MOTT MACDONALD

Environmental Appraisal Report (RAPID Gate Two)

Fens Reservoir

November 2022

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Mott MacDonald
22 Station Road
Cambridge CB1 2JD
United Kingdom

T +44 (0)1223 463500
mottmac.com

Anglian Water
Thorpe Wood House
Thorpe Wood
Peterborough PE3 6WT

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Acronyms and Abbreviations

AA	Appropriate Assessment
ACWG	All Company Working Group
AESI	Adverse Effect on Site Integrity
ALC	Agricultural Land Classification
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
AQMA	Air Quality Management Areas
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
BMV	Best and Most Versatile
BNG	Biodiversity Net Gain
BU	Biodiversity Units
CEMP	Construction Environmental Management Plan
CO_2	Carbon Dioxide
CPERC	Cambridgeshire and Peterborough Environmental Records Centre
CWS	County Wildlife Sites
DCO	Development Consent Orders
DEFRA	Department for Environment, Food and Rural Affairs
dWRMP	Draft Water Resource Management Plan
EA	Environment Agency
EAR	Environmental Appraisal Report
ECJ	European Court of Justice
ECoW	Ecological Clerk of Works
EDD	Emergency Drawdown
eDNA	Environmental DNA
EIA	Environmental Impact Assessment
EMS	Environmental Management Systems
ENCA	Enabling a Natural Capital Approach
ENG	Environmental Net Gain
EqIA	Equality Impact Assessment
EU	European Union
FLL	Functionally Linked Land
FR	Fens Reservoir
FRA	Flood Risk Assessment
FSA	Flood Storage Area
FWP	Fens Reservoir Water Partnership
GDP	Gross Domestic Product
GES	Good Ecological Status
GVA	Gross Value Added
GWDTE	Groundwater Dependent Terrestrial Ecosystems
HER	Historic Environment Record

HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
HMT	HM Treasury
HVO	Hydrogenated Vegetable Oil
IDB	Internal Drainage Board
IEMA	Institute of Environmental Management and Assessment
IMD	Index of Multiple Deprivation
INNS	Invasive Non-native Species
IRZ	Impact Risk Zones
km	Kilometres
kV	Kilovolt
LDF	Local Development Framework
LEEP	Land, Environment, Economics and Policy Institute
LI	Landscape Institute
LNR	Local Nature Reserve
LNRS	Local Nature Recovery Strategies
LSE	Likely Significant Effects
LSOA	Lower Super Output Area
LWS	Local Wildlife Sites
m	Metres
MAGIC	Multi-Agency Geographic Information for the Countryside
MAA	Mineral Allocation Area
MCM	Million Cubic Metres
MCZ	Marine Conservation Zones
MDA	Mineral Development Areas
MLC	Middle Level Commissioner
MPA	Marine Protected Areas
MSA	Mineral Safeguarding Areas
Ml/d	Megalitres per day
MW	Megawatts
NGR	National Grid Reference
NCA	Natural Capital Assessment
NCN	National Cycle Network
NECR285	National Natural Capital Atlas: Mapping Indicators
NERC	Natural Environment and Rural Communities
NEVO	Natural Environment Valuation Online Tool
NFM	Natural Flood Management
NNR	National Nature Reserve
NO2	Nitrogen Dioxide
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Projects
NVZ	Nitrate Vulnerable Zone

ONS	Office for National Statistics
ORVal	Outdoor Recreation Valuation Tool
PRoW	Public Rights of Way
RAG	Red-Amber-Green
RAPID	Regulator's Alliance for Progressing Infrastructure Development
RWT	Raw Water Transfer
RBMP	River Basin Management Plan
RSPB	Royal Society for the Protection of Birds
SAI-RAT	SRO Aquatic INNS Risk Assessment Tool
SAC	Special Areas of Conservation
SCI	Sites of Community Importance
SEA	Strategic Environmental Assessment
SLR	South Lincolnshire Reservoir
SPA	Special Protection Area
SPZ	Source Protection Zones
SSSI	Sites of Special Scientific Interest
SRO	Strategic Resource Option
STEM	Science, Technology, Engineering and Mathematics
TIA	Transport Infrastructure Areas
ToLS	Test of Likely Significance
TPO	Tree Preservation Order
TPS	Transfer pumping station
TWAO	Transport and Works Act Orders
UK	United Kingdom
UKCP18	UK Climate Projections 2018
UN	United Nations
WFD	Water Framework Directive
WMA	Waste Management Areas
WRA	Water Recycling Area
WRPG	Water Resources Planning Guideline
WRZ	Water Resource Zone
WRE	Water Resources East
WTW	Water Treatment Works
WWT	Wildfowl and Wetland Trust
Zol	Zone of Influence
ZVT	Zone of Theoretical Visibility

Executive summary

A new strategic reservoir in Cambridgeshire, referred to as the Fens Reservoir (FR), has been proposed for development as one of several nationally Strategic Water Resource Options (SRO) required to address increasing deficits in public water supply. The scheme is being progressed through the fast-tracked delivery framework overseen by the Regulatory Alliance for Progressing Infrastructure Development (RAPID). FR has previously progressed through gate one, the first opportunity to check progress on investigations and development of solutions in the gated process and is now at gate two.

This Environmental Appraisal Report (EAR) has been prepared with updated information since the gate one submission and includes the potential risks, barriers, mitigation measures and opportunities of FR. The aim of this EAR is to meet the requirements of the RAPID gate two guidance. It draws together the conclusions of all gate two environmental appraisal work into a single document.

This EAR has been informed by desk-based assessments using publicly available information in line with the requirements of the gate two submission. The work is at a preliminary stage and establishes an initial appraisal that can be built on during subsequent project stages. In future, this will also be informed by the undertaking of site surveys and collection of additional information and data that will inform an Environmental Impact Assessment likely to be required as part of any future consenting process. This EAR includes topic-based desk-based informal strategic assessments and a wider benefits study. A summary of the key topic findings is outlined below:

- **Water Framework Directive (WFD) Assessment** – the level 1 assessment identified 13 waterbodies which could potentially be affected by the scheme. Following the level 1 assessment, three of these waterbodies were identified as requiring a level 2 assessment due to the potential effects on the WFD waterbodies. The level 2 assessment couldn't rule out the potential for minor/ major adverse risks on these waterbodies, so further assessments would be required as the project progresses.
- **Informal Habitats Regulations Assessment (HRA)** – the Stage 1 Test of Likely Significance ("Screening") identified six designated sites subject to likely significant effects as a result of the construction or operation of the Scheme; Ouse Washes SPA, SAC and Ramsar, and The Wash SAC, SPA and Ramsar. The informal Stage 2 Appropriate Assessment (AA) concluded that residual adverse effects cannot be excluded after taking into account mitigation for the operation phase of the Scheme for all designated sites considered. It is also not possible, at this stage, to exclude adverse effects during the construction phase for the Ouse Washes SPA and Ramsar. Further surveys, data collection, modelling and assessment, together with the detailed consideration of mitigation measures, will be required in order to conclude that there will be an absence of effect on the integrity of designated sites. The strategy to produce the evidence base required for the formal stages of HRA will be agreed at the next stage in consultation with the regulator. Ultimately, a strong and robust evidence base will be required to conclude that there will be no adverse effects on the integrity of any designated site as a result of the construction or operation of the scheme. The level of detail available at this stage (which is considered proportionate) means that such effects cannot be ruled out. As a result, this will need further consideration and assessment as part of the next stages of design development to conclude what the effects (if any) of the Scheme on designated sites will be and any further work required by the HRA process. All of this would need to be undertaken in dialogue with key stakeholders, including Natural England and the Environment Agency.

- **Invasive Non-Native Species (INNS)** – INNS were recorded within the proposed abstraction sources and within associated study areas. The assessment concluded that the proposed transfers will not introduce a new hydrological connection between 'isolated' WFD Operational Catchments, as defined in Environment Agency guidance. However, the proposed scheme would result in increased connectivity between waterbodies and will need to be further assessed and appropriately mitigated as the design develops.
- **Natural Capital Assessment and Biodiversity Net Gain** - the scheme is likely to generate the permanent and temporary loss of natural capital stocks during construction. However, some habitat is expected to be reinstated/compensated to pre-construction conditions following good practice technique and will likely have no permanent impact to the provision of ecosystem services. The scheme is likely to result in a biodiversity net loss for both habitat and river biodiversity units. However, the scheme presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats.
- **Strategic Environmental Assessment (SEA)** – the SEA ratings were informed by the other environmental assessments undertaken for the scheme. The SEA considered anticipated construction and operational effects, both without any mitigation applied and expected residual effects after implementation of identified mitigation measures. It identified potential effects for Biodiversity, Flora and Fauna, Soil, Water, Air, Climatic Factors, Landscape, Historic Environment and Material Assets. Positive effects were identified for Population and Human Health. In-combination effects have been considered for WFD and HRA and cumulative effects have been considered as part of the wider environmental appraisal process.

The wider benefits considered the potential benefits for employment impacts, tourism, health and well-being, education and apprenticeships. A summary of the results from the assessment are outlined below:

- **Employment Benefits** - employment impacts are expected to result in positive outcomes. The beneficiaries are those who are directly employed, as well as indirect and induced impacts on the local economy (goods and services).
- **Tourism** – there is the potential to create a new tourism destination, as there is a local catchment area for visitors to the new reservoir. Several opportunities were identified including the creation of wetlands, cycleways, footpaths, bridleways, a visitor centre, transport links and a bathing area.
- **Health and Wellbeing** – greener environments are associated with better mental health and wellbeing outcomes including reduced levels of depression, anxiety, and fatigue, and enhanced quality of life for both children and adults. Opportunities are identified to improve public access and recreation.
- **Education** - the new reservoir would provide an additional educational resource for the community. There are opportunities for school visits and is it anticipated that the Visitor Centre, could include an educational centre.
- **Apprenticeships** – The project promotors have existing apprenticeship schemes to assist in introducing people to the workplace and develop skills through a variety of advanced, higher and degree level apprenticeships across a range of roles.
- **Partnership Strategy** - The ongoing design development will identify and engage partner organisations to identify and enhance the benefits of the FR scheme. This is expected to include working with agricultural stakeholders and environmental regulators on issues such as irrigation supply and flood storage areas.

Recommendations have been included for further, more detailed and site-specific environmental assessments and surveys as the scheme progresses.

Notice

Position statement

This EAR has been produced to accompany the gate two submission for the FR SRO, which is part of the process set out by RAPID in the 'Strategic regional water resource solutions guidance for gate two' published in February 2022.

As the scheme progresses and the preferred planning route is identified, it is expected that a full environmental appraisal will be produced, which will set out the likely environmental impacts and mitigation. The RAPID guidance for gate three states that most solutions will require a statutory Environmental Impact Assessment (EIA) to support planning and permitting applications. The EIA should be sufficiently advanced to support EIA scoping requirements for the gate three process. All pre-application activities will be carried out in accordance with the requirements of the Planning Act 2008.

Community and stakeholder engagement is crucial to the development of the scheme. Some high-level activity has been undertaken to date, but more detailed engagement and formal consultation will be required as the scheme progresses. Prior to applying for the necessary permissions and consents, the project promotors will need to demonstrate that information about the proposals has been presented to the community for feedback and stakeholder views and this has been considered throughout the design's development.

The scheme is currently at an early stage of development and the details set out in the gate two documents are still in a formative stage. The information contained within the report is intended to identify whether there are any 'showstopper' type concerns that would mean the scheme could not progress to gate 3. The report is based on available information relevant to the stage of development. It should be noted that this is an initial environmental appraisal and it has not been prepared for the purpose of seeking permissions.

Disclaimer

This document has been written in line with the requirements of the RAPID gate two guidance. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, the project promotors will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

1 Introduction

1.1 Background

A new strategic reservoir in Cambridgeshire, referred to as the Fens Reservoir (FR), has been proposed for development as one of several nationally strategic water resource options required to address increasing deficits in public water supply. The scheme is promoted by Anglian Water and Cambridge Water (the 'project promoters') and is being progressed through the fast-tracked delivery framework overseen by RAPID.

The FR has previously progressed through gate one in 2021, the first opportunity to check progress on investigations and development of solutions in the gate process and is now at gate two. Gate two is intended to look at solutions in more detail, with focus on ensuring that funding for continued investigation and development of solutions is aligned to water resources planning.

The FR environmental assessments carried out as part of the gate one submission considered the initial concept design. The gate one assessments carried out included an informal Habitats Regulation Assessment (HRA), a Water Framework Assessment (WFD) assessment, a Strategic Environmental Assessment (SEA), an Invasive Non-Native Species (INNS) risk assessment, a Natural Capital Assessment (NCA) and an analysis of Biodiversity Net Gain (BNG). The combination of environmental assessments carried out at gate one showed that environmental benefits would result from the FR scheme. At gate one it was also concluded that construction would likely result in adverse environmental impacts even after the application of proposed mitigation measures, for example associated with loss of predominately agricultural land and changes to the water regime.

Since gate one, a four-stage site selection process has been completed to identify and assess potential locations for development of a strategic reservoir against community, environmental, economic, planning and technical criteria. A separate process was used to identify suitable locations for the water abstraction and potential pipeline corridors. Further detail on the site selection process is outlined within Section 2.2.

Updated environmental appraisals have been carried out for the scheme to support the gate two submission and to feed into the Anglian Water and Cambridge Water draft Water Resource Management Plans 2024 (dWRMP24) and to support the regional draft water resources plan for Eastern England, as summarised in this report.

1.2 Regional resource planning context

The regional draft water resources plan for Eastern England, Water Resources East (WRE) has identified the need for two new strategic raw water reservoirs in the region to address part of the supply deficit – one of which is the FR. This has been confirmed in the Anglian Water and Cambridge Water's (dWRMP24).

Water resources modelling has confirmed that the required reservoir capacity to meet public water supply requirements should be 55 million cubic metres (MCM) to provide a supply of up to 87 megalitres per day (Ml/d). The source of the water for the FR is proposed to come from the River Great Ouse (300Ml/d) and River Delph (400Ml/d), subject to abstraction consents and water availability. As a waterbody the reservoir would also provide environmental, socio-economic and wellbeing benefits for the communities around it.

1.3 Environmental Appraisal Report (EAR)

This EAR is a technical document prepared to support the gate two submission for the FR SRO. The aim of this EAR is to meet the requirements of the RAPID gate two guidance. It draws together the conclusions of all gate two environmental appraisal work into a single document.

This EAR has been informed predominantly by desk-based assessments using publicly available information in line with the requirements of the gate two submission. The work is at a preliminary stage and establishes an initial appraisal that can be built on during subsequent project stages. In future, this will also be informed by the undertaking of site surveys and collection of additional information and data that will inform any future consenting process.

This EAR does not definitively scope potential environmental effects in or out of any future EIA process at this stage and the recommendations for further technical work outlined within this EAR are subject to change as information becomes available at subsequent project stages. Future work will be carried out in conjunction with relevant stakeholders to inform the approach to the subsequent EIA.

The details set out in this EAR are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of making decisions on progress but does not form part of the Development Consent Order (DCO) process.

1.4 Scope of environmental assessment

For the purpose of the gate two submission, the FR has been subject to a predominantly desk-based environmental appraisal, building on the work undertaken at gate one, to identify potential environmental and social impacts, potential mitigation measures and enhancement opportunities. The following informal, strategic (appropriate for this stage) environmental assessments have been undertaken for the gate two submission:

- WFD Stage 1 and Stage 2 assessments, updating the gate one WFD assessment (summarised in Section 3.1 of this document and a full assessment in Appendix A.1: Water Framework Directive Assessment).
- Informal HRA Test of Likely Significance (ToLS) and report to inform Appropriate Assessment (AA), updating the gate one HRA (summarised in Section 3.2 and full assessment in Appendix A.2: Informal Habitats Regulations Assessment).
- SEA, to align with the WRE Regional Plan, Anglian Water dWRMP24 and Cambridge Water dWRMP24, updating the gate one SEA (summarised in Section 3.3 and full assessment in Appendix A.3: Strategic Environmental Assessment).
- INNS risk assessment, updating the gate one INNS risk assessment (within Chapter 12).
- NCA, updating the gate one NCA (within Chapter 13).
- BNG calculations using Defra Metric 3.0, updating the gate one consideration of BNG (within Chapter 13).
- Qualitative assessment of how the scheme achieves Environmental Net Gain (ENG), including potential mitigation measures or enhancements required (within Section 13.7).

The following additional technical documents relevant to the FR scheme, have also informed and are referred to within this EAR:

- Water Quality Risk Assessment, RAPID gate two

Table 1.1 signposts relevant sections of this EAR that demonstrate the requirements of the RAPID gate two guidance.

Table 1.1: EAR sections and other relevant documents for informing gate two requirements

Gate two requirement	Relevant sections of this EAR
WFD Assessment (6.1)	Section 3.1 (Water Framework Directive Assessment)
Informal HRA (6.2)	Section 3.2 (Informal Habitats Regulations Assessment)
Environmental assessment to feed into Regional Plan and WRMP SEA (6.3)	Section 3.3 (Strategic Environmental Assessment)
Update to gate one environmental appraisal work where relevant (6.3)	All
Summary of environmental appraisal work undertaken to date, likely to be at strategic scale (6.3)	All
Summary of environmental baseline and analysis undertaken (6.3)	Chapters 4 – 14
Options assessment, with sufficient detail to allow comparison of options within the solution and identify potential effects (positive and negative) and opportunities (6.3)	Section 2.2 (Alternatives considered). See also separate Site Selection Report for how proposed option was selected balancing multiple factors.
Assessment of the effects of the solution, an evaluation of their significance and any cumulative or in-combination effects (6.3)	Chapters 4 – 14
Clear justification as to options discounted, those taken forward, and the proposed option selected, and potential environmental effects and opportunities associated with the proposed option (6.3)	Section 2.2 (Alternatives considered) for discounted and proposed options. Chapters 4 – 14. See also separate Site Selection Report for how proposed option was selected balancing multiple factors.
Consideration of resilience (e.g. to climate change) (6.4)	Chapter 7 (Carbon)
Description of connections to other assessments (e.g. BNG, WFD, NCA, carbon) and demonstration of how they have been considered (6.3)	Chapter 3 (Environmental Assessments), Chapters 4 – 15
Summary of proposed mitigation and enhancement opportunities (6.3)	Chapters 4 – 14
Summary of future monitoring requirements and efficacy of mitigation measures (6.3)	Chapters 4 – 14
Plan to address uncertainties and data gaps (6.3)	Section 15.3 (Recommended gate three activities)
Consideration of BNG, supporting the net gain actions in the 25 year Environment Plan (6.4)	Chapter 13 (Natural Capital and Biodiversity Net Gain)
Natural capital assessment, consistent with approaches for the Regional Plan and WRMP (6.4)	Chapter 13 (Natural Capital and Biodiversity Net Gain)
Assessment of the whole life carbon cost (6.5)	Chapter 7 (Carbon)
Description of how innovative designs and opportunities to generate or be powered by renewable energy and/or sequester carbon are embraced, and joint opportunities with other sectors are explored (6.5)	Chapter 7 (Carbon)

1.5 Structure of this report

This EAR is structured as follows below, other topics (such as air quality, noise and vibration, transport and accidents) will be considered at the next stage of the project.

- Chapter 1 (Introduction).
- Chapter 2 (Scheme description) presents an overview of the FR scheme and signposts to other Technical Supporting Documents where further information can be found.
- Chapter 3 (Environmental assessments) the results of the informal HRA and WFD assessments and updates to the WRE SEA as part of the gate two submission).
- Chapter 4 (Biodiversity, flora and fauna appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 5 (Soil appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 6 (Water appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 7 (Climatic factors and carbon appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 8 (Landscape appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 9 (Historic environment appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 10 (Population and human health appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 11 (Cumulative and in-combination effects appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 12 (Invasive Non-Native Risk Assessment) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 13 (Natural Capital and BNG appraisal) presents desk-based assessment undertaken to inform the gate two submission.
- Chapter 14 (Wider benefits) study to inform the gate two submission.
- Chapter 15 Conclusions and next steps.

1.6 Stakeholder engagement

The principles of the approach to stakeholder engagement applied to the FR scheme are as follows:

- To build on the engagement undertaken to date, taking account of any issues and concerns raised by the local communities or stakeholders, ensuring discussions are timely and inform the final design.
- To fit within the regulatory processes established under relevant guidance to understand and agree expectations.
- To be integrated with regional and company water resource planning.

Stakeholder engagement has been important to the gate two work from site selection to preliminary scheme concept development. The Fens Reservoir Water Partnership (FWP) was established to bring together stakeholders with an interest in the project

Membership of the FWP includes, amongst others, representatives from local authorities, the Environment Agency (EA), Natural England, Historic England, Internal Drainage Boards, Royal Society for the Protection of Birds (RSPB), Wildfowl and Wetland Trust (WWT) and the National Farmers Union. FWP meetings were held monthly throughout the gate two period and allowed stakeholders the opportunity to challenge and influence site selection and scheme development. The stakeholders also contributed towards the multiple-criteria decision analysis tool, used in stage three of site selection. The main gate two report contains further details of stakeholder engagement.

In terms of environmental stakeholders, monthly meetings were convened jointly with the Environment Agency and Natural England. These provided the opportunity for the project team to share updates on technical work packages and discuss comments. Outside of the monthly meetings, bespoke workshops were held with the environmental stakeholders to cover specific work packages such as hydro-ecology, ecological monitoring and flood risk studies.

Periodic meetings were also held with Historic England to discuss heritage and archaeological considerations relating to site selection.

In some cases, draft technical reports were shared with the environmental stakeholders at various points throughout site selection (including for this Environmental Appraisal Report), which allowed the project team to review and respond to comments and refine the reports considering any challenges/suggestions.

In order to inform stage four of site selection (preferred site selection), the project team organised a series of in-person topic workshops to allow stakeholders to share their local knowledge and discuss both the constraints and opportunities associated with the prospective reservoir sites. Workshops were convened for the following topic areas: ecology and biodiversity, landscape and heritage, flood risk and community opportunities. The workshops were well-attended, and the outputs captured and fed into site selection decision making.

Further engagement with stakeholders will continue into gate three and focus on refinement of scheme options and more detailed concept design development. Both statutory and non-statutory consultations are an important part of the Development Consent Order (DCO) and EIA process, with a requirement that they iteratively influence scheme design and environmental assessment.

1.7 Assumptions and limitations

The following overarching assumptions have been applied in the environmental assessments that inform this gate two EAR:

- Aside from the broad area of the proposed reservoir site, all other components of the scheme (including abstraction and transfer locations and associated infrastructure) are indicative at this stage.
- A summary of the site selection process and consideration of alternatives is contained in section 2.2.
- All scheme components identified for gate two are provisional only, and the designs indicative, and will be subject to further refinement, informed by the outcomes of further assessments and stakeholder engagement that will be undertaken between gates two and three.
- The main construction period, inclusive of enabling works has been assumed as between 2027 to 2037. The earliest that the scheme is estimated to be in supply is between 2035 to 2037.
- All assessments undertaken to date have been predominantly desk-based and based on third party information, although some preliminary site investigations have been

undertaken. Desk-based assessment will in some cases be subject to verification by site surveys in the next phase of work.

- Water abstractions from rivers will be in line with future licence agreements from the EA.
- For the purposes of this appraisal, the water transfer corridors have been assumed to be up to 100m wide.
- All assessments for gate two are based on assumed pipe transfer conveyances and not open water transfer (although this will be investigated as a potential supply option).
- For infrastructure associated with the reservoir, only key elements (e.g. the waterbody, embankments, water treatment works, inlets, outlets) have been assessed as indicative concepts have been developed to support the gate two works. Information on the status and design of associated infrastructure and amenity elements is not available at this stage.
- Emergency drawdown (EDD) details are under consideration, and further work will be required to assess the implications of new required infrastructure and discharge of water as the design progresses.
- The type of emergency situation that would require use of the EDD are considered to be highly unlikely to arise and would fall outside the normal operating conditions of the scheme.
- Detailed design and construction information for the scheme will be progressed in subsequent stages of development, so while good practice is assumed, detailed assessments of construction impacts have not been carried out at this stage. The following assumptions have been made in relation to construction methodology.
  - Whilst proposed mitigation within this report follows good practice, any recommended mitigation measures should be considered provisional and not confirmed at this stage. Mitigation will be refined in an iterative process as the scheme design evolves in future phases, and in response to more detailed environmental impact assessment.
  - While temporary construction compounds will be required, locations for these have not yet been confirmed so they are not considered within gate two environmental assessments (but would be considered further as the scheme progresses).
  - Risk assessments with regard to impact on water quality and water levels would be undertaken at appropriate points in subsequent phases of the scheme development for site investigations and construction phase excavation works and dewatering. This will be to mitigate temporary adverse impact on water quality or water levels from site works on watercourses, wetland habitats or abstractions and inform relevant mitigation measures.
  - Water extracted from the ground during construction would be assumed to be treated to a standard agreed with the regulatory authority before discharging at less than the agreed maximum rate to the water environment.
  - Discharge from the new water treatment works (WTW) would be assumed to be treated to a standard agreed with the regulatory authority at less than the agreed maximum rate so as to mitigate potential impacts to water quality of the receiving water body.
  - A Construction Environmental Management Plan (CEMP) , or similar construction management plan, would be developed at an appropriate stage to ensure that environmental risks such as uncontrolled discharges from construction are minimised and that Emergency Response Plans are in place in the event of an incident.
  - Good practice pollution prevention assumed to be followed with reference to relevant good practice guidance.

The project promotors will need to have established Environmental Management Systems (EMS) in place for their assets. The EMS aims to identify and implement the necessary actions to avoid adverse effects to the environment during the operational phase. For example, the EMS will include standard measures relating to pollution control and control of disturbance from light and noise. It is expected that these would be updated to incorporate the requirements of new assets, and the appropriate EMS will be followed to avoid adverse effects to the environment.

Other assumptions relating to specific assessments and components of this report are also outlined in the sections and appendices to which they apply.

2 Scheme description

2.1 Scheme overview

The FR scheme includes the development of a new embanked raw water reservoir for water storage for public water supply. It also comprises abstractions from the River Great Ouse and River Delph, raw water transfers, treatment works, and distribution into supply.

Key scheme parameters include:

- River Great Ouse maximum abstraction and transfer flow to reservoir: 300Ml/d
- River Delph maximum abstraction and transfer flow to reservoir: 400Ml/d
- Reservoir total capacity: 55Mm^3
- Reservoir usable volume: 50Mm^3
- Treatment distribution flow[1]: 150Ml/d
  - Fens Reservoir to Anglian Water
  - Fens Reservoir to Cambridge Water (North)
  - Fens Reservoir to Cambridge Water (South)

2.1.1 Reservoir overview

The proposed reservoir site is shown in Figure 2.1, located within the Fenland district of Cambridgeshire. The proposed site is between Chatteris and March, near to Doddington, Wimblington and Manea. The Forty Foot Drain, the Sixteen Foot Drain and the A141 surround the site on three sides.

An indicative concept plan has been developed for the scheme. This indicative concept has been established to provide reference for cost and carbon estimation in gate two. The summary provisional details are provided below, but much work is still required to develop the scheme and the final details will develop accordingly.

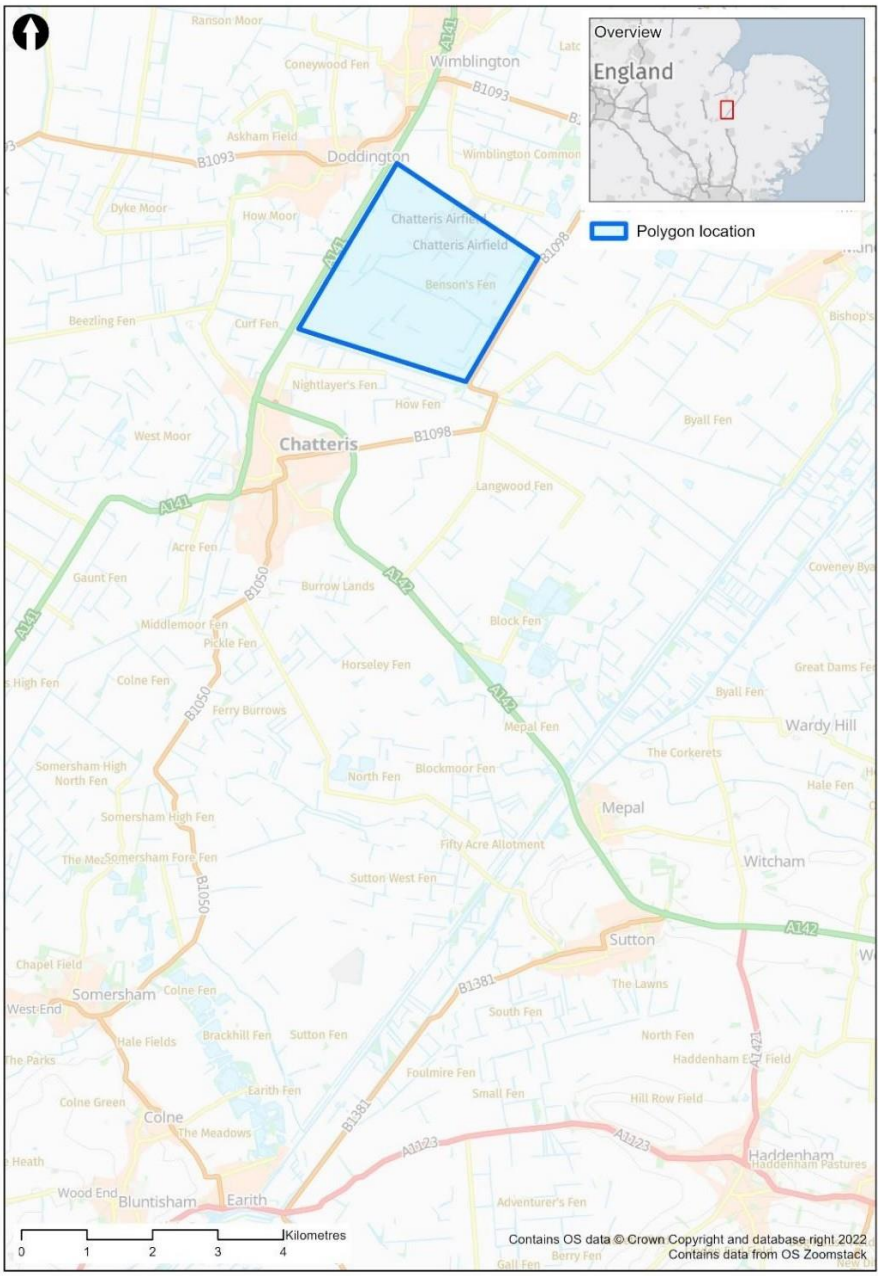
The provisional reservoir parameters are:

- At its greatest dimensions the reservoir is about 2.6km wide and 2.4km long to the embankment toe.
- The embankment crest is estimated at 12.5mAOD (above ordnance datum) making the embankment an average of 12m above the typical existing ground level at the toe. This is with approximate relative embankment elevations of maximum 15m and a minimum of 4m above existing ground levels.
- The total perimeter length of the crest is about 8.5km and the estimated reservoir surface area is about 4.4km^2.

[1] The proposed capacity of the water treatment works and transfer pipelines has been updated since this assessment was completed. The figures quoted in the gate two report include a scheme deployable output of 87Ml/d and works capacity up to 100Ml/d. These changes are not anticipated to have any material impact on the completed assessments.

The reservoir would include key infrastructure necessary for its safe operation, including intake and outtake structures; drawdown facilities; a spillway and water sampling facilities. The reservoir will also be expected to provide benefits beyond public water supply. Opportunities to incorporate facilities to enable recreation (such as a visitor centre and parking), infrastructure to improve health and wellbeing (such as multi-use footpaths, quiet areas and leisure opportunities) and careful design to enhance and encourage biodiversity are planned and will be developed further, with the features that would deliver these wider benefits being subject to further assessment and consultation. Landscaping would be carefully designed surrounding the reservoir to minimise the visual impact of the reservoir whilst ensuring it sits within the existing landscape and delivers wider recreational and biodiversity benefits.

Figure 2.1: Site context map



2.1.2 Raw water abstraction and transfers

It is proposed that water is abstracted from the River Great Ouse at an intake located south of Earith and transferred to the reservoir via approximately 18km of 1500mm diameter steel pipeline. An additional abstraction point is also proposed from the River Delph, with water transferred to the reservoir by about 6km of 1600mm diameter steel pipeline. The precise abstraction location will be identified following further detailed work (including stakeholder engagement) for gate three.

The proposed abstraction rate from the River Great Ouse is up to 300Ml/d and from the River Delph up to 400Ml/d when flows allow. This is subject to further assessment to be undertaken in collaboration with the Environment Agency (EA) to develop an abstraction rate which is licensable. The associated abstraction licences are expected to stipulate a minimum flow and water level requirement at the point of abstraction below which it would not be possible to abstract. Abstraction to fill the reservoir would only be possible during high flow periods.

Further work is planned for the next stage to confirm locations for the abstraction points and routes for the transfers involving landowner engagement, environmental surveys, and preliminary ground investigations. The opportunity for the transfer conveyance to be open channel is still being investigated and will be confirmed during the next stage of project development. The information provided in this report and accompanying appendices are assumptions based on indicative locations only at this stage. The indicative transfer routes for are shown in Figure 2.2.

The abstraction facilities are expected to comprise an intake structure, a transfer pumping station (TPS) and pipeline.

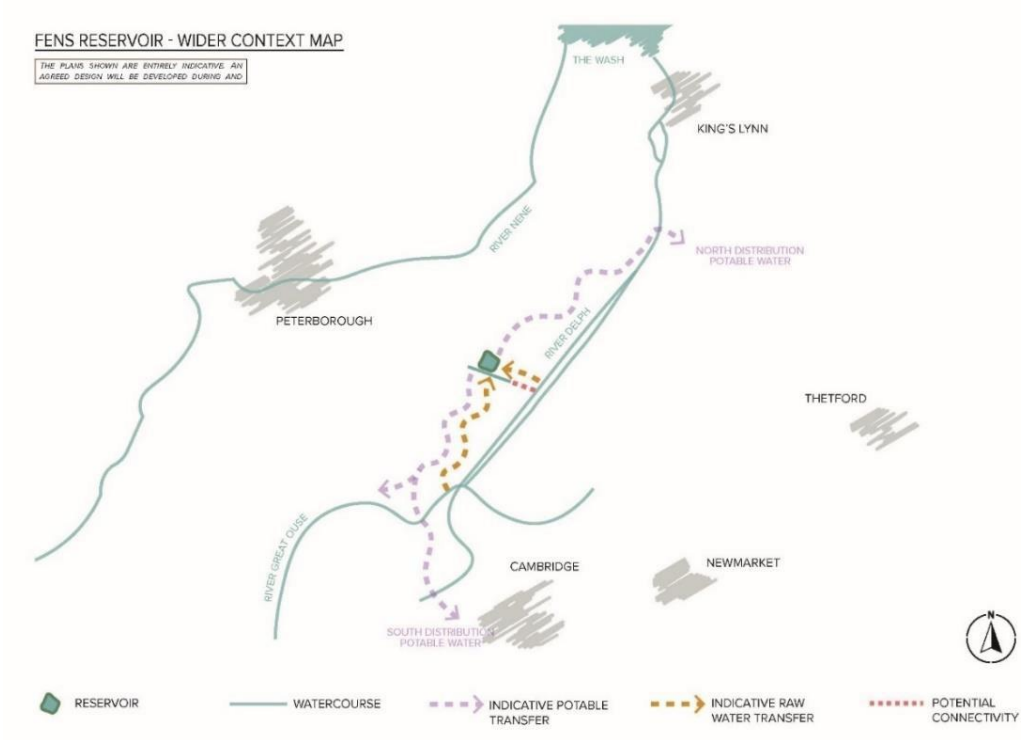
2.1.3 Water treatment and potable transfers

Stored water will subsequently be abstracted from the reservoir and treated to a potable quality. It is proposed that a WTW is located on land adjacent to the reservoir with a peak throughput capacity of 100Ml/d.

It is proposed that the treated water will be transferred by an approximate 32km 900mm diameter steel pipeline to an existing Anglian Water Service Reservoir (SR). The Cambridge Water connection will include about 12km 900mm steel pipeline to one take-off point, and approximately 22km 700mm steel pipeline spur to a second take-off point. The reservoir is to supply over 250,000 homes in Cambridgeshire.

Further work is planned for the next stage to confirm the routes for the transfers involving landowner engagement, environmental surveys, and preliminary ground investigations. The information provided in this report and accompanying appendices are assumptions based on indicative locations only at this stage. See Figure 2.2 for an illustration of indicative proposed transfer corridor locations.

Figure 2.2: Proposed transfer corridors



2.1.4 Summary of operation and use

Development and operation of the reservoir will be subject to the Reservoirs Act 1975 (as amended by the Floods and Water Management Act 2010). The embankments and associated water retaining elements of the reservoir will need to be maintained and supervised in accordance with the Act to maintain public safety.

Provision of EDD must be designed in accordance with the Reservoirs Act. The proposed solution at this stage is to discharge to the Forty Foot Drain, but this is to be further modelled and confirmed as part of the next stage of development. Although the risk of needing to fully drawdown the reservoir is very low, there is a need for regular testing and maintenance to confirm functionality. This will involve the opening and testing of relevant valves and gates. Test flows are envisaged to be held in a pond to avoid disruption and to enable water to be returned back to the reservoir.

The operation and maintenance of the water treatment works and the distribution water supply system inclusive of distribution pump stations are expected to be in constant regular use according to water supply demand. The water supply components will need regular inspections and maintenance activities in accordance with the requirements of the respectively installed equipment.

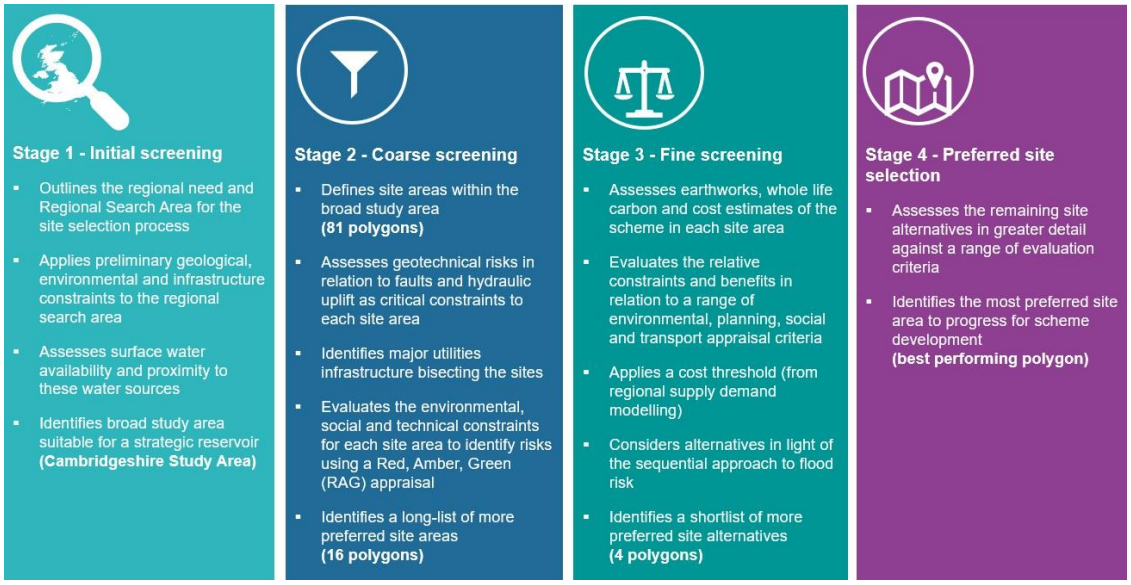
2.1.5 Associated infrastructure and features

It is proposed that there will be a need for associated infrastructure and other features such as environmental mitigation to minimise the impacts of the reservoir, as well as enhancement opportunities. The location and design of the additional infrastructure has not been established and will therefore need to be confirmed at the next phase of scheme development.

2.2 Alternatives considered and site selection

A site selection process was undertaken to identify a best performing site in Cambridgeshire suitable for a strategic reservoir, as summarised in Figure 2.3. Stakeholders, legal advisors, planning advisors and land agents influenced and informed this process to ensure it was robust and that the best performing site was identified.

Figure 2.3: Summary of the four-staged site selection process



The application of the four-stage site selection process has identified and assessed potential suitable locations for the new reservoir based upon a broad range of community, economic, environmental, and other technical criteria (constraints and opportunities). The methodology, criteria and findings have been informed by subject matter experts and local stakeholders. These stakeholders were engaged through the Fens Water Partnership, local planning authorities and statutory stakeholders.

Stage 1 – initial screening - comprised a high-level review within the Regional Search Area of underlying geology, proximity to the abstraction sources, sites designated for the protection of nature conservation, major infrastructure, and large areas of existing developments such as settlements. This was used to define the Cambridgeshire Study Area, providing the boundaries for the site selection process.

Stage 2 – coarse screening - involved the delineation of areas of land (referred to as “polygons”) within the Cambridgeshire Study Area that could accommodate a strategic reservoir with a minimum footprint of 5km^2, based on preliminary design requirements to accommodate a reservoir of the size determined as being required by regional water resources modelling. 81 polygons were delineated. These polygons were screened against a more detailed review of geological risks, an analysis of major existing utilities and other technical constraints. Polygons were then ranked to identify those containing the greatest level of constraint on project delivery. 16 polygons which presented the lowest level of risk to project delivery were taken forward to fine screening.

At Stage 3 – fine screening - these 16 polygons were then subjected to more detailed investigation and evaluated against key differentiators, including community, economic, environmental and planning criteria. In consultation with the Environment Agency, a strategic Sequential Test was carried out to prioritise polygons which were both affordable and carried the lowest level of flood risk. This stage identified a shortlist of four best performing alternatives taken forward to Stage 4 – proposed site selection. These were titled Polygons A, B, C and D.

At Stage 4 – proposed site selection - more detailed desk-based assessments by subject matter experts and further stakeholder engagement informed a comparative review of the four remaining polygons. These polygons were considered against nineteen criteria to identify the best performing polygon, having regard to the advantages and disadvantages of each Polygon against each criterion. This best performing polygon has been taken forward as the proposed site for the reservoir.

A separate option selection process was used to identify suitable locations for the water abstraction and potential pipeline corridors. A longlist of feasible corridor routes were identified and environmental and engineering assessments completed to determine the best performing route option. The route corridor assessments were based on achieving a balance between the shortest distance from the abstraction locations to the FR location and from the FR location to the potable network, and at a high-level checks that the route is functional in terms of pipeline hydraulics, as well as avoiding environmentally sensitive areas.

The proposed reservoir site, the indicative transfer routes, abstractions and associated infrastructure, will all be subject to further analysis and stakeholder engagement and consultation between gates two and three. At present the proposals put forward to gate two therefore remain provisional.

3 Environmental Assessments

3.1 Introduction

Three environmental assessments; WFD, informal HRA and SEA have been undertaken to support the gate two submission and are presented as standalone Technical Supporting Documents and are included as appendices to this report. This section of the EAR presents a summary of these assessments. Chapters 3 through to 13 inclusive provide an updated feasibility statement in relation to gate one that includes potential risks, barriers and mitigation measures for the scheme, this is informed by these environmental assessments.

The environmental appraisals have highlighted effects requiring further consideration and assessment. These were mostly associated with changes to the aquatic environment, impacts on biodiversity, landscape and heritage. There would also be a permanent loss of soils and agricultural land on the reservoir site.

Overall, the gate two environmental assessment and report work has identified key issues that will inform the next stages of the scheme design, including measures and plans to mitigate and manage predicted impacts. As the scheme progresses, the design will be subject to an iterative process of environmental assessment, informed by further surveys and modelling, to identify and agree suitable mitigation and enhancement measures. This work will be undertaken in consultation with the relevant stakeholders.

Although further work is required to clarify the nature of WFD and HRA effects, the environmental appraisal work undertaken for the gate two submission has not identified any fundamental regulatory barriers that mean the scheme cannot be progressed to the next stages of development and investigation.

SEA is implemented at the strategic scale and applies to plans and programmes. The FR scheme feeds into the dWRMP24 and Regional Plan, which are both undergoing SEAs, and as such the scheme is more appropriately assessed for SEA purposes as part of these plans. Therefore, the environmental assessments and appraisal that has been undertaken for this scheme has been fed back into the Regional Plan and dWRMP24 and is correctly represented below.

3.2 Water Framework Directive assessment

The Water Framework Directive is transposed into law for England and Wales through *The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003* and updated in 2017[3].

The WFD requires all waterbodies (both surface and groundwater) to achieve ‘good status or potential’. The Directive also requires that waterbodies experience no deterioration in status or potential. Good status/potential is a function of good ecological status (GES)/potential (biological, physico-chemical and hydromorphological elements and specific pollutants) and good chemical status (Priority Substances and Priority Hazardous Substances).

[3] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available online at: https://www.legislation.gov.uk/uksi/2017/407/made

The All Company Working Group (ACWG)[4] has developed a consistent framework for undertaking WFD assessments for SROs to demonstrate that options will not cause deterioration in status/potential of any WFD waterbodies. The assessment considers mitigation that would need to be put in place to protect waterbody status/potential. The assessment also considers WFD future objectives to ensure the option would not preclude affected WFD waterbodies from reaching good status/potential.

At the time of writing, the EDD concept is not developed sufficiently for a valid WFD assessment to be undertaken and is therefore excluded from this assessment. The EDD will be developed further in the subsequent phases of the scheme and is to be included within the WFD assessment at gate three once the design has been developed.

3.2.1 Screening process

The WFD assessment included two stages, an initial Level 1 basic screening and a Level 2 detailed impact screening. Full details of this methodology are set out in the WFD Assessment report (Appendix A.1).

The Level 1 screening calculates a score on a six-point scale (from -2 to +3) based on scheme information. Waterbodies and scheme activities with no or very minor potential impacts are screened out, while others (with a maximum impact score greater than +1) are taken forward to Level 2 screening. Level 2 screening involves expert assessment of potential impacts, levels of confidence and certainty, mitigation needs and their effectiveness for reducing impacts, and identification of activities to improve certainty in assessment outcomes.

Level 1 assessment identified 13 waterbodies which could potentially be affected by the scheme. Following the Level 1 screening, three of these waterbodies were identified as requiring a Level 2 assessment due to the potential effects on the WFD waterbodies. The waterbodies included in the Level 2 assessment are as follows:

- GB205033000050 – Middle Level
- GB105033047921 – River Great Ouse (Roxton to Earith)
- GB205033000060 – Old Bedford River/River Delph (incl. the Hundred Foot Washes).

With regard to in-combination effects (see Appendix A.2 for details) the search concluded that the combination of FR and with one development, one major planning application and one other SRO scheme have the potential to adversely impact on a WFD waterbody.

3.2.2 Summary of results

3.2.2.1 Middle Level (ID: GB205033000050)

Minor localised adverse risk to the Middle Level (ID: GB205033000050) channel from the loss of open watercourse from the land take required for the reservoir and 1.1% of the catchment due to the presence of the reservoir. This loss of catchment and watercourses could impact on habitat, flow and hydromorphology within this waterbody.

[4] All Company Working Group (Nov 2020). Water Framework Directive: Consistent framework for undertaking no deterioration assessments

3.2.2.2 River Great Ouse (Roxton to Earith; ID: GB105033047921)

A potential amber adverse risk to biological quality elements within the River Great Ouse (Roxton to Earith; ID: GB105033047921) was identified as a result of the proposed new surface water abstraction. Abstraction rates are expected to reduce the flow volume and velocity. This change could potentially impact on biological status elements. A minor localised risk on the hydrological regime and water quality are anticipated. Further investigation is required to determine the full extent of the impacts.

3.2.2.3 Old Bedford River/River Delph (incl. the Hundred Foot Washes; ID: GB205033000060)

A potential amber adverse risk to the Old Bedford River/River Delph (incl. the Hundred Foot Washes; ID: GB205033000060) was identified as a result of the proposed new surface water abstraction. Abstraction rates are expected to decrease the water levels and flow velocity. This reduction in level could lead to a deterioration in hydrological regime from the current High status. Additionally, this change could impede fish migration and cause deterioration to the habitat. A minor localised risk on the hydrological regime and water quality are anticipated. Further investigation is required to determine the full extent of the impacts.

3.2.3 Mitigation

Potential mitigation measures have been suggested for each individual waterbody and scheme activity based on the risk that it poses. The risks identified with the surface waterbodies are due to the loss of open watercourses or with reductions in flow and associated deterioration of biological status elements and water quality.

Potential, indicative mitigation measures have been suggested for each individual waterbody and scheme activity based on the risk that it poses. The potential mitigation measures should be considered and where feasible embedded into the scheme design.

Potential indicative mitigation measures for the waterbodies include:

Watercourses should be realigned around the reservoir footprint, where reasonably practicable, to re-provide lost habitat and flow into the main rivers.

Channel modifications should seek to offer the change to incorporate environmental gain by widening drains to allow fringe vegetation to be retained or berms to be constructed, subjection to financial burdens during construction, land take and maintenance.

Banks besides rivers and ditches within the Fens can support a range of species-rich wet and dry grassland as well as stands of sedges, reed and willow scrub, ideal for supporting the local ecology. Due to the proximity of scheme to the riparian zone, biodiversity conservation measures should be put in place during construction to ensure that the area isn't detrimentally impacted.

- Intake structures should be fitted with appropriate fish / eel screens.
- Measures to avoid deterioration to hydromorphological determinants including how the flow and quantity of water changes over time.

Industry good practice measures including Environment Agency Planning Policy Guidelines (PPG's)[5].

Ensure all works carried out in accordance with guidance provided by the regulator, the Environment Agency, for working on/or near water[6].

Consideration of mitigation options in line with guidance provided in 'A Guide to Management Strategies and Mitigation Measures for Achieving Good Ecological Potential in Fenland Waterbodies'[7].

3.2.4 In-combination effects

A high-level in-combination effects assessment has been undertaken. The assessment identified one development (Block Fen/ Langwood Fen), one major planning application (Planning application Ref. 21/00033/FUM) and one Regional Water Resource Plan within the vicinity of the scheme that has the potential of being impacted by the scheme. There is the potential for in-combination effects on The Wash as a result of the FR and South Lincolnshire Reservoir schemes. Further work will be undertaken at gate three to determine the extent of potential in-combination effects on the Wash, following the outcome of ongoing hydrological assessments.

The Block Fen/ Langwood Fen Master Plan, which was adopted as part of the Cambridgeshire and Peterborough Minerals and Waste Local Plan, has the potential of being impacted by the reservoir. The Block Fen/ Langwood Fen allocation area is adjacent, and in close proximity, to the River Delph and infrastructure associated with abstraction and treatment of water supplying the FR. The scheme has the potential to cause localised impacts to the River Delph, as the abstraction from the River Delph is likely to lead to minor changes in water quality due to changes in flow volume and velocity.

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[5] Although PPGs are considered outdated, they remain industry good practice and should be used as embedded mitigation where applicable.

[6] Environment Agency, Protecting and improving the water environment. Water Framework Directive compliance of physical works on or near rivers.

[8]East Cambridgeshire District Council, 2021. Planning application reference 21/00033/FUM. Available at: 21/00033/FUM | To Divert existing Internal Drainage Board Main drain to create a coherent contiguous block of lowland wet grassland to add on to the already created habitat at Coveney Byall Fen under the auspices of the Ouse Washes Habitat Creation Project | Land At Coveney Byall Fen Old Lynn Drove Coveney Cambridgeshire (eastcambs.gov.uk)

The planning application (Ref. 21/00033/FUM)[8] is to divert the existing Internal Drainage Board (IDB) Main Drain to create a coherent contiguous block of lowland wet grassland to add on to the existing Coveney Byall Fen under the River Delph Habitat Creation Project. The development is located 2km south-east of the proposed option. The use of good practice construction methods from both the proposed option and the development would pose a negligible risk to the affected watercourses.

The scheme is identified as a supply option in the WRE draft Regional Water Resource Plan, and, therefore, will be subject to further in-combination effects assessment with neighbouring water company plans and neighbouring regional plans. Until the WRE Best Value Regional Plan has been developed, it is not known when the scheme would be implemented and therefore which other developments it could act in-combination with.

3.2.5 Regulation 19

It is possible that an exemption would need to be sought under Regulation 19 of the Water Environment (WFD) (England & Wales) Regulations 2017 (WFD Regulations 2017) in respect of potential deterioration in status of one or more waterbodies. Further investigation will be required to fully quantify the impact, identify possible mitigation and determine the need for any potential exemption.

3.2.6 Proposed future work

The following recommendations for proposed future work have been identified in the WFD assessment to improve confidence in the assessment of the surface water bodies:

- Ongoing refinement of the design in consultation with a WFD specialist.
- Land drainage and site drainage design to understand which watercourses will be diverted/realigned and which are lost.
- Request for further specific details of mitigation measures assessment and RBMP measures (including Artificial and heavily modified water bodies (A/HMWB) measures where relevant) from the Environment Agency to understand impact of the scheme and to identify opportunities to improve the water body as part of the scheme.
- Update to WFD baseline data to include 2019 status in line with Cycle 3 2021-2027 RBMPs once published.
- It is recommended that a hydrology study is undertaken to understand the potential reduction in catchment area, impacts on flow and therefore biological status elements for the Middle Level water body.
- The ongoing Hydroecology studies should be continued to better understand potential impacts of reduced flow in the River Great Ouse (Roxton to Earith) and Old Bedford River/River Delph (incl. the Hundred Foot Washes) catchments on the hydrological regime and biological status elements.
- It is recommended that additional water quality monitoring (both continuous and spot) is carried out on the River Great Ouse (Roxton to Earith) and Old Bedford River/River Delph (incl. the Hundred Foot Washes) waterbodies. This data should then be used in further water quality analysis to determine the effects of the abstractions on river water quality and therefore biological quality elements.
- Development of WFD mitigation to offset impacts of the scheme.

[8] East Cambridgeshire District Council, 2021. Planning application reference 21/00033/FUM. Available at: 21/00033/FUM | To Divert existing Internal Drainage Board Main drain to create a coherent contiguous block of lowland wet grassland to add on to the already created habitat at Coveney Byall Fen under the auspices of the Ouse Washes Habitat Creation Project | Land At Coveney Byall Fen Old Lynn Drove Coveney Cambridgeshire (eastcambs.gov.uk)

- Completion of full WFD assessment for consenting stage.

These further investigations will support the development of WFD mitigation to offset impacts of the scheme.

3.3 Informal Habitats Regulations Assessment

An informal HRA for the scheme was undertaken, building on the informal HRA for gate one and in accordance with the following guidance, which can be found in Appendix A.2.

Although the Habitats Regulations have been amended by The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, due to the UK's exit from the EU, the effect of these amendments is largely related to wording and requirements and processes remain the same, as protection levels remain unchanged. This assessment has been undertaken in an iterative and objective manner following the above stages, with reference to good practice guidance and relevant case law, notably that provided by the Waddenzee case (European Court of Justice (ECJ) 2002) and Sweetman (ECJ 2011) to inform the interpretation and therefore correct application of the terms 'likelihood, 'significance' and 'in combination'. The informal HRA followed the methodology in the Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15).

All potential options were included in the informal HRA screening and potential sites were identified from this process. This assessment has been undertaken in an iterative and objective manner following the stages detailed in Appendix A.2. with reference to good practice guidance and relevant case law.

3.3.1 Summary of results

The Stage 1 Screening identified six Designated Sites within the Zone of Influence (ZoI) of the Scheme. These are:

- Ouse Washes SAC (UK0013011)
- Ouse Washes Ramsar (UK11051)
- Ouse Washes SPA (UK9008041)
- The Wash SPA (UK9008021)
- The Wash Ramsar (UK11072)
- The Wash and North Norfolk Coast SAC (UK0017075)

At this stage, Likely Significant Effects (LSE) could not be ruled out for any of these sites and, therefore, the Scheme has progressed to the next HRA stage, Appropriate Assessment (AA). The AA provides an assessment to determine whether the scheme will result in an adverse effect on the site integrity (AESI) of the Designated Sites identified at the screening stage with potential for LSE.

The AA considered that residual adverse effects cannot be excluded after taking into account mitigation for the operation phase of the Scheme for all designated sites considered. It is also not possible, at this stage, to exclude adverse effects during the construction phase for the Ouse Washes SPA and Ramsar.

3.3.1.1 Construction effects

The Wash SPA and Ramsar Site and The Wash and North Norfolk Coast SAC

Reservoir construction effects

These Designated Sites are located approximately 35km from the proposed reservoir construction area. Therefore, they are sufficiently distant to exclude adverse effects on the qualifying species and habitats due to noise, vibration, visual or human disturbance during the construction stage. Additionally, there is no potential for the physical loss, degradation or fragmentation of supporting habitats for these Designated Sites due to construction activities associated with the reservoir construction.

Transfer construction effects

The transfer route construction area is hydrologically connected to the Wash Designated Sites. In the event of a pollution event during the intake construction there is a possibility for the Designated Site to be affected through changes in water quality which could affected the qualifying species and habitats. Standard good practice procedures should be followed during construction to limit contamination. It is considered that no residual adverse effects remain on the designated sites' qualifying features.

Ouse Washes SPA, SAC and Ramsar

Reservoir construction effects

The reservoir site lies approximately 200m outside of Natural England's *Goose and Swan Functional Land Impact Risk Zone (IRZ)* for Ouse Washes SPA. However, some sections of the indicative transfer routes fall inside the IRZ. The IRZ represents land beyond the Designated Site's boundary which may also provide important functional habitat for qualifying bird species, specifically geese and swans. In addition, the Ouse Washes SPA is designated for its high ornithological importance for wintering waterfowl, providing good quality feeding areas for an excellent diversity of waterfowl species.

The construction of the reservoir may result in:

- Physical loss and damage, including fragmentation and degradation of functional linked land used by qualifying bird species are expected as a result of land clearance during construction.
- The use of vehicles, machinery and movement of personnel within this Designated Site may result in adverse effects due to noise and light pollution potentially affecting sensitive bird species. Disturbance to qualifying species when foraging may jeopardise adult fitness, survival, and breeding success by displacing birds from preferred feeding and/or roosting areas.
- Effects of displacement, including displacement from the reservoir construction embankments, may be temporary or long-lasting and may result in impacts to bird populations. The identified effects may also have the potential to reduce the extent and distribution of functional linked habitat used by qualifying species' populations outside the designated site.
- The Designated Sites are hydrologically connected to the Scheme via the River Great Ouse, constituting a potential pathway for effects during construction, including pollution events. Changes in water quality due to pollution events including toxic and non-toxic contamination during construction may also lead to changes in turbidity and increased sedimentation which can also have negative effects on the life cycle of the qualifying species. The effects of non-toxic contamination are considered to be temporary and localised, assuming that directional drilling is employed at main river crossings and small tributaries.

Transfer routes and associated infrastructure

The proposed intake from the River Delph lies inside the designated area of the Ouse Washes. Potential construction effects may arise due to changes to water quality from pollution events and physical loss or damage to habitats around the intake structure. In addition, the Ouse Washes SAC is designation for its population of spined loach, which could be affected during construction.

Overall, the Stage 2 AA concluded that adverse effects on the Ouse Washes SPA could not be ruled out, even when considering mitigation measures, for one indicative transfer option: River Delph to FR.

As this route is indicative, the final corridor would need to be chosen to avoid or minimise these effects.

The Stage 2 AA also concluded that the proposed scheme would involve permanent land take from the Designated Sites in order to accommodate an intake and intake/transfer pumping station compounds. As such, alternative options should be explored that do not require land take from the Designated Sites' boundary, for example by using existing infrastructure or seeking alternative locations outside of the SPA boundary.

The following effects from the construction of the transfer and associated infrastructure include:

- Construction of the intake within the River Delph will result in the permanent loss of up to 70m of modified riparian bankside habitat within the SAC, SPA and Ramsar site. This habitat is potentially suitable for qualifying SPA/Ramsar bird species such as breeding mute swan and mallard, though is considered to be of lesser importance to the qualifying feature of the SAC; spined loach, which are generally found close to the bottom of rivers/drains where they utilise submerged macrophytes and sandy/silty substrate for spawning and refuge.

- Construction of the river intake and transfer pumping station compounds meanwhile will result in the permanent loss of approximately 10,800m^2 of lowland grassland habitat within the SPA/Ramsar site boundary which supports breeding, foraging and roosting waterbirds. This loss represents approximately 0.05% of the overall lowland grassland habitat within the SPA/Ramsar site.
- Loss of habitats to accommodate both the intake and intake/transfer pumping station compounds, albeit small scale, will reduce the availability of habitats supporting the qualifying bird species, potentially resulting in SPA/Ramsar populations being displaced from current foraging, breeding and roosting sites. This may affect adult fitness, survival and breeding success by displacing birds from preferred breeding and foraging grounds.
- There is also the potential for indirect effects on the qualifying species of the SAC, SPA and Ramsar through noise, visual and artificial lighting disturbances generated as a result of construction activities (including directional drilling), increasing vehicular movement and personnel. Disturbance effects can result for example in changes to the feeding or roosting behaviours of birds, increased energy expenditure due to more frequent flights, abandonment of nests, disrupted incubation of eggs and desertion of supporting habitat. Disturbance to qualifying species when foraging may affect adult fitness, survival and breeding success by displacing them from preferred foraging and breeding/spawning grounds. Effects of displacement may be temporary or long-lasting and may result in redistribution within or away from a site.
- This option also partly intersects land beyond the SPA and Ramsar boundary that falls within Natural England's Goose and Swan Functional Land IRZ
- Temporary loss of this habitat therefore has the potential impact the ability of the surrounding functional land to support the SPA and Ramsar populations. The ability of these qualifying species to move safely and successfully to and from nesting, feeding and roosting areas is critical to adult fitness and survival, and breeding success.
- There is also the potential for non-physical disturbance to the qualifying swan species utilising the surrounding functional land through noise, visual and artificial lighting disturbances generated from construction activities which could affect adult fitness, survival and breeding success.

The Stage 2 AA also concluded that when applying mitigation measures, adverse effects on the integrity of The Ouse Washes Designated Sites could be avoided for the following transfer options:

- River Great Ouse to FR
- FR to Cambridge Water (South)
- FR to Cambridge Water (North)
- FR to Anglian Water

The mitigation measures proposed to avoid or reduce adverse effects include reducing the working transfer width in order to minimise the temporary loss of functional land, as well as sensitive timings of construction and operation works to avoid the spawning season for spined loach and key periods for overwintering and breeding bird populations. It is also recommended that a Construction Environmental Management Plan (CEMP) be in place that will include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

Further design iterations will require revisions to this document and may result in changes to the current conclusion.

3.3.1.2 Operation effects

The Wash SPA and Ramsar Site and The Wash and North Norfolk Coast SAC

These Designated Sites are hydrologically connected to the scheme via the River Great Ouse. Therefore, there is a potential pathway for adverse effects during operation which cannot be ruled out at this stage.

Abstraction may result in changes in water quality and flows in the River Great Ouse and consequent AESI. These could include:

Water quality:

During operation potential changes to water levels and flows due to direct intake and outfall from/to the River Great Ouse could lead to changes to water quality due to increased turbidity and sedimentation that could affect natural estuarine-coastal processes downstream affecting the saltmarshes which are a feature of the Ramsar Site and support SPA qualifying bird species. Intertidal habitats are also important as they provide ideal conditions for common seals (*Phoca vitulina*) breeding and hauling out.

Changes to salinity, nutrient levels and thermal regime may also adversely affect this Designated Site and its qualifying features due to the direct increased water abstraction, discharges, storage, and reduced compensation flow releases into the River Great Ouse.

Changes to sediment transport are also possible as a result of the new abstractions. Suspended sediment can decrease the light levels needed for photosynthesis affecting primary productivity of coastal ecosystems. Sediment deposition can also smother the estuarine floor leading to anoxic conditions and reducing habitat complexity. Additionally, sediments can also transport pollutants and microplastics to The Wash estuarine environment, which can bioaccumulate in the prey of seabirds and shorebirds.

New abstractions from the River Great Ouse at Earith and the River Delph at Welches Dam are unlikely to have a significant long-term impact on water quality, as demonstrated by the SIMCAT modelling (Simulation of Catchment – the EA's water quality river model) which showed very small changes to the concentrations that would not impact WFD status. All sites showed a mixture of increased and decreased concentration of the modelled determinants along the length of the watercourse from abstraction to estuary. However, uncertainty still remains, particularly in regards with salinity and sediment transport changes, and more studies are recommended to address this.

Hydrology:

- The abstraction regime proposed to supply the Fens Reservoir will result in decreases in flows under medium and high flow conditions along the system downstream of the proposed abstraction points. These reductions will primarily occur during the winter months between November and March. In consideration of the Hands-Off Flow conditions, no abstraction is permitted below a certain threshold and as such, no reduction in flows is observed for lower flow conditions. The abstraction at Earith will impact the diversion and result in less frequent and lower flows entering the River Delph.

- Habitats within the Great Ouse estuary and larger Wash embayment are subject to significant daily changes in flow velocity from flooding and draining of the waterbody into the North Sea. Flow conditions are in constant flux and the habitats associated with these areas are adept at coping with stressors derived from these changes. The proposed changes to flow at the Great Ouse outlet are unlikely to affect estuarine habitats that are subject to daily background changes that are beyond these changes in flow due to the tidal nature of the Wash embayment. However, uncertainty remains and further studies are recommended to address this.

Ouse Washes SAC/SPA/Ramsar Site

Changes in flows:

- The potential abstraction from the two surface water bodies proposed to supply the Fens Reservoir will result in decreases in flows under medium and high flow conditions along the system downstream of the proposed abstraction points. These reductions will primarily occur during the winter months between November and March. In consideration of the Hands Off Flow conditions, no abstraction is permitted below a certain threshold and as such, no reduction in flows is observed for lower flow conditions.
- Modelling has been undertaken to investigate the potential hydrological changes associated with the FR scheme abstraction schemes. The results indicate that the average water level between January and October for the abstraction scenario is closer to the levels proposed under the 'new ideal' water regime than current baseline conditions are (based on The Ouse Washes Hydro-ecological Prescriptions for Favourable Conditions[9]. Although, water levels for the most part still exceed the recommended maximum.
- Consequently, the abstraction has the potential to have a positive influence removing some water when flows are excessive. However, there is potential for increased siltation leading to water quality degradation further downstream, which has been linked to flooding of potentially important bird areas[10]. As such, there is potential that likely significant effects could occur if slowing of flows increases siltation and results in increased flooding rather than reduce excessive flows. Given that it is unclear the degree of flow change it has been determined as a precaution that a significant impact on the designated features of the Ouse Washes SPA could occur. Further work will be undertaken at the next stages of the design process to investigate this further and determine the potential changes in sediment transport on the River Delph as a result of abstraction.

Water quality:

- The proposed abstractions on the Bedford Ouse at Earith, are unlikely to have a significant long-term impact on water quality, as demonstrated by SIMCAT modelling and flow concentration load calculations which both showed very small changes to the annual average concentrations with no impact on WFD status.
- In SIMCAT modelling, all sites showed both minor increase and decrease in concentration of the modelled determinants along the length of the watercourse from abstraction points down to the Wash Estuary.

[9, 23] Graham, J., 2003. Hydro-ecological Prescriptions for Favourable Condition Ouse Washes Special Protection Area (SPA) and Candidate Special Area of Conservation (cSAC)

[10] WWT, 2021. Flooding on the Ouse Washes. Available from https://www.wwt.org.uk/news-and-stories/news/flooding-on-the-ouse-washes. Accessed 09/08/2022.

3.3.2 Mitigation

The potential mitigation measures assume a worst-case scenario at this stage, in the absence of detailed survey data or local records. Mitigation measures have been proposed for both construction and operation phases at all sites. However, more detailed and targeted mitigation measures can only be formulated once the exact nature of the impacts are better understood, following the additional assessment work recommended in this report.

In addition to best practice measures for construction including pollution control, biosecurity, and disturbance, the mitigation measures proposed to avoid or reduce adverse effects include reducing the working transfer width in order to minimise the temporary loss of functionally linked habitats, as well as sensitive timings of construction and operation works to avoid the spawning season for sea and river lamprey, and key periods for overwintering and breeding bird populations. It is also recommended that a CEMP be in place that will include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

3.3.3 In-combination effects

3.3.3.1 In-combination effects with other plans and projects

Adverse effects to the sites' integrity were identified during the construction and operation stages that can affect the integrity of the following sites:

- Ouse Washes SAC (UK0013011)
- Ouse Washes Ramsar (UK11051)
- Ouse Washes SPA (UK9008041)
- The Wash SPA (UK9008021)
- The Wash Ramsar (UK11072)
- The Wash and North Norfolk Coast SAC (UK0017075)

Consequently, an in-combination assessment is required for the scheme. The following developments have been identified within 10km of the option (Table 3.1). It should be noted that the in-combination assessment will be revised and updated as the scheme evolves, and additional plans and developments come to light.

Table 3.1: Plans and developments within 10km of the FR option

Planning Authority	Local Plan	Reference	Location/ Description	Potential for in-combination effects
Peterborough district council	Cambridgeshire and Peterborough Mineral and waste development plan	Mineral safeguarding zone	Earith and Mepal zone Mineral safeguarding zone for Earith and Mepal area	Yes – some sites are sufficiently close to the Ouse Washes Designated Site so that potential AEIS are possible due to pollution events.
N/A	21/00033/FUM	Land At Coveney Byall Fen Old Lynn Drove Coveney Cambridgeshire	To Divert existing Internal Drainage Board Main drain to create a coherent contiguous block of lowland wet grassland to add on to the already created habitat at Coveney Byall Fen under the auspices of the Ouse Washes Habitat Creation Project	Yes – the site is sufficiently close to the Ouse Washes Designated Site so that potential AEIS are possible due to pollution events.

3.3.3.2 In-combination effect with South Lincolnshire Reservoir (SLR)

The SLR SRO scheme includes the development of a new raw water reservoir for public water supply within the Anglian Water region. The informal HRA undertaken for SLR has identified potential effects to the following sites that also may share potential effects with the FR SRO scheme:

- The Wash SPA (UK9008021)
- The Wash Ramsar (UK11072)
- The Wash and North Norfolk Coast SAC (UK0017075)

The following effects that could result in in-combination effects from both SLR and FR options are presented in Table 3.2.

Table 3.2: FR and SLR in-combination effects

Designated Sites/ Qualifying Feature	FR	SLR	In-combination effects
The Wash SPA and Ramsar bird assemblages	Yes – uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Yes– uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Uncertain – further modelling should aim to look at the potential effects from water quality changes and changes in flows. Further modelling would reduce uncertainty in this assessment.
SAC Common seals	Yes -– uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Yes– uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Uncertain – further modelling should aim to look at the potential effects from water quality changes and changes in flows. Further modelling would reduce uncertainty in this assessment.
SAC Otters	Yes – uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Yes– uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Uncertain – further modelling should aim to look at the potential effects from water quality changes and changes in flows. Further modelling would reduce uncertainty in this assessment.
The Wash and North Norfolk Coast SAC and The Wash Ramsar saltmarsh vegetation	Yes -– uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Yes– uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats	Uncertain – further modelling should aim to look at the potential effects from water quality changes and changes in flows. Further modelling would reduce uncertainty in this assessment.

3.3.4 Proposed future work

Further studies are recommended to address uncertainty and should include:

- Hydrodynamic modelling of flows and salinity into The Wash Designated Sites.
- Studies and modelling of the water demand from the River Delph and the River Great Ouse to identify whether the changes in the water levels and flows as a result of the operation of the FR will have an impact on the Designated Sites and their qualifying features. Further modelling of the current nutrient level analysis due to the abstraction is also recommended to determine the effect of nutrient loading. In addition, potential changes in levels, salinity and sediment transport should be investigated.
- Further assessment and modelling of the effects of the new discharge and abstraction on the River Great Ouse to reduce uncertainty and determine the effects on the Designated Sites located downstream. A detailed review of the baseline ecological data is also recommended including bird data.
- Climate change scenario analysis to assess whether the adverse effects identified through this HRA may be compounded through the more frequent and intense effects of heat waves, droughts, floods and rising sea levels.

3.3.5 Conclusion

Potential adverse effects cannot be ruled out at this stage for:

- Ouse Washes SPA (UK9008041)
- Ouse Washes Ramsar (UK11051)
- Ouse Washes SAC (UK0013011)
- The Wash SPA (UK9008021)
- The Wash Ramsar Site (UK11072)
- The Wash and North Norfolk Coast SAC (UK0017075)

The main effects on the designated sites, both during the construction and operation phases, are as follows:

During construction, the scheme may result in the following effects on designated sites:

- Physical loss during the construction of the pipelines, the reservoir, and their associated built infrastructure. This may also include loss of land functionally linked to the Designated Sites and used by qualifying species with large distribution ranges like birds.
- Physical damage, including habitat degradation as a result of water quality changes in case of pollution events may affect spawning areas for designated fish species.
- Non-physical disturbance caused by noise/visual presence and light pollution leading to the displacement of qualifying bird species from foraging areas.
- Toxic contamination leading to biomass reduction and food web disruptions that may affect the life cycle of qualifying species.
- Non-toxic contamination as a result of changes in water turbidity, sediment loading and silt deposition altering ecosystem processes and food webs; as well as dust effects smothering habitats, affecting photosynthesis and reducing productivity.
- Biological disturbance as a result of changes to habitat availability including functional linked habitat; changes in species abundance or distribution; potential for populations to be displaced from current spawning grounds and feeding areas; changes in natural succession.

During operation, the scheme may result in:

- Changes to water levels and flows due to abstraction, storage and emergency discharge drawdown flows leading to fluctuations in water temperature regimes and salinity levels downstream.
- Physical damage as a result of changes in flow velocity and sediment fluxes leading to changes in natural coastal processes; functionally linked habitat degradation as a result of water quality changes in case of pollution events.
- Toxic contamination leading to biomass reduction and food web disruptions that may affect the life cycle of qualifying species.
- Non-toxic contamination as a result of changes in water turbidity, sediment loading and silt deposition altering ecosystem processes and food webs; as well as dust effects smothering habitats, affecting photosynthesis and reducing productivity.
- Biological disturbance including direct mortality, changes to habitat availability including functional linked habitat; changes in species abundance or distribution; potential for populations to be displaced from current spawning grounds and feeding areas; changes in natural succession.

The Wash SPA, Ramsar Site and The Wash and Norfolk Coast SAC may be affected at both construction and operation. The potential effects may lead to changes on:

- The extent and distribution of qualifying habitats.
- The structure and function of the qualifying habitats.
- The supporting processes on which habitats of qualifying species rely.

Additionally, the identified effects have the potential to reduce the extent and quality of functional linked habitats supporting qualifying species' populations.

An in-combination assessment was undertaken with other plans or projects and identified potential effects in-combination with:

- SLR – potential effects on The Wash Ramsar Site and SPA and Wash and North Norfolk Coast SAC.
- Cambridgeshire and Peterborough Mineral and waste development plan - potential effects on the Ouse Washes SAC, Ramsar Site and SPA.
- Land At Coveney Byall Fen Old Lynn Drove Coveney Cambridgeshire - potential effects on the Ouse Washes SAC, Ramsar Site and SPA.

It should be noted that these conclusions are based on preliminary, indicative design assumptions available at this time, commensurate with the stage of scheme development the project is at and are primarily informed by available, appropriate desktop information. Further design iterations will require revisions to this document and may result in changes to the current conclusion.

Further surveys, data collection, modelling and assessment, together with the detailed consideration of mitigation measures, will be required in order to conclude that there will be an absence of effect on the integrity of designated sites. The strategy to produce the evidence base required for the formal stages of HRA will be agreed at the next stage in consultation with the regulator.

Ultimately, a strong and robust evidence base will be required to conclude that there will be no adverse effects on the integrity of any designated site. as a result of the construction or operation of the scheme. The level of detail available at this stage (which is considered proportionate) means that such effects cannot be ruled out at this stage. As a result, this will need further consideration and assessment as part of the next stages of design development to

conclude what the effects (if any) of the FR on designated sites will be and any further work required by the HRA process. All of this would need to be undertaken in dialogue with key stakeholders, including Natural England and the Environment Agency.

3.4 Strategic Environmental Assessment

The SEA Review (see Appendix A.3) presents an update to the SEA level option assessment for the FR prepared by WRE for the regional plan and included in the dWRMP24. This is in-line with the methodology in the WRE Regional Plan Environmental Assessment Methodology Guidance[11]. This formed an update to the SEA undertaken at gate one. The SEA was broken down into environmental topics and objectives. It assigned ratings to each on a seven-point scale (from 'Major Positive' to 'Major Negative') based on scoring criteria. The ratings were informed by the other environmental assessments (WFD, HRA, BNG, NCA, INNS) for the scheme. The SEA considered anticipated construction and operational effects, both without any mitigation applied and expected residual effects after implementation of identified mitigation measures.

The SEA topic and objectives can be found below in Table 3.3.

Table 3.3: SEA topics and objectives from dWRMP24

SEA topic	SEA objective
Biodiversity, flora and fauna	• To protect designated sites and their qualifying features. • To protect and enhance biodiversity, priority species and vulnerable habitats such as chalk rivers. • To avoid the spread of, and where required, manage, invasive and non-native species (INNS). • To meet WFD objectives relating to biodiversity.
Soil	• To protect and enhance the functionality, quantity and quality of soils, including the protection of high-grade agricultural land, and geodiversity.
Water	• To reduce or manage flood risk, taking climate change into account. • To enhance or maintain surface water quality, flows and quantity. • To enhance or maintain groundwater quality and resources. • To meet WFD objectives and support the achievement of environmental objectives set out in River Basin Management Plans. • To increase water efficiency and increase resilience of Public Water Supply (PWS) and natural systems to droughts.
Air	• To reduce and minimise air emissions during construction and operation.
Climatic factors	• To reduce embodied and operational carbon emissions. • To introduce climate mitigation where required and improve the climate resilience of assets and natural systems.
Landscape	• To conserve, protect and enhance landscape, townscape and seascape character and visual amenity.
Historic environment	• To conserve, protect and enhance historic environment and heritage assets, and their setting, including archaeologically important sites.
Population and human health	• To maintain and enhance the health and wellbeing of the local community, including economic and social wellbeing. • To secure resilient water supplies for the health and wellbeing of customers. • To increase access and connect customers to the natural environment, provide education or information resources for the public. • To maintain and enhance tourism and recreation.
Material assets	• To minimise resource use and waste production. • To avoid negative effects on built assets and infrastructure.

[11] WRSE Regional Plan Environmental Assessment Methodology Guidance, Mott MacDonald June 2020

The SEA identified the following potential effects, outlined in Table 3.4.

Table 3.4: Summary of potential effects.

SEA topic	Main effects
Biodiversity, flora and fauna	It is not possible to rule out adverse effects for the operational phase for The Wash SPA/SAC/Ramsar Site and the Ouse Washes SPA/SAC/Ramsar Site, as the potential adverse effects of increased sedimentation and changes in water levels and flows and are currently unknown. Direct effects are possible from the construction of the proposed intake within the Ouse Washes designated site. These effects have the potential to affect the extent and distribution of qualifying species, the structure and function of the habitats of qualifying species; and the supporting processes on which habitats of qualifying species rely due to the physical loss, physical damage and biological disturbances identified.
Soil	Permanent loss of soils and associated agricultural land, primarily Grade 2.
Water	There is the potential to cause a deterioration in the status of affected waterbodies or a failure to achieve good status.
Air	No long terms effects on air quality are anticipated, there may be short term effects arising from construction.
Climatic factors	The proposed scheme is unlikely to affect the local environment's resilience to hazards such as flood risk, temperature extremes, storms, and gales, but may assist in managing resilience of surrounding flora and fauna to drought. There may be short and medium term increases in carbon emissions.
Landscape	The reservoir itself and above ground infrastructure associated with the WTW, potential visitor centres, pumping stations and access infrastructure have potential to negatively affect landscape character and visual amenity.
Historic environment	The reservoir and associated built infrastructure have the potential to permanently and adversely alter the setting of historic assets, through visual intrusion. There may also be operational impacts resulting from increased noise pollution, traffic and potential tourism that may impact the setting of historic assets although these are considered minor.
Population and human health	There may be minor benefits to local community as facilities at the reservoir may generate jobs. The reservoir would promote local recreational activities.
Material assets	There may be construction and operational effects to roads that will connect the reservoir, with an increase in heavy goods vehicles (HGVs) from deliveries and potential increase in traffic from visitors.

3.4.1 Mitigation

As the scheme is developed further mitigation will be proposed. However, it should be noted the WFD and informal HRA assessments provide details of specific proposed mitigation and further investigations that will increase confidence in assessments that will inform the ongoing scheme design.

4 Biodiversity, flora and fauna appraisal

4.1 Introduction

This section presents potential impacts on biodiversity, flora and fauna from the FR scheme. The objectives of the section are to summarise the biodiversity baseline associated with the scheme, and identify constraints, opportunities, and issues that require further investigation.

The need to consider biodiversity, flora and fauna is underpinned by legislation (including the Conservation of Habitats and Species Regulations 2017, Wildlife and Countryside Act 1981 and Natural Environment and Rural Communities Act 2006) and national planning policy.

To inform the assessments, the following biodiversity-related receptors were considered:

- Statutory designated sites identified using Multi-Agency Geographic Information for the Countryside (MAGIC). Non-statutory sites identified using data from Cambridgeshire and Peterborough Environmental Records Centre (CPERC)
- SSSI Impact Risk Zones (IRZ) identified using MAGIC
- Other sites identified for nature conservation such as RSPB reserves
- Priority habitats identified using the Priority Habitats inventory on MAGIC
- Ancient woodland identified on MAGIC
- Tree Preservation Orders (TPOs)
- European Protected Species licences identified using MAGIC
- Great crested newt class survey licence returns and pond surveys identified using MAGIC
- Biological records, including protected species, from CPERC
- A ‘first pass’ habitat map using OS Mastermap data converted into UK Habitat Classification (UKHab) data
- Statutory designations – Local Nature Reserves (LNRs), National Nature Reserves (NNRs), Ramsar Sites, SACs (including candidate SACs), Sites of Community Importance (SCIs), SPAs (including proposed SPAs), SSSIs, SSSI risk zones, Marine Protected Areas (MPAs) and Marine Conservation Zones (MCZs).
- Non-statutory designations; Ancient Woodlands, Local Wildlife Sites (LWS), Priority Habitat
- Biodiversity opportunity areas – Nature Improvement Areas, National Priority Focus Areas

The overarching assumptions and limitations outlined in Section 1.7 apply to the appraisal of biodiversity, flora and fauna, as do the following issue-specific limitations:

- Biological records obtained from third parties and presented in the desk study do not represent a full and complete species list for the area (they are mostly given by individuals on an ad hoc basis often meaning there are areas of deficiency in the data).
- The resolution of location data for biological records is variable and often limited to a 1km grid square.
- No site visits or species-specific surveys have been undertaken to confirm habitat suitability and potential presence of any protected species.
- The potential for wider benefits identified within this section are subject to the constraints of associated environmental and social appraisals set out within this environmental appraisal.

A summary of potential effects of the FR scheme on biodiversity, flora and fauna is provided below.

4.2 Reservoir and associated infrastructure

The proposed new reservoir is located is sufficiently distant from the Humber Estuary SPA, SAC and Ramsar, and Baston Fen SAC such that no adverse effects on the designated sites and their qualifying features are expected. The Wash SPA, SAC and Ramsar site is hydrologically connected to the Scheme via the South Forty-Foot Drain (located 5km from the Scheme construction area). However, considering the nature of these connections through a slow small, slow flowing ditch network and the distance to the construction area, it is unlikely that any pollution events during the construction phase will have any potential adverse effects as they will be contained and/or diluted before reaching the designated site assuming best practice and mitigation measures are implemented. Any effects of contamination during the construction phase are considered to be temporary and localised and not expected to affect the designated site.

The reservoir site is located within 2km of three non-statutory County Wildlife Sites (CWS), as outlined in Table 4.1.

Table 4.1: Designated Sites within 2km of the reservoir

Designated site	Distance from site (km)	Reason for designation
Forty Foot Drain CWS	Immediately adjacent to the south	Supports at least 0.5ha of NVC S4 Common Reed swamp; contains at least five species of submerged, floating and emergent vascular plant per 20m stretch; supports a population of a Nationally Scarce vascular plant; and is Grade C site in the JNCC ISR.
Wimblington Common Gravel Pits CWS	1.45km north	Supports at least 0.5ha of NVC S4 community Common Reed swamp and has well developed vegetation mosaics representing hydroseral zonation. Also qualifies for habitat mosaic as it has woodland, scrub, swamp and open water in close association.
Langwood Hill Pit CWS	1.20km southeast	The site qualifies as CWS because it supports at least 0.05ha of NVC community S13 Lesser Reedmace swamp.

Habitat mapping, inclusive of the reservoir site and a 2km buffer, identified that the following habitats are present: cropland, watercourses (rivers and streams), grassland (neutral, other), modified grassland, dense scrub, and developed land and buildings. The habitats on site have the potential to support the following protected species: otter *Lutra lutra*, great crested newt *Triturus cristatus*, bats, water vole *Arvicola amphibius*, badger *Meles meles*, widespread reptiles, breeding and overwintering birds, notable plant species, aquatic invertebrates, invertebrates, aquatic macrophytes, and fish, as well as invasive non-native species.

Of the habitats identified, there are four areas of coastal and floodplain grazing marsh, one area of lowland fen, and one area of lowland mixed deciduous woodland within 1km of the reservoir site, all of which are considered to be priority habitats.

Assessment of potential impacts suggests that works within the site are unlikely to have any direct adverse effects on designated sites. A small number of areas of priority habitat would be permanently lost to the scheme; however, the value of other habitats within the site is generally low, being dominated by intensive arable agriculture (cropland).

Following relevant ecological field surveys to determine presence of protected species, and subsequent confirmation of presence, mitigation measures would likely be required, such as translocation preceded by creation of suitable habitat elsewhere in advance. Habitat creation associated with the site should tie closely to the Nature Recovery Network areas to the northwest and southeast, both of which focus on watercourses and associated riparian habitats. Habitat creation for translocation of protected species (if required) could be combined with opportunities for habitat creation/enhancement.

Mitigation could include:

- Designing the reservoir shape to maximise retention of grazing marsh along the east side.
- Expanding habitat associated with existing ponds on the west side of the reservoir
- Introducing wetland habitat in the reservoir waterbody.
- Identifying large potential areas to the north and south sides of the reservoir waterbody for habitat creation and biodiversity enhancement.

Good practice construction practices will also be prescribed to reduce the habitat clearance required. Furthermore, areas around the reservoir have been identified as potential target areas for habitat enhancement and delivery of Biodiversity Net Gain.

4.3 Transfers

4.3.1 Abstractions

The raw water source for the reservoir is from the River Great Ouse and River Delph. The overall scheme is potentially hydrologically connected to the following Designated Sites:

- Ouse Washes SAC (UK0013011)
- Ouse Washes Ramsar (UK11051)
- Ouse Washes SPA (UK9008041)
- The Wash SPA (UK9008021)
- The Wash Ramsar (UK11072)
- The Wash and North Norfolk Coast SAC (UK0017075)

4.3.1.1 Changes in flows

The Ouse Washes Hydro-ecological Prescriptions for Favourable Conditions[12] considered both the role of flooding and nutrient enrichment in driving ecological conditions in the River Delph. It set out a ‘new ideal’ physical water regime for the River Delph that would benefit designated bird features by securing the plant communities they rely upon for nesting, feeding and roosting. This ‘new ideal’ water regime is based on 30 years of bird recording by the RSPB.

The ‘new ideal’ water regime suggested that the water level in the River Delph should fluctuate widely between the ideal maximum and ideal minimum to accommodate a wide range of bird species with differing water level requirements. Water levels should ideally abide by this regime for three in every four years[13].

The potential abstraction from the two surface water bodies proposed to supply the FR will result in decreases in flows under medium and high flow conditions along the system downstream of the proposed abstraction points. These reductions will primarily occur during the winter months between November and March. In consideration of the Hands Off Flow conditions, no abstraction is permitted below a certain threshold and as such, no reduction in flows is observed for lower flow conditions.

The abstraction at Earith will impact the diversion and result in less frequent and lower flows entering the River Delph. In combination with the abstraction from the River Delph, this will drive lower water levels across the designated site/FSA, which will primarily occur in winter when sufficient flows are passing through the system that trigger both abstractions and the diversion.

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[12] Graham, J., 2003. Hydro-ecological Prescriptions for Favourable Condition Ouse Washes Special Protection Area (SPA) and Candidate Special Area of Conservation (cSAC)

Overall, the abstractions will lead to lower flows along the tidal River Great Ouse downstream of Denver, further exacerbated by reductions in flows from the Middle level, discharged into the River Great Ouse at St Germans.

Though water table/availability are important aspects of the designated features of the Ouse Washes SPA, the main listed management concern relates to negative effects of summer flooding identified as an issue within the site improvement plan for these sites[14]. Consequently, the abstraction has the potential to have a positive influence removing some water when flows are excessive. However, there is potential for increased siltation leading to water quality degradation further downstream, which has been linked to flooding of potentially important bird areas[15]. As such, there is potential that likely significant effects could occur if slowing of flows increases siltation and results in increased flooding rather than reducing excessive flows. Given that the degree of flow change is unclear, it has been determined as a precaution that a significant impact on the designated features of the Ouse Washes SPA could occur.

Further work will be undertaken at the next stages of the design process to investigate this further and determine the potential changes in sediment transport on the River Delph as a result of abstraction. Specific mitigation to reduce increased sedimentation and silt deposition downstream of the proposed works should include silt screening around the area of works to limit the movement and redeposition of material.

4.3.1.2 Changes in water quality

The plant species found within the washlands, ditch systems and grassland that support the SPA qualifying bird species are susceptible to water pollution and nutrient enrichment which is a factor in the decline of grasses in the River Delph[16].The River Delph represent spined loach *Cobitis taenia* populations within the River Great Ouse catchment. The Counter Drain is particularly important and a healthy population of spined loach is known to occur due to clear water and abundant macrophytes.

It is expected there will be little to no change to water quality concentration as any new abstraction will remove flow containing some of the load of pollutants from the river at the point of abstraction, however dilution opportunity may alter as other discharges and tributaries join the river system. SIMCAT and SAGIS models were used to estimate the potential change in water quality parameters of interest.

The proposed abstractions are unlikely to have a significant long-term impact on water quality, as demonstrated by the SIMCAT modelling and flow concentration load calculations which both showed very small changes to the annual average concentrations with no impact on WFD status.

The Environment Agency's Prevention of Pollution Guides (PPG1: General Guide to Prevention of Pollution; PPG6: Pollution prevention guidance for working at construction and demolition sites), should be followed in order to prevent or mitigate any potential impact on water quality.

[14] Natural England, 2014. Site Improvement Plan: Ouse Washes. Available from http://publications.naturalengland.org.uk/file/6561880306876416. Accessed 29/07/2022

[15] WWT, 2021. Flooding on the Ouse Washes. Available from https://www.wwt.org.uk/news-and-stories/news/flooding-on-the-ouse-washes. Accessed 09/08/2022.

[16] Natural England, 2014. Site Improvement Plan: Ouse Washes. Available from http://publications.naturalengland.org.uk/file/6561880306876416. Accessed 29/07/2022

4.3.2 Transfers

The appraisal below is based on broad indicative proposed transfer routes. The exact location of the routes, and their consequent impacts on designated sites, will require confirmation at the next stage of project development. Desk-based assessments carried out for the indicative transfer routes found minor effects in relation to impacts on nature conservation and biodiversity.

Further information about the potential extent of construction and operational effects of the indicative transfer routes on biodiversity features, and mitigation, enhancement and monitoring recommendations, is provided below.

4.3.2.1 European designated sites and their qualifying features (SPA, SAC, Ramsar)

River Great Ouse to FR

The proposed route is situated approximately 1.1km north west of the Ouse Washes SPA, SAC and Ramsar site boundaries at its closest point. The route also intersects Natural England's Goose and Swan Functional Land IRZ which represents land beyond the SPA/Ramsar boundaries which may provide important functional habitat for qualifying bird species, specifically geese and swans. Due to the potential for this option to lead to effects these receptors, a Stage 2 AA has been undertaken.

Due to the distance to the Ouse Washes site boundary (1.1km), disturbance of qualifying bird species of the SPA/Ramsar site during construction or operation of this element is considered unlikely. Physical loss and damage of Functionally Linked Land (FLL) will occur temporarily during construction and will be reinstated following construction of the transfer.

Mitigation measures are set out in the HRA report and include reducing the working width of the transfer in order to minimise the temporary loss of functional land, and the sensitive timings of construction and operation works to avoid the spawning season for spined loach and key periods for overwintering and breeding bird populations.

This concluded that on the basis proposed mitigation and good practice measures are implemented, it is considered there will be **no adverse effects** on the integrity of the European designated sites.

River Delph to FR

The proposed abstraction point is situated within the Ouse Washes SPA, SAC and Ramsar site boundaries. The indicative transfer route also intersects land beyond the SPA/Ramsar boundaries within Natural England's Goose and Swan Functional Land IRZ. Due to the potential for this option to lead to effects on these receptors, a Stage 2 AA has been undertaken.

The proposed works may lead to temporary and permanent effects on these sites and qualifying features as a direct result of physical habitat loss, habitat degradation and/or fragmentation.

Mitigation measures are set out in the HRA report and include reducing the working width of the transfer in order to minimise the temporary loss of functional land, and the sensitive timings of construction and operation works to avoid the spawning season for spined loach and key periods for overwintering and breeding bird populations.

Adverse effects cannot be ruled out, even after taking into account proposed mitigation.

FR to Cambridge Water (South)

The proposed route intersects the Ouse Washes SAC, SPA and Ramsar site boundaries. The route also intersects land beyond the SPA/Ramsar boundaries within Natural England's Goose and Swan Functional Land IRZ.

The Ouse Washes SAC, SPA and Ramsar will be tunnelled under, and no direct effect or encroachment is anticipated, however, due to the potential for this option to lead to effects on these receptors, a Stage 2 AA has been undertaken.

On the basis proposed mitigation and good practice measures are implemented, it is considered there will be **no adverse effects** on the integrity of the European designated sites.

FR to Cambridge Water (North)

The proposed route is situated approximately 1.9km northwest of the Ouse Washes SPA, SAC and Ramsar site boundaries at its closest point. The route also intersects Natural England's Goose and Swan Functional Land IRZ. Due to the potential for this option to lead to effects on these receptors, a Stage 2 AA has been undertaken.

On the basis proposed mitigation and good practice measures are implemented, it is considered there will be no adverse effects on the integrity of the European designated sites.

FR to Anglian Water

The proposed route is situated approximately 100m northwest of the Ouse Washes SAC and Ramsar site boundaries and 1.4km northwest of the Ouse Washes SPA boundary at its closest point. The route also intersects Natural England's Goose and Swan Functional Land IRZ. Due to the potential for this option to lead to effects on these receptors, a Stage 2 AA has been undertaken.

On the basis proposed mitigation and good practice measures are implemented, it is considered there will be no adverse effects on the integrity of the European designated sites.

4.3.2.2 Nationally designated sites and their qualifying features (SSSI)

River Great Ouse to FR

There is one biological SSSI located approximately 70m east of the transfer route, Berry Fen, and an additional SSSI located approximately 1.1km east of the transfer route, River Delph. There is hydrological connectivity of the River Great Ouse (Roxton to Earith) and Counter Drain (Sutton and Mepal IDB incl. Cranbrook Drain) waterbodies to Berry Fen SSSI.

Although the route has no directed effect or encroachment on the SSSIs, potential impacts include hydrological changes, invasive species, and air pollution during construction. Given the distance of the proposed transfer route to Berry Fen SSSI, consideration should be given at detailed design stage to reducing working width where the route is in close proximity to the site. Given the distance of the proposed transfer route to these sites and absence of works within or adjacent, introduction or spread of invasive non-native species or impacts due to air quality changes at the site are considered unlikely.

The abstraction is located on the River Great Ouse and the transfer route will be constructed in close proximity, requiring implementation of good practice working methods to prevent contamination, as well as measures to mitigate change to water levels or flow within the waterbodies. The transfer route is located within multiple SSSI IRZs, as such the local planning authority will be required to consult Natural England on likely risks from the transfer route.

River Delph to FR

The abstraction and transfer route falls inside the Ouse Washes SSSI. There is hydrological connectivity of the Counter Drain (Manea and Welney IDB) waterbody to Ouse Washes SSSI. The transfer route is located within SSSI IRZs.

The route will have a direct effect and encroachment on the SSSI, with physical loss or damage to habitats, and other potential impacts including hydrological changes, invasive non-native species, and air pollution during construction. As works are proposed within and adjacent to the designated site, the introduction or spread of invasive non-native species at the site is potentially likely. Bio-security measures must be in place and adoption of best construction practices will be important.

It is anticipated that construction of the transfer pipeline will utilise tunnelling technologies beneath the waterbody thereby minimising potential contamination, however, as the abstraction and sections of the transfer will be constructed within the designated site good practice working methods to prevent contamination must be implemented, as well as measures to minimise changes to water levels or flow within the waterbodies. There is potential for air quality effects due to the works occurring within and adjacent to the designated site. Best management practices should be implemented to reduce generation of dust and air pollution on the site.

The local planning authority will be required to consult Natural England on likely risks from the transfer route due to its location within SSSI IRZ.

FR to Cambridge Water (South)

The transfer route intersects the Ouse Washes SSSI. There is hydrological connectivity of the Counter Drain (Manea and Welney IDB) waterbody to Ouse Washes SSSI. The transfer route is located within multiple SSSI IRZs.

The Ouse Washes SSSI will be tunnelled under, and no direct effect or encroachment is anticipated, however, adverse effects on linkages and qualifying features are considered likely without mitigation, and other potential impacts including hydrological changes, invasive species, and air pollution during construction. As works are proposed within and adjacent to the designated site, the introduction or spread of invasive species at the site is potentially likely. Bio-security measures must be in place and adoption of best construction practices will be important.

It is anticipated that construction of the transfer pipeline will utilise tunnelling technologies to intersect the waterbody thereby minimising potential contamination, however, as sections of the transfer will be constructed within and adjacent to the designated site good practice working methods to prevent contamination must be implemented, as well as measures to minimise changes to water levels or flow within the waterbodies. There is potential for air quality effects due to the works occurring within and adjacent to the designated site. Best management practices should be implemented to reduce generation of dust and air pollution on the site.

The local planning authority will be required to consult Natural England on likely risks from the transfer route due the location within multiple SSSI IRZ.

FR to Cambridge Water (North)

Ouse Washes SSSI is located approximately 1.6km east of the route, and Berry Fen SSSI is located approximately 1.5km east of the route. There is hydrological connectivity of the Ouse (Roxton to Earith) and Counter Drain (Sutton and Mepal IDB including Cranbrook Drain) waterbodies to the Berry Fen SSSI and Ouse Washes SSSI. The transfer route is located within multiple SSSI IRZ.

Although the route has no direct effect or encroachment on the SSSIs, potential impacts include hydrological changes, invasive non-native species, and air pollution during construction. Given the distance of the proposed transfer route to these sites and absence of works within or adjacent, introduction or spread of invasive species or impacts due to air quality changes at the site are considered unlikely.

The implementation of good practice working methods to prevent contamination, as well as measures to mitigate change to water levels or flow within the waterbodies will be required.

The local planning authority will be required to consult Natural England on likely risks from the transfer route due to the location within multiple SSSI IRZ.

FR to Anglian Water

Ouse Washes SSSI is located approximately 100m east of the route. There is hydrological connectivity of the Great Ouse waterbodies to Ouse Washes SSSI. The transfer route is located within multiple SSSI IRZ.

Although the route has no direct effect or encroachment on the SSSIs, potential impacts include hydrological changes, invasive species, and air pollution during construction. Given the distance of the proposed transfer route to the Ouse Washes SSSI and absence of works within or immediately adjacent, introduction or spread of invasive species or impacts due to air quality changes at the site are considered unlikely.

The implementation of good practice working methods to prevent contamination, as well as measures to mitigate change to water levels or flow within the waterbodies.

The local planning authority will be required to consult Natural England on likely risks from the transfer route due to the location within multiple SSSI IRZ.

4.3.2.3 Other designated sites (Ancient Woodland, NNR, LNR) and priority habitats

There are no ancient woodlands, NNRs or LNRs within 500m of any indicative transfer routes. However, priority habitats are present within 500m of all indicative transfer routes. Beyond this extent, no likely effects are expected on ancient woodland, NNR, LNR or priority habitats; these are considered neutral environmental constraints to the development of the scheme.

Further site-specific ecological assessments and discussions with regulators will be required to help inform the detailed design of the scheme for all indicative transfers.

River Great Ouse to FR and River Delph to FR

For both the indicative transfers River Great Ouse to FR and River Delph to FR, there will be some minor permanent loss of coastal and floodplain grazing marsh habitat associated with the transfer and intake infrastructure. Coastal and floodplain grazing marsh is not considered irreplaceable habitat and with application of good practice construction measures and reinstatement of habitat, the overall effect of other designated sites comprises a minor environmental constraint to the development of the scheme.

Trenchless tunnelling to protect priority habitats should be further assessed and confirmed at detailed design.

FR to Cambridge Water (South)

The indicative transfer FR to Cambridge Water (South) intersects coastal and floodplain grazing marsh. Coastal and floodplain grazing marsh is primarily located within the Ouse Washes SPA, SAC, Ramsar, and SSSI where trenchless tunnelling will be utilised, therefore, there will be no loss of this habitat.

There are several other areas of habitat along the route, however, reduced working width in these locations will prevent any direct permanent loss. Implementing good practices near these habitats (e.g., locating compounds and materials storage away from these habitats) will mitigate potential indirect adverse effects on these habitats. This habitat comprises a minor/neutral environmental constraint to the development of the scheme.

FR to Cambridge Water (North) and FR to Anglian Water

None of the priority habitats within 500m of the FR to Cambridge Water (North) and FR to Anglian Water indicative transfers will be directly impacted by the routes.

Implementing good practices near these habitats (e.g., locating compounds and materials storage away from these habitats) will mitigate potential indirect adverse effects on these habitats. These are considered a minor environmental constraint to the development of the scheme.

4.4 Section Summary

The construction of the reservoir itself is unlikely to have any direct adverse effects on designated sites but will result in the permanent loss of some priority habitat areas and may impact protected species. Following relevant protected species surveys, and subsequent confirmation of their presence, mitigation measures may be required such as translocation of protected species, habitat creation and enhancement.

Abstraction from surface water bodies is likely to impact water flows. Water level in the River Delph should in principle fluctuate widely between ideal minimum and maximum levels. Potential abstraction will reduce water levels primarily between November and March when flows are typically highest, therefore helping to ensure water levels remain below the ideal maximum, and no abstraction will be permitted below a certain. Summer flooding is identified as a management concern at the Ouse Washes SPA and may be reduced by the potential abstraction, having a positive effect on the site integrity. Increased siltation leading to water quality degradation downstream and subsequent increased flood risk of potentially important bird areas may result and therefore it has been determined as a precaution that a significant impact on the designated features of the Ouse Washes SPA could occur. Further work is required to investigate this, and mitigation could be required such as silt screening around the area of works.

The proposed abstractions are unlikely to have a significant long-term impact on water quality. However, plant species found within the washlands, ditch systems and grassland that support SPA qualifying bird species are susceptible to water pollution and nutrient enrichment. Spined loach, *Cobitis taenia*, populations within the River Delph are also dependent on low levels of pollution. Good practice guidelines should be followed in order to prevent or mitigate any potential impacts on water quality.

The indicative transfer River Delph to FR, with proposed abstraction point situated within the Ouse Washes SPA, SAC and Ramsar site and transfer intersecting Functional Land IRZ, may lead to temporary and permanent effects on the site as a result of physical habitat loss, degradation or fragmentation. Mitigation measures set out in the HRA report include reducing the working width of the transfer and the sensitive timing of construction and operation works. However, residual adverse effects after mitigation cannot be ruled out. No other indicative transfers are likely to have adverse effects on European designated sites after mitigation.

The indicative transfers are expected to have varying effects on some nationally designated sites through direct encroachment and physical loss or degradation of habitats, hydrological changes and air pollution resulting from construction. Implementation of good practice working

methods to prevent contamination, as well as measures to mitigate change to water levels or flow within the waterbodies, may be required.

There are no ancient woodlands, NNRs or LNRs within 500m of any indicative transfer routes. However, priority habitats are present within 500m of all indicative transfer routes. For both the indicative transfers River Great Ouse to FR and River Delph to FR, there will be some minor permanent loss of coastal and floodplain grazing marsh habitat associated with the transfer and intake infrastructure. Mitigation is likely to include the reinstatement of habitat, with the overall effect on priority habitats comprising a minor environmental constraint to the development of the scheme. Trenchless tunnelling to protect priority habitats should be further assessed and confirmed at detailed design. Reduced working width and good practice will prevent direct permanent habitat loss and mitigate potential indirect adverse effects on habitats close to other indicative transfer routes.

Ultimately, a strong and robust evidence base will be required to conclude that there will be no adverse effects on the integrity of any designated site as a result of the construction or operation of the scheme. The level of detail available at this stage (which is considered proportionate) means that such effects cannot be ruled out at this stage. As a result, this will need further consideration and assessment as part of the next stages of design development to conclude what the effects (if any) of the scheme on designated sites or protected species will be.

5 Soil appraisal

5.1 Introduction

This section presents potential impacts on soils from the FR scheme. The objectives of this section are to summarise the soil baseline associated with the scheme, and identify constraints, opportunities, and issues that require further investigation.

The need to consider soils and land quality is underpinned by national planning policy, which seeks to minimise the loss of the best and most versatile (BMV) agricultural land where possible to minimise impacts on soil quality.

Loss of agricultural land to the FR scheme and its associated infrastructure will be unavoidable. A key principle for development of the scheme is to avoid losing soil, which is a non-renewable natural resource and vital component of natural capital. Soil resource reuse should be maximised. This is in line with Safeguarding our Soils.

To inform the assessment, the following receptors relating to soil and land use were considered:

- Soils of the Cambridge and Ely District (SS10) 1:63,360 Outline Soil Map (R. S. Searle and C. A. H Hodge, 1976)
- Digitised Detailed National Soil Mapping (Cranfield University)
- Digitised Soil Auger Bore Profile Records (Cranfield University)
- Post-1988 ALC Mapping (Natural England)
- Provisional ALC Mapping (Natural England)
- Predictive BMV Land Assessment (Natural England, 2017)
- Peaty Soils Locations (Natural England)
- SSSIs designated for their geological importance
- Historic and permitted landfill sites
- Nationally significant infrastructure including mineral sites, allocated major developments, major planning applications (Nationally Significant Infrastructure Project (NSIP) land, mineral safeguarded land, allocated local plan major development, EIA development planning applications)
- Land Referencing Data for Farm Holdings
- Land quality – authorised landfill sites, historic landfill sites
- Land use – Grade 1 agricultural land, Grade 2 agricultural land
- Geological SSSIs

The overarching assumptions and limitations outlined in Section 1.7 apply to the appraisal of soils, as do the following issue-specific limitations:

- Only provisional information is available for ALC grade distribution, soil type mapping and peat distribution, which is coarse by nature.
- Site surveys were not undertaken as part of the desk-based assessment and confirmation of such desk study outputs would be achieved through a subsequent detailed field survey if required.
- The outputs of the desk-based assessment were limited without the detailed data provided by a Soil Resources Survey but informed the need for future surveys and a Soil Management Plan, where required.

5.2 Reservoir and associated infrastructure

5.2.1 Soil types and agricultural land classification

Detailed 1:63,360 soil mapping highlights that the dominant Soil Series at the FR site is Downholland ('clayey and silty calcareous humic alluvial gley soils'). This is joined by the Peacock Series (‘calcareous humic gley soils, which has humose topsoils overlying mottled calcareous grey clay’) which is mapped in the north west corner and over a small section of the eastern boundary. In the north west, the Peacock Series is joined by smaller areas of the Denchworth (‘pelo-stagnogley soils’ that are ‘stoneless, strongly mottled and waterlogged for long periods in winter') and Milton ('medium loamy drift with siliceous stones’) Series. There are no past auger bore records from previous soil surveys within or proximal to the site area. In accordance with the extensive Downholland Series throughout the site, Natural England mapping depicts peaty soils throughout the site, with the exception of the north-western portion mapped as Denchworth/Milton soils.

The most proximal post-1988 ALC survey records Grade 1 land approximately 1.5km to the east. Provisional mapping indicates that Grade 2 is the most extensive ALC grade throughout the site, although a band of Grade 1 land is depicted running from north east to south west through the eastern portion of the site. A small area of Grade 3 land is also mapped on the northern boundary. These grades are in accordance with Natural England mapping which indicates that the site has a 'high' likelihood of BMV land throughout the polygon.

5.2.2 Potential impacts on soils

The main impacts of construction of the FR scheme will be associated with the temporary disturbance of soil during construction, including during provisional works such as access roads, and permanent loss of agricultural (and notably, BMV) land and peat soils. The magnitude of impact in the temporary phase would be dependent on the adoption of appropriate soil management practices to reuse soils where possible. A further impact could be the loss of stored carbon from the soils during construction.

5.3 Transfers and associated infrastructure

The main impacts of construction of the FR scheme transfer will be associated with the temporary disturbance of soil during construction of pipeline routes. This comprises potential disturbance during enabling works (such as access roads and compounds), and some permanent loss of agricultural (and notably, BMV) land from water treatment facilities.

5.3.1 Potential impacts on soils

There are no geological SSSIs within 1km of any of the proposed transfer routes. Therefore, no likely effects are considered, and this is a neutral environmental constraint to the development of the scheme.

Overall, construction and operational effects on agricultural land for all pipeline options is considered to be a minor constraint to the scheme.

5.3.1.1 River Great Ouse to FR

Approximately 32% of the proposed River Great Ouse to FR pipeline route passes through Grade 1 agricultural land, 48% through Grade 2, 20% through Grade 3, and less than 1% through Grade 4.

There will be temporary loss of Grade 1, 2, and 4 agricultural land, however, the potential effects on these soils will be temporary and reversible with the application of best construction practices.

There will be permanent loss of Grade 3 agricultural land where permanent limited infrastructure is developed, however, this will be of a minor scale.

There are multiple historic landfills within 500m of the proposed route, with the closest approximately 350m west. There are also a number of authorised landfills within 500m, with the closest approximately 320m west. Due to the distance, disturbance of the landfill sites during construction or operation is unlikely. Consideration may be given to reducing working width near these sites to increase this distance further. Construction and operational effects on landfill sites are considered to be a minor constraint to the scheme.

5.3.1.2 River Delph to FR

Approximately 54% of the proposed River Delph to FR pipeline route passes through Grade 1 agricultural land, 37% through Grade 2, 7% through Grade 3, and less than 4% through Grade 4.

There will be temporary loss of Grade 1, 2, and 3 agricultural land, however, the potential effects on these soils will be temporary and reversible with the application of best construction practices.

There will be permanent loss of Grade 4 agricultural land where permanent limited infrastructure is developed, however, this will be of a minor scale.

The proposed route does not lie within 500m of an authorised or historic landfill site. Construction and operational effects on landfill sites are therefore considered to be a neutral constraint to the scheme.

5.3.1.3 FR to Cambridge Water (South) potable water pipeline

Approximately 16% of the FR to Cambridge Water (South) pipeline route passes through Grade 1 agricultural land, 61% through Grade 2, 21% through Grade 3, and less than 2% through Grade 4.

There will be permanent loss of Grade 4 agricultural land where permanent limited infrastructure is developed, however, the potential effects on these soils will be temporary and reversible with the application of best construction practices.

The proposed route lies within 500m of an authorised landfill site, located approximately 320m north west. Due to the distance, disturbance of the landfill sites during construction or operation is highly unlikely. Consideration may be given to reducing working width near these sites to increase this distance further. Construction and operational effects on landfill sites are considered to be a minor constraint to the scheme. There are no historic landfills within 500m of the route, therefore a neutral constraint to the scheme.

5.3.1.4 FR to Cambridge Water (North) potable water pipeline

Approximately 29% of the FR to Cambridge Water (North) pipeline route passes through Grade 1 agricultural land, 58% through Grade 2, and 13% through Grade 3.

There will be temporary loss of Grade 1, 2, and 3 agricultural land, however, the potential effects on these soils will be temporary and reversible with the application of best construction practices.

There will be permanent loss of agricultural land where permanent limited infrastructure is developed, however, this will be of a minor scale.

The proposed route lies within 500m of several authorised and historic landfill sites. The closest authorised landfill is located approximately 320m north west, and the closest historic landfill is

located approximately 360m west of the route. Due to the distance, disturbance of the landfill sites during construction or operation is highly unlikely. Consideration may be given to reducing working width near these sites to increase this distance further. Construction and operational effects on landfill sites are considered to be a minor constraint to the scheme.

5.3.1.5 FR to Anglian Water potable water pipeline

Approximately 59% of the FR to Anglian Water pipeline route passes through Grade 1 agricultural land, 30.7% through Grade 2, and 10.3% through Grade 3.

There will be temporary loss of Grade 1, 2, and 3 agricultural land, however, the potential effects on these soils will be temporary and reversible with the application of best construction practices.

There will be permanent loss of agricultural land where permanent limited infrastructure is developed, however, this will be of a minor scale.

The proposed route does not lie within 500m of an authorised or historic landfill site. Construction and operational effects on landfill sites are therefore considered to be a neutral constraint to the scheme.

5.3.2 Mitigation

To mitigate against these potential impacts, construction methodologies should seek to incorporate Soil Management Plans to promote sustainable handling during construction and ensure reuse wherever possible. Reusing site soils within landscaping and ecological plans, for instance, represents an opportunity to maximise sustainability. Correct soil handling also ensures that carbon loss from the soil is minimised. Sustainable reuse (e.g., landscaping) has the potential to promote greater carbon storage than current agricultural practices.

To enable this mitigation of impacts on soils, the following activities will need to be carried out:

- Undertaking a detailed soil survey (soil resource survey) to confirm the soil resources present, map the distribution of soil types and inform a soil management plan. This would likely require auger boreholes at appropriate points along the route.
- The stripping, stockpiling, maintenance, reinstatement and aftercare of soil resources should be undertaken in accordance with Defra[17] and British Standards[18,19] soil guidance.
- Producing a soil management plan to detail the above guidance and provisions for stripping, stockpiling, maintenance, reinstatement and aftercare of soil resources.
- During construction activities, a qualified soil scientist to undertake on-site monitoring visits to ensure the good practice and guidance as stated in the soil management plan is followed.

[17] Department for Environment, Food & Rural Affairs. (2009) *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.* London: Defra.

[18] British Standards Institution. (2015) *BS 3882:2015 Specification for topsoil*. London: BSI Standards Limited.

[19] British Standards Institution. (2013) *BS 8601:2013 Specification for subsoil and requirements for use*. London: BSI Standards Limited.

5.4 Scheme summary

Loss of agricultural land to the FR scheme and its associated infrastructure will be unavoidable. Therefore, a key principle for development of the scheme is to avoid losing soil where possible, as this a non-renewable natural resource and vital component of natural capital. Soil resource reuse will therefore be maximised.

The main impacts of construction of the scheme in relation to soil are associated with the temporary disturbance of soil during construction, including during enabling works and permanent loss of agricultural (and notably, BMV) land as well further impact of the loss of stored carbon from the soils.

The impacts of the transfers could be minimised during detail design by careful realignment of the route to avoid areas of BMV (where practicable) and/or use of tunnelling. The construction methodologies should seek to incorporate soil management plans to promote sustainable handling during construction and ensure reuse wherever possible.

The scheme also presents soil enhancement opportunities by reusing site soils within landscaping and ecological plans to maximise sustainability which has the potential to promote greater carbon storage than current agricultural practices.

Further work is required to confirm the desk study outputs through detailed soil resources surveys and implementation of soil management plans into construction methodologies, where required.

6 Water appraisal

6.1 Introduction

This section presents potential impacts on water from the FR scheme. Several areas of work have been undertaken to appraise water-related impacts of the scheme. These include:

- Level 1 and Level 2 WFD assessments for the scheme, to the evaluate impacts on waterbodies affected by the site.
- An preliminary flood risk assessment (FRA) for the scheme, to provide a quantitative analysis of flood risk to support scheme design.
- A water quality risk assessment to support the scheme.
- A scheme-wide SEA for the scheme, which considered aspects related to groundwater and surface water.

The need to consider water is reinforced by national planning policy.

The WFD is transposed into law for England and Wales through *The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003* and updated in 2017[3].

The WFD requires all waterbodies (both surface and groundwater) to achieve 'good status or potential'. The Directive also requires that waterbodies experience no deterioration in status or potential. Good status/potential is a function of GES/potential (biological, physico-chemical and hydromorphological elements and specific pollutants) and good chemical status (Priority Substances and Priority Hazardous Substances).

The ACWG[20] has developed a consistent framework for undertaking WFD assessments for SROs to demonstrate that options will not cause deterioration in status/potential of any WFD waterbodies. The assessment considers mitigation that would need to be put in place to protect waterbody status/potential. The assessment also considers WFD future objectives to ensure the option would not preclude affected WFD waterbodies from reaching good status/potential. The WFD assessments are summarised in section 3.1, and the assessments are provided in Appendix A.1 and the supporting WFD assessment report.

The water industry ACWG provides a framework for undertaking WFD assessments for SROs. WFD assessments have been carried out covering the proposed FR abstractions, indicative transfer routes, reservoir site, and water treatment works. The WFD assessments are summarised in Section 3.1, and a full report of the assessments is provided in Appendix A.1.

When assessing flood risk associated with the reservoir, preliminary flood risk mitigation was developed as part of the gate two design. It analysed flood risk impacts from:

- Residual risk of overtopping assuming the defences remain in place
- Residual risk of flood defence breach assuming the defences remain in place across the rest of the catchment but breach at a single critical breach location
- An emergency drawdown scenario

The water quality risk assessment adopted a system approach (Source – Pathway – Receptor – Treatment Works) to provide a high-level qualitative assessment of water quality in the reservoir, and inform design considerations, and future activities.

[20] All Company Working Group (Nov 2020). Water Framework Directive: Consistent framework for undertaking no deterioration assessments

The SEA considered the scheme including the reservoir waterbody and associated infrastructure, abstractions and transfer routes. As part of the SEA the following aspects relating to water were considered:

- Ground water – Environment Agency Source Protection Zones (SPZs) (SPZ1, SPZ1c, SPZ2, SPZ2c), Environment Agency Groundwater Vulnerability Zones (Major Aquifer High, Intermediate and Low, and Minor Aquifer High, Intermediate and Low), WFD groundwater status, WFD ground water classifications, incursion into aquifers of 'good yield' and 'good quality' under the WFD (Principal aquifer / Secondary aquifer)
- Surface water – Environment Agency flood defences, Environment Agency main rivers, Environment Agency Flood Zone 3 (1 in 100 year), Environment Agency Flood Zone 2 (1 in 1000 year), OS Surface Water Features

A summary of potential effects of the FR scheme on water is provided below.

6.2 Reservoir and associated infrastructure

6.2.1 Surface water

One WFD waterbody (GB205033000050 – Middle Level) was identified as having potential adverse risk as a result of the new reservoir and associated infrastructure.

A potential minor localised risk to the Middle Level (ID: GB205033000050) Channel was identified from the loss of open watercourses (mostly maintained field drains), and loss of up to 1.1% of the catchment for this waterbody due to the presence of the reservoir. This loss of catchment and watercourses could impact on habitat, flow and hydromorphology within this waterbody catchment.

6.2.2 Groundwater

No WFD groundwater bodies were identified within the footprint of the reservoir. Furthermore, there are no Nitrate Vulnerable zones (NVZ) or Groundwater Dependent Terrestrial Ecosystems (GWDTE)s within proximity to the reservoir footprint.

6.2.3 Flood risk

6.2.3.1 Fluvial and tidal flooding

The reservoir is within the Middle Level Commissioner (MLC) IDB district; within Curf and Wimblington combined IDB and Nightlayers IDB catchment. Two watercourses (Forty Foot Drain and Sixteen Foot Drain) flow along the southern and eastern boundaries of the reservoir footprint, with the Counter Drain, Old Bedford River/River Delph and Hundred Foot Drain approximately 3km east. The Hundred Foot Drain is a tidal river and overtopping of this watercourse into the River Delph and subsequently the Old Bedford River/River Delph, may lead to tidal flooding.

The reservoir is located within Flood Zone 3, which means it has a high probability of river, and in this case, tidal flooding. However, the watercourses in the area are embanked channels which effectively means the area benefits from flood defences.

Flood risk studies undertaken to support the scheme conclude that the reservoir is considered to be at low risk from fluvial and tidal flooding. However, should fluvial flood defences fail, a residual flood risk may occur.

6.2.3.2 Surface water flooding

The reservoir is located in the Curf and Wimblington combined IDB catchment and the Nightlayers IDB catchment. Owing to the storage of rainwater within the reservoir, the IDB catchment flowing to Bensons Pumping Station would be captured, inferring that this IDB pumping station would no longer be required. The scheme would therefore lead to a reduction in peak modelled water levels within the Sixty Foot and Forty Foot drain due to the removal of this inflow.

The reservoir is at risk from surface water flooding owing to an increase in impermeable surface, resulting in increasing surface water runoff. A SuDS drainage scheme will therefore be required to ensure drainage from impermeable surfaces is appropriately managed, as well as to manage surface water flood risk to the scheme. The SuDS drainage scheme would assess the surface water flood risk and ensure surface water flooding is not increased elsewhere.

6.2.3.3 Groundwater flooding

The reservoir is considered to be at low risk from groundwater flooding. There are therefore no flood risk impacts from the scheme on this source of flooding.

6.2.3.4 Flood risk from existing reservoirs

The scheme was found to be at low risk of flooding from the existing Ouse Washes FSA. The reservoir footprint may result in a displacement of floodwaters in association with the Ouse Washes FSA.

6.2.3.5 Residual flood risk

The reservoir was found to have residual flood risk from potential breach of fluvial flood defences and the Ouse Washes FSA. The proposed development would lead to a displacement of floodwaters if the flood defences along the left bank of the Sixty Foot Drain or left bank of Forty Foot Drain in the vicinity of the reservoir were to fail. Emergency planning should be updated to reflect this change in risk.

6.3 Abstractions and discharges

6.3.1 Surface water

To provide water to the reservoir, it is proposed that water will be abstracted from River Great Ouse at Earith and River Delph at Welches Dam. Water will be conveyed from the abstraction points on the River Great Ouse and the River Delph to the reservoir for storage. Two WFD waterbodies (GB105033047921 - River Great Ouse (Roxton to Earith) and GB205033000060 - Old Bedford/River Delph (incl. The Hundred Foot Washes) were identified as having potential adverse risks as a result of the new surface water abstraction.

A potential amber adverse risk to biological quality elements within the River Great Ouse (Roxton to Earith; ID: GB105033047921) was identified. Abstraction rates are expected to reduce the flow volume and velocity which is likely to impede fish migration and cause deterioration to the aquatic habitat. A minor localised risk on the hydrological regime and to water quality is also anticipated due to the changes in flow (and therefore dilution of physico-chemicals downstream).

A potential amber adverse risk to the Old Bedford River/River Delph (including The Hundred Foot Washes; ID: GB205033000060) was identified. The abstraction has been modelled with a Hands-off Level (HoL) in place (HoL set at 1.05m). The Level duration curve shows that levels will be reduced across the range of levels and is particularly noticeable during low level periods (below Q90) where levels begin to drop off earlier than without the abstraction. This reduction in

level could lead to a deterioration in hydrological regime from the current High status. Additionally, the hydro-ecology assessment suggests that this change is likely to impede fish migration and cause deterioration to the habitat. A minor localised risk on the hydrological regime and water quality are also anticipated, due to the changes in flow (and therefore dilution of physio-chemicals downstream).

It is assumed good practice design will be implemented for the intake structure. Further investigation is required to determine the extent of impacts. It is recommended additional water quality modelling analysis should be undertaken to assist in determining the appropriate mitigation measures. Further hydraulic modelling is required to determine the extents of the impact within the catchments.

6.3.2 Groundwater

No WFD groundwater bodies were identified within the footprint of the abstractions and discharges.

6.4 Transfers

6.4.1 Surface water

At this stage it is assumed the construction of the pipeline will not involve in-channel modifications to WFD waterbodies. Construction methods are anticipated to involve trenchless activities and therefore the impact on individual watercourse catchments as a result of the pipeline is expected to be negligible risk. As the design processes through to gate three, this may need to be revised.

6.4.2 Groundwater

No WFD groundwater bodies were identified within the footprints of the pipelines.

6.5 Proposed further work

The recommendations identified in the WFD assessment to improve confidence in the assessment of the surface water bodies are set out in Section 3.2.6.

6.6 Mitigation

Potential mitigation measures have been suggested for each individual waterbody and scheme activity based on the risk that it poses. The proposed mitigation measures should be considered and where feasible embedded into the scheme design. The potential mitigation measures relating to the Water Framework Directive are set out in Section 3.2.3. Additional potential mitigation measures are set out below:

- Industry good practice during construction to prevent contamination of ground and surface water.
- A geomorphology walkover should be undertaken at future project stages to understand the status of the waterbodies, to provide suitable mitigation.
- The scheme shall be designed to be resilient to surface water flooding and to reduce residual flood risk.
- Inclusion of a suitable sustainable drainage system (SuDS) drainage scheme at the site to ensure drainage from impermeable surfaces is appropriately managed, as well as to manage surface water flood risk to the scheme.
- Where the indicative transfer route is in proximity to groundwater dependent SSSIs, mitigation measures should be identified that prevents damage to groundwater dependent habitats and plant species. Like-for-like mitigation is required for irreplaceable habitat/plants should there be any permanent loss.

6.7 Scheme summary

6.7.1 Surface water

The WFD concludes that precautionary WFD compliance risks were identified with all of the waterbodies. Adverse risk identified within the WFD level 2 assessment is as follows:

- GB205033000050 – Middle Level: potential minor localised risk.
- GB105033047921 – River Great Ouse (Roxton to Earith): potential amber adverse risk.
- GB205033000060 – Old Bedford River/River Delph (incl. the Hundred Foot Washes): potential amber adverse risk.

The risks identified with the surface waterbodies are due to the loss of open watercourses or with reductions in flow and associated deterioration of biological status elements and water quality.

6.7.2 Groundwater

No WFD groundwater bodies will be impacted by the scheme.

6.7.3 Flood risk

The reservoir is at risk from surface water flooding as well as at residual flood risk from a breach in the fluvial flood defences and a breach in the Ouse Washes FSA.

Assessments considering effects of the transfer routes on the floodplain and on water quality identified moderate constraints relating to water quality for all five transfer routes. This was a result of construction interactions with waterbodies, either through tunnelling, in-river works, or working alongside water. It is recommended that further investigation is undertaken at gate three to identify more site-specific mitigation measures to protect water quality during construction works, including potential realignment of the route and/or the potential need for additional tunnelling. A no or minimal effects were assigned to all routes for effects on the floodplain.

Where a pipeline is in close proximity to groundwater dependent SSSIs and/or groundwater dependent terrestrial ecosystems, mitigation measures should be implemented to prevent deterioration to the habitats and plant species.

Like-for-like mitigation is required for irreplaceable habitat/plants should there be any permanent loss. Approaches to mitigation could include standoff zones during construction, and the specific monitoring of sites. Consultation with Natural England will be required.

7 Carbon appraisal

7.1 Introduction

A whole-life carbon assessment, covering an 80-year period, has been undertaken along with a review of the opportunities to mitigate emissions across the life of the asset.

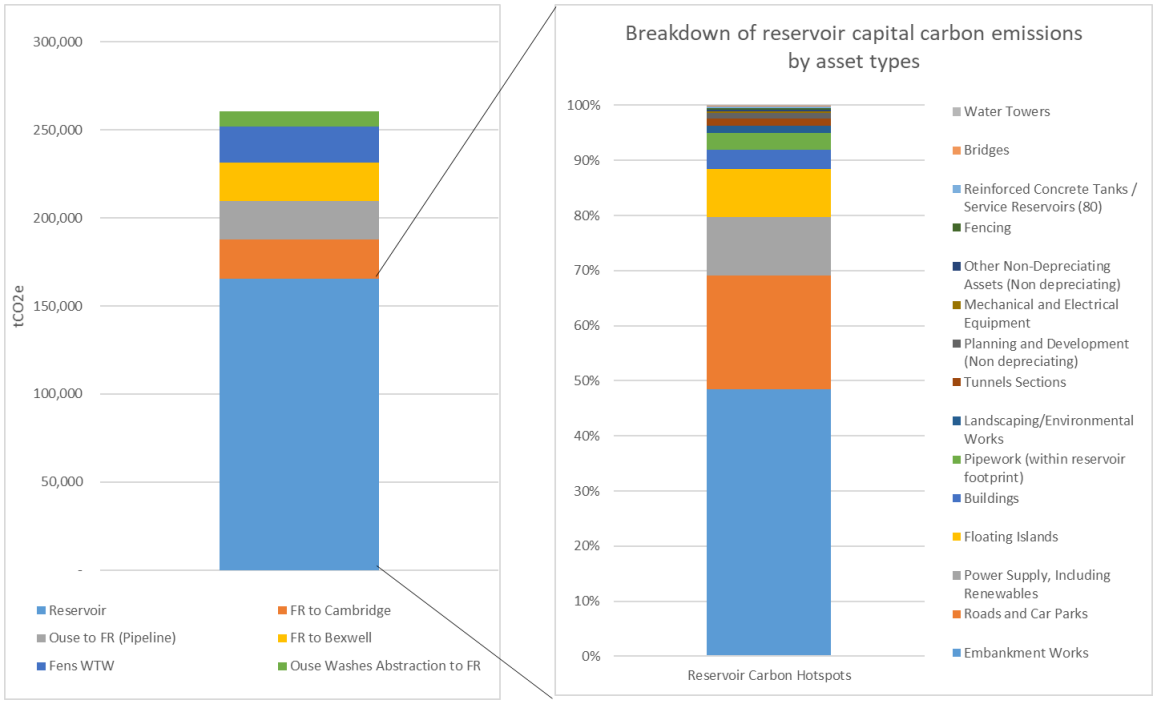
The carbon assessment and emissions mitigation approach has followed PAS2080[21] principles, having focussed on:

- Establishing a baseline assessment to determine carbon hotspots
- Identifying opportunities through the design, construction and supply chain to further mitigate emissions
- Prioritising emissions reductions to minimise residual emissions before developing a detailed carbon offsetting strategy
- Aligning with targets to achieve net zero operational emissions by 2030.

7.2 Assessment of capital carbon

Figure 7.1 summarises the capital carbon assessment. The total scale of capital carbon emissions is estimated to be 247,160tCO_2e (tonnes of Carbon Dioxide equivalent) and the capital carbon 'hotspots' identified at this stage of the design.

Figure 7.1: Total capital carbon of scheme and breakdown of reservoir carbon emissions by asset type



[21] PAS 2080 is a global standard for managing infrastructure carbon and has been authored to meet World Trade Organization requirements. The framework looks at the whole value chain, aiming to reduce carbon and reduce cost through more intelligent design, construction and use.

Table 7.1: Capital carbon hotspot summary

Scheme element	Capital carbon contribution
Reservoir embankment works	Reservoir embankment works account for 32% of total capital carbon emissions for the scheme and approximately 53% of the reservoir emissions. The majority of these emissions are driven by earthworks shift and haulage, including construction of associated haul roads and imported materials.
Transfer pipelines and pumping stations	The transfer pipelines account for 30% of scheme capital carbon emissions, with River Great Ouse to Fens Reservoir accounting for 9%, River Delph to Fens Reservoir 3%, FR to Anglian Water 9%, and FR to Cambridge 9%. The scheme accounts for steel pipe material and this contributes the majority of emissions followed by the excavation and reinstatement works required.
Water treatment	The water treatment works accounts for a total of 8% of scheme emissions. The majority of these emissions are associated with civil structures required for process units and associated buildings.
Roads	Reservoir roads account for 8% of scheme emissions, predominantly driven by the largescale perimeter roads and footpaths around the reservoir.
Buildings	Visitor centre buildings account for 2% of scheme capital carbon emissions. These have not been modelled in detail and will be refined as the design detail is developed.
Solar Power	The floating and land solar power arrays have been estimated to account for 7% of capital carbon emissions of the scheme but will also provide renewable power to be utilised on site.

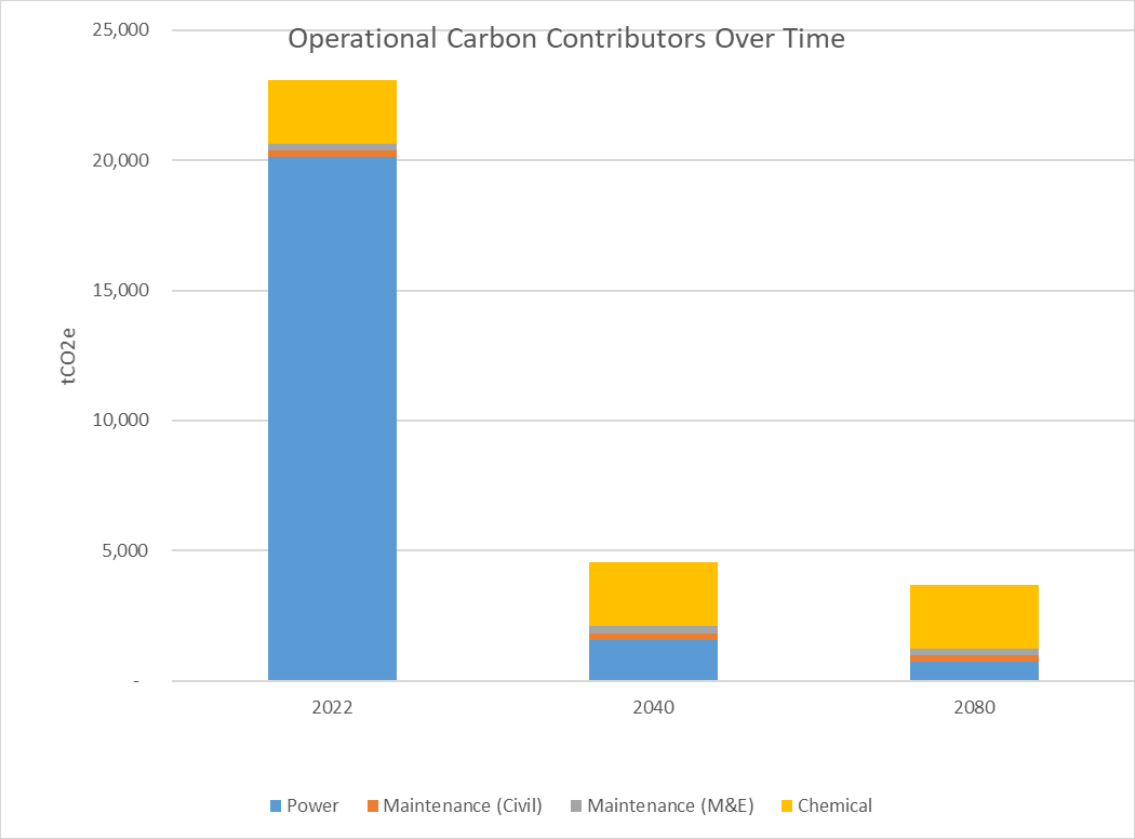
7.3 Assessment of operational carbon

Figure 7.2 summarises the total operational carbon emissions presented at three different time frames to highlight the impact of the predicted rate of grid decarbonisation on the scale of emissions associated with power consumption of the scheme. These include:

- Present day using the Defra 2021 emission factor for grid power consumption
- 2040 using BEIS grid carbon intensity forecasts (representing the forecast timeframe by when Fens Reservoir may become operational)
- 2080 using BEIS grid carbon intensity forecasts (representing predicted future grid carbon intensity impact)

Operational carbon is dominated by power and chemical consumption. At current day (2022) grid carbon intensity, power emissions account for ~87% of annual operational emissions. By 2040, when the scheme may come into full operation power emissions are estimated to contribute 35% of annual operational emissions and chemical consumption for water treatment becoming the major operational emissions source at 54%. This highlights the impact of predicted UK grid carbon decarbonisation, without accounting for the significant renewables also included within the Fens Reservoir scheme, which further reduces the emissions associated with power consumption. The assessment does not currently account for future decarbonisation of chemicals as no reliable future forecast is available for the future carbon intensity of the chemicals required for the WTWs. This is an area where the scheme and wider sector will need to work closely with the chemicals supply chain to drive decarbonisation across the life of the asset.

Figure 7.2: Total operational carbon in 2022, 2040 and 2080 grid carbon intensities at 100% utilisation



7.4 Assessment of whole-life carbon

A whole life carbon assessment has been undertaken aligned to the same parameters as the whole life cost assessment and extending over 80 years. The assessment is based on 100% utilisation of the scheme at 87Ml/d and accounts for average utilisation rates for the reservoir filling components to allow maximum deployable output to be achieved by the overall scheme.

Total whole life carbon emissions are estimated at 500,120CO_2e.

The breakdown of whole life carbon is presented in:

- Figure 7.3 – showing annual emissions across the life of the scheme by emissions category
- Figure 7.4 – showing cumulative annual emissions across the life of the scheme by emissions category

Figure 7.3: Annual emissions across the life of the scheme by emissions category

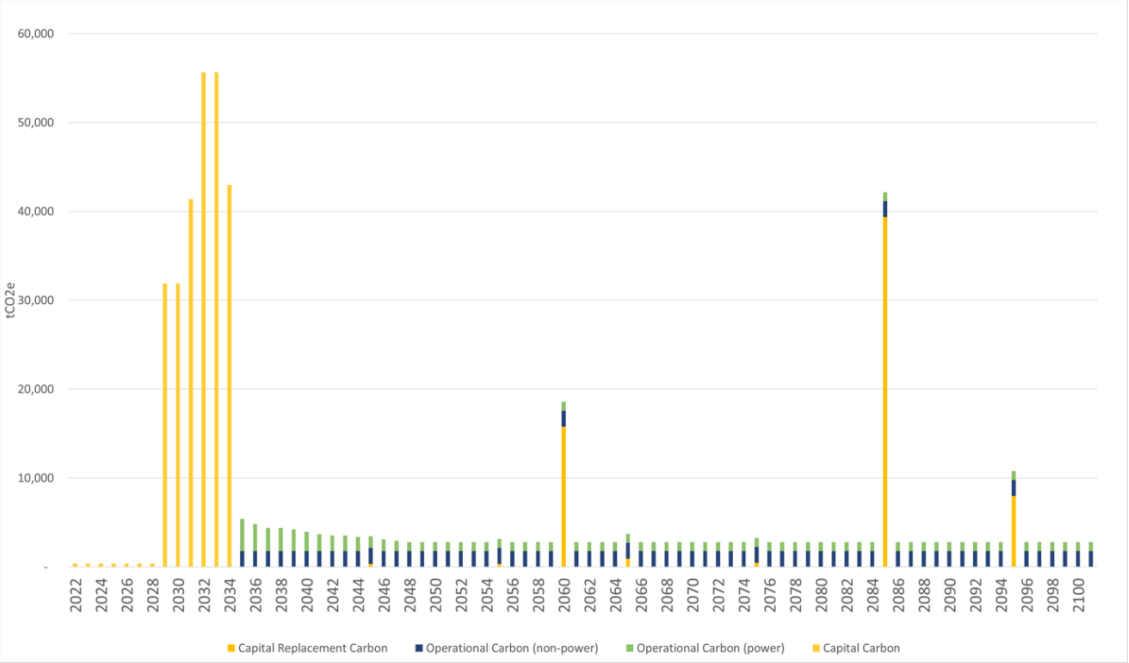


Figure 7.4: Cumulative annual emissions across the life of the scheme by emissions category

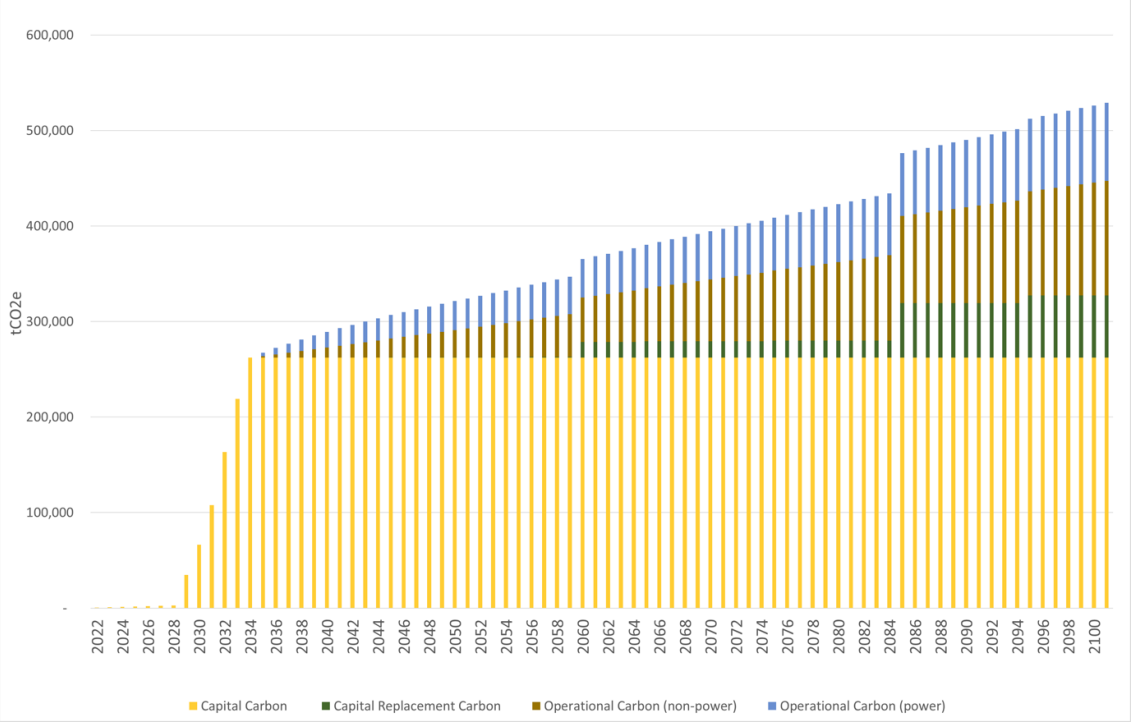


Table 7.2: summarises the main emissions categories across the whole life of the scheme and also provides the estimated carbon costs as a net present value (NPV) for each emissions category. The total Carbon NPV is estimated at £85m. The table highlights that capital carbon emissions account for approximately 64% of carbon costs, followed by non-power related operational carbon at 17%. Capital replacements and power related operational emissions account for 6% and 13% of emissions respectively. These carbon costs can be used to further assess cost efficiency of future mitigation measures as alternatives are tested in more detail at later design stages.

- Capital carbon, all emissions associated with the construction and delivery of the scheme, account for 50% of whole life carbon. This highlights the importance of continuing to explore opportunities with supply chains to decarbonise key construction activities and materials in the build of the scheme delivery.
- Non-power related operational emission mainly associated with chemical consumption are estimated to contribute 24% of whole life emissions. This highlights the importance continuing to optimise the design of the WTWs to minimise chemical consumption and work with the supply chain to understand the potential to decarbonise to production and supply of these chemicals.
- Power related emissions are estimated to contribute 16% of whole life carbon, the scheme already has ambitious plans to generate renewable power and further work will be explored to maximise the utilisation of the power generated, as well as improve the efficiency of pumping and treatment processes.

Table 7.2: Summary of whole life carbon emissions and associated carbon costs

Emissions type	tCO_2e	% total emissions	Carbon £M NPV	% carbon costs
Capital Carbon	248,738	50%	51.3	64%
Capital Replacement Carbon	51,824	10%	5.0	6%
Operational Carbon (non-power)	117,635	24%	13.9	17%
Operational Carbon (power)	81,923	16%	10.4	13%
Total	500,120		84.5	

7.5 Opportunities for carbon reduction

The key mitigation opportunities to reduce carbon in the scheme design and operation are summarised in Table 7.3. Further opportunities for carbon reduction to be explored further as the scheme evolves are presented in Table 7.4. Both tables also provide an indication of the areas of supply chain and wider stakeholder engagement required to drive these opportunities through to realised emissions reductions.

Table 7.3: Carbon mitigations embedded within the existing design

Scheme area	Mitigation measures	Supply chain engagement requirements
Cut-fill balance	The site selection process considered a number of factors including whole life carbon emissions. A key driver for both cost and carbon was identifying a site where a cut-fill balance could be achieved thus reducing the need for import and disposal of surplus materials. The best performing site was one of the lowest whole life carbon options of those considered.	Not applicable
Renewables	The scheme has made allowances for significant land and floating solar array infrastructure to generate renewable power	District Network Operators and other power users to maximise value of renewables in the region

Table 7.4: Carbon mitigations opportunities as scheme evolves

Scheme area	Mitigation measures	Supply chain engagement requirements
Low carbon construction plant	The earthworks element of the reservoir construction is the largest hotspot area of the scheme. A significant proportion of this is driven by the fuel used in the construction plant to carry out the earthworks. The current assessment has been undertaken assuming conventional plant using diesel fuel. However, there are significant savings possible through further exploration of use of alternative fuels, such as Hydrogenated Vegetable Oil (HVO), hydrogen or electric for smaller scale excavations. These alternative fuels would also have knock on air quality impacts during the construction programme.	Equipment manufacturers HVO suppliers Hydrogen suppliers Other asset owners: Highways England, Defra, EA Other water companies delivering similar schemes
Low carbon construction materials	There are significant emissions associated within the embodied carbon of construction materials used. Particularly for substantial civil structures for the WTWs and also temporary and permanent road structures. The opportunity to work with the supply chain to identify low carbon alternatives for concrete, steel, pipelines and other construction materials can have a significant impact on the scheme. There is also opportunity to engage with the supply chain to help support them to	Contractors Concrete suppliers Structural steel suppliers Road and temporary road product/material suppliers

Scheme area	Mitigation measures	Supply chain engagement requirements
	decarbonise the products and materials they supply.	
Efficient construction approaches	The use of efficient construction approaches that improve fuel and resource efficiency during delivery of the scheme will be explored in more detail as the scheme design detail develops. This includes consideration of automation and opportunities to minimise waste generated though construction.	Contractors
Transport of materials – Opportunity for water transport of materials	Transport of construction materials can contribute significant emissions but also have implications on road congestion and air quality. There is an opportunity for the scheme to develop and utilise water transport for construction materials, which has the potential to then be integrated and utilised for navigation post construction.	Product and material suppliers
Multi-sector opportunities	The Fens Reservoir scheme has further opportunities to integrate with the wider region and potentially support multi-system benefits, including supporting regional decarbonisation efforts. These opportunities continue to be explored with relevant stakeholders across the region.	Regional stakeholders
Maximise land-use benefits	As the scheme progresses there will be greater detail built into maximising the value generated within and beyond the scheme footprint. This will focus on maximising overall value, incorporating water quality, flood defence, biodiversity and carbon sequestration benefits to help offset residual emissions associated with the scheme.	Various technical disciplines and regional stakeholders

Overall, the scheme at its current stage of design has looked to minimise carbon impacts whilst maximising water supply and wider environmental benefits within the region. However, there are still significant opportunities available to further mitigate the whole life emissions associated with the scheme. As the scheme progresses to gate three and beyond, it is expected more mitigation measures will be embedded into the scheme design and costing and a detailed offsetting plan to cover the remaining residual emissions will be developed. The scheme carbon assessments will continue to be updated as the design evolves.

8 Landscape and visual appraisal

8.1 Introduction

This section presents potential impacts on landscape from the FR scheme. The appraisal of landscape effects associated with the indicative transfer routes and associated infrastructure have not been undertaken, this will be assessed as the project progresses. At this stage, only a short summary of the potential effects from these elements has been made.

The objectives of the section are to establish the landscape baseline associated with the scheme, and identify constraints, opportunities, and issues that require further investigation. Landscape considerations will be integral to the design of the FR scheme.

The judgement concerning susceptibility to the type of change proposed is made by considering the nature/characteristics of the change and receiving landscape and visual receptors, upon site selection and concept design, further evaluation of receptor value and appraisal of effects will provide a clearer indication of the likely magnitude of impact.

To inform the assessments, the following sources of information relating to landscape and visual amenity were considered:

- Statutory landscape designations (National Parks, Areas of Natural Beauty (AONB)) identified using MAGIC
- Non-statutory designations identified using data from Natural England and local development plans
- National landscape character assessments including No. 46 The Fens
- Local landscape character assessment including the landscape character assessment of the River Delph[22] and the Cambridgeshire Landscape Guidelines1991 Cambridgeshire County Council as referenced in East Cambridgeshire Local Plan[23]
- Public Right of Way (PRoW), national trails and Sustrans cycle routes using MAGIC
- Common land/open access land
- Green infrastructure strategies
- Greenbelt designated land
- Topography
- Other resources including Google Streetview were also utilised as necessary

Other data sources that primarily informed appraisal against other environmental topics were also considered, for example historic landscape appraisal, conservation area maps and appraisals, historic parks and gardens and historic battlefields, scheduled monuments and listed buildings, ancient woodlands, and wetlands.

[22] Ouse Washes, (no date). Landscape Character Assessment. Available at: Landscape_Character_Assessment-low-res.pdf (ousewashes.org.uk)[Accessed 05/05/2022]

[23] East Cambridgeshire District Council, 2015. East Cambridgeshire Local Plan Adopted April 2015. Available at: https://www.eastcambs.gov.uk/sites/default/files/Local%20Plan%20April%202015%20-%20front%20cover%20and%20inside%20front%20cover_0.pdf[Accessed 05/05/2022] and Cambridge City Council, nodate. Cambridgeshire Green Infrastructure Strategy Appendix 9. Available at: Landscape Character (cambridge.gov.uk)[Last accessed 05/05/2022]

The assessment criteria used to determine the likely landscape and visual impact upon the introduction of a reservoir draws upon the good practice methodology highlighted within the 'Guidelines for Landscape and Visual Impact Assessment: Third Edition' (Landscape Institute, LI, and Institute of Environmental Management and Assessment, IEMA, 2013) and 'Landscape Character Assessment – Guidance for England and Scotland' (Countryside Agency/Scottish Natural Heritage, 2002). It should be noted that a full assessment using the above methodology is not provided at this stage. Following the above guidance, this section addresses landscape character and visual amenity separately.

The assessment does not identify sensitive visual receptors or the impact on their views because this would require more detailed design information and confirmation on site. It is acknowledged that the scheme, particularly the reservoir component, will incur potentially significant visual changes for local residents living adjacent to it. This will be an important consideration as the project progresses through its development stages.

8.2 Reservoir and associated infrastructure

8.2.1 Overview of landscape character

Desk-based assessments indicated the site falls within the Fens National Character Area profile (46). The Fens are notable for the large-scale, flat, open landscape. The open topography allows an appreciation of the vast Fenland skies which convey a strong sense of place and tranquillity.

There is no published landscape character assessment for Fenlands District Council, however, the River Delph landscape character assessment and preliminary site surveys identified the key landscape characteristics of the study area.

Elevations rarely pass the 10m contour height, and typically vary by little more than one or two metres over long distances. All rivers have artificial canalised alignments and are bounded by high banks to contain the watercourse from the lower adjacent fields. Settlements and isolated farmsteads are mostly located on the modestly elevated 'geological islands' and the low, sinuous roddon banks (infilled ancient watercourses within fens). Elsewhere, villages tend to be dispersed ribbon settlements along the main arterial routes through the settled fens, and scattered farms remain as relics of earlier agricultural settlements.

The area has a distinctive fen and 'Fen Isle' topography with the settlements of Chatteris, Doddington, Wimblington and Manea on higher ground. This is a well-managed but intensively farmed Fenland landscape. Drains, drove tracks and roads follow straight linear alignments. Conservation areas are designated for the settlements of Doddington and Chatteris. Noted heritage features associated with Honey Hill, Stonea Camp and Forty Foot drain (between the Sixteen Foot Drain and the Counter Drain) are key elements in the landscape. Man-made features are present including the embanked rivers, drains and in the wider context wind turbines and the River Delph. The area has some sense of tranquillity. No statutory landscape designations were recorded that could be affected by the scheme.

Several PRoW and a byway cross the wider study area, notably following the Forty Foot and Sixteen Foot drains and link to Doddington and Mount Pleasant. However, PRoW and cycling connectivity from the main settlements and the wider study area is limited.

Table 8.1 Key landscape features, sensitivities and constraints

Landscape features	Potential impacts	Potential mitigation
Fen Isle and contrasting open peat fen topography Landscape Setting for Chatteris, Manea and Doddington Distinctive topography and settlement pattern Long views from higher ground.	Adverse effect on landscape setting, sense of place and long views.	Scale of proposed earthworks and extensive flat topography limit options to mitigate impacts. However, careful and sensitive design of the embankments and use of planting may help reduce some visual effects.
Drainage channels including the Forty Foot and Sixteen Foot drains	Loss of landscape features but Forty Foot and Sixteen Foot drains not directly affected.	N/A
Historic tracks, green lanes and drove roads with associated PRoW and byways	Some severance of routes linking settlements.	Some links may be lost but alternative routes could be provided around the reservoir.

The presence of the reservoir would have an adverse effect on landscape setting of the Fen Isle topography. The reservoir would be an uncharacteristic element in the landscape. However, the rising ground to the north-west could be utilised to soften the overall earthworks appearance. There would be a loss of landscape features but the Forty Foot and Sixteen Foot drains would not be directly affected. PRoW would be directly affected but could be re-provided.

Along the indicative transfer routes, there would a temporary effect on local landscape character due to construction activity and the loss of landscape cover (mainly arable land). However, it is expected that the pipelines would be located underground, and the land reinstated to the previous land use following construction. There would be localised effects on landscape character during operation from permeant structures associated with the transfers, such as intake pipes and pumping stations.

8.2.2 Overview of visual amenity characteristics

The Doddington Conservation Area appraisal sets out that the natural flatness of the Fenland landscape results in dramatic wide expanses of sky in all long ranging views, broken up by the occasional cluster of trees, agricultural structures or the presence of modern wind turbines, several of which are now sited within the parish[24].

Long open views are possible from Chatteris, Doddington and Manea and notably from the local roads (A141, A142 and B1098) and PRoW. There are no protected views identified in the local plan. No principal views or vistas into and out of the Doddington conservation area are noted in the conservation area appraisal that would be affected by the proposals.

The extensive flat topography of the Fens landscape surrounding the site is reflected in the predicted visibility of the reservoir. The higher ground to the north-west around Doddington and Wimblington and to the south associated with Chatteris contain the visibility of the proposed reservoir. Also notable is the effectiveness of existing vegetation, where present, in filtering and screening views in the flat landscape.

The proposed reservoir would create a visually dominant element in the local landscape. The scheme would be prominent in views from the Fen Isle settlements, creating a new skyline in open and partly filtered views for residents in properties along the edges of settlements. In the flat, fenland landscape setting, the presence of intervening built elements and vegetation could provide effective in filtering views, where present.

[24] Fenland District Council, 2011. Doddington Conservation Area Appraisal October 2011. Available at Doddington Conservation Appraisal - FINAL VERSION - March 2011 (fenland.gov.uk) [Accessed 05/05/2022]

The majority of the visual effects associated with the indicative proposed transfers would be temporary in nature and associated with the construction phase. It is expected that the pipelines would be located underground, and the land cover reinstated to its previous use following construction. However, there would some visual effects during operation from permanent new structures associated with the transfers, such as intake pipes and pumping stations. Mitigation will be required for the permanent structures once their locations have been confirmed at the next stage of scheme design.

Table 8.2: Key Visual Amenity Sensitivities and Constraints

Key Views	Potential Impact	Potential mitigation measures
Views from Chatteris and Doddington	The scheme would be prominent in elevated views from the Fen Isle settlements, creating a new skyline in open and partly filtered views for residents in properties along the edges of the settlements	Careful design of embankments. Off-site planting may partly filter views. Small scale blocks of tree planting would be compatible with the existing landscape character. On-site planting would aid in breaking up the visual mass of the earthworks.
Views from Manea	The reservoir would be noticeable on the skyline in partly filtered views from the settlement.	Careful design of embankments. On-site planting would aid in breaking up the visual mass of the earthworks.
Views from PRoW and local roads (A141, A142 and B1098) and scattered properties.	The reservoir would be dominant on the skyline.	Careful design of embankments. Off-site planting may partly filter views. On-site planting would aid in breaking up the visual mass of the earthworks.

8.2.3 Key landscape opportunities

Landscape enhancement opportunities include the retention of existing important landscape and ecological features such as areas of lowland fen habitat and associated prominent tree blocks identified on site and incorporating wider habitat linkages and habitat creation to extend these areas. Tree cover associated with these habitats would provide additional landscape screening elements. Extensive areas of tree planting are not characteristic of the area and the any potential planting would build on the existing pattern of tree cover, which in a flat landscape can be effective in integrating large scale elements into the landscape.

The earthworks design could incorporate micro variation in plan and profile of the reservoir embankments to create visual interest and increase biodiversity. Areas adjacent to the reservoir footprint could be considered for the suitability for the development of wetlands and grassland habitats with the benefits of improving the water quality and habitat value. Habitat creation and enhancement on site, along the Forty Foot and Sixteen Foot Drains and creating linkages to wider initiatives such as Network Enhancement Zones and Fens for Future Partnership Landscape Corridors.

Opportunities to improve green infrastructure through the creation of a footpath and cycle network incorporating the site and connecting to settlements of Chatteris and Doddington. Provision of public open space as a recreation destination associated with the reservoir linking with onsite multiuse recreation routes

Table 8.3 Key landscape opportunities for the site:

Opportunity	Existing opportunity/feature	Location
Enhancement of connectivity to long distance walking trails, national cycling network and navigation routes.	Limited existing long-distance trails/routes within the study area. Opportunity to improve PRoW within the site area and promote wider links beyond the site through third parties. Opportunity to improve navigation routes along Forty Foot Drain with potential for longer distance 'Fens links' connecting Peterborough, Cambridge avoiding the tidal reach at Denver requiring a new lock at Earith.	Enhance linkages within the site. Links outside the site delivered by third parties.
Enhancement of local PRoW routes linking Chatteris, Doddington, Welches Dam (and Ouse Washes) to adjacent settlements.	A number of PRoW and a byway cross the wider area. Opportunity to improve PRoW within the site area and promote wider links beyond the site through third parties.	Connectivity using the reservoir embankments. Wider links beyond the site polygon.
Creation of a recreation destination.	Creation of recreation facilities would benefit local communities in an area of lower economic activity. Potential to create wider links to heritage assets at Honey Hill and Stonea Camp to the north together with ecological links to the Wimblington Common, Welches Dam and the Ouse Washes.	Wider links beyond the site polygon.
Green Infrastructure connectivity/opportunities identified in East Cambridgeshire Local Plan Fens for The Future and Ouse Washes.	Limited areas of connected green infrastructure and poor public access. Green Infrastructure opportunities identified include the following within the wider area: Target areas for Sustainable, 'wildlife friendly' farming. The proposed priority landscape corridor focused along the Forty Foot drain and secondary corridor along the Sixteen Foot drain linking to the fenland restoration initiative at Block Fen.	Limited areas of connected green infrastructure and poor public access. Green Infrastructure opportunities identified include the following within the wider area: Target areas for Sustainable, 'wildlife friendly' farming. The proposed priority landscape corridor focused along the Forty Foot drain Secondary corridor along the Sixteen Foot drain linking to the fenland restoration initiative at Block Fen.

8.2.4 Scheme summary

The key impacts due to the construction and operation of the overall scheme in relation to landscape character would be an adverse effect on landscape setting of the Fen Isle and flat fen topography. The reservoir would be an uncharacteristic, dominant element in the local landscape. The scheme would be prominent in some views from the Fen Isle settlements, creating a new skyline in open and partly filtered views for residents in properties along the edges of settlements and from PRoW. In the flat, fenland landscape setting, the presence of intervening built elements and vegetation could provide effective filtering of views where present. The majority of landscape effects for the proposed transfers would be temporary in nature and confined to the construction phase, with the exception of a small number of permanent built structures.

The mitigation measures could include the incorporation of targeted off-site planting of small scale blocks of tree planting, that would be compatible with the existing landscape character, to partly filter views and strengthen the tree cover pattern associated with settlement edges. On-site planting would help in breaking up the visual mass of the earthworks. The scheme also presents landscape enhancement opportunities through habitat creation and enhancement on site, along the Forty Foot and Sixteen Foot Drains and through creating linkages to wider initiatives such as Network Enhancement Zones and Fens for Future Partnership Landscape Corridors. Recreation opportunities to improve green infrastructure through the creation of a footpath and cycle network incorporating the site and connecting to settlements of Chatteris and Doddington. Provision of public open space as a recreation destination associated with the reservoir linking with onsite multiuse recreation routes.

9 Historic environment appraisal

9.1 Introduction

This section presents potential impacts on designated and non-designated heritage assets and unknown archaeology from the FR scheme. The objectives of the section are to summarise the historic environment baseline associated with the scheme, and identify constraints, opportunities, and issues that require further investigation.

The need to consider the historic environment is underpinned by legislation (Ancient Monuments and Archaeological Areas Act 1979 and Planning (Listed Buildings and Conservation Areas) Act 1990), Infrastructure Planning (Decisions) Regulations 2010 and planning policy.

The appraisal of constraints and opportunities in relation to the historic environment focussed on the potential for impact on built heritage, historic landscape and archaeological remains.

To inform the appraisal in relation to historic environment considerations, a preliminary visual appraisal was undertaken and a review of the archaeological and historic baseline, including a brief remote sensing appraisal.

Construction and operational effects were considered on statutory designated heritage assets including Listed Buildings, Scheduled Monuments and Conservation Areas, and other heritage assets such as Registered Parks and Gardens and Battlefields.

The overarching assumptions and limitations outlined in Section 1.7 apply to the appraisal of historic environment as do the following issue-specific limitations:

- Information available about the historic environment depends on previous opportunities for research, fieldwork and discovery, and therefore may be limited – where nothing of historic interest was shown in a particular area, this could have been down to lack of targeted research or investigation rather than the genuine absence of sub-surface archaeological deposits
- Documentary sources are rare before the medieval period, and many historic documents are inherently biased – older primary sources often fail to accurately locate sites and interpretation can be subjective
- Historic maps provide a glimpse of land-use at a specific moment – it is therefore possible that short-term structures or areas of land-use are not shown and therefore not recorded within this assessment.

9.2 Reservoir and associated infrastructure

Desk-based assessments outline that the reservoir site lies within a predominantly low-lying area to the east of Doddington and north of Chatteris. The area would have been dry until the later Neolithic and early Bronze Age period, when it was subject to marine inundation and peat formation. There is a lack of archaeological evidence for prehistoric and Roman activity at the site. However, there is extensive activity on Honey Hill to the east, where Bronze Age barrows and an Iron Age Roman settlement have been identified. Bronze Age funerary activity has been identified on the area of raised ground within the north-western part of the site and there is potential for further prehistoric activity.

There is very little evidence for early medieval activity, however during the medieval period Doddington became the centre of the parish and was the site of a bishop's palace (now a Scheduled Monument) for the Bishops of Ely. This also had a deer park which extended into the north-west part of the site and Fentons Lode, a navigation channel, also likely extended into the site during this period.

A number of drainage channels were constructed in the post-medieval period to allow agricultural production. This includes the Forty Foot and Middle Level drains which run to the south and east of the site, and were designed by Vermuyden, a Dutch engineer and key figure in the history of Fens drainage. A number of wind pumps and later engine houses are recorded alongside the drains to aid drainage.

Within 1km of the reservoir site, 23 designated heritage assets have been identified. These include two Grade I Listed Buildings, one Grade II* Listed Building, 141 Grade II Listed Buildings, three Scheduled Monuments, and one Conservation Area. In addition, eight non-designated assets are recorded on the Historic Environment Record (HER) within the reservoir footprint, and five within 100m of the boundary. They range in date from the Mesolithic to the post-medieval period and range from negligible to medium value.

The Moated bishop's palace at Manor Farm is designated as a scheduled monument and is located approximately 190m north-west of the reservoir waterbody. The manor was a high-status domestic residence and appears to have been established in the 13th century. There were a number of manorial and religious buildings recorded but it was converted to secular use by the 15th century. It was then utilised as a farmstead from the 19th century onwards. The moated site itself is broadly square, measuring around 105m² with an inner bank that is 3m wide and 0.5m high. The site is contained by a partially water-filled moat which measures 6-12m wide and up to 2m in depth. The asset derives its value from its historic and archaeological interest. The historic interest derives from the continued occupation of the same site from the 13th century, as well as demonstrating past religious and secular manorial history. The archaeological interest derives from the asset's ability to retain evidence for buried structures and other features relating to the character and development of the site. It has been identified as a key heritage asset that the reservoir will interact with. Due to the close proximity of this asset, it has been subject to a high-level statement of significance and setting assessment. It has not been possible to ascertain if there are upstanding remains associated with the Scheduled Monuments identified to the east of the site, and so these have not been appraised at this stage.

The asset also has group value with the Great Park, a medieval deer park which lay to the south-east. The asset sits in a relatively isolated position away from the main village of Doddington and in a predominantly agricultural, flat landscape. The island is surrounded by a densely vegetated boundary, which reduces the connection of the asset with the surrounding landscape. Whilst there is an association with the Great Park through group value, there appears to be no upstanding features associated with this asset. The park appears to survive as buried archaeological remains and provides no physical connection to the moated manor. The setting as it is currently understood, therefore does little to contribute to our understanding of the asset and its value.

Key historic constraints identified are detailed in Table 9.1.

Table 9.1: Key constraints associated with the historic environment within the scheme

Key issue	Implication of scheme development
Scheduled monuments on Honey Hill and the moated bishops' palace	The construction of the reservoir could block views to and from the scheduled barrows on Honey Hill. However, further work is needed to ascertain whether these still survive as upstanding monuments. The reservoir would also remove the remains of the deer park, which has group value with the moated palace. Again, further work would need to ascertain if there are any upstanding remains associated with this asset.
Designated assets identified	There is potential for assets to experience an impact on their value, as a result of change within their setting. The extent of this impact will depend on the design of the final scheme. Some assets identified may not be impacted by the final scheme and additional assets may be identified at later stages.
Designated assets in Doddington	The open fen landscape contributes to the value of designated assets within Doddington. The scheme would change the open, agricultural landscape, and potentially altering the setting of the Doddington Conservation Area. This could potentially impact on the value of the conservation areas as it could alter their character. The scheme could also alter views from the site towards local landmarks within these settlements.
Archaeological remains	There is high potential for archaeological remains to survive within the site. Any settlement sites of prehistoric date could be regionally significance and therefore of medium value. The construction of the reservoir would truncate and remove archaeological remains which at present, are not fully understood.

Table 9.2 summarises potential opportunities for mitigation of impacts on heritage assets.

Table 9.2: Potential measures to mitigate impacts on the historic environment at the scheme

Approach	Mitigation measures proposed
Embedded mitigation	The landscape design of the reservoir should look to minimise the impacts of changes to setting and key views. Specific measures could include: • Where possible, key views identified, should be retained or adapted. • Appropriate landscape earthworks should be utilised to minimise the scale of the reservoir. • Planting that is appropriate to the fens landscape to reduce and visually break up the scale of embankments. • Redesign to avoid significant archaeological remains through retention in situ.
Archaeological assessment/mitigation	The programme of archaeological mitigation proposed would form an evaluation phase, to assess the nature, extent and significance of the archaeological resource within the site. This should be designed in consultation with relevant stakeholders. These works would likely lead on to a full programme of excavation. Evaluation and excavation does not mitigate the loss of heritage assets but helps to offset the effect and retain an understanding of the historic environment. The archaeological mitigation programme could include: • Assessment of deep sediment sequences, through deposit modelling. • A programme of fieldwalking and trial trenching is also recommended to complement the programme of geoarchaeological works. This should focus on areas of higher ground and target known non-designated heritage assets, such as the deer park and undated cropmarks. • Additional aerial investigation would be essential to gain a more thorough understanding of the archaeological evidence.

The programme of archaeological mitigation also presents opportunities to enhance understanding of the historic environment. Specific measures could include:

- Education and outreach programmes designed to explain and interpret the historic environment.
- Community engagement through online and in person events throughout the mitigation programme.
- Working with land-based disciplines including landscape and ecology to produce trails, walks and viewpoints with digital and/or permanent viewpoints/display boards, which explain the historic landscape around Doddington, Chatteris and the Fens.
- Interpretation boards and displays of artefacts derived from the mitigation within a visitor's centre, detailing the development of Doddington, Chatteris and the Fens as a landscape.

9.3 Transfers and associated infrastructure.

The appraisal of transfers and associated infrastructure summarised below is based on indicative broad corridors only. Further work to confirm the exact locations, considering any heritage constraints in more depth, will be undertaken at the next stage of scheme development.

9.3.1 River Great Ouse to FR

There are a number of listed buildings (Grade I, II, and II*) within 500m of the indicative route, which are primarily situated within Cambridge Water (North), Colne, and Earith. The closest listed building is the Grade I Parish Church of St Mary building which is located approximately 110m west of the route. A reduced working width can be utilised near these assets to minimise disturbance, which will only be temporary during construction. The operation of the transfer will not affect statutory designated heritage assets as it will be below ground level with the ground reinstated following completion of works. The majority of assets are located over 300m from the proposed transfer, with hedgerows, treelines, or urban areas block views of the temporary construction works, thereby limiting impacts on the settings of heritage assets. There are no scheduled monuments or world heritage sites located within 500m of the transfer route. Construction and operational effects on statutory designated heritage assets are considered to be a minor constraint to the scheme.

There are two conservation areas located within 500m of the transfer route: Earith, located less than 30m east of the buffer and Cambridge Water (North), located approximately 360m north east. A reduced working width can be utilised near these areas to minimise disturbance, which will only be temporary during construction. Hedgerows, treelines, other infrastructure (such as road networks), or urban areas block views of the temporary construction works, thereby limiting minor impacts on setting. The operation of the transfer will not affect the conservation areas as it will be below ground level with the ground reinstated following completion of works. There are no registered parks gardens or battlefields within 500m of the transfer route. Construction and operational effects on other statutory designated heritage assets are considered to be a minor constraint to the scheme.

9.3.2 River Delph to FR

There are a number of scheduled monuments within 500m of the route, the closest approximately 110m north (Romano-British settlement near Honeybridge). There will be no direct effect on this site and a reduced working width can be utilised near these assets to minimise disturbance, which will only be temporary during construction. The use of qualified archaeologists to provide a watching brief during the construction is a mitigation measure that could be utilised in proximity to sensitive receptors. Impacts on setting will only be experienced during the temporary construction period, and screening mitigation measures should be considered where applicable during this phase. The operation of the transfer will not affect statutory designated heritage assets as it will be below ground level with the ground reinstated following completion of works. There are no listed buildings or world heritage sites located within 500m of the transfer route. Construction and operational effects on statutory designated heritage assets are considered to be a minor constraint to the scheme.

There are no registered parks gardens, battlefields, or conservation areas within 500m of the transfer route. As such, construction and operational effects on other statutory designated heritage assets are considered to be a neutral constraint to the scheme.

9.3.3 FR to Cambridge Water (South) potable water pipeline

There are a number of listed buildings (primarily Grade II) within 500m of the route, the closest located 230m north, and the others are over 300m. There are two scheduled monuments within 500m of the route, including: three bowl barrows 450m and 570m east of New England, part of the Haddenham round barrow cemetery, is located approximately 160m west; and two bowl barrows 370m and 505m south of New England, part of the Haddenham round barrow cemetery, is located approximately 250m west. There will be no direct effect on these sites and a reduced working width can be utilised near these assets to minimise disturbance, which will only be temporary during construction. The operation of the transfer will not affect statutory designated heritage assets as it will be below ground level with the ground reinstated following completion of works. The majority of assets are screened by hedgerows, treelines, or urban areas blocking views of the temporary construction works, thereby limiting minor impacts on setting. There are no world heritage sites located within 500m of the transfer route. Construction and operational effects on statutory designated heritage assets are considered to be a minor constraint to the scheme.

There is one registered parks and gardens within 500m, located approximately 440m north (Cambridge Water (South) Hall). The asset is a significant distance from the route, with hedgerows and treelines screening the majority of the temporary construction works. There is likely to be minor effects on setting, which can be mitigated through use of screening. Operation of the transfer will have no effect on this asset. As such, construction and operational effects on other statutory designated heritage assets are considered to be a minor constraint to the scheme. There are no battlefields, or conservation areas within 500m of the transfer route.

9.3.4 FR to Cambridge Water (North) potable water pipeline

There are a number of Listed Buildings (primarily Grade II) within 500m of the route, the closest approximately 200m east. There will be no direct effect on these sites and a reduced working width can be utilised near these assets to minimise disturbance, which will only be temporary during construction. The operation of the transfer will not affect statutory designated heritage assets as it will be below ground level with the ground reinstated following completion of works. The majority of assets are screened by hedgerows, treelines, or urban areas blocking views of the temporary construction works, thereby limiting minor impacts on setting. There are no scheduled monuments or world heritage sites located within 500m of the transfer route. Construction and operational effects on statutory designated heritage assets are considered to be a minor constraint to the scheme.

There is one conservation area within 500m, located approximately 430m east (Cambridge Water (North) Conservation Area). The conservation area is a significant distance from the route, with hedgerows and treelines screening the majority of the temporary construction works. There is likely to be minor effects on setting, which can be mitigated through use of screening. Operation of the transfer will have no effect on this asset. As such, construction and operational effects on other statutory designated heritage assets are considered to be a minor constraint to the scheme. There are no registered parks and gardens, or registered battlefields located within 500m of the transfer route.

9.3.5 FR to Anglian Water potable water pipeline

There are a number of Listed Buildings (primarily Grade II) within 500m of the route, the closest approximately 460m east. There is one scheduled monument within 500m of the route located approximately 300m south east (Romano-British settlement near Honeybridge). There will be no direct effect on these sites and a reduced working width can be utilised near these assets to minimise disturbance, which will only be temporary during construction. The operation of the transfer will not affect statutory designated heritage assets as it will be below ground level with the ground reinstated following completion of works. The majority of assets are screened by hedgerows, treelines, or urban areas blocking views of the temporary construction works, thereby limiting minor impacts on setting. There are no world heritage sites located within 500m of the transfer route.

There is one conservation area within 500m, located approximately 65m north (Wimbotsham Conservation Area). A reduced working width can be utilised near these areas to minimise disturbance, which will only be temporary during construction. Hedgerows and treelines, partially block views of the temporary construction works, thereby limiting minor impacts on setting. There is likely to be minor effects on setting, which can be mitigated through use of screening. The operation of the transfer will not affect the conservation areas as it will be below ground level with the ground reinstated following completion of works. This is considered a minor constraint for the scheme. There are no registered parks and gardens, or registered battlefields located within 500m of the transfer route.

9.4 Mitigation and further investigations

Potential mitigation measures and further investigations that should be considered for at the next stage of scheme design could include:

- Good practice measures to be implemented to minimise setting effects for other heritage assets during construction.
- Incorporate measures to reduce setting impact of the reservoir and embankment e.g., planting of trees as screening (where appropriate to the landscape setting) and reducing the height of any embankment. However, although design features will likely reduce the setting impact, there may be residual effects.
- Further work likely to be required to determine significance of effect, depending on the presence or absence of buried archaeology. Residual effects may remain due to potential loss of archaeological remains.
- A programme of archaeological field investigation to identify areas of unknown archaeology. This would include fieldwalking, geophysical survey, metal-detecting and trial-trenching.
- Targeted programmes of archaeological investigation where sites of archaeological potential have been identified. This should include any known locations of archaeology, such as sites identified on the HER, by aerial investigation and mapping and/or geophysical survey.

9.5 Scheme summary

The overall key impacts due to the construction and operation of the scheme in relation to the historic environment are the loss of key views of prominent historic environment elements alongside the loss of heritage value due to the permanent loss of habitats within the reservoir site.

Construction and operational effects on statutory designated heritage assets are considered to be a minor constraint to the scheme for all indicative transfer routes.

Some impacts could be mitigated by creating alternative viewpoints, where possible, and retaining and/or adapting key original views, where possible. Redesigning sections of the scheme to avoid significant archaeological remains may allow for retention in situ.

The scheme also presents historic environment enhancement opportunities through availing education, outreach and community programmes to explain and interpret the historic environment and collaborating with land-based disciplines including landscape and ecology to produce trails, walks and viewpoints with digital and/or permanent viewpoints/display boards including in visitor centres, which explain the historic landscape around the overall scheme.

Further work is required to undertake a heritage assessment, a historic landscape assessment and form an archaeological mitigation programme; the results of which would feed back into the design process to identify potential for retaining critical views or areas of preserved historic landscape through redesign.

10 Population and human health appraisal

10.1 Introduction

This section presents potential impacts on population and human health arising from the scheme. It is based on the desk-based assessments, complemented by findings from the scheme-wide SEA of the gate two scheme. The objectives of the desk-based assessment were to establish the population and human health baseline associated with the design elements of the site, identify constraints and opportunities, and identify the issues and features that require further investigation.

The need to consider population and human health is driven by planning policy, including the draft NPS for Water Resource Infrastructure (Section 3.12 Health, Section 4.10, Land use including open space, green infrastructure, and Green Belt and 4.13, Socio-economic impacts) and the NPPF (Section 8, Promoting healthy and safe communities, Section 12, Achieving well-designed places, Section 15, Conserving and enhancing the natural environment, paragraph 185).

The study area for this topic is a 500m buffer of the working area around each of the proposed transfer pipelines, abstractions, the reservoir and water treatment works. Refer to Section 10.2 Assumptions and Limitations.

To inform potential population and human health constraints, the following sources were considered, as outlined in Table 10.1 below.

Table 10.1: Population and human health – data sources

Data to be collected	Source
Housing and private property	AddressBase Plus Pro, Google Maps and land referencing data[25].
Businesses	AddressBase Plus Pro, Google Maps and land referencing data.
Community facilities, focusing on: • Schools and education facilities • Hospitals and medical facilities • Care homes • Places of worship	AddressBase Plus Pro, Google Maps and land referencing data.
Open space and recreation, focusing on: • National and regional trails • Recreational facilities • Allotments • Regional tourist attractions	AddressBase Plus Pro, Google Maps and land referencing data.
Population demographics and health	English Indices of Multiple Deprivation (IMD) 2019 – for the measurement and comparison of relative levels of deprivation (poverty – total IMD and individual domains for Health, Employment and Living Environment Public Health England data sets Office for National Statistics (ONS) data sets on demography Nomis datasets

[25] Land referencing data has been used to appraise only the reservoir waterbody area, and not the associated reservoir grey infrastructure, transfer pipelines and abstractions and water treatment works.

The appraisal identifies the likely impacts on population and human health resources and receptors including:

- Land requirement – a temporary or permanent (or both) requirement for land affecting resources.
- Change in access – a temporary or permanent (or both) restriction in access, either directly affecting a resource (such as a trail) or affecting the ability of a resource to function (e.g. customers being able to access a business, or children/staff being able to access a school). This could also include positive changes where new or enhanced facilities are provided. a detailed assessment of transport infrastructure that bisects design elements has not been undertaken at this stage but will be undertaken at the next stage in the gated process.
- Change in amenity – a temporary or permanent (or both) in-combination change in environmental conditions (e.g., noise, air quality, visual impacts, presence of HGV traffic) which may affect the enjoyment of residential property, neighbourhoods, community and recreational facilities.
- Changes to transport routes – temporary or permanent changes to transport routes including roads, PRoW, cycle routes, bus stops and routes, rail, stations are not included in this report. This will be considered in the next stages of assessment.

The appraisal considered the greatest impacts to be where:

- A residential property is demolished or a business cannot continue to operate.
- A community facility or recreational facility cannot function or a new / enhanced facility is provided.
- Impacts occur over a long period (e.g., over a year) and/or affect an activity that is undertaken frequently (e.g., daily trip to school).
- Limited accessible alternatives to a resource, such as a recreational facility, are available.
- A large number of people are affected or those with vulnerabilities are affected.

Assessment of potential population and human health opportunities is covered in the Wider Benefits chapter, Section 14.

10.2 Assumptions and limitations

The overarching assumptions and limitations outlined in Section 1.7 apply to the appraisal of landscape, as well as the following:

- At this early stage of the scheme, only an indicative scheme design was available for assessment. For the purposes of quantifying the number of affected receptors assumptions have been made about the location of the main features including the reservoir, water treatment works and transfer routes. However, the locations of these features have not been agreed and further work will be necessary to update this assessment.
- Appraisal of potential impacts on transport routes including roads, PRoW, cycle routes, bus stops and routes, and rail corridors and stations is not included in this report. This should be considered in the next stages of assessment.
- The study area for this topic is a 500m buffer around each of the design elements, therefore some receptors may be double-counted where design elements are close by. This approach was taken to ensure all potential impacts associated with each design element are captured.
- Whilst Ordnance Survey (OS) AddressBase is the most accurate dataset available at the time of reporting, the accuracy of this data cannot be guaranteed and therefore can only provide an approximation of numbers of residential properties, community facilities, businesses, open spaces and recreational areas.

10.3 Baseline summary

Table 10.2 provides an overview of the six local authority areas within the scheme working area and its 500m buffer.

Table 10.2: Local authority areas within the scheme working area and a 500m buffer of the scheme working area.

Element	Cambridgeshire				Norfolk
	Fenland	East Cambridge shire	South Cambridge shire	Huntingdon	King's Lynn and West Norfolk
Abstraction point: River Great Ouse	✓				
Abstraction point: River Delph	✓				
Transfer: River Great Ouse River to Fens	✓				
Transfer: River Delph to Fens Reservoir	✓				
Transfer: Fens Reservoir to Anglian Water	✓			✓	✓
Transfer: Fens Reservoir to Cambridge Water (North)	✓			✓	
Transfer: Fens Reservoir to Cambridge Water (South)	✓	✓	✓		
Reservoir and water treatment works	✓				

10.3.1 Housing and private property

There are over 2600 residential properties located within 500m of the scheme working area. A large proportion of these are within 500m of the proposed transfer pipeline options. The communities in which these residential properties are located are outlined below.

Table 10.3: Communities within 500m of the scheme working area

Location	Number of residential properties within 500m of the scheme working area
Bar Hill	662
Barroway Drove	4
Bexwell	5
Bluntisham	290
Christchurch	6
Colne	80
Doddington	16
Dry Drayton	6
Earith	24
Haddenham	4
Hardwick	43
Lolworth	4
Longstanton	182
Madingley	2
Manea	7
Mount Pleasant	5
Nordelph	18
Over	2
Salters Lode	82
Somersham	14
Stonea	17
Sutton	2
Welney	45
Willingham	193
Wimblington	4
Wimbotsham	78
March	6
Chatteris	176
Downham Market	684

Source: Ordnance Survey MasterMap (2022)

10.3.2 Businesses

There are over 300 businesses located within 500m of the scheme working area, comprising of 320 businesses and 37 agricultural receptors. These businesses include farms, aerodromes, restaurants and cafes, service stations, industrial parks and supermarkets. These businesses are within 500m of the proposed transfer pipeline options.

Table 10.4: Businesses within 500m of the scheme working area

Location	Number of businesses and agricultural receptors within 500m of the scheme working area
Bar Hill	118
Bexwell	2
Bluntisham	1
Colne	4
Doddington	2
Dry Drayton	1
Earith	1
Hardwick	42
Lolworth	1
Longstanton	2
Madingley	1
Manea	1
Nordelph	1
Over	3
Somersham	2
Sutton	1
Willingham	32
Wimblington	2
March	2
Chatteris	137
Downham Market	1

Source: Ordnance Survey MasterMap (2022)

10.3.3 Community facilities

There are 33 community facilities located within 500m of the scheme working area. The locations of these facilities are as outlined below and include churches, village halls, health and dental centres, nursing homes and schools.

Table 10.5: Community facilities within 500m of the scheme working area

Location	Number of community facilities within 500m of the scheme working area
Bar Hill	3
Bluntisham	1
Salters Lode	1
Welney	1
Willingham	1
Wimblington	3
Wimbotsham	1
Chatteris	22

Source: Ordnance Survey MasterMap (2022)

10.3.4 Open space and recreation

There are 9 open spaces located within 500m of the reservoir scheme working area as outlined below. These are a combination of informal open spaces, public open spaces, amenity areas and allotments.

Table 10.6: Open spaces and recreation areas within 500m of the scheme working area

Location	Number of open spaces and recreational areas within 500m of the scheme working area
Chatteris	9

Source: Ordnance Survey MasterMap (2022)

10.3.5 Population and human health

10.3.5.1 Population data

Table 10.7 provides an overview of key population indicators for each affected local authority area as outlined in Table 10.2. These indicators highlight that, the age-based proportions for each local authority broadly align with those for England. However, King's Lynn and West Norfolk has a considerably lower proportion of its population aged 16-64 (56%) than the national proportion (62%), and both Fenland and King's Lynn and West Norfolk have a considerably higher proportion of the population over age 65 (23% and 26% respectively) than the England average (19%).[26]

Table 10.7: Key population indicators by local authority

Indicator	Fenland	East Cambridge shire	South Cambridge shire	Huntingdon shire	King's Lynn and West Norfolk	England
Total population (2020)	102,100	90,200	160,900	179,000	151,200	6,269,200
Percentage of population aged under 16 (2020 mid year estimates)	18%	20%	20%	19%	18%	19%
Percentage of population aged 16-64 (2020 mid year estimates)	59%	60%	60%	61%	56%	62%
Percentage of population aged 65 and over (2020 mid year estimates)	23%	21%	20%	20%	26%	19%

Source: ONS Mid-year population estimates 2020

10.3.5.2 Health data

Table 10.8 provides an overview of key health indicators for the population within each affected local authority areas as outlined in Table 10.2. These indicators include conditions and impairments that might be affected by the potential effects associated with the scheme (for example, changes in air pollution, noise, traffic, employment and physical activity).

[26] In comparing these local authorities, where a local authority deviates by more than 3% from the England rate/value, the difference is regarded to be considerable and is reported as such.

Table 10.8: Key population and health indicators

Indicator	Fenland	East Cambridge shire	South Cambridge shire	Huntingdon shire	King's Lynn and West Norfolk	England
Life expectancy at birth (Male), 2018-2020	75	81	83.1	81	79.3	79.4
Life expectancy at birth (Female), 2018-2020	82.2	84.8	85.9	84.1	82.7	83.1
Under 75 mortality rate: all causes (per 100,000), 2018-2020	382.3	273.9	221.5	270.7	331.9	336.5
Under 75 mortality rate from cardiovascular diseases (per 100,000), 2017-19	84	61.3	44.7	48.8	62.9	70.4
Emergency hospital admissions from Chronic Obstructive Pulmonary Disease (COPD), 2019-2020	631	308	280	344	528	415
Percentage of people who reported having a long term illness or disability, 2011	21%	15%	14%	15%	21%	18%
Percentage of physically active adults (over 19); 2020-2021;	56%	68%	73%	69%	58%	66%
Percentage of adults (aged 18+) classified as overweight or obese (2020/2021)	67%	63%	58%	65%	68%	63%
Percentage of people in employment, 2020-2021	68%	89%	75%	79%	78%	75%
Percentage of Universal Credit claimants as a proportion of resident population of area aged 16-64 (2022)	4%	2%	2%	2%	3%	4%

Source: Public Health England (2022), Department of Education 2020 and Nomis (2022)

As shown in Table 10.8 above, all authorities perform relatively well on key public health indicators, broadly aligning with the national rates. Life expectancy (both male and female) is slightly higher than the England average for all local authorities except King's Lynn and West Norfolk and Fenland. The under-75 mortality rates from all causes are lower than the national rate for all local authorities except Fenland. The percentage of people in employment is considerably higher than the national average (75%) for all local authorities except Fenland where the rate is considerably lower (68%), and South Cambridgeshire where the rate aligns with the national average. The percentage of physically active adults is considerably higher than the national average (66%) in South Cambridgeshire (73%) and considerably lower than the national average in King's Lynn and West Norfolk (58%) and Fenland (56%).

The English Indices of Multiple Deprivation (IMD) 2019 are commonly used for the measurement and comparison of relative levels of deprivation (poverty). Table 10.9 summarises the IMD for the Lower-layer Super Output Areas (LSOAs) within each local authority and outlines the deprivation data by quintile.

Table 10.9: Deprivation summary

Deprivation Quintiles	Fenland	East Cambridgeshire	South Cambridgeshire	Huntingdonshire	King's Lynn and West Norfolk	England
Most deprived	6%	0%	0%	1%	5%	20%
Second most deprived	33%	1%	0%	3%	28%	20%
Third most deprived	38%	28%	5%	12%	40%	20%
Fourth most deprived	23%	27%	33%	21%	13%	20%
Least deprived	0%	43%	61%	49%	14%	20%

Source: 2019 mid-year population estimates, ONS and 2019 English Indices of Deprivation

The table above shows that for each local authority a large proportion of LSOAs are in the fourth most or least deprived quintiles in the country, however there are also a considerable proportion of LSOAs within the second and third most deprived quintiles, particularly in Fenland and King's Lynn and West Norfolk. Table 10.10 outlines the deprivation data for total IMD and health deprivation and disability, employment deprivation, and living environment deprivation in turn.

Table 10.10: Deprivation indicators

Local Authority	Fenland	East Cambridgeshire	South Cambridgeshire	Huntingdonshire	King's Lynn and West Norfolk
IMD total - Proportion of LSOAs in most deprived 10% nationally	6%	0%	0%	1%	5%
Health Deprivation and Disability - Proportion of LSOAs in most deprived 10% nationally	3%	0%	0%	0%	2%
Employment - Proportion of LSOAs in most deprived 10% nationally	1%	0%	0%	0%	1%
Living Environment - Proportion of LSOAs in most deprived 10% nationally	1%	0%	0%	0%	2%

Source: 2019 mid-year population estimates, ONS and 2019 English Indices of Deprivation

As shown in Table 10.10, a very small proportion or none of the LSOAs within the local authorities are within the most deprived 10% nationally for total IMD, employment, health deprivation and disability and living environment.

10.3.5.3 Location of community assets relevant to health outcomes

There are four community assets that have been identified within the scheme working area and their 500m buffers as outlined in the community baseline described above, that have particular relevance to health outcomes. These will need to be considered further as the scheme develops.

10.4 Scheme summary

The potential impacts on housing and private property, businesses, community facilities and open space and recreation were considered as part of the evaluation of the proposed scheme development. It is expected that there would be a range of population and human health impacts affecting housing and private property, businesses and open space and recreation as a result of the scheme during both construction and operation. These potential impacts include land requirement, road, PRoW and cycle route closure, travel disruption and employment impacts during construction.

During operation, several beneficial impacts may be expected as a result of the scheme. These could include:

- A new community facility for local people, through the provision of potential new water sports infrastructure
- A new recreation opportunity for walkers and cyclists, through the provision of new recreational routes
- Potential beneficial employment impacts on local economy, through new jobs associated with the new reservoir facilities
- A proposed visitor centre could provide environmental education opportunities for the local community and schools in wider area.

10.4.1 Mitigation and enhancement opportunities

To avoid or mitigate potential disruption and disturbance to communities during construction and operation of the scheme, good practice mitigation should be implemented during construction and be managed through development of a CEMP. This could include:

- Setting out how engagement with local communities will be undertaken during construction.
- Implementation of specific measures in relation to air quality and noise to reduce impacts on neighbouring residents' communities, particularly for sensitive community resources such as educational facilities, health facilities and care homes.
- Developing mitigation for local road closures and diversions when details are known regarding timing and duration of closure.
- The above ground assets should have landscaping, air quality and noise mitigation included in their design, in order to limit the potential indirect impacts from noise and air pollution on properties and businesses and open spaces.
- Sensitive layout and siting of potential construction compounds that take into consideration the potential impacts from noise, traffic, air quality and visual effects on communities.
- Maintenance or diversion of key routes used by the community such as footpaths and pedestrian and cycling routes.

The following enhancements should also be considered:

- New recreational paths for walking and cycling should be designed to be accessible, addressing the mobility needs of all user groups.
- Local community input on the design of the new facilities should be sought, including target user groups.
- Inclusive design principles should be followed in the design of reservoir facilities.
- There should be assessment of the impact of the scheme on different sections of society, including those living, working or owning businesses who may be displaced as a result of the scheme. This could be undertaken through an Equality Impact Assessment (EqIA).

11 Cumulative and in-combination effects appraisal

11.1 Introduction

Initial cumulative and in-combination effects assessments have been undertaken as part of the gate two informal HRA,WFD and update to the SEA assessments. It is understood that the scheme is selected as an option in the WRE Regional Plan and Anglian Water dWRMP24 and Cambridge Water dWRMP24, it will be subject to further in-combination effects assessments with the other selected options, neighbouring water company plans and neighbouring regional plans. Until the WRE Best Value Regional Plan has been finalised and agreed, it is not known when the other schemes would be implemented or which other developments it could act in-combination with.

For the purposes of this assessment, assumptions were therefore made about other plans, programmes and projects that could act in-combination with the FR scheme, and the following were considered within the in-combination effects assessments these assumptions were based on scale, type of development or plan, and temporal and spatial location:

- Other SROs – SLR Reservoir
- Local Development Frameworks (LDFs)
- DCOs for NSIPs
- Hybrid Bills
- Relevant Transport and Works Act Orders (TWAO)
- Relevant planning applications (only where there is the potential for cumulative effects on the future baseline)

During construction there is the potential for noise and air quality effects on single receptors this can be increased when there are multiple construction projects within a short timeframe. During operation there is the potential for water quality impacts associated with multiple abstractions from a waterbody.

11.2 Reservoir and associated infrastructure

Table 11.1 summarises the findings of the in-combination effects assessments for the reservoir and associated infrastructure.

Table 11.1: In-Combination Effects Assessment Findings

Plan or Project		Cumulative/in-combination effects
SRO	SLR Reservoir- SLR is being developed as an earth embanked reservoir with 50MCM capacity to provide 166Ml/d of deployable output.	Located 54.9km North East of the FR scheme informal HRA has identified potential effects to the following sites: Humber Estuary SPA (UK9006111); Humber Estuary SAC (UK0030170); Humber Estuary Ramsar Site (UK11031); The Wash SPA (UK9008021); The Wash Ramsar (UK11072); The Wash and North Norfolk Coast SAC (UK0017075). Potential effects were identified due to uncertainty around potential effects from changes in flows and water quality and indirect effects on estuarine habitats. Further modelling should aim to look at the potential effects from water quality changes and changes in flows. There is the potential for in-combination impacts on The Washes WFD water body. An in-combination WFD assessment will be undertaken at gate three.
LP9 - South-east March	Predominantly residential (around 600 dwellings). It will include provision for new sports pitches for Neale Wade Academy, if required. Direct cycle and pedestrian routes should be provided to the Academy. Some fairly significant surface water attenuation features to mitigate local flood risk are likely to be necessary.	Located 3.3km North of the scheme, the timing and phasing of construction is unknown at present. There is the potential for cumulative impacts on traffic and local roads during the construction period. Potential receptors include A141, A142, B1098.
LP9 - West March	Predominantly residential (around 2,000 new dwellings) with potentially some business provision gaining access from the A141. The broad concept plan for the area should show how development will relate acceptably to the strategic and local highway network, including the town centre, as well as indicating direct sustainable transport links to the north of the town, the town centre and Neale Wade Academy. Noise and landscape mitigation measures should be provided along the A141 as appropriate. Education provision will be necessary and local convenience shopping will need to be provided. Opportunities should be taken to add to the area of open space currently forming part of the Recreation Ground in The Avenue as a focus for the community.	Located 3.1km North of the scheme, the timing and phasing of construction is unknown at present. There is the potential for cumulative impacts on traffic and local roads during the construction period.

Plan or Project		Cumulative/in-combination effects
F/YR18/0708/F	Predominantly a mix of open space and a high quality, relatively low density, residential area (around 300 dwellings).	Located 0.3 km South of the scheme and the site allocation are within 1km of flood alert areas- potential for cumulative effects on flood risk, however good practice construction will likely mitigate and residual risk. There is potential for cumulative effects on landscape from construction the scheme that will result in permanent alteration to the landscape. Timing and phasing of construction is unknown at present. There is the potential for cumulative impacts on traffic and local roads during the construction period. Potential for operational impacts from traffic, and permanent impacts to setting of residential areas.
LP10 - South Chatteris	Predominantly residential (around 850 dwellings) with some business uses likely close to and gaining access from, the A142.	Located 1.1km South of the scheme there is potential for cumulative effects on flood risk, however good practice construction will likely mitigate and residual risk. Timing and phasing of construction is unknown at present. There is the potential for cumulative impacts on traffic and local roads during the construction period.
Mineral safe guarding zone	Mineral safeguarding zone for Earith and Mepal area- Earith and Mepal zone	Adjacent to the scheme there is potential for cumulative construction effects on Ouse Washes (SPA) (a Ramsar site), Ouse Washes SSSI. informal HRA indicate some sites are sufficiently close to the Ouse Washes Designated Site so that potential AEIS are possible due to pollution events. Potential for cumulative impacts on setting of historical assets including listed building -Fortrey's Hall, which is located alongside the Old Bedford River. Site is accessed via Chatteris A142- potential for cumulative effect on traffic during construction. Plans included in the minerals and waste plan include the restoration of mineral void to high quality wet grassland adjacent to the Ouse Washes- this has potential for beneficial cumulative effects with local biodiversity should adjacent habitat creation if incorporated into the FR plan. WFD assessment indicate the scheme has the potential to cause minor localised risks to the Ouse Washes, as the abstraction from the River Delph is likely to lead to minor changes in water quality due to changes in flow volume and velocity. The Block Fen/ Langwood Fen allocation area is adjacent to the WTW infrastructure of the FR and thus in close proximity. However, there are potential opportunities for the scheme to contribute to the creation of wetland habitats proposed in the Master Plan. There is potential for cumulative positive benefits for the community and tourism and local economy by increasing access to the countryside.

Plan or Project		Cumulative/in-combination effects
21/00033/FUM	Land At Coveney Byall Fen Old Lynn Drove Coveney Cambridgeshire- To Divert existing Internal Drainage Board Main drain to create a coherent contiguous block of lowland wet grassland to add on to the already created habitat at Coveney Byall Fen under the auspices of the Ouse Washes Habitat Creation Project	Located 2km south-east of the scheme informal HRA assessment indicate the site is sufficiently close to the Ouse Washes Designated Site so that potential AEIS are possible due to pollution events. WFD identified all existing field ditches within the development area will be isolated from the new IDB by extensive clay dams. Use of good practice construction methods from both the scheme and the development would pose a negligible risk to the affected watercourses and could provide a potential opportunity for the expansion of or enhancement to the wetland habitat being created.
F/YR21/0145/F	Skylark Garden Centre and Country Store Manea Road Wimblington March Cambridgeshire PE15 0PA- Erect 67 x holiday lodges, a toilet block, a reception building with associated parking and landscaping, and extensions to existing garden centre building and car park	Potential for positive cumulative effects on tourism, recreation and connecting the public the natural environment and enhancing wellbeing in the community.
F/YR18/0708/F	Land North Of Bluebell Way March Cambridgeshire- Change of use of land to form Riverside Country Park	Potential for positive cumulative effects on tourism, recreation and connecting the public the natural environment and enhancing wellbeing in the community.
19/01961/FM	Pisces Country Park Bedford Bank Welney Norfolk PE14 9TB- Use of land for the stationing of additional holiday lodges (falling within the definition of a caravan)	Scheme incorporates use of land for the stationing of additional holiday lodges- potential for positive cumulative effects with FR on increasing the opportunity for enhancing tourism.

11.3 Transfers and associated infrastructure

11.3.1 River Great Ouse to FR

There are no NSIPs within 1km of the indicative transfer route, construction effects are temporary and are likely to have been concluded or nearly completed by the time construction starts on the scheme.

No major development planning applications have been identified within 500m of the indicative transfer that were submitted in the last three years. The transfer route intersects a sand and gravel Mineral Safeguarding Areas (MSA). The route also intersects consultation areas for Mineral Allocation Areas (MAA), Mineral Development Areas (MDA), Waste Management Areas (WMA) and Transport Infrastructure Areas (TIA). The works to install the transfer will be temporary in nature and the transfer area will be limited in extent. However, the existence of the transfer may limit future mineral workings in close proximity to the installed transfer. Further investigation of any potential plans for development along the transfer route is to be undertaken during the development of the detailed design. Overall, this is considered a minor constraint to the scheme. The proposed transfer route also intersects land allocated in the Fenland District Council Local Plan for residential and business use south of Chatteris. This is considered a moderate constraint. The opportunity for route amendment at later design stages should be investigated.

11.3.2 River Delph to FR

There are no NSIPs within 1km of the proposed transfer route.

No major development planning applications have been found within 500m of the indicative transfer that were submitted in the last 3 years. The indicative transfer route intersects a sand and gravel MSA. The works to install the transfer will be temporary in nature and the transfer area will be limited in extent. However, the existence of the transfer may limit future mineral workings in close proximity to the installed transfer. Further investigation of any potential plans for development along the transfer route is recommended during the development of the detailed design. As these are not mineral safeguarding sites, as specified in the Cambridgeshire and Peterborough Minerals and Waste Local Plan, this is considered a minor constraint to the scheme.

11.3.3 FR to Cambridge Water (North)

There are no NSIPs within 1km of the proposed transfer route.

No major development planning applications have been found within 500m of the indicative transfer that were submitted in the last 3 years. The indicative transfer route intersects a sand and gravel MSA. The works to install the transfer will be temporary in nature and the transfer area will be limited in extent. However, the existence of the transfer may limit future mineral workings in close proximity to the installed transfer. Further investigation of any potential plans for development along the transfer route is recommended during the development of the detailed design. As these are not mineral safeguarding sites, as specified in the Cambridgeshire and Peterborough Minerals and Waste Local Plan, this is considered a minor constraint to the scheme.

The indicative transfer route intersects land allocated in the Fenland District Council Local Plan for residential and business use south of Chatteris, as well as land in the North Chatteris broad location for growth which will comprise a mix of uses. The route also intersects land allocated in the South Cambridgeshire District Council Local Plan for a new settlement/extension of Northstowe. This is considered a moderate constraint, however, route amendment at later design stages should be investigated in gate three.

11.3.4 FR to Cambridge Water (South)

There are two NSIPs that may have a direct interface with the indicative transfer route:

11.3.4.1 A14 Cambridge to Huntingdon Improvement Scheme

The A14 Cambridge to Huntingdon Improvement Scheme would potentially be intersected by the transfer near Bar Hill. The NSIP was granted consent in 2017, and although the main A14 is open for traffic, there are still finishing works along the new road. There are likely to be ongoing improvement and maintenance works.

11.3.4.2 East West Rail

The Bedford to Cambridge and Western improvements is currently in pre-application and there are no plans available to view yet. The works involve connecting Bedford station and Cambridge station, which may have either a direct interface or occur within 1km of the proposed transfer route. At this stage the timetable for construction and completion is unknown.

As the scheme will include tunnelling under the above infrastructure developments, no direct interface is expected. As such this is considered a minor constraint to the scheme.

No Major development planning applications have been found within 500m of the proposed transfer that were submitted in the last 3 years.

The potential transfer route intersects a MSA and MAA, specifically Site M019: Bare Fen & West Fen, Willingham/Over (sand and gravel). The indicative route also passes through a sand and gravel MSA, a limestone MSA, and consultation areas for MAA, MDA, WMA, TIA, and a Water Recycling Area (WRA). The works to install the transfer will be temporary in nature and the transfer area will be limited in extent. However, the existence of the transfer may limit future mineral workings in close proximity to the installed transfer. Further investigation of any potential plans for development along the transfer route is recommended during the development of the detailed design. Consultation with the local council is also recommended to mitigate potential effects. Overall, this represents a moderate constraint to the scheme.

The indicative transfer route intersects land allocated in the Fenland District Council Local Plan for residential and business use south of Chatteris, as well as being in a North Chatteris broad location for growth which will comprise a mix of uses. The route also intersects land allocated in the South Cambridgeshire District Council Local Plan for a new settlement/extension of Northstowe. This is considered a moderate constraint, however, route amendment at later design stages should be investigated.

11.3.5 FR to Anglian Water

There are no NSIPs within 1km of the indicative transfer route.

The indicative transfer route interacts with two major development planning applications to the north of Downham Market:

- Anglian Water potable water transfer, East Cambridgeshire District Council, 20/01081/SCOPE
- Anglian Water potable transfer, Fenland District Council, F/YR20/1224/SCOPE

Both of these planning applications involve construction works being undertaken by Anglian Water; therefore, internal discussions are likely to mitigate any effects that the route may have on these schemes. As such, this is considered a minor constraint to the scheme.

The indicative transfer route intersects a sand and gravel MSA, silica sand MSA, Carstone MSA, and WRA consultation area. The works to install the transfer will be temporary in nature and the transfer area will be limited in extent. However, the existence of the transfer may limit future mineral workings in close proximity to the installed transfer. Further investigation of any potential plans for development along the indicative transfer route is recommended during the development of the detailed design. As these are not mineral safeguarding sites, as specified in the Cambridgeshire and Peterborough Minerals and Waste Local Plan, and the Norfolk Minerals Site Specific Allocations Development Plan, this is considered a minor constraint to the scheme.

The indicative transfer route intersects land allocated in the Fenland District Council Local Plan as North Chatteris broad location for growth which will comprise a mix of uses. The route also intersects land allocated in the Norfolk County Council Local Plan for residential use east of Downham Market. This is considered a moderate constraint, however, route amendment at later design stages should be investigated further.

11.4 Summary

There are a number of potential cumulative effects arising from the development of the scheme as there are some key interactions with Local Development Plan allocations. These will need further investigation and may support the scheme design.

12 Invasive Non-Native Species risk assessment

12.1 Introduction

12.1.1 Background

The transfer of water from one location to another may increase the risk of spreading INNS. The introduction of INNS to a waterbody can have significant detrimental effects on ecosystem structure and functioning, as well as jeopardising compliance with environmental legislation – including the Wildlife and Countryside Act (1981), the Invasive Non Native Species Regulations (2019), the Invasive Alien Species Order (2019), and the Water Environment (Water Framework Directive) (England and Wales) Regulations (2017). Understanding the INNS risk associated with each of the proposed FR transfers and asset components is essential to inform the development of appropriate mitigation measures. A high-level assessment into the impact of abstraction from the River Great Ouse and River Delph on the potential to increase habitat suitability for INNS is also included within the scope of this section.

12.1.2 Assessment objectives

The overall aim of this section is to present an assessment of the potential increase in INNS risk arising from the scheme, and will:

- Outline the legislative context of INNS risk assessment.
- Establish if the scheme will introduce a hydrological connection between previously isolated catchments.
- Identify INNS within an appropriate study area to understand the current INNS distribution.
- Provide a high-level overview of potential impacts on INNS in relation to abstraction of water from the River Great Ouse and River Delph.
- Use the SRO Aquatic INNS Risk Assessment Tool[30] (SAI-RAT) developed on behalf of the Environment Agency to quantify the INNS risk associated with the scheme based on the conceptual design information currently available.
- Review potential biosecurity options for implementation to mitigate the INNS risk associated with the scheme.

[30] APEM Ltd (2021). SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) – User Guide. Produced on behalf of the Environment Agency.

12.2 Key legislation and guidance

12.2.1 Key legislation

The translocation of INNS is subject to regulation under the following national legislation:

- **The Wildlife and Countryside Act 1981 (as amended)** – Under Section 14 it may be an offence to release or allow to escape into the wild any animal which 'is of a kind which is not ordinarily resident in and is not a regular visitor to Great Britain in a wild state'; or is included in Part I of Schedule 9. Under Section 14 it may also be an offence to plant or otherwise cause 'to grow in the wild any plant which is included in Part II of Schedule 9.
- **The Invasive Non-Native Species (Amendment etc.) (EU Exit) Regulations 2019** - ensures the continued operability of **EU Invasive Alien Species Regulation 1143/2024**, which outlines a set of measures to combat the spread of INNS on the list of EU concern, through prevention by a number of robust measures that aim to prevent introduction of INNS, early detection and eradication of INNS through a surveillance system and rapid eradication measures, and management action to prevent further spread and harm.
- **The Invasive Alien Species (Enforcement & Permitting) Order 2019** - it may be an offence to release, cause to escape, plant, or grow species of animal or plant 'not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state', or otherwise listed in article 1 of Schedule 2.
- **Water Environment (Water Framework Directive) (England and Wales) Regulations 2017** guidance[31] states that a waterbody initially classified as 'High Status' (representing near-natural conditions), may drop in classification if populations of High Impact INNS are showed to be significantly affecting the waterbody. High Impact INNS are identified on the current aquatic alien species list produced by the Water Framework Directive UK Technical Advisory Group[32]. Species on the High Impact list are used within the WFD Classification process.

[31] Water Framework Directive – United Kingdom Technical Advisory Group (WFD UKTAG) *Guidance on the assessment of alien species pressures* [pdf] Available at: https://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Alien%20species%20guidance%20modified%20from%20Feb%2004%20-%20March%202013.pdf [Accessed 24 October 2022].

[32] Water Framework Directive – United Kingdom Technical Advisory Group

(WFD UKTAG) *UKTAG Assessment Method – Alien Species* [pdf] Available at: http://wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Biological%20Method%20Statements/Alien%20Species%20UKTAG%20Method%20Statement.pdf [Accessed 24 October 2022].

12.2.2 EA guidance

The Environment Agency position statement *Managing the Risk of Spread of Invasive Non-Native Species Through Raw Water Transfers*[33] outlines how the INNS risks associated with raw water transfers (RWT) should be managed. The key points of relevance to this report are as follows:

- The focus of the Environment Agency's approach is on the pathways that the transfers create, not on current INNS distribution.
- New schemes that create a hydrological connection between isolated catchments must have mitigation measures in place to ensure INNS cannot be spread by the new transfer.
- Where water transfer into another watercourse remains the proposed solution, mitigation will need to be fail safe, resilient, and completely effective for all life stages and forms (eg, plant propagules, animals, microscopic organisms and larval stages).
- Where catchments are already connected, a risk assessment will be required, which the Environment Agency will use to decide whether subsequent mitigation is required, to ensure the risk of INNS transfer is not significantly increased.

12.3 Methodology

12.3.1 Study Area

This SRO involves the transfer of raw water from the River Great Ouse and River Delph to the proposed FR. The exact locations of the transfer routes and abstraction points has yet to be determined and are considered indicative. This assessment is divided into two components and examines the risk associated with the transfer of raw water to and from the reservoir, and the risk associated with the operation of assets which form part of this SRO. The scheme was divided into the following transfer sections for the purposes of assessment using the raw water transfer[34] assessment tab in the SAI-RAT:

- Transfer of raw water from the River Great Ouse to FR
- Transfer of raw water from the River Delph to FR
- Transfer of raw water from FR to emergency drawdown testing discharge pond
- Emergency drawdown of water from FR to a tributary of the Forty Foot Drain – intended to be used in emergency situations only
- Reservoir spillway to local drain network – expected to be higher than operating water level and unlikely to required operationally for embankment reservoir.

[33] Environment Agency (2017). Managing the Risk of Spread of Invasive Non-Native Species Through Raw Water Transfers. Position 1321_16.

[34] Note the SAI-RAT defines raw water transfer as 'movements of untreated water by means other than the natural flow of the water source'

The asset components were defined as:

- Inlet pumping station and water sampling building – for control of water supply to the proposed reservoir
- FR – the proposed reservoir
- EDD pond – used to hold and slowly release water in testing of the emergency drawdown system
- Proposed FR WTW – for treatment of water abstracted from the FR
- Potable pumping station – for pumping of water to supply network
- Outlet pumping station – for distribution of potable water to the established distribution network
- Buried service reservoir (SR) – for storage of treated water

A high-level qualitative study into the impact of abstraction on INNS was also undertaken using all available literature detailing the habitat preferences and flow requirements of all INNS records found within 1km of the abstraction points on the River Great Ouse and River Delph. This 1km search radius was aligned with the search buffer required for scheme components being assessed using the SAI-RAT[30].

12.3.2 Screening Against EA guidance

The scheme was screened to determine if it will create a link between isolated catchments, as mapped in the Environment Agency document *Invasive Non-Native Species Isolated Catchment Mapping*[35].

12.3.3 Desk study

Open-source macroinvertebrate, macrophyte and fish data for the period 1965 to 2020 was obtained for the study area as relevant to each water transfer and asset component of the scheme. This data was collated the proposed route option from the Environment Agency Ecology and Fish Data Explorer app[36] and the National Biodiversity Network (NBN) Atlas online records[37]. The data were screened against Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) and WFD-UKTAG guidance[38] in order to identify INNS present within the study area and their level of impact according to UKTAG classification.

The desk study also included records from surveys undertaken during March 2021 and reported at gate one. These surveys involved physical surveys and environmental DNA (eDNA) at six sites, which are detailed in Table 12.1.

Table 12.1: Gate one INNS field survey sites.

Waterbody	Location	NGR	Survey Date
River Great Ouse	Brampton	TL 22341 70580	18/03/2021
Old West River	Earith	TL 39411 74620	18/03/2021
Old Bedford / River Delph	Mepal	TL 43685 81333	18/03/2021
Old Bedford / River Delph	Welney	TL 52872 93660	19/03/2021
Ten Mile River	Denver	TF 58710 00668	19/03/2021
Middle Level Main Drain	Wiggenhall St. Mary the Virgin	TF 58636 13900	19/03/2021

[35] Environment Agency (2018). Invasive Non-Native Species Isolated Catchment Mapping. v3.

[36] EA Ecology and Fish Data Explorer app [online] Available at: <https://environment.data.gov.uk/ecology/explorer/>

[37] NBN Atlas available [online] Available at: <https://nbnatlas.org/>

[38] WFD-UKTAG V8 2021. UK Technical Advisory Group on the Water Framework Directive. Revised classification of aquatic alien species according to their level of impact. Public working draft.

12.3.4

12.3.4 Limitations

The SAI-RAT tool used in this assessment quantifies the risk associated with the operational phase of a water transfer option, rather than the construction phase. The scheme would involve the construction of a new transfer, which poses the risk of INNS being spread through the movement of personnel, vehicles and equipment to and from construction sites, as well as the excavation and disposal of materials (e.g., sediment and vegetation). As the conceptual design is developed, construction-phase risks relating to INNS should also be considered as more information becomes available.

The data and information input into the INNS risk assessment tool were based on the latest available conceptual design. As the conceptual design is still in development, these details may be subject to change. The INNS risk assessment should be revised during the design process to ensure that it remains accurate with the availability of new information.

12.4 Results

12.4.1 Screening against EA guidance

The sources of the FR, the River Great Ouse and River Delph, fall within Area 90 of the Environment Agency's *Invasive Non-Native Species Isolated Catchment Mapping v3*[35]. This area is connected to 'Canal – CRT', meaning that it is connected to one or more canals controlled by the Canal and River Trust (CRT). The FR itself also falls area within Area 90. Therefore, it is concluded that the scheme will not create a new hydrological connection between 'isolated' catchments.

The Environment Agency guidance for raw water transfers states: 'where catchments are already connected, a risk assessment will be required, which the Environment Agency will use to decide whether subsequent mitigation is required, to ensure the risk of INNS transfer is not significantly increased'.

Although the scheme would not create a link between isolated catchments as defined in EA guidance[35], the scheme has the potential to increase or create connectivity between catchments or waterbodies not already connected, and this should be considered and appropriately mitigated as the design develops.

12.4.2 Desk Study

Results of INNS surveys undertaken by Mott MacDonald for gate one are shown in Table 12.2.

Table 12.2: Positive detections of INNS from gate one surveys by physical survey techniques (●) and eDNA sampling (○)

Species	1 – River Great Ouse	2 – Old West River	3 – Old Bedford / River Delph	4 – Old Bedford / River Delph	5 – Ten Mile River	6 – Middle Level Main Drain
Caspian mud shrimp (*Chelicorophium curvispinum*)	●	●				
Demon shrimp (*Dikerogammarus haemobaphes*)	●	●	●	●	●	●
Northern River/Florida Crangonyctid *Crangonyx pseudogracilis/floridanus*		●	●	●	●	●
Zebra mussel (Dreissena polymorpha)		○		○	●○	●○
Quagga mussel (*Dreissena bugensis*)					○	
Asiatic clam (*Corbicula fluminea*)			○			

INNS records derived from Environment Agency open-source data, NBN Atlas records, and surveys undertaken by Atkins within 1km scheme components are shown in Table 12.3 to Table 12.6. Search areas around assets include short transfers which With respect to assets, no INNS records were found within 1km of inlet pumping station, FR, outlet pumping station, and EDD pond locations.

Table 12.3: INNS identified in Environment Agency (●) and NBN Atlas (○) records, and other surveys (·) records within 1km of the proposed assets.

Species	Functional group	Non-native status	WTW	Buried reservoir	Potable pumping station	Discharge pond for low level outlet
Jenkin's spire snail (*Potamopyrgus antipodarum*)	Mobile, juvenile <1mm, no eggs	UKTAG – Moderate				○
Northern River/Florida crangonyctid (*Crangonyx pseudogracilis / floridanus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown				○
Zebra mussel (*Dreissena polymorpha*)	Sessile, juvenile <1mm, eggs	UKTAG – High				○

Species	Functional group	Non-native status	WTW	Buried reservoir	Potable pumping station	Discharge pond for low level outlet
Nuttall's waterweed (*Elodea nuttallii*)	Vegetative, aquatic, perennial	UKTAG – High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	○	○	○	○

Table 12.4: INNS identified in Environment Agency (●) and NBN Atlas (○) records, and other surveys (·) within 1km of the proposed EDD components.

Species	Functional group	Non-native status	Emergency drawdown option	Spillway
Northern River/Florida crangonyctid (*Crangonyx pseudogracilis/ floridanus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	●■	○
Side swimmer (*Gammarus tigrinus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	○	
Zebra mussel (*Dreissena polymorpha*)	Sessile, juvenile <1mm, eggs	UKTAG – High		○
Jenkin's spire snail (*Potamopyrgus antipodarum*)	Mobile, juvenile <1mm, no eggs	UKTAG – Moderate	●	○
Water fern (*Azolla filiculoides*)	Seed + vegetative, aquatic, perennial	UKTAG – High impact WACA 1981 Sch. 9	●○	
Nuttall's waterweed (*Elodea nuttallii*)	Vegetative, aquatic, perennial	UKTAG – High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	●○	○
Bitterling (*Rhodeus amarus*)	Mobile, juvenile >1mm, eggs	UKTAG – Unknown WACA 1981 Sch. 9		○
Himalayan balsam (*Impatiens glandulifera*)	Seed, riparian, annual	UKTAG - High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	○	
Side swimmer *Gammarus tigrinus*	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	○	
Canadian waterweed *Elodea canadensis*	Vegetative, aquatic, perennial	UKTAG – High	○	
Least duckweed *Lemna minuta*	Vegetative, aquatic, perennial	UKTAG – Unknown	●○■	

Table 12.5: INNS identified in Environment Agency (●) and NBN Atlas (○) records, and other surveys (■) within 1km of proposed raw water transfers.

Species	Functional group	Non-native status	River Great Ouse to FR abstraction	River Delph to FR abstraction	Reservoir to discharge pond
Zander (*Sander lucioperca*)	Mobile, juvenile >1mm, eggs	UKTAG – Moderate WACA 1981 Sch. 9	○		
Jenkins' spire snail (*Potamopyrgus antipodarum*)	Mobile, juvenile <1mm, no eggs	UKTAG – Moderate		●	○
Northern River/ Florida crangonyctid (*Crangonyx pseudogracilis/ floridanus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown		● ■	○
Zebra mussel (*Dreissena polymorpha)*	Sessile, juvenile <1mm, eggs	UKTAG – High			○
Water fern (*Azolla filiculoides*)	Seed + vegetative, aquatic, perennial	UKTAG – High impact WACA 1981 Sch. 9		●	
Nuttall's pondweed (*Elodea nuttallii*)	Vegetative, aquatic, perennial	UKTAG – High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2		●	○ ●
Bitterling (*Rhodeus amarus*)	Mobile, juvenile >1mm, eggs	UKTAG – Unknown WACA 1981 Sch. 9	○		○
Side swimmer (*Gammarus tigrinus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown		●	
Canadian waterweed (*Elodea canadensis*)	Vegetative, aquatic, perennial	UKTAG – High		●	
Least duckweed (*Lemna minuta*)	Vegetative, aquatic, perennial	UKTAG – Unknown		● ■	

Table 12.6: INNS identified in Environment Agency (●) and NBN Atlas (○) records, and other surveys (■) within 1km of the proposed abstraction points.

Species	Functional group	Non-native status	River Great Ouse (site u/s Brownshill sluice) TL 35963 70830	River Great Ouse (site d/s Brownshill sluice) TL 37026 73560	River Delph TL 47355 86055
Zander (*Sander lucioperca*)	Mobile, juvenile >1mm, eggs	UKTAG – Moderate WACA 1981 Sch. 9	●○	○	
Jenkin's spire snail (*Potamopyrgus antipodarum*)	Mobile, juvenile <1mm, no eggs	UKTAG – Moderate	●○		●
Northern River/ Florida crangonyctid (*Crangonyx pseudogracilis/ floridanus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	●○		●
Nuttall's waterweed (*Elodea nuttallii*)	Vegetative, aquatic, perennial	UKTAG – High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	●○		●
Least duckweed (*Lemna minuta*)	Vegetative, aquatic, perennial	UKTAG – Unknown	●		●■
Bitterling (*Rhodeus amarus*)	Mobile, juvenile >1mm, eggs	UKTAG – Unknown WACA 1981 Sch. 9	●○	○	
Bladder snail (*Physella gyrina*)	Mobile, juvenile <1mm, no eggs	UKTAG - Unknown	●○		
Himalayan balsam (*Impatiens glandulifera*)	Seed, riparian, annual	UKTAG - High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	○		
Side swimmer (*Gammarus tigrinus*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	●○		●
Water fern (*Azolla filiculoides*)	Seed + vegetative, aquatic, perennial	UKTAG – High impact WACA 1981 Sch. 9	○		●

Species	Functional group	Non-native status	River Great Ouse (site u/s Brownshill sluice) TL 35963 70830	River Great Ouse (site d/s Brownshill sluice) TL 37026 73560	River Delph TL 47355 86055
Caspian mud shrimp (*Chelicorophium curvispinum*)	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	●○		■
Canadian waterweed (*Elodea canadensis*)	Vegetative, aquatic, perennial	UKTAG – High	○		
Demon shrimp (*Dikerogammarus haemobaphes*)	Mobile, juvenile >1mm, no eggs	UKTAG – High	●○		
Wautier's limpet (*Ferrissia wautieri*)	Sessile, juvenile <1mm, eggs	UKTAG - Unknown	●		
Zebra mussel (*Dreissena polymorpha*)	Sessile, juvenile <1mm, eggs	UKTAG – High	●○		

12.4.3 Potential impact of abstraction

Assessment of the potential impact of the abstractions on the distribution and abundance of the INNS species found within the vicinity of the abstractions is shown in Table 12.7. The impact of the abstraction may alter the environmental conditions of the waterbody as a reduction in flow could lead to higher temperatures, greater presence of pollution through reduced dilution, and increased turbidity. However, as abstraction will only occur during high flows this is unlikely, the table below lists potential impacts arising from changes to flows.

Table 12.7: Potential impact of abstraction on INNS.

Common name	Scientific name	Habitat preferences	Impact of abstraction
Jenkin's spire snail	*Potamopyrgus antipodarum*	• *P. antipodarum* prefers to inhabit littoral zones in high nutrient waterbodies with a slower flow but can also tolerate high flow environments where sediment is prevalent[39] • Optimum salinity 15ppt • Prefers lower velocity (86400 cm/h is harmful) • Can tolerate high levels of ammonia in low pH environments • Tolerant of a wide range of dissolved oxygen and turbidity[40] • LIFE score: Group II-Moderate/fast	Localised changes in flow are unlikely to increase habitat suitability for *P. antipodarum*
Northern River/Florida crangonyctid	*Crangonyx pseudogracilis/ floridanus*	• Very pollution tolerant[41] • LIFE score: Group II-Moderate/fast	Localised changes in flow are unlikely to increase habitat suitability for *Crangonyx pseudogracilis/floridanus*
Tadpole physa	*Physella gyrina*	• Tolerant of organic water pollution/ Indicates eutrophic conditions[42] • Found in standing and slow flowing waters	Potential for localised changes in flow regime to increase habitat suitability for *Physella gyrina.*
Side swimmer	*Gammarus tigrinus*	• In the UK this species is found to inhabit sheltered places at the edge of the river among leaves, roots and debris, preferring shallow turbid environments. It is also very pollution tolerant and will displace other species in this environment[43] [44] • Optimum salinity 4-20 ppt • LIFE score: Group III-Slow/sluggish	Potential for localised changes in flow regime to increase habitat suitability for *Gammarus tigrinus.*

[39] Benson, A et al. (2022) *Potamopyrgus antipodarum* (J.E. Gray, 1853): U.S. Geological Survey, Nonindigenous Aquatic Species Database

[40] Alonso, A (2013). CABI: Invasive Species Compendium Potamopyrgus antipodarum (New Zealand mudsnail)

[41] Nature Spot. n.d. Crangonyx pseudogracilis. [online] Available at: <https://www.naturespot.org.uk/species/crangonyx-pseudogracilis> [Accessed 19 August 2022].

[42] Anderson, R., (2016). Physella gyrina (Say 1821). [In] MolluscIreland.

Available at: <http://www.habitas.org.uk/molluscireland/species.asp?ID=59> [Accessed on 2022-08-19]

[43] Kipp, R et al. (2022) Gammarus tigrinus Sexton 1939: U.S. Geological Survey, Nonindigenous Aquatic Species Database

[44] CABI Invasive Species Compendium. n.d. Gammarus tigrinus Data Sheet. [online] Available at: <https://www.cabi.org/isc/datasheet/82074> [Accessed 19 August 2022].

Common name	Scientific name	Habitat preferences	Impact of abstraction
Caspian mud shrimp	*Chelicorophium curvispinum*	• *C. curvispinium* prefers large, slow flowing stagnant waters but is extremely adaptable to different environments and is regarded as a habitat generalist[45]. • Flow preferences – Standing (LIFE Score) • Optimum depth 2-3m • Optimum salinity <6 ppt • Optimum suspended solids-30 mg/l[46] • LIFE score: Group V-Standing	Potential for localised changes in flow regime to increase habitat suitability for *C. curvispinium.*
Demon shrimp	*Dikerogammarus haemobaphes*	• *D. haemobaphes* prefers to inhabit large rivers and lakes solid substrates, macrophytes, and filamentous algae but is very adaptable to a variety of conditions[47] • Optimum salinity 0-8 ppt • Preference for deeper waters • LIFE score: Group II-Moderate/fast	Localised changes in flow are unlikely to increase habitat suitability for *D. haemobaphes*
Wautier's limpet	*Ferrissia wautieri*	• Populations of *F. fragilis* are not typically found in especially warm or stagnant waters, or in environments that are artificially enriched or severely polluted[48].	Localised changes in environmental conditions are unlikely to increase habitat suitability for *F. fragilis.*

[45] Gallardo, B and Aldridge, D. (2013). Review of the ecological impact and invasion potential of Ponto Caspian invaders in Great Britain

[46] CABI Invasive Species Compendium. n.d. *Chelicorophium curvispinum* (Caspian mud shrimp) Data Sheet. [online] Available at: <https://www.cabi.org/isc/datasheet/108307> [Accessed 19 August 2022].

[47] Baker, E. et al. (2022) *Dikerogammarus haemobaphes* (Eichwald, 1841): U.S. Geological Survey, Nonindigenous Aquatic Species Database

[48] Freshwater Gastropods of Northern America. n.d. Ferrissia fragilis. [online] Available at: <https://www.fwgna.org/species/ancylidae/f_fragilis.html> [Accessed 19 August 2022].

Common name	Scientific name	Habitat preferences	Impact of abstraction
Zebra mussel	*Dreissena polymorpha*	• The typical habitats colonised are estuaries, rivers and lakes, particularly where there are firm surfaces suitable for attachment[49] • Capable of tolerating a wide range of conditions - they can tolerate starvation for extended periods, desiccation, extremes of high and low temperatures, and highly variable dissolved oxygen levels • *D. polymorpha* can adapt and inhabit brackish areas - they are capable of tolerating a certain degree of pollution, although they are absent from heavily polluted waters • LIFE score: Group IV – Slow/standing	Localised changes in environmental conditions are unlikely to increase habitat suitability for *D. polymorpha.*
Nuttall's waterweed	*Elodea nuttallii*	• Found in nutrient-rich environments • Competitive and well adapted to a broad array of environmental conditions[50] • Able to grow in highly eutrophic waters and turbid conditions. • Growth of *E. nuttallii* is stimulated by fertilization with nitrogen and benefits from an excess of ammonia • Ellenberg Value: Light – 6, Nitrogen – 7, Moisture - 12	Localised changes in environmental conditions may increase habitat suitability for *E. nuttallii*.
Least duckweed	*Lemna minuta*	• *L. minuta* is found in its introduced areas in sluggishly moving waters[51] • Grows fast in eutrophic conditions. • Strongly resistant to pollution • Ellenberg Value: Light – 6, Nitrogen – 7, Moisture - 12	Localised changes in environmental conditions may increase habitat suitability for *L. minuta.*

[49] CABI Invasive Species Compendium. n.d. *Dreissena polymorpha* (zebra mussel) Data Sheet. [online] Available at: <https://www.cabi.org/isc/datasheet/85295> [Accessed 19 August 2022].

[50] CABI Invasive Species Compendium. n.d. *Elodea nuttallii* (Nuttall's waterweed) Data Sheet. [online] Available at: <https://www.cabi.org/isc/datasheet/20761> [Accessed 19 August 2022].

[51] CABI Invasive Species Compendium. n.d. *Lemna minuta* Data Sheet. [online] Available at: <https://www.cabi.org/isc/datasheet/108968> [Accessed 19 August 2022].

Common name	Scientific name	Habitat preferences	Impact of abstraction
Himalayan balsam	*Impatiens glandulifera*	• *Impatiens glandulifera* typically inhabits riparian sites adjacent to fast flowing water and is typically drought intolerant[52] • Ellenberg Value: Light – 6, Nitrogen – 7, Moisture - 8	Localised changes in flow are unlikely to increase habitat suitability for *Impatiens glandulifera*
Water fern	*Azolla filiculoides*	• *A. filiculoides* has a preference for slow-flowing waters[53] • Not drought tolerant • Can tolerate temperature changes • Phosphorus-limited growth • Ellenberg Value: Light – 7, Nitrogen – 8, Moisture - 11	Localised changes in environmental conditions may increase habitat suitability for *A. filiculoides.*
Canadian waterweed	*Elodea canadensis*	• *E. canadensis* adaptable and has can spread under a wide range of conditions and nutrient concentrations ranging from oligotrophic to eutrophic[54] • Maximum depths recorded were 4m in Europe in slow moving waters • Dominates warmer, shallower waters • Can tolerate brackish waters and prefers water with organic sediment • Ellenberg Value: Light – 7, Nitrogen – 6, Moisture - 12	Localised changes in environmental conditions may increase habitat suitability for *E. canadensis.*

12.4.4 Risk assessment

The INNS risk assessment results of RWT and asset components are summarised in Table 12.8 and Table 12.9 below. It should be noted that these scores do not take into account any engineering interventions that may be required as mitigation to prevent the spread of INNS.

Table 12.8: INNS Risk Scores for raw water transfer components.

Transfer route section	Risk score (%)
River Great Ouse to FR	50.25
River Delph (Ouse Washes) to FR	44.75
Reservoir to discharge pond	36.00
Emergency Drawdown	49.75
Spillway	47.00

[52] CABI Invasive Species Compendium. n.d. *Impatiens glandulifera* (Himalayan balsam). [online] Available at: <https://www.cabi.org/isc/datasheet/28766> [Accessed 19 August 2022].

[53] CABI Invasive Species Compendium. n.d. *Azolla filiculoides* (water fern) Data Sheet. [online] Available at: <https://www.cabi.org/isc/datasheet/8119> [Accessed 19 August 2022].

[54] Duenas-Lopez M A, Popay I and Dawson H, 2018. *Elodea canadensis* (Canadian pondweed). Invasive Species Compendium. Wallingford, UK: CABI. DOI:10.1079/ISC.20759.20203483396

Table 12.9: INNS Risk Scores for asset components.

Asset Name	Risk Score (%)
Inlet pumping station	11.84
Reservoir	56.55
Outlet pumping station	11.84
WTW	15.81
Buried Reservoir	15.38
Potable pumping station	14.24
Emergency drawdown test pond	23.50
Discharge pond to low level outlet	39.06

The highest scoring RWT component was the transfer of raw water from the River Great Ouse to the FR which generated a Risk Score of 50.25%. This score was particularly influenced by the length of transfer, the high volume of water being transferred, and the presence of greater than three washout/maintenance points outside of the catchment. The other RWT from the River Delph to the FR generated a Risk Score of 44.75%, which is slighter lower due to a shorter transfer length.

Both the reservoir and the discharge pond for low level outlet were the only assets to generate the highest risk scores. This is likely due to the frequency of personnel entering or in contact with raw water, the presence of vehicles at these assets and the presence of mammals/waterfowl which increases the risk of the transfer of INNS from outside the area. The potential recreational usage of the reservoir is also a factor that increases the risk score of the reservoir.

12.4.5 Biosecurity assessment

The risk assessment tool identified a range of biosecurity measures to mitigate the risk associated with key pathways of INNS spread that would be introduced by the proposed water transfers and assets. Potential biosecurity measures specific to transfer pathway type are presented in Table 12.10, biosecurity measures specific to each asset type are presented in Table 12.11 and biosecurity measures for recreational activities are presented in Table 12.12.

The biosecurity measures with a ‘High’ confidence rating are those most likely to reduce INNS risk associated with the corresponding pathway. [30]

Table 12.10: Potential biosecurity measures for pathway types.

Biosecurity measure	Description	Applicable to pathway type(s)	Confidence
Biosecurity strategy	Biosecurity measures incorporated into water company standard operating procedure.	Canal and pipeline	Medium
Chlorination	Chlorination of transferred water using hypochlorite, chlorine gas or chlorine dioxide. Suggested pipeline concentration of 1mg Cl/L over 10 days of continuous dosing.	Canal and pipeline	High
Chemical treatment	Could include coagulation and flocculation, OZONE treatment, pH or salinity alteration, or application of an herbicide.	Canal and pipeline	High
Anti-fouling paints	Paint applied to surfaces of pipeline to create toxic/unfavourable substrate for bio-fouling INNS.	Pipeline	Medium
UV treatment	UV is transmitted through water as it flows through a specialised chamber. The radiation damages cells and DNA and causes mortality in the exposed organisms.	Pipeline	Medium
Active filtration	Active filtration using screen filters, bed filters or other pumped filtration methods.	Pipeline	Medium
Passive filtration	Installation of fish screens, rundown screens or conveyor screens to prevent the passage of suspended matter and organisms.	Canal and pipeline	Low

Potential biosecurity measures which could be incorporated at different assets are presented in Table 12.11. Assets in which personnel and equipment are likely to come into contact with raw water on a more regular basis should be prioritised.

Table 12.11: Potential biosecurity measures for implementation at assets

Biosecurity measure	Description	Confidence
Check, clean, dry (CCD)	Promotion of CCD protocol amongst WTW personnel.	Medium
Biosecurity strategy	Biosecurity strategy developed by water company.	Medium
Site-specific operational equipment	Provision of site-specific operational equipment (e.g., pontoons, buoys, vehicles) to reduce the inter-site movement of INNS.	High
Equipment and personal protective equipment (PPE) cleaning (dry)	Installation of waterless cleaning stations. May involve the use of brushes to decontaminate dirty equipment.	Low

Biosecurity measure	Description	Confidence
Static water wash equipment and PPE (cold)	Water < 35°C to aid manual removal of INNS (ambient temperature water will not cause mortality of INNS). May involve use of dip tank.	Low
Static water wash equipment and PPE (hot)	A temperature of > 35°C for 15 minutes, or > 45°C for 1 second has been proven effective against many invasive invertebrate species. May involve use of dip tank.	Medium
Running water (cold)	Running water can be effective against invertebrate INNS. However, efficacy (mortality endpoint) is reduced in comparison to pressurised water. Efficacy is dependent on the method and effort of cleaning	Low
Running water (hot)	Running water can be effective against invertebrate INNS; however, efficacy (mortality endpoint) is reduced in comparison to pressurised water. Efficacy is dependent on the method and effort of cleaning	Medium
PPE cleaning (dry)	Boot brushing/cleaning stations are a simple approach to decontamination of footwear. Can be a simple brush or boot scraper. All waste should be treated as hazardous and disposed of accordingly.	Low
PPE cleaning (dip tank or sink, cold)	A dip tank or sink to allow total immersion of PPE. Brushes and cleaning tools would be a requirement. Ambient temperature water will not cause direct mortality in INNS (unless of much different salinity), so cleaning relies on manual action (scrubbing and drying). Wastewater would be contaminated, so appropriate disposal needed	Low
PPE cleaning (dip tank or sink, hot)	A dip tank or sink to allow total immersion of PPE. A temperature of >35°C for 15 minutes, or >45°C for 1 second has been proven effective against many INNS. The efficacy of hot water against INNS plant species (mortality endpoint) is not as high as for invertebrates, so it is important that equipment is treated for sufficient time; immersion of equipment at 50°C for 5 minutes is recommended to achieve high INNS plant mortality.	Medium
Pressure wash (cold)	High-pressure cold water can be effective against invertebrate INNS. However, efficacy (mortality endpoint) is reduced in comparison to pressurised hot water. Efficacy is dependent on the method of application of the spray, regarding duration and distance from surface.	Low
Pressure wash (hot)	High-pressure, hot water can be very effective against invertebrate INNS. However, the efficacy is dependent on the method of application of the spray, regarding duration and distance from surface	Medium
Drying	Allowing equipment to completely dry ensures that hitchhiker INNS are rendered non-viable. Providing a drying room or other designated area on site for this purpose would allow PPE to be stored and dried at the same location.	High
Operational equipment	Provision of site-specific operational equipment (e.g., pontoons, buoys, vehicles) could reduce the inter-site movement of INNS.	High

As water sports activities are a potential amenity to the reservoir there is a risk of INNS from outside the area being introduced on equipment, implementation of High confidence biosecurity measures should be considered a priority within this asset. As shown in Table 12.12 below, there are a number of potential options which are likely to vary in their feasibility and effectiveness. This assessment indicates that site-specific and thorough drying of equipment being transported between waterbodies would be the most effective measure.

The implementation of High confidence biosecurity measures to prevent the spread of INNS due to recreational activities should also be implemented, as the reservoir is expected to be used by many users, which increases the risk of INNS spreading. This assessment indicates that site specific equipment and thorough drying of equipment being transported between waterbodies would be the most effective measures.

Table 12.12: Potential biosecurity measures for recreational activities.

Biosecurity measure	Description	Applicable to activities	Confidence
Check, clean, dry (CCD)	Promotion of CCD protocol amongst recreational user of the canal network.	Angling and water sports	Medium
Biosecurity strategy	Biosecurity strategy developed by canal recreational user groups.	Angling and water sports	Medium
Event management	A reduction in the number of events or scale of events. Increased biosecurity during events.	Angling and water sports	Medium
Site-specific recreational equipment	Equipment not to be transported between waterbodies. Use restricted to one site to prevent spread of INNS.	Angling and water sports	High
Live bait restrictions	Either prohibiting the use of live bait entirely, or managing live bait use, ensuring source from site only.	Angling	High
Equipment and personal protective equipment (PPE) cleaning (dry)	Installation of waterless cleaning stations. May involve the use of brushes to decontaminate dirty equipment.	Angling and water sports	Low
Static water wash equipment and PPE (cold)	Water < 35°C to aid manual removal of INNS (ambient temperature water will not cause mortality of INNS). May involve use of dip tank.	Angling and water sports	Low
Static water wash equipment and PPE (hot)	A temperature of > 35°C for 15 minutes, or > 45°C for 1 second has been proven effective against many invasive invertebrate species. May involve use of dip tank.	Angling and water sports	Medium
Pressure wash equipment (cold)	High-pressure cold water can be effective against invertebrate INNS; however, efficacy (mortality endpoint) is reduced in comparison to pressurised hot water.	Water sports	Low
Pressure wash equipment (hot)	High-pressure, hot water can be very effective against invertebrate INNS.	Water sports	Medium
Drying	Allowing equipment to completely dry ensures that hitchhiker INNS are rendered nonviable. Providing a drying room or other designated area for this purpose would allow PPE to be stored and dried at the same location.	Angling and water sports	High

Biosecurity measures which involve the use of hot water have a high efficacy against all functional groups and are effective against species that have demonstrated ability to resist other methods of removal, such as mussel veligers (larvae) and pathogens.

Removal of INNS prior to the raw water entering the FR would eliminate a large proportion of risk associated with this section of the scheme, as INNS are easier to eliminate within a closed system. Therefore, appropriate biosecurity measures should be considered to reduce the risk of INNS entering the FR via abstracted river water.

Additionally, implementation of recreational equipment restrictions and biosecurity measures for site staff and maintenance equipment would further reduce the likelihood of INNS transmission to and from the reservoir.

The inclusion of an EDD pond to hold and return water evacuated would create a more closed reservoir system, thereby reducing INNS risk in comparison to an open system.

12.5 Conclusions

Screening against EA guidance determined that the scheme would not create a link between 'isolated' catchments. However, the scheme has the potential to increase or create connectivity between catchments or waterbodies not already connected, and this should be considered and appropriately mitigated as the design develops.

The INNS assessment results are shown in Table 12.13. It includes the average scores and maximum scores for both the asset and RWT components as well as the Overall Risk Score for the SRO as a whole.

Table 12.13: INNS assessments results summary.

	Average Risk Score (%)	Maximum Risk Score (%)	Overall Risk Score (%)
Asset components	23.53	56.55	-
RWT components	45.55	50.25	-
SRO Overall Score	-	-	34.54

- INNS were recorded within the area of the scheme:
  - The proposed raw water transfer route and approximate 1km radius already host High impact aquatic INNS including three invasive non-native plant species and two invasive non-native fish species.
  - High impact species including three High impact invasive plant species were found along the EDD transfer routes.
  - No INNS were recorded within the 1km of the reservoir asset itself although four of the assets within the scheme did have INNS present within the 1km buffer.
  - INNS were also found to be present within the River Great Ouse and River Delph (Ouse Washes) abstraction locations.
- There is a possibility that the abstractions on the River Great Ouse and River Delph will have an impact on the INNS currently recorded at these locations. Due to the abstractions at these locations, there may be potential for decreases in water levels and flow velocity although as abstraction is occurring at times of high flows this is considered unlikely. Some of the INNS identified prefer these conditions and therefore the abstractions may have the potential to increase the suitability of this habitat to these species, further work to understand this will be undertaken at the next stage of design.
- The raw water transfers from the reservoir to the discharge pond - Emergency Drawdown - are classed at a higher risk.
- The operation of new assets was mostly found to be lower risk and unlikely to create a new pathway for INNS introduction, however the reservoir and discharge pond were higher risk.
- Biosecurity measures should be considered to reduce the risk of INNS introduction at the site due to the transfer of raw water from the River Great Ouse and River Delph (Ouse Washes).

12.6 Proposed future work

Although the scheme would not create a link between 'isolated' catchments as defined in EA guidance[35], any potential change or increase in connectivity between other catchments should be investigated at gate three and appropriate mitigation proposed.

The data and information entered into the INNS risk assessment tool were based on the latest available conceptual design. It is recommended that the INNS risk assessment is reviewed upon finalisation of the conceptual design to account for any changes that may introduce INNS risk, and in light of further survey data or information obtained at that time.

For gate three it is recommended that a wider range of information sources are used to determine INNS distribution, including non-open-source EA records and CPERC, such as those relating to floating pennywort (*Hydrocotyle ranunculoides*).

It is recommended that the proposed design and operation of the scheme are reviewed in light of the risk assessment and biosecurity assessment. Medium and High confidence biosecurity measures identified should be considered in scheme design and operational protocol, in addition to measures already embedded in the scheme design.

12.7 Mitigation and biosecurity recommendations

All opportunities to improve biosecurity practices amongst recreational users of the FR should be encouraged. Implementation of measures would be most beneficial prior to the abstracted water entering the reservoir, which would help to reduce the likelihood of further INNS spread from the reservoir. Not all potential biosecurity and mitigation options are likely to be feasible and it is recommended that engagement with the Environment Agency and angling clubs may identify those which are most appropriate.

The highest confidence biosecurity measures were chlorination, chemical treatment, site-specific operational equipment, drying, operational equipment, and site-specific recreational equipment.

Although these principles may not be universally adopted, promotion of Check-Clean-Dry[55] principles should be included in any biosecurity strategy.

Mitigation measures at the abstraction points on the River Great Ouse and River Delph (Ouse Washes) should also be fully investigated and implemented.

As discussed in section 12.6, any potential increase in connectivity between other catchments should be considered and mitigated through biosecurity practices where appropriate.

[55] Non-native Species Secretariat (2022). Check Clean Dry.

13 Natural Capital and Biodiversity Net Gain appraisal

13.1 Natural capital and ecosystem services

Natural capital refers to the elements of the natural world that provide benefits to society and includes aspects such as woodland, grassland, freshwater, marine, urban greenspace and wetland habitats.

The benefits that are provided to humans by the natural environment vary from regulating services such as natural flood management to cultural services such as recreational value.

13.2 Biodiversity Net Gain

In November 2021, the Environment Bill achieved royal assent, passing into UK law and becoming the Environment Act 2021. Part 6 on nature and biodiversity covers all areas of biodiversity net gain across two core sections. The first section covers biodiversity net gain for planning as part of applications for planning and nationally significant infrastructure projects, as well as more detail on site registers and biodiversity credits. The second section focuses on the primary objective of biodiversity net gain, highlighting the importance of on-site and off-site habitat enhancement and conservation over a period of at least 30 years in all development projects, and offers an overview of biodiversity net gain reports specifically produced to cause measurable improvements to the state of biodiversity.

Although the Environment Act 2021 is a part of UK law, its policies – with mandatory biodiversity net gain included – aren't expected to be fully integrated until the year 2023 as it goes through a two-year transition period. Many local planning authorities, however, are already enforcing the new NPPF in line with detailed guidance from Defra and Natural England and are applying a 10% biodiversity net gain requirement on each new development proposal in preparation for it becoming the norm.

It is advised that the project promoters consider achieving a 10% net gain for the scheme at this stage and later stages of the gated process in order to avoid impacts later on.

Biodiversity Net Gain (BNG), in the context of this report, refers specifically to the combination of habitats present at a site and their ability to support biodiversity. Each habitat has an associated score, which is then weighted by characteristics such as its area, condition, distinctiveness, and connectivity. The change in habitat due to the construction and operation of the SRO determines the BNG score and whether the scheme is likely to achieve a net gain in biodiversity.

13.3 Overview of gate one

At gate one, a Natural Capital Assessment (NCA) incorporating ecosystem services and BNG were undertaken for the FR SRO as part of the submission to RAPID.

This assessment used the most-up-to-date guidance available at the time to undertake the assessment, The Defra Biodiversity Metric 2.0[56]. In July 2021, Defra and Natural England launched The Biodiversity Metric 3.0. The 3.0 metric presented significant improvements for measuring and accounting for nature losses and gains. The 3.0 metric was used for this gate two assessment, which updates and supersedes the assessment carried out at gate one.

In April 2022 Defra released another update to the Biodiversity metric, the Biodiversity Metric 3.1. However, the Biodiversity Metric 3.0 was used for the gate two assessment, for methodological consistency with Anglian Water's Water Resources Management Plan 2024 and the Water Resources East Regional Plan. This approach is supported by Defra guidance.

This section outlines some opportunities to achieve BNG, however more detailed habitat mitigation and enhancement proposals will be set out in the next phases of design.

13.4 Methodology

13.4.1 Defining the natural capital baseline

13.4.1.1 Zone of influence

The zone of influence was defined as the area of receiving (i.e., a watercourse receiving a discharge) or providing (i.e., a watercourse where abstraction will occur) environment with the potential to be altered or changed as a result of the scheme.

This can include the operational catchment for a surface water abstraction in addition to the footprint of the scheme. In later stages of design, the ZoI would need to be further refined with the availability of greater design detail and site survey data, likely during gate three.

13.4.1.2 Developing a natural capital baseline

As part of the NCA, a natural capital baseline was developed for the study area. The study area was defined as the Anglian Water operating boundary. This baseline was developed using open-source data as described in the National Natural Capital Atlas: Mapping Indicators (NECR285)[57] to generate a natural capital account of the stocks within the zone of influence. methodology used to map natural capital utilises the same breakdown of stocks as the NECR285 where possible. However, the list has been supplemented with additional abiotic stocks and key habitats that are vital such as chalk streams and rivers.

The natural capital baseline reported the total quantity of each stock within the study area.

[56] Defra Biodiversity Metric 2.0. Available at: ARCHIVE SITE for the Biodiversity Metric 2.0 and the Biodiversity Metric 3.0 (naturalengland.org.uk)

[57] NECR285. Available at: http://publications.naturalengland.org.uk/publication/4578000601612288

13.4.2 Overview of natural capital assessment methodology

A natural capital assessment has been undertaken on the scheme in accordance with the Water Resources Planning Guideline[58] (WRPG) and Enabling a Natural Capital Approach (ENCA) requirements. ENCA is recommended for use by HM Treasury's Green Book: appraisal and evaluation in central government (2020)[59] and represents supplementary guidance to the Green Book.

In August 2021, ENCA updated its guidance. Therefore, the NCAs were updated in line with the values used to quantify the provision of ecosystem services.

The August 2021 ENCA guidance[60] includes updated values within the Asset Databook and Service Databook. Within the Service Databook, the carbon reduction tab now includes BEIS (2021) carbon values - a set of values produced by the government to be used in policy appraisal and evaluation, reflecting the latest evidence. The climate regulation section of the assessment has been updated in line with this.

The impact of the scheme on the natural capital stocks and indicators of condition was reported for each element quantitatively. This impact was reported for during construction and post construction to give an estimation of the impact of the scheme's whole lifecycle. The results of the stock assessment were reported in total losses and gains within each option's zone of influence.

The results of the change in natural capital stocks informed the assessment against the eight natural capital metrics (ecosystem services) listed below using the Natural England logic chains (Figure 13.1). The cost / benefit assessment was informed by the option type, option description and any embedded mitigation. The outputs of the NCA were compared to the pre-construction provision of impacted services to assess the impact of the scheme. Five ecosystem services were monetised, and the results of the assessment reported as a discreet monetary figure (subject to the ecosystem service scoping exercise set out below), water purification was assessed qualitatively and biodiversity has been assessed via the Biodiversity 3.0 Metric. Water regulation has not been included for assessment to avoid the potential double accounting of benefits with capacity-based and financial assessment, and to align with Environment Agency guidance[61], which recommends not including the monetisation of water regulation benefits in decision making.

[58] 2021, Available online at Water resources planning guideline - GOV.UK (www.gov.uk).

[59] 2020. The Green Book Central Government Guidance On Appraisal And Evaluation. [online] London: HM Treasury. Available at: <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf> [Accessed 16 March 2022].

[60] GOV.UK. 2021. Enabling a Natural Capital Approach guidance. [online] Available at: <https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance> [Accessed 16 March 2022].

[61] Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making.

Figure 13.1: Ecosystem Services valuation logic chain

The metrics used to assess the impact on natural capital include:

- Carbon sequestration (Climate regulation)
- Natural hazard management
- Water purification
- Water flow regulation
- Biodiversity and habitats
- Air pollutant removal
- Recreation and amenity value
- Food production

Both natural capital assessment strategies, as outlined in the Environment Agency's Water Resource Planning Guidelines[62] and the Defra's ENCA guidance, discuss taking a proportionate approach to the assessment. It is therefore important to accommodate this when integrating a natural capital approach within the SRO gated process. A natural capital approach has the potential to inform concept design and aid decision making, by quantifying the relative cost benefits and disbenefits of the scheme to aid the initial assessment of the identified strategic solutions.

13.4.3 Ecosystem Services screening

During the initial phase of the NCA, the ecosystem services listed (excluding biodiversity and habitats which is covered under the BNG assessment) were reviewed and scoped in or out due to the geographical or socio-economic context of the scheme and its zone of influence. Guidance on the screening process for individual metrics is provided below.

13.4.3.1 Climate regulation

The climate regulation metric focuses on carbon sequestration, which can be defined as the capture and secure storage of carbon that would otherwise be emitted to, or remain, in the atmosphere. The carbon sequestration NCA will be in addition to construction and operational carbon calculations and provides a holistic assessment of carbon emissions for the scheme.

[62] Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making.

The assessment was determined by land management within the scheme's footprint which influenced the carbon store for prolonged periods of time and results in a change in net emissions. The estimate of the carbon stocks for the scheme footprint was based on the area of broad land use types according to literature and research. The estimated carbon stocks for broad habitat types are listed below and the sequestration rates are show in Table 13.1.

Table 13.1: Carbon sequestration rates for broad habitat types (JBA Consulting) [63] [64]

Land use type	Carbon Sequestration rate ($tCO_2e/ha/yr$)
Woodland - (deciduous)	4.97
Woodland – (coniferous)	12.66
Arable Land	0.107
Pastoral land	0.397
Peatland - Undamaged	4.11
Peatland - Overgrazed	-0.1
Peatland - Rotationally burnt	-3.66
Peatland - Extracted	-4.87
Grassland	0.397
Heathland	0.7
Shrub	0.7
Saltmarsh	5.188
Urban	0
Green Urban	0.397

The carbon sequestration rates were converted to monetary values using standard methods and the Department for Business, Energy and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values from 2021 (Table 13.2). The natural capital assessment is based on a 2022 price year; however, it is assumed that adjustments for inflation have been accounted within the annual projections provided by BEIS and therefore the 2022 value presented below has not been adjusted. High series values were used to reflect a conservative estimate for the price of carbon.

[63] Alonso, I., Weston, K., Gregg, R. and Morecroft, M. 2012. Carbon storage by habitat - Review of the evidence of the impacts of management decisions and condition on carbon stores and sources. Natural England Research Reports, Number NERR043.

[64] The Environment Agency, (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making.

Table 13.2: BEIS updated short-term traded sector carbon values for policy appraisal, £/tCO_2e (£2022)

Year	Low series	Central series	High series
2020	120	241	361
2021	122	245	367
2022	124	248	373
2023	126	252	378
2024	128	256	384
2025	130	260	390
2026	132	264	396
2027	134	268	402
2028	136	272	408
2029	138	276	414
2030	140	280	420
2031	142	285	427
2032	144	289	433
2033	147	293	440
2034	149	298	447
2035	151	302	453
2036	155	307	460
2037	156	312	467
2038	158	316	474
2039	161	321	482
2040	163	326	489
2041	165	331	496
2042	168	336	504
2043	170	341	511
2044	173	346	519
2045	176	351	527
2046	178	356	535
2047	181	362	543
2048	184	367	551
2049	186	373	559
2050	189	378	568

13.4.3.2 Natural Hazard regulation

Different habitat types have intrinsic flood risk management values by intercepting, storing and slowing water flows. This is known as natural flood management (NFM) and is listed as a policy within the 25-year Environment Plan[65]. The capacity of habitats to achieve this can be quantified, and then a monetary value can be assigned based on the damage-costs avoided from flooding or replacement costs due to their capacity to regulate flood waters. The capacity for a given natural capital asset to provide a flood regulation service will depend on two factors:

- Its capacity to slow overland flows
- Whether the asset is located in an area of flood risk

This ecosystem service also applies in urban areas, where vegetation can reduce surface water flooding from heavy rainfall, with benefits to sewerage capacity. Coastal flood risk, which has been predicted to increase with future climate change, is reduced by coastal margin habitats such as saltmarsh.

The scheme was assessed on their ability to positively or negatively impact flood risk through the comparison of pre and post construction natural capital stocks and the catchment in which it is located. The assessment is restricted to catchment areas which drain to downstream communities impacted by flooding. These communities were identified using the Environment Agency's Indicative Flood Map[66], which overlays areas at risk of fluvial flooding and the National Receptor Database. The ecosystem service was scoped in for assessment where it was identified that the SRO would have a temporary or permanent impact upon the relevant natural capital stocks, such as areas of woodland, located within the floodplain.

Reduced flood damage to downstream or coastal settlements as a result of reduced magnitude / frequency of flood / storm events; and / or lower sewer capacity or water storage costs was valued in line with Broadmeadow et al, 2018[67]. This assessment was developed to provide indicative national estimates of water regulation services of woodland to inform natural capital accounts, this is based on modelling to estimate the potential volume of flood water avoided by woodland ecosystems in flood risk catchment. The methodology adopts a replacement-cost (rather than damage cost) approach to valuing the flood regulation service of woodland by applying annualised average capital and operating costs of flood reservoir storage that would be required in the absence of the ecosystem service.

Central estimate of the average annual costs of reservoir floodwater storage is £0.42/m^3. The range is from £0.10 to £1.19/m^3 per year. The central estimate was used to derive an annual average estimate for the flood regulation service of woodland in Great Britain, which was then uplifted to a 2022 price year. These "replacement costs" can be considered a lower bound of the benefit if it can be assumed that such expenditure would be deemed value for money by the flooding authorities within flood risk catchments in terms of avoided flood damage costs.

[65] 25 Year Environment Plan - GOV.UK (www.gov.uk)

[66] GOV.UK. Get flood risk information for planning in England. Available at: https://flood-map-for-planning.service.gov.uk/

[67] Broadmeadow, S., Thomas, H., Nisbet, T. and Valatin, G., 2018. Valuing flood regulation services of existing forest cover to inform natural capital accounts. *Forest Research*.

13.4.3.3 Water purification

Based on their ecological functioning, different habitat types, have varying capacities for absorbing pollutants from a given water source. This service is dependent on the location of the natural capital asset and the nature of the surrounding area. If a natural capital asset has a high capacity to remove pollutants but is not close to a water source, the service will not be provided. Due to this, valuation of the static water purification services of different natural capital assets as part of the NCA was not considered appropriate. A common value for different habitat types could not be applied due to extensive variation in local factors which determine the provisioning of this service.

To account for the provision of this service within the NCA the impact of the scheme associated with the provision or removal of woodland and semi-natural grassland was considered qualitatively and with consideration of the modelling results from the Natural Environment Valuation Online Toom (NEVO)[68] tool, developed by the Land, Environment, Economics and Policy Institute (LEEP) at The University of Exeter. The NEVO Tool is a web application to help users explore, quantify and make predictions about the benefits that are derived from existing and altered land use across England and Wales. The tool brings together spatially explicit data, natural science and economic models to provide insights into the integrated relationships between climate change, land use change, ecosystem service flows and economic values. The tool defines the resulting changes for the following water quality variables:

- Dissolved oxygen concentration
- Nitrogen concentration (including organic nitrogen, nitrate, nitrogen dioxide, ammonium)
- Phosphorous concentration (including organic and mineral phosphorous)
- Pesticide concentration (for eighteen different pesticide types

This approach followed the methodology that if an area of woodland were to be lost, the resultant impacts on water quality can be qualitatively assessed within the schemes zone of influence. Any negative changes to the natural capital in theory, reflects the loss of this service within the schemes zone of influence.

13.4.3.4 Air pollutant removal

Air pollution presents a major risk to human health, resulting in premature deaths and reduced quality of life. By removing air pollution, habitats help to lessen these impacts on health and wellbeing. The provisioning of the service is positively related to several key aspects:

- The surrounding area of the natural capital assets with regards to background pollution, especially particulate pollutant
- The quantity and type of natural capital asset, woodland is the major service provider
- The density of population potentially benefiting from reduced exposure. Because pollutants are transported, beneficiaries may be downwind of the ecosystem[60]

The scheme was screened against the provision of air pollutant removal according to its location. Air pollutant removal was only be considered within built up areas or when the zone of influence includes Air Quality Management Areas (AQMA). The impact of the scheme was assessed according to changes in natural capital stocks within these areas.

[68] Luizzo, L., (2019) Natural Environment Valuation Online Tool - Chapter 6a: Water Quantity & Quality Model

The value provided by natural capital assets was taken from the UK government's air quality economic assessment methodology[69]. The assessment embeds these values (based on the damage cost approach, i.e., damage to health avoided from reductions in air pollution) and estimates the present value automatically based on the quantitative estimates provided.

Indicative average values for air pollution removal in 2015 for different habitats were calculated from aggregate UK values published in February 2019, as shown in Table 13.3.

The value of each habitat will be combined with the changes expected in natural capital stocks to provide a value for the change in service provision. The final impact will be reported as a single value that will be incorporated within the NCA metric.

Table 13.3: Air pollutant value by habitat type (£2022)

Habitat group	Value (£ per hectare per year)
Urban Woodland	942
Rural Woodland	299
Urban grassland	182
Enclosed farmland	17
Coastal margins	31

13.4.3.5 Recreation and amenity

The recreational value of green spaces can be significant. This value reflects both the natural setting and the facilities on offer at the site and often has a strong non-market element. It varies with the type and quality of habitat, location, local population density and the availability of substitute recreational opportunities. Recreational values can be beneficially affected by enhancements in green spaces, or adversely affected by new developments or infrastructure. The wider tourism and outdoor leisure sector is also dependent upon nature to varying degrees.[60] This metric depends on the extent to which the natural capital stocks the scheme provides will enhance the opportunity for recreation.

The key parameter needed to estimate in this category is the number of additional or enhanced recreational visits created because of the option. This was estimated using the Outdoor Recreation Valuation Tool (ORVal). ORVal[70] is referenced in HM Treasury Green Book[71]. Random utility / travel cost model of recreational demand for all sites in England and Wales generates probabilistic predictions of visitor numbers for any publicly accessible outdoor recreation park, path or beach. It takes account of scarcity of sites and substitution possibilities, as well as travel distances to sites and their attributes. This is useful for baseline initial assessment, accounting, and multiple sites. This should be seen as an estimation in the absence of site-specific data on visitor numbers.

The change in natural capital stocks and the creation or removal of greenspace was entered into ORVal according to the NCA. The change in visitors and estimated change in value will be reported for using the ORVal online tool.

[69] Jones L., Vieno M., Morton Dan et al. (2017) Developing Estimates For The Valuation Of Air Pollution Removal In Ecosystem Accounts. Final Report For Office Of National Statistics - NERC Open Research Archive.

[70] ORVal | Land, Environment, Economics and Policy Institute | University of Exeter

[71] The Green Book: appraisal and evaluation in central government - GOV.UK (www.gov.uk)

13.4.3.6 Food production

Food is produced by a range of ecosystems and in some cases, the food for human consumption is effectively the same as the ecosystem service (e.g. wild fruit, fishing). More often the provisioning service is a raw material (e.g. crops) that is harvested and processed by humans and produced capital into added value processed food (e.g. bread). The boundary between what is provided by natural capital and the contribution of other forms of capital is often a grey area, e.g. crops require agricultural management; livestock need grassland ecosystems.

Food production has been calculated using the NEVO agricultural model. The NEVO Tool is a web application developed by the LEEP Institute at the University of Exeter with support from Defra and Natural Environment Research Council (NERC). NEVO's primary purpose is to help explore, quantify and make predictions about the benefits that are derived from existing and altered land use across England and Wales. This is a structural model of agricultural land use and production for Great Britain estimated using Farm Business Survey (2005 – 2011) and June Agricultural Census data. The agricultural land use component in NEVO builds upon the approach developed by Fezzi and Bateman[72]. NEVO was used to assess the impact of the creation or removal of agricultural land for the scheme. The change in value of food provision for the footprint of the scheme was calculated using this online tool and reported within the NCA.

13.4.3.7 Assumptions and limitations

There are number of limitations to the approach taken and several assumptions were made to keep the assessment proportionate to the requirements of the relevant guidance. Namely, these were:

- To align with the BNG assessment, the natural capital assessment has been limited to the option boundary and does not expand into the options' zone of influence.
- Impacts are largely assumed to be temporary due to the reinstatement of natural capital assets following construction. Where reinstatement is not possible due to the footprint of permanent infrastructure or the loss of irreplaceable habitats, impacts are considered to be permanent.
- All natural capital stocks are assumed lost during construction. The exception is aquatic abiotic assets such as lakes and standing water, which are assumed to be retained unless directly impacted by permanent infrastructure.

13.4.4 Overview assessment methodology: BNG

The BNG requirement as outlined in the WRPG stipulates that each SRO should look to maximise BNG. The gate one assessments used the most-up-to-date guidance available at the time to undertake the assessment, The Biodiversity 2.0 Metric. In July 2021, Defra and Natural England launched The Biodiversity 3.0 Metric[73]. The 3.0 metric presents significant improvements for measuring and accounting for nature losses and gains. It encourages users to create and enhance habitats where they are most needed to help establish or improve ecological networks through rural and urban landscapes. By linking to current and future habitat plans and strategies, including the future Local Nature Recovery Strategies (LNRS), the 3.0 metric incentivises habitat creation and enhancement where most needed. It also 'rewards' landowners who undertake work early, creating or enhancing habitats in advance, allowing them to generate more biodiversity units from their land. Condition assessment approaches have also been significantly updated and simplified for the 3.0 metric and some key changes made.

[72] Fezzi, C., Bateman, I., Hadley, D. & Harwood, A. 2019. Natural Environment Valuation Online Tool - Chapter 1: Agriculture Model

[73] Archive site for the BNG Metric 2.0 and 3.0 http://publications.naturalengland.org.uk/publication/5850908674228224

The 3.0 metric is the recommended approach to net gain assessments. The government anticipates the 3.0 metric to become the industry standard for biodiversity assessments for on-land and intertidal development types in England. As proposed in the Environment Act 2021[74] in November 2021, biodiversity net gain must be measured using a recognised biodiversity metric. The 3.0 metric essentially underpins the Environment Act's provisions for mandatory biodiversity net gain in England, subject to any necessary adjustments for application to major infrastructure projects. The Environment Act 2021 further specifies the requirement of biodiversity reports to include specified quantitative data relating to biodiversity, and as such any tool which evaluation is predominantly qualitative is not recommended.

As such, the gate two approach has updated all assessments undertaken at gate one to the 3.0 metric. Any new scheme elements brought into the gated process at this stage have also been assessed by the 3.0 metric, in line with current guidance. The BNG calculation would be revisited and updated using the latest version of the metric, including updates for Biodiversity Metric 3.1 and any subsequent revisions, in later stages of design. These calculations are to be further refined throughout the gated process to inform planning requirements.

A biodiversity baseline has been developed from spatial data sets of habitats inventories to calculate BNG change through land use. The Priority Habitat Inventory and sites with SSSI, SAC, SPA and Ramsar designations were used to consider areas with high biodiversity importance. Units have been assigned to the pre-construction land use according to the habitats present in the scheme boundary. Post construction land use described in the scheme description, has been used to calculate the post construction score. As this assessment was carried out using only open-source data, a precautionary approach has been applied. These initial BNG calculations are desk-based and will be further refined at later design stages to inform planning requirements. Habitat identification would need to be refined with habitat survey data at subsequent stages of design to refine the accuracy of the BNG calculations.

13.4.5 Assumptions and limitations of the NCA and BNG assessments

The following assumptions and limitations are applicable to the results.

- The methodology for the NCA and BNG assessments has been collaboratively developed and consistently applied across the scheme. However, the assessments undertaken for the indicative transfer pipeline have been subject to a separate assurance process.
- The NCA and BNG assessments have considered the temporary and permanent impacts associated with the main reservoir, service reservoir, water treatment works, indicative transfer pipeline, intake structures and associated outlet discharges. The NCA and BNG assessments have not considered the amenity elements, infrastructure and diversion elements, and ecological and environmental elements set out in the scheme description, at this stage. These elements would be subject to NCA and BNG assessment following further design development and informed by site surveys, at later stages of the gated process. This would avoid potentially under or over-estimating the potential benefits to BNG and NCA.

13.4.5.1 Natural Capital Assessment

To align with the BNG assessment, the natural capital assessment has been limited to the option boundary and does not expand into the options' zone of influence.

Impacts are largely assumed to be temporary due to the reinstatement of natural capital assets following construction. Where reinstatement is not possible due to the footprint of permanent infrastructure or the loss of irreplaceable habitats, impacts are considered to be permanent.

[74] Environment Act 2021 (legislation.gov.uk)

All natural capital stocks are assumed lost during construction. The exception is aquatic abiotic assets such as lakes and standing water, which are assumed to be retained unless directly impacted by permanent infrastructure.

The provision of public water supply, including an assessment of water flow regulation, has been excluded from all assessments to avoid potential double accounting of benefits with capacity-based and financial assessment.

The desk-based assessment was carried out using open-source data.

13.4.5.2 Biodiversity Net Gain

The BNG assessments have been undertaken using the natural capital stocks mapped using open-source datasets. Therefore, at this stage, the scheme has not had access to site surveys and subsequently assumptions have been made as to the condition and strategic significance of habitats in order to provide the most accurate calculations, at this stage. The assumptions used in this assessment are provided below:

- Any habitat areas that are also within the Priority Habitat Inventory have been classified as ‘Good’ condition. This includes the priority habitat category ‘No main habitat but additional habitat exists’.
- All rivers have been classified as ‘Good’ condition based on being Priority Habitats.
- All habitats within statutory sites such as SSSIs, SACs and Ramsar designations or non-statutory sites such as local nature reserves have been classified as ‘Good’ condition and ‘Formally identified in local strategy’ strategic significance.
- All remaining habitats have been classified as ‘Moderate’ condition.
- All habitats adjacent to statutory sites such as SSSIs, SACs and Ramsar designations or non-statutory sites such as local nature reserves have been classified as ‘Location ecologically desirable but not in local strategy’ strategic significance.
- All habitats within National Priority Focus Areas have been classified as ‘Location ecologically desirable but not in local strategy’ when assessing strategic significance as these are likely to be of some ecological value.
- Any habitat areas classified as ‘Active floodplain’ in the natural capital baseline map was classified as ‘Floodplain wetland mosaic (CFGM)’, where it could not be otherwise classified by the datasets used to compile the baseline map. However, as the Floodplain wetland mosaic (CFGM) is a Priority Habitat but these areas are not within the Priority Habitat Inventory, they have been classified as ‘Moderate’ condition rather than ‘Good’.
- No enhancement of biodiversity post-construction was considered. BNG habitat units were assigned to the pre-construction land use according to the habitats present within the boundary of the site. The post construction land use was used to calculate the post construction biodiversity score. Where temporary impacts are expected, it is assumed that habitats will be replaced on a like-for-like, and irreplaceable habitats are assumed to be permanently lost.
- Where habitat reinstatement is not possible due to the footprint of permanent infrastructure or the loss of irreplaceable habitats, impacts are considered to be permanent.
- The duration of disturbance and timeline for habitat creation has not been included in the assessment. Durations of disturbance, including proposals for creating habitats in advance of disturbance, would need to be refined with greater design detail at subsequent stages in the gated process to refine the accuracy of the BNG calculations.
- Aquatic abiotic habitats such as rivers, lakes and standing water are assumed to be retained unless directly impacted by permanent infrastructure.
- It is assumed there will be no habitat loss in trenchless pipeline areas.

- All rivers are assumed to have 'No Encroachment' for both Watercourse encroachment and Riparian encroachment.
- The desk-based assessment was carried out using open-source data.

13.4.6 Opportunities

The potential opportunities for the scheme to enhance NC and BNG were considered following the NCA and BNG assessments, utilising the data and results to inform on the most appropriate potential opportunities for enhancement of the scheme and wider benefits.

13.5 Results

The gate two NCA and BNG outputs for the scheme are summarised below.

A summary of what is included within each table is as follows:

- Table 13.4**:** shows the predicted impacts on natural capital during and post construction. **Note:** Only those stocks with predicted impacts are listed.
- Table 13.5 summarises the predicted impacts to the provision of ecosystem services screened in for detailed assessment.
- Table 13.6 summarises the predicted impacts to the provision of water purification for the scheme, where screened in for qualitative assessment.
- Table 13.7 shows the unmitigated BNG outputs for the scheme which have been informed using the predicted impacts on natural capital in Table 13.4. **Note:** At this stage the BNG only takes account reinstatement, not reprovision or additional habitat creation unless outlined in the scheme description.

Table 13.4: Predicted unmitigated impacts on natural capital during and post construction

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
River Great Ouse to FR				
Coastal and floodplain grazing marsh	3.44	0.00	2.41	-1.04
Arable	160.93	4.80	160.87	-0.06
Greenspace	0.16	0.02	0.16	0.00
Active floodplain	0.19	0.01	0.19	0.00
Rivers	0.82	0.60	0.60	-0.22
Ponds & linear features	1.62	0.02	1.60	-0.02
River Delph to FR				
Coastal and floodplain grazing marsh	2.24	0.42	1.37	-0.88
Arable	50.70	1.29	50.64	-0.06
Rivers	0.47	0.32	0.32	-0.16
FR to Cambridge Water (South)				
Coastal and floodplain grazing marsh	6.09	5.68	6.09	0.00
Arable	327.15	12.79	327.02	-0.13
Pastures	1.17	0.00	1.17	0.00
Active floodplain	2.88	1.24	2.88	0.00

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
FR to Cambridge Water (North)				
Arable	159.88	3.10	159.82	-0.06
Orchards and top fruit	0.16	0.00	0.00	-0.16
FR to Anglian Water				
Arable	302.20	6.39	300.86	-1.34
Pastures	4.23	0.00	4.23	0.00
Active floodplain	0.98	0.00	0.98	0.00
Lakes and standing water	1.97	1.97	1.97	0.00
Rivers	1.85	1.85	1.85	0.00
Ponds & linear features	3.97	3.83	3.83	-0.14
Fens Reservoir				
Coastal and floodplain grazing marsh	1.26	0.00	1.22	-0.05
Lowland fens	0.01	0.00	0.01	0.00
Arable	69.61	0.00	14.97	-54.64
Pastures	515.47	0.00	118.12	-397.35
Other semi-natural grassland	0.00	0.00	1.10	1.10
Coniferous woodland	0.26	0.00	0.19	-0.07
Lakes and standing waters	3.93	0.00	0.51	-3.42
Rivers	1.22	0.00	0.56	-0.65
Modified waters (reservoirs)	0.00	0.00	438.02	438.02
Ponds & linear features	5.50	0.00	1.64	-3.86

Table 13.5 Predicted unmitigated impacts to the provision of ecosystem services screened in for detailed assessment

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
River Great Ouse to FR					
Carbon storage	£6,423	£192	-£6,231	£6,420	-£3
Total	**£6,423**	**£192**	**-£6,231**	**£6,420**	**-£3**
River Delph to FR					
Carbon storage	£2,024	£51	-£1,972	£2,021	-£3
Total	**£2,024**	**£51**	**-£1,972**	**£2,021**	**-£3**
FR to Cambridge Water (South)					
Carbon storage	£13,480	£510	-£12,970	£13,475	-£5
Total	**£13,480**	**£510**	**-£12,970**	**£13,475**	**-£5**
FR to Cambridge Water (North)					
Carbon storage	£6,381	£124	-£6,258	£6,379	-£2
Total	**£6,381**	**£124**	**-£6,258**	**£6,379**	**-£2**
FR to Anglian Water					
Carbon storage	£13,670	£255	-£13,415	£13,536	-£134
Food production	£2,300,000	£2,298,500	-£1,500	£2,298,500	-£1,500
Total	**£2,313,670**	**£2,298,755**	**-£14,915**	**£2,312,036**	**-£1,634**
Fens Reservoir					
Carbon storage	£80,344	£0	-£80,344	£18,937	-£61,407
Natural hazard management	£26	£0	-£26	£14	-£11
Food production	£973,700	£771,700	-£202,000	£771,700	-£202,000
Total	**£1,054,068**	**£771,700**	**-£282,368**	**£790,650**	**-£263,418**
TOTAL SCHEME	**£3,396,046**	**£3,071,332**	**-£324,714**	**£3,130,981**	**-£265,063**

Table 13.6: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation

Ecosystem service	Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification					
	Abstraction River Great Ouse to FR Abstraction River Delph to FR FR to Cambridge Water (South) FR to Cambridge Water (North) FR to Anglian Water FR Reservoir	The stock likely provides a high provision of the ecosystem service due to the natural capital assets high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced.	The provision of water purification provided by the stock will likely be reduced due to the option.

Ecosystem service	Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water flow regulation					
	Abstraction River Great Ouse to FR Abstraction River Delph to FR FR to Anglian Water FR Reservoir	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The loss of stocks will increase negative impacts to the ecosystem service.	The provision of some water flow regulation services of contributing stocks will be lost during construction.	The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a level 2 WFD. As the pipeline forms part of the water resource option, the impact of the option on water flow regulation cannot be assessed at this stage.	-
	FR to Cambridge Water (South) FR to Cambridge Water (North)	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The increase of stocks will reduce negative impacts to the ecosystem service.	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the stock will likely to remain.	0

Table 13.7: Summary of the unmitigated BNG outputs

Option element	On-site Baseline (Habitat BUs*)	On-site Baseline (River BUs)	On-Site Post Intervention (Habitat BUs)	On-Site Post Intervention (River BUs)	Total Net Unit change (Habitat BUs)	Total Net Unit change (River BUs)	Total Percentage Change (Habitat BUs)	Total Percentage Change (River BUs)
River Great Ouse to FR	478.73	16.91	404.00	12.36	-74.73	-4.55	-15.61%	-26.90%
River Delph to FR	168.83	9.81	130.77	6.54	-38.65	-38.65	-22.90%	-33.30%
FR to Cambridge Water (South)	917.98	22.52	869.52	22.52	-48.47	0.00	-5.28%	0.00%
FR to Cambridge Water (North)	406.26	11.45	392.17	11.45	-14.09	0.00	-3.47%	0.00%
FR to Anglian Water	750.39	38.25	706.81	38.25	-43.57	0.00	-5.81%	0.00%
Fens Reservoir	2521.28	91.82	2689.21	40.73	167.83	-51.09	45.29%	-0.5564%
Total scheme	5243.56	190.76	5191.88	131.88	-51.68	-58.91	-0.99%	-30.88%

*Biodiversity Units (BUs)

13.5.1 Summary of the NCA and BNG assessments

13.5.1.1 Natural capital and ecosystem services

The scheme is likely to generate the permanent and temporary loss of natural capital stocks during construction. However, some habitat is expected to be reinstated/compensated to pre-construction conditions following good practice technique and will likely have no permanent impact to the provision of ecosystem services.

Broadleaved/mixed/yew/priority/coniferous woodland have a significant maturity time with a delay of 30 years. Therefore, this delay is considered within potential future provision of this stock through the ecosystem services assessment. This can be accounted to the tree mortality rate presumed after woodland areas are replanted.

Construction impacts include the release of CO_2 due to habitat clearance, loss of natural hazard management, loss of food production and a reduction in water purification. It is expected to permanently affect the future value of the ecosystem services provided despite some stocks being reinstated. There an increase anticipated to water flow regulation. Permanent loss of coniferous woodland is expected which has the potential to affect carbon storage i.e. release of CO_2 due to habitat clearance and natural hazard management ecosystem services. Permanent loss of some arable stocks due to option construction expected hence loss of associated carbon storage i.e. release of CO_2 due to habitat clearance and loss of food production ecosystem services expected.

The scheme presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The scheme crosses several Natural England habitats, Network Enhancement Zones and is therefore suitable for the planting of new high value habitats.

13.5.1.2 BNG

The scheme is anticipated to result in a net loss of 0.99% in habitat biodiversity units (BU). The scheme is also anticipated to result in a net loss of 30.88% in river BU.

During gate three, with refined designs and site surveys, the amenity elements of the scheme, infrastructure and diversion elements, and ecological and environmental elements set out in the scheme description that were not assessed for BNG (as described in Section 13.5.5), would be assessed and potentially will create an overall increase in habitat and river biodiversity units. The project promoters could also look to achieve 10% net gain offsite with collaboration with the local authority etc. An overall BNG of 10% can only be achieved if all biodiversity units relating to habitats and rivers are achieved.

13.6 Opportunities for environmental net gain

Following the BNG and NCA, opportunities should be considered so that the natural environment is left in a better condition than pre-construction conditions. This should be achieved by one or both of the following:

- Mitigation: Opportunities to offset the net loss of biodiversity asset(s) and/or Natural Capital stock(s) (ecosystem service).
- Enhancements: Opportunities that, once introduced and established, would result in a net gain to a biodiversity asset and/or Natural Capital stock(s) (ecosystem service).

As a core principle, where possible, the scheme should aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG. The latter could be achieved by identifying local sites of ecological interest and proposing measures. Any habitats that are created or enhanced to achieve BNG are required to be secured for 30 years, through management, maintenance and monitoring. The natural capital map which is based on the methodology described in the NECR285 should be utilised, where possible, to assist in identifying opportunities to improve natural capital.

A summary of the potential NCA, BNG mitigation and enhancement measures for each sub-component type are outlined in Table 13.8. Further explanation into the potential enhancement measures is provided within the sections below.

Table 13.8: Summary of potential net gain mitigation and enhancement opportunities

Scheme element	Mitigation opportunity	Enhancement opportunity
All scheme elements	Scheme layouts to be amended to avoid the permanent loss of high value natural capital assets that once lost, cannot be easily reinstated. Assets include ancient woodland and traditional orchards.	Creation of higher value habitat within grassland, arable and pasture natural capital assets onsite to achieve an increase in Biodiversity Units (BU) and work towards a 10% uplift in BNG.
	Schemes to identify area for the creation and/or reinstatement of high value natural capital assets, including: Coastal and floodplain grazing marsh Broadleaved, mixed and yew woodland Woodland priority habitat	Habitat creation work within the adjacent priority habitats. Scheme falls within or are in the vicinity of habitat network zones[75]: These areas identify specific locations for a range of actions to help improve the ecological resilience for each of the habitats/habitat networks. The scheme should look to identify habitat network zones and priority habitats within the near vicinity and look to improve/create/restore habitats which would help to work towards increasing BU and work towards a 10% uplift in BNG.
	Construction practices to be considered to reduce the amount of clearance required for, especially in areas that include high value natural capital assets (see above for list).	Increase the quality/quantity of freshwater assets, including lakes, ponds located in designated SSSIs, pending detailed assessment of local conditions and available space.
	Directional drilling to be used where possible to avoid loss of high value natural capital assets (see above for list).	Scheme to identify suitable areas offsite for the creation, enhancement and/or restoration in order to develop off-site net gains, working towards achieving a 10% uplift in BNG.
		Identify areas of local peatland restoration
Main reservoir		Possibly create man-made floating wetland islands, enabling plants and microbes to form and attract wildlife both above and below the water's surface and create biochemical and physical processes to improve things such as water quality.
Wastewater treatment works, abstraction and treatment works, and other scheme elements that contain above ground infrastructure		Seeding of grassland within footprints of the above ground infrastructure, where possible.

[75] Edwards J, Knight M, Taylor S & Crosher I. E (May 2020) 'Habitat Networks Maps, User Guidance v.2', Natural England

13.6.1 BNG Unit Purchase

Habitat creation possibilities, other than unit purchase, to achieve a 10% BNG gain could include:

- On-site: Improve the existing habitats on-site through post construction remediation and replacement of low BNG value habitats with higher BNG value habitats
- Off-site: Purchase suitable areas of off-site land within the local area and/or at a regional scale to offset BNG decrease by improving the existing habitats within the off-site land and/or by replacing existing habitats with higher BNG value habitats.
- On-site and off-site: Improve existing habitats and/or replacement of low BNG value habitats with higher BNG value habitats as part of the catchment management options.

It is important that, where possible, the scheme starts to consider reaching out to local non-government organisations and planning authorities who may potentially be able to carry out BNG both onsite and offsite before gate three. Early engagement may help to get the best ideas of local opportunities for enhancement, how this can be achieved, local priorities and limiting factors which can all help to inform the NCA and BNG assessments during gate three.

Currently, the scheme is anticipated to result in a net loss of 0.99% in habitat biodiversity units. The scheme is anticipated to result in a net loss of 30.88% in river biodiversity units, as set out in Table 13.7. However, this is an approximation of the potential BNG that the scheme may produce. During gate three, detailed field surveys comprising UK Habitats Classification surveys and Habitat Condition Assessments in accordance with the Metric 3.1 Technical Supplement will be required. This additional information will result in changes to the baseline biodiversity units and natural capital stocks and associated provision of ecosystem services, in addition to the units gained as part of the schemes as given above. Following this, the BNG assessments can be recalculated, and mitigation, habitat creation and/or habitat enhancement (over and above the assumed habitat reinstatement in the current assessment) developed to achieve the 10% biodiversity unit increase required for the project.

BNG may be achieved via a new statutory biodiversity credits scheme. Credits may be bought by developers as a last resort when onsite and local offsite provision of habitat cannot deliver the BNG required, the processes for the price of biodiversity credits will be set higher than prices for equivalent biodiversity gain on the market and are expected to be purchased through a national register for net gain delivery sites. Natural England is in the process of running pilot schemes to provide a practical insight into the implications of the scheme, which is expected to go live spring 2023.

13.6.2 Network Recovery Networks

The Government's 25 Year Environment Plan[76] includes provision for a Nature Recovery Network (NRN) and states that it will deliver on the recommendations of the Lawton Report[77] and that recovering wildlife will require more habitat; in better condition; in bigger patches that are more closely connected. As well as helping wildlife thrive, the NRN could be designed to bring a wide range of additional benefits: greater public enjoyment; pollination; carbon capture; water quality improvements and flood management.

[76] 25 Year Environment Plan - GOV.UK (www.gov.uk)

[77] Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.A., Tew, T.E., Varley, J., & Wynne, G.R. (2010) Making Space for Nature: a review of England's wildlife sites and ecological network. Report to Defra.

Natural England have produced a series of habitat network maps[78] to help address the challenges outlined in the Lawton report and believe they should provide a useful baseline for the development of a NRN as required within the 25 Year Environment Plan and Local Nature Recovery Strategies as proposed within the Environment Bill. The maps have been created to provide a national overview of the distribution of habitat networks with suggestions for future action to enhance biodiversity, to help stimulate local engagement with partners and to agree local priorities and identify where action might help build more ecologically resilient ecosystems across landscapes.

- **Habitat Creation/Restoration:** Areas where work is underway to either create or restore the primary habitat.
- **Restorable Habitat:** Areas of land, predominantly composed of existing semi-natural habitat where the primary habitat is present in a degraded or fragmented form and which are likely to be suitable for restoration.
- **Network Enhancement Zone 1:** Land connecting existing patches of primary and associated habitats which is likely to be suitable for creation of the primary habitat. Factors affecting suitability include proximity to primary habitat, land use (urban/rural), soil type, slope and proximity to coast. Action in this zone to expand and join up existing habitat patches and improve the connections between them can be targeted here.
- **Network Enhancement Zone 2:** Land connecting existing patches of primary and associated habitats which is less likely to be suitable for creation of the primary habitat. Action in this zone that improves the biodiversity value through land management changes and/or green infrastructure provision can be targeted here.
- **Fragmentation Action Zone:** Land within Enhancement Zone 1 that connects existing patches of primary and associated habitats which are currently highly fragmented and where fragmentation could be reduced by habitat creation. Action in this zone to address the most fragmented areas of habitat can be targeted here.
- **Network Expansion Zone:** Land beyond the Network Enhancement Zones with potential for expanding, linking/joining networks across the landscape i.e., conditions such as soils are potentially suitable for habitat creation for the specific habitat in addition to Enhancement Zone 1. Action in this zone to improve connections between existing habitat networks can be targeted here.

There are opportunities for the scheme to support the NRN, for example, where transfers are to be constructed within one of the identified habitat zones, reinstatement of land following construction could be linked to the priorities of that area such as habitat creation, restoration or improvement.

It is recommended that these opportunities be further explored at gate three. Wider partnership working with landowners, conservation groups and other organisations should be explored to help deliver opportunities for biodiversity enhancement.

[78] Edwards J, Knight M, Taylor S & Crosher I. E (May 2020) 'Habitat Networks Maps, User Guidance v.2', Natural England

13.6.3 Potential wider benefits

Blue infrastructure systems and riparian areas provide a wide range of ecosystem services to human populations, notably because they are a key component in many biogeochemical cycles and global biodiversity and these services are seen to hold an important economic value. Some of the wider ecosystem services that these natural capital stocks can provide that are not already considered as part of the gate two assessments are listed in Table 13.9.

Table 13.9: Potential wider ecosystem services and possible restoration/improvement practices

Ecosystem service	Wider benefit	Examples of possible restoration/improvement practices
Recreation and tourism	The association of water is positively appreciated for several activities such as fishing, canoeing or aesthetic enjoyment.	Dedicate some areas to such activities to channel the public into appropriated zones, where possible.
Education values	Blue infrastructure and riparian areas provide sites for formal and informal education and heritage learning.	Create some information points or paths for the public in well-equipped zones, where possible.
Sense of place	Build community ownership and enhance the local populations spirit and sense of place. This may encourage enjoyment and understanding of the natural, historic and cultural heritage.	Improve and create the blue infrastructure and provide arts-based creative community interpretation to enhance and celebrate culture and heritage assets, where possible. This may reconnect the local population with their canal heritage and cultural assets.
Mental and physical health and wellbeing	The 'Canal and River Trust' conducted research showing that spending time by the water promotes better mental and physical wellbeing[79]	Improve and create habitats around blue infrastructure. Allow greater access to people through creating paths/parking etc.

Wider benefit case studies along the scheme are being prepared as part of a separate workstream, which will consider wider benefits the scheme can provide to people, including habitat creation, which may potentially improve the provision of ecosystem services, BNG and provide wider benefits such as those listed in Table 13.9. However, these case studies are conceptual and are yet to be finalised. These wider benefit case studies should be further considered within the gate three NCA and BNG.

13.7 Summary and next steps

At gate three, the natural capital assessment would be refined further to work alongside the environmental impact assessment process to provide a natural capital input. The assessment would be further updated, as required, in lieu of developed design and following UK Habitats Classification surveys as required.

For gate three the BNG assessment can be revisited, and mitigation or enhancement opportunities developed further to achieve the 10% BNG required within the scheme.

[79] Assessing the wellbeing impacts of waterways usage in England and Wales (canalrivertrust.org.uk)

Additionally, where possible, the scheme could aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall Biodiversity Net Gain in line with regulatory requirements for BNG (at the time of the project consenting) as stated as a mandatory requirement within the Environment Act 2021[80]. The latter could be achieved during the gate three assessments by identifying local sites of ecological interest and proposing measures which enhance these features.

The NCA, BNG and ecosystem services outputs identified the following:

- **NC:** The scheme will cause the temporary and permanent loss of natural capital stocks.
- **BNG:** The scheme is likely to result in a net loss of terrestrial habitat units and net loss of river habitat units due to the temporary and permanent loss of natural capital assets during construction. Mitigation and enhancement opportunities for the scheme have been suggested within this section of the report, which can work in tandem to reducing the loss of BNG and introducing net gain. These will be developed further during gate three.
- **BNG:** Further detailed assessment will be required as the designs of the schemes progress. This will need to include detailed field surveys comprising UK Habitats Classification surveys and Habitat Condition Assessments in accordance with the Metric 3.0 Technical Supplement. This additional information will result in changes to the baseline biodiversity units and natural capital stocks and associated provision of ecosystem services, in addition to the units gained as part of the schemes as given above. Following this, the BNG assessments can be recalculated, and mitigation, habitat creation and/or habitat enhancement (over and above the assumed habitat reinstatement in the current assessment) developed to achieve the 10% biodiversity unit increase required for the project.
- **BNG:** It should be noted that the latest iteration of the Biodiversity Metric is currently version 3.1 and the use of the latest version should be considered when undertaking further BNG assessments during gate three.
- **Ecosystem services:** Permanent and temporary impacts of the scheme are likely to result in the release of CO_2 due to habitat clearance, loss of natural hazard management, loss of food production and a reduction in water purification services. The scheme presents opportunities to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats.

The opportunities identified in the BNG/NC assessment have the potential to contribute to government ambitions for environmental net gain. This could take the form of habitat compensation, creation and/or species relocation schemes. Any schemes would need to be taken forward based on a comprehensive understanding on the interaction between natural systems and between natural systems and social uses of land.

[80] Environment Act 2021 (legislation.gov.uk)

14 Wider benefits

14.1 Introduction

This chapter summarises the wider benefits that could arise from implementing the FR scheme. Wider benefits are those areas of environmental and social value that are associated with constructing and operating the scheme.

The consideration of wider benefits draws on the findings of other assessment work to inform the gate two submission, as well as introducing additional information where material in the context of the FR scheme. The wider benefits have been considered for the scheme as a whole, rather than individual components. Where benefits are specific to one component of the scheme, this is identified.

14.2 Methodology

This section sets out the methodology for identifying and assessing wider benefits.

14.2.1 Six capitals framework

There is no specific methodology guiding wider benefits assessments for SROs. Approaches set out in WRMP Guidance[81] (on identifying benefits (both monetary and non-monetary) for customers, environment and society) and Ofwat's Public Value Principles[82] have influenced the methodology. The starting point for the assessment of wider benefits is the Six Capitals framework[83] (see Table 14.1) which is used by organisations, including UK water companies, as a framework for considering social, governance and environmental issues.

Table 14.1: The Six Capitals framework

Capital	Description
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 motivation 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.
Social	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.
Natural	The physical stocks of renewable and non-renewable resources that provides goods and services of value to society.

[81] https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline

[82] https://www.ofwat.gov.uk/about-us/our-strategy/ofwats-public-value-principles/

[83] https://www.integratedreporting.org/resource/international-ir-framework/

14.2.2 Draft National Policy Statement for Water Resource Infrastructure

The draft National Policy Statement (NPS) for Water Resource Infrastructure[83] identifies potential impacts and mitigations across several environmental and social topics. The mitigations relevant to wider benefits includes:

- Biodiversity and nature conservation: Biodiversity enhancement measures (such as new habitat creation and provision of green corridors) could be incorporated where possible into the project design.
- Flood risk: New or enlarged reservoirs may provide an opportunity to address existing flood risk (for example, by providing extra space for flood water storage or by improving monitoring and control of water flows).
- Landscape and visual: Opportunities could be sought to enhance landscape character through, for example, green infrastructure provision; opportunities could be sought to improve public access to the countryside.
- Socio-economic: Where possible, work could be carried out by local firms and contractors that could help contribute to the local economy and meet any employment needs; potential opportunities for public education could be identified as part of proposals; and opportunities for proposals to provide recreation/tourism opportunities could be considered.
- Traffic and Transport: Where new transport infrastructure is required (for example, roads) consideration should be given to how this can be delivered to maximise public benefit.

14.2.3 Scoping of potential benefits

The Zone of Influence (ZoI) was defined as the area of receiving (i.e. experiencing a benefit or disbenefit) or providing (i.e. providing workforce) environment with the potential to be altered or changed as a result of the FR scheme.

A review of the potential wider benefits that are relevant to the FR scheme was undertaken. Table 14.2 sets out the findings of the review.

Table 14.2: Wider benefits scoping

Capital	Description	Applicability to the FR scheme	Scoped in to Wider Benefits
Financial	Economic benefits – Job creation	The scheme could generate temporary and permanent employment opportunities. This will bring benefits through the supply chain.	Yes
Financial	Economic benefits – through capital expenditure	The scheme could generate temporary and permanent employment opportunities. This will bring benefits through the supply chain.	Yes
Financial	Economic benefits – through supply chain	The scheme could generate temporary and permanent employment opportunities. This will bring benefits through the supply chain.	Yes
Financial	Economic benefits – increase in tourism related to new recreation assets	The scheme is expected to create an asset that could be used for tourism or recreation.	Yes
Social	Health and wellbeing – from access to recreation and / or open space	The scheme could provide the opportunity to enhance recreation features.	Yes
Social	Education – opportunities to provide educational resource	The scheme could provide the opportunity for additional educational resources.	Yes
Social	Social value – quality of life benefits associated	The scheme could provide an opportunity to continue the deployment of apprenticeships.	Yes

Capital	Description	Applicability to the FR scheme	Scoped in to Wider Benefits
	with other economic benefits		
Social	Partnerships – working collaboratively with other organisations	The scheme could provide the opportunity to link with local organisations to deliver benefits, for example, implementing BNG initiatives.	Yes
Natural	Natural capital – any additional benefits in addition to the scope of the NCA	The ability of the scheme to contribute to other aspects of natural capital has been reviewed and no additional issues to the NCA have been identified.	No
Natural	Flood risk – any additional benefits derived from decreasing flood risk	The scheme is not likely to affect wider flood risk management measures.	No

The scoping exercise identified that items applicable to financial, social and natural capital were relevant to the assessment, and that items relating to human and intellectual capital were not specifically relevant. Issues relating to manufactured capital and the benefits of functioning assets are covered in the technical engineering descriptions and performance of the scheme. The items relating to natural capital are already covered and assessed and are therefore not duplicated here.

In summary, the key issues for the FR scheme are:

- Economic impacts deriving from employment and the benefits through the supply chain;
- Economic benefits from increase in tourism related to new recreation assets;
- Health and well-being benefits occurring from opportunities to enhance local environment;
- Education and opportunities to provide educational resource;
- Ongoing contribution to enabling apprenticeships;
- Partnership strategy to work with local organisations.

The detailed methodology for assessing the wider benefits varies for each of these issues and the following section presents these details alongside the results.

14.3 Results

This section sets out the findings from the assessment of wider benefits for employment impacts, health and well-being benefits and apprenticeships.

14.3.1 Employment impacts

Employment impacts are expected to result in positive outcomes. The beneficiaries are those who are directly employed, as well as indirect and induced impacts on the local economy (goods and services).

Numbers of proposed employees can be used to calculate Gross Value Added (GVA) per worker to generate estimates for positive economic impacts (direct, indirect and induced) in GBP. This includes the benefits from spending with suppliers and spending by people whose incomes are changed directly or indirectly by the scheme.

Work has not been completed on identifying the numbers of construction workers that may be required to construct the scheme. Work has also not been completed to identify the number of staff that would be required to operate the new water infrastructure, as well as the recreational elements of the reservoir. However, as an example of the scale of potential benefits, comparable water infrastructure operations have around 15 full time equivalent staff with another 15 full time equivalent staff supporting the recreational aspects of a reservoir. The

operational jobs could generate positive economic impacts (direct, indirect and induced) of approximately £15 million.

Employment impacts were calculated by applying standard data from the ONS on Gross Value Added (GVA) per worker at the UK level in the production sector, as this includes employment in the utilities and water industries the number of jobs estimated by the client. This gross figure was adjusted for additionality by applying deadweight and displacement. Leakage was considered to be zero as the study area for this analysis is too large for leakage to be likely. This data was adjusted to 2022 prices using Gross Domestic Product (GDP) deflators from HM Treasury (HMT). The GVA impact was then modelled over a 30-year appraisal period and the present value of this benefit was calculated using the standard HMT discount rate of 3.5% per annum. Indirect and induced employment impacts were calculated using a standard multiplier of 1.1 from the HCA (now Homes England) Additionality Guide. GVA per worker data was then applied to the multiplier jobs and discounted.

14.3.2 Tourism

The new reservoir component of the scheme has the potential to create a new tourism destination. There are approximately 100,000 people living in the Fenland local authority area and another approximately 580,000 living in the surrounding local authority areas of East Cambridgeshire, South Cambridgeshire, Huntingdonshire and King's Lynn and West Norfolk. This represents a potential local catchment area for visitors to the new reservoir, providing a local recreational resource and a regional tourism destination.

Other Anglian Water Parks attract thousands of visitors each year; a comparable facility, Grafham Water, has around 300,000 visitors per year. Anglian Water Parks also host events, such as triathlons, dragon boat races, charity fun-runs and bike rides, alongside national and international fishing competitions. Anglian Water Parks provide recreational facilities, including Fishing, Walking, Cycling, Camping, Café and Picnic facilities. Some also provide opportunities for water sports.

Opportunities that could be delivered through the FR scheme that would benefit tourism and recreation include:

- Visitor amenities could include footpaths, cycleways and bridleways, particularly along the crest of the embankment – a linking footway around the full circumference of the reservoir. These could be supported by additional paths on the external embankments allowing shorter walks and connections to a visitor centre and a bathing area. A water sports centre could support activities on the reservoir such as rowing or sailing. An educational centre can provide information for the public on reservoir operation and the ecological benefits of wetlands and woodlands.
- A potential main visitor centre could provide a focal point for people visiting the reservoir for recreation and education. A visitor centre is a primary way for people to interact and experience the site.
- There are two rail stations in proximity to the site: March (7.5km away) and Manea (4km away). Both stations are on the London – Peterborough Line. There are also bus routes with the closest bus stop 300m from the FR site. There is an opportunity to improve bus accessibility by re-routing the bus route and providing an additional bus stop closer to the proposed visitor centre. There is also an opportunity to consider the role of shuttle bus or demand-responsive transit service.
- While other forms of transport to the site are encouraged by the scheme, car parks are likely to be required for visitors in recognition of the dominant use of personal vehicles. The exact location and sizing of car parking will be based on access points and expected visitor

numbers. Visitor car parking is likely be provided at key areas around the reservoir to encourage full use of the scheme.

- Potential provision of shallow water and wetland habitats. These mosaics of wetland habitats can become visitor attractions and support carefully designed public use that balances access with nature conservation.
- The reservoir waterbody itself could offer visitors a range of potential recreational activities from quiet contemplation and engagement with nature, to more active pursuits such as open water swimming, sailing, rowing and kayaking.

14.3.3 Health and wellbeing

A Public Health England[84] review concluded that people who have greater exposure to greenspace have a range of more favourable physiological outcomes. Greener environments are also associated with better mental health and wellbeing outcomes including reduced levels of depression, anxiety, and fatigue, and enhanced quality of life for both children and adults.

For the transfer routes, opportunities to enhance access to greenspace are most likely to occur in areas where construction activity is affecting existing PRoW. This is likely to benefit local people, although linkages to any national trails could have a wider benefit. No specific proposals have been incorporated into the scheme design at this stage, therefore benefits are qualitative. The benefits could accrue following construction activity.

Examples of opportunities include:

- Opportunities to enhance nearby riparian vegetation and strengthen connections within the blue-green network.
- Opportunities to enhance nearby sections of the long-distance footpaths in terms of planting, resurfacing, information boards, way markers and social enhancements.
- Opportunities to strengthen the green corridor through additional planting to link vegetation.
- Opportunities to enhance landscape character and the character of views from PRoW through additional planting.

For the reservoir, a number of elements of the scheme could contribute to health and wellbeing benefits.

Firstly, being able to access the reservoir is a key consideration, particularly making use of active travel modes – walking and cycling – to reach the reservoir. The construction of the reservoir and its overall site footprint will impact some Public Rights of Way (PRoW). In order to retain and increase accessibility to the reservoir and to further increase the connectivity of the surrounding towns and villages, potential footways could connect Wimblington to the north, Manea to the east and Chatteris to the south as well as allowing the reservoir to be a focal point of the PRoW network. Doddington can also be connected to the reservoir with a cycleway to the western edge of the reservoir.

Secondly, at the reservoir, there are opportunities to provide new cycle and pedestrian routes. For example, a new multi-user access path is proposed around the full circumference of the reservoir. These could be supported by additional paths on the external embankments allowing shorter walks and connections visitor and recreational facilities.

Thirdly, new greenspace includes potential areas for wetland creation, shallow water habitats and woodland/scrub planting. As discussed above, the proposed network of pedestrian and

[84] Public Health England (March 2020): Improving access to greenspace- a new review for 2020 [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904439/Improving_access_to_greenspace_2020_review.pdf

cycle routes will enable those visiting the reservoir site to be able to access the new greenspace.

Finally, the creation of the reservoir as a new piece of 'blue space' provides benefits. An evidence review of the social benefits of Blue Space collated by the Environment Agency[85] found that blue spaces were found to provide a range of social and health benefits including those people who use blue space saying they gain psychological benefits from the experience and people report feeling happier when they are in proximity of water.

14.3.4 Education

The new reservoir could provide an additional educational resource for the community. The existing Anglian Water Parks provide opportunities for school visits and is it anticipated that potential features of the FR scheme, including a possible visitor centre, which could include educational facilities, might also afford this opportunity.

In terms of the change in educational value expected the reservoir itself could provide easier access to incorporate primary curriculum learning alongside scientific concepts. The variety of STEM (Science, Technology, Engineering Mathematics) educational opportunities available could enable engagement upon topics such as water resource management, flood prevention and biodiversity. The proposed infrastructure within the site could enable children to safely access the surrounding environments and effectively learn. This could also provide a greater range of educational value, catering for different key stages within schools from more basic principles around nature conservation to early career engagement opportunities presented within engineering and environmental science.

The existing Anglian Water Parks provide opportunities for volunteers to get involved in activities. As well as helping maintain and improve the water parks, volunteering provides the opportunities to learn new skills and knowledge.

14.3.5 Apprenticeships

The project promoters have existing apprenticeship schemes to assist in introducing people to the workplace and develop skills through a variety of advanced, higher and degree level apprenticeships across a range of roles. As well as benefits to the individual employee, a skilled workforce contribute to increased Human capital of the organisation. The educational / training facility also benefits through running successful apprenticeship programmes (developing knowledge, skills of trainers) and the local employment and economic market also benefit. Although the apprenticeships are timebound for an individual, organisations such as water companies can provide long term career options as a wide range of roles at all levels are available. Water companies also partner with other organisations, such as contractors, and it is therefore likely that apprentices contribute to construction activities.

As the project promoters run the apprenticeship schemes at a corporate level, rather than recruit for specific projects, it is not possible to assign particular numbers of apprentices to the Fens Reservoir scheme.

14.3.6 Partnership strategy

The ongoing design development will identify and engage partner organisations to identify and enhance the benefits of the FR scheme. In addition to the opportunities identified in this chapter,

[85] Environment Agency (October 2020): The social benefits of Blue Space: a systematic review https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/928136/Social_benefits_of_blue_space_-_report.pdf

this is expected to include working with agricultural stakeholders and environmental regulators on issues such as irrigation supply and FSAs as part of a suite of system interventions.

It is recognised that the reservoir scheme could be a catalyst for a much broader multi-sectoral system that has the potential to benefit a range of sectors including agriculture, nature conservation and flood risk management, as well as delivering ecosystem services such as carbon sequestration and biodiversity net gain. This wider system vision would be outside the scope of the core reservoir (public water supply) scheme and therefore would require additional funding and partnership to deliver.

A preliminary report has been undertaken to examine options for wider system opportunities and to identify and map potential landscape-scale interventions and sources of external funding.

15 Conclusions and next steps

15.1 Conclusions

During gate two, the environmental assessments undertaken for gate one have been updated and expanded, following selection of a single proposed site and initial concept design work for this site.

At gate two the Rapid guidance states[86] the submission should be supported by an annexed initial environment appraisal report that addresses a number of issues. These issues are listed in Table 15.1 and where the issue is addressed within this report.

Table 15.1: Rapid Guidance

Rapid guidance requirements	Report reference
An update of the gate one work where relevant.	Chapters 1 and 2
The environmental appraisal work undertaken to date – likely to be at a strategic scale.	Chapter 3
Baseline and analysis – this might include results of monitoring, modelling, environmental surveys, etc.	Chapters 4 - 10
Options assessment, with sufficient detail to allow comparison of options within the solution and identify potential effects (positive and negative) and opportunities.	Chapters 4 - 11
Assessment of the effects of the solution, an evaluation of their significance and any cumulative or in-combination effects.	Chapter 11 Appendices A1, A2, A3
Clear justification as to options within the solution discounted, those taken forward, and the proposed option selected. Where the proposed option is identified, potential environmental effects and opportunities should be discussed.	Chapter 2, Sections 4 -10
The appraisal work should include consideration of resilience (e.g. climate change,)	Chapter 2 Section 7
A description of the connection to other assessments (e.g. biodiversity net gain, WFD, natural capital, carbon) and demonstrate how they have been considered within this initial appraisal work.	Chapter 13, Appendices A1, A2, A3, A4
Development of mitigation and enhancement opportunities.	Chapter 14
Any future monitoring requirements of the identified environmental effects and efficacy of any included mitigation measures.	Chapter 3 Appendices A1, A2, A3
A plan to address uncertainties and data gaps.	Chapter 15

A number of potential impacts were identified through the environmental assessment of the reservoir, and associated abstractions, transfers and water treatment works. These were mostly associated with changes to the aquatic environment, impacts on biodiversity, landscape and heritage. There would also be a permanent loss of a soils and agricultural land on the reservoir site.

[86] Regulators' Alliance for Progressing Infrastructure Development April 2022 Strategic regional water resource solutions guidance for gate two

These issues will require further investigation and may impose constraints to consider in subsequent phases of the scheme development. However, several opportunities were also identified which could be considered at the next stage of the development, which could result in enhancements to the environment and community.

A summary of the key topic findings is outlined below:

- Water Framework Directive (WFD) Assessment – the level 1 assessment identified 13 waterbodies which could potentially be affected by the scheme. Following the level 1 assessment, three of these waterbodies were identified as requiring a level 2 assessment due to the potential effects on the WFD waterbodies. The level 2 assessment couldn't rule out the potential for minor/ major adverse risks on these waterbodies, so further assessments would be required as the project progresses.
- Informal Habitats Regulations Assessment (HRA) – the Stage 1 Test of Likely Significance ("Screening") identified six designated sites subject to likely significant effects as a result of the construction or operation of the Scheme; Ouse Washes SPA, SAC and Ramsar, and The Wash SAC, SPA and Ramsar. The informal Stage 2 Appropriate Assessment (AA) concluded that residual adverse effects cannot be excluded after taking into account mitigation for the operation phase of the Scheme for all designated sites considered. It is also not possible, at this stage, to exclude adverse effects during the construction phase for the Ouse Washes SPA and Ramsar. Further surveys, data collection, modelling and assessment, together with the detailed consideration of mitigation measures, will be required in order to conclude the effect on the integrity of designated sites. The strategy to produce the evidence base required for the formal stages of HRA will be agreed at the next stage in consultation with the regulator. Ultimately, a strong and robust evidence base will be required to conclude that there will be no adverse effects on the integrity of any designated site as a result of the construction or operation of the scheme. The level of detail available at this stage (which is considered proportionate) means that such effects cannot be ruled out. As a result, this will need further consideration and assessment as part of the next stages of design development to conclude what the effects (if any) of the Scheme on designated sites will be and any further work required by the HRA process. All of this would need to be undertaken in dialogue with key stakeholders, including Natural England and the Environment Agency.
- Invasive Non-Native Species (INNS) – INNS were recorded within the proposed abstraction sources and within associated study areas. The assessment concluded that the proposed transfers will not introduce a new hydrological connection between 'isolated' WFD Operational Catchments, as defined in Environment Agency guidance. However, the proposed scheme would result in increased connectivity between waterbodies and will need to be further assessed and appropriately mitigated as the design develops.
- Natural Capital Assessment (NCA) and Biodiversity Net Gain (BNG)- the scheme is likely to generate the permanent and temporary loss of natural capital stocks during construction. However, some habitat is expected to be reinstated/compensated to pre-construction conditions following good practice technique and will likely have no permanent impact to the provision of ecosystem services. The scheme is likely to result in a biodiversity net loss for both habitat and river biodiversity units. However, the scheme presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats.

- Strategic Environmental Assessment (SEA) – the SEA ratings were informed by the other environmental assessments undertaken for the scheme. The SEA considered anticipated construction and operational effects, both without any mitigation applied and expected residual effects after implementation of identified mitigation measures. It identified potential effects for Biodiversity, Flora and Fauna, Soil, Water, Air, Climatic Factors, Landscape, Historic Environment and Material Assets. Positive effects were identified for Population and Human Health. In-combination effects have been considered for WFD and HRA and cumulative effects have been considered as part of the wider environmental appraisal process.

As well as the topic-based desk assessments, a wider benefit assessment was undertaken which looked at the potential benefits for employment impacts, tourism, health and well-being, education and apprenticeships. A summary of the results from the assessment are outlined below:

- **Employment Benefits** - employment impacts are expected to result in positive outcomes. The beneficiaries are those who are directly employed, as well as indirect and induced impacts on the local economy (goods and services).
- **Tourism** – there is the potential to create a new tourism destination, as there is a local catchment area for visitors to the new reservoir. Several opportunities were identified including the creation of wetlands, cycleways, footpaths, bridleways, a visitor centre, transport links and a bathing area.
- **Health and Wellbeing** – greener environments are associated with better mental health and wellbeing outcomes including reduced levels of depression, anxiety, and fatigue, and enhanced quality of life for both children and adults. Numerous opportunities were identified following the construction activity along the pipeline route (particularly around PRoW areas) and within the reservoir site.
- **Education** - the new reservoir could provide an additional educational resource for the community. The existing Anglian Water Parks provide opportunities for school visits and is it anticipated that features of FR scheme, including a potential visitor centre, which could include an educational centre, may also afford this opportunity.
- **Apprenticeships** – the project promoters have existing apprenticeship schemes to assist in introducing people to the workplace and develop skills through a variety of advanced, higher and degree level apprenticeships across a range of roles.
- **Partnership Strategy** - The Fens Water Partnership have been involved in the development of concept designs and provided representations on the gate one submission. The ongoing design development will identify and engage partner organisations to identify and enhance the benefits of the FR scheme. This is expected to include working with agricultural stakeholders and environmental regulators on issues such as irrigation supply and FSAs.

As the scheme progresses, the design will be subject to an iterative process of environmental assessment, informed by further surveys and modelling, to identify and agree suitable mitigation and enhancement measures.

A provisional summary of recommended environmental assessment activities beyond gate two is outlined in the next steps section. The scope of this additional work would be agreed in consultation with relevant environmental stakeholders and regulators, as part of a formal EIA process cons3ented through a Development Consent Order.

15.2 Regulatory Barriers

Although detailed environmental assessments will need to be undertaken during the next stages of the project, and only indicative details of scheme design were available at gate two, the appraisal work described in this report has not identified any fundamental regulatory barriers that mean the scheme should not progress to the next stage of evaluation.

The environmental appraisals have highlighted that some uncertainties and risks remain that will need resolving, particularly in relation to the nature of Habitats Regulations and Water Framework Directive effects. For both HRA and WFD, a detailed strategy to develop a robust evidence base to inform subsequent assessments, and potentially derogation tests, will need to be developed in consultation with the regulators.

Detailed surveys and investigations will be needed to evaluate and refine the initial EAR findings in relation to topic areas such as Biodiversity Net Gain, Natural Capital, ecology (both terrestrial and aquatic), landscape and historic environment.

15.3 Proposed future work

The environmental activities carried out for the next stages of the project will be influenced by the programme for delivering the SRO. A list of activities that could be prioritised is provided below, but noting that some of these will address an immediate need while for others it may be more appropriate to carry out later in the development process. Activities that should be considered include:

WFD and HRA

- Further assessment and modelling of the effects of abstraction on the River Delph and River Great Ouse.
- Hydrodynamic modelling of flows and salinity into The Wash Designated Sites.
- WFD and HRA Assessments of EDD options.
- Further engagement with stakeholders including the Environment Agency and angling clubs.
- Land drainage and site drainage design, to understand which watercourses will be diverted/realigned and which are lost.
- Detailed field surveys comprising UK Habitats Classification surveys and Habitat Condition Assessments in accordance with the Metric 3.1 Technical Supplement.
- Re-run of the INNS risk assessment including the SAI-RAT to include latest species distribution data, updated details of the scheme, and consideration of any new or increased connectivity between catchments due to the scheme.

Biodiversity

- Ecological walkovers and surveys.

Soil

- Detailed soil resource to confirm the soil resources present, map the distribution of soil types and inform a soil management plan.

Carbon

- Update carbon assessments as the design evolves.

Landscape

- Development of landscape proposed mitigation and opportunities to offset impacts of the scheme, including the appraisal of landscape effects associated with the indicative transfer routes and associated infrastructure.

Cumulative and in-combination effects

- There are a number of potential cumulative effects arising from the development of the scheme as there are some key interactions with Local Development Plan allocations. These will need further investigation and may support the scheme design.

Population

- Assessment of the impact of the scheme on different sections of society, including those living, working or owning businesses who may be displaced as a result of the scheme. This could be undertaken through an EqIA.

INNS

- Although the scheme would not create a link between 'isolated' catchments as defined in EA guidance, any potential change or increase in connectivity between other catchments should be investigated and appropriate mitigation proposed.
- The INNS risk assessment is reviewed upon finalisation of the conceptual design and further survey data, to account for any changes that may introduce INNS risk.
- Undertake a review of a wider range of information sources are used to determine INNS distribution, including non-open-source EA records such as those relating to floating pennywort (Hydrocotyle ranunculoides).

NCA and BNG

- The NCA would be refined further to work alongside the environmental impact assessment / DCO process to provide a natural capital input into the EIA. The assessment would be further updated, as required, in lieu of developed design and following Phase 1 habitat surveys as required.
- The BNG assessment can be revisited, and mitigation or enhancement opportunities developed further to achieve the 10% BNG required within the scheme.

The above activities and data are to be reviewed in the updated regulatory assessments, namely the refinished SEA, HRA, WFD, NCA, BNG and INNS assessments in next phases of the scheme development.

The RAPID guidance for gate three[87] states that for most solutions a statutory EIA will be required to support planning and permitting applications. The EIA should be sufficiently advanced to support EIA scoping requirements for the gate three process. All pre-application activities will be carried out in accordance with the requirements of the 2008 Planning Act.

[87] Gate Three Guidance, RAPID (2022), online at RAPID-Gate-Three-Guidance.pdf (ofwat.gov.uk)

A. Appendices