewed to assess community and habitat conditions. Biological Monitoring Working Party score (BMWP), is an index that is primarily used to monitor the impact of organic water quality, but will also show responses to toxic pollution, siltation, habitat reduction and reduced flows. Average score per taxon (ASPT), is an index that is derived from

the BMWP index and is the average BMWP sensitivity score of all the taxa occurring in the sample. It is primarily used as an indicator of organic pollution. Whalley, Hawkes, Paisley & Trigg (WHPT), is an index that is primarily used to monitor the impact of organic water quality, but will also show responses to toxic pollution, siltation, habitat reduction and reduced flows. Derived metrics include Average Score Per Taxon (WHPT ASPT) and total number of scoring taxa (WHPT N TAXA). WHPT metrics replaced the BMWP (Biological Monitoring Working Party) metrics used for status classifications in the first river basin planning cycle. However, WHPT metrics were not available for all survey sites, so both BMWP and WHPT metrics have been included for completeness and comparability between survey sites. Lotic Invertebrate Flow Evaluation (LIFE) is an index used to determine the sensitivity of an invertebrate's community to changes in flows. Proportion of sediment-sensitive Invertebrates (PSI) is a biotic index designed to describe an invertebrate community's sensitivity to sedimentation.

Table 8-3 – Baseline macroinvertebrate data and potential impact pathways

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
1	**Cow Common Brook**: one Environment Agency site was identified that has been surveyed three times since 2010, the most recent was from the 3 March 2015 (Site ID 34389). The biological metrics are indictive of an invertebrate community suffering from stress due to reduced water and habitat quality (BMWP Total: 61; BMWP ASPT: 4.6; WHPT Total: 74.4; WHPT-ASPT: 4.96), in fast flowing (LIFE 7.18), sedimented stream (PSI: 40.74). No notable or invasive species were recorded, however there were large numbers of Chironomidae recorded, with 840 individuals found. These are often ubiquitous taxa but have a range of tolerances. **Childrey Brook**: one Environment Agency site was identified which has been sampled twice since 2010, with most recent data from 3 September 2013 (Site ID 36237). Biological metrics are indicative good water and habitat quality (BMWP Total: 126; BMWP ASPT: 5.48; WHPT Total: 134.7; WHPT-ASPT: 5.61), despite a moderately sedimented channel bed (PSI: 52). Invertebrate communities here are adapted to fast flow regimes (LIFE: 7.45) and are likely to be sensitive to reductions in flow. No notable species were recorded here, however there were two invasive species found. These included *Crangonyx pseudogracilis/floridanus* and *Potamopyrgus antipodarum.* Furthermore, there were large numbers of Chironomidae recorded, with 900 individuals recorded. These are often ubiquitous taxa but have a range of tolerances.	Direct loss of 3–4 km of watercourse habitat along the Cow Common Brook resulting in potential loss of macroinvertebrate communities associated with fast flowing conditions. Reduction in flow in the retained reach of Cow Common Brook downstream of the reservoir resulting from the loss of upstream watercourses and changes to overall catchment hydrology due to loss under the reservoir footprint. This may further reduce habitat availability for macroinvertebrates, particularly those associated with faster flows. Additional flow diverted to the Childrey Brook from the Cow Common Brook diversion may affect water levels across specific habitat features, such as riffles. It is currently uncertain whether this would result in a measurable effect on the macroinvertebrate composition within Childrey Brook. Additionally, there is potential for general construction related pollution and sediment entrainment impacts within retained reaches which could result in habitat degradation and direct mortality if unmitigated. In terms of the reservoir itself, there is a risk of vector pathways such as midges and mosquitos associated with new lentic waterbodies such as reservoirs; previously seen at the construction of Farmoor reservoir. Overall, there will be a change in local	Although the data is informative, more recent macroinvertebrate data is required to complete a robust impact assessment, as there may have been changes in community assemblages since these surveys were conducted. The baseline is indicative of a macroinvertebrate community sensitive to reduced flows, however resilient to channel sedimentation. Good habitat and water quality was indicated by high BMWP and BMWP ASPT.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	Previous historic project data are available from Thames Water, which shares commonality with the species found here. There are no available data for watercourses such as **Portobello Ditch**, **Landmead Ditch** and **Hanney Ditch** that are within the redline boundary for this scheme. No historical project data are available for these watercourses.	macroinvertebrate community composition through change from a lotic to lentic system.	
2	**Sandford Brook**: one Environment Agency site was identified, with most recent data from 15 March 2015 (Site 35273). Biological metrics are indicative of good water and habitat quality (BMWP Total: 91; BMWP ASPT: 5.35; WHPT Total: 108.1; WHPT-ASPT: 5.69), despite a moderately sedimented channel bed (PSI: 58.82). Invertebrate communities are adapted to fast flow regimes (LIFE: 7.88). No notable species were recorded here, however one invasive species was present, *Potamopyrgus antipodarum.* **River Ock:** there is one Environment Agency site that has been surveyed twice since 2010, the most recent record was from 3 September 2013 (Site 35982). Biological metrics are indicative of good water and habitat quality (BMWP Total: 191; BMWP ASPT: 5.79; WHPT Total: 197.4; WHPT-ASPT: 5.64), despite a sedimented channel bed stream (PSI: 39.29). Invertebrate communities here are adapted to moderate flow conditions (LIFE: 6.73). No notable species or invasive species were found. This is line with previous survey work conducted by Thames Water in 2008. Previous historic project data are available from Thames Water.	All options include new crossings of Sandford Brook and River Ock for an access road. This may result in direct loss of habitat for aquatic macroinvertebrates. Extent of loss will depend on the type of structure proposed and whether this incorporates a natural channel bed. The watercourse diversion of the Cow Common Book into the Childrey Brook will result in an increase in flow within the River Ock between its confluences with these two watercourses. This may also affect water quality. Changes to hydrology within this reach may alter the habitat typology available for macroinvertebrates which could result in a shift in community composition. However, it should be noted that the community present currently appears to be adapted to moderate flows. Additionally, there is potential for general construction related pollution and sediment entrainment impacts within retained reaches which could result in habitat degradation and direct mortality if unmitigated. During operation, a deterioration in water quality may be attributable to increased run	Although the data is informative, more recent data is required to complete a robust impact assessment, as there may have been changes in community assemblages since these surveys were conducted. The baseline is indicative of a macroinvertebrate community sensitive to reduced flows, however resilient to channel sedimentation. Good habitat and water quality are indicated by high BMWP and BMWP ASPT.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	Mere Dyke: there are no Environment Agency data or project data for this watercourse.	off and pollution from impermeable infrastructure, affecting taxa that have high sensitivity to environmental change if unmitigated.	
3	**Ginge Brook**: there is one Environment Agency sampling site that has been surveyed four times since 2013, the most recent being 5 November 2015 (Site ID: 36117). Biological metrics are indicative of good water and habitat quality (BMWP Total: 119; BMWP ASPT: 5.67; WHPT Total: 122.1; WHPT-ASPT: 5.81), with slight channel bed sedimentation (PSI: 67.5). The invertebrate community here is adapted fast flow regimes (LIFE: 7.9). No notable species were recorded; however, one invasive species was found, *Potamopyrgus antipodarum*. **Mill Brook**: there are no Environment Agency monitoring sites or historical data available for this post 2010. No historical project data are available for these watercourses.	Potential loss of headwater channels and existing aquatic habitat for all options associated with proposed railway sidings and a materials handling area. At this stage, it is unclear whether there are any channels likely to be impacted due to a lack of baseline survey. Potential loss of headwaters may reduce flow, thus water quality in downstream watercourses within this reach. This may also facilitate sedimentation which may lead to changes in habitat availability and result in a shift in community composition. If impacts to headwaters are confirmed, there will be potential for general construction related pollution and sediment entrainment impacts to downstream watercourses which could result in habitat degradation if unmitigated. During operation, a deterioration in water quality may be attributable to increased run off and pollution from impermeable infrastructure, affecting taxa that have high sensitivity to environmental change if unmitigated.	Although the data available provide some information on macrophyte species present within Reach 3, there is a limited spatial spread in the data (all surveys on main stem of the Ginge Brook). Moreover, the data are over six years old and therefore may not be fully representative of the current baseline condition. As such, further surveys are required to complete a robust impact assessment. This will also allow for the data to be comparable across reaches. The baseline is indicative of a macroinvertebrate community sensitive to reduced flows, however resilient to channel sedimentation. Good habitat and water quality is indicated by high BMWP and BMWP ASPT.
4	**River Thames:** there were seven Environment Agency sites identified, that have been sampled 15 times since 2010, the most recent on 15 May 2019 (Site ID: 184225). Biological metrics are indicative of good water and habitat quality (BMWP Total:	This reach is upstream of direct impacts.	The baseline is recent and indicative of a macroinvertebrate community moderately sensitive to reduced flows, however resilient to channel sedimentation. Good habitat and

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	127; BMWP ASPT: 5.52; WHPT Total: 135.7; WHPT-ASPT: 5.03), despite the channel bed being sedimented (PSI: 26.67). Invertebrate communities here are adapted to moderate flow regimes (LIFE: 6.72). No notable species were identified, however there were seven invasive species present. These were Dreissena *polymorpha, Ferrissia wautieri, Pacifastacus leniusculus, Dikerogammarus haemobaphes, Potamopyrgus antipodarum, Hypania invalida, Corbicula, Dreissena bugensis, Physella, Chelicorophium curvispinum*. Previous historic project data is available from Thames Water.		water quality is indicated by high BMWP and BMWP ASPT.
5	**River Thames (Evenlode to Thame)**: two survey sites were found within this reach, the most recent was surveyed was 27 October 2016 (Site ID: 184229). Biological metrics were indicative of good water and habitat quality (BMWP Total Score: 97; BMWP ASPT: 6.06; WHPT Total: 94.9; WHPT ASPT: 6.06), despite a heavily sedimented habitat (PSI: 14.71), with invertebrate communities adapted to moderate flow regimes (LIFE: 6.62). No notable species were recorded, however there were nine invasive species recorded. There was a commonality in biological metrics and community assemblages, with no further notable species recorded, however there were 11 invasive species present. These were *Dreissena polymorpha, Potamopyrgus antipodarum, Dikerogammarus haemobaphes, Chelicorophium curvispinum, Crangonyx pseudogracilis/floridanus, Dreissena polymorpha, Ferrissia wautieri, Hemimysis anomala, Hypania invalida and Corbicula fluminea*.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The main area of hydrological influence is considered to be up to the River Thame confluence.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow and velocity and the effects of this on marginal habitat inundation and exposure. Further investigation is needed on the level of impact that will be experienced by marginal habitats and associated macroinvertebrate species for appropriate mitigation suggestions and measures to be put in place. Although the data is informative, more recent data is required to complete a robust impact assessment, as there may have been changes in community assemblages since these surveys were conducted.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	Previous historic project data are available from Thames Water.		
6	**River Thames:** there were six Environment Agency sampling sites in this reach of the river that have been sampled 33 times since 2016 (Site ID: 188053). The most recent record was 15 May 2019. Biological metrics were indicative of good water and habitat quality (BMWP Total: 142; BMWP ASPT: 5.26; WHPT Total: 128.1, WHPT ASPT: 4.42), despite a sedimented channel bed (PSI: 17.24). Invertebrate communities here are adapted to moderate flows (LIFE: 6.51). There was a commonality in biological metrics and community assemblages. No notable species were recorded; however, there were five invasive species recorded here, *Dreissena polymorpha*, *Potamopyrgus antipodarum, Dikerogammarus haemobaphes, Hypania invalida, Chelicorophium curvispinum* and *Crangonyx floridanus.* Previous historic project data are available from Thames Water.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There remains a potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the River Thames. The magnitude of impact will lessen as distance from the structure increases.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place. Although the data is informative, more recent data is required to complete a robust impact assessment, as there may have been changes in community assemblages since these surveys were conducted.
7	**River Thames:** most recent survey data has been supplied by Ricardo, which was undertaken 26 May 2020 at the Affinity Datchet intake (SU9852676822). Biological metrics are indicative of a community living in moderate water quality (BMWP Total: 60; BMWP ASPT: 5.00) and a heavily sedimented channel bed (PSI:13.64). Invertebrate communities here are adapted to moderate flow regimes (LIFE: 6.88). No notable species were recorded; however, one invasive species was present, *Dikerogammarus haemobaphes.*	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	No Environment agency data available post 2010. Previous historic project data are available from Thames Water.	The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	mitigation suggestions and measures to be put in place.
8	**River Thames:** most recent survey data was provided by Ricardo on 26 May 2020, at Affinity Sunnymeads uptake (SU9845575603). Biological metrics are indicative of a moderately impacted reach but with good water quality (BMWP Total: 58; BMWP ASPT: 5.27). The community is also indicative of a sedimented channel bed (PSI 38.89). Invertebrate communities here are adapted to moderate flow regimes (LIFE: 6.57). No notable species were recorded; however, one invasive species was recorded, *Dikerogammarus haemobaphes.* No Environment Agency Data available post 2010. Previous historic project data are available from Thames Water.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place.
9	**River Thames:** most recent survey data available has been provided by Ricardo, which was undertaken on 26 May 2020, at Affinity Egham intake (TQ0186672009). Biological metrics are indicative of a slightly impacted reach with good water quality (BMWP Total: 76; BMWP ASPT: 5.43), and a sedimented channel bed (PSI: 29.63). Invertebrate communities here are adapted to moderate flow regimes (LIFE: 7.00). No notable species were recorded; however, one invasive	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	species was recorded, *Dikerogammarus haemobaphes.* This is contradictory to the Environment Agency data available; however, this can be attributed to different sampling efforts and seasonal variation. Previous historic project data are available from Thames Water.	extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place.
10	**River Thames**: most recent data have been supplied by Ricardo which was undertaken on 26 May 2020, at Chertsey intake (TQ0499968345). Biological metrics are indicative of a slightly impacted reach but with good water quality (BMWP Total: 80; BMWP ASPT: 5.00), however the channel bed is heavily sedimented (PSI: 10.71). Invertebrate communities are adapted to moderate flow regimes (LIFE: 6.36). No notable species were recorded; however, one invasive species was recorded here, *Dikerogammarus haemobaphes.* This is contradictory to the Environment Agency data available; however, this can be attributed to different sampling efforts and seasonal variation. Previous historic project data are available from Thames Water.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
11	**River Thames**: most recent data was supplied by Ricardo on 28 May 2020 at Walton intake (TQ0863766703). Biological metrics were indicative of a slightly impacted reach, where invertebrate assemblages are experiencing stress with moderate habitat and water quality (BMWP Total: 78; BMWP ASPT: 4.88), which is also indicated by a heavily sedimented channel bed (PSI:11.1). Invertebrate communities here are adapted to moderate flow regimes (LIFE: 6.91). No notable species were recorded; however, one invasive species was present, *Dikerogammarus haemobaphes.* This is contradictory to the Environment Agency data available; however, this can be attributed to different sampling efforts and seasonal variation. Previous historic project data are available from Thames Water.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place.
12	**River Thames:** most recent survey data was provided by Ricardo on 28 May 2020 at Hampton intake (TQ1318169115). Biological metrics were indicative of a moderately impacted reach with invertebrate communities experiencing stress due to reduced water quality (BMWP Total: 59; BMWP ASPT: 4.92), and heavily sedimented channel bed (PSI: 13.33). Invertebrate communities here are adapted to moderate flow regimes (LIFE: 6.43). No notable species were recorded, however there were two invasive species recorded here, *Dikerogammarus haemobaphes.* No Environment Agency survey sites or historical data post 2010.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
	Previous historic project data are available from Thames Water.	discharges, lock structures and land use pressures.	
13	**River Thames:** most recent survey data supplied by Ricardo was completed on 28 May 2020 at Teddington Weir (TQ1722171306). Biological metrics are indicative of moderately impacted reach, but with good water quality (BMWP Total: 51; BMWP ASPT: 5.1), with a heavily sedimented channel bed (PSI: 13.33). Invertebrate communities are adapted to moderate flow regimes (LIFE: 6.5). No notable species were recorded; however, there was one invasive species recorded here, *Dikerogammarus haemobaphes.* Previous historic project data are available from Thames Water. This is contradictory to the Environment Agency data available; however, this can be attributed to different sampling efforts and seasonal variation.	Changes in level, velocity and/or water quality as a result of operation of the scheme. There is potential for the operation of the intake discharge structure to impact macroinvertebrates within the River Thames within this reach due to inundation and exposure respectively which may alter community composition; however there may be associated benefits for some vulnerable species as there will be a reduction in extreme flows and levels changes in the Thames. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	The baseline is recent and indicative of good habitat and water quality, with the macroinvertebrate community showing preference for moderate flows, and resilience to channel sedimentation. The main impact pathway will be the fluctuations in flow will result in prolonged period of marginal habitat being inundated or exposed. Further investigation is needed on the level of impact that will be experienced by marginal habitats and macrophyte species for appropriate mitigation suggestions and measures to be put in place.

8.4.3.2. Conclusions

For reaches 1, 2 and 3, there are data available for some of the watercourses within these reaches. There were gaps in the data for Portobello Ditch, Landmead Ditch, Hanney Ditch and Mere Dyke as well as other minor ditches. The baseline indicated that macroinvertebrate communities here are sensitive to reductions in flow, however, are relatively resilient to channel sedimentation. Further macroinvertebrate surveys are needed where data are missing, in addition to habitat surveys to identify sensitive habitats.

For reaches 1, 2, and 3 habitat loss is the primary impact pathway, in addition to changes in flows and potential reduction in water quality resulting from construction works. Watercourse habitat loss will result in a reduction in abundance of flowing habitats within the reach and thus there is likely to be changes to community composition. This may be particularly significant if there were to be a loss of rare habitats. However, it is also recognised that the reservoir itself, could provide significant opportunities for new aquatic habitat establishment, albeit within a lentic system. Moreover, there are opportunities to create an ecologically sensitive realignment design that presents morphological improvement and habitat creation for the watercourse diversion.

For Reaches 2 and 3, mitigation measures will need to be developed for SESRO's construction activities to avoid significant effects on macroinvertebrates. These should include best practice pollution prevention measures such as those specified in Section 6.4.1.2.

For Reach 5, there were recent data available. The baseline is indicative of a macroinvertebrate community adapted to moderate flows, and resilient to channel bed sedimentation. It also indicates good habitat and water quality. The main impact pathways to this reach are associated with the construction and operation of the intake and discharge structure at Culham. This includes habitat loss, potential changes to water quality and to regimes of inundation and exposure of marginal habitats. Further investigation is needed on the level of impact that will be experienced for appropriate mitigation suggestions and measures to be put in place.

For the remaining Reaches (6–13), the baseline indicated a macroinvertebrate community that is associated with moderate flows and shows resilience to channel sedimentation. It also indicated that habitat and water quality was poorer than in other reaches. Marginal habitats will mainly be impacted by the intake and discharge of water, due to inundation and exposure respectively, which may reduce macroinvertebrate species and abundance. The level of impact will likely reduce further downstream, however further investigation is needed on the level of impact that will be experienced by marginal habitats and macroinvertebrate species for appropriate mitigation suggestions and measures to be put in place.

Further improvements and opportunities for habitat creation should be investigated to ensure adequate mitigation for impacts. Preventative measures will also be needed for the reservoir itself to reduce the risk of midges and mosquitoes that may pose a risk in the local area. These can include circulation and/or biological controls such as fish.

8.4.3.3. Assessment framework to Gate 2

A full updated desk study will be required, including a review of all available Environment Agency monitoring data to identify any new records that can inform the macroinvertebrate baseline for the Scheme as well as identification of notable and/or protected species.

For reach 1, updated macroinvertebrate surveys for drainage ditches that are lacking data are required, as there may be isolated invertebrate assemblages with notable importance present. Furthermore, habitat surveys are needed to identify areas of high sensitivities to the impacts associated with the scheme.

For reach 2, further surveys needed for waterbodies that are missing invertebrate data. Updated macroinvertebrate surveys for Mere Dyke, as there may be isolated invertebrate assemblages with notable importance present. Furthermore, habitat surveys are needed to identify areas of high sensitivities to the impacts associated with the scheme.

For reach 3, surveys are needed for Mill Brook as this is missing data invertebrate data. Furthermore, habitat surveys are needed to identify areas of high sensitivities to the impacts associated with the scheme.

For remaining reaches (4–13), habitat surveys will need to be conducted to provide a more robust baseline and identify marginal habitats, to inform and mitigate for environmental stress associated

with the scheme. This will also need to be comparable with other survey sites in reach. Any changes to water quality, notably dissolved oxygen and suspended sediments, may also warrant investigation to determine if the changes are sufficient to change macroinvertebrate populations.

8.4.4. Diatoms and Phytoplankton

8.4.4.1. Gate 1 proportional assessment findings

Most recent diatom and phytoplankton data are presented in Table 8-4. Biological metrics were reviewed to assess community and habitat conditions. These indices include the percentage (%) of motile taxa and percentage (%) of planktonic taxa.

Available data for phytoplankton were limited to the River Thames and the most recent samples taken in the Culham were from March 2007. Further long-term phytoplankton datasets are however held by the Centre for Ecology and Hydrology (CEH) for the River Thames at Wallingford (Reach 6) but were not available for detailed review as part of Gate 1.

Phytoplankton monitoring was previously undertaken by Thames Water fortnightly between April and September; and at monthly intervals between October and March in 2005, 2006 and 2008. Sites included the River Thames upstream of SESRO at Nuneham and Abingdon Marina; and River Thames downstream of SESRO at Culham, Appleford, d/s River Thame, Caversham near Reading and Romney Lock, Windsor. In total, 134 taxa were noted, composed of 56 chlorophytes, three euglenoids, two dinoflagellates, one xanthophyte, many of which were recorded sporadically. There is no significant difference in composition over the study period. The data do not suggest that the enhanced retention of the lower River Thames presents any significant departure in phytoplankton-recruitment behaviour from that typical of other low-gradient, lowland rivers elsewhere in the UK. Although informative, more data are needed for reaches of the study area associated with the reservoir, especially those that will be lost, as a change in water quality and increased pollution may have changed algal communities over time.

A summary of Environment Agency data is presented in Table 8-4.

Table 8-4 – Baseline diatom data and potential impact pathways

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
1	**Childrey Brook:** one Environment Agency site was found that has been sampled twice since 2010, the most recent being on 12 November 2010 (Site ID: 36237). Biological metrics are indicative of diatoms with low percentage of motile taxa (39.87%), with no planktonic taxa. This indicates that siltation levels are low within the channel, and plants such as filamentous algae are not choking the channel. No phytoplankton data made available.	Direct loss of habitat and reduction in flows may facilitate loss of diatom species and abundance. A change in diatom assemblages could see an increase taxon composition due to siltation. No future operational discharge from the reservoir into the River Ock system.	Although informative, more recent data are needed to complete a comprehensive impact assessment and to be comparable with other reaches. The data available are over ten years old and therefore may not be representative of current baseline conditions. No data for Cow Common Brook and other watercourses within this reach. As such, further surveys are required to inform a robust impact assessment and to provide detailed understanding of the habitat provided by these watercourses to ensure appropriate mitigation can be designed.
2	No Environment Agency data available post 2010. Due to the proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. No phytoplankton data made available.	Direct loss of habitat and reduction in flows may facilitate loss of diatom species and abundance. A change in diatom assemblages could see an increase taxon composition due to siltation. No future operational discharge from the reservoir into the River Ock system.	Data missing for watercourses within this reach. The main impact pathway is the direct loss of habitat and reduction in flows that will lead to the loss of species and abundance.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
3	No Environment Agency data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. No phytoplankton data made available.	Potential loss of headwater channels for all options associated with proposed railway sidings and a materials handling area. At this stage, it is unclear whether there are any channels likely to be impacted due to a lack of baseline survey. Direct loss of habitat and reduction in flows may facilitate loss of diatom species and abundance. A change in diatom assemblages could see an increase taxon composition due to siltation. No future operational discharge from the reservoir into the River Ock system.	The main impact pathway is the direct loss of habitat and reduction in flows that will lead to the loss of species and abundance. Data missing for watercourses within this reach. As such, further surveys are required to inform a robust impact assessment and to provide detailed understanding of the habitat provided by these watercourses to ensure appropriate mitigation can be designed.
4	**River Thames:** three Environment Agency monitoring sites were found that have all been sampled once since 2010, the most recent being on 26 July 2011 (Site ID: 34675). Biological metrics are indicative of diatoms with low percentage of motile taxa (38.15%), with a low planktonic taxon (9.52%). No phytoplankton data made available.	This reach is upstream of direct impacts.	No impact anticipated.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
5	River Thames: No Environment Agency diatom data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. Specific monitoring for phytoplankton was undertaken in 2005, 2006 and 2008. The phytoplankton community in the River Thames appeared to be dominated by diatoms and chlorophytes throughout 2005, with cryptophytes increasing in abundance in the summer of 2006. Chlorophyll-*a* concentration was similar temporally at all sites surveyed in 2005–6, and a phytoplankton bloom was detected on 9 September 2005. The phytoplankton community in 2008 was dominated by diatoms and picoplankton with chlorophytes also making up a significant portion of the community. Chlorophyll-*a* concentrations appeared to show peaks that coincided with the abundance of diatoms. Peaks in picoplankton abundance occurring in the latter half of the 2008 survey period were not reflected in the chlorophyll-*a* concentrations. This is probably linked to the fact that although picoplankton were numerous, their small size results in a very low biomass. No phytoplankton data made available.	It is considered unlikely that the discharge from the reservoir will affect diatom species in the River Thames due to a level controlled environment with low sensitivity to changes in flows and velocity. There is a potential for changes in phytoplankton communities in the River Thames as a result of SESRO discharges. This can both be 'seeding' of the River Thames by SESRO phytoplankton as well as moving existing phytoplankton downstream as a result of the discharge. As the flow slows, there may be a local build-up of phytoplankton biomass, especially under low conditions which can affect dissolved oxygen levels locally. The main area of hydrological influence is considered to be up to the River Thame confluence. Any effects would be greatest in this reach.	No further assessment required for diatoms. Algal mass in SESRO should be managed through mitigation measures, notably vertical mixing. Further monitoring and assessment is required to determine the potential for SESRO to change phytoplankton communities in the River Thames downstream of the discharge. The timing of the discharge is more likely to affect the 'autumn bloom' compared to the much larger 'spring bloom'.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
6	**River Thames:** one Environment Agency monitoring site was found that has been sample once on 2 August 2011 (Site ID: 153530). Biological metrics are indicative of diatoms with a low percentage of motile taxa (20.38%), with no planktonic taxa. No Environment Agency phytoplankton data made available, although there is a long-term CEH monitoring site at Wallingford.	It is considered unlikely that the discharge from the reservoir will affect diatom species in the River Thames due to low sensitivity to changes in flows and velocity. There is a potential for changes in phytoplankton communities in the River Thames as a result of SESRO discharges. The impacts associated with the discharge will lessen as distance from the structure increases and may become eclipsed by other pressures, such as additional intakes and discharges, lock structures and land use pressures.	No further assessment required for diatoms. Algal mass in SESRO should be managed through mitigation measures, notably vertical mixing. Further monitoring and assessment is required to determine the potential for SESRO to change phytoplankton communities in the River Thames downstream of the discharge. For reaches downstream of Reach 5 (6–13), this should consider primary and/or secondary effect (if any) of phytoplankton being moved downstream.
7	**River Thames**: No Environment Agency data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. No Environment Agency phytoplankton data made available.	See Reach 6.	See Reach 6.
8	**River Thames:** one Environment Agency monitoring site was found that has been sampled twice since 2010, the most recent of which was on 14 September 2012 (Site ID: 35862). Biological metrics are indicative of diatoms with a low percentage of mobile taxa (14.43%) and low planktonic taxa (19.75%). No Environment Agency phytoplankton data made available.	See Reach 6.	See Reach 6.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
9	**River Thames:** one Environment Agency site was found that has been sampled four times since 2010, the most recent of which was 22 September 2014 (Site ID: 35919). Biological metrics are indicative of diatoms with a low percentage of motile taxa (22.29%), and no planktonic taxa. No Environment Agency phytoplankton data made available.	See Reach 6.	See Reach 6.
10	**River Thames:** No Environment Agency data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. No Environment Agency phytoplankton data made available, although there are historic Thames Water data for the AMP5 LTOA investigation in this reach	See Reach 6.	See Reach 6.
11	**River Thames:** No Environment Agency data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. No Environment Agency phytoplankton data made available, although there are historic Thames Water data for the AMP5 LTOA investigation in this reach.	See Reach 6.	See Reach 6.

Reach	Baseline Description	Potential impact pathway	Gate 1 proportional initial assessment findings
12	No Environment Agency data available post 2010. Due to the close proximity to the other reaches and the similarities across them, we can assume that there will be commonality in the assemblages and metrics found across the study area. No Environment Agency phytoplankton data made available, although there are historic Thames Water data for the AMP5 LTOA investigation in this reach.	See Reach 6.	See Reach 6.
13	**River Thames:** one Environment Agency monitoring site was found that has been sampled tice since 2010, the most recent being on 28 September 2010 (Site ID: 35900). Biological metrics are indicative of diatoms with a low percentage of mobile taxa (15.77%), and low planktonic taxa (2.84). No Environment Agency phytoplankton data made available, although there are historic Thames Water data for the AMP5 LTOA investigation in this reach.	See Reach 6.	See Reach 6.

8.4.4.2. Conclusions

For all watercourses within the Ock catchment and the River Thames, diatom data was either outdated or not available from the Environment Agency. Where data were available, diatom communities were indicative of 'less than Good' WFD status, which is in keeping with overall elevated phosphate levels in the River Thames river basin (including the River Ock). For Reaches 1,2 and 3, the main impact pathway will be direct loss of habitat and reduction on flows may facilitate loss of diatom species and abundances. There is also a risk of impacts associated with construction activities, which can be managed through implementation of best practice pollution prevention measures such as those specified in Section 6.4.1.2.

For the River Thames, the impact pathway constitutes potential changes in flow and water quality. Diatoms have low sensitivity to changes in flow and velocity, meaning that any changes in flow/velocity are unlikely to affect this group. With regard to changes in water quality, although the SIMCAT work suggests that phosphate levels may decrease when the scheme is operational, it is unlikely that this will be result in a noticeable different diatom community. Further assessment is therefore not proposed, although some updates to the River Ock baseline are needed to characterise the nutrient levels Reaches 1 & 2.

Riverine plankton are largely controlled by of the river's discharge regime and are therefore among those aquatic organisms likely to be affected directly by any alterations to discharge regime, such as from reservoir operation. As the reservoir is expected to release more frequently between June and November, this is likely to avoid the phytoplankton 'spring bloom' in the River Thames; but may affect the 'autumn bloom'. The exact timing of these two blooms in the Culham reach will need to be defined by ongoing monitoring work. The importance of plankton in the ecosystem of the River Thames is as a food source for larval and juvenile fish, both directly and indirectly via predation on the invertebrates which graze upon the phytoplankton, zooplankton and diatoms. The timing, magnitude and composition of phytoplankton blooms and zooplankton abundance peaks are the major factors influencing the early growth rates of cyprinid fish and ultimately their long-term population performance. Adequate baseline data for plankton, and also for young fish, are crucial for informing assessments undertaken as part of Gate 2.

Alternative impact pathway is potential 'seeding' of the River Thames with phytoplankton contained in SESRO and vice versa. Mitigation measures required include vertical mixing in SESRO to reduce the occurrence of phytoplankton blooms. It is possible that a discharge of SESRO containing phytoplankton during lower flow conditions in the River Thames can move existing phytoplankton communities as well as 'seed' the river with more algae. Given SESRO abstracts at higher flows and discharges at lower flows, water quality conditions in the reservoir and river are likely to be different. Away from the discharge location, as the flow slows, there may be a local build-up of phytoplankton biomass, especially under low conditions which can affect dissolved oxygen levels locally. There is, however, uncertainty if any algae discharged into the River Thames would thrive or perish and this requires further investigation.

8.4.4.3. Assessment framework towards Gate 2

No further assessment is proposed for diatoms due to low sensitivity to changes in flow and velocity, although some River Ock and River Thames surveys would bring the baseline more up to date than the current dataset available.

For phytoplankton, it is proposed that seasonal monitoring is undertaken March – October ideally during higher, low and normal flow years to understand variability in relation to river flow. For SESRO, key sampling locations include Culham as well as key other locations downstream where water may be abstracted including the proposed T2ST and T2AT abstraction locations. Analysis should be for different phytoplankton groups using flow cytometry, allowing comparison to CEH's longer-term datasets.

A review of algal modelling undertaken by Atkins has revealed that there are significant uncertainties related to the accurate representations of algal biomass over time. This position was documented as part of the Atkins modelling review paper[45] and agreed with the Environment Agency on 18 February 2021. Algal modelling is therefore not proposed for the River Ock or the River Thames and, instead, the potential for SESRO to impact phytoplankton communities in the River Thames should be

[45] Atkins (2020) SESRO Reservoir and River Modelling Review (Task 3 & 6). Technical Note. Issued 17 December 2020.

investigated using multiple lines of evidence. As mentioned above, it is hypothesized that SESRO may cause algal 'seeding' of the River Thames as it discharges under lower flow conditions and could cause a local build-up of phytoplankton in reaches where the flow slows. The proposed approach, therefore, includes:

- An eutrophication risk modelling approach to understand the driving factors for phytoplankton blooms in the River Thames, including flow conditions, light, temperature and nutrient conditions. The aim of this work would be to understand if discharges from SESRO could change these conditions and if there is a possibility that a discharge from SESRO at a certain time of year may cause an adverse effect. The work would also involve CEH's future flow predictions and predicted climate projections for sunshine, air temperature and nutrient conditions in the River Thames;
- A set of field-based 'microcosm' and lab-based 'microcosm' experiments to investigate the fate of phytoplankton abstracted from the River Thames into SESRO and the fate of phytoplankton discharged from SESRO into the River Thames at three different times of the year (April, June, August), using Farmoor algae as a proxy for SESRO algae.

An outline methodology of different algal assessment methods was shared with the Environment Agency on 19 February 2021. At the time of writing no formal comments have been received but we welcome the opportunity to discuss further and agree the proposed approach for Gate 2. As set out in 6.3.1, it is also proposed that algae are modelled in the reservoir by CEH using the PROTECH model. At the time of writing no formal comments have been received but the opportunity to discuss further and agree the proposed approach for Gate 2 is welcomed.

8.4.5. Zooplankton

8.4.5.1. Gate 1 proportional assessment findings

Although not part of WFD status assessments, zooplankton is fundamentally important as a food source for fish populations in river systems like the River Thames. The occurrence of riverine zooplankton is fundamentally linked to the availability of a food source notably phytoplankton. Zooplankton 'blooms' are also largely controlled by of the river's discharge regime and are therefore among those aquatic organisms that are likely to be affected directly by any alterations to discharge regime, such as from reservoir operation.

8.4.5.2. Conclusions

River Thames zooplankton monitoring was undertaken by Thames Water fortnightly between April and September; and at monthly intervals between October and March in 2005, 2006 and 2008. Sites included the River Thames upstream of SESRO at Nuneham and Abingdon Marina; and River Thames downstream of SESRO at Culham, Appleford, d/s River Thame, Caversham near Reading and Romney Lock, Windsor.

This found that, generally, the zooplankton community of the River Thames was dominated by cladocerans in the summer of 2005, while in 2006 large numbers of copepods were found. The zooplankton community in 2008 was predominantly composed of cladocerans and copepods with relatively low numbers of rotifers, when compared with abundance in previous studies undertaken by the Environment Agency. Zooplankton abundance appeared to be linked to phytoplankton density, with increasing abundance of zooplankton animals typically occurring shortly after peaks in phytoplankton density and chlorophyll-*a* concentration, indicative of 'grazing' of phytoplankton by zooplankton.

As the scheme is expected to operate more frequently between June and November, there is a possibility that the zooplankton blooms are affected by any larger discharges that may occur earlier in the year. Timing of larger discharges as well as sufficient backwater habitat will be important mitigation considerations for zooplankton. Any effects are anticipated to be greatest in Reach 5, reducing further downstream.

This suggests that the velocity as well as the timing of any SESRO discharges is an important consideration when understanding the impacts of the proposed reservoir on zooplankton communities.

8.4.5.3. Assessment framework towards Gate 2

Further review of (grey) scientific literature is needed to understand the main zooplankton groups in the River Thames, when these are expected to be present and what their environmental preferences are in terms of general water quality, flow and velocity.

Further monitoring of zooplankton within the Culham reach is also required to better understand the seasonality of zooplankton in the vicinity of the proposed SESRO outfall and link this back to the availability of phytoplankton; and predation by fish larvae and fish fry.

The assessment of potential impacts on zooplankton should be semi-quantitative and focus on the flow and velocity conditions when 'blooms' are expected to occur as well as habitat availability e.g. marginal macrophytes in the vicinity of the proposed outfall which may provide shelter during changing flow conditions.

9. Invasive and Non-Native Species (INNS)

9.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO, including the reservoir itself; the River Ock underneath and downstream of the SESRO footprint; and in the River Thames upstream and downstream of the proposed discharge point near Culham.

The methodology for the approach has been outlined in an INNS Methodology Statement provided to the Environment Agency on 24/11/2020[46], with local and NAU Environment Agency discussions held on 18/12/2020 and 10/02/2021 respectively. The NAU provided confirmation in writing on 11/02/2021 that the SESRO INNS assessment methodology was suitable for Gate 1.

Therefore, only a summary of the methods is provided within, and most of the report focuses on the results from the asset and raw water transfer risk assessments and the options appraisal of the biosecurity measures.

9.2. Datasets Reviewed

The following datasets were used for the assessments in this report:

- National Biodiversity Network (NBN);
- Invasive Non-Native Species Survey Results, Ricardo (2020);
- Cascade Consulting (2009) Invasive Species Review. March 2009;
- Thames Water (2009) Phase 1 Habitat, Higher and Lower Plan Surveys v1.1. Prepared by Applied Ecology on behalf of Cascade Consulting;
- Thames Water WRMP19 Resource Options: Abingdon Reservoir Conceptual Design Report (2018); and,
- Preliminary Design Report, Jacobs (2007)[47].

Data from the above datasets were used to identify INNS in the vicinity of the proposed reservoir and raw water transfers. It is noted that the 2009 Cascade Consulting and Thames Water work included Thames Valley Environmental Records Centre (TVERC) data, but that these need updating. As per the method statement only data for “high priority” INNS were collated. This includes all species categorised as “high impact” on the WFD UKTAG aquatic alien species list and all species of Union Concern or listed under Schedule 9 of the Wildlife and Countryside Act, 1981. It does not, however, include any invasive pathogens (terrestrial or aquatic).

9.3. Gate 1 proportional assessment methodology

With the construction of a new site there will be the potential for INNS to enter the asset and become established, and then subsequently spread to other locations. In the case of a surface water reservoir such as SESRO, this could be in the form of aquatic and riparian species entering with supply water or being spread with discharged water in the form of new raw water transfers. Similarly, activities in and around the reservoir can also lead into the introduction and subsequent spread of aquatic INNS, for example, boating and angling may lead to INNS picked up from elsewhere to transfer on equipment to the new site. There is also the potential for terrestrial and avian INNS to enter the site and become established. Understanding the risk presented by the proposed site in the context of INNS is an essential stage in the process of developing mitigation measures to reduce the risk of introduction and spread. For this purpose, two separate risk assessment tools are proposed to be used, which have extensive track record of implementation.

- The **asset risk assessment tool** (‘Tool 1’) has been initially designed by Wessex Water (in consultation with the Environment Agency) and considers a wide range of pathways and species types, and as such, will be used to examine the risk of introduction of INNS into the reservoir and

[46] Atkins (2020). SESRO INNS Risk Assessment Methodology – 24 November 2020.
[47] Jacobs (2007). Upper Thames Reservoir – Preliminary Design Report, Jacobs, Version 4.0, January 2007

surrounding area. This assessment tool will cover aquatic species introduced by pathways other than raw water transfers; and,

- The **raw water transfer tool** ('Tool 2') is specifically developed to meet the requirements of the Environment Agency's PR19 guidance on the assessment of raw water transfers[48]. This assessment tool has been used previously by Northumbrian Water Limited and will be used to examine the risk that the movement of raw water from and into the site may present.

Both tools use a pathway-based approach and are based around the use of a comprehensive list of functional groups. Both tools were updated by APEM to take account of the latest scientific understanding. For both tools this included an extension of the number of functional groups from four originally in the Wessex Water tool to 45 different groups identified as part of a piece of work undertaken on behalf of Yorkshire Water; as well as extending the number of different pathways for Tool 1.

Both tools use functional INNS groups rather than the traditional species-by-species approach. This approach takes account of life cycle strategies meaning that the use of functional group can take accounts of risks by a group of species, including horizon species not yet established, rather than focusing on specific species which are present at this moment in time. In addition to the assessment of relevant pathways, the process also includes an options appraisals stage whereby suitable control measures can be identified. These focus on functional groups, but can also be made species-specific, as required. The outcome of the work will be a process by which the priority risk pathways associated with the site are identified and suitable mitigation measures to reduce the risks presented by these pathways are recommended. These will be included in an up-dated scheme design as appropriate.

9.3.1. INNS and transfer pathways

It is important to note that, as described in the methods statement, the risk assessment and options appraisal are not species-specific, and that each INNS included in the assessment is assigned to a category (terrestrial plants, terrestrial animals, aquatic plants and aquatic animals) and each of these categories is further reduced to several functional groups. As stated above, a total of 45 different functional groups were identified (see Appendix 1 in the INNS Methodology Paper). The risk assessment and options appraisal are both conducted at a functional group level i.e. it is considered that species within the same functional group are associated with similar potential pathways of introduction/spread and can be targeted with similar mitigation measures.

Based on the draft designs of the reservoir, pathways which may result in the introduction/spread of INNS into or out of the reservoir were identified. This information, and the INNS data collated, were used to inform the asset based (section 9.3.2) and raw water transfer risk assessments (section 9.3.3). Existing datasets for terrestrial and aquatic INNS were reviewed for the following reaches:

- The whole River Ock catchment;
- a 20 km radius from the centre of the proposed SESRO reservoir site;
- a 2.5 km radius from the centre of the proposed SESRO reservoir site;
- an upstream reach of the River Thames bordering the river intake site; and,
- a downstream reach of the River Thames bordering the river discharge site.

This approach allows an assessment of which INNS in the local area are of greatest likelihood to establish themselves on site and therefore pose a risk to the biosecurity of the SESRO site.

9.3.2. Risk assessment of assets

The risk assessments for the reservoir and associated assets was conducted using a pathway-based tool. The tool used is hosted in Excel and follows a similar process to that developed by Wessex Water for their INNS asset assessments. More detailed information on the functionality of the tool has been provided in the INNS method statement. To create a linear (rather than exponential) trend in the range of final risk scores produced by the tool, a square root function has been added. This means that the total risk scores for each asset generated by the tool were square rooted to produce a final asset risk score of between 1 and 100 (from low to high risk).

[48] Environment Agency (2017). PR19 - Assessing the risks of spread of Invasive non-native species posed by existing water transfers - OFFICIAL

Based on the draft designs of the reservoir, scenarios were created based on different options of use and operation, which will affect the risk of INNS being introduced to the site. Data for each scenario were run through the assessment tool and the final asset risk scores compared.

The final asset risk scores were categorised on a Red Amber Green (RAG) scale as presented in Table 9-1. This is an indicative risk categorisation and the assessment of risk must always be considered on a case by case basis with expert judgement to support the findings of the tool.

Table 9-1 – Asset risk assessment tool – overall asset risk score risk categories

Score	Risk
0–33	Low
31–66	Medium
67–100	High

9.3.3. Risk assessment of raw water transfer

The risk assessment for raw water transfers was conducted using an excel-based tool which has been developed in accordance with the Environment Agency's PR19 guidance based on a template originally developed by Northumbrian Water. More detailed information on the functionality of the tool has already been provided as a methods statement.

Scenarios were created for the transfer of water from the reservoir to the Thames and vice versa. These scenarios take into consideration variations within the plans for the different transfer options, to account for how these may affect the risk of INNS being transferred via raw water transfers. Data for each scenario were run through the assessment tool to generate a final risk score of between 183 (low risk) and 630 (high risk). Overall scores were compared between scenarios to give an indication of relative risk in relation to INNS. The breakdown of these scores was also analysed to identify high risk pathways/activities to aid in the determination of where mitigation measures should be targeted.

The final raw water transfer risk scores were categorised on a RAG scale as presented in Table 9-2. This is an indicative risk categorisation and the assessment of risk must always be considered on a case by case basis with expert judgement to support the findings of the tool.

Table 9-2 – Raw water transfer risk assessment tool – overall risk score risk categories

Score	Risk
183–332	Low
333–481	Medium
482–630	High

9.3.4. Mitigation measures options appraisal

For each scenario a mitigation measures options appraisal was conducted, which has been reported in Technical Annex B1, Appendix A9 (INNS). This involved reviewing known biosecurity approaches (e.g. boat wash down facilities, signage, foot baths, targeted species management, screens) and assessing their appropriateness of use in each scenario, in relation to the key identified pathways. This involved the consideration of several factors such as: the type of transfer pathway, operationality, safety to the environment, efficacy against the species known to be present on site and overall feasibility of use. A simple scoring system was applied for each mitigation measure assessed and how suitable it would be for each high-risk asset/raw water transfer identified.

All options were scored from 1 to 3 for efficacy and feasibility and given a RAG colour code from which a cumulative score has been generated, also colour coded on a RAG scale (Table 9-3). Efficacy is the ability to produce the desired outcome, in this case to prevent or remove INNS; feasibility is the applicability of the option with regard to operational, environmental and social costs. These scores are derived from expert judgement and are to be used as an indication only of which methods are best recommended for implementation.

Table 9-3 – Three-point scoring for efficacy and feasibility

Score and Colour Code	Efficacy	Feasibility
1	Not effective at preventing or removing INNS	Significant negative operational, environmental or social cost
2	Moderately effective at preventing or removing INNS	Moderate operational, environmental or social cost
3	Highly effective at preventing or removing INNS	Minimal operational, environmental or social cost

9.4. Outputs/findings

9.4.1. INNS records search

9.4.1.1. Ock Catchment

Information on the high priority INNS (defined in section 9.3.1) located from NBN records within the Ock catchment is provided in Table 9-4.

Table 9-4 – Recorded presence of High Impact invasive species in the Ock catchment

Species	Common Name
Cotoneaster horizontalis	Wall Cotoneaster
Crocosmia pottsii x aurea = C. x crocosmiiflora	Montbretia
Parthenocissus quinquefolia	Virginia-Creeper
Robinia pseudoacacia	False-Acacia
Aix galericulata	Mandarin Duck
Alopochen aegyptiacus	Egyptian Goose
Anser indicus	Bar-Headed Goose
Branta canadensis	Canada Goose
Cervus nippon	Sika Deer
Cygnus atratus	Black Swan
Muntiacus reevesi	Chinese Muntjac
Neovison vison	American Mink
Netta rufina	Red-Crested Pochard
Oxyura jamaicensis	Ruddy Duck
Sciurus carolinensis	Eastern Grey Squirrel
Azolla filiculoides	Water Fern
Crassula helmsii	New Zealand Pigmyweed
Elodea canadensis	Canadian Waterweed
Elodea nuttallii	Nuttall's Waterweed
Fallopia japonica	Japanese Knotweed
Heracleum mantegazzianum	Giant Hogweed

Species	Common Name
Hydrocotyle ranunculoides	Floating Pennywort
Impatiens glandulifera	Himalayan Balsam
Lysichiton americanus	American Skunk-Cabbage
Rhododendron ponticum	Rhododendron Wyllt
Ambloplites rupestris	Rock Bass
Carassius auratus	Goldfish
Corbicula fluminea	Asian Clam
Cyprinus carpio	Common Carp
Dikerogammarus haemobaphes	Demon Shrimp
Dreissena polymorpha	Zebra Mussel
Hemimysis anomala	Bloody Red Shrimp
Pacifastacus leniusculus	Signal Crayfish
Silurus glanis	Wels Catfish

Colour coding correlates with the overarching functional group category:
Yellow = Terrestrial Plants;
Red = Terrestrial/ Aerial Animals;
Green = Aquatic/ Riparian Plants;
Blue = Aquatic Animals.

9.4.1.2. Within 20 km and 2.5 km radius of Reservoir

Information on the high priority INNS (defined in Section 9.3.1) located from NBN records within a 20 km and 2.5 km radius, centred on the location of the proposed reservoir, are provided in Table 9-5. These distances were selected to represent those species likely to pose an immediate risk (2.5 km) of being introduced and a medium-term risk (20 km).

Table 9-5 – Recorded presence of High Impact invasive species in the 20 km and 2.5 km radiuses

Species	Common Name	20 km Radius	2.5 km Radius
Cotoneaster horizontalis	Wall Cotoneaster	✓	
Crocosmia pottsii x aurea = C. x crocosmiiflora	Montbretia	✓	
Parthenocissus quinquefolia	Virginia-Creeper	✓	
Robinia pseudoacacia	False-Acacia	✓	
Cotoneaster simonsii	Himalayan Cotoneaster	✓	
Ailanthus altissima	Tree-of-Heaven	✓	
Aix galericulata	Mandarin Duck	✓	
Alopochen aegyptiacus	Egyptian Goose	✓	
Anser indicus	Bar-Headed Goose	✓	
Branta canadensis	Canada Goose	✓	✓
Cervus nippon	Sika Deer	✓	
Cygnus atratus	Black Swan	✓	
Muntiacus reevesi	Chinese Muntjac	✓	✓

Species	Common Name	20 km Radius	2.5 km Radius
Neovison vison	American Mink	✓	✓
Netta rufina	Red-Crested Pochard	✓	
Oxyura jamaicensis	Ruddy Duck	✓	
Sciurus carolinensis	Eastern Grey Squirrel	✓	✓
Hydropotes inermis	Chinese Water Deer	✓	
Tadorna ferruginea	Ruddy Shelduck	✓	
Anser caerulescens	Snow Goose	✓	
Aix sponsa	Wood Duck	✓	
Azolla filiculoides	Water Fern	✓	
Crassula helmsii	New Zealand Pigmyweed	✓	
Elodea canadensis	Canadian Waterweed	✓	✓
Elodea nuttallii	Nuttall's Waterweed	✓	
Fallopia japonica	Japanese Knotweed	✓	
Heracleum mantegazzianum	Giant Hogweed	✓	
Hydrocotyle ranunculoides	Floating Pennywort	✓	
Impatiens glandulifera	Himalayan Balsam	✓	✓
Lysichiton americanus	American Skunk-Cabbage	✓	
Rhododendron ponticum	Rhododendron Wyllt	✓	
Rosa rugosa	Japanese Rose	✓	
Myriophyllum aquaticum	Parrot's-Feather	✓	
Allium triquetrum	Three-Cornered Garlic	✓	
Ambloplites rupestris	Rock Bass	✓	
Carassius auratus	Goldfish	✓	
Corbicula fluminea	Asian Clam	✓	
Cyprinus carpio	Common Carp	✓	✓
Dikerogammarus haemobaphes	Demon Shrimp	✓	
Dreissena polymorpha	Zebra Mussel	✓	
Hemimysis anomala	Bloody Red Shrimp	✓	
Pacifastacus leniusculus	Signal Crayfish	✓	✓
Sander lucioperca	Zander	✓	✓

Colour coding correlates with the overarching functional group category:
Yellow = Terrestrial Plants;
Red = Terrestrial/ Aerial Animals;
Green = Aquatic/ Riparian Plants;
Blue = Aquatic Animals.

Several features and pathways which may result in the introduction/spread of INNS into or out of the reservoir were identified in the original 2018 CDR (see Technical Annex B1: EAR Figures, Figure 9-1). Not all of these have been taken forward in the 2021 CDR update, but the full list of activities has

been taken forward for assessment on a precautionary basis in case one or more are considered for inclusion at a later stage. Activities specified include:

- Car park;
- Boat park;
- Water sports clubhouse;
- Visitor centre;
- Equestrian centre;
- Outdoor educational centre;
- Heritage centre;
- Footpaths;
- Bridleways;
- Jetty;
- Pier;
- Slipway;
- Beach promenade;
- Cove;
- Road access;
- Angling pond;
- Water treatment works;
- Pumping station;
- Fully bunded reservoir;
- River intake;
- Pipe from river to pumping station;
- Pipe from pumping station to the main tower in the reservoir;
- Formal sports area e.g. tennis;
- Wetland and woodland; and,
- Auxiliary Discharge Channel (Reservoir to River Thames).

The pathways of INNS transfer identified and incorporated into the SESRO asset risk assessment tool were the following:

- Staff and contractor site visit (not entering water);
- Staff and contractor site visit entering or in contact with raw water e.g. sampler;
- Road Vehicle (INNS attached to tyres etc.);
- Grounds maintenance not entering water;
- Capital/mechanical maintenance in water;
- Fishing tackle, nets and waders;
- Live bait;
- Fish stocking;
- Inflatable or small boat if brought onto site;
- Inflatable or small boat if moved to another site;
- Water sports equipment if brought onto site;
- Water sports equipment if moved to another site;
- Aquatic birds;
- Wild animals: mammals and dogs;
- Terrestrial birds;
- Recreational walkers/joggers;
- Specialist contractors entering water e.g. hydro/eco surveys;

- Site development (e.g. planting vegetation/creating habitat corridors);
- Raw water transfer to site; and,
- Raw water transfer from site.

As set out in Technical Annex B2 (HRA), no statutorily designated sites were found within the risk assessment area as defined by the proposed site plans. No adjustment was, therefore, made to the risk assessment scoring to take account of designated sites.

9.4.2. Asset risk assessment tool outputs

Several scenarios were run in the asset risk assessment tool. These included a baseline of the SESRO reservoir site; multiple variations of the baseline, exploring the effects of changes in pathway use frequency; and a worst-case scenario building on the baseline scenario. Table 9-6 provides descriptions of the scenarios and Table 9-7 provides details of the pathway frequency scores for each scenario. As per the methods statement frequency scores are categorised on a five-point scale with 0.5 point increments between 0 and 2, 0 indicating that the pathway is not applicable to that scenario and 2 indicating that the pathway is very common under that scenario. Final risk scores for the asset under each scenario are also provided (see bottom of Table 9-7).

Table 9-6 – Asset risk assessment tool scenario descriptions

Scenario	Description
Baseline	The most realistic scenario for the reservoir, based on the information provided in the 2021 CDR. All other scenarios are alterations of this scenario.
1	No terrestrial or aquatic recreational activities on site.
2	No aquatic recreational activities on site. Terrestrial recreational activities such as walkers continue.
3	No vehicles on site. All people and recreational activities frequencies reduced by 0.5 compared to the baseline scenario to account for the reduction in transport to site.
4	Bankside angling in the reservoir, no water sports or boating.
5	Just boating the reservoir, no angling or water sports.
6	Just water sports in the reservoir, no angling or boating.
7	No vehicles on site, all other activities at anticipated level of frequency.
8	Angling, water sports and boating in the reservoir.
9	‘Worst case scenario’, with all anticipated activities at maximum frequency.

Table 9-8 indicates which mitigation measures would be suitable for reducing the risk associated with each scenario. Some options are selected based on a scalable response with regard to the level of risk associated with the proposed scenario. All pathways are scored on a frequency of use (1–2, absent–very common). All scenarios had the same scoring with relation to the existence of high impact INNS and protected species on site and the highest order of designation at the site. These scores are on a scale of 1–2. However, their weighting is greater than that of the frequency of use scores assigned to the pathways. The significance of this additional weighting is exemplified in scenario 9, which although a worst-case scenario for the SESRO reservoir achieves a risk category of medium. The final asset risk score is colour coded on a RAG scale as presented in Table 9-1.

Table 9-7 – Asset risk assessment tool scenarios. Scenarios defined in Table 9-6.

Activity	Scenario									
	Baseline	1	2	3	4	5	6	7	8	9
Same for all scenarios, these scores carry a greater weighting than the frequency of use scores assigned to each pathway below.	Existing high impact INNS on site: Known to be on site. Carries a weighting of 2. Existing protected species on site: Not known to be present. Carries a weighting of 1. Highest order site designation of asset: None. Carried a weighting of 1.									
Staff site visit (not entering water)	2	1.5	2	1.5	2	2	2	2	2	2
Staff site visit (in contact with water)	1.5	1	1	1	1	1.5	2	1.5	1.5	2
Road vehicle	2	1.5	2	0	2	2	2	0	2	2
Grounds maintenance not in water	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5	2
Capital/mechanical maintenance in water	1	0.5	0.5	0.5	0.5	1	1	1	1	2
Fishing tackle, nets and waders	0	0	0	0	2	0	0	0	2	2
Live bait	0	0	0	0	2	0	0	0	2	2
Fish stocking	0.5	0	0.5	0.5	2	0	0	0.5	2	2
Berthed boat if brought onto site	0	0	0	0	0	0	0	0	0	0
Berthed boat if moved to another site	0	0	0	0	0	0	0	0	0	0
Small/inflatable boat if brought onto site	1.5	0	0.5	1	0	2	0	1.5	1.5	2

Activity	Scenario									
	Baseline	1	2	3	4	5	6	7	8	9
Small/inflatable boat if moved to another site	1	0	0	0.5	0	2	0	1	1	2
Water sports equipment if brought onto site	2	0	0	1.5	0	0	2	2	2	2
Water sports equipment if moved to another site	1.5	0	0	1	0	0	2	1.5	1.5	2
Mammals/birds entering the water	2	1	1.5	2	2	2	2	2	2	2
Mammals/birds not entering the water	2	1	2	2	2	2	2	2	2	2
Sludge transferred to land	0	0	0	0	0	0	0	0	0	0
Recreational walker/jogger/runner	2	0	2	1.5	2	2	2	2	2	2
Specialist contractors entering the water	1	1	1	0.5	1	1	1	1	1	2
Site development	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2
Raw water transfer to site	2	2	2	2	2	2	2	2	2	2
Raw water transfer away from site	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2
Final Asset Risk Score (out of 100)	**40**	**29**	**33**	**35**	**38**	**38**	**38**	**39**	**44**	**50**
Interpretation (see Table 9-1)	**Medium**	**Low**	**Low**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**

Table 9-8 – Mitigation methods suitable for each pathway scenario (see detailed description in Technical Annex B1, Appendix A9)

Mitigation method options	Scenario									
	Baseline	1	2	3	4	5	6	7	8	9
Biosecurity Check Points										
Separate wash-down and drying areas	✓			✓	✓	✓	✓	✓	✓	✓
Boat wash down unit	✓			✓		✓		✓	✓	✓
Pressure washing hose		✓	✓				✓			
Disinfectant stations	✓			✓	✓			✓	✓	✓
Boot washing	✓		✓	✓	✓	✓	✓	✓	✓	✓
Tyre troughs										✓
Site Development										
Hard surfaces for high risk points such as car parks, paths and access to reservoir	✓		✓	✓	✓	✓	✓	✓	✓	✓
Deer fencing and grids	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bird deterrents	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Root barrier fabric	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Structural										
Limited access points	✓			✓	✓	✓	✓	✓	✓	✓
Physical net around launching area	✓			✓	✓	✓	✓	✓	✓	✓
Gas bubble curtain	✓			✓	✓	✓	✓	✓	✓	✓
Aquatic Recreational Activity										
Site owned equipment	✓			✓	✓	✓	✓	✓	✓	✓
Prohibit live bait	✓			✓	✓			✓	✓	✓

Mitigation method options	Scenario									
	Baseline	1	2	3	4	5	6	7	8	9
Limit fishing to members only	✓			✓	✓			✓	✓	✓
Events										
Limit number and/ or scale of events	✓			✓	✓	✓	✓	✓	✓	✓

9.4.3. Raw Water Risk Assessment

9.4.3.1. Thames to Reservoir

Information on the high priority INNS (defined in Section 9.2) located from NBN records within the River Thames reach from Oxford to Culham is provided in Table 9-9. This stretch of river was selected as representative of an area which will affect the proposed reservoir via the intake of INNS from the river.

Table 9-9 – Recorded presence of High Impact invasive species in the River Thames reach from Oxford to Culham

Species	Common name
Cotoneaster horizontalis	Wall Cotoneaster
Parthenocissus quinquefolia	Virginia-Creeper
Cotoneaster simonsii	Himalayan Cotoneaster
Azolla filiculoides	Water Fern
Elodea canadensis	Canadian Waterweed
Elodea nuttallii	Nuttall's Waterweed
Fallopia japonica	Japanese Knotweed
Impatiens glandulifera	Himalayan Balsam
Corbicula fluminea	Asian Clam
Dikerogammarus haemobaphes	Demon Shrimp
Dreissena polymorpha	Zebra Mussel
Hemimysis anomala	Bloody Red Shrimp
Pacifastacus leniusculus	Signal Crayfish
Eriocheir sinensis	Chinese Mitten Crab

Colour coding correlates with the overarching functional group category:
Yellow = Terrestrial Plants;
Green = Aquatic/Riparian Plants;
Blue = Aquatic Animals.

Records of two protected species were found in the stretch of the River Thames from Oxford to Culham, the depressed river mussel (*Pseudanodonta complanata*) and European eel (*Anguilla anguilla*).

9.4.3.2. Raw water transfer risk assessment tool outputs

Two scenarios were run in the raw water transfer risk assessment tool; a realistic baseline of the raw water transfer from the River Thames to the reservoir and a variation of the baseline, exploring the effects that changes in the raw water transfer might have on the overall risk of INNS transfer to the SESRO site. Table 9-10 provides a description of each of the raw water transfer risk assessment tool scenarios, while Table 9-11 provides details of the data inputted into the tool for each of these scenarios across the range of variables considered.

Table 9-10 – Raw water transfer risk assessment tool scenario descriptions

River Thames to Reservoir	Baseline	The most realistic scenario for raw water transfer from the River Thames to the reservoir. All other scenarios are based upon this baseline.
	1	>3 washout/ maintenance points in the raw water transfer.

Table 9-12 indicates which mitigation measures explored in the options appraisal (Technical Annex B1, Appendix A9) would be suitable for reducing the risk associated with each raw water transfer scenario. Some options are selected based on a scalable response with regards to the level of risk associated with the proposed scenario. The overall risk score is colour coded on a RAG scale as presented in Table 9-2.

Table 9-11 – Raw water transfer risk assessment tool scenarios. Scenarios defined in Table 9-10.

Raw water transfer tool options	River Thames → Reservoir		
	Scenario		
	Baseline		1
Source type	River intake		River intake
Number of raw water transfer inputs to source	3		3
Pathway type	Pipe		Pipe
Receptor type	ESR		ESR
Volume of water	>300 Ml/d		>300 Ml/d
Frequency of operation	Year round continuous, partial full and partial sweetening flow		Year round continuous, partial full and partial sweetening flow
Transfer distance (km)	1.1–5		1.1–5
Number of washout/ maintenance points	1		>3
Boat navigation source	Very high traffic		Very high traffic
Boat navigation pathway	None		None
Angling source	No		No
Angling pathway	No		No
Water sports source	Casual use by individuals		Casual use by individuals
Water sports pathway	No		No
Barriers to migration source	No		No
Barriers to migration pathway	No		No
Number of high priority INNS source	>5		>5

Raw water transfer tool options	River Thames → Reservoir		
	Scenario		
	Baseline		1
Number of high priority INNS pathway	None		None
Number of high priority INNS receptor	None		None
Highest order site designation source	National		National
Highest order site designation receptor	None		None
Number of protected species source	2		2
Number of protected species pathway	None		None
Number of protected species receptor	None		None
Other existing connections	None		None
Overall Risk Score (out of 630)	**449.5**		**451.5**
Interpretation (see Table 9-2)	**Medium**		**Medium**

Table 9-12 – Mitigation methods suitable for each raw water transfer scenario

Detailed descriptions of each are provided in Technical Annex B1 EAR: Appendix, A9.1

Mitigation method options	Scenario		
	Baseline		1
Preventative Measures			
Gas bubble curtain around draw down tower	✓		✓
Physical netting around draw down tower	✓		✓
Pipe overhangs and biosecure structure design	✓		✓
Silicone based coating in the lining of the pipeline – in conjunction with increased flow	✓		✓
Sand filters	✓		✓
Mussel Mast'R Aquatic Invasive Species Filter	✓		✓
Operational Measures			
Stopping flow to dry out the pipeline	✓		✓
Increase flow to dislodge biofouling	✓		✓
Water Treatment			
Coagulation and flocculation	✓		✓
Chlorination	✓		✓
BioBullets	✓		✓
Zequanox	✓		✓

9.4.3.3. Reservoir to Thames

Information on the high priority INNS (defined in section 9.3.1) located from NBN records within the River Thames reach from Culham to Benson is provided in Table 9-13. This stretch of river was selected as representative of an area which will be affected by the discharge of water from the proposed reservoir.

Table 9-13 – Recorded presence of High Impact invasive species in the River Thames reach from Culham to Benson

Species	Common Name
Muntiacus reevesi	Chinese Muntjac
Elodea canadensis	Canadian Waterweed
Elodea nuttallii	Nuttall's Waterweed
Heracleum mantegazzianum	Giant Hogweed
Impatiens glandulifera	Himalayan Balsam
Corbicula fluminea	Asian Clam
Cyprinus carpio	Common Carp
Dikerogammarus haemobaphes	Demon Shrimp
Dreissena polymorpha	Zebra Mussel
Hemimysis anomala	Bloody Red Shrimp
Pacifastacus leniusculus	Signal Crayfish
Eriocheir sinensis	Chinese Mitten Crab

Colour coding correlates with the overarching functional group category:
Red = Terrestrial/ Aerial Animals;
Green = Aquatic/ Riparian Plants;
Blue = Aquatic Animals.

9.4.3.4. Raw water transfer risk assessment tool outputs

Seven scenarios were run in the raw water transfer risk assessment tool. These included a realistic baseline of the raw water transfer from the reservoir to the River Thames and variations of the baseline, exploring the effects that changes in the raw water transfer might have on the overall risk of INNS transfer from the SESRO site. Table 9-14 provides a description of each of the raw water transfer risk assessment tool scenarios, while Table 9-15 provides details of the data inputted into the tool for each of these scenarios across the range of variables considered.

Table 9-14 – Raw water transfer risk assessment tool scenario descriptions

Raw water transfer	Scenario	Description
Reservoir to River Thames	Baseline	The most realistic scenario for raw water transfer from the reservoir to the River Thames. All other scenarios are based upon this baseline.
	1	No angling or water sports in the reservoir.
	2	International angling events, but no water sports in the reservoir.
	3	International water sports events, but no angling in the reservoir.
	4	>3 washout/ maintenance points in the raw water transfer.
	5	International angling and water sports events in the reservoir.
	6	Emergency drawdown pipe raw water transfer[49].

Table 9-16 indicates which mitigation measures explored in the options appraisal (Technical Annex B1, Appendix A9) would be suitable for reducing the risk associated with each raw water transfer scenario. Some options are selected based on a scalable response with regards to the level of risk associated with the proposed scenario. The overall risk score is colour coded on a RAG scale as presented in Table 9-2.

[49] The emergency drawdown pipe will in reality be a feature of all scenarios. However, for the purpose of the tool, this has been assessed as a separate raw water transfer.

Table 9-15 – Raw water transfer risk assessment tool scenarios. Scenarios defined Table 9-14.

Raw water transfer tool options	Reservoir → River Thames						
	Scenario						
	Baseline	1	2	3	4	5	6
Source type	ESR	ESR	ESR	ESR	ESR	ESR	ESR
Number of raw water transfer inputs to source	1	1	1	1	1	1	1
Pathway type	Pipe	Pipe	Pipe	Pipe	Pipe	Pipe	Pipe
Receptor type	River intake	River intake	River intake	River intake	River intake	River intake	River
Volume of water	>300 Ml/d	>300 Ml/d	>300 Ml/d	>300 Ml/d	>300 Ml/d	>300 Ml/d	>300 Ml/d
Frequency of operation	Year round – intermittent	Year round – intermittent	Year round – intermittent	Year round – intermittent	Year round – intermittent	Year round – intermittent	For regulatory compliance, i.e. infrequent, regular short-term use
Transfer distance (km)	1.1–5	1.1–5	1.1–5	1.1–5	1.1–5	1.1–5	1.1–5
Number of washout/ maintenance points	1	1	1	1	>3	1	1
Boat navigation source	None	None	None	None	None	None	None
Boat navigation pathway	None	None	None	None	None	None	None
Angling source	No	No	Members and day ticket holders, international events	No	No	Members and day ticket holders, international events	No

Raw water transfer tool options	Reservoir → River Thames						
	Scenario						
	Baseline	1	2	3	4	5	6
Angling pathway	No	No	No	No	No	No	No
Water sports source	National events	No	No	International events	National events	International events	National events
Water sports pathway	No	No	No	No	No	No	No
Barriers to migration source	No	No	No	No	No	No	No
Barriers to migration pathway	No	No	No	No	No	No	Yes
Number of high priority INNS source	None	None	None	None	None	None	None
Number of high priority INNS pathway	None	None	None	None	None	None	None
Number of high priority INNS receptor	>5	>5	>5	>5	>5	>5	>5
Highest order site designation source	None	None	None	None	None	None	None
Highest order site designation receptor	International	International	International	International	International	International	International
Number of protected species source	None	None	None	None	None	None	None
Number of protected species pathway	None	None	None	None	None	None	None
Number of protected species receptor	None	None	None	None	None	None	None
Other existing connections	None	None	None	None	None	None	None
Overall Risk Score (out of 630)	**455.5**	**452.5**	**460.5**	**456.5**	**458.5**	**464.5**	**476**
Interpretation (see Table 9-2)	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**

Table 9-16 – Mitigation methods suitable for each raw water transfer scenario. Detailed descriptions of each are provided in Technical Annex B1, Appendix B9.

Mitigation method options	Scenario						
	Baseline	1	2	3	4	5	6
Preventative Measures							
Gas bubble curtain around draw down tower	✓	✓	✓	✓	✓	✓	✓
Physical netting around draw down tower	✓	✓	✓	✓	✓	✓	✓
Pipe overhangs and biosecure structure design	✓	✓	✓	✓	✓	✓	✓
Biocidal paint in the lining of the pipeline		✓	✓				
Silicone based coating in the lining of the pipeline – in conjunction with increased flow	✓	✓	✓	✓	✓	✓	✓
Sand filters	✓	✓	✓	✓	✓	✓	✓
Mussel Mast'R Aquatic Invasive Species Filter	✓			✓	✓	✓	✓
Operational Measures							
Stopping flow to dry out the pipeline	✓	✓	✓	✓	✓	✓	✓
Increase flow to dislodge biofouling	✓	✓	✓	✓	✓	✓	✓
Water Treatment							
Coagulation and flocculation	✓		✓	✓	✓	✓	✓
Chlorination	✓		✓	✓	✓	✓	✓
BioBullets	✓	✓	✓	✓	✓	✓	✓
Zequanox	✓	✓	✓	✓	✓	✓	✓

9.5. Conclusions

Detailed, transparent and auditable assessment tools have been used to assess the risk of INNS being introduced and spread by the creation of the proposed reservoir itself as well as the raw water transfers to and from the River Thames. While these tools are based on existing methods such as the Wessex Water asset assessment tool and Northumbrian Water raw water transfer tool. The risk scores of different scenarios are presented. These scenarios have been developed based on the 2021 CDR but will require updating as the design progresses. These scenarios take into consideration different variations in the pathway frequency to understand how this will alter the risk. For example, there being no recreational activities at the site, or if no vehicles were to be allowed on site.

In relation to the asset risk assessments, under baseline conditions the site would be considered a 'medium risk' according to the RAG scale applied. The full removal of all terrestrial recreational activities or aquatic recreational activities means the site would be considered a 'low risk'. This result illustrates the elevated risk that recreational activities, especially those in the aquatic environment, present in relation to the transfer of INNS. Further work is needed as part of Gate 2 to balance the risk of INNS transfer and the potential cost of biosecurity measures with the large socio-economic benefits that can be gained from allowing recreation at the reservoir.

All the raw water transfer scenarios assessed were considered of a 'medium risk' according to the RAG scale applied. It is noted that the raw water transfer outputs were in the upper part of the medium risk band, with the medium risk applicable to the reservoir itself, the River Thames and not the River Ock. While there were no major changes between scenarios in the way in which the raw water transfers will operate (e.g. type of transfer or volumes of water being moved), the medium risk category is based on the inherent risk of unmitigated movements of water of this volume. This activity cannot be prevented from occurring and thus mitigation is required.

Both the asset itself and the raw water transfer will require mitigation measures to reduce the risks identified. In relation to construction, there is a commitment from Thames Water to remove all INNS on-site prior to construction starting. A range of biosecurity measures have been evaluated for both the management of the site and raw water transfers. The selection of suitable biosecurity measures is based on an initial assessment of the efficacy and feasibility of implementing the measures. Those biosecurity measures considered most suitable for use are then used within the recommendation on how best to tackle a particular pathway. A base line set of biosecurity measures are recommended as a minimum standard for the establishment of a modern surface water asset. Additional measures are suggested to tackle specific pathways under the different scenarios. Thames Water are currently undertaking a set of AMP7 WINEP investigations for INNS for assets with public access (including, but not limited to, Farmoor Reservoir) as well as raw water transfers which includes specifying and (where feasible) installing biosecurity measures at assets with public access. The SESRO SRO will take account of the findings of this study as the WINEP work progresses over the next 12 months. Many of the options presented, especially in relation to the raw water transfers have not be tested and are presented will require further investigation prior to implementation.

This report provides preliminary assessments of INNS related risks based on scenarios derived from concept plans and ideas. The assessments provide an initial picture of where the risks are in relation to the proposed reservoir and how these could potentially be reduced. The report also highlights the importance of considered biosecurity early in the planning phase of such sites so suitable measures can be incorporated into future design iterations.

9.6. Assessment framework towards Gate 2

The INNS risk assessment findings of this study will inform design iterations of the site, not only in relation to the activities proposed, but also biosecurity measures which can be incorporated into the design. With further refinement of the design and clarification of which activities are likely to take place in and around the proposed reservoir, then the risk assessments can be further refined, and a more definitive score provided. This will in turn aid in the further refining of the biosecurity plan for the site and raw water transfers.

As requested by the Environment Agency, it will be of value to consider the AMP7 WINEP findings for sites like Farmoor Reservoir and other similar surface waters and to risk assess these sites using the same method as means of comparison. Atkins have been commissioned to complete the WINEP work and thus will use the same INNS tools across the Thames Water estate and also undertake options appraisals of mitigation measures.

The next stage in the work (for Gate 2) will be to build on this by examining biosecurity measures being implemented elsewhere within Thames Water as part of the AMP7 WINEP investigations for public access sites

and raw water transfers. This will aid in validation of the assessment process and optional appraisal providing a live case for comparison. The timeframes for completing the AMP7 WINEP work will allow this to feed into the Gate 2 submission.

Gate 2 work will also take account of any further ecological surveys for macroinvertebrates, fish, macrophytes and INNS as well as any updated records collected by the Environment Agency as part of routine sampling along with updated data from TVERC.

As indicated above, the INNS assessment will need to continue to balance the risk of INNS transfers that recreational activities could bring with the large socio-economic benefits of those activities.

10. Other Habitats and Species

10.1. Introduction/explanation of topic area

This chapter examines the potential impacts of the construction and operation of SESRO, including the reservoir itself; on terrestrial and aquatic habitats and species of note within the River Ock catchment; and around the proposed discharge point near Culham.

The assessment has been mostly based on the largest reservoir footprint, which encompasses all six options and is, as such, precautionary. However, reference is made to specific options where necessary, as dictated by the findings of the assessment.

10.2. Datasets reviewed

The following datasets, existing report and online resources were reviewed whilst undertaking this assessment:

- Thames Water WRMP19 Resource Options: Abingdon Reservoir Conceptual Design Report (2018);
- Applied Ecology Ltd (2009) Water Vole Baseline Survey 2006–2008. March 2009;
- Applied Ecology Ltd (2009) Otter Monitoring Survey. March 2009;
- Applied Ecology Ltd (2009) Herpetofauna Baseline Survey. January 2009;
- Applied Ecology Ltd (2008) Harvest Mouse Survey. July 2008;
- Paul Chanin (2008) Water Shrew Baseline Survey 2006–2008. August 2008;
- Applied Ecology Ltd (2008) Brown Hare Survey. June 2008;
- Cascade Consulting, Bat Pro Ltd and Applied Ecology Ltd (2009) 2005–2009 Bat Survey. Version 1.3 (Draft). March 2009;
- Cascade Consulting (2009) Invasive Species Review. March 2009;
- Applied Ecology Ltd (2008) Badger Baseline Survey. November 2008;
- Applied Ecology Ltd (2009) Dormouse Survey. January 2009;
- Applied Ecology Ltd (2008) Terrestrial Invertebrate Baseline Survey 2005–2006. November 2008;
- Applied Ecology Ltd (2008) Ornithology Baseline Survey 2005–2008. August 2008;
- Applied Ecology Ltd (2009) Native Crayfish Baseline Survey 2006–2008. February 2009.

The following online resources were accessed:

- Multi-Agency Geographic Information for the Countryside (MAGIC)[50] website;
- Ordnance Survey maps from the Grid Reference Finder[51] website; and,
- The Woodland Trust Ancient Tree Inventory[52].

No extended Phase 1 habitat survey or other baseline habitat assessment was available for review.

OS maps and the Grid Reference Finder website (https://gridreferencefinder.com/) were used to identify the presence of waterbodies (standing water) within 500 m of the proposed Scheme boundary, in order to establish if the land within and immediately surrounding the Scheme boundary could be used as terrestrial habitat for great crested newt. This species typically uses suitable terrestrial habitat up to 500 m from a breeding pond. However, there is a notable decrease in great crested newt abundance beyond a distance of 250 m from a breeding pond[53].

[50] https://magic.defra.gov.uk/
[51] https://gridreferencefinder.com/
[52] http://ati.woodlandtrust.org.uk/
[53] Natural England (2004) An assessment of the efficiency of capture techniques and the value of different habitats for the great crested newt (ENRR576). [Available from: http://publications.naturalengland.org.uk/publication/134002]

10.3. Gate 1 proportional assessment methodology

The geographical area for obtaining ecological data through desk studies has been determined using professional judgement, with reference to technical guidance from the Chartered Institute of Ecology and Environmental Management (CIEEM)[54]. Baseline data has been gathered from a range of sources through using online resources and pre-existing reports as detailed in Section 10.2. This included data gathering in relation to statutory and non-statutory designated sites and protected and priority species[55]. The study areas used for the data gathering are detailed in Table 10-1. The desk study was undertaken on 03/02/2021.

OS maps and the Grid Reference Finder website (https://gridreferencefinder.com/) were used to identify the presence of waterbodies (ponds and ditches) within 500 m of the proposed Scheme boundary, in order to establish if the land within and immediately surrounding the Scheme boundary could be used as terrestrial habitat for great crested newt. This species typically uses suitable terrestrial habitat up to 500 m from a breeding pond. However, there is a notable decrease in great crested newt abundance beyond a distance of 250 m from a breeding pond. Table 10-1 lists the data search areas for each data type collected or reviewed.

Table 10-1 – Data search areas

Data type	Search area – distance from proposed Scheme boundary
Internationally designated sites for nature conservation	10 km (30 km for Special Areas of Conservation (SAC) with bats as a qualifying feature)
Nationally designated sites for nature conservation	5 km
Priority habitats and ancient woodland/veteran trees	1 km
European Protected Species licence applications (on MAGIC website)	2 km

In relation to internationally designated sites, a review and update of the Habitats Regulations Assessment (HRA) has been undertaken (see Technical Annex B2).

The scope of the desk study was limited to reviewing reports shared with Atkins and publicly available data from the sources listed above. No biological records have been requested from the local records centre at this time; a series of existing report (as listed in 10.2) have been reviewed and summarised in order to assess the species which may be present within the Scheme boundary.

10.4. Outputs/findings

The following sections outline the findings of the Gate 1 assessment. This has been undertaken with respect to construction only. Operation has not been considered in detail at this stage due to only high-level information being available in relation to the creation of terrestrial and aquatic habitats, which needs refining as part of Gate 2. The majority of ecological operational impacts can be minimised provided all construction impacts are adequately mitigated and the basic ecological principle of maintaining habitat connectivity is upheld. The Scheme will, on the whole, also deliver a number of benefits in terms of biodiversity. In addition, to a large body of water (the reservoir), which will provide habitat for birds and a number of aquatic species, the proposed habitat creation works around the reservoir will provide alternative or improved habitat for species already present and habitat for other species not yet recorded in the locality. Some existing habitats will be retained and enhanced to improve biodiversity and the following broad habitat types will be created where suitable conditions (topography, hydrology, geology and access) exist:

- Carr woodland, fen and wet grassland habitats associated with a watercourse/flood alleviation;
- Native broadleaved woodland;
- Scrubland/grassland with scattered scrub;
- Species-rich grassland/wildflower meadow;

[54] CIEEM (2017) Guidelines for Preliminary Ecological Appraisal, 2nd edition. Chartered Institute of Ecology and Environmental Management, Winchester.
[55] 'Priority Habitats' and 'Priority Species' in England are those listed as habitat or species 'of principal importance for the purpose of conserving biodiversity' within Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006.

- Species-rich hedgerows (with or without trees); and,
- Ponds/waterbodies.

10.4.1. Statutory and non-statutory designated sites for nature conservation

10.4.1.1. Statutory designated sites for nature conservation

Table 10-2 details the statutory designated sites identified through the desk study. There are no statutory designated sites for nature conservation under the footprint of the reservoir for any of the options.

Table 10-2 – Internationally designated sites within 10 km and nationally designated sites within 5 km of each option

Site name	Designation	Location of designated site	Features of interest (including qualifying features of internationally designated sites and reasons for designation for Sites of Special Scientific Interest (SSSIs))
Cothill Fen	Special Area of Conservation (SAC)	2.7 km north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Annex I habitats that are a primary reason for selection of this site 7230 Alkaline fens Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) * Priority feature
Little Wittenham	SAC	7.1 km east of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Annex II species that are a primary reason for selection of this site 1166 Great crested newt *Triturus cristatus*
Hackpen Hill	SAC	8.9 km southwest of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites) Annex II species that are a primary reason for selection of this site 1654 Early gentian *Gentianella anglica*
Barrow Farm Fen	SSSI	0.5 km to the north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	This site is primarily of interest for its remnants of calcareous fen vegetation which are found within a matrix of dense wet and dry carr woodland. This type of fen community has declined considerably within Oxfordshire and the only sizeable area now remaining is the nearby Cothill Fen.
Frilford Heath, Ponds and Fens	SSSI	1.9 km to the north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Fen marsh and swamp and dwarf shrub heath

Site name	Designation	Location of designated site	Features of interest (including qualifying features of internationally designated sites and reasons for designation for Sites of Special Scientific Interest (SSSIs))
Culham Brake	SSSI	1.7 km to the northwest of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Site is unmanaged willow carr, subject to flooding. Dominated by mature crack willow, occasional mature oak and ask.
Dry Sandford Pit	SSSI	2.4 km to the north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Abandoned quarry with calcareous vegetation, including fen, grassland, scrub and lichen-rich heath. Associated with the pools and their inflow and exit streams is a rich calcareous fen which differs from the neighbouring fen at Cothill in some aspects of its vegetation, particularly the bryophyte flora. Such fens are rare and confined to the Corallian beds of Oxfordshire. Five nationally rare solitary bees and wasps have been recorded including *Andrena hattorfiana*, *Psen bicolor* and *Nomada armata*, together with the very local *Dasypoda altercator*, a species normally confined to coastal duneland. Nationally rare Diptera (true flies) have also been found here including the only recent record of *Stratiomys chamaeleon*. Three local but conspicuous insects which have large populations here are the marbled white butterfly *Melanargia galathea*, the scarlet tiger moth *Callimorpha dominula* and the great green bush-cricket *Tettigonia viridissima*.
Cothill Fen	SSSI	2.7 km to the north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Large species rich lowland calcareous fen. Grass snakes, lizards and a large number of scarce invertebrates have been recorded including southern damselfly and Desmoulin's whorl snail. Several uncommon plants including alkaline fens, including narrow-leaved marsh orchid, marsh helleborine, bog pimpernel, black bog rush and marsh valerian.
Cothill	National Nature Reserve (NNR)	2.8 km to the north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Cothill NNR is known for its fens and their rich invertebrate life, but in addition the site also has open water, reedbeds and oak and alder woodland. Part of Cothill Fen SSSI and SAC.

Site name	Designation	Location of designated site	Features of interest (including qualifying features of internationally designated sites and reasons for designation for Sites of Special Scientific Interest (SSSIs))
Abbey Fishponds	Local Nature Reserve (LNR)	3.0 km to the north of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Wetlands, wet woodland, reedbed, fen and meadow.

Due to the distance of the three SACs from the proposed Scheme (over 2 km), direct impacts are not anticipated. The HRA produced for the Scheme is included in Technical Annex B2. There may be potential for indirect impacts on Barrow Farm Fen SSSI due to its location within 500 m of the Scheme extent. Despite the absence of a downstream hydrological link with Barrow Farm Fen SSSI, there may be potential for impacts during construction, e.g. via changes in air quality, which will need to be considered when more construction details become available. Impacts on all other SSSIs, and the NNR and LNR are not anticipated due to distance and absence of downstream hydrological links. However, all options fall within the SSSI Impact Risk Zone (IRZ) for the listed SSSI's, with a reservoir falling within the 'water supply' category. However, the potential for the Scheme to affect SSSIs is being assessed and will need to be considered in more detail during later stages of assessment in consultation with Natural England.

10.4.1.2. Non-statutory designated sites for nature conservation

No non-statutory designated sites information has been requested from the local records centre at this time. Therefore, the potential impact on such features has not been fully assessed. However, information in the existing reports indicate that two County Wildlife Sites (CWS) are present. These are The Cutting CWS and Hutchins's Copse CWS. The location of these CWS in relation to the option boundaries are summarised in Table 10-3 below.

Table 10-3 – Location of the two known CWSs (The Cutting and Hutchin's Copse) in relation to each option

Site name	Designation	Location of designated site	Features of interest
The Cutting	County Wildlife Site (CWS)	Within the redline boundary of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 30+100 Mm^3 and 80+42 Mm^3. Partially within option 75 Mm^3.	Deciduous woodland Priority Habitat
Hutchin's Copse	CWS	Immediately to the south of the railway line and to the south of the redline boundary of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 80+42 Mm^3	Deciduous woodland Priority Habitat

All Scheme options have potential to result in direct impacts upon The Cutting CWS and indirect impacts upon Hutchin's Copse CWS, depending on the construction works or other activities in the vicinity. As these are located close to the proposed railway sidings and material handling area adjacent to the railway line, and the diverted Hanney to Stevenson Road, there is potential for air quality impacts (dust, vehicle emissions) to adversely affect these sites. A detailed assessment of all potential impacts will be required.

The screening mound (assumed planted with trees) between the proposed railway siding and woodland and waterbodies, including The Cutting CWS, will potentially provide a habitat buffer and could act as an extension to the habitat if designed and installed appropriately. However, the potential impacts from habitat creation works on the CWSs will also need to be assessed during Gate 2, when details become available.

10.4.2. Habitats

The habitats within the Scheme boundary are largely agricultural fields consisting of arable, improved and semi-improved grassland. There are pockets of woodland, scrub and scattered parkland and trees throughout the Scheme boundary. Hedgerows and lines of trees border fields and there are flowing watercourses, ponds and ditches present throughout the Scheme boundary. Two solar farms, Goose Willow Solar Farm to the south and Landmead Solar Farm to the west, are present and lie within the footprint of all options.

The wider landscape has habitats largely similar to those within the Scheme boundary itself, consisting primarily of agricultural fields in all directions. There are a number of villages and towns surrounding the Scheme, including Drayton to the east, Steventon to the south east, Grove to the south west, West Hanney and Garford to the west and Marcham to the north.

No National Vegetation Classification surveys of habitats have been undertaken as part of the existing suite of surveys, so it is assumed that there are unlikely to be areas of botanical interest within the Scheme extent. However, the need for such surveys will be re-assessed when the Phase 1/ UKHab survey is updated.

10.4.2.1. Priority and notable habitats

Table 10-4 lists all of the priority and notable habitats within 1 km of the Scheme boundary.

Table 10-4 – Priority and notable habitats within 1 km of the Scheme boundary

Habitat type	Locations of the closest parcel of each habitat	Number of habitat parcels within 1 km
Floodplain grazing marsh	Within the northern extent and eastern extent of the Scheme boundary, primarily in the fields alongside the River Ock, for all options	87 parcels for all options
Deciduous woodland[56]	A number of parcels within the Scheme boundary, including Drayton Copse towards the centre of the Scheme and parcels associated with the Old Canal, the railway line and Steventon Storage Facility, off Hanney Road. Areas of woodland listed on the National Forest Inventory are present within the extent of the Scheme (all options) mostly associated with deciduous woodland Priority Habitat	260 parcels for options: 150 Mm^3, 30+100 Mm^3 and 80+42 Mm^3 248 parcels for options: 125 Mm^3, 100 Mm^3 and 75 Mm^3
Wood-pasture and parkland	Within the southern extent of the Scheme boundary (Hutchins's Marsh) for all options	Five parcels for all options
Traditional orchards	Within the south eastern extent of the Scheme boundary for all options	79 parcels for all options
Open mosaic habitat (draft)[57]	5 m to the west of the Scheme boundary	Four parcels for all options

[56] No further details of the type of deciduous woodland was available.
[57] Open Mosaic Habitats on Previously Developed Land - Probably the priority habitat but some uncertainty of interpretation.

Habitat type	Locations of the closest parcel of each habitat	Number of habitat parcels within 1 km
Lowland dry acid grassland	370 m to the north of the Scheme boundary	One parcel for all options
Lowland meadows	415 m to the west of the Scheme boundary for all options	Five parcels for all options
Good quality semi-improved grassland (non-priority)	505 m to the west of the Scheme boundary	Six parcels for all options
Lowland fens	615 m to the north of the Scheme boundary	One parcel for all options

All Scheme options will result in the loss of or direct impact upon priority habitat, primarily flood plain grazing marsh, deciduous woodland, traditional orchard and wood-pasture and parkland. All other priority habitats are located outside the option boundaries and only those within 500 m are considered likely to be require further investigation in detailed assessment whether they could be affected by construction. In this case, open mosaic habitat (on previously developed land), lowland dry acid grassland and lowland meadows. It is considered unlikely that priority habitats over 500 m from the Scheme option boundaries are likely to be affected. However, this assessment will need to be revisited as the Scheme progresses.

10.4.2.2. Ancient woodland and veteran trees

One area of ancient and semi-natural woodland has been identified, Hydes Copse, located 450 m to the north of the Scheme boundary for all options. Impacts on this area of ancient woodland are not anticipated given the distance from the Scheme boundary and absence of hydrological connectivity.

A search for records of ancient, veteran and other notable trees on the Woodland Trust Ancient Tree Inventory[58] website identified two such trees within the Scheme boundary for all options and approximately 27 trees within 1 km of the boundary for all Scheme options. The two trees within the Scheme redline boundary are as follows:

- Ancient crack willow associated with the Old Canal, north of Willowbrook Farm (Tree ID 212182) – located towards the centre of the Scheme area; and,
- Veteran crack willow near Marcham Mill (Tree ID 212174) – located on the northern boundary.

Site survey, and review of available old maps, will be required to update the baseline and ascertain whether any potentially irreplaceable features such as unrecorded ancient woodland and veteran trees are present. Review of available old maps would be undertaken during Gate 2. Site survey would be undertaken at the appropriate stage when access can be arranged, to search for veteran trees and to assess the woodland if the mapped evidence is inconclusive.

10.4.2.3. Waterbodies, ditches and watercourses

The following section provides information about waterbodies i.e. standing water in the form of ponds; ditches, which may hold standing water or a slight flow; and, watercourses i.e. all flowing water. Habitat features such of these are of note in terms of their potential to support great crested newts, water vole, otter and other protected and priority species. Specific details about watercourses within the Scheme extent, such as the lengths to be lost, are provided in Section 4.

Waterbodies and ditches

The waterbodies and drainage ditches within the Scheme boundary and within 500 m were identified from OS maps and aerial imagery. The numbers of drainage ditches and ponds for each option are summarised in Table 10-5.

[58] Ancient Tree Inventory - Woodland Trust

Table 10-5 – Ponds within the Scheme boundary and up to 500 m and drainage ditches within 500 m of each option

Option	Number of ponds within the Scheme extent	Number of ponds within 500 m	Number of ditches within the Scheme extent (see length in Table 4-1)	Number of ditches within 500 m (see length in Table 4-1)
150 Mm^3	12	32	69	41
125 Mm^3	12	32	69	41
100 Mm^3	11	33	69	37
75 Mm^3	10	34	69	32
30+100 Mm^3	12	32	69	41
80+42 Mm^3	12	32	69	41

Roads and development can present a barrier to the movement/dispersal of amphibians and other species; however, the majority of ponds and ditches have habitat connectivity for species movement (such as great crested newts) through hedgerows, scrub and potentially suitable grassland throughout the Scheme area.

All of the ponds and ditches within the extent of the Scheme options will be lost, with associated impacts on the species they support, which may include great crested newts, water vole, water shrew, grass snake and invertebrate assemblages of note. The loss of waterbodies, regardless of any species impacts, will be locally significant.

Watercourses

The watercourses that either intersect each Scheme boundary or are within 500 m of each Scheme boundary are included below in Table 10-6. Information about watercourses potentially affected by the Scheme is also presented in Section 4.4.

Table 10-6 – Watercourses within 500 m of the Scheme boundary

Watercourse	Location and connectivity to the site
Cow Common Brook	Within the Scheme boundary
Portobello Ditch	Within the Scheme boundary
Hanney Ditch	Within the Scheme boundary
Landmead Ditch	Within the Scheme boundary
Mere Dyke	Within the Scheme boundary
Sandford Brook	Within the Scheme boundary
River Ock	Within the Scheme boundary
Oday Ditches	Within the Scheme boundary
Childrey Brook	Directly adjacent to the Scheme Boundary, connectivity to the River Ock
Marcham Brook	Directly adjacent to the Scheme boundary, connectivity to the River Ock
Upper Thames	Directly adjacent to the east of the Scheme boundary
Letcombe Brook	190 m to the west, connectivity to Childrey Brook
Nor Brook	55 m north, connectivity to Childrey Brook and the River Ock

Impacts on these watercourses and the associated habitats are considered unavoidable as a result of the Scheme, given all are either within the Scheme boundary, directly adjacent or have connectivity to the Scheme. The loss of watercourses within the extent of the Scheme will have associated impacts on the species they support, which may include otter, water vole, water shrew and invertebrate assemblages of note.

10.4.3. Protected species, species of principal importance and other key species

The following section gives a very brief summary of the ecological baseline established for the proposed reservoir location, mostly from 2005 and 2006 with some updates in 2008 and 2009. The main study area described below is defined as all non-residential land located within the bounds of the River Ock (to the north), A34 (east), west-coast mainline (south) and the A338 (west). It must be noted that the existing surveys focussed on the main reservoir footprint and did not include areas to the north of the River Ock or to the east of the A34. As such, an update to this baseline will be required as part of Gate 2.

10.4.3.1. Bats

The MAGIC search for European Protected Species (EPS) licences returned six records of granted EPS licences for bats within 2 km of the Scheme boundary for all options. These licences related to soprano pipistrelle, brown long-eared bat, common pipistrelle and Daubenton's bats. The closest licence application was 0.7 km to the north of the Scheme boundary for all options. The licence (2017-29056-EPS-MIT) was valid from 20/06/2017–30/06/2022 and allowed for the destruction of brown long-eared bat resting place.

Bat survey work undertaken in 2005 and 2006 identified that at least ten, and possibly up to twelve[59], species of bat either have roosts within or use the main study area for foraging and commuting. The species found are noctule, Leisler's bat, common pipistrelle, soprano pipistrelle, serotine, brown long-eared, barbastelle and up to five species of the genus *Myotis* (i.e. Daubenton's bat, Natterer's bat, whiskered bat, Bechstein's bat and Brandt's bat) were identified. Pipistrelle species, noctule and Leisler's bats were the most common across the main study area. Species of note are the barbastelle, which is rare and endangered, and the serotine, whiskered and Brandt's bats, which are restricted in range and vulnerable.

The populations of these bats within the main study area are either low or very low compared with other sites across southern England, possibly due to the dominance of arable land within the main study area.

Preliminary bat roost appraisals were carried out as part of previous work undertaken in 2006. A total of 27 trees were found to have high potential for roosting bats, particularly around Hutchins's Copse CWS, Drayton Copse and the route of the Old Canal. Ten trees with medium potential for roost bats were found to be present within the water transfer system study area[60], mainly concentrated along the right bank of Culham Reach. A maternity colony of soprano pipistrelles were reported to roost in Willow Bank Farm by the occupiers in 2006. It was also considered probable that a maternity colony of noctules occupies trees in Drayton Copse in July and August.

Dusk surveys carried out in 2007 and 2008 assessed the size of the bat colonies using Willow Bank Farm and Drayton Copse. No bats were recorded at Willow Bank Farm. Noctule and soprano pipistrelle bats were recorded at Drayton Copse.

All Scheme options will result in the loss of known and potential roost sites, and foraging and commuting habitat for bats. Further surveys, including preliminary bat roost appraisals (with tree climbing if necessary), emergence/ re-entry surveys, roost categorisation surveys and activity surveys will need to be undertaken. If appropriate habitat is identified, hibernation surveys may also be necessary. The impacts on bats will need to be fully mitigated, with EPS licences for roosts that will be lost.

10.4.3.2. Otter

Otter monitoring surveys have been carried out in 2006 and 2008/9. The survey area as a whole provides plentiful suitable terrestrial habitat for otters, with woodland and scrub close to the watercourses within the survey area. The surveys carried out in 2006[61] found eleven potential holt sites recorded along the River Ock and Childrey Brook, all were associated with ash trees.

During 2006, otter activity was recorded on the River Ock and Cow Common Brook, which both had fairly fresh (not dried) spraints, and Childrey Brook, where footprints were identified. During the 2008/9 surveys significant levels of otter activity were found along the River Ock, including spraints, feeding remains and tar. Spraints were also recorded on Childrey Brook and Hollywell Brook. Potential holt habitat was recorded at two locations in the boughs of willow trees near Childrey Brook and Mere Dyke West.

[59] The echolocation calls of whiskered bat and Brandt's bat, and likewise Natterer's bat and Bechstein's bat, are almost indistinguishable. Therefore, at least one of each pair and possibly both are present within the Study Area.
[60] Area within the redline boundary of all options that extends from the eastern side of the A34 to the western bank of Culham Reach.
[61] Cascade Consulting and Paul Chanin (2009) Otter Monitoring Survey. March 2009.

The development of all Scheme option would result in the loss of otter habitat, which may include holts (potential for natal holts not ruled out), potential holt habitat and wider foraging territory. Further surveys will be required, and this will indicate whether an EPS mitigation licence could be required.

10.4.3.3. Amphibians

The MAGIC search returned seven EPS licence applications for great crested newts within 2 km of the Scheme boundary for options 125 Mm^3, 150 Mm^3, 30+100 Mm^3 and 80+42 Mm^3. The closest of these EPS licences are all associated with the same pond 1.1 km to the south west of the Scheme boundary for the options listed previously. The details of the licences are shown in Table 10-7 below.

Table 10-7 – EPS licences within 2 km of Scheme options 125 Mm^3, 150 Mm^3, 30+100 Mm^3 and 80+42 Mm^3

Case reference	Dates	Activity allowed by licence
2014-2879-EPS-MIT	22/08/2014–31/07/2019	Impacts, damage and destruction of a breeding place and damage and destruction of a resting place.
2014-2879-EPS-MIT-1	30/01/2015–31/07/2019	
2014-2879-EPS-MIT-2	30/01/2015–31/07/2019	
2014-2879-EPS-MIT-3	21/05/2015–31/07/2019	
2014-2879-EPS-MIT-4	17/10/2016–31/07/2019	
2014-2879-EPS-MIT-6	24/11/2017–31/07/2019	

Amphibian surveys were carried out between 2005 and 2008[62]. Great crested newts were found to be present in seven ponds, six of which were within The Cutting CWS and the seventh in the northwest of the main study area near Venn Mill. The survey results confirmed the presence of three separate breeding populations of great crested newt, located in The Cuttings CWS along the southern boundary of the main study area. Only a single newt was recorded at Venn Mill, the habitat at the pond is considered sub-optimal for breeding great crested newt.

Low numbers of stickleback were recorded in ponds across The Cuttings CWS, one of which is a confirmed great crested newt breeding pond. Therefore, it is possible that great crested newt populations have declined over the last decade. They are deterred by the presence of fish and may not use a pond that contains a population of sticklebacks.

Other common species of amphibian (smooth newt, common frog and common toad) are widespread across the main study area in ponds and ditches.

The Cutting CWS lies within the redline boundary of options 150 Mm^3, 125 Mm^3, 100 Mm^3, 30+100 Mm^3 and 80+42 Mm^3, and partially within option 75 Mm^3. Therefore, there is potential for impacts on both great crested newt breeding and terrestrial habitat. Further surveys will be required to establish the current status of great crested newts across the extent of the Scheme for all options and, if required, suitable mitigation devised as part of an EPS mitigation licence. This may include the creation of new ponds suitable for amphibians in areas of created habitat to the north-west and west of the reservoir and/or the enhancement of existing ponds in The Cutting CWS, if there is scope to do so. or a need to do so. This may include the creation of new ponds suitable for amphibians and/or enhancing existing ponds in The Cutting CWS if there is scope/a need to do so.

10.4.3.4. Water voles

The water vole baseline survey carried out in 2006–2008[63] identified that small and fragmented populations of water vole are present in the Scheme footprint. Water vole field signs (such as faeces, latrines, feedings stations, footprints and burrows) were searched for along the entire length of each watercourse within the red line boundary.

Signs of water vole (burrows and latrines) were identified along Childrey Brook, Mere Dyke West, Cow Common Brook and the old River Ock during the survey. No signs of water vole were identified along Ginge Brook during the October 2006 survey (likely due to high water levels), but incidental records of latrines and

[62] Applied Ecology Ltd (2009) Herpetofauna Baseline Survey. January 2009.
[63] Cascade Consulting and Applied Ecology Ltd. Water Vole Baseline Survey 2006–2008. March 2009.

droppings were made along Ginge Brook during other surveys earlier in 2006. These findings indicate that Ginge Brook is a stronghold for water vole in the local area.

No signs of water vole were recorded along Hanney Ditch or Orchard Farm Ditch during the 2006 survey, these watercourses were dry or drying at the time of survey. The fluctuating water level makes these ditches sub-optimal for breeding water vole.

Water vole droppings, runs and feedings signs were identified along Cow Common Brook. However, only the northern section of Cow Common Brook, at its confluence with the River Ock, was found to support permanent standing water. Given the lack of water vole burrows along the brook, it is likely that water voles are only present here in a transitory capacity.

During the 2008/9 otter surveys, mink scats were recorded on the River Ock, Childrey Brook and Cow Common Brook. Mink is known to predate on water vole, so it is possible the mink population in the area has negatively impacted the water vole population since these surveys were carried out.

The construction of the Scheme (all options) will result in the loss of water vole habitat and potential killing and injury of water vole. Further survey will be required with licencing and mitigation, if necessary.

10.4.3.5. Badger

The main study area was surveyed for badger signs and setts between February and May 2006, with a re-survey being carried out in 2008[64]. This includes bait-marking studies carried out over February to April 2006 and in February 2008, in order to confirm the status of main and suspected main setts within the main study area and to determine the extent of territorial ranges.

A total of 72 setts were identified across the main study area. The 2006 surveys identified five main setts. The re-survey in 2008 identified eight main setts across the main study area. In 2008, 49 setts within the main study area were active setts. Following bait-marking surveys and observations of activity levels associated with each of the main setts, a total of eight social groups of badgers were identified.

It is likely that some badger social groups could be displaced by the Scheme, requiring the closure of main setts and other setts under licence and resulting in the loss of suitable clan habitat. The scale of habitat loss means a mitigation strategy taking both sett loss and habitat loss into account will be required.

10.4.3.6. White-clawed crayfish

A native crayfish baseline survey was carried out in 2006–2008[65] of the River Ock, Nor Brook, Childrey Brook, Cow Common Brook, Portobello Ditch, Marcham Brook and the Ginge Brook. There are historic records of white-clawed crayfish in Childrey Brook.

Portobello Ditch, Cow Common Brook and Nor Brook were found to be completely dry at the time of the 2006 crayfish survey, this renders them unsuitable habitat for crayfish on the assumption they are subject to regular drying.

During the surveys, no white-clawed crayfish were recorded in the River Ock, Childrey Brook, Ginge Brook or Marcham Brook. Signal crayfish were recorded in the River Ock and Ginge Brook in 2006. As no white-clawed crayfish were identified and signal crayfish were present in some of the watercourses, it is likely that white-clawed crayfish are now absent from the area.

No European Protected Species licences for white-clawed crayfish were identified on MAGIC within 2 km of the Scheme.

Further surveys will be undertaken to update the baseline and could utilise environmental DNA (eDNA) techniques to reduce survey effort. However, based on the information above, it is unlikely that this species is now present within the Scheme extent.

10.4.3.7. Hazel dormice

Surveys were carried out using nest tubes between March and November 2006[66]. No dormouse nests or other evidence of dormouse were found within the main study area. In addition, it was considered that the main study area provides poor quality habitat for dormice.

The Phase 1 habitat survey/UKHab survey required to update the baseline will be extended to identify any habitat with potential for hazel dormouse and subsequently the need for further targeted surveys. It is currently

[64] The Badger Consultancy (2008) Badger Baseline Survey. November 2008.
[65] Applied Ecology Ltd (2009) Native Crayfish Baseline Survey 2006–2008. February 2009.
[66] Paul Chanin and Applied Ecology Ltd (2009) Dormouse Survey. January 2009

considered unlikely that this species is present within the Scheme area, but the age of the data means this cannot be relied on without update surveys.

10.4.3.8. Reptiles

Reptile surveys were carried out between 2005 and 2008[67]. Four breeding populations of grass snake were identified in rank grassland habitat adjoining Hutchins's Copse CWS, Steventon Depot, Childrey Brook and Mere Dyke West. Juvenile or sub-adult individuals were recorded at all four locations. The maximum number of individuals recorded in one survey was seven animals, it is considered the main study area supporting a 'Good' population of grass snake[68].

Common lizards were recorded at Steventon Depot, Hutchins's Copse CWS and near Cow Common Brook. The most recorded in a single survey was 27 adults and 13 juveniles, the population is considered to be 'Exceptional'.

During the previous surveys a single slow worm was recorded in the main study area; therefore, the population was considered to be 'Low'.

Habitat suitable for grass snake and potentially other reptiles will be lost under all proposed Scheme options, with potential for killing and injury of individuals. It is considered likely that further survey and mitigation (potentially including capture and translocation to a suitable receptor site) will be necessary.

10.4.3.9. Birds (breeding and wintering)

Baseline surveys for breeding and wintering birds were carried out between 2005 and 2008[69]. Survey data for breeding and wintering bird species diversity, density and distribution across the main study area was collected between May 2005 and February 2006. Further work was carried out between May and July 2008 to confirm barn owl nest locations.

The most important habitat area for breeding birds within the study area consisted of the adjoining habitats within The Cuttings, Hutchins's Copse and Hutchins's Marsh which supported a total of 18 breeding species of Birds of Conservation Concern (BoCC) in 2006. Species recorded across the survey area included marsh tit, reed bunting, yellowhammer and turtle dove. In addition, kingfisher was recorded along Childrey Brook and a nesting tunnel was recorded on the River Ock. Tawny owl and long-eared owl were also found to be using habitats in the study area for nesting.

Barn owls have been recorded breeding in the study area. In 2005 an Occupied Nesting Site was found in a black poplar tree on the left bank of Cow Common Brook to the north of Steventon Road bridge. In 2008 breeding barn owls were confirmed at three sites, two in barns and another in a barn owl box. A pair of nesting red kites were found in the 2008 surveys in a poplar plantation in the north-west of the study area.

A total of 103 bird species were recorded in the main study area over both the breeding and wintering bird surveys and of these, 79 species were breeding. The majority of species are classed as common or very common; however, approximately 17% of the records are classed as uncommon, rare or very rare for Oxfordshire.

Further bird surveys will be required across the Scheme extent to update the baseline. Barn owl and kingfisher are Schedule 1 species under the Wildlife and Countryside Act 1981 (as amended) and are therefore subject to greater protection whilst breeding. Mitigation will be required to reduce the impact of the Scheme on bird species using the Site. This will chiefly be through timing of works, habitat creation and the provision of additional alternative locations for nesting. The new reservoir will attract and provide habitat for species of waterfowl and gull not currently present in the locality.

10.4.3.10. Terrestrial invertebrates

The terrestrial invertebrate surveys[70] paid special attention to significant landscape features and habitats, including woodlands and wetlands. A range of sampling techniques were used, including flight interception trapping, pitfall trapping and light trapping.

During the 2005–2006 surveys of the main study area a total of 1,665 species of terrestrial invertebrates were identified, bringing the total number of species from this and previous surveys to 2,154. This does not include any protected by the Wildlife and Countryside Act 1981 (as amended) or any Biodiversity Action Plan (BAP)

[67] Applied Ecology Ltd (2009) Herpetofauna Baseline Survey. January 2009.
[68] Froglife Advice Sheet 10. (November 1999) Reptile Survey – An Introduction to Planning, Conducting and Interpreting Surveys for Snake and Lizard Conservation.
[69] Applied Ecology Ltd (2008) Ornithology Baseline Survey 2005–2008. August 2008.
[70] Peter Hammond and Colin Plant (2008) Terrestrial Invertebrate Baseline Survey 2005–2006. November 2008.

species. A total of 18 species were recorded as Potentially Threatened in the UK (Red Data Book species) and 162 species were classed as Nationally Scarce.

Assemblages of decaying wood-associated invertebrates (present in Drayton Copse and Hutchin's Copse CWS) were indicated by the invertebrate report to be of moderately-high conservation interest.

Wetland habitats (especially near Hutchins's Copse CWS in the south and the River Ock in the north and northwest) harbour invertebrate assemblages exhibiting remnant fen characteristics that were indicated by the invertebrate report to be of moderately-high conservation interest. Scarlet tiger moth, an Oxfordshire county BAP species, was observed in a damp meadow to the east of Hutchins Copse CWS.

Grassland invertebrate assemblages associated with Steventon Depot, Cow Common and the older and least disturbed green lanes, bridleways and hedgerows were also considered to be of some conservation interest.

Further surveys for terrestrial invertebrates will be required to update the baseline and inform a mitigation strategy. Assemblages of conservation interest and species that are Potentially Threatened and Nationally Scarce have been recorded in the Scheme extent and could be lost as a consequence of reservoir construction. However, it is likely that the proposed habitat creation works will be able to provide ample alternative habitat to support a diverse assemblage of terrestrial invertebrates.

10.4.3.11. Brown hare

Surveys for brown hare were carried out from April 2005 to January 2006[71]. The initial walkover survey found that brown hare was widely distributed across the main study area. Transect surveys between November 2005 and January 2006 identified a total of 18 hares. Using statistical analysis, the total number of hares across the study area is estimated to be 294.

Further surveys for brown hare will be necessary and a mitigation plan is likely to be needed to minimise the impact on this species. This may include retaining suitable land within the Scheme extent e.g. to the north, in agriculture and managing it in such a way that the maximum number of brown hares can be supported.

10.4.3.12. Water shrews

Surveys to determine the presence or likely absence of water shrews were carried out in 2006[72] using tubes baited with larvae, in order to attract water shrews, which are then likely to leave scats in the tube. Water shrews were detected at nine of the 19 sites surveyed along ditches and watercourse within the survey area. Four of the positive sites were dry when the tubes were collected, showing that water shrews will use waterways that are not permanently wet.

Overall, the survey identified water shrews across much of the survey area, at northern and southern boundaries as well as within the centre. Water shrew evidence was found along the River Ock and a number of small ditches across the survey area.

Further surveys for water shrew will be necessary and, if present, a mitigation plan devised to minimise the habitat loss and subsequent effect on this species within the extent of the Scheme.

10.4.3.13. Harvest mouse

Harvest mouse surveys were carried out in 2006[73]. Nest searches were carried out in the autumn, focusing on areas of suitable habitat. In total, four harvest mouse nests were found, all of which were close to rivers. Two nests were found near Cow Common Brook, one near the River Ock and another near Childrey Brook. An additional nest was found near Cow Common Brook, but it was not possible to confirm confidently that it was a harvest mouse nest.

Barn owl pellet analysis identified that harvest mouse was the second most abundant prey species.

Overall, the surveys show that harvest mice are widespread in the area to the north of the Hanney-Steventon road.

Further surveys for harvest mouse will be required to check the distribution of this species across the Scheme extent. A mitigation plan may be necessary to minimise the impact to this species as a result of the Scheme.

[71] Applied Ecology Ltd (2008) Brown Hare Survey. June 2008.
[72] Paul Chanin (2008) Water Shrew Baseline Survey 2006–2008. August 2008.
[73] Paul Chanin (2008) Harvest Mouse Survey. July 2008.

10.4.3.14. Invasive non-native plant species

A review of existing survey information from Thames Water, NBN Gateway data, Thames Valley Environmental Records Centre data and Environment Agency data are covered explicitly in Section 9.4.1 of this report. Therefore, no further assessment is made here.

10.4.4. Limitations

No existing extended Phase 1 habitat survey or other baseline habitat assessment has been provided and no surveys to establish or update the baseline have been carried out.

The reports summarised in this assessment are dated between 2008 and 2009, and the data included in these reports was collected between 2005 and 2006, with updates in some instances in 2008 and 2009. Given the age of this data, it is possible the habitats and species within the Scheme boundary, and their distribution, have changed over time. Species that were present at the time of the surveys may no longer be present, and species that were not recorded may be present now. Furthermore, the existing surveys have not covered the full redline boundary for all Scheme options; the area to the north of the River Ock and to the east of the A34 were excluded.

Records of non-statutory designated sites and records of protected and priority species have not yet been requested from the local records centre.

The search for waterbodies within 500 m of the Site was undertaken by using Ordnance Survey plans and aerial photographs only. These sources may not show all ponds and or waterbodies within 500 m of the Site boundary and, therefore, some waterbodies may not have been identified.

10.5. Conclusions

In summary, it is considered that the proposed Scheme, without mitigation, will have an adverse impact on non-statutory designated sited for nature conservation, priority habitats and protected and priority species. However, it is considered that the implementation of appropriate mitigation measures (including protected species development licences, where required) and compensation for losses, will avoid/reduce potentially adverse impacts on these ecological features.

Mitigation works will be required in advance of and during construction. This is particularly the case where species groups need to be relocated and require suitably established alternative habitat either within the redline boundary or at a receptor site outside the redline boundary. Actions such as early planting to maintain habitat connectivity around the Scheme boundary during construction will also be considered during the drafting of mitigation proposals. Specific mitigation measure to address typical construction impacts, such as dust and suspended sediment from earthworks, air quality impacts linked to access routes, disturbance impacts from noise and vibration, and potential for entrapment of animals.

A number of habitat opportunities within the redline boundary have been identified which will bring biodiversity benefits. These include but are not limited to: the retention and enhancement of existing habitats, waterbodies, and linear features, such as hedgerows; creation of new wetland habitats associated with diverted watercourses (carr, fen and wet grassland); the planting of woodland and hedgerows; and the creation of scrubland and species-rich grassland. There is scope for residual adverse effects, certainly in the short-term, for impacts to The Cutting CWS should habitat compensation be required. This is due to the time required for the habitat establish and improve in condition and quality.

The high-level assessment of the terrestrial ecology impacts undertaken indicates that there is little difference between the Scheme options in terms of impacts. Three options (150 Mm^3, 30+100 Mm^3 and 80+42 Mm^3) have the same redline boundary with sequential marginal reductions for the 125 Mm^3, 100 Mm^3 and 75 Mm^3 options. The only difference noted at this time is that The Cutting CWS lies outside 75 Mm^3 option boundary, whereas it is within or partially within all the other options. It is considered that there will be an impact on the habitats and species identified above for all options, but with scope for fewer individual features to be affected where less land-take is required.

The ecological baseline will need to be fully updated to inform ongoing design alterations and ultimately a full Ecological Impact Assessment (EcIA) will be required.

10.6. Assessment framework towards Gate 2

A full updated desk study will be required, including a data request from TVERC (covering both protected species and INNS) and details of recorded ancient and other veteran trees from the Woodland Trust Ancient Tree Inventory.

A consultation with the Local Planning Authority (LPA) may be required regarding the removal of important hedgerows[74] (if present). The LPA may need to consult further with Natural England regarding potential impacts on SSSIs as the Scheme falls within the IRZ of a number of SSSIs.

The assessment framework towards Gate 2 will require the completion of an extended Phase 1 habitat survey/ UKHab survey of all the land within and up to at least 50 m from the Scheme boundary, in order to update the currently available information. This will include areas within the redline boundary not previously surveyed, namely the Scheme extent to the north of the River Ock and east of the A34. This should be undertaken as soon as possible upon instruction in 2021.

Following the completion of the Phase 1/UKHab survey, further targeted Phase 2 surveys will be required in order to complete the EcIA to inform detailed design and support any subsequent DCO or planning application for the proposed Scheme. These may include the further surveys listed in in Annex F. Table 10-8 below indicates the timing of these surveys. Potential survey requirements for brown hare, water shrew and harvest mouse are to be discussed with key stakeholders early in Gate 2, so targeted surveys for these and other groups identified during the Phase 1 survey may need to be added to the list of Phase 2 surveys required.

Table 10-8 – Timing of Phase 2 Ecology Surveys

Survey	Timeframe
Bats	Start surveys – assessment of potential roost features (PRF) in 2021, emergence & activity for rest of active season in 2021. Hibernation surveys winter 2021, complete emergence & activity surveys (walked transects and static detector deployment) May–Sept 2022 (with reporting on going).
Otter	Surveys not seasonally constrained.
Great crested newt	Habitat Suitability Index (HSI) assessments can be undertaken at any time of year. Survey season limited to spring, mid-March to mid-June for presence/absence (four survey visits) and population size class assessment (additional two survey visits). eDNA sampling can be undertaken 15 April to 30 June.
Water vole	Spring (April–June) and autumn (September and October) surveys required, with two survey visits undertaken.
Badger	No specific time constraints to survey but Nov–April optimum.
White-clawed crayfish	Activity surveys, torch only April–June, trap and torch mid-July to mid-September.
Hazel dormouse	Surveys run from April to October in one year.
Reptiles	Surveys normally spring (March–June) or autumn (September).
Breeding birds	Surveys undertaken April to July.
Wintering birds	Surveys undertaken in winter 2021/22 (monthly visits between December and March), if required.
Terrestrial invertebrates	Surveys are undertaken between April and September, with adjustment for local weather conditions and latitudes, and may target the flight times of key species. The need for invertebrate scoping surveys will be identified by the Phase 1 habitat survey.
National Vegetation Classification (NVC)	Surveys may be required May to July, depending on the type of habitat.
Hedgerow Regulations survey	Surveys to identify hedgerows classed as important under the Hedgerow Regulations 1997 can be undertaken between April and October, with June and July being the optimum months.

[74] Countryside hedgerows: protection and management - GOV.UK (www.gov.uk)

Survey	Timeframe
Veteran tree survey	No specific time constraints.

11. Natural Capital Assessment (NCA) and wider benefits

11.1. Natural Capital

11.1.1. Introduction/explanation of topic area

11.1.1.1. Natural capital

Natural Capital is an economic concept recognising that nature provides benefits to people, underpinning our health, society and economic activity. Natural capital has emerged as the framework of choice for gaining a better appreciation of the interlinkages between the economy and the environment and has been promoted by the government in the 25 Year Environment Plan (25 YEP)[75]. It considers natural capital (habitats, species, air, soil, water, oceans, minerals and natural processes) as stocks of assets from which ecosystem services flow to deliver benefits and value to people. The SESRO options have the potential to change existing natural capital stocks (assets) through land use changes and therefore alter the flows of ecosystem services and thus the valuable benefits they provide.

11.1.1.2. Guidance

The Water Resources Planning Guidelines (WRPG) and Supplementary Guidance (SG) "Environment and society in decision making"[76] (Environment Agency, Ofwat and Natural Resources Wales, 2021) require environmental, social and economic valuations to be delivered through a Natural Capital Assessment (NCA). The All Companies Working Group (ACWG) reviewed the draft WRPG SG and the RAPID process to devise "WRMP environmental assessment guidance and applicability with SROs" (referred to throughout this chapter as "ACWG guidance")[77]. This ACWG guidance specifies that for RAPID Gate 1 an initial NCA based on the draft WRPG SG is required to help inform concept design and aid decision making by quantifying the relative cost, benefits and disbenefits of SRO schemes to aid the initial assessment of the identified strategic solutions. The Environment Agency has indicated that for Gate 1 it is expected that an NCA should follow at least the "minimum" methodologies listed in the WRPG SG. SESRO therefore requires an NCA to comply with WRPG SG and ACWG guidance, thereby contributing to the optioneering process in RAPID Gate 1.

11.1.1.3. Scope

As SESRO falls within the Water Resources South East (WRSE) region, an NCA has been undertaken at the regional level as part of the WRSE regional plan. The WRSE regional-level NCA was conducted using the earlier iterations of SESRO design data available at the time and a methodology appropriate for the regional scale. The results were released to the individual water companies in January 2021 and revised in February 2021[78] for them to review and update with respect to their individual SROs. The approach provided a framework to be built upon within the individual water companies' WRMPs and SRO assessments.

This NCA has been undertaken for the six SESRO options based on the latest option design data[79] issued on 28/01/21 and incorporating more detailed site-specific information to provide enhanced valuation where possible. Results of the assessment have been translated into "Natural Capital Metrics". Comparisons with WRSE regional NCA results are discussed. It is noted that the WRSE regional NCA tables for SESRO have been revised following comment since January 2021: the comparisons in this chapter can therefore be considered preliminary and subject to change.

The NCA is focused on ecosystem services benefits and their value arising from Natural Capital stocks and changes in those stocks, but does not quantify those which are based on other capital e.g. built capital. This is compliant with the WRPG SG and ACWG guidance. The contributions of other capitals to options' benefits and

[75] HM Government (2019). 25 Year Environment Plan.
[76] Environment Agency, Ofwat and Natural Resources Wales (2021). Water Resources Planning Guidelines (WRPG) and Supplementary Guidance (SG) Environment and Society in Decision Making
[77] Mott MacDonald, (2020a). All Companies Working Group (ACWG) WRMP environmental assessment guidance and applicability with SROs
[78] Mott MacDonald, (2021a). WRSE Natural Capital and Biodiversity Net Gain Assessment tables (January 2021 and February 2021)
[79] Mott MacDonald, 2021b, SESRO WRMP24 Geopackage issued on 28/01/21

disbenefits are considered in the Wider Benefits study. The NCA methodology, findings and suggested Gate 2 scope are summarised within this chapter. A fully detailed report is included in Appendix A11.1.

11.1.2. Datasets reviewed

A range of different datasets were reviewed to support this assessment and their use within the NCA methodology is specified for each assessment step below. The main datasets underpinning the NCA were:

- Natural England, (2020), Natural Capital Indicators: for defining and measuring change in natural capital
- SESRO Water Resource Management Plan (WRMP) 24 designs issued by Mott MacDonald on 28/01/21 including GIS data for each option comprising main design features
- CORINE land cover map 2018
- Natural England's Priority Habitat Inventory
- Ordnance Survey (OS) MasterMap
- Crop Map of England (CROME) 2017
- CDR report (2021)
- WRSE regional NCA for SESRO options (Mott MacDonald, 2021)
- WRPG SG and ENCA values databases, including Defra Environmental Value Look-Up Tool

11.1.3. Gate 1 proportional assessment methodology

The proportional NCA methodology consists of six steps (Technical Annex B1: EAR Figures, Figure 11.1):

1. Natural Capital Baseline
2. Change in Natural Capital assets
3. Identify ecosystem services
4. Qualitative assessment
5. Quantitative assessment and monetisation
6. Calculate Natural Capital Metrics

The methodology was developed to align with the following guidance and with the WRSE regional NCA methodology where appropriate:

- All Companies Working Group (ACWG) WRMP environmental assessment guidance and applicability with SROs (Mott MacDonald, 2020a)
- Water Resources Planning Guidelines (WRPG) and Supplementary Guidance (SG) Environment and Society in Decision Making (consultation draft, September 2020)
- WRSE Natural Capital & Biodiversity Net Gain Method Statement (Mott MacDonald, December 2020b)
- WRSE Regional Plan Environmental Assessment Methodology Guidance (Mott MacDonald, June 2020c)
- Natural England, (2020), Natural Capital Indicators: for defining and measuring change in natural capital.
- Defra's Enabling a Natural Capital Approach (ENCA) guidance (2020)

This section outlines the main components of the NCA methodology and highlights the main points of comparison with the WRPG SG, ACWG and the WRSE regional NCA methodology. The fully detailed methodology is described in EAR Appendix A11.1, Chapter 2.

11.1.3.1. Method Step 1: Natural Capital baseline

The existing natural capital stocks within the SESRO options' Zone of Influence (ZOI) were identified and categorised to align with Natural England's (2020) National Natural Capital Atlas (NNCA) asset quantity indicators (based on habitat and land cover types). The ZOI is defined in accordance with the SEA study area as the maximum extent of all the six SESRO options' land acquisition boundaries (LABs) combined into a single boundary area, plus a 2 km buffer. This therefore excludes upstream and downstream impacts outside of this boundary.

The stocks were mapped using open-source data of the same or similar nature and quality as the NNCA approach. The different land cover or habitat classes within each open-source dataset were aligned with the NNCA asset types. A single asset type was then assigned to individual land parcels identified from OS MasterMap data within the ZOI based on the dominant CORINE, Priority Habitat Inventory, CROME or OS land cover class in the land parcel. If more than one category was present in a land parcel, priority was given to

Priority Habitat Inventory, OS, CROME and CORINE data in that order based on the level of detail and accuracy of the data. This was verified through use of satellite photography and checked against the WRSE environmental geodatabase. Asset quantities were reported by area (hectares) in an asset register.

The methods for Step 1 align with relevant guidance and the WRSE regional methods as follows:

- Identifying existing natural capital stocks is a prerequisite for carrying out the assessment methodologies outlined in the WRPG SG and ACWG guidance.
- Asset quality and use of quality indicators are not required for the Gate 1 NCA according to the WRPG SG and ACWG guidance, so this NCA is focused on asset quantity only (area in hectares).
- The approach builds on that used in the WRSE regional NCA baseline, using additional other open-source data to provide a greater level of detail and accuracy for the site. These data enabled identification and mapping of assets at the field scale for individual land parcels delineated in OS MasterMap.

11.1.3.2. Method Step 2: Change in Natural Capital assets

Natural Capital stock configurations were mapped and quantified for the alternative landcover arrangements that would be introduced by the six SESRO options. These changes in landcover have the potential to change asset quantities through introduction of reservoir features such as new water bodies, bunds, screening mounds, flood compensation areas and grey infrastructure as set out in the SESRO WRMP24 designs issued on 28/01/21. This is a more recent design than used for the WRSE regional NCA. As no landscape design has been undertaken at Gate 1, habitat and landcover types were assigned to GIS polygons corresponding to these design features as informed by the 2021 CDR, Biodiversity Net Gain assessment (Chapter 12) and a review of corresponding assumptions made in the WRSE regional NCA for SESRO. The coverage (area in hectares) of the various natural capital stocks were calculated for each option (in hectares) and presented in a natural capital asset register for comparison with the baseline.

As no landcover changes are detailed outside of the options' LABs in the 2021 CDR, assessment of change in natural capital stocks was focused only on assets inside the LABs for each option, with no change assumed for assets located in the wider ZOI. This is consistent with the WRPG SG which specifies option footprint as the minimum spatial extent of assessment and the WRSE regional NCA for the SESRO options. A static baseline was also assumed: no changes to existing asset quantities would occur within the LABs (e.g. due to climate, demographic or land use change) under a "do-nothing" scenario without the reservoir options or during the timeframe between the present day and a reservoir's construction. This is sufficient to comply with the WRPG SG and ACWG guidance for Gate 1.

The following additional assumptions were made when assessing changes in natural capital stocks, and both are consistent with the assumptions used in the WRSE regional NCA for the SESRO options:

- Given that landscape design had not been undertaken for Gate 1 and the limited detail available in the 2021 CDR, assets or parts of assets located in areas within LABs that are not covered by design polygons (i.e. are outside of the design features mapped in the January 2021 design issue) were assumed to be restored post-construction to their original baseline asset type and were calculated as such.
- As location-specific construction mitigation plans were not available at Gate 1, all stocks within the LABs were assessed as if they would be lost during the construction period to provide a conservative estimate of their value given limited information.

The methods for Step 2 align with relevant guidance and the WRSE regional methods as follows:

- Calculating changes in assets is a prerequisite for being able to carry out the assessment methodologies outlined in the WRPG SG and ACWG guidance. The approach and assumptions outlined above are consistent with that used in the WRSE regional NCA and are in accordance with the WRPG SG and ACWG guidance.
- The points of departure with the WRSE regional NCA for this assessment are that updated design data has been used in the mapping and quantification of assets at an enhanced resolution and the enhanced baseline mapping undertaken in Step 1.

11.1.3.3. Method Step 3: Identification of ecosystem services

Natural Capital assets deliver valuable benefits to people through flows of ecosystem services. The ACWG guidance specifies that in a Gate 1 NCA the five ecosystem services set out in the WRPG SG should be assessed (definitions accord with WRPG SG usage):

- Biodiversity and Habitat: biodiversity acts as a supporting service, underlying the provisioning of many other ecosystem services;

- Climate Regulation (carbon storage): the capture and secure storage of carbon [by natural capital assets] that would otherwise be emitted to, or remain, in the atmosphere (in addition to construction and operational carbon);
- Natural Hazard (flood and drought) regulation: different habitat types have intrinsic flood risk management values by intercepting, storing and slowing water flows, and mitigate impacts of drought or improve drought resilience;
- Water Purification: the treatment service of natural capital assets, i.e. an asset that intercepts, removes or stores pollutants;
- Water Regulation: value of the benefit of the water to customers, current and future abstractors, as well as the value of leaving the water in the environment (note: this usage corresponds to description of the "water supply" as a provisioning service in ENCA (Defra, 2020), rather than the "water flow regulation" used in ENCA or National Ecosystem Assessment (2011).

Biodiversity and Habitat is considered in the SESRO Gate 1 Biodiversity Net Gain chapter so was not repeated within the NCA. It is also not possible to assess drought regulation as part of the Natural Hazard Regulation service as there is no established methodology as detailed in the WRPG SG. Both of these exclusions align with the approach taken within the WRSE regional NCA.

The WRPG SG states that it should be considered whether an NCA should go beyond the minimum five services noted above. The WRSE regional NCA methodology[80] identified three additional ecosystem services could be relevant to the regional study area. These three additional services were included in this NCA. The need to include them was determined by reviewing the results and scoping decisions in the WRSE regional NCA against the natural capital asset register generated in Steps 1 and 2. Other additional ecosystem services could also be considered in a Gate 2 NCA. The additional services considered as defined in ENCA were:

- Food production: food in its various forms is produced by a range of ecosystems;
- Air pollutant removal: by improving air quality, vegetation helps to lessen these impacts on health and wellbeing, resulting in lower health costs;
- Recreation: the recreational value of natural spaces reflects both the natural setting and the facilities on offer at the site and varies with the type of habitat, location, population density and the availability of substitute recreational opportunities.

The methods for Step 3 align with relevant guidance and the WRSE regional methods as follows:

- Where any of the minimum five ecosystem services specified in the WRPG SG and ACWG guidance for Gate 1 will be excluded from this NCA, this is consistent with the WRSE regional NCA.
- Where any of the minimum five ecosystem services WRPG SG and ACWG guidance or additional three services identified for the WRSE regional study area are scoped in to depart from the WRSE regional NCA, the rationale is explained.

11.1.3.4. Method Step 4: Qualitative assessment

Each of the selected ecosystem services has been assessed qualitatively for each of the six SESRO options in accordance with the WRPG SG. The purpose of the qualitative assessment is to support the quantitative assessment and interpret the results of monetisation. A qualitative assessment of significance has been assigned to help determine which selected services could be significantly improved or diminished under each option.

The methods for Step 4 align with relevant guidance and the WRSE regional methods as follows:

- Qualitative assessments have been be carried out according to the specification of the WRPG SG.
- The need for qualitative assessments is specified in the ACWG guidance and has also been performed in the WRSE regional NCA to interpret quantitative outputs.

11.1.3.5. Method Step 5: Quantitative assessment and monetisation

The ecosystem services selected for assessment were quantified and (where possible) monetised for each SESRO option based on the asset quantity indicator (area in hectares) calculated in the asset register. Ecosystem services flow and value have therefore been quantified based on the change in area for each asset type within each option's LAB footprint. This aligns with the ACWG guidance and the approach used in the WRSE regional NCA.

[80] Mott MacDonald, (2020b). WRSE Natural Capital & Biodiversity Net Gain Method Statement.

The valuation tables listed in the WRPG SG and WRSE NCA Method Statement have been used to monetise these services, and these have been supplemented where appropriate in accordance with best practice using other valuation databases referenced within the WRPG SG list of suitable datasets. Where supplementary datasets have been used these are explained. The sources of the monetary values are reported and it is highlighted and justified where these deviate from the WRPG SG, ACWG guidance and WRSE NCA Method Statement. Sensitivity analysis was completed using lower and upper transfer values for each ecosystem service where available and appropriate. Where relevant all values are based on 2019 prices to ensure comparability between the baseline and scenario and are calculated on a "per year £ value" aligning with the ACWG and WRSE regional NCA. To ensure values are representative against the most up-to-date prices, monetary values were converted using the most recent government GDP deflators[81].

The detailed methods used for the quantitative assessment and valuation of each ecosystem service are discussed in EAR Appendix A11.1 (Table 2-3) including alignment with relevant guidance and the WRSE regional NCA. The methods for Step 5 align with them as follows:

- The methods broadly align with the WRPG SG, ACWG guidance, and the WRSE regional NCA, and where alternative data sources, tools, or reference values have been used these align with approaches referenced in the WRPG SG.
- Where the techniques used within this NCA do depart from those used in the WRSE regional NCA, they provide an updated assessment using the latest design data for each option, enabling comparison with more granular asset data and site-specific information, and draw on a wider range of established values databases for monetisation.

11.1.3.6. Method Step 6: Calculate NC metrics

In translating the results of this study into Gate 1 NC metrics, it is important to recognise that there are both benefits and disbenefits associated with each option due to differences in the direction of change for individual ecosystem services. It is important to recognise this in decision making and informing choice of options because trading off benefits against disbenefits or one service against another might not be appropriate in all circumstances. For each option three metrics have therefore been generated by this assessment:

- Total disbenefit: sum of services with negative change values (baseline versus option);
- Total benefit: sum of services with positive change values (baseline versus option);
- Net benefit: overall change in value across all services.

It is recommended that both the disbenefits and benefits are recognised in investment decision making. Note that these values are for the operational period of the reservoir only, with the natural capital value during construction assumed to be zero.

The methods for Step 6 align with relevant guidance and WRSE as follows:

- This approach aligns with the WRSE regional NCA in that a net benefit based only on operational value on a £/year basis was calculated, summed across all services – this corresponds to the net benefit metric defined above.
- The approach differs from the WRSE regional NCA in that additional services are accounted for, and two additional metrics are reported to distinguish total disbenefits and total benefits for the reasons outlined above.

11.1.4. Outputs/findings

11.1.4.1. Step 1 Results: Natural Capital baseline

The majority of land within the ZOI is categorised as Arable and Horticulture: this is the largest stock by land area. The second largest area consists of built assets named as "Manmade" in the NNCA i.e. buildings, sealed surfaces, etc. There are also large areas of Improved Grassland and Coastal and Floodplain Grazing Marsh assets. The full breakdown of assets and quantities within the ZOI is detailed in EAR Appendix A11.1, Table 3-1. The assets are mapped across the ZOI in Technical Annex B1: EAR Figures, Figure 11.2.

The following points of comparison were made with the baseline WRSE regional NCA results as follows:

- Alignment in dominant assets and asset type coverage within the LABs.

[81] UK Government (2020). UK Government, 2020 GDP deflators at market prices, and money GDP December 2020 (Quarterly National Accounts) - GOV.UK (www.gov.uk)

- The WRSE regional NCA uses the whole surface water operational catchment to define the ZOI meaning that the reported asset quantities are larger as a different spatial extent is used.
- Within the SESRO options' footprints (i.e. LABs), baseline values correspond in relative values and are sufficiently similar in absolute terms. Differences in baseline values are likely due to use of updated design data (including updated LAB extents) and the field-scale mapping of assets by this NCA.

11.1.4.2. Step 2 Results: Change in Natural Capital assets

As no landcover changes are detailed outside of the options' LABs in the options design data, assessment of changes in natural capital stocks only accounted for assets inside the LAB for each option, with no change assumed for assets located in the wider ZOI. Table 11-1 presents the asset register, detailing changes in asset quantities (area in hectares) for each SESRO options compared to the baseline of existing assets within each LAB. Only asset types present within the LABs are reported. Changes in assets are only reported for options once operational: for the purposes of the NCA all assets are assumed to be lost during construction (see Appendix A11, Chapter 2). The assets are mapped for each SESRO option in Figures 11-4 to 11-9 (Technical Annex B1: EAR Figures).

The changes in assets between baseline and option scenarios are broadly similar across the six options: net losses of Arable and Horticulture, Improved Grassland and Watercourses, with net increases in the areas of Modified Water (the reservoir water body), smaller increases in Broadleaved, mixed and yew woodland, Other semi natural grassland and Ponds. The changes are more pronounced for the larger capacity options because of their larger footprints, and differences between options on the basis of individual assets are due to alternative configurations of option design features.

The following comparisons can be made with the WRSE regional NCA results:

- Changes in asset quantities and differences between options are sufficiently similar to the WRSE regional NCA results.
- The WRSE regional NCA asset register also includes habitats outside of the option boundary within the wider ZOI, but changes are only assessed for assets within the LABs for the ecosystem services valuation which aligns with this NCA.

Table 11-1 – Natural Capital Asset register (operation only, construction excluded)

Asset	150 Mm³ (ha)			125 Mm³ (ha)			100 Mm³ (ha)			75 Mm³ (ha)			30/100 Mm³ (ha)			80/42 Mm³ (ha)		
	Baseline	With scheme	Change	Baseline	With scheme	Change	Baseline	With scheme	Change	Baseline	With scheme	Change	Baseline	With scheme	Change	Baseline	With scheme	Change
Arable and Horticulture	1400	486	−914	1387	537	−850	1283	516	−767	1215	546	−669	1400	483	−916	1400	501	−899
Broadleaved, mixed and yew woodland or Woodland priority habitat	48	81	32	48	82	34	45	75	30	42	65	24	48	81	32	48	81	33
Coastal and floodplain grazing marsh	67	147	81	67	160	94	67	159	92	67	131	65	67	147	80	67	148	81
Coniferous woodland	0.2	0.2	0	0.2	0.2	0	0.2	0.2	0	0.2	0.2	0	0.2	0.2	0	0.2	0.2	0
Improved grassland*	148	31	−117	148	49	−99	148	71	−77	148	80	−69	148	31	−117	148	34	−114
Pastures	44	22	−22	44	23	−21	44	24	−20	44	22	−22	44	22	−22	44	22	−22
Manmade	51	65	14	51	66	16	50	68	18	49	70	21	51	66	15	51	55	4
Modified Water	3	664	662	3	585	583	2	497	495	2	394	392	3	654	651	3	650	647
Other semi natural grassland	0	229	229	0	210	210	0	195	195	0	223	223	0	238	238	0	243	243
Ponds	5	13	8	5	13	8	5	13	8	4	12	8	5	13	8	5	14	9
Watercourses: rivers and ditches)* (length in km)	67	30	−28	67	40	−27	62	40	−22	59	40	−19	67	38	−30	67	42	−25

*Note this differs from Table 4-1 where watercourse length is based on rivers only, whereas the asset register here combines lengths of both rivers and ditches for the purpose of the NCA.

11.1.4.3. Step 3 Results: Identification of ecosystem services

In addition to the four ecosystem services identified for assessment in section 11.1.3, to comply with relevant guidance, the additional three services considered in the WRSE regional NCA were also identified for assessment in this NCA on the following grounds:

- Food Production: largest asset within the LABs is Arable and Horticulture land;
- Air Pollutant Removal: nearby Air Quality Management Areas (AQMAs) Marcham and Abingdon are less than 0.5 and 2 km from the LABs respectively, while option LABs are adjacent to main roads;
- Recreation: CDR includes mention of potential to provide visitor amenities and recreational features.

The full list of ecosystem services identified for assessment within this NCA were therefore:

- 1. Climate Regulation (carbon storage and sequestration)
- 2. Natural Hazard (flooding) regulation
- 3. Water Purification
- 4. Food production
- 5. Air Pollutant Removal
- 6. Recreation
- 7. Water regulation

To compare this selection with the WRSE regional NCA:

- The WRSE regional NCA for the SESRO options had scoped out Natural Hazard (flooding) regulation despite the presence of an active floodplain within the LABs based on the assumption that the impact of the construction of the reservoir (built capital) would supersede the effect of the removal of trees (natural capital) within the LABs. The service was scoped in for this NCA to incorporate changes in Coastal and floodplain grazing marsh assets as well as woodlands which also contribute to this service.
- The WRSE regional NCA for the SESRO options had scoped out Air Pollutant Removal on the grounds that the AQMAs are not within the options' LABs. This NCA has identified this service for assessment on the grounds that the AQMAs are within the SEA ZOI and option LABs are adjacent to main roads.
- The WRSE regional NCA scoped out Water Regulation as this is considered in the WRSE Environmental Destination workstream. It has been included as part of this NCA for SESRO options (no monetisation).
- There were no differences in the rationale for inclusion of all the other services.

11.1.4.4. Step 4 Results: Qualitative assessment

Table 11-2 presents the results of the qualitative assessment by each individual ecosystem service. The options were expected to differ slightly only in terms of their magnitude due to their differences in spatial extents. A key for the qualitative score is shown in Table 11-3.

Table 11-2 – Qualitative assessment results by service

Service	Commentary	Score
Climate Regulation (carbon storage and sequestration)	Conversion of arable land to woodland, wetland and other habitats may provide benefits in terms of carbon sequestration due to the higher sequestration potential of the latter assets. There is an increase in deciduous woodland for all scenarios. Caution is advised in interpreting results as there may be significant carbon losses during land use change and it will take time for new landcover to become established before net sequestration rates increase. Results should be compared with assessments of construction and operational carbon emissions to provide a full lifecycle carbon assessment.	✓
Natural Hazard (flooding) regulation	Based on an overall increase in woodland and grazing marsh asset types (habitat-based assessment only), all scenarios have the potential to improve the flood regulation service compared to the predominantly arable landscape.	✓

Service	Commentary	Score
Water Purification	Conversion of arable land to a variety of higher quality habitats is likely to reduce inputs of nutrients and pesticides to local watercourses, as well as providing filtration of surface water runoff from surrounding agricultural land.	✓
Air Pollutant Removal	Conversion of arable land to a variety of other habitat types, in particular woodland, will provide increased capacity for air pollutant removal with potential benefit to local air quality. This is expected to be minor for all six scenarios given that AQMAs are not present within the LABs but are less than 0.5 km away.	✓
Food Production	All options will result in loss of Arable and horticulture assets, reducing food production potential. There may be potential for some food production to continue to occur within the site although the area is likely to be much reduced.	xx
Recreation	Designs for all six scenarios include new recreational facilities such sailing, angling, new footpaths and car parking. Furthermore, the land use change away from agricultural land to freshwater habitats and woodland will increase the biodiversity and aesthetic attraction value of land within the LABs compared to its existing agricultural usage and this is expected to increase visitors.	✓✓
Water Regulation	All options will deliver an additional deployable output in water supply with the magnitude of increase varying depending on the capacity of each option, representing a positive change in provision of this service for customers. Considering the provision of this service for other abstractors (current and future), water will be abstracted from the River Thames to fill the reservoir and then released back into the river to be re-abstracted further downstream. The hydrological assessment (EAR, Chapter 4) outlines that abstraction would usually take place during times of higher flows and discharge in the drier parts of the year, so the value of water in left in the environment will be maintained while enabling provision of this service to other abstractors. One of the benefits that has been proposed for the SESRO options is in creating a surplus to facilitate a reduction in abstractions in other locations such as vulnerable chalk streams. This potential benefit is likely to vary depending on the capacity of the reservoir and is proposed for analysis in Gate 2.	✓✓ (but change is not due to changes in the natural capital assets as indicated by landcover change)

Table 11-3 – Qualitative assessment key

Score	Outcome
xx	Potentially major negative change
x	Potential minor to moderate negative change
o	No material change expected
✓	Potential minor to moderate positive change
✓✓	Potentially significant positive change

Comparing these results with the WRSE regional NCA:

- Results are comparable for the quantitative outputs of Climate regulation, Food production, Water purification and Recreation. Qualitative results are not reported in the WRSE regional NCA.
- The other services assessed here were scoped out in the WRSE regional NCA.

11.1.4.5. Step 5 Results: Quantitative assessment and monetisation

The following ecosystem services were quantified and monetised:

- Climate Regulation (carbon storage and sequestration)
- Natural Hazard (flooding) regulation
- Water Purification
- Air Pollutant Removal
- Food Production
- Recreation

Water Regulation was quantified in limited terms but not monetised.

For each SESRO option the results are presented, interpreted and compared to the WRSE regional NCA results for each ecosystem service in Appendix A11.1, Chapter 3, sections 3.5.1 to 3.5.7. These results are summarised for each option with a breakdown by ecosystem service in Figure 11-10 (Technical Annex B1: EAR Figures) (excludes water regulation which was not monetised and aligns with the WRPG SG). In this chapter, only the combined results across all ecosystem services are presented, interpreted and compared with the WRSE results. Appendix A11.1 should be consulted for further in-depth analysis.

Table 11-4 below presents the overall balance of ecosystem value provided by natural capital assets across each of the six SESRO options. This is for all the services assessed, except water regulation, which was not monetised, comparing natural capital value for the baseline with each SESRO option. All six options show an increase in overall ecosystem services value and have a positive total net value. This is primarily due to the significant increase in recreation value expected for the site, which outweighs the decrease in ecosystem value of food production. Improvements in all the other services also exhibit an improvement in value compared to the baseline scenario, but as illustrated Figure 11-10 (Technical Annex B1: EAR Figures), without the increase in recreation value they are insufficient both alone and in combination to outweigh the loss in Food production value.

Overall, options 75 and 100 exhibit the largest net positive change in value at £640k and £605k per year respectively. This is due to the combination of changes in different ecosystem service values, in particular:

- Food production: with a range in values due to the various arable land extents in the baseline and how much land is converted into other land uses in the scenario;
- Climate regulation: with variation based on woodland extent in the scenario and the associated carbon sequestration.
- Water purification: sees a range in values with the greatest benefits seen for scenarios with more wetland type habitats and less arable land.

Table 11-4 – Summary results table for each SESRO option across all ecosystem services from NCA undertaken within this study

Option	Baseline Value (£/year)	With SESRO Option Value (£/year)	Change in Value (£/year)
150 Mm^3	£1,558,701	£2,031,938	£473,237
125 Mm^3	£1,525,429	£2,064,148	£538,719
100 Mm^3	£1,421,270	£2,026,570	£605,300
75 Mm^3	£1,343,956	£1,984,143	£640,187
30/100 Mm^3	£1,560,547	£2,031,340	£470,793
80/42 Mm^3	£1,560,547	£2,029,325	£468,778

Note all values are in 2019 prices using the most recent government GDP deflators (UK Government, 2020).

Sensitivity analysis was completed using lower and upper transfer values for each ecosystem service where available and appropriate. The analysis compared the figures for change in value between options for the different scenarios. The results demonstrated that confidence can be placed in the conclusion that the SESRO options could offer an overall improvement in natural capital value for the ecosystem services assessed, and that comparison between options on this basis is robust. Nevertheless, caution should be applied in using the absolute values generated in this study (as well as the WRSE regional NCA) as the outputs are contingent on

the transfer values used. The fact that the assessment was based on a limited set of ecosystem services also means that the results of this study (and the WRSE regional NCA) should therefore be used only for comparison between options and not to provide an overall indication of natural capital value for the SESRO options or the existing site. Appendix A11.1 should be consulted for further detail on the sensitivity analysis results and interpretation.

The figures for change in value were compared with the WRSE regional NCA results for each option, as shown in Table 11-5, and the following conclusions were drawn:

- Figures representing the change in natural capital value are higher in this study than the WRSE regional NCA. For options 100, 75, 30/100 and 80/42 Mm^3 capacities this is within one order of magnitude difference, which in the emerging practice error of natural capital accounting is not considered significant. For options 150 and 125 Mm^3 the values in this study are 20 and 43 times higher respectively. The higher values are likely to originate from the methodological differences between the two studies, most significantly accounting for additional visitor numbers for specific recreational activities, and inclusion of three additional services in the valuation for this study.
- The results show differences in the relative rank of options between this study and the WRSE regional NCA. This could be due to use of the updated design data within this study, including different LAB extents and new configurations of screening bunds and flood compensation areas.
- Sensitivity analysis was not conducted as part of the WRSE regional NCA. The results from the sensitivity analyses carried out here suggest that caution should be applied in citing absolute values from both studies and the results should only be used for comparison between options at Gate 1, and not for an overall indication of change in natural capital value.

Table 11-5 – Comparison of change in value between this study and the WRSE regional NCA

	This study		WRSE regional NCA	
Option	Change in Value (£/year)	Relative rank*	Change in Value (£/year)	Relative rank*
150 Mm^3	£473,237	4	£23,943	5
125 Mm^3	£538,719	3	£12,580	6
100 Mm^3	£605,300	2	£102,217	1
75 Mm^3	£640,187	1	£93,259	2
30/100 Mm^3	£470,793	5	£52,107	4
80/42 Mm^3	£468,778	6	£62,454	3

* Note: relative rank is based only on relative differences between options based on comparison of overall net change in value for each option and does not suggest or prescribe option preferences.

11.1.4.6. Step 6 Results: Calculation of NC metric

In translating the results of this study into Gate 1 NC metrics, it is important to recognise that there are both benefits and disbenefits associated with each option due to differences in the direction of change for individual ecosystem services. In the case of SESRO, negative changes are estimated for the food production service, while the other services are expected to increase in value across the options. The metric excludes the water regulation service which was not valued. Table 11-6 reports the total disbenefit (negative change) and total benefit (positive change) in ecosystem services value, compared to the baseline value. A net value is calculated to demonstrate the overall balance in changes to the values across all ecosystem services. It is recommended that both the disbenefits and benefits are recognised in investment decision making. Note that these values are for the operational period of the reservoir only, with the natural capital value during construction assumed to be zero. It should also be noted that these changes in value will not be immediately realised on opening of the scheme and will take time for services such as carbon sequestration and water purification to become positive. Comparison with the NC metrics delivered by the WRSE regional NCA are already provided in Step 5 Results.

Table 11-6 – SESRO Gate 1 NC metrics

	Option					
NC Metric	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30/100 Mm^3	80/42 Mm^3
Total disbenefit (£/year)	−£896,268	−£835,134	−£750,331	−£658,853	−£899,402	−£900,716
Total benefit (£/year)	£1,369,505	£1,373,853	£1,355,631	£1,299,040	£1,370,195	£1,369,494
Net value (£/year)	£473,237	£538,719	£605,300	£640,187	£470,793	£468,778

11.1.5. Conclusions

The main conclusions of the SESRO Gate 1 NCA were:

- All options demonstrate an overall positive change in natural capital value compared to the baseline on a £/year basis, although it should be noted that this improvement in natural capital value is unlikely to be realised immediately after scheme completion as it will take time for assets to become established;
- The reported positive change in natural capital value is primarily due to the significant increase in Recreation value expected for the site, which outweighs the decrease in ecosystem value of food production – although improvements in all the other services are also reported in comparison to the baseline, without recreation they are insufficient both alone and in combination to outweigh the loss in Food production value;
- Sensitivity analysis concluded that the results were sufficiently robust to allow comparison between options on the basis of their natural capital values, but caution should be used when citing the absolute values as these are contingent which transfer values are used in calculations;
- Options 75 Mm^3 and 100 Mm^3 exhibited the largest net positive change in value at £640k and £605k per year respectively due to the combination of changes in specific ecosystem service values, in particular their lower losses in Food production due to their smaller footprint relative to the other options;
- The results were compared with the findings of the WRSE regional NCA at each stage in the assessment and for each ecosystem service. It is proposed that the NC metrics developed in this assessment can be used to update the WRSE values for the SESRO options given the enhancement in natural capital asset mapping resolution, extended valuation of additional ecosystem services and use of supplementary values databases.

11.1.6. Assessment framework towards Gate 2

According to the ACWG guidance, the purpose of the Gate 2 NCA is to support detailed feasibility, concept design and multi-solution decision making, producing metrics suitable for use in cost-benefit analysis (CBA). The ACWG guidance states that it should be informed by and compliant with both the WRPG SG and ENCA guidance.

The Gate 2 NCA should therefore provide an NCA with an expanded scope in comparison to Gate 1. This could include:

- Use of “best practice” WRPG SG methodologies for the minimum five ecosystem services;
- Consideration of a broader range of ecosystem services based on stakeholder consultation and more detailed uses of the existing options sites; e.g. consideration of the renewable energy (solar power) value;
- Drawing on ENCA approaches such as the HMT Green Book four step approach and Natural Capital Accounting methodologies;
- Accounting for construction phase changes in value, the total lifecycle of the scheme, and ecosystem dynamics to determine if and when a tipping point in the balance of benefits (such as carbon sequestration) might occur;
- Use of NNCA quality and location indicators, as well as quantity indicators to provide more refined total benefit valuation figures for scheme lifecycle which are more appropriate for stakeholder consultation and design;
- Assessment of potential abstraction reductions in chalk streams and associated natural capital benefits.

The Gate 2 NCA should also be informed by use of field surveys, such as the UK Habs survey which will inform the BNG assessment, as well as Gate 2 scheme designs.

To maximise the value of the Gate 2 NCA it is proposed that it should be incorporated into the iterative design process, both informing and utilising outputs of aspects such as option landscape designs. This will enable the scheme design to maximise the natural capital value of options with a view to achieve environmental net gain through Biodiversity Net Gain, and support flood risk and carbon assessments to account for the contribution of natural capital assets. This will enable the NCA to deliver greater value, not only as part of the design and assessment process, but also in supporting delivery of greater natural capital value to benefit customers, stakeholders, society and the environment.

11.2. Wider Benefits

11.2.1. Introduction/explanation of topic area

11.2.1.1. Context and objectives

The South East Strategic Reservoir Option (SESRO) partners have identified that there is a need to understand the wider benefits beyond the scheme and associated beneficiaries in order to explore the concept of a collaborative partnership for the scheme. This work will feed into the RAPID Gate process, the aim of which is to provide increasingly detailed assessments of the various options of the conceptual design. Each Gated assessment will support decision making in the following Gates to progress the design and ultimately planning permission for the scheme.

The remainder of this section sets out how this piece of work fits with the wider benefits study, the approach that has been used for this assessment, the opportunities and beneficiaries that should be considered as part of the development of a collaborative strategy and for consideration as part of further design works.

11.2.1.2. Assessment approach

Six Capitals Framework

Whilst there is no standard methodology that can be applied to understand and quantify the wider benefits and dis-benefits that SESRO could provide, a ***six capitals*** framework has recently emerged as a systematic and integrated approach for assessing and reporting environmental, social and economic impacts and can be used to support the scoping and identification of these wider benefits and dis-benefits. The six capitals are different types of assets that provide flows of services to people over time[82].

The aim of the six capitals approach is to support investment decisions to be affordable and resilient both now and in the future. The framework allows for the quantification and accounting of impacts or dependencies on natural, social, human, manufactured and intellectual capital alongside the traditional financial capital upon which decisions are made. Under this framework, natural capital is typically shown as underpinning all other capitals, as shown in Technical Annex B1: EAR Figures, Figure 11.11.

The six capitals can be described as follows, based on the definitions developed by the International Integrated Reporting Council (IIRC)[83]:

- **Financial** – the pool of funds available for use in the production of goods or provision of services, obtained through financing or generated through operations or investments;
- **Human** – people's competencies, capabilities and experiences, and their motivations to innovate;
- **Manufactured** – manufactured physical objects available to an organisation for use in the production of goods and services;
- **Intellectual** – organisational, knowledge-based intangible aspects such as intellectual property, systems and procedures;
- **Natural** – the physical stocks of renewable and non-renewable resources that provide goods and services of value to society and business;
- **Social and relationship capital** – the institutions and relationships within and between communities, groups of stakeholders and other networks and the ability to share information to improve individual and collective wellbeing.

[82] https://www.yorkshirewater.com/media/1763/report.pdf
[83] https://integratedreporting.org/wp-content/uploads/2021/01/InternationalIntegratedReportingFramework.pdf

Table 11-7 below provides a summary of how each of these capitals relate to SESRO.

Table 11-7 – Six capitals and their relevance to SESRO

Capital	Relevance to SESRO
Financial	The impacts of the scheme on Thames Water's and any Direct Procurement for Customer (DPC) entity's finances and customer bills; local and regional economic impacts (e.g. from tourism and job creation).
Human	The impacts of the scheme on employment (both during construction and operation) and its contribution to workforce skills and volunteering opportunities; educational value of the scheme.
Manufactured	The value of the physical assets created by the scheme and impacts on other manufactured assets.
Intellectual	The organisational knowledge and experience gained during development and operation of the scheme.
Social	The impact of the scheme on the health and wellbeing of local communities and reservoir users; the value of stakeholder relationships and networks developed during scheme development and operation; the impact of the scheme on stakeholder and customer relationships and levels of trust with Thames Water.
Natural	The impacts of the scheme on the natural physical assets present at the site and the value of ecosystem (and abiotic) services they provide.

The wider benefits and dis-benefits assessment and report will use this six capitals framework to ensure that the all relevant impacts and benefits are captured.

11.2.1.3. Wider benefits and dis-benefits assessment approach

There are a number of tasks included as part of the study:

Task 1: Quantify, where possible, the local, regional and national societal and economic costs and benefits to third parties that the proposed SESRO development may result in. *The scoping of these metrics and the proposed methodology has been delivered for Gate 1; however, the assessment itself will be post Gate 1.*

Task 2: Identify and map all opportunities for coordination/contribution to other regional and national multi-sector strategic priorities. *This has been completed this for Gate 1. It may need to be revisited following Gate 1 dependant on Task 1 above or other aspects of the SESRO works for example stakeholder engagement. It was not possible to map these opportunities within the timeframe for Gate 1.*

Task 3: Identify the specific key groups of stakeholders (incl. private sector, voluntary, NGOs and public bodies), who might benefit from the SESRO development. *The initial, long-list has been developed as part of the scoping exercise and will be revisited as part of Task 4 post Gate 1.*

Task 4: Propose an implementation strategy to engage and develop a collaborative partnership for the SESRO scheme, for the mutual benefit of these stakeholder groups. *This will be completed post Gate 1 along with Task 1.*

This scoping stage aims to set out the approach we are proposing to take for Task 1 (ahead of RAPID Gate 2) and how this has been developed, as well as undertaking the identification of opportunities and an initial review of the relevant stakeholders and beneficiaries for the scheme to support Task 4.

The assessment approach for Task 1 is summarised in Technical Annex B1: EAR Figures, Figure 11.12. Following data gathering, the initial approach set out in this scoping document may need to be updated and this will be discussed with the client if necessary.

The natural capital assessment developed separately for the Gated Process and set out in the previous section focuses on the appraisal of natural capital aspects of the scheme within its geographic zone of influence as defined by the SEA update. The wider benefits assessment goes beyond this spatial area and considers the other five capitals outlined above, including local economic impacts alongside regional, national and global impacts, where relevant. We have reviewed any elements at risk of double counting between the different technical analyses and scoped these out of the wider benefits assessment, where appropriate.

11.2.2. Datasets reviewed

Below we outline the datasets reviewed and how this has fed into the assessment.

Review of benefits and impacts for scoping assessment:

1. Stakeholder feedback on SESRO, or other similar schemes, was reviewed to inform the understanding of potential benefits or dis-benefits to various stakeholders.
2. In order to understand which benefits may be of significance for particular beneficiaries and therefore prioritise which are considered for further assessment, a qualitative assessment was undertaken based on current available information on the impacts of the scheme, predominately taken from the WRMP19 SEA.

The proposed methods for quantitative assessment section below outlines which benefits have been scoped out of further assessment and the reasons for this based on the qualitative assessment.

The identification of beneficiaries presented at the end of this section of the report is **also** based on the qualitative assessment and an initial, long-list of potential beneficiaries that may be impacted by SESRO has been developed. This will be used as part of the assessment itself to develop a strategy for a collaborative partnership with key stakeholders.

In addition, we have **reviewed** relevant plans, programmes and strategies, and the opportunities that presents for SESRO for coordination, or to contribute to or benefit from:

1. A brief summary of each document or programme reviewed will be outlined.
2. Underneath each document, a list of opportunities has been summarised along with suggestions of how SESRO could support or benefit from these opportunities. These will need to be considered in the following Gates through the collaboration of the design and environmental assessment team as well as the client.

11.2.2.1. Assumptions

We have assumed that GIS layers for each option will be available to inform the assessment as to how the conceptual design of these options, and their associated betterment features e.g. wetlands, visitor centres etc, will change with the various sizing options as above. Alternatively, sensible assumptions will need to be applied as to how land use may change, and this will be agreed with the client and other technical advisors upfront.

The wider benefits assessment will include both benefits and dis-benefits of the scheme to provide SESRO partners with a balanced picture of information to inform their engagement moving forwards. Alongside opportunities which SESRO may benefit from, we have also identified opportunities where SESRO could contribute to other priorities beyond its core function as a strategic water resource asset. Whilst the assessment has focussed on opportunities and considers these through a positive lens, it is acknowledged that there are ways in which these opportunities could be seen through a more negative lens, for example local residents could view the opportunity to draw more visitors into the area differently. These two lens' will be applied when considering the collaborative partnership strategy for task 4.

In reviewing relevant documents to identify opportunities, and in the scoping stage where we have undertaken a qualitative assessment we have relied on the information provided on the mitigation and betterment features of the design as outlined in the 2018 CDR on the final page which includes a drawing by Jacobs from 2007[84], which has not changed significantly according to recent conversations with the Mott MacDonald design team. Examples of these features include:

- Formal water and land sports area and informal recreational areas;
- Rehabilitation of the canal (to be confirmed in Gate 2 onwards);
- Visitor centre and heritage/archaeological centre;
- School study centre and outdoor educational water science park;
- Extended footpaths/bridleways;
- Woodland, shrubland grassland and wetland areas;
- Lagoons and coves;
- Fishing and angling pond; and,
- Floodplain compensation and watercourse diversions amongst others.

Strategic documents or programmes relating to specific assessments that are being undertaken by the broader SESRO Environmental Assessment such as the Natural Capital Assessment and the Biodiversity Net Gain

[84] Ref – 7LTC-E2-80006-EX-REV-A (Thames Water, Mott MacDonald, and Cascade 2018)

Assessment have not been reviewed. The purpose of this task and deliverable is to identify opportunities for SESRO to contribute or benefit from other multi-sector priorities and the opportunity to maximise the environmental benefits of the scheme will be captured by these assessments moving forwards.

11.2.3. Gate 1 proportional assessment methodology

11.2.3.1. Review of stakeholder feedback

The first stage in identification of wider benefits and disbenefits of the scheme was to review stakeholder feedback relevant to SESRO or similar schemes. The following feedback sources have been summarised;

- 2019 Water Resource Management Plan (WRMP19) stakeholder feedback;
- Feedback from the Vale of White Horse Local Plan – specifically around the core policy which secures and protects the site proposed for the reservoir; and,
- Consultation feedback from the Havant Thicket work Atkins have been involved in; this is a similar scheme which may elicit similar feedback and concerns or views on opportunities and has been used as specific stakeholder consultation on SESRO has not been undertaken recently.

Key themes from the feedback have been summarised and we have highlighted how it has impacted our scoping of impacts. The feedback summarised is constrained to only those aspects of feedback considered to be relevant for this wider benefits piece of work for SESRO as a Strategic Resource Option, and not, for example on the programme of options and the decision making behind those choices made in WRMP19.

11.2.3.2. Qualitative assessment of impacts

The qualitative assessment of the potential benefits and disbenefits has been considered within a six capitals framework. During the next stage (Task 1) these will be quantified, where possible, using the methods outlined below. This qualitative assessment is based on information on impacts from the work undertaken to date by others (predominately the WRMP19 SEA and information contained in its technical appendices, subsequently cross-checked against the WRSE 2021 SEA). The assessment below may need to be updated as part of the Gate 2 works dependant on updates to the design or other environmental assessments, as appropriate. Where impacts are relevant to multiple capitals and there is potential for double counting between different capitals and impacts, this is highlighted below and will be taken into account in the next stage of the study.

11.2.3.3. Scoping of impacts for quantification and monetisation

The likely significance of each potential impact category identified has been assessed based on the qualitative assessment and a decision made as to whether it will be taken forward to the next stage for quantification and monetisation, with the reasons for this outlined in the outputs section.

Where potential impacts are identified as significant and are not captured under other assessments, but it is unlikely to be possible to quantify and monetise them, the wider benefits assessment will ensure these are captured qualitatively. Where impacts are likely to be significant and will be captured under other assessments, the wider benefits assessment will collate and report these values to enable a holistic six capitals assessment to be reported as part of Task 1.

11.2.3.4. Outlining methods for further assessment in Task 1

The metrics presented below will be assessed by considering the change from the baseline during construction and post construction (including mitigation) and the permanence of the impact, wherever possible. It is envisaged that this change will be based on conceptual drawings available for each option showing areas of habitat creation, recreation or other enhancements and drawing on the outputs of the assessments of the main environmental assessment, as appropriate. If such information is not available, reasonable assumptions will need to be made about the change. Data requirements to undertake these assessments have also been presented.

11.2.3.5. Review of beneficiaries, dis-beneficiaries and stakeholders

An initial long-list of potential beneficiaries and those who may be disadvantaged by the scheme has been developed based on the qualitative assessment. This review will also inform Tasks 2, 3 and 4 as set out above, which will seek to identify opportunities for coordination or contribution to strategic priorities, identify specific stakeholders who may benefit from SESRO and ultimately to propose a strategy to develop a collaborative partnership for SESRO. This will be reviewed, and more specific stakeholders identified as part of Task 4.

11.2.3.6. Review of relevant plans, programmes and strategies, and the opportunities that presents for SESRO

The list of documents outlined in section 11.2.4 below was identified through drawing on the current understanding of the proposed SESRO scheme, its beneficiaries and potential benefits from the scoping work undertaken for task 1, and searching for relevant open-source materials of plans and initiatives that fall across the six capitals framework. This included local and regional government development and economic strategies, river basin management plans, Canal and River Trust initiatives, and local and regional water and flood risk management strategies as well as searching for other local priorities such as health and wellbeing. We also liaised with consultation leads from Thames Water and Affinity Water to confirm and further identify other relevant strategies and programmes for review.

To understand and maximise the potential in which the scheme could provide multiple benefits for the economy, society and environment, a multi-sector and multi-level spatial approach was used to ensure a holistic and comprehensive review was taken, whereby themes of socio-economic and environmental opportunities from a local to national scale were considered. A wide array of benefits and opportunities to develop synergies between SESRO and other parties have been considered and detailed in section 11.2.4. These include opportunities to enhance the potential benefits of the proposed scheme and also provide further mitigation opportunities compared to the existing proposal for the dis-benefits.

The documents and programmes which have been identified as relevant to the wider benefits and dis-benefits assessment have been selected based on the benefits and beneficiaries identified as part of the scoping exercise undertaken for Task 1. Strategic documents or programmes relating to specific assessments that are being undertaken by the SESRO Environmental Assessment such as the Natural Capital Assessment and the Biodiversity Net Gain Assessment have not been reviewed. The purpose of this task and deliverable is to identify opportunities for SESRO to contribute or benefit from other multi-sector priorities and the opportunity to maximise the environmental benefits of the scheme will be captured by these assessments moving forwards.

The Public Value framework[85] has identified that more attention and rigour has been historically placed on reporting against environmental themes than social themes by water companies. In addition, it has been found that a majority of companies were focussed on mitigating the effects of social and environmental challenges, rather than trying to work with others to address the interlinking factors that underpin numerous problems. Therefore, the opportunities identified in this output have focussed away from mitigation (as these will be picked up by the other aspects of the environmental assessment work) and instead on both opportunities within the footprint of SESRO in addition to those in the wider geographic area where SESRO could make significant contributions over and above mitigation and contribute to community focussed activity as part of its corporate social responsibility. An example could be that in addition to providing recreational facilities, efforts are also made to provide easy access to these facilities for all, for example through connecting the reservoir to local communities by green networks for active travel, or by enabling easier access for those in more deprived areas to realise the benefits of wellbeing provided by the proposed scheme. The report has attempted to consider the priorities of stakeholders and frames the opportunities from their point of view where possible.

The value or benefits that these opportunities could provide to local communities, to the local and regional economy and environment could be considerably greater than their cost; for example, improvements to the A34 in addition to the proposed works that will be required for the proposed reservoir drawdown channel/canal could provide significant economic benefits to the local and regional economy. Following Gate 1 we would recommend reviewing the opportunities with the client and their engineering partner, along with stakeholders to discuss opportunities missed, alongside gauging the feasibility and likely impact and priority of undertaking these opportunities which will inform task 4.

11.2.4. Outputs/findings

11.2.4.1. Review of stakeholder feedback

WRMP19 – Statement of Response

The feedback summarised below is in relation to appraisal of future options and assessing the environmental impact of the WRMP19 from both Affinity Water and Thames Water's WRMP19s and their statement of responses which have been published on their websites.

[85] Purpose Union and Impact Institute (2020). Public Value in the Water Sector. Accessed February 2020 – Ofwat Purpose And Public Value Report.pdf

Table 11-8 – WRMP19 stakeholder feedback and impact on scoping

Key Theme	Gathered information, commentary and conclusions	How the stakeholder feedback has impacted the scoping of wider benefits
Impact on flows in the River Thames. Support for reduced abstractions made possible by SESRO to vulnerable watercourses.	Affinity Water concluded that the longer-term introduction of strategic supply schemes, such as SESRO, will have beneficial effect on low flows.	The beneficial impact of SESRO in terms of reducing abstractions to sensitive chalk streams is acknowledged in the scoping.
Insufficient understanding of the environmental effects and impacts of SESRO i.e. drought resilience, and floodplain loss.	A flood risk assessment and design of floodplain compensation and river re-alignment is being undertaken by the Mott MacDonald team, which may feed into the wider benefits assessment if the outputs are available within the timeframes of the study. The drought regulation function of SESRO will not be assessed by this piece of work as it is considered to be a core benefit of the scheme (as outlined in Table 11-11 and will be highlighted under the natural capital assessment. An environmental appraisal is being undertaken as part of Gate 1 and it is assumed that this will help develop a more detailed understanding of the environmental impacts of the scheme.	These aspects will be covered under other pieces of work ongoing for SESRO, including the natural capital assessment, flood risk assessment and environmental appraisals. If these link to or provide details for the wider benefits study then we will make use of these.
Need to identify mitigation for those impacts on environment and protected sites alongside opportunities to enhance.	An environmental appraisal is being undertaken as part of Gate 1 and it is assumed this will help build on the understanding of the environmental impacts of the scheme and proposed mitigations.	These aspects will be covered under other pieces of work ongoing for SESRO. If these link to or provide details for the wider benefits study, then we will make use of these.
The importance of transparency in decision-making		We will endeavour to provide full details of the input data, methods and assumptions to ensure transparency.

Key Theme	Gathered information, commentary and conclusions	How the stakeholder feedback has impacted the scoping of wider benefits
Visual impact of the scheme	The SEA for the WRMP19 acknowledged that there would be a major adverse impact on the landscape setting, and views and visual amenity from the North Wessex Downs AONB both during construction and operation. However, the development of an environmental design and mitigation strategy is planned to integrate the SESRO with the sensitive location in the AONB setting and to protect and enhance local landscape character and to help mitigate the effect on views and visual amenity through the enhancement of recreational and landscape features. A landscape and visual impact assessment will be undertaken at Gate 2 as part of an appraisal report to better understand this impact.	The scoping acknowledges that this is a significant impact.

Vale of White Horse Local Plan 2031 Summary of Representations

Table 11-9 – Vale of White Horse Local Plan 2031 stakeholder feedback and impact on scoping

Key Theme	Gathered information, commentary and conclusions	How the stakeholder feedback has impacted the scoping of wider benefits
Impact of reservoir on highways access	Core Policy 14 ensures that any proposed for the reservoir includes a new diversion route including off-road cycle path	The scoping acknowledges that disruption to local residents is likely to be significant without mitigations in place. Off-road cycle paths delivered as part of the scheme will provide benefits to cycling.
Impact of reservoir on environment, including designated sites, priority habitats, local conservation sites, the River Thames and visual impact on the AONB.	An environmental appraisal is being undertaken as part of Gate 1 and it is assumed this will help build on the understanding of the environmental impacts of the scheme and proposed mitigations.	These aspects will be covered under other pieces of work ongoing for SESRO. If these link to or provide details for the wider benefits study then we will make use of these.

Havant Thicket – stakeholder feedback

Table 11-10 – Havant Thicket stakeholder feedback and impact on scoping

Key Theme	Gathered information, commentary and conclusions	How the stakeholder feedback has impacted the scoping
Concerns around plans being future proof; for example, meeting future recreational demands		It is suggested that this scoping and the outcomes of it, along with the natural capital assessment, are shared with the client and design team to inform their assessments (e.g. visitor number assessment) and in turn our own.
Concerns around impact of construction on residents, environment (including loss of important habitats) and transport/access.	An environmental appraisal is being undertaken as part of Gate 1 and it is assumed this will help build on the understanding of the environmental impacts of the scheme and proposed mitigations.	Concerns around loss of habitat will be covered under other pieces of work ongoing for SESRO, including the biodiversity net gain assessments. If these link to or provide details for the wider benefits study then we will use these. The scoping acknowledges the impact on residents and transport and this is considered below.
Concerns around impact of re-routing water for use in the reservoir and the knock-on impacts this might have.	An environmental appraisal is being undertaken as part of Gate 1 and it is assumed this will help build on the understanding of the environmental impacts of the scheme and proposed mitigations.	These aspects will be covered under other pieces of work ongoing for SESRO, including the natural capital assessment and environmental appraisals. If these link to or provide details for the wider benefits study then we will make use of these. The beneficial impact of SESRO in terms of reducing abstractions to sensitive chalk streams is acknowledged in the scoping and natural capital assessments.
Queries around how the reservoir provides access to recreation (along with some concerns about the level of activity expected and potential local disruption) and how it fits with wider transport network and encourages more sustainable methods of travel	It is suggested that this scoping and the outcomes of it are shared with the client and design team to inform their assessments (e.g. transport assessment, design to take account of access considerations etc) and in turn more detailed impact assessments as the designs are further developed.	The opportunities to improve physical and mental health have been included as part of this scoping, for example through active travel opportunities, alongside disruption.

Key Theme	Gathered information, commentary and conclusions	How the stakeholder feedback has impacted the scoping
Visual impact of the scheme	The SEA for the WRMP19 acknowledged that there would be a major adverse impact on the landscape and visual amenity from the North Wessex Downs AONB both during construction and operation. However, the development of an environmental design and mitigation strategy is planned to integrate the SESRO with the sensitive location in the AONB setting and to protect and enhance local landscape character and to help mitigate the effect on views and visual amenity through the enhancement of recreational and landscape features. A landscape and visual impact assessment will be undertaken at Gate 2 as part of an appraisal report to better understand this impact.	The scoping acknowledges that this is a significant impact.
Concerns around the operation of the site mainly; impact on wildlife by visitors, antisocial behaviour, safety, littering etc	It is suggested that this scoping and the outcomes of it are shared with the client and design team to inform their design and in turn our own.	The scoping assessment proposes to assess all betterment and recreational features proposed in the design, as far as possible.

11.2.4.2. Qualitative assessment of impacts

As part of the qualitative assessment of impacts, a series of metrics have been identified for each of the six capitals based on the following

- Natural capital – see approach and guidance set out in section 11.1 above;
- Other capitals: review of information sources available for the study as set out in 11.2.2 above; review of International Integrated Reporting Council (IIRC)[86]; guidance; and input from specialist technical experts in the fields of social value and infrastructure economics.

Note that where impacts identified as being relevant to multiple capitals, their value will only be included once to avoid double counting. Where proposed metrics are relevant to multiple capitals, this is highlighted in the tables below.

Natural capital

A separate natural capital assessment has been undertaken as part of the Gate 1 environmental assessments. Impacts on natural capital associated with the development of SESRO will therefore not be included under the wider benefits study; however, below we provide a summary of qualitative impacts for completeness.

Table 11-11 – Qualitative assessment of potential impacts of proposed scheme – natural capital

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Flood risk reduction (also relevant to all other capitals)	Local population – residents and businesses	Following a meeting with the Mott MacDonald flood modelling team on 25/11/20 it is understood that there will be no detriment from the development of the proposed reservoir in terms of flood risk due to diversion of the channels and also floodplain compensation. There may be some benefit in terms of flood risk downstream in Abingdon. However, it has not yet been quantified and confirmed through additional modelling. The potential of supporting the delivery of the Abingdon Flood Alleviation Scheme (FAS) (previously dismissed as not being cost-effective) conjunctively through the creation of the embankment which will form the access road to the reservoir is also being investigated. However, it is too early in the programme and investigations to be able to confirm whether there will be a significant flood risk benefit and therefore further quantification of flood risk benefit will not be included as part of the Gate 1 natural capital assessment. It may be possible later in the programme once a final decision has been made around the conjunctive development of the reservoir and the Abingdon FAS or wider Thames Valley Flood Scheme (TVFS) being investigated by the EA.				
Climate regulation	Wider society – global	The construction of the reservoir will result in a change in land use, habitat and vegetation, causing changes in carbon stocks and carbon sequestration within the zone of influence of the reservoir, which will be assessed within the natural capital assessment. The carbon costs of the scheme (carbon emissions through construction and embodied carbon of materials, alongside operational carbon) will be calculated and included as part of the engineering assessment. Care will be taken to avoid double counting if costs also include the Climate Change Levy.				

[86] https://integratedreporting.org/wp-content/uploads/2021/01/InternationalIntegratedReportingFramework.pdf

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Food production (also relevant to financial capital)	Local Farmers/UK food production	The construction of the reservoir will result in a loss of food production services due to a reduction in agricultural land area, which will be included under the natural capital assessment.				
Air quality and impact on human health (also relevant to social capital)	Local population	Presence of trees and vegetation which sequester air pollutants in fields and woodland areas that are there presently. There is also agricultural land which can be a source of air pollution. This will be covered by the natural capital assessment.	-	Increase in traffic and other transport during construction e.g. HGV movements and the increase in pollutant emissions (e.g. NO_2, SO_2 and particulate matter (PM). This is covered under social capital below. Mitigation measures are anticipated to be put in place to minimise impacts.	Mitigations proposed include extensive planting on site. Impacts on air quality regulation as a result of land use change are covered under the natural capital assessment.	Increase in local traffic due to visitors to and the operation of the reservoir. This is covered under social capital below.

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Access to and impact on recreation (also relevant to social capital)	Local population, users and non-users of proposed reservoir recreational features and potentially visitors from outside of the local area. Chalk stream users	Unimpeded access to public rights of way, bridleways and local roads. Current abstractions from sensitive chalk streams; proposed reservoir aims to reduce these abstractions. Presently derelict section of the nearby canal.	-	Some disruption to and closure of public rights of way, bridleways and local roads. Impacts will be covered under the natural capital assessment.	Improved access to and improvements to quality and quantity of public rights of way (including improved accessibility for users of mobility scooters or wheelchairs), bridleways and local roads. New recreational features at the proposed reservoir; e.g. angling, boating, cycling, birdwatching, informal recreation. Potential rehabilitation of dismantled canal for recreation purposes. Proposed reservoir aims to reduce the abstractions from sensitive chalk streams. Impacts will be covered under the natural capital assessment.	Draw down of the reservoir water level during drought could impact on formal recreational use of reservoir. Impacts will be covered under the natural capital assessment.

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Water supply and drought regulation (also relevant to financial capital)	Local population and wider water resource zone including wider and long-term strategy for water supply for the South East	-	Assume that reservoir would be filled in winter during times of high flow to mitigate potential impact on watercourses. Assume that there is no dis-benefit in terms of water supply uncertainty as the timing of implementation of the scheme will be in line with water resource needs.		Major local, regional and national beneficial effects for resilience of water supply. This is the core benefit of the proposed reservoir and is not therefore included within the wider benefits assessment	Reduced availability of water for other abstractors. This is being considered under the natural capital assessment (water regulation) although guidance suggests it should not be used for decision making as the methods available are not sufficiently robust[87].
Biodiversity	Impacts relating to biodiversity will be covered in detail under the separate biodiversity net gain assessment.					

[87] As stated in the 'Water Resources Planning Guideline Supplementary guidance – Environment and society in decision making' (draft for consultation published 23/09/20)

Social capital

Table 11-12 – Qualitative assessment of potential impacts of proposed scheme – social capital

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Air quality and impact on human health (also relevant to natural capital)	Local population	Presence of trees and vegetation which sequesters air pollutants in fields and woodland areas that are there presently. There is also agricultural land which can be a source of air pollution. This will be covered by the natural capital assessment.	-	Increase in traffic and other transport during construction e.g. HGV movements and the increase in pollutant emissions (e.g. NO_2, SO_2 and particulate matter (PM)). Mitigation measures are anticipated to be put in place to minimise impacts.	Mitigations proposed include extensive planting on site. Impacts on air quality regulation as a result of land use change are covered under the natural capital assessment.	Increase in local traffic due to visitors to and the operation of the reservoir. Mitigations proposed include the addition of electric vehicle charging points in the car park.
Noise and disruption and impact on human health	Local population	Present road usage in the vicinity of the proposed site is likely to be mostly local traffic.	-	Increase in traffic and other transport during construction e.g. HGV movements and the increase in local noise levels and dust etc. Mitigations proposed include controlling dust though dampening of haul roads and earthworks, along with other standard good practice for large construction sites.	-	Increase in local traffic due to visitors to and operation of the reservoir.

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Visual amenity	Local population Visitors to the area from outside of the local area – non users of reservoir	Uninterrupted views of and from the North Wessex Downs Area of Outstanding Natural Beauty (AONB).	-	Extensive disruption to views, and character of landscape. Mitigation measures planned.	Development of environmental design and mitigation strategy is planned to integrate the SESRO with the sensitive location in the AONB setting and to protect and enhance local landscape character and mitigate the effect on views and visual amenity through the enhancement of recreational and landscape features – to be investigated as part of the design process.	Creation of a new prominent and large scale feature in the landscape impacting on landscape character views and visual amenity, including reduced enjoyment of recreational experiences such as walking in the nearby AONB. Environment design and mitigation strategy is planned and landscape mitigation/enhancement measures are to be investigated as part of the design process.
Heritage and Archaeology	Local population Visitors to the area from outside of the local area – non users of reservoir	Uninterrupted access to local conservation, heritage and archaeological features.	-	Potential disruption of access, enjoyment of conservation areas, the various listed buildings, parks/gardens etc that are close to the proposed reservoir site. In addition, loss of East and West Hanney ditches through diversion which are locally important.	Localised enhancements to interpretation and heritage /archaeological centre to be investigated through design process. Rehabilitation of dismantled canal for recreation purposes.	Potential disruption of access, enjoyment of conservation areas, the various listed buildings, parks/gardens etc that are close to the proposed reservoir site. In addition, loss of East and West Hanney ditches through diversion which are locally important.

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Physical and mental health benefits from exercise (also relevant to financial and human capital)	Local population – users of the proposed reservoir site and its recreational features	Unimpeded access to public rights of way for exercise. Currently predominantly agricultural land and therefore not a key resource for recreational exercise.	-	Some disruption to and diversions of public rights of way and a national cycle route. There will be a loss of allotments and sports facilities within the reservoir footprint. Nearby services such as golf courses and public parks may also face disruption for users. Potential for increased stress and anxiety caused by both the presence of construction works close to local communities and also disruption to recreational opportunities.	Improved access to and improvements to quality and quantity of public rights of way, new walk/cycleways, rehabilitation of dismantled canal, bridleways and local roads. New recreational features at the proposed reservoir as part of the compensatory measures being investigated through the design process.	-

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Social relations	Stakeholder groups	There are a significant number of stakeholder groups with interest in the current site, River Thames and proposed scheme (see Table 11-20 below).	Participation in stakeholder engagement processes during development of the scheme may help to foster improved social relations between stakeholders (e.g. members of the local community).	The contentious nature of large infrastructure schemes such as this could result in antagonism between different stakeholders and groups due to differing views on the scheme.	There may be opportunities for community engagement and events associated with the reservoir, which could be of benefit to social relations.	The scheme may affect different stakeholder groups to a different extent over the long-term (e.g. some communities and groups may benefit more than others), which could result in negative impacts on social relations in the long-term
Customer relations; customer service metrics such as C-MeX	Thames Water; customers	Thames Water has had some of the lowest customer satisfaction scores over the past few years within the water industry[88].	If handled effectively, any interruptions to supply or other customer impacts during construction of the scheme should not result in dis-benefits to customer relations and could result in an improvement.	If not handled effectively, any negative impacts on customers during construction of the scheme could have an adverse impact on customer relations and trust.	Engagement with customers on the improved resilience, as well as other benefits, provided by the scheme could be beneficial to customer relations in the long-term.	Poor communication on the benefits of the scheme or perceived dis-benefits of the scheme amongst customers in the long-term could have an adverse impact on customer relations in the long-term.

[88] https://www.ofwat.gov.uk/regulated-companies/company-obligations/customer-experience/service-incentive-mechanism/

Human capital

Table 11-13 – Qualitative assessment of potential impacts of proposed scheme – human capital

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Local and regional economy – business and employment opportunities (also relevant to financial capital)	Local population and businesses Regional and national population and businesses. Volunteering organisations.	-	Direct impact of construction work – related GVA and employment Indirect and induced impact – temporary increase in local economic activity due to knock on impact of construction and construction workers (GVA impact from supply chain and local spend).	Disruption to local businesses through construction in terms of traffic delays, reduction in passing trade and custom, as visitor numbers could reduce due to the construction activity and impact on amenity. Some businesses may need to re-locate.	Business opportunities (and related GVA and employment) through recreation and destination offer from SESRO and visitor centre. Post-construction, longer term employment opportunities e.g. maintenance of reservoir, visitor facilities. Potential volunteering opportunities.	Long-term loss of some local businesses. There are community concerns around house price increases, increase in nearby developments and issues around local facilities becoming more pressured such as car parking.
Education	Local population Regional educational establishments	-	-	-	Opportunity for education and research around water resources and supply alongside other aspects of the proposed development such as environmental mitigation. Opportunity for educational facility at visitor centre.	-
Tourism (also relevant to financial capital)	Regional, national and international visitors	-	-	-	Potential increase in visitors from tourists to the local area to visit the reservoir and other local attractions. Local spend impacts – local business support and local employment	Potential decrease in visitors to AONB and other heritage /conservation attractions nearby as a result of impacted views and/or reduced enjoyment of their experience.

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Workforce skills and experience (also relevant to intellectual capital)	Thames Water, Affinity Water and supply chain employees, potential apprentices	-	Development and construction of the reservoir will provide opportunities for upskilling of the workforce and could involve creation of a number of apprenticeships.	-	Operation of the scheme will provide opportunities for training and upskilling of the workforce.	-

Intellectual capital

Table 11-14 – Qualitative assessment of potential impacts of proposed scheme – intellectual capital

		Baseline	During Construction		Post-scheme	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Organisational knowledge and experience	Thames Water, supply chain partners (and Affinity Water as partners)	SESRO is a large-scale, complex scheme. There may be a lack of current organisational knowledge and experience in developing a reservoir of this scale, although individuals and project partners involved are likely to have experience from other sites (e.g. Havant Thicket) and recent large-scale infrastructure schemes.	Improvement in organisational knowledge and experience relating to construction of a large-scale reservoir.	-	Improvement in organisational knowledge and experience relating to operation of a large-scale reservoir.	-

Financial capital

There are close links between the impacts on financial capital and manufactured capital for this scheme as it involves investment in the creation of a new manufactured asset, which holds value. Within the reporting of the results, this will be clearly reported and the value only included once (i.e. not under both capitals) to avoid double-counting.

Table 11-15 – Qualitative assessment of potential impacts of proposed scheme – financial capital

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiaries	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Financial asset value (also relevant to manufactured capital)	DPC entity, Thames Water, Affinity Water, shareholders	Water companies' regulatory capital values are updated annually and represent the value of their regulated assets. The RCV for Thames Water was calculated by Ofwat as £14.7bn as of March 2020 and £1.2bn for Affinity Water[89]. However, the scheme is likely to be delivered by a separate, new DPC entity[90].	New financial assets would be created by the DPC provider .	-	New financial assets would be created by the DPC provider .	-
Customer bills	Thames Water and Affinity customers	Average annual customer bills for water were £210 for Thames Water and £161-£193 for Affinity Water depending on the region.	-	Customer bills are expected to increase as a result of construction of the scheme, in order to secure a long-term more resilient supply of water.	-	Customer bills are expected to increase as a result of construction of the scheme, in order to secure a long-term more resilient supply of water.

[89] https://www.ofwat.gov.uk/publication/regulatory-capital-values-2020/
[90] our-plan-2020-to-2025.pdf (thameswater.co.uk), Thames-Water-Direct-procurement-for-customers-detailed-actions.pdf (ofwat.gov.uk)

Manufactured capital

Table 11-16 – Qualitative assessment of potential impacts of proposed scheme – manufactured capital

		Baseline	During construction		During operation	
Metrics	Beneficiaries/ Dis-beneficiary	Existing situation	Benefits	Dis-benefits	Benefits	Dis-benefits
Value of newly created assets (also relevant to financial capital)	Thames Water, Affinity Water and customers	The value of Thames Water and Affinity Water's current asset base is represented by the RCV as set out under financial capital above.	Construction of SESRO will create a new valuable asset for both companies. Costings are currently being developed for the scheme.	-	Construction of SESRO will create a new valuable asset for both companies. Costings are currently being developed for the scheme.	-

11.2.4.3. Scoping of impacts for quantification and monetisation

Table 11-17 – Summary of qualitative assessment and scoping impacts for quantification and monetisation

Relevant capitals	Metric	Construction or operational impact likely to be significant?	To be quantified and monetised as part of the wider benefits assessment? (Green = yes, amber = uncertain, red = no)
Natural capital	Flood risk reduction	No permissible detriment; flood risk benefits currently uncertain and subject to design.	May be quantified and monetised at a later stage upon further development of the design.
Natural capital/social capital	Climate regulation	Yes	**No** – impacts due to changes in carbon stocks and sequestration to be covered and reported under the **natural capital assessment**. Embodied and operational carbon emissions of the scheme to be quantified and monetised as part of the **engineering assessment**.
Natural capital	Food production	Yes	**No** – to be quantified and reported under the **natural capital assessment**.
Natural capital/social capital	Air quality and impact on human health	Yes	**Yes** – air pollutant emissions associated with construction and operation of the scheme to be quantified and monetised as part of the wider benefits assessment. Impacts due to changes in land cover to be covered under the natural capital assessment.
Natural capital/social capital	Access to and impact on recreation	Yes	**No** – changes in recreational value of the site to be assessed and reported under the **natural capital assessment**.
Natural capital	Water supply and drought regulation	Yes	**No** – to be considered under the natural capital assessment.
Natural capital	Biodiversity	Yes	No – to be considered under the **natural capital assessment** and quantified as part of the **biodiversity net gain assessment**.

Relevant capitals	Metric	Construction or operational impact likely to be significant?	To be quantified and monetised as part of the wider benefits assessment? (Green = yes, amber = uncertain, red = no)
Social capital	Noise and disruption and impact on human health	Yes	**No** – although this is considered to be a significant dis-benefit of the scheme, it is assumed that there will need to be a much more detailed assessment than has been carried out to date in order to inform a confident qualitative assessment of the impact relating human health. It is recommended that this assessment is undertaken either at Gate 2 or 3 depending on when a suitable level of assessment on noise and disruption can be made. The SEA will undertake a separate qualitative assessment of this impact and it will not be covered under the wider benefits assessment.
Social capital	Physical and mental health benefits from exercise	Yes	**Yes**
Social capital	Social relations	Yes	**No** – although impacts have the potential to be significant, there is currently no known method to allow quantification and monetisation of this category. To be captured **qualitatively** under the wider benefits assessment.
Social capital	Customer relations; customer service metrics such as C-MeX	Yes	**No** – although impacts have the potential to be significant, there is currently no known method to allow quantification of this category under future scenarios. To be captured **qualitatively** under the wider benefits assessment.
Social capital	Visual amenity	Yes	**No** – whilst this impact is significant, it will be qualitatively assessed by the SEA, and there is not considered to be a method of robustly and confidently assessing the direct impact of changes to visual amenity without considerable risk of double counting with the other metrics being assessed such as recreation. In addition, a landscape and visual impact assessment will be undertaken at Gate 2 as part of an appraisal report to better understand this impact. This information will be considered at this point in time.
Social capital	Heritage and Archaeology	Yes	**No** – whilst this impact is likely to be significant, as discussed in the qualitative assessment, it is mostly covered by other metrics, for example the increase in noise and traffic, impacts on the local economy and recreational impacts. It will not be quantified or reported separately to reduce the risk of double counting.

Relevant capitals	Metric	Construction or operational impact likely to be significant?	To be quantified and monetised as part of the wider benefits assessment? (Green = yes, amber = uncertain, red = no)
Human capital	Local/ regional economy – business activity and employment opportunities	Yes	**Yes**
Human capital	Education	Yes	**Yes**
Human capital	Tourism	No	**No** – it is not considered to be a significant benefit of the proposed reservoir and there is the risk of double counting of the recreational benefits. The impact of the reservoir will be considered qualitatively by the SEA and not covered separately under the wider benefits assessment.
Human capital	Workforce skills and experience	Yes	**Yes**
Intellectual capital	Organisational knowledge and experience	Yes	**No** – although impacts have the potential to be significant, there is currently no known method to allow quantification and monetisation of this category. To be captured **qualitatively** under the wider benefits assessment.
Financial capital/manufactured capital	Financial asset value	Yes	**Yes** – values from the engineering cost assessment to be included.
Financial capital	Customer bills	Yes	**Yes** – impacts are uncertain; however, customer bill impacts to be included if data are available.

11.2.4.4. Outlining methods for further assessment in Task 1

There are multiple methodologies that can be used to understand the impacts of a scheme such as SESRO and to calculate social, economic and environmental value. These methodologies include:

- Cost Benefit Analysis (CBA) – HM Treasury Green Book
- Social Return on Investment (SROI) – Cabinet Office
- Environmental Wellbeing and Sustainability – Sustainable Development Goals and the Sustainability Capitals Framework
- Local Economic Multiplier at 3 Rounds (LM3) – New Economic Foundation
- Gross Value Added (GVA) – Office of National Statistics (National Accounts)
- Asset Value (Operational Social Value) – Combined CBA, SROI and GVA to understand the long term social, economic and environmental impact of built environment projects

Atkins has a social value calculator that can be used to forecast, monitor and evaluate social value of a project both during construction and post construction whilst operational. We also have access to a number of tools and approaches for undertaking natural capital assessments. By combining all of these methodologies we will be able to calculate the whole life value of the scheme against the lifecycle costs to understand the Whole Life Return on Investment Ratio over the benefits realisation period. In addition, the data can be aggregated to show performance against any model approach – Capitals Framework, SDGs, PPN 06/20, Regional Impact, Sub-regional Impact and Local Area Impact etc. In this case, we will present results under the Six Capitals framework, as described in section 0.

Each of the methodologies is endorsed by Government and uses data from the HM Treasury Green Book, Unit Cost Database, the Global Value Exchange, Office of National Statistics, HCA Employment Density Guidance, HM Treasury Additionality Guidance, amongst others. The social value calculator database currently consists of 1,000 KPIs underpinned by 6,000 outcomes, proxy values and standardised impact metrics linked to deprivation which are used for CBA, SROI and environmental impact calculations. It also has a database of 1,700 spending proxies across the UK used for LM3 calculations and 2,800 productivity values used for calculating GVA at a local, sub-region, regional and UK level, both of which are both used to understand economic impact.

We will present both operational and construction impacts, along with benefits and dis-benefits values, in combination and separately to ensure that any potential trade-offs are made explicit. The sections below provide a summary of the impacts that will be assessed in more detail in the next phase of the study, along with brief details of the data and methodologies that will be used.

Table 11-18 – Proposed data requirements and outline methodology

Relevant capital	Metric	Data Requirements	Commentary on proposed methodology
Social capital	Impact on human health – air pollution	Details of Air Quality Management Areas Energy use during scheme construction and operation (e.g. vehicle movements, fuel consumption and electricity use (details of which TBC based on engineering assessment) Defra air quality damage costs	• Impacts on air quality as a result of land use change will be covered under the natural capital assessment as described above. • Impacts on air quality due to construction and operation of the scheme will need to be based on the same assumptions as the carbon assessment being undertaken as part of the engineering development of the scheme; e.g. vehicle movements during construction, fuel consumption and electricity use during operation of the scheme.
Social capital	Physical and mental health benefits from exercise	Visitor number and type assessment for the present situation vs with scheme options (details of which will be made available as part of the engineering assessment) Local population health information Transfer values relating to health benefits/cost savings from improved mental and physical health Use of the WHO HEAT (Health Economic Assessment) Tool if sufficient data are available.	• This category reflects both the cost savings as result of increased physical activity in addition to the associated wellbeing benefits. The latter will be covered under the recreational assessment to avoid double counting; this assessment will focus on potential cost savings due to mental and physical health improvements. • Develop an understanding of current health of local population and activity levels or alternatively use a suitable average. • Develop an understanding of how this may change as a result of the scheme, above and beyond the current levels of activity in the population to reduce the risk of double counting with recreational benefits. New linkages with other sustainable travel networks may also be considered if applicable. • Value to physical and mental health benefits in terms of reduced mortality or avoided health costs and emotional health benefit.
Human capital	Education	Visitor number and type assessment (details of which will be made available as part of engineering assessment) Details of capacity of educational facilities from design team (TBC) Transfer values relating to economic benefit of educational visits.	• Develop an understanding of potential number of educational visitors per year either through assessment by design team or understanding of capacity of similar facilities. An assumption may need to be made regarding likely use of these facilities in comparison with the capacity.

Relevant capital	Metric	Data Requirements	Commentary on proposed methodology
Human capital	Local economy Regional economy	Construction timeline, budget/ spend by broad type and supply chain areas. Local businesses that may be impacted during construction, such as disruption or a need to re-locate Capacity guide for onsite recreation and business use during operation, with visitor numbers an input here alongside identified site uses/ space. GVA equivalents for temporary activity (construction stage) and longer-term (operational), for direct, indirect and induced impacts, with FTE estimates.	• Socio-economic baseline of sectoral employment and businesses. To understand a) the local capacity to respond to business and employment opportunities during construction and operation. And b) the employment generating activities that may be impacted by construction. For example, disruption to access for operations and customers. An impact assessment will be made for the likely magnitude and significance of such adverse effects. These will support suggested mitigations and approaches to reduce adverse effects/ enhance benefits as human capital outcomes. • Translate indicative construction spend to GVA equivalent and FTE jobs estimate for the direct work and the supply chain impact, using sector turnover/GVA and employment ratios and Additionality Guidance. Broad assumptions are likely to be needed for the key types of spend and the geography of this supply chain for construction. • Estimate induced effects from on-site construction workers spend in local economy, using national/ regional data sources including ONS multipliers. • Estimate employment capacity from operational uses and assign GVA value to this, considering Additionality. Recognise the longer-term nature of this activity, with visitor facilities and maintenance.
Human capital	Workforce skills and experience		• Wellbeing impact of employment. Quantify the potential social impact of different groups having access to employment opportunity. Consider opportunities for apprentices, training opportunities and moves into work for different groups. • Consider the potential role of SMEs in the supply chain • Use of Social Value Calculator database
Financial capital/manufactured capital	Financial asset value	Estimated scheme cost from engineering assessment	• It will be assumed that the scheme cost represents the financial value of the new asset.
Financial capital	Customer bills	Operating expenditure and capital/financing costs of the scheme from engineering assessment Customer numbers from Thames Water	• The expected bill impact will be estimated based on the operating expenditure and capital/financing costs of the scheme • This will be expressed as approximate average £ increase per customer and as an average % increase.

Limitations

It is recognised that there are a number of limitations associated with a study of this type. Table 11-19 below provides the main limitations relevant to both this scoping study and the next stage of the assessment, identifying how the limitation should be understood and mitigated, where possible.

Table 11-19 – Limitations

Limitation	Response
This scoping assessment is based on the current information available regarding scheme design, which is in the early stages of development.	Updated and newly available information relevant to the wider benefits and dis-benefits of the scheme will be reviewed prior to the next stage of the assessment.
There is no standard approach to six capitals valuation, with approaches tailored to each specific site.	The assessment will draw on the best available information, approaches and data to undertake a valuation of the wider impacts of the scheme.
The approach used will rely on value transfer.	Whilst we will seek to use the best available data and studies at the time, there are inherent uncertainties associated with transferring values from a primary study to the site in question. The results should therefore be considered as approximations of the value of the scheme.
Not all potential impacts will be valued.	Due to current gaps in data or research, it is unlikely to be possible to quantify and/or monetise all impacts.
The interconnections between different metrics and capitals may lead to double-counting.	Where possible we will use conservative figures and seek to identify the potential for and avoid double counting within our assessment. Furthermore, the calculations will not seek to identify all benefits and dis-benefits and therefore values will not represent the final or total figure but an estimate using the available information.
The valuation approach will not take full account of the changes that may occur over time.	For the purposes of the study, it will be necessary to assume that post-scheme land cover, designs, facilities and mitigation measures will remain fixed over the duration of the assessment time horizon. It is important to recognise that the values generated represent high-level estimates of the economic value of each impact category.
The approach assumes values are comparable.	The advantage of assigning a monetary value to as many different impacts as possible is that this helps to enable trade-offs to be explored and evaluated. However, it should be borne in mind that although impacts have been converted to a common currency where possible, this does not mean that there is full comparability between different values.
The valuation does not include intrinsic values and some decisions must draw on information beyond the bounds of economics.	A wider benefits and six capitals valuation approach does not fully capture the ethical and moral arguments for investing in infrastructure and protecting and enhancing ecosystems and should not be seen as replacing or negating these; the arguments should be considered as complementary.

11.2.4.5. Review of beneficiaries, dis-beneficiaries and stakeholders

The spatial scale of each identified stakeholders be defined as follows:

- Local can be considered as the area covered by the Vale of White Horse District Council and surrounding wider Oxfordshire County Council
- Regional can be considered as the south-east of England
- National is considered to be England or the United Kingdom, as appropriate.

Table 11-20 – Long list of beneficiaries and stakeholders

Beneficiary/Dis-beneficiary	Scale	Types of stakeholders identified
Wider society	Global	Carbon Trust
UK population	National	
Land Managers and Farmers	Local/National	NFU, CLA
Local Population – non-users of the current or proposed recreational features	Local	Local resident associations or campaign/environmental groups e.g. GARD and flood action groups.
Local Population – users of the current or proposed recreational features	Local	Local equestrian groups, e.g. Vale of White Horse-Riding Club, Asti Equestrian. Local cycling clubs and Cycling UK. Local angling clubs in Vale of White Horse, e.g. Abingdon Fisheries, White Horse Country Park. Water sports or boating clubs.
Population – workforce for the scheme construction and operation	All scales	Local employment and training organisations Local business groups Local Authorities and Oxfordshire LEP
Local Authorities	Local	Oxfordshire County Council Vale of White Horse District Council Local Wards and Parish Councils
Local businesses and their supply chain	Local	Vale of White Horse District Council, Oxfordshire LEP, and local business groups
The scheme supply chain – procurement and opportunities across the scheme stages	Local/ regional/ national	Local and regional business groups Oxfordshire LEP Potential scheme suppliers and partners
Regulators	Local/Regional/ National	Environment Agency, Natural England, Ofwat, DWI
Thames Water and Affinity Water customers	Regional	Thames and Affinity Water Customer Challenge Groups Thames Water and Affinity Water Social Value and partner teams
Royal Society for Protection of Birds (RSPB)	Local/Regional	RSPB
Historic England	Local/Regional	Historic England
National Trust	Local/Regional	National Trust
River and Canal Trusts	Local/Regional	Canal and Rivers Trust Wilts and Berks Canal Trust The Rivers Trust Thames Rivers Trust The Wandle Trust Thames 21 South East Rivers Trust
Wildlife trusts and conservation groups	Local	Berks, Bucks & Oxon Wildlife Trust WWF, WWT, RSPB, Earth Trust, Environment Agency, CPRE Wild Oxfordshire

Beneficiary/Dis-beneficiary	Scale	Types of stakeholders identified
Local conservation sites e.g. Special Areas of Conservation, Local Nature Reserves, SSSI's etc	Local/Regional/ National/International	Management organisations and users of these sites
Chalk stream users, users of other nearby watercourses such as the River Thames and Ock and the Wiltshire and Berks Canal (currently derelict in the vicinity of SESRO site)	Local/Regional	Revive the Wye The Wild Trout Trust Bexley Wildlife River Thames interest groups, as appropriate Local angling clubs on the Wye, Wandle and Cray (e.g. Cray Anglers Conservation Group) Chalk Streams First group
NHS, local health trusts and primary care providers e.g. GPs	Local	Oxford Health NHS Foundation Trust
Voluntary organisations	Local	National Council for Voluntary Organisations Local charities and voluntary organisations, as appropriate
Local Educational facilities such as Schools, Colleges and Universities	Local/Regional	Department for Education Oxfordshire Schools Forum Local educational facilities e.g. Abingdon and Witney College
Visitors from outside the local area – users of the proposed features	Regional	Tourist Board
Visitors from outside the local area – non-users of the proposed features	Regional	National Association of AONBs North Wessex Downs AONB

11.2.4.6. Review of relevant plans, programmes and strategies, and opportunities identified

A wide array of relevant open-source materials relating to plans and initiatives have been reviewed as part of this work and structured below into the six capitals framework based on where the majority of opportunity lies. There are documents which fall across two or a number of the capitals also (such as Local Plans) and therefore each opportunity has been identified as one or more of the capitals too. The impacts on human and intellectual capital associated with SESRO are not covered in a specific section below as there is not a single document which fits within this capital and therefore these opportunities are found throughout the section below.

This included local and regional government development and economic strategies, river basin management plans, Canal and Rivers Trust initiatives, and local and regional water and flood risk management strategies. We also liaised with consultation leads from Thames Water and Affinity Water to confirm and further identify other relevant strategies, priorities and programmes for review.

The following is a list of documents or sources of information that have been reviewed:

- Vale of White Horse Local Plan[91]
- Thames River Basin Management Plan[92]
- Oxfordshire County Council Flood Risk Management Strategy[93]

[91] Vale of White Horse District Council (2016). Local Plan 2031: Part 1 Strategic Sites and Policies. Accessed February 2020 – Local Plan 2031 Part 1.pdf
[92] Environment Agency and Defra (2015). Thames River Basin District River Basin Management Plan. Accessed February 2020 – Thames RBD.pdf
[93] Oxfordshire County Council (2014). Local Flood Risk Management Strategy. Accessed February 2020 – Local Flood Risk Management Strategy.pdf

- Oxfordshire Plan 2050[94]
- WRMP19 – Affinity Water and Thames Water
- Canal and Rivers' Trusts
- Local physical and mental health initiatives
- Local priorities for designated sites and from environmental organisations such as Wildlife Trusts and the RSPB
- Local priorities for education
- Local air quality plans
- Local opportunities for recreation and tourism
- The Oxfordshire Local Enterprise Partnership (LEP) strategies relating to; economy, infrastructure, energy, skills, the environment and investment
- Other key local issues and priorities (as championed by the local Member for Parliament and identified by previous stakeholder engagement in 2006)

Natural Capital Documents

Natural capital refers to physical stocks of renewable and non-renewable resources that provide goods and services of value to society and business. The impact on natural capital associated to SESRO include the natural physical assets present at the site and the value of ecosystem (and abiotic) services they provide.

Rivers Trust

The Rivers Trust is a national charity which has member trusts that represent local rivers. Their vision is wild, healthy, natural rivers which are valued by all. They are committed to enabling everyone to value and enjoy rivers by addressing and promoting equality, diversity and inclusion (ED&I). They are the umbrella for 60 local member trusts, one of which is the Thames Rivers Trust which covers the area of the proposed site. The Thames Rivers Trust promotes an ecosystem approach to river restoration and supports catchment management and habitat improvements also, along with supporting pilot projects on Natural Flood Management (NFM) and developing a sustainable water resources strategy for the Thames basin with the EA and water companies.

Table 11-21 – Rivers Trust – opportunities

Capitals	Opportunities	How SESRO can benefit or contribute
Natural	River diversion around the proposed reservoir	Maximise the opportunities to naturalise and enhance the watercourses' ecosystem and societal functions as part of this work.
Social	Ability for SESRO to support everyone to enjoy and value the rivers	In line with the rivers trust ED&I commitment, all efforts should be made as part of the design and environmental assessment work to support everyone to enjoy the rivers around the reservoir.
Human	Working with charities and volunteers to enhance the rivers being diverted to form part of a larger project to maximise its wider environmental, social and economic benefits	Actively engage with the Thames Rivers Trust to maximise the support the two programmes can provide to one another particularly around skills building, improving access and enjoyment for all and enhancing the functions provided by the river for example biodiversity, recreation etc.

[94] Oxfordshire Local Authorities (Cherwell District Council, West Oxfordshire District Council, Oxford City Council, South Oxfordshire District Council, Vale of White Horse District Council and Oxfordshire County Council), 2019. Introducing the Oxfordshire Plan. Accessed February 2020 – Introducing the Oxfordshire_Plan.pdf

Capitals	Opportunities	How SESRO can benefit or contribute
Natural	Natural Flood Management	Consider as part of or in addition to the floodplain compensation work, consideration of whether the Abingdon flood alleviation scheme (FAS) can be incorporated into the proposed works, and whether additional NFM measures could contribute towards achieving flood risk benefits but also wider benefits such as biodiversity net gain and education.

Canal Trust

The Wiltshire and Berkshire Canal runs from Melksham in Wiltshire, in a north-easterly arc to Abingdon where it meets the River Thames, in Oxfordshire. The current route of the canal runs through the proposed SESRO site; therefore as part of the SESRO proposal, the canal will need to be diverted from its current path to the west of the proposed reservoir site. At present, the stretch of the canal between the Great Western Main Line and Abingdon is not filled with water (up to the point just to the north of Drayton Copse) and to the north of this identified by the Trust as a section of new canal that will be built. Along the existing southern section to the north of the Great Western Main Line, there are lengths of the canal which are both accessible and inaccessible to the public (see interactive mapping here).

Whilst there are no formal plans that could be found by the Wiltshire and Berkshire Canal Trust, it is clear that the Trust is committed to restoring the full length of the historic canal in order to create a sustainable and bio-diverse blue and green corridor that provides a host of benefits both to the environment and to local communities and visitors, particularly around heritage, creating space for wildlife and recreation opportunities and improved wellbeing of canal users. The Trust have worked with a number of volunteers, along with Veterans and injured servicemen and women who have made major contributions towards re-building abandoned stretches of the canal and locks as well as developing their skills[95]; this also includes employees of organisations who encourage and facilitate their employees undertaking charitable work[96].

There is a clear overlap between SESRO and the canal restoration which could be achieved as part of the proposed canal diversion around the reservoir. In addition to this diversion around the reservoir, there is a need to rehabilitate a further section of the canal downstream of SESRO (to the north-east) for the emergency drawdown of the reservoir to the River Thames.

Table 11-22 – Canal Trust – opportunities

Capitals	Opportunities	How SESRO can benefit or contribute
Natural/ Social	Canal rehabilitation downstream of the proposed reservoir to provide conveyance for emergency drawdown to the River Thames	Maximise the opportunities to enhance the canal's ecosystem and societal benefits as part of this work
Natural/ Social	Canal diversion around the proposed reservoir	Maximise the opportunities to enhance the canal's ecosystem and societal benefits as part of this work
Human	Working with charities and volunteers to rehabilitate the canal to form part of a larger project to bring the canal back into use and maximise its wider environmental, social and economic benefits	Actively engage with the Wiltshire and Berkshire Canal Trust to maximise the support the two programmes can provide to one another particularly around skills building and enhancing the functions provided by the canal; for example, biodiversity, recreation, navigation etc.

[95] Canal & River Trust (2016). Press Release: A Hero's Return. Accessed February 2020 – Press Release.pdf
[96] Wilts & Berks Canal Trust (2020). Corporate Volunteering. Corporate Volunteering

River and Flood Risk Management Plans

There are several watercourses which are tributaries to the River Thames that overlap the proposed area of development, so there are potential opportunities to manage rivers and flood risk in liaison with the Environment Agency and Oxfordshire County Council, alongside other risk management authorities. For example, in the design process of the proposed river diversion, floodplain compensation and new surface drainage channel as stated in the 2021 CDR there is the opportunity to maximise SESRO's potential to benefit neighbouring areas in terms of reducing flood risk. In addition, there are two flood risk management schemes which have the potential to be conjunctively developed alongside the reservoir, which are the Abingdon FAS or the wider Thames Valley Flood Scheme (TVFS) being investigated by the EA.

Thames River Basin Management Plan (RBMP)

The River Thames flows through the county of Oxfordshire, and the closet point of the River Thames to SESRO is the east side of the site which is ~3 km in distance, where the River Thames meanders through the town of Abingdon-on-Thames.

The Thames RBMP[97] sets out the framework for protecting and enhancing the benefits provided by the water environment and it is used to inform decisions of land-use planning. The objectives established in the framework is set to be achieved by the default deadline of 2021. However, where appropriate, the deadlines of some objectives are extended to 2027 or beyond to consider the fact the environment needs time to respond to measures. Also, the on-going COVID-19 pandemic may further change the deadlines. The dynamic prospect of Brexit may also change the current national commitment to the Water Framework Directive (WFD) – a piece of legislation that aims to improve and maintain the aquatic ecosystems to ensure the long-term sustainable use of water for people, business and nature – which is one of the key aspect of the RBMP.

Oxfordshire County Council Local Flood Risk Management Strategy (LFRMS)

The Oxfordshire County Council LFRMS[98] developed in partnership with the local district councils and the Environment Agency, sets out how the Lead Local Flood Authority (i.e. Oxfordshire County Council) will develop, maintain, apply and monitor flood risk management. The vision for the strategy is as follows:

> *"To improve the approach to reducing flood risk and thereby increase the resilience of communities across the county"*

Table 11-23 – River and Flood Risk Management Plans – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Manufactured/ Natural	Reduce flood risk in other neighbouring areas as well as the proposed reservoir area	The measures proposed in the CDR – channel diversion and floodplain compensation – ensure there will be no detriment from the development in term of flood risk. It was identified there may be reduced risk of flood downstream in Abingdon as a result of these measures; however, this is subject to further modelling by the engineering partner, Mott MacDonald. The potential for supporting the delivery of the Abingdon Flood Alleviation Scheme (FAS) through the creation of the embankment which will form the access road to the reservoir (which was previously dismissed as not being cost-effective) alongside enhancing the proposed flood risk measures (i.e. excavate the compensated floodplain area to be deeper) should be considered alongside any mutual benefits which may be provided to the wider Thames Valley Flood Scheme.

[97] Environment Agency and Defra (2015). Thames River Basin District River Basin Management Plan. Accessed February 2020 – Thames RBD.pdf
[98] Oxfordshire County Council (2014). Local Flood Risk Management Strategy. Accessed February 2020 – Local Flood Risk Management Strategy.pdf

Capitals	Opportunity	How SESRO can benefit or contribute
Natural	Improve the ecological status of water environments	The proposed watercourse diversion due to SESRO is to be designed using a 'naturalised' form (i.e., meandering), which will facilitate the return to natural flow levels, reduce excessive build-up of sediment in surface waterbodies and microhabitat loss that is associated with artificially modified watercourses which is the current case with the present land-use of the area where SESRO is proposed to be develop on – straight streams flowing around the parcels of agricultural land.
Natural	Reduce the abstraction from vulnerable watercourses	SESRO is a long-term commitment to securing resilient water resources sustainably in the south-east. The reduced pressure of abstracting of water from sensitive chalk stream, made possible by diverting the abstraction to the proposed reservoir, can help address the issue of changes to natural flow and level of water as it can be detrimental to the water environment,
Manufactured/ Natural	Address pollution from highway run-off	Considerations should be given to work with Highway England and other Highways authorities as appropriate to collaboratively design SuDS along the stretch of the A34 which is closely located to the east side of the proposed reservoir site, e.g. filter strips, filter trenches and bioretention area as the reservoir is expected to increase visitor numbers to the area.
Natural	Create inspiring new natural resources that are wildlife rich and attractive	A number of potential environmental provisions have been identified in the CDR. These include the creation of aquatic and grassland habitats around the reservoir perimeter, as well as areas of woodland and scrub. The measures that will be undertaken to compensate flood risk associated to the scheme – channel diversion and floodplain compensation – can be designed to be more natural and wild-rich, for example tree planting and hedgerows can be incorporated to those areas of compensated floodplains as well as floodplain meadows and shallow scrapes to accommodate wetland birds.

Other key local issues and priorities

Priorities as identified by the Member of Parliament

The Member of Parliament (MP) for Wantage, in which the proposed SESRO development will be located within, is David Johnston. The plan on his website is outlined in the following six points[99]:

- Fighting to get Grove station re-opened;
- Campaigning for safety improvements on the A34 and A420;
- Pushing to ensure that the new houses that are built are high-quality, affordable and contribute to our efforts to combat climate change;
- Fighting to ensure we get the health services we need;
- Helping rural areas to get better broadband; and,
- Working with local schools/colleges and employers to spread opportunities for our local young people.

He is known for his work around social mobility (he is co-chair of the Social Mobility All-Party Parliamentary Group (APPG)) and is a member of the Education Select Committee.

[99] Johnston, D. (no date). My Plan. Accessed February 2020 – My Plan

Priorities for SESRO as identified by previous stakeholder discussions

In 2006 a workshop was undertaken by Land Use Consultants (on behalf of Cascade)[100]. The aim of the workshop was to draw on the experience and expertise of a number of people, primarily to produce options for the conservation, access and recreation and landscape aspects of the proposed reservoir. The stakeholder discussion identified a number of key issues to consider when proposing options for use of the reservoir and what opportunities for recreation it should be designed for which included;

- Providing tranquil recreation opportunities;
- Providing several recreational opportunities;
- Providing access by other means and not just by car;
- Creation of wetlands;
- An ambition around providing opportunities for biodiversity, not just within the water but also the hinterland; and,
- An ambition to provide a model for sustainable living, fun and education, with the involvement of agriculture.

Other key local issues and priorities – opportunities

Physical and mental wellbeing, recreational, sustainable travel and communities, wetland provision and educational priorities and opportunities are covered in other sections and will not be repeated here.

Table 11-24 – Other key local issues - opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Manufactured	A34 safety improvements	Throughout this report the traffic and congestion issues, and now safety, on the A34 have been drawn out as a key constraint to further development in the area. As a responsible developer, the scheme could seek to facilitate or support improvements to the A34 as part of the proposed development. Liaison with the County Council and MP would allow further discussion of this potential opportunity and assess the feasibility of additional works (in addition to what has been proposed i.e. crossing of the A34 over the drawdown channel/canal) alongside any other planned improvements.
Human	Working with employers to spread opportunities for local young people	There is the opportunity both during construction and operation of the proposed scheme, to work closely with local people and support them in developing skills or gaining employment. This should be considered carefully as part of the design and construction planning work as well as once construction is complete.

Environmental Priorities

There is a wide array of legislative, policy and moral imperatives for improving the environment wherever possible. Adverse impacts from development should be carefully mitigated against and the potential damage reduced but also importantly opportunities should be seized to maximise the environmental opportunities development can bring.

In the UK, the government has set out a 25-year plan to improve the environment[101]. The goals are identified as: clean air, clean and plentiful water, thriving plants and wildlife, reduced risk of harm from environmental hazards such as flooding and drought, using resources from nature more sustainably and efficiently and

[100] Land Use Consultants (on behalf of Cascade) (2006). The Upper Thames Major Resource Development - Conservation, Access and Recreation Visionary Workshop Report.
[101] HM Government (2018). A Green Future: Our 25 Year Plan to Improve the Environment. Accessed February 2020 – 25-Year-Environment-Plan.pdf

enhancing beauty, heritage and engagement with the natural environment. The proposed reservoir has opportunities to contribute towards all of these goals at a regional level.

Natural England is the government's advisor for the natural environment and their vision is 'thriving nature for people and planet'. They aim to achieve this through building partnerships for natures recovery and their mission and ambitions up to 2025 are very much aligned to the 25 year Environment Plan, for example; a well-managed nature recovery network, people connected to the environment for their own and society's wellbeing, and a focus on nature based solutions to tackle climate change and other hazards.

Defra is the government department responsible for safeguarding the natural environment. There are a number of policies and strategies which are of relevance to SESRO:

- Defra Government Review of Waste Policy in England[102] – which envisions moving to a zero-waste economy where resources are re-used, recycled or recovered wherever possible.
- Defra The UK Climate Change Risk Assessment[103] – findings of the assessment include: increased pressure on UK water resources with deficits identified in the Thames region, increases in water demand for agriculture, lower summer river flows, increases in precipitation in the winter and the impact on flood risk and drainage/sewer infrastructure and also flash flooding due to combined sewer overflows.

In addition to Defra, the Environment Agency in England work to create better places for people and wildlife and support sustainable development. The Thames River Basin Management Plan and its associated opportunities have been reviewed[104]. In addition, in 2011 they outlined their strategic priorities for enjoying water which includes[105];

- Ensuring everyone can enjoy water environments
- Deliver well managed, new and better opportunities for people to enjoy water environments

In neighbouring areas to the proposed reservoir site there are a number of sensitive receptors. Whilst the SEA will seek to assess the impact of the proposals on these, the summary below highlights the opportunities presented by the organisations' plans which manage these natural assets.

There are a number of charities, locally, regionally and nationally which set out their priorities for the environment through plans and policies. These are outlined below.

RSPB

Whilst a specific plan or position for reservoir development could not be found, the RSPB do have relevant positions (available on their national website) on a number of related issues which are summarised below[106];

- Water and wetlands – controlling pollution at source, using water resources wisely, restore a landscape rich in wetlands for both wildlife and resilience to climate change, and by working with nature we can improve water quality and reduce the risk of flooding.
- Climate change – calling for a revolution in generating clean power and assisting wildlife in adapting.
- Environment and economy – highly interconnected and fundamentally important to illustrate benefits people gain from biodiversity alongside guarding against policies which could cause damage to the environment and working towards supporting sustainable development and also economic opportunities which are environmentally sustainable.
- Nature education – regular opportunities for every child and young person to connect and learn to value and prioritise it in order to take action to save it.
- Woodlands – protect, restore and extend native woods
- Human health and nature – outdoor activities and spending time in green space offers accessible and cheaper routes to addressing many public health issues and inspiring a healthier lifestyle both physically and mentally.
- Safeguarding wildlife sites through the use of the Site of Special Scientific Interest (SSSI designation)

[102] Defra (2011) Government Review of Waste Policy in England. Accessed February 2020 – Waste Policy Review.pdf
[103] Defra (2012). UK Climate Change Risk Assessment: Government Report. Accessed February 2020 – Climate Risk Assessment.pdf
[104] In section 11. 2.4.6.1 Natural Capital Documents; River and Flood Risk Management Plans; Thames River Basin Management Plan (RBMP)
[105] Environment Agency (2011) Enjoying Water - Strategic Priorities for Water Related Recreation in London and South East England. Microsoft Word - London-and-South-East-Appendices.doc (brighton.ac.uk)
[106] RSPB (2020). Policy Positions on website. Accessed February 2020 - Positions on Climate Change, Wind Farms, Biofuels & Wild Birds - RSPB

North Wessex Downs AONB

The North Wessex Downs Area of Outstanding Natural Beauty (AONB) is to the south of the proposed site. The management plan up to 2024[107] presents objectives and policies for partners to apply in helping conserve and enhance the nationally important landscape. It is anticipated that SESRO will alter the views from The Ridgeway to the north of the AONB. Long-term goals set out in the plan which are of relevance to this potential impact include:

- Where highest environmental quality is seen as a key economic driver;
- Where all economic activity is in harmony with the landscape;
- Where new development display high quality design worthy of the landscape;
- Ensuring a countryside rich in wildlife, heritage and recreational opportunities;
- With high quality habitats reflecting distinctive character of landscape;
- Where management conserves water resources and retains the distinctive seasonable chalk streams;
- Natural beauty and tranquillity are predominate;
- Nationally recognised centre for responsible tourism and enjoyment of the countryside; and,
- Contributes to physical and mental wellbeing and contributes to opportunities for social interaction and volunteering.

Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust

The Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT)[108] has a vision of a wilder place, restoring nature and empowering people to connect with their local wildlife by providing vital breathing spaces in a crowded world. The BBOWT work with more than 1,700 volunteers to look after 85 nature reserves and four education centres, run events, and campaign to make nature's recovery a reality. The strategic plan is designed to restore nature, value the benefits that nature provides, get people involved and empower them to take action for wildlife alongside the urgent need to build more strong partnerships to help achieve the vision set out.

Wild Oxfordshire

Wild Oxfordshire is a local charity which provides a coordinated and strategic approach to conservation in Oxfordshire. They support and encourage environmental organisations and volunteers to work together in ways that benefit wildlife by working in partnership with over 60 organisations. Current projects include: Saving our bees and other pollinators under threat, delivering natural solutions for effective flood management and giving nature a voice in strategies and planning. Wild Oxfordshire also work to improve the water quality and ecology of watercourses such as the Ock, which is to the north of the proposed site[109].

[107] The North Wessex Downs AONB Management Plan 2019–2024 - . Accessed February 2020 – AONB Management Plan - North Wessex Downs AONB
[108] Berkshire Buckinghamshire Oxfordshire Trust (2016). Be Part of Nature's Recovery (Strategic Plan). Accessed February 2020 – Nature's Recovery
[109] Wild Oxfordshire (2020). Charity priorities outlined on website. Accessed February 2020 - Wild Oxfordshire

Table 11-25 – Environmental Priorities – opportunities

Whilst nature education is a great opportunity and a priority, this is covered under other aspects of this review and so hasn't been included below. This also applies to mental and physical health opportunities.

Capitals	Opportunity	How SESRO can benefit or contribute
Natural	Provide additional environmental and biodiversity benefits outside of SESRO proposed site boundary through improving connectivity across habitats.	There are several SSSIs within the local area e.g. Frilford Heath, Ponds and Fens (north) and Whitehorse Hill SSSI along with Local Nature Reserves (e.g. Mowbray fields to the east) and national nature reserves (e.g. Chimney Meadows to north-west). There is the opportunity to create or improve connecting features (e.g. green corridors, hedgerows or wildflower buffer strips) for wildlife between habitats in the neighbouring areas and those created by SESRO. There are also likely to be many other opportunities to support local designated sites and these should be explored with those who manage the sites to ensure support is targeted and effective.
Natural	Maximise the opportunity for the environment along grey infrastructure e.g. road verges	As part of the SESRO proposals a new access road to the site, alongside the diversion of roads is being proposed. There is therefore the opportunity to maximise the environmental benefits these grey assets provide, for example by creating wilder verges as per the example project from the BBOWT – Creating wilder verges in West Berkshire | Berks, Bucks & Oxon Wildlife Trust (bbowt.org.uk)
Natural	Maximise the environmental opportunities associated with the diversion of watercourses and floodplain compensation design.	As part of these proposed works, consideration should be given to enhancing the areas through the provision of floodplain meadows, shallow scrapes for wading birds amongst other similar opportunities associated with the design of these features.
Natural	Wetlands	The reservoir proposals include for the potential creation of wetlands which not only provide space for wildlife, the opportunity for education, resilience to climate change and also water quality benefits amongst others
Natural	Reduced abstraction across sensitive streams	Both the Thames Water and Affinity Water WRMP19 preferred plans include the development of SESRO. The low operating costs of this option means it is more cost effective to stop or reduce these abstractions and thereby improve flows at sensitive chalk streams and associated abstraction locations.
Natural	Undertake construction and operation of the proposed reservoir in adherence with the ambition of a zero-waste economy	The construction of the proposed reservoir should be carefully planned and considered to adhere to the ambitions of a zero-waste economy wherever possible. This should extend to considering whether there are also opportunities outside of the construction site, in relation to other neighbouring projects such as road schemes, or community groups who could benefit from donations of spare materials, or involvement in another way. Once operational, consideration of site waste management should be undertaken in adherence with the ambition of a zero-waste economy.

Capitals	Opportunity	How SESRO can benefit or contribute
Social	Design opportunities to improve the enjoyment of both built and natural assets by all.	SESRO proposals include the design and construction of number of facilities, alongside natural assets such as the river diversion which should be able to be enjoyed and valued by all and this should be supported throughout the lifecycle of the proposed reservoir for example by providing accessible paths which are maintained.
Natural/ Manufactured	Climate change – opportunities for mitigation and enhancing resilience	Aside from the core benefit of the proposed reservoir contributing to the long-term resilience of water supply in the south east there are also a number of other opportunities the proposed development could contribute towards and these should be considered as part of the design and environmental assessment; • Clean energy generation as per the opportunity outlined in the 'Cross-Capital Documents' below. • As part of construction seek to utilise the lowest carbon options for all aspects. • Ensure the environments created or enhanced as part of the proposal are resilient and able to adapt to climate change. • Consider contributing to or supporting habitat banks or carbon stores to offset carbon. This could be through supporting the enhancement or extension of woodlands in the area, for example.
Natural	Minimise the visual impact from the AONB.	Liaise with the North Wessex Downs AONB in developing designs to minimise the impact of the reservoir on views from The Ridgeway.
Natural, Social and Human	Build strong partnerships to maximise environmental opportunities from SESRO.	Build a strong partnership with not just statutory stakeholders but also charities and organisations such as the BBOWT and other local environmental charities such as Wild Oxfordshire to maximise the opportunities and benefits from the proposals for both people, the environment and wildlife.
Social and Human	Empower people to take action to restore or contribute towards looking after the environment.	Consider opportunities for volunteering, as well as other forms of skills development and educational opportunities for all ages in all aspects of the construction and operation of the proposed reservoir. The CDR includes the potential to develop educational provisions. These will support environmental engagement at all ages.
Social/ Natural	Opportunity to reduce environmental damage and human health and wellbeing impacts due to construction and operational road use.	As part of the design and construction planning works, carefully consider ways to mitigate and minimise the environmental damage and impact on humans of the road use by construction vehicles, and during operation by visitors and operational staff.

Social Capital Documents

Social capital refers to institutions and relationships within and between communities, groups of stakeholders and other networks and the ability to share information to improve individual and collective wellbeing. The impact on social capital associated to SESRO include the health and wellbeing of local communities and reservoir users; the value of stakeholder relationships and networks developed during scheme development and operation; the impact of the scheme on stakeholder and customer relationships and levels of trust with Thames Water.

Physical Health and Mental Wellbeing

The importance of improving and giving greater priority to physical and mental health and well-being is anticipated to increase due to greater dialogue of the topic as result the ongoing COVID-19 pandemic. There are opportunities for SESRO to play a key facilitating role in improving quality of life in the area, by delivering space for physical activities (i.e. walking, cycling and water sports) and amenities that provide mental well-being (i.e. green space and artist hubs).

Oxfordshire Prevention Framework 2019–2024

The Oxfordshire Prevention Framework[110] sets out the vision for addressing physical health and mental wellbeing in order to improve the quality of life for all those who live and work in the county. The framework outlines the agenda to place measures that tackle illnesses and issues linked to physically inactive lifestyles, loneliness and poor mental wellbeing, which would alleviate pressure on our public health service.

Oxfordshire Mental Health Prevention Framework 2020–2023

The Oxfordshire Mental Health Prevention Framework[111] sets out the plan to improve mental wellbeing for everyone in Oxfordshire by bringing together various parties to achieve the following objectives;

> *"*Increase people's knowledge, skills and confidence. Targeted action and robust evaluation. Support and advice for good mental wellbeing. Working with partners across the system*".*

The framework also outlines the members of the '*Mental Health Prevention Concordat Partnership Group*' (OMHP) which are parties who are committed to delivering the agenda of improving mental wellbeing to those who live and work in Oxfordshire.

Table 11-26 – Physical Health and Mental Wellbeing – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Social	Provide an environment that enables and encourages good physical health and mental wellbeing through environmental and leisure provisions.	The proposed reservoir project can be considered as part of the 'Healthy Place Shaping' vision the local authorities have and is proposed to create sustainable and well-designed built environments that enable healthy behaviours. As SESRO can enhance the accessibility of the local community to high-quality green space and opportunities for recreational and sports provision such as cycling, canoeing and fishing as well as other physically and socially interactive activities that would contribute to health and well-being. This benefit is particularly important for disadvantaged residents who live in areas deprived of and/or have limited ability to access such space.
Social/Human	Offer socio-economic opportunities that are enablers of mental wellbeing	Another aspect of 'Healthy Place Shaping' is providing a sense of belonging, community and identity. The proposed development of a number of amenities, as a result of SESRO, could offer economic and social opportunities for the local community; jobs, training/up-skilling and volunteering related to the running and maintenance of those environmental and recreational provisions. Therefore, SESRO can provide a place that offers a sense of purpose and belonging and contribute to reduced isolation and positive wellbeing. The proposals can also offer a safe and attractive space for the running of social projects such as the 'Walking for Wellbeing Project'[112]. Consideration should be made to creating footpaths and cycling trails around the proposed reservoir perimeter and through woodlands/grassland in

[110] Collison, K., Wilderspin, J., and Oxfordshire County Council (2019). Oxfordshire Prevention Framework 2019–2024. Accessed February 2020 – Oxfordshire Prevention Framework.pdf
[111] Oxfordshire Mental Health Partnership (2020a). Oxfordshire Mental Health Prevention Framework. Accessed February 2020 – Oxfordshire Mental Health Prevention Framework.pdf
[112] Oxfordshire Mental Health Partnership (2020b). Breaking down the barriers to staying active: The Walking for Wellbeing Project. Accessed February 2020 – Walking for Wellbeing Project

		the surroundings, being mindful of different users and accessibility. In addition, during the operation of the proposed reservoir, projects and programmes of activities and other opportunities that can actively reduce social isolation through social interaction, should be considered.
Social and Human	Offer a safe and educationally interactive space for children to play and learn	The CDR includes the proposal to develop potential educational provisions. There are opportunities to collaborate with the OMHP to deliver a range of health and wellbeing related workshops. SESRO can also contribute to providing active environments that support physical recreation; outdoor land and water-based sports. This can promote healthy behaviours and improve the well-being of children and young adults if targeted appropriately.

Air Quality Plans

Air Quality Action Plan 2015

The Air Quality Action Plan 2015[113] is a framework that seeks to address NOx – an irritant gas that can cause acute and chronic inflammatory effects. Three areas were identified and declared as Air Quality Management Area (AQMA), whereby NO_2 exceeds the standard limit of 40µg/m^3 (set by European and UK regulations). Those three areas which require measures to tackle the risk of the public being significantly exposed to the pollution over a long period, include Abingdon, Botley and Marcham. The local authority identified the air pollution is largely due to road traffic emissions.

Air Quality Developer's Guidance

The Air Quality Developer's Guidance[114] complements and supports the Air Quality Action Plan 2015 (as mentioned above) as well as considers the importance to tackle other atmospheric pollution such as particulate matter, volatile organic compounds (VOC) and CO_2. It sets out the vision and approaches required for developments in the area in order to protect people and natural environment from the impacts of air pollution. The Developer's Guidance outlines the minimum conditions for a detailed air quality assessment, scope and approach to addressing local air quality through development management, which includes improving the quality of new developments and taking additional measures to address air pollution. As similarly noted in the Air Quality Action Plan 2015, there are local hotspots of air pollution in the district due to traffic congestion, which is related to the historic layout of the towns; narrow streets, street canyons and limited alternative routes and modes of travel.

The Marcham AQMA neighbours the proposed reservoir site and contains the Marcham Rd (A415) where a permanent access road from the reservoir site is proposed to be linked to. Also the central ring road around the centre of Abingdon – the area where Abingdon AQMA was declared – contain road Ock St which feeds into the stretch of the A34 that is next to SESRO through Marcham Road. Therefore, considerations could be given to work with the local authority to ensure no detrimental, or even reduce the impact associated with SESRO through collaboratively designing an efficient traffic system that enable better movements.

Table 11-27 – Air Quality Plans – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Manufactured	Support the local authority facilitate the case for developing by-pass roads in order to improve the flow of movement and thus reduce air pollution related to traffic congestion.	There were considerations around developing a Marcham bypass; an alternative route for the A415 traffic, and the Abingdon bypass; an alternative of entering the town centre. However, no funding has been found for these bypasses due to viability issues at present, as the Air Quality Action Plan 2015 states '*without significant development in the area*'. The completion of SESRO is likely to bring in more visitors to the area, thus greater numbers of people on the road. This would help support

[113] Vale of White Horse District Council (2015a). Air Quality Action Plan 2015. Air Quality Action Plan.pdf
[114] Vale of White Horse District Council (2015b). Air Quality Developer's Guidance. Air Quality Developer's Guidance.pdf

		the case for the local authority to obtain funding to enhance the current infrastructure network (which offer limited alternative routes as well as being narrow), to ease traffic congestion and reduce air pollution. Also, consideration could be given to include off-road cycle paths along the Marcham and Abingdon bypass, and existing roads, that lead to the proposed site. This could encourage greener modes of transport to the proposed reservoir and alleviate traffic congestion.
Manufactured	Help promote and encourage the community to convert to greener modes of transport and reduce the number of vehicles on roads.	Consideration could be given to install charging stations for electric vehicles in the cark park of the proposed site and create a system that provides incentives for greener vehicles, alongside a secure and free bike storage station.

Financial Capital Documents

Financial capital refers to pool of funds available for use in the production of goods or provision of services, obtained through financing or generated through operations or investments. The impact on financial capital associated to SESRO include the local and regional economic prosperity (e.g. from tourism and job creation).

Recreation and tourism priorities

The Oxfordshire LEP's Creative, Culture, Heritage and Tourism Investment Plan (CCHTIP)[115] is one of a series of investment plans under the Strategic Economic Plan (SEP) – the ambition to strive for a strong economic growth in the county up to 2030. This Investment Plan sets out the growth agenda of Oxfordshire's economy in relation to the CCHT sector, which involves creating productive and engaging experiences; skills, talent development and business growth; and creative place-making.

SESRO as a scheme has a number of creative, recreational and leisure-related opportunities it can offer. Therefore, considerations of collaborative support between SESRO and the local authorities such as the LEP can maximise the beneficial synergies relating to socio-economic initiatives and facilitate the wider vision of healthy place-making; creating a sustainable place to live and work.

In addition to the Oxfordshire LEP's priorities for the local economy (see below), there are national priorities to improve the public rights of way through the development of local authority public rights of way improvement plans which set out how improvements to the public rights of way will be undertaken. There will be some disruption to public rights of way during construction and these are envisaged to be mitigated to minimise disruption to users; however, it is the aim of the scheme to maintain connectivity wherever possible.

The Royal Yachting Associations (RYA) is the national body for all forms of inland sailing and there are several sailing clubs throughout Oxfordshire. They support a variety of programmes for different demographics of sailing participants from advanced, youth sailing, returners, and beginners. They also have a fund which supports tackling inequalities and promoting access for all to the sport along with 'The Green Blue' programme which seeks to reduce the environmental impact of boating.

[115] Oxfordshire Local Enterprise Partnership, Oxfordshire County Council, and Arts Council England (2016). Creating the Environment for Growth: A Strategic Investment Plan for Oxfordshire. Accessed February 2020 – CCHTIP.pdf

Table 11-28 – Recreation and tourism priorities – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Financial/ Human	Increase tourism in the local area and bring socio-economic benefits including job generation and business opportunities.	The CDR of the proposed reservoir includes a number of environmental and recreational provisions, which would attract nature and sports enthusiasts to the region. SESRO could diversify and spread-out Oxfordshire's tourism sector, which is better known for its education institution and the historical City of Oxford. As a result, it could generate greater job opportunities and further put Oxfordshire on the map. SESRO can also benefit areas neighbouring the site, because those who come to the district to visit the proposed reservoir and its amenities, may also visit the surrounding area. Therefore, it has the potential to increase local tourism for those neighbouring areas.
Manufactured/ Social	Enabling visitors to get the most from their visits.	SESRO, in addition to the built infrastructure to support visitor education and enjoyment, could also seek to provide softer infrastructure too such as guided walks and seasonal events. SESRO can also help provide and support sustainable linkages with wider destinations to support visitor flows and spending across the local area.
Manufactured/ Social	Improve public rights of way.	SESRO has the opportunity, following construction predominantly, to not only re-instate disrupted access to public rights of way but also improve the quantity and quality of them within the vicinity of the proposed scheme to increase their use for members of the public. These routes should also be considered as a means of accessing the reservoir site by more sustainable/active travel means wherever possible to maximise the opportunity for mental and physical health benefits and also reduce reliance on car visits wherever possible therefore reducing carbon emissions from operation indirectly.
Social	Maximise the opportunities for socially and environmentally responsible recreation as part of the SESRO proposals	In discussion with bodies such as the RYA, ways in which recreation opportunities such as boating can be designed and operated to be more environmentally and socially responsible should be considered.

Manufactured Capital Documents

Manufactured capital refers to manufactured physical objects available to an organisation for use in the production of goods and services. The impact on manufactured capital associated to SESRO include the value of the physical assets created through the scheme and impacts on other manufactured assets.

Water Resource Management Plans

Water Resource Management Plans seek to set out how water companies plan to provide a reliable, resilient, efficient and affordable supply of water to customers. SESRO is identified in the constrained list of options and as part of the preferred plan to provide sufficient water supply in the future. The two water company's plans were reviewed to identify opportunities which may be relevant for SESRO.

Thames Water

The Thames Water WRMP19[116] has been reviewed specifically in relation to the following sections: the constrained list of options (to identify opportunities local to the proposed SESRO scheme which may have synergies) and the preferred plan also in the vicinity to SESRO proposed site. SESRO has the potential to either be a water resource for the London Water Resource Zone (WRZ), Slough Wycombe and Aylesbury or the Swindon and Oxfordshire WRZ all of which are expected to have a deficit from 2030 onwards as a result of climate change and as a result of population growth.

None of the proposed SESRO options have been identified as having interdependencies with other options on the constrained list of the Thames WRMP19, as set out in the 2018 CDR. There are a number of other elements which may be required; for example, additional treatment capacity at water treatment works. However, this varies with the option considered and therefore any opportunities should be considered once the choice of option has been made.

There is wide support for regional transfer options, with the Severn Thames Transfer (STT) being recognised by the National Infrastructure Commission as of national importance. There is an opportunity to combine the use of SESRO with the STT which is being considered as part of the RAPID Gate process.

As part of short-medium term preferred plan action, the continued promotion of water efficiency with customers is included to provide an overall reduction in water usage throughout the Thames area. The preferred plan also highlights the ability for the proposed reservoir to reduce abstraction at watercourses, which is a key environmental opportunity.

Affinity Water

The Affinity Water WRMP19[117] has been reviewed specifically in relation to the following sections: best value plan, strategic supply options and alignment with Thames Water. The proposed SESRO scheme will provide significant additional water resource to Affinity Water to meet their deficit and also mitigate some of the risks identified in their WRMP. Due to the scale of the strategic options Affinity Water and Thames Water are collaborating on their development. Presently SESRO has been selected as offering the best value of the strategic resource options considered within the WRMP. The necessary works to develop the transfer and treatment aspects of SESRO are proposed in two stages comprising of initially developing an abstraction on the River Thames (to fill the reservoir) a supply to a new treatment works, followed by extending that transfer into other WRZs and other works.

Table 11-29 – Water Resource Management Plans – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Manufactured/ Natural	Severn to Thames Transfer	In the shorter term, the construction programmes do not align (SESRO in 2030s and STT in 2080s) and therefore there is no immediate benefit to either scheme from this aspect. This position will be kept under review as the results of the WRSE regional modelling emerge in mid 2021, which may change the relative timing of the SROs.
Human	Continued promotion of water efficiency to help customers use water wisely.	The proposed SESRO facilities could include an educational water science park, a dedicated school study centre and visitor centres which all provide opportunities to educate customers and visitors about water efficiency. Thames Water could also consider further school and community outreach as part of the SESRO proposals and stakeholder engagement.
Intellectual	Opportunities for water companies from developing strategic resource options together.	The opportunity to work across water companies may provide benefits to individual water companies from shared learnings but also has the potential to improves processes, scheme etc moving forwards. Improvements in organisational knowledge and experience relating to

[116] Thames Water (2019). Water Resources Management Plan. Accessed February 2020 – Water Resources Management Plan.pdf
[117] Affinity Water (2020). Water Resources Management Plan. Accessed February 2020 – Water Resources Management Plan.pdf

		construction of a large-scale reservoir will be gained for both water companies and their supply chains.
Intellectual	Combined construction programme of proposed reservoir and associated assets	It is assumed most aspects of the scheme are required to meet the requirements of both Affinity and Thames Water; for example, the bunded reservoir itself but also associated assets such as the intake from the River Thames. If all works can be done across the same timeframe there are opportunities to seize in relation to minimising disruption, managing waste minimisation across various aspects of the construction etc. This will need to be considered carefully at this stage to maximise these opportunities.

Cross-Capital Documents

Cross-capital in the context of this report are documents which has been reviewed and identified as having multiple capital opportunities that are relevant to SESRO.

Vale of White Horse Local Plan 2031

The proposed reservoir site is located within the Vale of White Horse – a south-west district of Oxfordshire – between the villages of East Hanney, Marcham, Steventon and Drayton, and in proximity to the town of Abingdon-on-Thames.

The Local Plan 2031[118] is a policy framework that sets out the strategic guidelines for the district to deliver sustainable development, used to inform decisions on planning applications in the district and is aligned to the National Planning Policy Framework (NPPF). The strategic proposals and initiatives include a number of new homes and jobs to be provided in the area, as well as commercial, leisure and infrastructure development. Alongside the Local Plan, the Local Plan 2031: Part 2 Appendices[119] was also reviewed in detail as it contains the 'Strategic Site Development Templates' which describes the allocated sites for housing development.

In the process of developing the proposed reservoir and the running of it post-completion, beneficial opportunities will arise that facilitate and support the local authority's socio-economic and environmental initiatives (e.g. job creation and attractive green space). Therefore, considerations for collaborative effort between SESRO and the Vale of White Horse Council can maximise the beneficial synergies surrounding socio-economic and environmental projects and programmes.

Table 11-30 – Vale of White Horse Local Plan 2031 – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Social	New open space and leisure provision for the proposed new housing developments in the area	SESRO proposes to deliver new infrastructure such as publicly accessible green open space (woodland and grassland areas) and recreational facilities (angling, boating and cycling).
Social	Facilitate or contribute to the delivery of an upgrade to the A34 to alleviate traffic issues and provide better access to the strategic road network.	SESRO could support the upgrade of the A34– as the proposed scheme is anticipated to increase visitor numbers and therefore traffic to the area. Presently the engineering partners of SESRO are undertaking assessments and analysis for the access strategy which includes junction modelling and alterations around the crossing point with the proposed drawdown channel/canal. Opportunities for improvements should be discussed in further detail following completion of these initial assessments for Gate 1.

[118] Vale of White Horse District Council (2016). Local Plan 2031: Part 1 Strategic Sites and Policies. Accessed February 2020 – Local Plan 2031 Part 1.pdf
[119] Vale of White Horse District Council (2019). Local Plan 2031 Part 2: Strategic Sites and Policies. Local Plan 2031 Part 2 Appendices.pdf

Capitals	Opportunity	How SESRO can benefit or contribute
Human	Provide employment and help with up-skilling the local workforce	The construction and the operation of the reservoir site along with the numerous environmental provision and recreational facilities, will generate jobs and could support volunteering opportunities. These can help fill part of the unemployment gap and up-skill the local workforce, as well as bring the socio-economic and wellbeing benefits that comes with it.
Financial	Promote tourism and improve economic prosperity	A number of new provisions will be created through SESRO that will bring greater interest to the area. This can convert the significant proportion of day-visitor tourists to overnight-visitors as there are greater recreational activities, which could address the shortage of hotel accommodation. The proposals will also support local businesses in the surrounding perimeter of the reservoir site through bringing greater footfall and thus economic activity to the area.
Manufactured	Respond to climate change by reducing greenhouse gas emissions through low carbon and renewable energy generation	There are potential energy recovery opportunities from the scheme. One possible way of renewable energy generation is the installation of a solar farm on the surface of the reservoir. The other mode is through the pump station turbines during the reservoir discharge. In addition, SESRO could facilitate with the re-location of the existing solar farm that sits on the designated area of development, in order not to cause a net loss of renewable energy generation as a result of the scheme.
Natural/ Social	Create green space provision for people, as well as wildlife, with the potential to attract people away from more sensitive environment sites nearby	Environmental and social enhancement of the land – currently used for solar panel and agriculture –through the creation of natural and leisure provisions will create an environment that designed to be sustainably used by people, a space where people and wildlife can co-exist. This will reduce pressure on nearby SSSIs and ancient woodlands as there is a potential for decrease visitors to these attractions.
Social	Engage with the local authority to improve and promote low-impact modes of transport	If there is a need to reroute the public rights of way because of proximity to the works, SESRO can work in unison with the council to improve the quality of the new routes, such as better experience for mobility scooter and wheelchair users, as well as enhance the connectivity of local communities to the reservoir site by creating additional new routes into and within the network. This would encourage more active and greener transport, i.e. walking and cycling, to the revisor site and facilitate the aim to not further impact and reduce pressure on existing roads.
Natural/ Social	Work with the council and housing developers to enhance biodiversity and wildlife habitat through incorporating green infrastructure such as SuDS, hedgerow, tree planting and wetlands that can additionally manage flood risk and improve water quality both on site, and within the vicinity of the site.	SESRO could consider collaborating with the local authority and other developers to cultivate a strategy for the development of mutually beneficial green infrastructure such as regional SuDS. This would involve identifying the most appropriate measures and locations to build green infrastructure that would add value to the neighbouring areas as well as the proposed site itself, e.g. favourable visuals in high footfall areas and help reduce flood risk as well as supporting sustainable development of housing which is a priority nationally as well as within Oxfordshire.

Capitals	Opportunity	How SESRO can benefit or contribute
Human	Offer educational value and provide recreational provision to schools and early childcare centres in the surrounding and neighbouring area	Public education facilities were identified as potential provisions in the design. In addition to these facilities, SESRO could collaborate with local educational charities which promote outdoor learning such as the Oxfordshire Outdoor Learning Trust which raises funds to support those from more disadvantaged backgrounds accessing these valuable experiences.

Oxfordshire LEP (OxLEP) Strategies

The Oxfordshire LEP (Local Enterprise Partnership) is the ambitious aim by Oxfordshire County Council to enhance and maintain Oxfordshire's position as the world-leading centre of knowledge and innovation in order to make it the location of choice for world-leading businesses. The three key areas of priorities that will lead to achieving the vision of creating investor confidence and enabling-infrastructures that will maximise the global potential global of attracting businesses to the county – include place-making, productivity and connectivity.

There are several relevant plans and strategies that present potential opportunities of mutual benefits between SESRO and OxLEP which relate to making Oxfordshire a vibrant and sustainable place: Strategic Economic Plan (SEP), Strategic Environmental and Economic Investment Plan (SEEIP), Oxfordshire Energy Strategy, Skills Strategy, and Oxfordshire Infrastructure Strategy (OxIS).

In addition to wider geographic economic strategies and aspirations, there are other smaller initiatives to support the local economy. Examples include:

- Abingdon-on-Thames town council host local excellence markets on Saturdays which support local farmers, craftspeople and other local producers for example beer brewers. This not only supports the local economy but contributes to lower food airmiles and therefore carbon emissions reductions.
- Abingdon town centre is also a Business Improvement District which raises funds to improve the town centre.

There are opportunities, as demonstrated by the examples above, for SESRO to play a wider role in the local communities and their economies, for example by making space for community food growing or small local commercial enterprises such as breweries. It has not been possible for this process to delve into these opportunities in detail; however, opportunities such as this should be discussed further with local representatives, and as part of task 4, to target understanding of opportunities to the needs and aspirations of local communities.

Strategic Economic Plan (SEP)

The SEP[120] outlines the sustainable and inclusive development strategies for achieving a strong economic growth relating to skills, innovation, culture and heritage, natural resources and the environment by identifying potential opportunities and prospects of Oxfordshire from a multi-level perspective (i.e. local, regional, national and international) and a multi-stakeholder perspective (i.e. engaging with the county's businesses, education and research institutions, local authorities, community sectors and the local residents)

Oxfordshire Infrastructure Strategy (OxIS)

The OxIS[121] is an Oxfordshire Growth Board-commissioned project involving six of the county's local authorities as part of OxLEP, with the purpose of prioritising the development and enhancement of region's infrastructure to 2040 and beyond. The objectives of the strategy are as follows;

> *"To set out the priority strategic infrastructure investment needed to **support jobs** and **housing growth** in Oxfordshire. To shape & influence **investment** strategies and plans at a national, sub-regional and local level."*

[120] Oxfordshire Local Enterprise Partnership (2014). Oxfordshire LEP Strategic Economic Plan: Driving Economic Growth Through Innovation. Accessed February 2020 – SEP.pdf
[121] AECOM (2017). Oxfordshire Infrastructure Strategy. Accessed February 2020 – OxIS.pdf

Oxfordshire Strategic Environmental Economic Investment Plan (SEEIP)

The SEEIP[122] is a framework that sets out the direction on how investment to the natural environment will be delivered by Oxfordshire County Council in collaboration with other relevant parties including the five local district councils, Wild Oxfordshire and Berkshire Buckinghamshire Oxfordshire Wildlife Trust (BBOWT). The Plan is one of the series of investment plans under SEP.

The aims of the SEEIP, through highlighting the importance of socio-economic development and health and well-being in the county, is to attract funding from the government, environmental stakeholders and businesses for environmental investment in Oxfordshire which would be coordinated to create a sustainable built environment as well as mitigate and build resilience to climate change.

Oxfordshire Energy Strategy

The Oxfordshire Energy Strategy[123] sets out the framework to enable the county's vision of being at the forefront of green energy innovation and fostering clean energy growth. It also sets out the ambition to be part of delivering the local and national expectations of; reduced emissions, in-line with supporting the government policy goal of Net-Zero by 2050, addressing climate change, supporting the wider agenda of healthy place-making and sustainably creating a place for the community to live and work. In addition, Oxfordshire is identified as facing significant resource constraints in the form of power supply in part due to grid constraints which would need to be addressed prior to realising the full potential of low carbon energy and local generation and cementing Oxfordshire's ambition.

Skills Strategy

The Oxfordshire Skills Strategy[124] recognises that human capital is one of the most valuable resources in terms of economic growth, and in order to support Oxfordshire's growth ambitions, the area requires an aware and responsive skills infrastructure which helps those furthest away from the labour market by assisting them with overcoming barriers to employment. The vision set out by the strategy is a vibrant, sustainable and inclusive world-leading economy, driven by innovation, enterprise and research excellence. The 'people' aspect of the SEP is the focus of this strategy with the aim that local residents need to better skilled in order to develop a more flexible and productive workforce. There are opportunities for young people and businesses in particular. The strategy's priories are:

- To meet the needs of local employers
- To ensure that young people are prepared for the world of work
- To address Oxfordshire's tight labour market and skills shortage
- To support the government's agenda to increase the number of apprenticeships
- To retain more graduates and meet the demand for higher level skills

The Strategy offers no action plan as it is envisaged that stakeholders and businesses will develop their own response to priorities which are relevant to them. Opportunities have been identified on this basis.

[122] Oxfordshire Local Enterprise Partnership, Oxfordshire Local Authorities (Cherwell District Council, West Oxfordshire District Council, Oxford City Council, South Oxfordshire District Council, Vale of White Horse District Council and Oxfordshire County Council), Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust, and Wild Oxfordshire (2016). Creating the Environment for Growth: Strategic Environmental and Economic Investment Plan for Oxfordshire. Accessed February 2020 – SEEIP.pdf

[123] Oxfordshire Local Enterprise Partnership (2018). The Oxfordshire Energy Strategy. Accessed February 2020 – Energy Strategy.pdf

[124] Oxfordshire Local Enterprise Partnership and Oxfordshire County Council (2016). Oxfordshire Skills Strategy: Building a 21st century skills ecosystem. Accessed February 2020 – Skills Strategy.pdf

Table 11-31 – Oxfordshire LEP Strategies – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Social	Working with local authorities to improve traffic congestion along road network	The scheme can seek to facilitate and support the local councils and Highway England with identifying a long-term solution to traffic management along and around the A34 system, by collaboratively developing a strategic network improvement that would alleviate and enable efficient flow of movement (in addition to the proposed works i.e. excavation along the Wilts and Barks canal pass under the A34 and crossings; mitigation measure to reduce the impact associated to the construction of the proposed reservoir on roads).
Human	Offer employment and opportunities to build awareness, and up-skill the local workforce and younger community	The construction and the operation of the reservoir site (i.e. the running and maintenance of the numerous environmental and leisure provisions) will provide employment, and will consider apprenticeships, vocational education and volunteering opportunities for the local community, which should be particularly targeted towards disadvantaged and marginalised young adults and adult residents. Therefore, SESRO in collaboration with the LEP could facilitate the local councils' agenda to tackle the widening socio-economic inequality within the county alongside feeding into the OxLEP's understanding of the needs of local employers and wider training provision. SESRO could also consider outreach support to local educational establishments to promote well informed careers choices with local young people and retain graduates in higher level skills jobs.
Social	Healthy place-making through the development of environmental and leisure provisions.	SESRO could be considered a part of sustainable built-environment vision because the scheme would convert the land of the proposed development site – which is largely agricultural – to a more environmentally enhanced space with a number of environmental and leisure provisions. Therefore, SESRO could improve the local community's accessibility to high-quality green space, and socially interactive and physically active recreations (i.e. place for walking, cycling, canoeing and fishing) which support physical health and mental wellbeing. The enhanced accessibility to such space is particularly important for disadvantaged residents.

Capitals	Opportunity	How SESRO can benefit or contribute
Social	Improve air quality by encouraging the use of more sustainable transport by enhancing the public right of way network and providing facilities for bikes and electric vehicles. Also, support the local authorities' goal of reducing CO_2, in-line with the national government policy goal of Net-Zero, by enhancing the natural environment through biodiversity net gain (i.e. creating woodlands and scrublands).	Liaison with the local councils to discuss the potential to increase the connectivity of the current cycling and footpath (in addition to the rerouting of the public rights of way) by introducing additional routes to the network that leads to and around the proposed reservoir. This would promote the use of alternative modes of transport that are more physically active and greener, which could alleviate the number of vehicles on the road associated with the proposed reservoir. Consideration could be given to installing charging stations for electric vehicles in the cark park of the proposed site and create a system that provides incentives for low-carbon vehicles, also build a secure and free bike storage station for visitors. A number of environmental provisions and designs have been proposed in the CDR, including woodlands, scrubland, hedgerows and green infrastructure (i.e. green walls and roofs). Therefore, the SESRO scheme would convert the current land of the proposed reservoir site, which is largely agricultural (a source of greenhouse emission), into a carbon sequestration and storage environment.
Natural	Improve water resource and environment.	SESRO is a long-term commitment to securing resilient water resources sustainably in the south-east, which involve addressing the issues of abstracting from vulnerable watercourses (i.e. sensitive chalk streams) by diverting abstraction to the proposed reservoir. To ensure the sustainable re-routing of watercourses that overlap the proposed reservoir site, considerations have been taken to design those watercourse diversion as naturalised form (i.e. meandering), which would enhance the quality of the water environment and thus ecological status
Natural	Managing and reducing flood risk.	There are several opportunities for SESRO to contribute towards flood risk management which have been identified and outlined previously which are predominately; • Consider the inclusion of the Abingdon FAS within the proposals. • Promote the use of SuDS to manage surface water and mitigate flood risk from built infrastructure developed as part of the reservoir for example highways but also consider the development of regional SuDS to support sustainable development in the local area. • Consider the use of NFM in addition to floodplain compensation and naturalisation of the rivers around the proposed reservoir.

Capitals	Opportunity	How SESRO can benefit or contribute
Manufactured	Low carbon energy resources	There are potential energy recovery opportunities from the scheme. One possible way of renewable energy generation is the installation of a solar farm on the surface of the reservoir. The other mode is through the pump station turbines during the reservoir discharge, in which the estimated energy output is ~120–65 kW as identified by the CDR. In addition, SESRO could facilitate with the re-location of the existing solar farm that sits on the designated area of development, in order not to cause a net loss of renewable energy generation as a result of the scheme.
Human	Creating a space that facilitate and support existing small-medium local businesses in the community as well as offer potential new business ventures	There are wide-ranging local economic priorities and initiatives which this process has not been able to delve into in detail, but could be further discussed with local councils and communities such as the authorities of Abingdon-on-Thames and their local markets which SESRO could support, for example by providing space for community food growing, if this was of interest to the local community. One of the suggested provisions in the CDR is an events area within the proposed site that would host community and family-friendly events. This would offer a marketplace for local business to come and trade during these special occasions of high footfall. Also, the development of a new space with a number of environmental and leisure provisions, as a result of SESRO, will attract and increase footfall to the area – so there for potentials for new business to open around the perimeter of proposed reservoir site (e.g. cafes, restaurant, convenience store)

Oxfordshire Plan 2050

The Oxfordshire Plan 2050[125] sets out the framework for future decision making on big issues like development, infrastructure and placemaking and seeks to use the opportunity of growth to improve the quality of life for everyone. It seeks to achieve this by seeking views from residents about what is important to them and their aspirations. The plan is anticipated to be adopted in May 2023; however, timelines are subject to change due to the ongoing COVID-19 pandemic. To date the consultation on vision and objectives has been undertaken, and the consultation on spatial growth options is proposed for summer 2021. Following this, the outputs from task 2 should be reviewed to identify any further opportunity. Future Vale of White Horse Local Plans (post 2031) will sit within the framework defined by the Oxfordshire Plan, alongside other adjacent areas in Oxfordshire. The vision set out for the plan is as follows:

> *"In 2050 the people of Oxfordshire are living in* **sustainable communities** with a **high quality of life** and **strong sense of community.** The integrity and richness of the county's **historic character and natural environment are valued and conserved.** A wide range of **secure and good quality housing** options are within reach for all. Existing and new communities are well connected, integrated, distinct, attractive and desirable places to live; their design and layouts **facilitate healthy lifestyles** and sustainable travel options. Productivity has increased and **residents are well-skilled** and able to access a wide range of high-value job opportunities and share in wealth creation. The private and public sector continue to have the confidence to invest in the county. Oxfordshire has embraced the technological, demographic and lifestyle changes of recent decades and new developments are fit for the future and **resilient to climate change**. The **wellbeing of residents and workers** is enhanced through being part of this special place."

[125] Oxfordshire Local Authorities (Cherwell District Council, West Oxfordshire District Council, Oxford City Council, South Oxfordshire District Council, Vale of White Horse District Council and Oxfordshire County Council), 2019. Introducing the Oxfordshire Plan. Accessed February 2020 – Introducing the Oxfordshire_Plan.pdf

SESRO is a long-term commitment to securing resilient water resources in the south-east and as such is proposed to be in operation for decades to come. It is important that the long-term priorities of Oxfordshire and its residents are taken into account in SESRO's proposed development and operation.

The opportunities outlined below are the high-level aspirations and associated objectives which are relevant to SESRO, alongside other key opportunities identified and summarised from the document 'Introducing the Oxfordshire Plan 2050' (Oxfordshire Local Authorities, 2019).

Table 11-32 – Oxfordshire Plan 2050 – opportunities

Capitals	Opportunity	How SESRO can benefit or contribute
Natural	Protect environmental quality • Maintain and enhance historic build and natural environment • Protect and enhance county's distinctive landscape character, recreational and biodiversity value	Through the environmental assessment work for SESRO, the opportunity to enhance environmental quality and maximise wherever possible will be a key consideration.
Social	Strong and Healthy communities • Improve health and wellbeing • Create sustainable communities (encompassing access to employment, housing open space, transport, education, services and facilities, along with responding to climate change challenges)	SESRO currently proposes to include a number of facilities which support the health and wellbeing of communities, for example high quality natural spaces and recreational facilities. In addition, there is proposed to be educational facilities and a positive impact on the local and regional economy as a result of both construction and operation of the proposed reservoir. Throughout the design process, SESRO should continue to consider the opportunities to support sustainable communities and maximise the benefits able to be provided by the proposed scheme for example by working with local schools and delivering educational activities.
Financial	Support economic growth • Sustain and strengthen Oxfordshire's role in UK economy • Create a prosperous, successful and enterprising economy with benefits felt by all	The qualitative assessment undertaken as part of the scoping exercise considers there will be positive impacts on the local and regional economy as a result of both construction and operation of the proposed reservoir. An effective procurement and training/ employment approach during construction and operation, considering Social Value, would support prosperity and inclusion aspirations. Opportunities to build relationships with nearby research institutes should be explored and developed in order to contribute to Oxfordshire's economic ambitions.

Capitals	Opportunity	How SESRO can benefit or contribute
Social	Improve connectivity and movement • Reduce the need to travel and provide better choices i.e. walking and cycling, and encourage public transport to be preferred over private cars • Promote development in sustainable locations and connecting those less sustainable locations	As part of the proposed works to the East Hanney-Steventon road diversion, and also the permanent access road to the north of the proposed site, consideration should be given as to whether these works can further improve local congestion and connectivity issues and also provide space for more active and sustainable methods of travel. The proposed development should also consider the opportunity to provide connectivity to the site from local communities, along active and green travel routes as well as connectivity to local public transport hubs.
Manufactured	Energy – the plan will facilitate a shift towards low carbon forms of energy development	The energy recovery opportunities outlined in the CDR should be considered during further design stages. In addition, the re-location of the solar farm could be facilitated or assisted by SESRO in order not to cause a net loss of renewable energy generation as a result of the proposed development.
Manufactured	Community Infrastructure Levy and Section 106 to support growth in relation to transport connectivity (to address issues of existing congestion and poor air quality, alongside planned new homes impact)	The CIL payment from the proposed buildings around SESRO, such as the potential Visitor Centre, could fund a wide range of infrastructure that is needed locally as a result of development. This includes new or safer road schemes, flood defences, schools, hospitals and other health and social care facilities, park improvements, green spaces and leisure centres.

11.2.5. Conclusions

The objective of this scoping is to set out the approach we are proposing to take for Task 1 (quantifying where possible the benefits and dis-benefits of the proposed SESRO scheme) and how this has been developed, as well as undertaking an initial review of the relevant stakeholders and beneficiaries for the scheme to support Tasks 2–4. We have used a six capitals approach to provide the framework for the study and to ensure that the all relevant impacts and benefits are captured.

Through the qualitative review, the scoping has been able to identify the significance of potential impacts, both positive and potentially detrimental, at both the construction and operational stage. Where impacts are identified as significant and are not captured under other assessments, but it is unlikely to be possible to quantify and monetise them, the wider benefits assessment will ensure these are captured qualitatively. Based on this review, the following impacts will be assessed either qualitatively or quantitatively (depending on the nature of the available data and information) and reported within the wider benefits assessment:

- **Air quality and impact on human health – impacts due to construction and operation of the reservoir**
- **Physical and mental health benefits from exercise**
- **Educational value**
- **Impacts on local/regional economic**
- **Impacts on workforce skills and experience**
- Impacts on organisational knowledge and experience
- **Financial asset value**
- **Impacts on customer bills**

The wider study will attempt to quantify the impacts above in **bold** and in section 11.2.6 we have outlined the proposed approach and data requirements for post Gate 1.

As described above, there are close links between the Intellectual capital metric of ‘impacts on organisational skills and experience’ and the Human capital metric of ‘impacts on workforce skills and experience’. The key

difference between these is where this value is held: Intellectual capital relates to 'organisational knowledge-based intangibles' whereas Human capital relates to individuals and their 'competencies, capabilities, experience and motivations to innovate' (IIRC, 2021[126]). It is anticipated that it will be challenging to quantify and value benefits relating to Intellectual capital due to the lack of available methods and datasets, whereas it may be possible to quantify some aspects of Human capital-related benefits. Therefore, there is not anticipated to be any double counting of values within the quantitative results for these two categories, but this will be kept under careful review. Furthermore, where impacts identified as being relevant to multiple capitals, their value will only be included once to avoid double counting.

The objective of the review of relevant documents and priorities was to identify opportunities for SESRO to coordinate/contribute to or benefit from other regional and national multi-sector strategic priorities. The list of documents outlined in section 11.2.4.6 was identified through drawing on the current understanding of the proposed SESRO scheme, its beneficiaries and potential benefits from the scoping work undertaken for task 1, and searching for relevant open-source materials of plans and initiatives within the six capitals framework. This included local and regional government development and economic strategies, river basin management plans, Canal and River Trust initiatives, and local and regional water and flood risk management strategies as well as searching for other local priorities such as health and wellbeing. A wide array of opportunities to develop beneficial synergies between SESRO and other parties have been considered and detailed in section 11.2.4.6. Broadly these opportunities can be summarised as:

- Improvements and enhancements to both the canal diversion around the proposed reservoir and as well as the drawdown channel downstream to provide greater opportunities for enhanced ecosystem and societal benefits.
- Improvements and enhancements to the river diversions and floodplain compensation around the proposed reservoir to maximise the opportunities for nature and people. This includes opportunities to local and vulnerable chalk streams through reduced abstraction.
- Opportunities for flood risk management, through naturalisation of the river diversions, consideration of inclusion of the Abingdon FAS or Thames Valley Flood Scheme options within the proposals if technically viable, consideration of NFM measures in addition to floodplain compensation. Wherever possible the opportunity to maximise the environmental benefits should be taken.
- Opportunities to enhance the local and regional leisure and recreation provision for local communities and visitors/tourists – both built and natural assets.
- Opportunities to contribute to education and skills provision, including empowering people through volunteering for example and upskilling the local young workforce.
- Opportunities from increased tourism to contribute to a more prosperous local economy and job generation whilst ensuring this tourism is both environmentally and socially responsible.
- Opportunities to help mitigate impacts on air quality as a result of construction and more visitors to the area.
- Consider the inclusion of clean energy generation within the design, and/or support the solar farm in re-locating to support the national priorities of greener energy provision and our collective response to climate change.
- Opportunities from developing the scheme collaboratively, for water companies and their supply chain to learn from one another and improve organisational knowledge and experience.
- Opportunities for the scheme to actively support sustainable communities – economically, socially and environmentally, perhaps through the provision of community infrastructure as well as other opportunities set out in the tables above.
- Opportunities for construction efficiencies, lower carbon choices and carbon offsetting, and also potential opportunities for applying the zero-waste principles which may benefit other projects or vice versa in the vicinity.
- Creating opportunities for different uses of green and blue spaces for both wildlife and people alongside providing different functions, for example:
    - Regional SuDS to support the sustainable provision of housing developments
    - Connecting green infrastructure and providing corridors for wildlife
    - Wetlands to contribute to climate change resilience and water quality improvements

[126] InternationalIntegratedReportingFramework.pdf

  - Flood risk management
- Contribute to local highways improvements:
  - Congestion and safety issues on the adjacent A34
  - Consider opportunities to maximise environmental enhancements along the permanent access road for example wild verges
  - Consider opportunities to address pollution and runoff from highways with SuDS
  - Consider opportunities for more active and more sustainable methods of travel within these improvement works
  - Opportunities to provide infrastructure to support greener forms of transport such as charging stations for electric vehicles and bike storage
- Support a healthier population:
  - Providing space, facilities and activities for mental and physical wellbeing
  - Supporting access to these facilities by all
  - Providing routes to the reservoir, and connections between other recreational spaces and communities for active and more sustainable modes of travel for example walking and cycling
- Opportunities to build strong partnerships to maximise benefits from the proposed development

The identification of opportunities which are beneficial for both SESRO and stakeholders in different sectors which sit across multiple spatial scales (i.e. ranging from local charities to regional authorities) will feed into the development of the implementation strategy to engage and develop a collaborative partnership for the promotion of the SESRO scheme, for the mutual benefit of these stakeholder groups. The value or benefits that these opportunities could provide to local communities and to the local and regional economy and environment could be considerably greater than their cost of implementation.

11.2.6. Assessment framework towards Gate 2

The next steps for this study are as follows:

- Iterative designs to inform the Task 1 quantification of benefits assessment.
- Undertake the quantification of the benefits (Task 1) using the approaches and data outlined in this scoping. This will inform the development of the collaborative partnership strategy (Task 4) along with a review of the work done to date on Tasks 2 and 3 if required. The wider benefits study will also be updated, if necessary, in response to Gate 1 stakeholder feedback.
- Undertake engagement with SESRO key stakeholders to gather their views on the proposed methods and collaborative partnership strategy, alongside supporting the stakeholders collectively reviewing the opportunities for synergies identified as part of Task 2.
- The opportunities identified will be discussed with the client and will form the basis of the collaborative partnership strategy post Gate 1. Following Gate 1 we would also recommend reviewing the opportunities with the client and their engineering partner, along with stakeholders to gauge the feasibility and likely impact of undertaking these opportunities which will also inform Task 4.

12. Biodiversity Net Gain

12.1. Introduction/explanation of topic area

Biodiversity net gain (BNG) is an approach that aims to leave the natural environment in a measurably better state than beforehand. Natural England's Biodiversity Metric 2.0 provides a way of measuring and accounting for biodiversity losses and gains resulting from development or land management change[127].

At the time of writing (February 2021) the draft Water Resources Planning Guideline supplementary guidance[128] indicates an expectation that plans, and therefore logically projects such as SESRO, deliver BNG and environmental gain and use a natural capital approach. Thames Water have committed to a 10% improvement in BNG for new projects like SESRO. While no target level of net gain is set within current law, it is of note that the Environment Bill would, if enacted, result in a net gain target of 10% for projects covered by the Town & Country Planning Act 1990.

For Gate 1, the WRSE BNG assessment has been reviewed to provide an initial indication of whether or not a metric measured BNG is predicted to be achievable for each option.

As part of this review, it was identified that watercourses (including rivers and ditches) were not included in the WRSE assessment. Watercourses lost as a result of the reservoir scheme include the Cow Common Brook and Portobello Ditch WFD waterbodies (which are also classed as 'Main River'), in addition to the loss of a dense network of agricultural ditches in the Scheme footprint. To account for this loss, a high-level assessment of the watercourses was conducted using the Biodiversity Metric 2.0 to estimate the impact of watercourses on attaining BNG as part of the Scheme.

The Biodiversity Metric 2.0 includes separate elements for:

- habitat areas – which includes the reservoir itself, ponds, ditches, grassland, woodland, etc.; and,
- linear habitats - such as hedgerows and rivers.

It is our understanding that the revised 3.0 metric may move some habitats in the area metric e.g. ditches to linear.

The calculations for each of these two groups are undertaken separately and the results are judged separately and not interchangeably so, for example, the loss of a linear feature like a hedgerow cannot be compensated for by enhancing an area of habitat. Likewise, the loss of a linear length of river cannot be compensated for by a linear length in hedgerow. Within this chapter, in sections 12.3 to 0, each section is divided into two subsections, with habitat areas assessment described first, followed by watercourse assessment. In Section 12.3 (methodology), there is a third subsection, setting out the limitations and assumptions. In Section 0 there is a third subsection, providing a combined summary of conclusions.

Due to the high-level study, linear terrestrial habitats have not been quantified. The loss of hedgerows and tree lines has not been quantified during this stage of assessment. However, it is anticipated that any losses could be compensated through hedgerow creation and restoration within and, if necessary, through landowner agreement outside the SESRO boundary, to create a project design predicted to deliver BNG. Linear features should be assessed the next time the metric calculations are updated, based as far as practicable on field data.

12.2. Datasets reviewed

The WRSE output for SESRO, provided by Mott MacDonald, has been reviewed. This was cross checked with the indicative habitat areas predicted by Atkins' own natural capital studio tool, to confirm that broad habitat areas appeared a reasonable representation of the broad site areas.

For the watercourse assessment, the surface water lines from the Ordnance Survey (OS) VectorMap District[129] were used to identify the rivers and ditches within the red line boundary of each reservoir option. Rivers were defined as watercourses designated as WFD water bodies or 'Main Rivers'. All other 'Ordinary Watercourses' are straight and frequently run along field boundaries so were classified as 'ditches' for the purpose of this assessment. River condition was assessed from open-source data including satellite imagery from Google

[127] Natural England (2019). The Biodiversity Metric 2.0 (JP029). http://publications.naturalengland.org.uk/publication/5850908674228224
[128] Water Resources Planning Guideline (publishing.service.gov.uk)
[129] OS VectorMap District (version 2020–11) https://osdatahub.os.uk/downloads/open/VectorMapDistrict

Earth and River Habitat Surveys[130]. It is assumed that all rivers outside of the design features but within the red line boundary are retained and unchanged.

12.3. Gate 1 proportional assessment methodology

This section contains three parts, including the methodology for habitat areas (12.3.1) the methodology for watercourses (12.3.2) and limitations and assumptions (12.3.3).

12.3.1. Habitat areas assessment

The WRSE natural capital and BNG method statement was reviewed.

This included the high-level results of an application of the Biodiversity Metric 2.0 for each SESRO option, supplemented by sharing the completed Biodiversity Metric 2.0 calculation spreadsheet for each option, and these were reviewed.

During initial review, it was noted that all baseline and created habitats were accorded 'medium' connectivity within the metric. Under Biodiversity Metric 2.0, habitats of medium or low distinctiveness should be assigned low connectivity while those of high or very high distinctiveness should be assigned medium connectivity. As a sensitivity test, the connectivity scores within the spreadsheet for the option with lowest predicted net gain (75) were amended, to check whether this would reduce the predicted gain below 10%.

A cross check was made of the Ancient Woodland Inventory on Defra's MAGIC website[131], ancient woodland is a key example of an irreplaceable habitat, and its loss would mean a project could not be described as a BNG project overall[132], although metric-based net gain could still be achievable for other habitats. The Woodland Trust's Ancient Tree Inventory was also reviewed.

12.3.2. Watercourse assessment

The watercourse Biodiversity Net Gain assessment was conducted using the Biodiversity Metric 2.0 which splits watercourses into rivers and ditches. The rivers are assessed in a separate component of the metric and are assessed by length. The ditches are assessed in the terrestrial habitat component of the metric and are assessed by area. The results for each component are therefore reported separately.

12.3.2.1. Rivers

For the river component of the Biodiversity Metric 2.0, the river network was split into reaches with relatively homogenous characteristics based on available open-source datasets as field surveys were not part of this high-level assessment. Each reach requires three key inputs to the Biodiversity Metric 2.0[133]:

- the distinctiveness of the habitat (i.e., rarity of the habitat);
- the condition of the habitat (i.e., the degree of naturalness and human modification); and,
- the strategic significance of the site.

Each input is converted into weightings used in combination with river length to calculate biodiversity units delivered by each reach before the Scheme. A scenario is then estimated for each reservoir option after the Scheme is implemented so that a change in biodiversity units can be estimated. The methods for assessing these components are described below.

Biodiversity Net Gain reach delineation

Reaches were defined by river name, WFD status and by visual inspection of satellite imagery of the river on Google Earth. Eleven reaches were identified within the red line boundary of the largest reservoir option (150 Mm^3) and details about each reach are described in Table 12-1. Note that these reaches have been defined specifically for Biodiversity Net Gain and are purposefully different to the assessment reaches referred to in other chapters throughout this report. This exercise was required so that the watercourses can be directly attributed scores in relation to the river's condition. A map of rivers within the red line boundary can be found in Figure 1.2 in Annex B.1 EAR Figures.

[130] Environment Agency: https://data.gov.uk/dataset/b9dc8b96-b55a-4ecb-a341-fa193c74520b/river-habitat-survey
[131] MAGIC (defra.gov.uk)
[132] Biodiversity Net Gain: Good Practice Principles for Development. https://cieem.net/resource/biodiversity-net-gain-good-practice-principles-for-development/
[133] Natural England (2019) The Biodiversity Metric 2.0, auditing and accounting for biodiversity, User Guide, Beta Version. Natural England Joint Publication JP029

Baseline river distinctiveness

The distinctiveness score is based on the type of habitat present and its value based on its rarity. According to the Biodiversity Metric 2.0 guidance 162(Natural England, 2019), river distinctiveness is classed as 'very high' if the river is on the Priority River Habitat map or 'high' if the river appears on the Priority River Habitats sub-type. Where a river is not a Priority River Habitat, distinctiveness is classified using a River Naturalness Assessment. The River Naturalness Assessment uses components of the WFD investigations; physical, hydrological, chemical and biological. As this is a desk-based assessment, WFD status is considered as a proxy to reflect the River Naturalness Assessment. The rivers impacted by the Scheme are not classified as Priority River Habitat and have poor WFD status so are classified as 'moderate' distinctiveness, the lowest distinctiveness band.

Table 12-1 – Length of each reach within the red line boundary of each reservoir option and the estimated river condition. River condition is noted for each reach (see next Section for details).

Biodiversity Net Gain Reach number	River Name	WFD 'blue line' (✓)	Estimated river condition	Total length of river within each reservoir option red line boundary (km)			
				150 Mm^3 30+100 Mm^3 84+42 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3
1	Cow Common Brook u/s Portobello Road confluence		Fairly good	1.05	1.05	1.05	0.28
2	Cow Common Brook u/s Hanney Road	✓	Fairly good	0.99	0.99	0.99	0.97
3	Cow Common Brook d/s Hanney Road	✓	Fairly poor	2.86	2.86	2.86	2.86
4	Hanney Ditch		Fairly poor	2.09	2.09	1.86	1.51
5	Landmead Ditch		Fairly poor	0.73	0.73	0.73	0.73
6	Mere Dyke		Fairly poor	2.58	2.58	2.58	2.58
7	Oday Ditches on WFD blue line	✓	Fairly poor	0.34	0.34	0.34	0.34
8	Oday Ditches outside of WFD blue line		Fairly poor	0.25	0.25	0.25	0.25
9	Portobello Ditch	✓	Fairly poor	1.14	1.14	0.53	0.23
10	River Ock	✓	Fairly good	0.12	0.12	0.12	0.12
11	Sandford Brook	✓	Moderate	0.76	0.76	0.76	0.76
			Total:	**12.93**	**12.93**	**12.09**	**10.63**

Baseline river condition

According to the Biodiversity Metric Guidance, river baseline condition should be assessed using the Modular River Survey (MoRPh) field surveys that record the extent of a range of geomorphological features that reflect the functioning of a river reach. As this is a desk-based assessment, river condition was estimated by visual inspection of satellite imagery of the river on Google Earth and using Habitat Modification Scores from River Habitat Surveys (RHS) conducted on the rivers impacted by the Scheme (Table 12-2). It should be noted that although RHS collect similar data to the MoRPh surveys required as part of the Biodiversity Metric 2.0 methodology, the survey methodology is different, and the surveys were conducted in 1998 and 2008 so the modification scores may be outdated.

Table 12-2 – RHS on each reach with details of survey year and habitat modification score

Biodiversity Net Gain Reach number	RHS location (NGR)	Survey year	Habitat Modification Score
1	No RHS near reach	-	-
2	No RHS near reach	-	-
3	SU4480094200	15/07/1998	Heavily modified
4	SU4310094500	15/07/1998	Heavily modified
5	No RHS near reach	-	-
6	No RHS near reach	-	-
7	SU4894195057	15/09/2008	Heavily modified
8	No RHS near reach	-	-
9	SU4291290624	10/09/2008	Heavily modified
10	SU4720095800	10/07/1998	Predominantly unmodified
11	No RHS near reach	-	-

Inspection of satellite imagery revealed that reaches 3–9 have been artificially straightened to run alongside field boundaries. Of these reaches, those with available RHS data were identified as 'heavily modified' so are classified as 'fairly poor' condition in this assessment. These reaches are likely to be classified as 'poor' following a MoRPh survey, but a conservative approach is taken in this assessment. The sections of the Sandford Brook within the red line boundary (reach 11) showed some slight sinuosity so is classified as a 'moderate' condition. The upper reaches of the Cow Common Brook (reaches 1 and 2) are also more sinuous indicating a more natural system and flow through wooded areas so are classified as 'fairly good'. The River Ock (reach 10) also has a more natural planform and an RHS modification score of 'predominantly unmodified' so is also classified as 'fairly good' condition. The final condition scores are shown in Table 12-1.

Baseline strategic significance

Reaches that are identified as WFD water bodies (Table 12-1) are assigned a higher strategic significance score as they are identified within wider strategic plans. The remaining reaches are classified with a low strategic significance.

River watercourse scenario

The length of river reaches that will be lost due to the design features of the Scheme are calculated (Table 12-3). Road, track and pipeline components of the Scheme are excluded as that crossing designs are not currently known and as such habitat loss/alterations would be difficult to determine. For this assessment it is assumed that there will be no deterioration in river condition at these sites, but this should be assessed in the Gate 2 assessment when more detailed information on the crossings is available.

Three new areas of watercourse are proposed as part of the Scheme that would result in river habitat creation: the WWD, the EWD and the auxiliary drawdown channel. In the absence of further design iterations, for the purpose of the BNG calculations the EWD has currently been classified as a 'ditch' as it diverts from a ditch and will likely act as a toe drain to the reservoir embankment. The WWD diverts a WFD water body, the Cow Common Brook, will flow through a naturalised Compensatory Flood Storage Area and then enter the Hanney Ditch. Therefore, it is attributed a 'fairly good' condition score and a higher strategic significance.

The auxiliary drawdown channel is likely to be a wide and artificial channel and the significance of flow through the channel will be dependent on the operation of the reservoir, which is currently understood to only comprise emergency discharges and operational testing of these discharges once or twice a year. Therefore, this reach is classified conservatively as a 'moderate' condition with a low strategic significance. The river distinctiveness is unlikely to improve as part of the Scheme so is not changed from the 'moderate' score.

Table 12-3 – Total length of river watercourse lost through the Scheme and the total length of river watercourse created as part of the Scheme for each reservoir option

	150 Mm³	125 Mm³	100 Mm³	75 Mm³	30+100 Mm³	84+42 Mm³
Total river watercourse length lost (km)	9.03	7.36	6.39	4.10	9.02	8.79
River watercourse length created including West diversion channel[134] (km) and Auxiliary Drawdown channel	7.61	7.17	6.56	5.58	9.30	10.46

12.3.2.2. Ditches

The biodiversity units delivered by the extensive ditch network is also estimated in this assessment but are reported separately from river watercourses as the Biodiversity Metric 2.0 uses a different method to calculate biodiversity units. A map of ditches within the red line boundary (identified in this assessment as ordinary watercourses or watercourses not identified as WFD water bodies) can be found in Figure 1.2 in Annex B.1 EAR Figures. The length of ditches within the red line boundary is displayed in Table 12-4. In the Biodiversity Metric 2.0, ditches are included as an area feature rather than a linear feature. Therefore, an assumption is made that ditches are 1 m wide to calculate area for input into the metric. The ditches are automatically assigned a distinctiveness of 'medium' based on their habitat type and are manually assigned a condition score of 'moderate'. This is a conservative estimate of ditch condition given limited knowledge of the ditch habitat quality. The ditches are assigned a strategic significance of 'low' and a connectivity score of 'medium' as the ditch network is interconnected and covers a large area.

Table 12-4 – Total length of ditches within the red line boundary of each reservoir option

	150 Mm³ 30+100 Mm³ 84+42 Mm³	125 Mm³	100 Mm³	75 Mm³
Total ditch length (km)	54.47	53.94	49.71	48.13

The length of ditches that will be lost under design features of the Scheme are calculated (Table 12-5). Road, track and pipeline components of the Scheme are excluded as that crossing designs are not currently known and as such habitat loss/alterations would be difficult to determine. For this assessment it is assumed that there will be no deterioration in ditch condition at these sites, but this should be assessed in the Gate 2 assessment when more detailed information on the crossings is available.

Table 12-5 – Total length of ditch lost through the Scheme and the total length of ditch created as part of the Scheme for each reservoir option

	150 Mm³	125 Mm³	100 Mm³	75 Mm³	30+100 Mm³	84+42 Mm³
Total ditch length lost (km)	46.16	42.00	41.42	36.47	45.70	45.70
Ditch length created – East diversion channel (km)[135]	5.68	5.68	5.68	5.68	5.68	5.68

The east diversion channel is assumed to be a ditch habitat by this assessment. Distinctiveness, condition, ecological connectivity and strategic significance scores remain the same as baseline (i.e. 'medium' or 'moderate') as the condition of the new channel is uncertain.

[134] Values consistent with Technical Annex A1, CDR: Section 2.1.7.2, Table 2-13 and 2-14.
[135] Values consistent with Technical Annex A1, CDR: Section 2.1.7.2, Table 2-13 and 2-14.

12.3.3. Limitations and Assumptions

Assumptions are influenced by the high-level nature of this Gate 1 assessment. As the metric calculations are updated as part of Gate 2, it is intended that the baseline will be based as far as practicable on field data. For example, a standard level of strategic significance was assumed for all habitats, and this should be reviewed during the next update.

All work is based on existing available information, and no field surveys have been undertaken to inform this assessment. For this study, The Woodland Trust's Ancient Tree Inventory was reviewed. However, it is recognised that this is only a partial list of ancient and other veteran trees and that it relies on submitted records, so a field survey would be undertaken at a later stage of project development in any case to check for veteran trees. The Ancient Woodland Inventory was also reviewed. This Inventory is based on much more extensive and detailed study, but it is recognised that there are occasional errors in it so a precautionary approach would be taken at a later stage by checking older maps and, if required, field survey of any woodland suggested to have had continued presence during the series of Ordnance Survey maps.

Atkins has not undertaken a separate application of the Biodiversity Metric 2.0 for the habitat areas element of the metric or linear features (hedgerows). At this stage, the habitat areas-based exercise is high level and, therefore, this is not considered a limitation to the conclusions of the study; the study has been limited to review of the WRSE assessment. With regard to hedgerows and other terrestrial linear features, the calculations have not been undertaken. Next time the metric calculations are updated for terrestrial habitat and linear features (hedgerows and rivers) it should be based as far as practicable on field data such as MoRPh surveys to accurately assess river condition.

12.4. Outputs/findings

12.4.1. Habitat areas assessment

A precautionary approach was taken to judging habitat "score", which is assumed to include both habitat type (and therefore its distinctiveness) and condition. This approach is evidenced in the results in which, for example, high condition was assumed unless habitats were of low distinctiveness, such as cropland, for which poor condition was either assumed, or automatically required by the metric tool. It has also been assumed that all habitat areas would be lost, and also assumed created habitats would be in moderate condition, other than arable cropland. In order to justify this assumption, habitat management commitments, at least until target condition has been reached, are required.

The high-level predictions headline results for habitat areas element of the Natural England Biodiversity Metric 2.0 as set out in Table 12-6 below.

Table 12-6 – WRSE BNG Headline Results for Habitat Areas

Scheme Option	On site baseline habitat units	Onsite net change in number of units	Total net change predicted, as percentage of baseline
150 Mm^3	4,909.46	+2,447.23	+49.85%
125 Mm^3	4,489.28	+1,217.68	+27.12%
100 Mm^3	4,489.28	+1,217.70	+27.12%
75 Mm^3	4,228.43	901.84	+21.33%
30+100 Mm^3	4,909.45	+1,497.65	+30.51%
80+42 Mm^3	4,909.45	+1,500.88	+30.57%

The data available for the high level study indicated the presence, and potential loss, of areas of three types of habitat of high distinctiveness: lowland mixed deciduous woodland; ponds; and floodplain wetland mosaic grassland, the last of which falls within the definition of the priority habitat Coastal and Floodplain Grazing Marsh. Losses of these habitat types should be minimised as far as practicable. All are targets for habitat creation in the designs. Where loss of habitats of high distinctiveness cannot be avoided, compensation should target delivering at least the same area and, ideally, also the same number of units through habitat enhancement and creation. The WRSE assessment indicates that the current designs do not compensate fully in kind for loss of woodland or floodplain wetland mosaic grassland. Therefore, this should be taken into

account if design work is taken forward on SESRO, to avoid risks of failing to meet good practice due to 'trading down'.

It is noted in particular that the current assessment assumes lowland mixed deciduous woodland could be created, as opposed to plantation woodland. This would require particularly high-quality habitat creation works with, for example, dead wood introduced to the new woodland and other measures beyond normal woodland creation.

During the review, it was noted that floodplain wetland mosaic grassland was the one habitat where good condition was not assumed and instead its condition was recorded as moderate. However, a review of aerial imagery indicates that several of the fields labelled as this habitat type currently/recently support arable cropland. Therefore, a sensitivity test changing moderate to good condition was not undertaken because the fields' identification as floodplain wetland mosaic grassland is in itself highly precautionary for some areas.

One habitat type that is present on site but not included in the main habitat area metric spreadsheet is ditches. Within that calculation, these have been subsumed within the areas of adjacent habitats. Calculations have been made separately under the watercourse assessment.

Consideration was given to the potential for irreplaceable habitat to be present. From the location of SESRO, the only types of irreplaceable habitat likely to be encountered are ancient woodland and veteran trees. A review of the Ancient Woodland Inventory has not indicated the presence of any ancient woodland within or adjacent to the SESRO site. On ancient woodland, Hyde Copse, is approximately 450m from the Scheme area and would not be at risk of woodland loss. One woodland, Drayton Copse, which is located towards the centre of the Scheme area, is present on the first Ordnance Survey maps, so while it is reasonable to assume that the Ancient Woodland Inventory would not have excluded this wood accidentally, a check of older maps is recommended to confirm its status, supplemented by field survey if required. Based on the Ancient Tree Inventory (See chapter 10), there may be two veteran trees present. Even if none were reported on the Inventory, it is recognised that this is only a partial record. Field surveys should therefore include searching for any veteran trees.

12.4.2. Watercourse assessment

The outputs of the watercourse Biodiversity Net Gain assessment are described below including how many biodiversity units are lost and gained for each reservoir option. It must be noted that the Mott MacDonald assessment was conducted using the WRMP19 designs rather than the more recent WRMP24 designs used for this assessment. This WRMP24 designs are slightly different to the WRMP19 designs with notable changes that influence the BNG assessment including: (i) slight increase in the size of the red line boundary to accommodate changes to the road diversion and new access road; (ii) change in size and location of screening mounds; and (iii) increased size of flood alleviation area in the 150 Mm^3 option. This BNG assessment for watercourses will have differences to an assessment completed on the WRMP19 designs but it is expected that these differences are slight and are unlikely to influence the conclusions of the BNG assessment. Therefore, comparisons in the biodiversity units made between Mott MacDonald's terrestrial habitat assessment and this watercourse assessment are not consistent but do offer an idea of scale of the impact of watercourses on overall Biodiversity Net Gain. The results for rivers and ditches are again reported separately as rivers are assessed by length whereas ditches are assessed by area.

12.4.2.1. Rivers

The Biodiversity Metric 2.0 was run to determine the baseline river biodiversity units present within the red line boundary of each of the six reservoir options and how many are lost as a result of the Scheme. Between 4.10 and 9.03 km of river were calculated as lost as part of the Scheme (Table 12-3). The total biodiversity units lost ranges between 96.41 for the 150 Mm^3 option and 39.98 for the 75 Mm^3 option (Table 12-7a). These are the amount of biodiversity units associated with river habitats only that must be created through river habitat creation and enhancements to achieve net zero.

The total length of river created as part of the Scheme is between 5.58 and 10.46 km. This is greater than the length lost for options 100 Mm^3, 75 Mm^3, 30+100 Mm^3 and 84+42 Mm^3 but less for options 150 Mm^3 and 125 Mm^3 (Table 12-3). This results in the number of biodiversity units delivered by the Scheme, between 40.04 for the 84/42 Mm^3 option and 21.32 for the 75 Mm^3 option (Table 12-7b). The total units gained is lower than biodiversity units lost for all options. This is partly because the lengths of river lost include reaches of the Cow Common Brook that are classified as 'fairly good' condition which equate to higher number of biodiversity units. However, the key reason is due to the 'time to condition' and high 'difficulty of creation' multipliers that are part of the Biodiversity Metric 2.0 for river creation. In combination, these multipliers reduce the number of biodiversity units delivered by the new channels by over a third. These multipliers are designed to reflect that

fact that habitat cannot be instantly created but takes time to establish. This means that a like-for-like replacement of even the same length and condition of channel would not result in a net change in biodiversity units of zero; creation of a greater length of new channel is required to mitigate the effect of habitat loss. For the current WRMP24 SESRO designs, this means that there is a net biodiversity loss for in river habitat for all six reservoir options of between −17.41% for the 75 Mm^3 option and −49.46% for the 150 Mm^3 option (Table 12-7c).

Table 12-7 – River biodiversity units lost, gained and overall net gain of rivers for each reservoir option.

(a) River biodiversity units lost

Reach name	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30+100 Mm^3	84+42 Mm^3
1	13.72	14.07	6.27	0.00	13.72	13.72
2	18.23	18.23	18.23	2.22	18.23	18.23
3	23.86	23.86	23.86	23.85	24.63	24.58
4	16.71	6.13	2.85	0.00	16.53	16.71
5	0.00	0.00	0.00	0.00	0.00	0.00
6	8.15	6.19	9.72	6.19	8.15	6.19
7	0.48	0.48	0.48	0.48	0.48	0.48
8	0.78	0.78	0.78	0.78	0.17	0.17
9	7.95	6.84	1.89	0.00	7.95	7.95
10	0.07	0.00	0.45	0.00	0.07	0.07
11	6.46	6.46	6.46	6.46	6.46	6.46
Total units lost	**96.41**	**83.03**	**70.98**	**39.98**	**96.38**	**94.56**

(b) River biodiversity units gained

Design feature	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30+100 Mm^3	84/42 Mm^3
WWD	19.59	17.58	14.79	10.32	19.59	19.59
Auxiliary drawdown channel	11.00	11.00	11.00	11.00	16.60	20.45
Total units gained	**30.59**	**28.58**	**25.79**	**21.32**	**36.19**	**40.04**

(c) Biodiversity impact of Scheme on river metric

	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30+100 Mm^3	84+42 Mm^3
Net unit change	−65.82	−54.45	−45.18	−18.66	−60.19	−54.52
Net % gain	−49.46%	−40.92%	−35.96%	−17.41%	−45.23%	−40.97%

Red indicates high number of biodiversity units lost and green indicates high number of biodiversity units gained. Units have been taken from the Biodiversity Metric 2.0 and rounded up to 2 decimal places

12.4.2.2. Ditches

The length of ditch network lost as part of the Scheme is between 46.16 km for the 150 Mm^3 option and 36.47 km for the 75 Mm^3 option (Table 12-5). This equates to a loss of between 30.47 and 24.07 biodiversity units (Table 12-8a), the amount of biodiversity units that must be created through habitat creation and enhancements to achieve net zero.

The total length of ditch created as part of the Scheme is 5.68 km for all reservoir options which equates to 4.18 biodiversity units (Table 12-8b). The low value in biodiversity units delivered for ditches is primarily due to only between 14 and 17% of the length of ditch lost being created. The 'time to condition' and 'difficulty of creation' multipliers for ditches are also a factor but are less high than for rivers due to the type of habitat being created. Therefore, the biodiversity units delivered by ditches is only reduced by roughly 20% by these multipliers. For the current WRMP24 SESRO designs, this means that due to the amount of ditch length lost, there is a net biodiversity loss in ditch habitat for all six reservoir options of between −62.62% for the 75 Mm^3 option and −73.12% for the 150 Mm^3 option (Table 12-8c).

Table 12-8 – Biodiversity units lost, gained and overall net gain of ditches for each reservoir option.

(a) Ditch biodiversity units lost

	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30/100 Mm^3	84/42 Mm^3
Total units lost	30.47	27.72	27.34	24.07	30.16	30.17

(b) Ditch biodiversity units gained

	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30/100 Mm^3	84/42 Mm^3
EWD	4.18	4.18	4.18	4.18	4.18	4.18

(c) Biodiversity impact of Scheme on ditches

	150 Mm^3	125 Mm^3	100 Mm^3	75 Mm^3	30/100 Mm^3	84/42 Mm^3
Net unit change	−26.29	−23.54	−23.16	−19.89	−25.98	−25.99
Net % gain	−73.12%	−66.12%	−70.60%	−62.62%	−72.27%	−72.29%

Red indicates high number of biodiversity units lost and green indicates high number of biodiversity units gained. Units have been taken from the Biodiversity Metric 2.0 and rounded up to 2 decimal places

12.5. Conclusions

12.5.1. Habitat areas assessment

In terms of terrestrial habitat areas, the studies indicate that a net increase in biodiversity units of over 10% could be achieved for any of the options.

Suitable long-term management would be required for the created habitats. Under the current wording of the Environment Bill, a commitment to 30 years management is anticipated to be required.

Losses of woodland, floodplain wetland mosaic and ponds should be minimised as far as practicable for the final selected option, and compensation should include areas of these habitat types being subject to habitat creation or enhancement. This would require sensitive design to minimise losses, do high quality habitat creation, and thereby avoid risks of trading down. Habitat creation opportunities have been identified at a high level, but as design progresses refinements could include innovations such as rewilding to create added value for wildlife and local communities.

Studies have not identified any definite loss of irreplaceable habitat. However, field surveys using the new methodologies required to inform biodiversity metric calculations have not yet been undertaken. In particular, a search should be undertaken for ancient and other veteran trees, which constitute irreplaceable habitat. If found to be present, their loss should be avoided if practicable to achieve a BNG as defined by best practice guidance. If their loss could not be avoided, suitable compensation would be required and BNG could still be achievable for other habitats.

The loss of hedgerows and tree lines has not been quantified during this stage of assessment. However, it is anticipated that any losses could be compensated through hedgerow creation and restoration within and, if necessary, through landowner agreement outside the SESRO boundary, to create a project design predicted to deliver BNG. Linear features should be assessed the next time the metric calculations are updated, based as far as practicable on field data.

12.5.2. Watercourse assessment

A high-level biodiversity net gain assessment on the watercourses in the SESRO reservoir schemes was conducted using desk-based information and the WRMP24 designs issued on 28/01/21. Watercourses were not included in the WRSE biodiversity net gain assessment but showed to result in net biodiversity loss in all reservoir options and so should be considered in any future SESRO biodiversity net gain assessment.

In summary, there was a net loss of between −18.66 and −65.82 river biodiversity units resulting in a net percentage loss of between −17.41% and −49.46% depending on the reservoir option. The river component of the Biodiversity Metric 2.0 is considered separately so must achieve biodiversity net gain alone without including the terrestrial habitat biodiversity units. To achieve Biodiversity Net Gain the length of channel created could be extended or the condition of the created channel and/or other rivers within the red line boundary could be enhanced.

The loss of between −19.89 and −26.29 of ditch biodiversity units is included in the total terrestrial habitat Biodiversity Net Gain calculation in the Biodiversity Metric 2.0. Even with this loss in ditch biodiversity units, the overall net gain of the terrestrial habitats is unlikely to be significantly negatively impacted (Table 12-6in Section 12.4).

It should be noted that the designs of the diversion and auxiliary drawdown channels are in the conceptual design phase so appear relatively straight. Once more detailed design of these features is conducted, a planform with an appropriate level of sinuosity for the watercourse may be decided upon that will increase the length, and therefore biodiversity units, delivered by the Scheme. This may create enough new biodiversity units to achieve net gain for the river component of the Biodiversity Metric 2.0 in the reservoir options with a smaller footprint, although additional enhancement works may be necessary. However, it is unlikely that the EWD alone will ever mitigate for the loss of over 35 km of ditch network. Therefore, mitigation works are required to either create or more likely enhance existing ditches, to deliver additional biodiversity units. These mitigation areas should be included within the red line boundary of the Scheme and where not possible, within the respective water body or catchment.

12.5.3. Combined summary conclusions

In terms of terrestrial habitat areas, the studies indicate that a net increase in biodiversity units of over 10% could be achieved for any of the options.

Habitat creation opportunities have been identified at a high level, but as design progresses refinements could include innovations such as rewilding to create added value for wildlife and local communities.

The loss of hedgerows and tree lines has not been quantified during this stage of assessment. However, it is anticipated that any losses could be compensated through hedgerow creation and restoration within and, if necessary, through landowner agreement outside the SESRO boundary, to create a project design predicted to deliver BNG. Linear features should be assessed the next time the metric calculations are updated, based as far as practicable on field data.

From a watercourse perspective, neither rivers, or ditches, will achieve a net increase in biodiversity units in any of the proposed options. If fact, each option will produce a net loss in biodiversity units in rivers, largely by virtue of the fact that the 'time to condition' and high 'difficulty of creation' multipliers that are part of the Biodiversity Metric 2.0 for river creation which reduces the number of biodiversity units delivered by the new channels by over a third. However, the significant biodiversity net losses in ditch biodiversity units is marked in each option and reflects that large length of ditch that will be lost from the footprint and which is not currently mitigated for elsewhere. As the options progress, more biodiversity units will need to be gained for watercourses within the site boundaries wherever possible and, where not achievable, mitigation would need to be sought in impacted water bodies or within the wider catchment to deliver net gain.

12.6. Assessment framework towards Gate 2

During early 2021, Natural England are due to issue a revised version of the Biodiversity Metric (3.0). Once published, this will be reviewed to see how it could influence the predicted results for SESRO. It is understood that factors such as condition assessment may be revised for some habitat types. Most significantly for SESRO, some or all types of ditch are to be moved from the area-based part of the metric to the watercourse part of the metric. This may alter the amount of compensation required for watercourses substantially.

Field surveys would be essential to provide revised and refined information on the types and condition of habitats. This would involve recording the habitat types and their condition, following the most up to date Natural England guidance at the time of the survey. This would cover all habitats, but particularly those that could be of higher distinctiveness, such as the areas identified as being woodland or potentially being floodplain wetland mosaic grassland. This would record data for habitat areas (using the UKHab methodology) and for linear terrestrial features and watercourses (using the MoRPh methodology). The BNG metric would then be run again.

Further desk study and field survey would also be undertaken to check that the woodland on site is correctly identified as not being ancient. Field surveys will also be undertaken to confirm whether any of the mature trees on site constitute ancient or other veteran trees.

The metric would also be run for linear terrestrial features (hedgerows and tree lines). If field surveys are not possible, hedgerows and tree lines would be mapped based on available data and aerial imagery and the metric would be run based on this information, with assumptions about condition.

Currently, it is assumed that all rivers and ditches outside of the design features but within the red line boundary are retained and unchanged. This assumption should be revised as more detail around the design features of the Scheme become available. Details about the form of road, track or pipeline crossings across rivers and ditches and details of the new channels and flood alleviation area are of particular importance to the watercourse assessment. As the designs are furthered, a detailed mitigation and compensation plan can be developed accordingly.

13. Summary of main findings

Atkins has completed an assessment of potential effects and benefits associated with six different size options of the South East Strategic Reservoir Options (SESRO). The findings of this assessment have fed into the Water Framework Directive (WFD), Habitats Regulations Assessment (HRA) and scheme level Strategic Environmental Assessment (SEA) chapters, which are Technical Annex B2, B3 and B4 of the SESRO RAPID Gate 1 submission respectively. The assessment has covered the following technical working areas:

- Landscape;
- Historic environment;
- Physical environment – fluvial geomorphology;
- Physical environment – hydrology;
- Water quality;
- Aquatic ecology – covering fisheries, macrophytes, macroinvertebrates, diatoms, phytoplankton and zooplankton;
- Terrestrial ecology;
- Aquatic and terrestrial Invasive and Non-Native Species (INNS);
- Natural Capital Assessment and wider benefits; and,
- Biodiversity Net Gain.

The assessments have shown that:

For landscape, the proposed site is near to the North Wessex Downs Area of Outstanding Natural Beauty (AONB), necessitating the need for a Landscape and Visual Impact Assessment (LVIA) as part of Gate 2.

For the historic environment, the Gate 1 work has identified that there is a very high potential for archaeological remains within the red line boundary. Further impacts such as changes to settings of a number of designated heritage assets are also anticipated. The approach for Gate 2 will need to include the agreement of a Written Scheme of Investigation (WSI) for a Desk Based Assessment (DBA). The scope of this has been discussed and agreed with the Oxfordshire County Council archaeologist and Historic England.

The geomorphological assessment work has involved quantification of the loss of running and still water watercourses within the scheme's red line boundary, along with the amount of new habitat that will be gained via the West Watercourse Diversion (WWD) and East Watercourse Diversion (EWD) as well as the Auxiliary Discharge Channel. The geomorphological impacts of the proposed reservoir are expected to be experienced almost wholly within the Ock catchment. Whilst there will be alterations to the flow and sediment regime in the downstream River Thames, both are expected to be negligible in respect of their impacts on the formation and maintenance of geomorphological features of interest (e.g. weir pools) within such a large catchment as the Thames. The orientation of the combined intake/discharge structure (facing south east) is also expected to mitigate for any local scour. For these reasons, water bodies downstream of the River Thame are not considered further in this assessment.

In terms of hydrology, there will be no proposed discharge from SESRO into the River Ock and the only changes to flows are through the removal of some of the existing watercourses which means that flows will be rerouted via the WWD and EWD. More work is proposed to quantify some of these changes. To protect river ecology, SESRO will only abstract when River Thames flows exceed 1,450 Ml/day at Culham (approx. Q_{50}) with a daily cap of 1,000 Ml/day on the abstracted flow. Discharges will be governed by the Drought Event Level 1 (DEL1) trigger, which is based on River flows at Teddington Weir, London as well as total London Reservoir storage levels. The discharge regime makes provision for a 'stepped' discharge regime, allowing more sensitive species to seek shelter prior to the main release. The Gate 1 River Thames hydrological assessment work has involved development of a conceptual hydrological model for the River Thames at Culham, which has been used to demonstrate changes to river flows by running a number of abstraction and discharge scenarios for a typical non-drought year (1986–88) as well as a drought year (1996–98) in the hydrological record, and an extreme drought scenario (1933–34). Results were compared to flow statistics for the entire modelled flows period (1920–2010). Results show how the main discharge timing may be between June and October. Previous hydrological assessment work by Thames Water has concluded that the main hydrological zone of influence is up to the River Thame confluence.

Water quality assessment work has validated potential risks of algal growth within SESRO, which can be mitigated through mixing. SIMCAT modelling undertaken as part of Gate 1 has demonstrated that, in general,

the discharge is likely to result in slightly better water quality in the River Thames, although there is a potential risk associated with pesticides which may be abstracted into the reservoir which needs further investigation. It is also possible that dissolved oxygen in the SESRO discharge is not as high as the receiving River Thames or that there may be changes to temperature. Mitigation may include improved circulation through the use of multiple intake and discharge structures. Three-dimensional hydrodynamic modelling for the reservoir is proposed, most likely using Computational Fluid Dynamics (CFD), along with algal modelling using PROTECH-D. Further assessment of effects on level, flow, suspended sediments and WFD physico-chemical determinands (dissolved oxygen, pH, temperature, biochemical oxygen demand, orthophosphate and total ammonia) in the River Thames is proposed to be undertaken using a 1D hydrodynamic model.

In terms of aquatic ecology, the Gate 1 assessment has relied extensively on historic datasets for the River Ock whilst 2020 datasets for fish, macrophytes, macroinvertebrates and INNS were made available for the main River Thames. The main effects on the River Ock ecology are associated with the physical habitat loss as well as potential effects associated with construction activities, which can be mitigated using well-established pollution prevention measures. Updated habitat and species surveys are required in the River Ock system to understand what habitats and communities may be affected and understand local variability between the different watercourse types. In the River Thames, groups most sensitive to changes in hydrology include larval/juvenile fish, spawning fish, phytoplankton and zooplankton. More survey and assessment work is needed for these groups to understand their (physical) distribution within the main reach of hydrological influence between Culham and the River Thame. Timing in terms of phytoplankton/zooplankton blooms and the presence of larval/juvenile fish is also considered key. In the absence of sensitive species, macrophytes and diatoms are considered to have low to no sensitivity to anticipated changes to flow and level. There is a potential for some local risk to invertebrate communities and hydrodynamic water quality model outputs for dissolved oxygen, sediment and level are considered important to better understand this risk.

In terms of terrestrial ecology, the main impacts comprise loss of habitats and possible effects on Protected Species. No statutory designated sites are considered to be affected by the scheme. One locally designated site, Cutting County Wildlife Site (CWS) lies partially or wholly within the scheme's red line boundary except for the 75 Mm^3 option where it is just outside the red line boundary. Targeted surveys are required to quantify the risk to terrestrial habitats and species.

The terrestrial and aquatic INNS risk assessment has indicated there is likely to be a medium risk of introducing INNS at SESRO as a result of recreational activities and the raw water transfer. A number of mitigation measures are proposed focused on removal of INNS prior to construction work on-site, biosecurity measures at SESRO itself; as well as mitigation measures for the raw water transfer. These require further assessment work and options as there is more certainty on which activities are promoted at the reservoir as well as in light of Thames Water's AMP7 Water Industry National Environment Programme (WINEP) INNS investigation findings, which are expected to cover sites with public access; raw water transfer; and the installation of biosecurity measures at some of Thames Water's existing assets.

In terms of the Natural Capital Assessment, the key findings showed that all options demonstrate an overall positive change in natural capital value compared to the baseline on a £/year basis, after scheme completion (once assets are established). The positive change in natural capital value is due to the significant increase in recreation value expected for the site, which outweighs the decrease in ecosystem value of food production. Options 75 Mm^3 and 100 Mm^3 show the largest net positive change in value at £640k and £605k per year respectively due to the combination of changes in specific ecosystem service values, in particular their lower losses in food production due to their smaller footprint relative to the other options. At gate 2, the NCA will need be needed to support detailed feasibility, concept design and multi-solution decision making, producing metrics suitable for use in cost-benefit analysis (CBA).

The wider benefits qualitative study identified potential significant impacts, in particular, flood risk management; air quality and impact on human health; physical and mental health benefits from exercise; local/regional economy; education; workforce skills and experience; financial asset value; and customer bills. The wider benefits should include quantification of these potential impacts post gate 1. The review of relevant documents and priorities helped to identify opportunities for SESRO to coordinate/contribute to or benefit from other regional and national multi-sector strategic priorities. A wide array of opportunities to develop beneficial synergies between SESRO and other parties have been considered which include: enhanced ecosystem and societal benefits; improvements and enhancements to the river diversions and floodplain compensation around the proposed reservoir to maximise the opportunities for nature and people; flood risk management; enhance the local and regional leisure and recreation provision; contribute to education and skills provision; increased tourism to contribute to a more prosperous local economy and job generation; opportunities to help mitigate impacts on air quality as a result of construction and more visitors to the area; consider the inclusion of clean energy generation within the design; opportunities from developing the scheme collaboratively, for water

companies and their supply chain to learn from one another; opportunities for the scheme to actively support sustainable communities; construction efficiencies, lower carbon choices and carbon offsetting, and also potential opportunities for applying the zero-waste principles; creating opportunities for different uses of green and blue spaces for both wildlife and people alongside providing different functions; contribute to local highways improvements; support a healthier population; and, build strong partnerships to maximise benefits from the proposed development.

In terms of terrestrial habitat areas, the studies indicate that a net increase in biodiversity units of over 10% could be achieved for any of the options. Habitat creation opportunities have been identified at a high level, but as design progresses refinements could include innovations such as rewilding to create added value for wildlife and local communities. The loss of hedgerows and tree lines has not been quantified during this stage of assessment. However, it is anticipated that any losses could be compensated, to create a project design predicted to deliver BNG. Linear features should be assessed the next time the metric calculations are updated, based as far as practicable on field data. Field surveys will be essential to provide revised and refined information on the types and condition of habitats.

From a watercourse perspective, neither rivers, nor ditches, will achieve a net increase in biodiversity units in any of the proposed options. In fact, each option will produce a net loss in biodiversity units in rivers. However, the significant biodiversity net losses in ditch biodiversity units is marked in each option and reflects the large length of ditch that will be lost from the footprint and which is not currently mitigated for elsewhere. As the options progress, more biodiversity units will need to be gained for watercourses within the site boundaries wherever possible and, where not achievable, mitigation would need to be sought in impacted water bodies or within the wider catchment to deliver net gain. During early 2021, Natural England are due to issue a revised version of the Biodiversity Metric (3.0). Once published, this will be reviewed to see how it could influence the predicted results for SESRO. It is understood that factors such as condition assessment may be revised for some habitat types. Most significantly for SESRO, some or all types of ditch are to be moved from the area-based part of the metric to the watercourse part of the metric. This may alter the amount of compensation required for watercourses substantially. Early engagement with the Environment Agency for mitigation potential is advised.

Based on the review and assessments completed as part of this report, all six SESRO options are considered feasible and proceed to Gate 2.

For all topic areas, mitigation measures to offset impacts have been identified and have contributed to the 2021 Conceptual Design Report (Technical Annex A1). Environmental activities (surveys and assessments) required for Gate 2 have been set out in Annex F (Scheme Delivery Plan).

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