Annex B6: Biodiversity Net Gain, Natural Capital and Renewables Assessment Report

Standard Gate two submission for London Water Recycling SRO

Notice – Position Statement

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

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

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

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

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

Disclaimer

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

LONDON EFFLUENT REUSE SRO

Annex B.6. Biodiversity Net Gain, Natural Capital & Renewables Assessment Report

Report for: Thames Water Utilities Ltd

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APPENDICES

1. INTRODUCTION

1.1 BACKGROUND

London Effluent Reuse has been identified as a Strategic Resource Option (SRO) in the Price Review 2019 Final Determination, with funding allocated to Thames Water. As part of the assessment of water companies' PR19 business plans, Ofwat introduced proposals to support the delivery of SROs and set out an associated gated process for the co-ordination and development of a consistent set of strategic water resource options. This gated process provides a mechanism for the industry, regulators, stakeholders and customers to input into the development and scheduling of strategic solutions, through a combined set of statutory and regulatory processes.

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

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

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

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

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

The primary objective of the Gate 2 environmental assessment studies is to provide regulatory assessments for the London Effluent Reuse SRO and to ensure environmental and social considerations (including mitigation and net gain opportunities) of options are included in regional plans and that detailed feasibility, concept design and multi-solution decision making has been suitably informed.

In October 2020, the group of Water Companies involved in developing SROs (known as the All Company Working Group - ACWG), published guidance[1] for environmental assessment methods for SROs which is aligned to the draft Water Resources Planning Guideline (WRPG): Working Version for Water Resource Management Plan 2024[2] (WRMP24) to increase the consistency of environmental assessment and the evaluation of impacts on environmental water quality in particular. This is also in line with the Environmental Act 2021[3] detailing the provision for a minimum of 10% net gain on all planning applications.

1.2 PURPOSE OF THIS REPORT

This report sets out the Biodiversity Net Gain (BNG), Natural Capital (NC) and renewables assessment of the for the London Effluent Reuse schemes covering Beckton water recycling, Mogden water recycling, and Teddington DRA at Gate 2.

[1] Mott MacDonald Limited (2020). All Companies Working Group WRMP environmental assessment guidance and applicability with SROs. Published October 2020

[2] UK Government (2022) Water resources planning guidance. Water resources planning guideline - GOV.UK (www.gov.uk)

[3] UK Government (2021) Environment Act 2021. https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted

The purpose of this report is to provide firstly a BNG and NC assessment of the London Effluent Reuse SRO schemes, to inform the site selection work and secondly a preliminary assessment of BNG and NC losses and benefits for the London Effluent Reuse SRO, for reporting as part of the Gate 2 submission and to enable a comparison of the SROs.

This report applies the latest methodologies for BNG and NC assessment as set out in the ACWG current guidance to SRO Environmental Assessment and as noted in that guidance, the approach has been developed to be proportionate to the assessment, current data and also consider the options complexity. This report sets out the environmental evidence and data used to inform the natural asset baseline and the results of the BNG and NC assessments.

As part of this assessment, we have reviewed the tools outlined in the WRMP24 guidance and where feasible these have been used. Where this is not used for a specific ecosystem service, this has been justified as requested in the guidance noting that many tools have limitations or need a level of detail not necessarily currently available.

The report also identifies the remaining evidence and data gaps for further consideration in the next stage of development of the SRO.

This report includes an assessment of habitat loss (both temporary and permanent loss), a high-level assessment of habitat reinstatement required on-site and where necessary consider additional off-site mitigation to offset any habitat loss. An assessment of 'uplift' necessary to achieve a minimum of 10% net gain is also included. An associated NC assessment is included that accounts for temporary and permanent losses and additional benefits related to on-site and off-site mitigation required to obtain a minimum of 10% net gain.

This report also includes a high-level renewables assessment covering renewable energy opportunities that would be generated to offset the London Effluent Reuse SROs as part of the BNG and NC outputs.

Note:

The assessments undertaken in this report are based on the information available at this stage and uses assumptions. Assumptions are based on professional judgements and on the basis of discussion with engineers and data availability. This approach ensures that outputs are as accurate as possible given the current uncertainty related to detailed design.

Comments made at Gate 1 have been incorporated in the assessments for this Gate 2 process.

At Gate 3, the assessments will be refined further with more scheme information being available and due to further stakeholder engagement.

1.2.1 Link with other reports

This assessment report has assessed the operational effects and associated hydrologically impacted reaches based on the findings of the hydrological modelling and assessments presented in the London Effluent Reuse SRO Gate 2 Physical Environment Report[4]. The survey baseline data, scope and detailed assessment methodology used in this report are presented in the London Effluent Reuse SRO Gate 2 Terrestrial Ecology Assessment report[5].

1.3 STRUCTURE OF THIS REPORT

This report includes the following sections:

Section 1: Introduction

Section 2: Scheme descriptions

Section 3: Biodiversity Net Gain and Natural Capital Methodology

Section 4: Biodiversity Net Gain and Natural Capital assessment results of Beckton water recycling scheme

[4] Ricardo (2022) London Reuse Strategic Resource Option, Gate 2 Physical Environment Report.

[5] Ricardo (2021) London Reuse Strategic Resource Option, Annex B.2.6 Gate 2 Terrestrial Ecology Assessment Report.

2. LONDON EFFLUENT REUSE SRO SCHEMES

2.1 SCHEME DESCRIPTIONS

For Gate 2, the London Effluent Reuse SRO is set out as four source options and a range of sizes. One option is in east London, utilising final effluent from Beckton Sewage Treatment Works (STW). The other three options are in west London, utilising crude sewage or final effluent from Mogden STW to a maximum total reduction of 200 Ml/d, with differing London Effluent Reuse discharge locations in the freshwater River Thames (Figure 2-1).

Full details of the conceptual design of the four schemes are provided in the Conceptual Design Reports[6] (CDR). High level summaries of each option are provided below.

Figure 2-1 Schematic of the London Effluent Reuse SROs

2.1.1 Beckton water recycling scheme

Final effluent from Beckton STW would be treated at a new advanced water recycling plant (AWRP) within Beckton STW for advanced treatment. Recycled water would be conveyed via a new tunnel from the Beckton AWRP to Lockwood Pumping Station and then a Thames-Lee-Tunnel extension from Lockwood Pumping Station to a proposed new outfall located on a side channel of the freshwater Lee Diversion, known as the Enfield Island Loop, upstream of the existing Thames Water Enfield intake to the King George V Reservoir. Additional abstraction for public water supply on a put/take basis would be through existing intakes in the lower Lee, to supplement the raw water supply to the Lee Valley reservoirs. The option reduces the final effluent at the extant Beckton STW outfall to the estuarine Thames Tideway.

The Beckton water recycling scheme has been assessed for Gate 2 independently at 100 Ml/d, 200 Ml/d, and 300 Ml/d. The scheme variation assessed in this report is 300ML/d as this would result in the most significant land use change and therefore require greater areas for mitigation. Hence, the benefits relating to natural capital would be greater. If less infrastructure is required related to lower Ml/d, there would be more opportunity

[6] Jacobs (2022) London Reuse Strategic Resource Option, Gate 2 Conceptual Design Reports.

to mitigate on-site or nearer to the site. This is better for biodiversity net gain as less off-site mitigation will be required. At this stage, all options are being considered and suitable refinements will be made at Gate 3.

2.1.2 Mogden water recycling scheme

Final effluent from Mogden STW would be pumped in a new pipeline to a new reuse water recycling plant located at a site near Kempton water treatment works (WTW)) for advanced treatment via a new AWRP. Recycled water would be transferred in a new pipeline for discharge into the freshwater River Thames at a new outfall upstream of the existing Thames Water Walton intake. Additional abstraction for public water supply on a put-take basis would be through existing downstream intakes on the River Thames. AWRP wastewater and reverse osmosis (RO) concentrate would be conveyed back to Mogden STW inlet works via a return pipeline(s). There is an option that the AWRP wastewater could be discharged to the South Sewer for return to Mogden STW, but it is not possible to return the RO concentrate by this means. The scheme reduces the final effluent at the extant Mogden STW outfall to the estuarine Thames Tideway.

The Mogden water recycling scheme has been assessed for Gate 2 independently at 50 Ml/d, 100 Ml/d, 150 Ml/d and 200 Ml/d. The scheme variation assessed in this report is 200ML/d as this would result in the most significant land use change and therefore require greater areas for mitigation. Hence, the benefits relating to natural capital would be greater. If less infrastructure is required related to lower Ml/d, there would be more opportunity to mitigate on-site or nearer to the site. This is better for biodiversity net gain as less off-site mitigation will be required. At this stage, all options are being considered and suitable refinements will be made at Gate 3.

2.1.3 Mogden South Sewer scheme

During Gate 2, Thames Water took the decision to pause development of the Mogden South Sewer scheme due to limitations on available flow within the sewer, cost of the scheme and regional modelling not selecting the scheme under any water resources planning horizon scenario.

The Mogden South Sewer scheme has not been progressed through Gate 2 environmental assessments, and so a dedicated assessment section is not included within this report. However, due to the similarities with the 50 Ml/d Mogden water recycling scheme (AWRP, discharge location and volume), the outcomes of that assessment can be considered representative of a physical environment assessment of a 50 Ml/d Mogden South Sewer scheme.

2.1.4 Teddington DRA scheme

Final effluent from Mogden STW would be subject to further treatment at a new tertiary treatment plant (TTP) at Mogden STW. The treated water would be transferred in a new pipe-jacked tunnel for discharge into the freshwater River Thames at a new outfall upstream of the tidal limit at Teddington Weir. Additional abstraction for public water supply on a take-put basis would be through a new intake from the freshwater River Thames, upstream of the new outfall. Abstracted water would be pumped into the nearby Thames-Lee Tunnel for transfer to Lockwood pumping station, part of Thames Water's Lee Valley reservoirs in North London. The option reduces the final effluent at the extant Mogden STW outfall to the estuarine Thames Tideway.

The Teddington DRA scheme has been assessed for Gate 2 independently at 50 Ml/d and 75 Ml/d. The scheme variation assessed in this report is 75ML/d as this would result in the most significant land use change and therefore require greater areas for mitigation. Hence, the benefits relating to natural capital would be greater. If less infrastructure is required related to lower Ml/d, there would be more opportunity to mitigate on-site or nearer to the site. This is better for biodiversity net gain as less off-site mitigation will be required. At this stage, all options are being considered and suitable refinements will be made at Gate 3.

3. BIODIVERSITY NET GAIN AND NATURAL CAPITAL METHODOLOGY

3.1 TERRESTRIAL DATA PROCESSING

QGIS was used to map the physical environmental impacts that would result from the implementation of the four options. These impacts were split into permanent impacts and temporary impacts. Permanent impacts are the result of new above-ground structures being created. Habitats lost within these areas cannot be replaced in situ due to the presence of the new building and are therefore lost permanently. Temporary impacts occur in areas lost to construction zones, whereby the habitat will be removed to accommodate construction efforts but then replaced once the construction teams have finished.

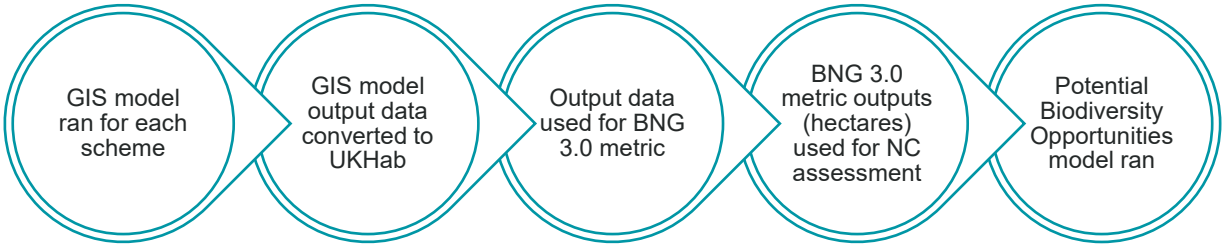
Working widths representing temporary habitat losses during construction were created along the pipeline routes. These were initially created through 25m buffers of the routes which were then edited using Google satellite images to identify and exclude existing structures, hedgerows and private gardens that will be avoided by construction teams. Ordinarily ancient woodland areas would also be avoided using working widths, but none were discovered along the pipeline route. Open areas such as fields and roads remained included in the working widths. Some scheme pipe elements cross various minor roads, for which we have assumed open cut construction methods. Roads are classified as 'Urban - built linear features', which scores 0 and therefore they are excluded from the assessment.

Once the areas of permanent and temporary loss had been identified, they were mapped then run through a model which identified habitats falling within these areas. This model prioritises the habitat layers that have higher resolution (out of the desk-based datasets), importance and validity. This ensures that the most accurate and important data was not missed due to overlapping data of lower resolution. Areas identified as being river were removed from the metric as these were assessed separately in the BNG Rivers part of the assessment (see Section 3.3).

Although efforts had been made to avoid hedgerows through working widths, some remained unavoidable. The metric calculates hedgerows differently to most other habitats in that it bases its calculations on lengths of hedgerow rather than areas. Areas identified in the UK Habitat Classification (UKHab) data as hedgerows therefore had to be converted into two-dimensional lengths before they could be entered into the metric. Rather than creating Habitat units, the metric outputs Hedge Units instead. Separate mitigation calculations were then made in a similar method to other terrestrial habitats, whereby mitigation comes from increasing the condition of other hedgerows from ‘Poor’ to ‘Moderate’, or ‘Moderate’ to ‘Good’. The lengths of enhanced hedgerows required to achieve 10% net gain in hedge units could then be calculated.

The NC Assessment is based on the BNG Metric 3.0 data for permanent loss, temporary loss and mitigation required to meet the 10% net gain. The habitats are categorised into broad habitats which is used as the NC baseline data required for the qualitative, quantitative and monetisation of ecosystem services. The GIS, BNG and NC assessment process is shown summarised in Figure 3-1.

Figure 3-1 Flow chart showing GIS, BNG and NC process



The NC qualitative assessments for natural hazard, water regulation and water purification ecosystem services are based on a buffer area of 5km around the scheme. This is the zone of influence and the size is proportionate at this stage, to assess any direct or indirect impact to the surrounding environment due to the scheme. The footprint of each scheme is assessed in permanent and temporary loss and the impact is captured within the zone of influence.

3.2 BIODIVERSITY NET GAIN – TERRESTRIAL HABITATS

BNG is the concept of going beyond mitigation of development impacts on the environment and putting in a conscious effort to initiate positive ecological change. It requires an understanding of the habitats that will be lost both temporarily and permanently through construction and provides a means to calculate how to mitigate the damage caused. This is accomplished through the use of the Biodiversity Metric 3.0 tool[7] which, through consideration of habitat type and condition, converts areas of habitats into Biodiversity Units. Once a value of habitat units lost has been calculated, a target for how many should be achieved to produce 10% BNG is also calculated. The metric tool then allows for plans to be made for habitat creation or enhancement in order to increase the net Biodiversity Units of the project until the target 10% gain is reached. The 10% gain was calculated for the whole scheme boundary (scheme route plus working width buffer). A newer version of the tool, 3.1, has been released but 3.0 was used for these assessments to provide consistency across multiple SROs. Although some BNG units per habitat have changed in version 3.1, the overall differences are minimal and at Gate 2 won't affect the BNG conclusions drawn. For future gates updated versions of the metric will be used.

In order to obtain accurate habitat data to input into the Biodiversity Metric, ecologists from Jacobs conducted habitat surveys along the London Effluent Reuse SRO routes and produced GIS shapefiles of the data they collected, detailing both habitat types and conditions. The methodology used in the field to obtain this data is detailed in presented in the London Effluent Reuse SRO Gate 2 Terrestrial Ecology Evidence Report[5]. The data itself is also presented in the London Effluent Reuse SRO Terrestrial Ecology Report[8]. For any areas which this did not cover, habitat types were obtained through datasets from the National Forest Inventory, Corine Land Cover, Corine High Resolution Grassland, Corine High Resolution Urban, Ordnance Survey Greenspace and Open Water, and the Priority Habitats Inventory.

Due to the high-level nature of the Gate 2 assessment and the scope of available detailed design information, several assumptions have been made to allow calculation of Biodiversity Net Gain requirements. The key assumptions are summarised below:

3.2.1 Statutory and non-statutory designated sites

Risks to designated sites from construction and operation is dealt with in the London Effluent Reuse SRO Gate 2 Habitats Regulations Assessment Report[9]. The terrestrial/area habitats BNG assessment covers only direct impacts from construction and does not include operational effects from hydrological changes associated with the scheme. No direct impacts to statutory sites or irreplaceable habitats were recorded during the terrestrial BNG assessment. Impacts to water dependent priority habitats and designated sites from operation of the London Effluent Reuse SRO are included in the London Effluent Reuse SRO Gate 2 Habitats Regulation Assessment report[9]. Operational Impacts to watercourses are assessed for the Rivers and Stream Biodiversity Metric, the methodology is outlined below.

3.2.2 Baseline habitat area and condition

The condition of each habitat type is assessed against specific requirements listed within the Natural England guidance document[10] from field survey data. These requirements are specific to each habitat type and relate to physical characteristics, structural attributes, typical species present and positive and negative indicators,

[7] Natural England (2021) Biodiversity Metric 3.0 – Calculation Tool. Available at publications.naturalengland.org.uk

[8] Ricardo (2022) London Effluent Reuse SRO, Terrestrial Ecology Assessment Report. Report For: Thames Water Utilities Ltd

[9] Ricardo (2022) London Effluent Reuse SRO, Gate 2 Habitats Regulation Assessment Report. Report For: Thames Water Utilities Ltd

[10] Stephen Panks, Nick White, Amanda Newsome, Jack Potter, Matt Heydon, Edward Mayhew, Maria Alvarez, Trudy Russell, Sarah J. Scott, Max Heaver, Sarah H. Scott, Jo Treweek, Bill Butcher and Dave Stone (2021). Biodiversity metric 3.0: Auditing and accounting for biodiversity – Technical Supplement. Natural England

such as the presence of invasive species. UKHab sampling surveys were undertaken by Jacobs in 2021 and 2022[11,12,13,14,15,16,17] at locations along the proposed routes to assess these conditions.

For the purpose of this assessment, open-source data has been used in situations where there was no UKHab data available and condition information is consequently not obtainable. The lack of survey data on baseline habitat condition means that habitat condition is assumed to be 'moderate' in all cases to apply the average condition multiplier therefore avoiding under or over estimating desk based habitats. The datasets used for the BNG and the Potential Biodiversity Opportunity (PBO) assessments are listed in Table 3-8.

3.2.3 Strategic significance

Strategic significance is measured at a landscape scale, taking into consideration local plans for green infrastructure and biodiversity, national character areas and national objectives. This category gives value to habitats that are situated within optimal locations which could enable biodiversity objectives to be met. For the purpose of this assessment strategic significance was assumed in all cases to be 'location ecologically desirable but not in local strategy'.

3.2.4 Habitat loss

All habitats within the construction easement are assumed to be lost and re-instated with the existing baseline habitat type and restored to the same condition, barring those that will be replaced by permanent above-ground infrastructure. There is no information at this stage on whether some of the habitat along the London Effluent Reuse SRO overall route will be retained but still be degraded from vehicle access and restored (temporary degradation). For the purpose of this assessment temporary habitat loss has been assumed to be longer than 2 years and therefore considered as a loss within the Metric. At Gate 3, if certain habitats are temporarily lost and restored within 2 years these habitats do not need to count as a loss and would therefore reduce the off-site mitigation requirements.

Priority habitat layers for hedgerows/arable field margins are not open-source information. Where an area was not subject to field survey, hedgerow intersections have been identified through aerial photography. An estimate has then been made of habitat loss based on a working easement of 25m either side of the pipeline, as provided by Jacobs.

Water courses along pipeline routes have been avoided through the use of shafts and tunnels underneath them and it has been assumed that drilling below watercourses will not result in temporary or permanent loss of riparian habitat located within 10m of the bank top of the watercourses. In order to achieve this, shaft compound sites have been allocated at either end of the proposed tunnel which have been included with the temporary habitat loss calculations, with small areas within (~65m^2) of permanent habitat loss. It should be noted that if these activities are located within 10m of the bank top of the watercourses, then river metric calculations will be required to estimate net loss of river metric and requirement for compensation.

3.2.5 Net gain calculation (terrestrial habitats)

The methodology follows guidance as set out in the ACWG current guidance to SRO Environmental Assessment, the emerging Environment Bill detailing requirements for mandatory BNG and the Natural England Biodiversity Metric 3.0 user guide.

The calculation of net loss/gain within the Biodiversity Metric 3.0 considers direct impacts resulting in habitat loss (whether permanent or temporary). The extent of areas potentially required to achieve a minimum of 10%

[11] Jacobs (2021). London Effluent Reuse SRO, Beckton UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 26. B22849BM/REP/ECO/001

[12] Jacobs (2021) London Effluent Reuse SRO Lockwood UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 17. B22849BM/REP/ECO/002

[13] Jacobs (2022). London Effluent Reuse SRO, Mogden Conveyance Route Shafts: UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 43. B22849BM/REP/ECO/012

[14] Jacobs (2021). London Effluent Reuse SRO, Mogden Discharge Location: UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 14. B22849BM/REP/ECO/003

[15] Jacobs (2022). London Effluent Reuse SRO, Mogden Sewage Treatment Works: UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 15. B22849BM/REP/ECO/010

[16] Jacobs (2021). London Effluent Reuse SRO, Hydes Field: UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 16. B22849BM/REP/ECO/005

[17] Jacobs (2021). London Effluent Reuse, Teddington DRA (Burnell Avenue) UK Habitat Classification Survey Report. Report for Thames Water Utilities Ltd, 1 – 17. B22849BM/REP/ECO/004

net gain for each option have been identified based on the baseline habitats present within the working width and following the requirement of the Biodiversity Metric 3.0. This included requirements such as same habitat required (high distinctiveness) or replacement of same habitat type or higher distinctiveness (low distinctiveness). In order to keep mitigation hectarages within one decimal place the percentage uplift can be higher than 10%.

The extent of off-site mitigation potentially required as identified in the assessment is intended to provide an indicative area off site habitat required to achieve a minimum 10% net gain for the full scheme and within each local authority. Habitats, where possible, were used in the same proportions as the baseline habitats excluding habitats which do not provide BNG Units and are not possible to enhance within the metric (e.g., Urban-sealed surface). Moderate to high distinctiveness habitats were mitigated through off site enhancement e.g., poor to moderate or moderate to good. Very high distinctiveness habitats require bespoke mitigation and are removed from the metric calculations. It is not possible to enhance cropland in the Biodiversity Metric so consequently modified grassland was used for off-site mitigation to offset impacts to crop land using a change in habitat type from poor condition modified grassland to moderate condition neutral grassland. Examples of off-site interventions are shown in Table 3-1 below.

When calculating off-site mitigation it was assumed there would be no advanced or delayed habitat enhancement and therefore values were set to '0'. The spatial risk category was also assumed in all cases to be set as 'compensation inside LPA or NCA, or deemed to be sufficiently local, to site of biodiversity loss'.

Table 3-1 Off-site habitat enhancement rules used to calculate habitat area required to achieve a minimum of 10% net gain[18]

On-site baseline habitat loss	Off-site habitat pre-mitigation		Enhancement or Creation	Off-site habitat post- mitigation	
	Habitat	Condition		Habitat	Condition
Cropland	Modified grassland	Poor	Enhancement	Other neutral grassland	Moderate
Modified grassland	Modified grassland	Moderate	Enhancement	Other neutral grassland	Moderate
Other neutral grassland	Neutral grassland	Moderate	Enhancement	Other neutral grassland	Good
Woodland (broad leaved)	Modified grassland	Moderate	Creation	Woodland (broad leaved)	Moderate
Woodland (mixed)	Modified grassland	Moderate	Creation	Woodland (mixed)	Moderate
Lowland mixed deciduous woodland	Modified grassland	Moderate	Creation	Lowland mixed deciduous woodland	Moderate
Traditional orchards	Modified grassland	Moderate	Enhancement	Traditional orchards	Moderate
Floodplain wetland mosaic (CFGM[19])	Modified grassland	Moderate	Enhancement	Floodplain wetland mosaic (CFGM)	Moderate
Lowland calcareous grassland	Modified grassland	Moderate	Enhancement	Lowland calcareous grassland	Moderate
Lowland acid grassland	Modified grassland	Moderate	Enhancement	Lowland acid grassland	Moderate
Bramble scrub	Bramble scrub	Poor	Enhancement	Mixed Scrub	Moderate
Mixed scrub	Mixed scrub	Poor	Enhancement	Mixed scrub	Moderate

[18] Natural England (2022) Habitat Condition Assessment Sheets
[19] Coastal Floodplain Grazing Marsh

On-site baseline habitat loss	Off-site habitat pre-mitigation		Enhancement or Creation	Off-site habitat post- mitigation	
	Habitat	Condition		Habitat	Condition
Saltmarshes and saline reedbeds	Saltmarshes and saline reedbeds	Poor	Enhancement	Saltmarshes and saline reedbeds	Good

3.3 BIODIVERSITY NET GAIN – RIVERS

The Biodiversity Metric requires the assessment of the following characteristics of rivers/streams and canals.

- River type and distinctiveness.
- Condition.
- Riparian zone encroachment.
- In-watercourse encroachment.
- Strategic significance.
- Dealing with risk: difficulty of creation and enhancement/ restoration, time to target condition and spatial risk.

The data sources and how they are used for the assessment are described in the sections below.

3.3.1 Condition

The rivers and streams condition assessment for the Biodiversity Metric is based on the extent and diversity of observed physical features in the river channel and riparian zone (including the physical structure of vegetation) as well as the extent and types of any human modifications. The rivers and streams condition assessment, called the River Metric Survey, is based on geomorphic principles and comprises largely desk-based reach-scale assessment, which indicates the current hydro-geomorphological river type, and a sub-reach scale field survey to inform the river type and assess its baseline condition (the Monitoring of River Physical habitat (MoRPh) survey).

River MoRPh surveys were undertaken at eight sites across potentially impacted reaches of the River Thames upstream of Teddington Weir, between Shepperton and Teddington, and one site on the River Lee north of King George V Reservoir. The sites were identified based on the presence of potentially sensitive habitats to hydrological changes caused by the London Effluent Reuse SRO. River MoRPh surveys were not conducted along potentially impacted rivers and streams from construction of London Effluent Reuse SRO at Gate 2. Therefore, WFD ecological condition has been used alternatively to MoRPh data for the baseline river condition for those watercourses. For the purposes of this assessment, WFD bad and poor status were assumed to equate to the same condition score (i.e., poor) in the metric.

Table 3-2 Condition weightings for rivers and streams (Natural England, 2021).

Classification	Weighting
Good	3
Fairly good	2.5
Moderate	2
Fairly poor	1.5
Poor	1

3.3.2 River type and distinctiveness

The river type is based on the Priority Habitats classification, as defined under section 41 of the Natural Environmental and Rural Communities Act 2006. Priority River Habitats include the following river types:

- Riverine water bodies of high hydro-morphological/ ecological status;
- Chalk rivers;
- Watercourses with water crowfoot assemblages (Habitats Directive Annex I habitat H3260); and

- Active shingle rivers.

The distinctiveness assessment is desk-based. Biodiversity Metric 3.0 determines a distinctiveness score via entering the following river type categories into the tool: Priority River Habitats, rivers and streams (other), canal, ditch and culvert (see Table 3-3 for more information).

Table 3-3 Distinctiveness categories (Natural England, 2021)

Category	Weighting	River type
Very High	8	On Priority River Habitat Map[20] Priority River Habitat and streams of high hydro-morphological and ecological status
High	6	Rivers and streams (other) All other rivers and streams that are not classified as Priority River Habitat
Medium	4	Canal Ditch - artificially created linear water-conveyancing features that are <5m wide and likely to retain water for more than 4 months per annum.
Low	2	Culvert A covered channel or pipe designed to prevent the obstruction of a watercourse or drainage path by an artificial construction.

3.3.3 Riparian zone encroachment

Riparian zone is defined as a 10 m zone from the bank top and urban development within the riparian zone is termed 'riparian encroachment'. This multiplier has been added to Biodiversity Metric 3.0 and therefore, was not included in the Gate 1 assessments as BNG assessment was not undertaken. Riparian zone encroachment is considered in the metric as either no encroachment, minor, moderate or major considering distance of the development from the river channel or area (calculated as %) of encroachment within the 10m riparian zone (see Table 3-4).

Table 3-4 Description of riparian zone encroachment bands (Natural England, 2021).

Riparian zone encroachment band	Multiplier	Description
No encroachment	1.00	"No development within 10 m of bank top"
Minor	0.95	"Any development 8 – 10 m from bank top (up to 100 % of area)"* or "where development footprint occupies 0 – 10% of the riparian zone area 4 – 10 m from bank top."
Moderate	0.85	"Any development where footprint occupies between 10 – 25 % of the riparian zone area 4 – 10 m from bank top."
Major	0.75	"Any development 0 – 4 m from bank top"* or "where development footprint occupies >25 % of the total riparian zone area. "

*These rules were not used to determine riparian zone encroachment band. Due to the lengths covered by the watercourse reaches, which have been defined by WFD waterbody ID, using these rules to determine the riparian encroachment band means for example the entire stretch of watercourse could be classified as major with just one development within 0 to 4m of the bank top.

The riparian encroachment band was calculated as an estimate using open-source GIS data. The CORINE 2018 landcover dataset[21] was used to determine areas of urban development. CORINE landcover layers assessed to fall under urban development included continuous urban fabric, discontinuous urban fabric, industrial or commercial units, port areas, airports, mineral extraction sites, dump sites, construction sites and

[20] Defra (2022). Priority River Habitat - Rivers (England) | Priority River Habitat - Rivers (England) | Natural England Open Data Geoportal (arcgis.com)
[21] European Environment Agency (2018). https://land.copernicus.eu/pan-european/corine-land-cover/clc2018

sports and leisure facilities. Ordnance Survey Open Map vector GIS layer[22] for surface water was used as the baseline watercourse width, using the Water Framework Directive (WFD) River Canal Surface Water Transfer Cycle 2 GIS layer[23] overlayed to assign the WFD watercourse ID. The total areas of urban development within two riparian zones, 0 – 4m and 4 – 10m buffers from the watercourse reaches, were calculated as percentages. The percentages were then applied to the descriptions in Table 3-4 above to give the final encroachment band.

3.3.4 In-watercourse encroachment

In-watercourse encroachment refers to any development within the riverbank (bank face) or river channel. This multiplier has been added to Biodiversity Metric 3.0 and therefore, was not included in the Gate 1 assessments as BNG assessment was not undertaken. In-watercourse encroachment is considered in the metric as minor or major based on how far the development has encroached into the river channel (% width) or along the bank (% length) (see Table 3-5).

Table 3-5 Description of in-watercourse encroachment bands (Natural England, 2021).

In-watercourse encroachment band	Multiplier	Description
No encroachment	1.0	<5 % bank length comprising an engineered bank revetment and no encroachment into channel
Minor	0.8	5 – 20 % bank length comprising engineered bank revetment or encroachment up to 10 % channel width (i.e., small headwalls, jetties and pontoons).
Major	0.5	>20 % bank length comprising an engineered bank revetment or encroachment >10 % of the channel width (i.e., weirs, barrage, bank revetment and large headwalls).

The definitions of in-watercourse encroachment detailed above were not used for this assessment due to lack of data coverage, i.e., the presence of engineered banks or other encroachments are not known along the entire lengths of each impacted watercourse. Therefore, rivers and streams with major in-watercourse encroachment were identified using the heavily modified waterbody dataset[24]. All other WFD waterbodies not designated as heavily modified were considered to have minor in-watercourse encroachment.

3.3.5 Strategic significance

Strategic significance of each river, stream or canal within the buffer area considers whether it is present within local and catchment plans, Catchment Planning Systems, River Basin Management Plans and Priority Habitats for Restoration. This category gives value to watercourses that are identified for action, which could enable biodiversity objectives to be met (see Table 3-6). A review was undertaken of these plans for each watercourse within the buffer area.

Table 3-6 Strategic significance categories (Natural England, 2019c)

Category	Multiplier	Point applied to calculation	
		Pre-impact	Post-impact
High strategic significance Within local and catchment plans, Catchment Planning Systems, River Basin Management Plans and Priority Habitats for Restoration	1.15	Yes	Yes
Low strategic significance Low environmental potential and not formally identified in any local plan	1	Yes	Yes

[22] Ordnance Survey (2022). https://osdatahub.os.uk/downloads/open

[23] Environment Agency (2022). https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/WFDRiverCanalAndSWTWaterBodiesCycle2&Mode=spatial

[24] Environment Agency (2020). https://data.gov.uk/dataset/39c5484d-90ea-41fe-8119-ea699b08689a/water-framework-directive-cycle-2-heavily-modified-water-body-use-and-physical-modification

3.3.6 Risk multipliers

The Biodiversity Metric for rivers includes risk multipliers to take account of uncertainty and difficulty of restoration/ enhancement and creation of offsets, plus spatial risk.

Spatial risk uses WFD waterbody and catchment boundaries to determine the spatial risk created by delivering offsets in different locations. This multiplier is demonstrated in Table 3-7 below.

Table 3-7 Spatial risk multipliers for rivers and streams (Natural England, 2021)

Description	Spatial risk multiplier
Within waterbody	1.0
Outside waterbody	0.75
Outside catchment	0.5

3.3.7 Calculation of net gains/ losses

3.3.7.1 Construction

Construction impacts considers both permanent and temporary construction associated with the London Effluent Reuse SRO in relation to impacted rivers and streams. For the purposes of this assessment, permanent construction is defined as abstraction and outfall infrastructure and temporary construction is defined as intersections of the proposed pipeline route with watercourses <2m wide, where it is assumed that an open cut method will be used.

The calculation of net loss/ gain within the Biodiversity Metric 3.0 only considers direct impacts resulting in river loss. The baseline river scores are then adjusted for the associated impacts (gains or losses) related to construction. This is assessed following construction and prior to river re-instatement and assumes typical good practice construction methods and mitigation will be used, such that potential for downstream effects of construction will be fully mitigated, i.e., there will be no change in river condition. Changes to riparian encroachment were included in the assessment to reflect the presence of bankside structures associated with the crossing of a river or stream. This part of the assessment identifies high risk areas where the proposals will result in a significant loss of biodiversity and offsetting will be more onerous.

The following assumptions, based on professional judgements, have been made when assessing the impact of construction on rivers and streams, and should be reviewed at the next stages:

- Intersections of the proposed pipeline route with watercourses <2 m wide will impact on a 20 m length of the watercourse;
- Permanent discharge and outfall infrastructure will result in a direct loss of 15 m of the bank face; and
- If the baseline river was assessed as ‘no encroachment’ for riparian encroachment, the encroachment category was changed to ‘minor’.

Any further permanent built infrastructure have been assumed to be located over 10m from the bank top of the watercourses and no river metric calculations have been included in this report. If any additional permanent infrastructure were to be built within 10m of the watercourses, then further river metric calculations will be required at Gate 3.

The gains and losses are calculated assuming all river habitat within the zone of influence from construction impacts will be lost and reinstated with the same river habitat. This is assessed as on-site river habitat loss and on-site river habitat creation within the Biodiversity Metric. Naturally however this is not possible for river habitats lost to permanent infrastructure i.e., intakes and outfalls. Due to the risk factors in habitat creation, such as time lags and difficulty in creation, the habitat units for reinstatement will not equally compensate for the units lost. This provides the potential loss of River Biodiversity Unit (RBU) required for offsetting/ net gain and identifies how many units are required for net gain.

3.3.7.2 Operation

The Biodiversity Metric tool is not specifically developed for assessing long-term habitat degradation, such as that which may occur through operation of the London Effluent Reuse SRO. However, the scheme is likely to impact on the flow, geomorphology, water level, water depth and geomorphology of reaches downstream of abstractions or releases. This in turn has the potential to alter habitat structure and function and associated

aquatic ecological communities. Therefore, using the principles of the Biodiversity Metric, an approach was developed to assess operational impacts to rivers. The operational impact is a change in habitat condition and the net loss/ gain is the difference in habitat condition. This is reflected as a change in the RBU score between the river baseline and the modelled operational output score. This provides the potential loss of RBU required for offsetting/ net gain.

The physical environment modelling outputs and ecological assessments undertaken at Gate 2 identified the rivers and streams where the risk of impact pathways that could impact on river condition are likely. For those rivers and streams only, the baseline condition assessment (determined via River MoRPh surveys conducted for Gate 2) were reviewed and amended to reflect potential alterations in positive and negative indicators as a result of the operation of the London Effluent Reuse SRO.

3.4 POTENTIAL BIODIVERSITY OPPORTUNITIES (PBOS) – TERRESTRIAL HABITATS

Gate 1 focused on identifying landscape scale plans and polices (nature recovery partnerships). At Gate 2, the process was refined to identify sites within 5km from the option locations based on a scoring system (as shown in Table 3-8). A bespoke model was developed to identify potential BNG offset sites as outlined in Figure 3.2. It pooled together over 20 datasets (see Table 3-8) to identify Potential Biodiversity Opportunities (PBOs), assigned scores to them so they could be prioritised and identify the most suitable PBOs[25] for habitat restoration or creation. The scoring system was largely based on the Lawton principals[26] (noting that these are still considered as a best practice approach to landscape scale conservation), whereby effort should be made for new/enhanced habitats to be actively part of a healthy ecological network including landscape corridors, buffer zones, sustainable use areas, etc., rather than isolated reservoirs. In addition to the, the system also took into account variables from the Biodiversity Metric.

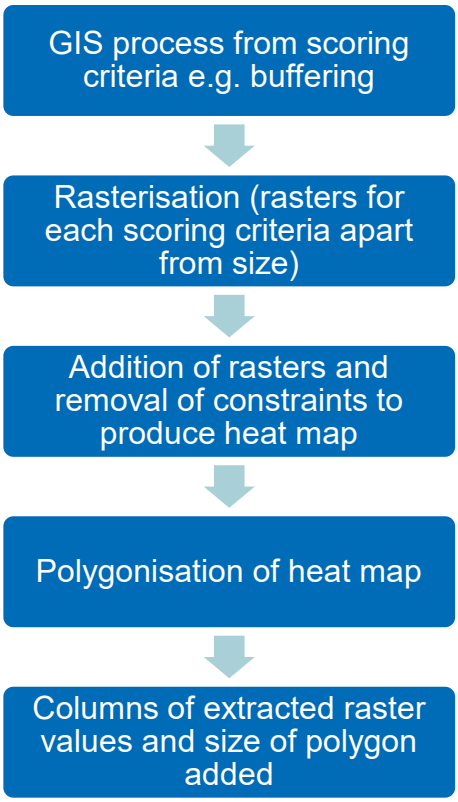
GIS processes such as buffering were carried out on each dataset (where applicable), scores were assigned, and the modified datasets were then rasterised at a 5m resolution (for computational efficiency). These rasters were added together and constraints such as building, railways, roads and planned developments were removed. This dataset was then polygonised, then the areas of each polygon and associated scores (based on the criteria) were calculated and areas less than 0.5 ha were removed. The overall score was calculated, and the dataset assigned IDs and exported into shapefile and excel spreadsheet formats indicating PBA sites prioritised based on an overall score. The top scoring sites have been mapped as potential sites for mitigation based on their score, however further surveys at the Gate 3 will be required to identify habitats present on the sites and whether they can deliver the specific habitats required to provide net gain.

[25] Identification of PBOs also takes into account Natural England's Biodiversity Opportunity Areas
[26] Prof. J. Lawton (2010), Making Space for Nature. Report for the UK Government

Table 3-8 PBO scoring criteria

Scoring criteria	Dataset/source	Score			
		3	2	1	0
Distance to pipeline	Pipeline options	<1 km	1-3 km	3-5 km	>5 km
Within same LPA as scheme/ option – county boundaries	Pipeline options Ordnance Survey GB Counties	Yes	-	-	No
Non-statutory designation	Local wildlife sites, proposed country parks, ecosites	Yes	-	-	No
Proximity to statutory sites	National Nature Reserves, Ramsar sites, Special Areas of Conservation, Special Protection Areas, SSSI sites, Local Nature Reserves	Within 2 km	Within 5 km	-	No
Strategic significance designation	Canal conservation and restoration, green networks, local greenspace, special landscape, sites for green infrastructure	Yes	-	-	No
Proximity to ancient woodland	Ancient Woodland England and Wales	0.3 km	1 km	-	No
Owned/ operated or managed by the relevant water company/companies	Information provided by relevant water company	Yes	-	-	No
Identified as common land	Common Land England	-	-	No	Yes
Size	Calculated using QGIS	>5 ha	1-5 ha	<1 ha	-

Figure 3.2 Flow diagram of PBA method



3.5 NATURAL CAPITAL ASSESSMENT METHODOLOGY

A NC Assessment has been carried out to identify the potential environmental benefits of the London Effluent Reuse SROs components to allow those with greater potential to achieve environmental enhancement to be considered through decision making. The socio-economic aspects of impacted features have also been considered to provide a more holistic view of the consequences of London Effluent Reuse SRO component implementation. This highlights the relationships between people and the affected environments and identifies how these relationships could change as a result of the options.

The EA's WRPG Supplementary Guidance states that NC Assessments in England should include as a minimum the following five ecosystem services:

- Biodiversity;
- Climate Regulation (carbon storage);
- Water Purification;
- Water Regulation; and
- Natural Hazard Regulation.

In addition to those services required as a minimum, we have also considered a **food production** ecosystem service metric. Assessment of social benefits is also advocated by the RAPID, therefore additional ecosystem services of **recreation and tourism** and **air quality** have been included to support this requirement (where the latter is related to urban and Air Quality Management Areas).

The NC Assessment is based on the Biodiversity Metric 3.0 data for permanent loss, temporary loss and mitigation required to meet the 10% net gain. The habitats are categorised into broad habitats which is used as the NC baseline data required for the qualitative, quantitative and monetisation of ecosystem services. The GIS and BNG assumptions followed through into the NC assessment are summarised in Section 3.1. The following section summarises the NC approach, assumptions and limitations for each ecosystem service.

3.5.1 Data sources, gaps, and assessment

The NC assessment has been completed using the following data sources (Table 3-8), as recommended by the ACWG environmental assessment guidance for SROs[27] and the EA[28] WRPG WRMP24 Supplementary Guidance on Environment and Society in Decision-Making. The required focus of this report is to provide a NC assessment. The assessment has therefore focused on construction related losses and potential gain related to mitigation including 10% BNG uplift based on open-source data.

The NC qualitative assessments for natural hazard, water regulation and water purification ecosystem services are based on a buffer area of 5km around the scheme. This is the zone of influence, and the size is proportionate at this stage, to assess any direct or indirect impact to the surrounding environment due to the scheme. The footprint of each scheme is assessed in permanent and temporary loss and the impact is captured within the zone of influence.

3.5.2 Natural Capital stocks

The ACWG Guidance for a NC Approach advises that land use should be used as a proxy for habitats, from which ecosystem services and benefits to society can be attributed and then monetised. The assessment for the NC approach is based on available open-source data. Habitat types were converted into the UKHab classifications using the conversation table within the Technical Data tab in the Biodiversity Metric. The area (ha) of each habitat type within a variable buffer was measured in GIS. The UKHab Classifications were then converted into eight broad habitat types to give the total area of each broad habitat within each zone of influence (Section 3.1.1). The conversion from the detailed habitat layers to broad habitat was undertaken and is outlined in Table 3-9.

[27] All Company Working Group (2020). WRMP environment assessment guidance and applicability with SROs

[28] Environment Agency (2020) Water resources planning guideline 2024 supplementary guidance- Environment and society in decision-making (England).

Groups were determined following the broad groups identified for calculation of carbon sequestration by land use from the EA's Supplementary Guidance[28] (see Table 3-10 below). Modified grassland has been classified as arable land and not grassland, as per advice from the Office for National Statistics (ONS) in developing a semi-natural grassland ecosystems account[29]. The UK NEA differentiates semi natural grassland from improved and amenity grassland as semi natural grassland has a much higher species-richness[30]. Where a land cover class could belong in multiple broad habitat groups it was placed within the one that had a lower carbon sequestration rate to give a more conservative estimate of benefits.

Table 3-9 Conversion from habitat data to broad habitat types

Land Cover Classification	Broad habitat type
Cropland – Cereal crops	Arable
Modified grassland	Semi natural grassland
Heathland and shrub	Heathland and shrub
Lowland mixed deciduous woodland	Deciduous woodland
Neutral grassland	Semi natural grassland
Lakes – pond	Freshwater
Other coniferous woodland	Coniferous woodland
No habitat	Urban
Broadleaved woodland	Deciduous woodland
Poor semi-improved grassland	Semi natural grassland
Other rivers and streams	Freshwater
Eutrophic standing waters	Freshwater
Other coniferous woodland	Coniferous woodland
River and streams	Freshwater
Sparsely vegetated land	Sparsely vegetated land
Lowland heathland	Heathland and shrub
Other woodland mixed	Deciduous woodland
Traditional orchards	Semi natural grassland
Lowland meadows	Semi natural grassland
Floodplain wetland mosaic	Semi natural grassland
Traditional orchards	Semi natural grassland
Bramble	Heathland and shrub
Saltmarshes and saline reedbeds	Wetlands

3.5.3 Climate regulations (carbon sequestration)

The carbon sequestration rates for NC stocks have been taken from the EA WRPG Supplementary Guidance[31] as shown in Table 3-10. Carbon sequestration rates of the relevant Natural Capital assets have been converted into monetary values using the Department for Business, Energy, and Industrial Strategy (BEIS) Carbon

[29] Office for National statistics (2018) Developing semi-natural grassland ecosystem accounts

[30] UK Habitat Classification Working Group (2018). *UK Habitat Classification - Habitat Definitions V1.0* at hhtp://ecountability.co.uk/ukhabworkinggroup-ukhab

[31] Table 7 of the EA Supplementary Guidance: Environment and Society in Decision-Making (2020).

Values. As the prices published by BEIS are in £2020, GDP deflators[32] were used to adjust them to the £2022 base year of modelling.

It is not possible to quantify the non-spatial changes in biodiversity and habitat ecosystem services arising from habitat condition improvement due to limited information currently available. To prevent overestimating the beneficial impact of the change in non-traded carbon sequestration value following BNG habitat creation / reinstatement, this value has been calculated by summing the change in non-traded carbon sequestration value during construction (the temporary loss), the permanent loss and creation.

The monetisation is based on the BNG calculation which is based on the size of the area, temporary or permanent loss, and biodiversity value of the habitats affected. Higher biodiversity value habitats (e.g., woodland, lowland meadows, heathland) have higher carbon sequestration monetised value. The higher biodiversity habitats are typically more difficult to recreate following completion of the construction phase so loss and reinstatement of these habitats will result in a greater impact relative to lower value habitats (e.g., arable fields or modified grassland).

The 30- and 80-year NPV covers the period 2022-2051 and 2022-2100 respectively. A three-year planning stage followed by five years of construction has been used so annual benefits are assumed to be zero until 2030. The discount rates used are 3.5% for the first 30 years (from 2022), 3% for years 31-75 and 2.5% for years 76-80 following the HMT Green Book Discount Rate. Carbon prices are only used to adjust future annual benefits from climate mitigation.

Table 3-10 Carbon sequestration of land use from EA WRPG Supplementary Guidance

Land use type	C seq rate (t/CO2e/ha/yr)
Woodland (deciduous)	4.97
Woodland (coniferous)	12.66
Arable land	0.10
Pastoral land	0.39
Grassland	0.39
Heathland & shrub	0.7
Urban	0

3.5.4 Natural hazard regulation

For the purposes of this assessment, flooding was determined to be the most significant natural hazard risk. A high-level qualitative assessment has been undertaken based on the EA flood risk zones[33] and the habitats impacted within the zone of influence area accounting for both temporary and permanent loss of grassland and woodland relative to natural hazard potential risks.

A drought risk has been considered related to Catchment Abstraction Management Strategy (CAMS) data with the impact to groundwater and surface water impact reviewed at an appropriate level to inform decision-making at this stage of the process. However, as the London effluent schemes are water recycling, no impact to water sources is expected. Further assessment will be undertaken at Gate 3 to assess the physical changes to natural capital stocks which potentially impact the capacity of habitats to slow the flow of flood water year-round.

Monetary values were sourced per broad habitat type from existing studies conducted in the UK. Values for woodland and wetlands/ floodplains broad habitat types were identified using the ENCA Services Databook[34] where the associated studies were evaluated to ensure their suitability for benefit transfer. A value for semi-natural grasslands was not available. Additional studies were identified with the final best estimate for semi-natural grasslands derived from a benefit function from an existing ecosystem services assessment (Christie

[32] GDP deflators used throughout the assessment to adjust monetary values to £2022 are those published by HM Treasury based on calendar year market prices. https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-march-2021-budget

[33] https://flood-map-for-planning.service.gov.uk/location

[34] https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca#enca-services-databook

et al, 2011[35]) noting however, that this value is mainly applicable to lowland meadows (Holzinger & Haysom, 2017[36]).

An annual monetary value was only derived for the flood regulating services of woodland, semi-natural grassland, and wetland/ floodplain assets (see Table 3-11). Robust monetary values for the urban and enclosed farmland broad habitat types are not currently available and hence it has not been possible to provide a monetised estimate of these services.

For example, estimates for enclosed farmland (71.4 EUR/ha) and urban (0.42 EUR/ha) habitats regarding their contribution to natural hazard regulation were identified (Vallecillo et al., 2020[37]) however these were only applicable at EU level and therefore not considered specific enough for application to the context of this study. For example, the estimates derived by Vallecillo et al. (2020) for broad habitat types other than agriculture are not comparable with the estimates employed within this study for semi-natural grasslands, woodlands, and freshwater. In addition, natural hazard benefits are provided per hectare of woodland and were estimated to be approximately £60 (in £2019) in comparison to the approximately £117 (in £2019) used within this study. In the case of Vallecillo et al. (2020) the estimates were derived following the approach outlined in the United Nations System of Environmental-Economic Accounting- Experimental Ecosystem Accounts (SEEA EEA)[38] with monetisation following a damage cost approach. However, as Vallecillo (2020) notes, damage functions are specific to each country and therefore these estimates may not reflect the UK context. As a result, the overall value of the NC assessment is likely to be understated at this stage. NPV assumes no change in annual benefits over 30- and 80-year period.

Table 3-11 Benefit Transfer Values: Natural Hazard Regulation

Broad habitat type	Annual Value	Reference	Additional Comments
Woodland	115 (£2018/ha)	Forest Research (2018)[39] & ENCA Services Databook	These results are experimental noting no semi-grassland value
Semi-natural grasslands	197 (£2015/ha)	Christie et al (2011)[35]& Holzinger & Haysom (2017)[40]	Appear applicable to lowland meadow only. Based on an ecosystem services assessment of Chimney Meadows Reserve (UK)
Freshwater (Open waters/ wetlands/ floodplains)	407 (£2011/ha)	Morris & Camino (2011)[41] & ENCA Services Databook	

3.5.5 Water purification

The WRPG[28] does not require the monetisation of water purification services, as these services are highly dependent on local factors and there are limited tools available to provide accurate monetised assessment. Thus, at this stage, only a qualitative assessment rather than a monetised assessment of this service has been undertaken. This qualitative assessment is based on habitat data and WFD status information from the EA's Catchment Explorer[42]. A baseline quantitative assessment for water purification was discounted using the

[35] Christie, Mike, Tony Hyde, Rob Cooper, Ioan Fazey, Petter Dennis, John Warren, Sergio Colombo, and Nick Hanley. 2011. Economic Valuation of the Benefits of Ecosystem Services delivered by the UK Biodiversity Action Plan. Report to Defra, London: Aberystwyth University.

[36] Holzinger, Oliver, and Karen Haysom. 2017. Chimney Meadows Ecosystem Services Assessment: An Assessment of how the new management of Chimney Meadows Nature Reserve by Bers, Bucks and Oxon Wildlife Trust impacts on the value of ecosystem services. Oxford: Berks, Bucks and Oxon Wildlife Trust.

[37] Vallecillo et al. (2020), Accounting for changes in flood control delivered by ecosystems at the EU level. *Ecosystem Services* (44), pp. 1-16.

[38] UN, 2017. Technical Recommendations in support of the System of Environmental Economic Accounting 2012 – Experimental Ecosystem Accounting. Available at:

https://seea.un.org/sites/seea.un.org/files/technical_recommendations_in_support_of_the_seea_eea_final_white_cover.pdf

[39] Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts.

[40] Holzinger, Oliver, and Karen Haysom. 2017. Chimney Meadows Ecosystem Services Assessment: An Assessment of how the new management of Chimney Meadows Nature Reserve by Bers, Bucks and Oxon Wildlife Trust impacts on the value of ecosystem services. Oxford: Berks, Bucks and Oxon Wildlife Trust.

[41] Morris & Camino (2011) UK National Ecosystem Assessment Economic Analysis Report, School of Applied Sciences, Cranfield University.

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

Natural Environment Valuation Online (NEVO)[43] tool due to negligible impact on land use change as the London Effluent SRO footprint will not have an impact on the River Thames given it is an effluent re-use scheme. Furthermore, the WFD report[44] assesses water quality, and this report assesses water purification services that terrestrial habitats provide to the receiving waterbody. The opportunities to further improve water purification and consider wider beneficiaries will be assessed at Gate 3, where wider stakeholder engagement will be feasible when specific BNG mitigation areas are identified.

A high-level assessment based on habitat data and WFD status information from the EA's Catchment explorer[45] has been undertaken.

Baseline provision of water purification services is dependent on the following:

- Land cover (habitat);
- Proximity to receptor (i.e. a water body);
- Current water quality of receptors;
- Interception and removal of contaminants; and
- Pollutant store opportunities.

3.5.6 Water regulation

The WRPG[28] does not require the monetisation of water regulation services. The main benefit of the London Effluent Reuse SRO is the deployable output from the transfer. As the schemes are effluent reuse, no additional water will be released into the environment and will have a neutral impact. A high-level assessment based on the WFD status and Catchment Abstraction Management Strategy (CAMS) assessing water resource availability, identifying water bodies status and potential deterioration due to the scheme has been undertaken. Resource rent value has not been calculated at this stage as there is no data for £2022 to be consistent with other ecosystem services. This will be calculated in Gate 3.

3.5.7 Air quality

Airborne pollutants represent a serious threat to human health and wellbeing: assessment of air quality regulation services is therefore also relevant to the well-being goals set out by the UK Government. Natural habitats can reduce these harmful effects by absorbing air pollution providing ecosystem service benefit to society. To quantify this benefit, values provided by Jones et al. (2019)[46] have been used to convert land cover types into estimates of monetary value for pollutant absorption per hectare per year (Table 3-12**)**. This has been used to assess the baseline value of the habitats within Air Quality Management Areas that fall within a defined zone of influence area surrounding each element. Any woodland identified in the zone of influence area has been classified as urban woodland for the air quality assessment as urban woodland is defined as "woodland within the boundary of a town or city[47]", thus all woodland found here meets this definition. Furthermore, classifying any possible urban woodland as rural woodland would significantly underestimate the benefit of this habitat. This approach aligns with the ENCA guidance. The £2019 values have been adjusted to £2022 for this assessment.

Table 3-12 Air pollutant value by habitat type

Habitat group	Value (£2019 per hectare per year)
Urban Woodland	871
Rural Woodland	277
Urban grassland	168

[43] https://sweep.ac.uk/portfolios/natural-environment-valuation-online-tool-nevo/

[44] [44] Ricardo (2022) London Effluent Reuse SRO, Gate 2 Water Framework Directive Report. Report For: Thames Water Utilities Ltd

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

[46] Laurence Jones, Massimo Vieno, Alice Fitch, Edward Carnell, Claudia Steadman, Philip Cryle, Mike Holland, Eiko Nemitz, Dan Morton, Jane Hall, Gina Mills, Ian Dickie & Stefan Reis (2019) Urban natural capital accounts: developing a novel approach to quantify air pollution removal by vegetation, Journal of Environmental Economics and Policy, 8:4, 413-428

[47] Forest Research (2022), Tools and Resources, Woodland. Accessible via: https://www.forestresearch.gov.uk/tools-and-resources/fthr/urban-regeneration-and-greenspace-partnership/greenspace-in-practice/benefits-of-greenspace/woodland/ [last accessed: 28/07/2022]

Habitat group	Value (£2019 per hectare per year)
Enclosed farmland	16
Coastal margins	29

3.5.8 Recreation and tourism

The Outdoor Recreation Valuation Tool (ORVal)[48] was used to estimate recreation demand from existing or new greenspace as a proxy for recreation value. The values represent the total welfare lost if the site in question were to be removed. In cases where components consist of more than one site, the marginal values of each site are aggregated based on the assumption that other sites that exist outside of the component scope are substitutes.

A conditional percentage was applied to the footpath values depending on the number of footpath intersections (and therefore alternative routes) present.

- If there are no intersections, and therefore no alternative routes, then we take 100% of the footpath value
- If there are 1-2 intersections present, then 50% of the value is taken
- If there are 3-4 intersections present, then 25% of the value is taken
- And if there are 5+ intersections present, 10% of the value is taken

The use of the ORVal tool has uncertainties surrounding the 'true' impact that the construction may have on recreation and tourism, with ORVal potentially giving an overstated account of the impact. This uncertainty has been reduced by using a developed conditional multipliers approach as outlined above. Additionally, this uncertainty has been reduced by stating that the impact to recreation and tourism will be a temporary impact of one year of closure. At this stage of assessment and when using the ORVal tool it is not currently possible to specify if some pathways and parks would be required to be closed for the whole year, or longer than a year. In a more refined assessment this is something that could be considered. However, at this level of assessment, ORVal remains the recommended and most informative data set to use.

The ORVal values are priced to £2016 and the values have been adjusted to £2022 for this assessment. Subject to planning and wider stakeholder engagement, details of timelines for implementation will strengthen the confidence of the assessment at future stages.

3.5.9 Agriculture

This assessment adopts the same principles to ecosystem services associated with agriculture as outlined in the UK Natural Capital Accounts. Namely, the distinction between what is considered natural capital, and therefore what is included in the estimation of provisioning services, and what is produced capital is defined as the *"point at which vegetable biomass is extracted"*[49]. For the purposes of this assessment, to estimate the annual value per ha of ecosystem services relevant to agricultural production, an adaptation of the whole-farm income method outlined by the UK Office of National Statistics (ONS) Natural Capital Accounts was used[50]. This approach was used as opposed to the industry residual value method adopted for the 2020 ONS Natural Capital Accounts as this method allows for differentiation between the provisioning services associated with different farm types - in this case arable and pasture- and were therefore considered more appropriate for this assessment. The marginal values estimated per hectare derived from this method (presented in Table 3-13 below) remain comparable to the estimated industry residual value per hectare reported by the ONS for their 2020 accounts (£241.80/ ha in 2018)[51]. The £2020 values have been adjusted to £2022 for this assessment.

[48] https://www.leep.exeter.ac.uk/orval/

[49] ONS (2017) Principles of Natural Capital Accounting. [Last accessed 29/04/2021] Accessible via: https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting

[50] Office for National Statistics (ONS), 2019. *UK natural capital accounts methodology guide: October 2019,* s.l.: ONS

[51] This was calculated by dividing the aggregate industry residual value reported by utilised agricultural area in the UK in 2018.

Table 3-13 Benefit transfer values: provisioning services supporting agriculture

Farm type	Estimated average £2019 /ha	Estimated average £2022 /ha
	England	*Southeast*
All farm types	293.63	328.12
Arable (cropping)	237.14	353.54
Pasture (grazing livestock)	227.74	163.78

These values represent the average farm output level estimate of the industry residual value for farms in the Southwest of England. Data was obtained from the Farm Business Survey (England)[52] and was subject to the following high-level calculation.

$$\frac{Average\ output\ from\ agriculture\ -Average\ costs\ for\ agriculture}{Average\ total\ farm\ area\ (ha)}$$

The original method outlined by the ONS (2019) was adapted after calculations with Southeast specific data resulted in a negative residual value per hectare for both arable and pasture. This would imply that the provisioning services of these natural assets have no inherent value and that they do not contribute to agricultural production. It is concluded in the literature that a probable explanation of negative resource rents is that they reflect market distortions such as subsidies[53]. The original method outlined by the ONS excludes subsidies and agri-environment payments and activities from their calculation, however the adapted method adopted for this assessment includes these factors. An overview of what is included is outlined in Table 3-14.

The total annual benefit values calculated for this assessment make use of the Southeast estimated averages calculated for each of the variables and component for each of the high-level farm types associated with this assessment (arable and pasture). The average used is defined as the average for all farms in that region for one year. The Farm Business Survey publishes annual average data so this assessment will be refined at Gate 3.

Table 3-14 Components included within the adapted farm income method

Variable	Components included
Output from agriculture	• Output from agriculture (excl. subsidies and agri-environment payments) • Subsidies and payments to agriculture (excl. agri-environment payments • Agri-environment and related payments (incl. HFA) • Basic Farm payment • Output from diversification
Costs for agriculture	• Costs for agriculture (excluding agri-environment activities) • Costs for agri-environment work • Costs of diversification out of agriculture • Costs associated with Basic Payment Scheme

[52] https://farmbusinesssurvey.co.uk/

[53] Obst, C., Hein, L., & Edens, B., (2016). National Accounting and the Valuation of Ecosystem Assets and their Services, *Environ Resource Econ* 64,pp 1-23.

4. BIODIVERSITY NET GAIN AND NATURAL CAPITAL ASSESSMENT: BECKTON WATER RECYCLING SCHEME

4.1 INTRODUCTION

The results for Beckton water recycling scheme for BNG and NC are summarised below. The scheme variation assessed in this report is 300ML/d as this would result in the most significant land use change and therefore require greater areas for mitigation. Hence, the benefits relating to natural capital would be greater. If less infrastructure is required related to lower required Ml/d, there would be more opportunity to mitigate on-site or nearer to the site. This would be better for biodiversity net gain as less off-site mitigation would be required.

4.2 BIODIVERSITY NET GAIN – TERRESTRIAL HABITATS

The survey baseline data, scope and detailed assessment methodology is used in this report are presented in the London Effluent Reuse SRO Gate 2 Terrestrial Ecology Assessment report as stated in section 1.2.1. The survey baseline and the habitat condition assessment used in this section provided in Tables 4-1, 4-2 and 4-4 below.

4.2.1 BNG permanent impacts

The permanent habitat loss from the construction across the Beckton water recycling scheme would result in the loss of 6.14 ha of baseline habitats. Not featured on Table 4-1 is the 0.102km loss of a moderate condition line of trees hedgerow, resulting in 0.45 hedge units lost.

Table 4-1 Beckton water recycling scheme permanent loss during construction

Habitat	Area (ha)	Habitat condition	Biodiversity units
Modified grassland	0.33	Moderate	1.44
Modified grassland	0.02	Poor	0.04
Artificial unvegetated, unsealed surface	0.01	N/A - Other	0.00
Developed land; sealed surface	0.58	N/A - Other	0.00
Other woodland; broadleaved	0.08	Moderate	0.38
Other neutral grassland	0.01	Good	0.19
Other neutral grassland	1.24	Moderate	10.88
Other neutral grassland	0.01	Poor	0.05
Mixed scrub	3.13	Moderate	27.55
Bramble scrub	0.75	Poor	3.28
Total Area	**6.14**		**43.82**

4.2.2 BNG – offsetting required to achieve a minimum of 10% net gain for permanent habitat loss

In order to achieve a 10% net gain 4.38 additional units would be required in addition to the units lost. A total unit uplift of 48.8 habitat units from off-site mitigation would achieve an 11.39% net gain for permanent habitat loss from the proposed works within Beckton water recycling scheme. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint, this could require a total of 15.5 hectares of off-site habitat. The off-site habitats required to achieve a minimum 10% net gain for temporary habitat loss in Beckton water recycling scheme are shown in Table 4-2. Not featured in Table 4-2 is 0.35km of poor condition native hedgerow with trees which will have its condition enhanced to moderate in order to deliver a hedge unit benefit of 2.09 units.

Table 4-2 Beckton water recycling scheme off-site mitigation to achieve 11.39% net gain for permanent habitat loss

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Modified grassland	Moderate	1.5	Enhancement	Other neutral grassland	Moderate	4.32
Other neutral grassland	Moderate	3.5	Enhancement	Other neutral grassland	Good	9.38
Mixed scrub	Poor	7	Enhancement	Mixed scrub	Moderate	24.37
Modified grassland	Moderate	0.5	Creation	Other woodland; broadleaved	Moderate	0.28
Bramble scrub	Poor	3	Enhancement	Mixed scrub	Moderate	10.45
Total		**15.5**				**48.8**

Table 4-3 Beckton water recycling scheme construction permanent loss BNG summary post mitigation

Total net unit change (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**4.99**
	Hedgerow units	**0.10**
Total on-site net % change plus off-site surplus (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**11.39%**
	Hedgerow units	**22.04%**

4.2.3 BNG temporary impacts

The temporary habitat loss from the construction across the Beckton water recycling scheme would result in the loss of 8.05 ha of baseline habitats. This loss would be mitigated for in the first instance by reinstating baseline habitats. Not featured on Table 4-4 is 0.037km of moderate condition line of trees hedgerow.

Table 4-4 Beckton water recycling scheme temporary habitat loss

Habitat	Area (ha)	Habitat condition	Biodiversity units
Saltmarshes and saline reedbeds	0.03	Moderate	0.39
Modified grassland	2.54	Moderate	11.17
Modified grassland	0.30	Poor	0.66
Other neutral grassland	0.33	Good	4.34
Other neutral grassland	0.90	Moderate	7.96
Other neutral grassland	0.12	Poor	0.54
Mixed scrub	0.09	Moderate	0.80
Bramble scrub	0.08	Poor	0.34
Developed land; sealed surface	3.41	N/A - Other	0.00
Felled woodland	0.01	Good	0.25
Other woodland; broadleaved	0.24	Moderate	2.10
Total Area	**8.05**		**28.55**

4.2.4 BNG – offsetting required to achieve a minimum of 10% net gain

In order to achieve a 10% net gain an additional 8.58 units are required as 22.83 units were delivered through habitat reinstatement. A total of 8.66 habitat units from off-site mitigation would achieve a 10.27% net gain for temporary habitat loss from the proposed works within Beckton water recycling scheme. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint this would require a total of 2.5 hectares of off-site habitat. The off-site habitats required to achieve a 10% net gain for temporary habitat loss in Beckton water recycling scheme are shown in Table 4-5. Due to the small length of lost hedgerow, compensation is more than provided by the permanent hedgerow mitigation, which itself provides a hedgerow uplift of 22.04%. Therefore, no additional mitigation is required.

Table 4-5 Beckton water recycling scheme off-site mitigation to achieve a 10.27% net gain for temporary habitat loss

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Saltmarshes and saline reedbeds	Poor	0.5	Enhancement	Saltmarshes and saline reedbeds	Good	2.27
Modified grassland	Moderate	0.8	Enhancement	Other neutral grassland	Moderate	2.58
Modified grassland	Moderate	0.5	Creation	Other woodland; broadleaved	Moderate	0.28
Other neutral grassland	Moderate	0.5	Enhancement	Other neutral grassland	Good	1.61
Bramble scrub	Poor	0.5	Enhancement	Mixed scrub	Moderate	1.92
Total		**2.8**				**8.66**

Table 4-6 Beckton water recycling scheme construction temporary loss BNG summary post mitigation

Total net unit change (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**2.93**
	Hedgerow units	**0.00**
Total on-site net % change plus off-site surplus (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**10.27%**
	Hedgerow units	**0.00%**

4.3 POTENTIAL BIODIVERSITY OPPORTUNITIES (PBO)

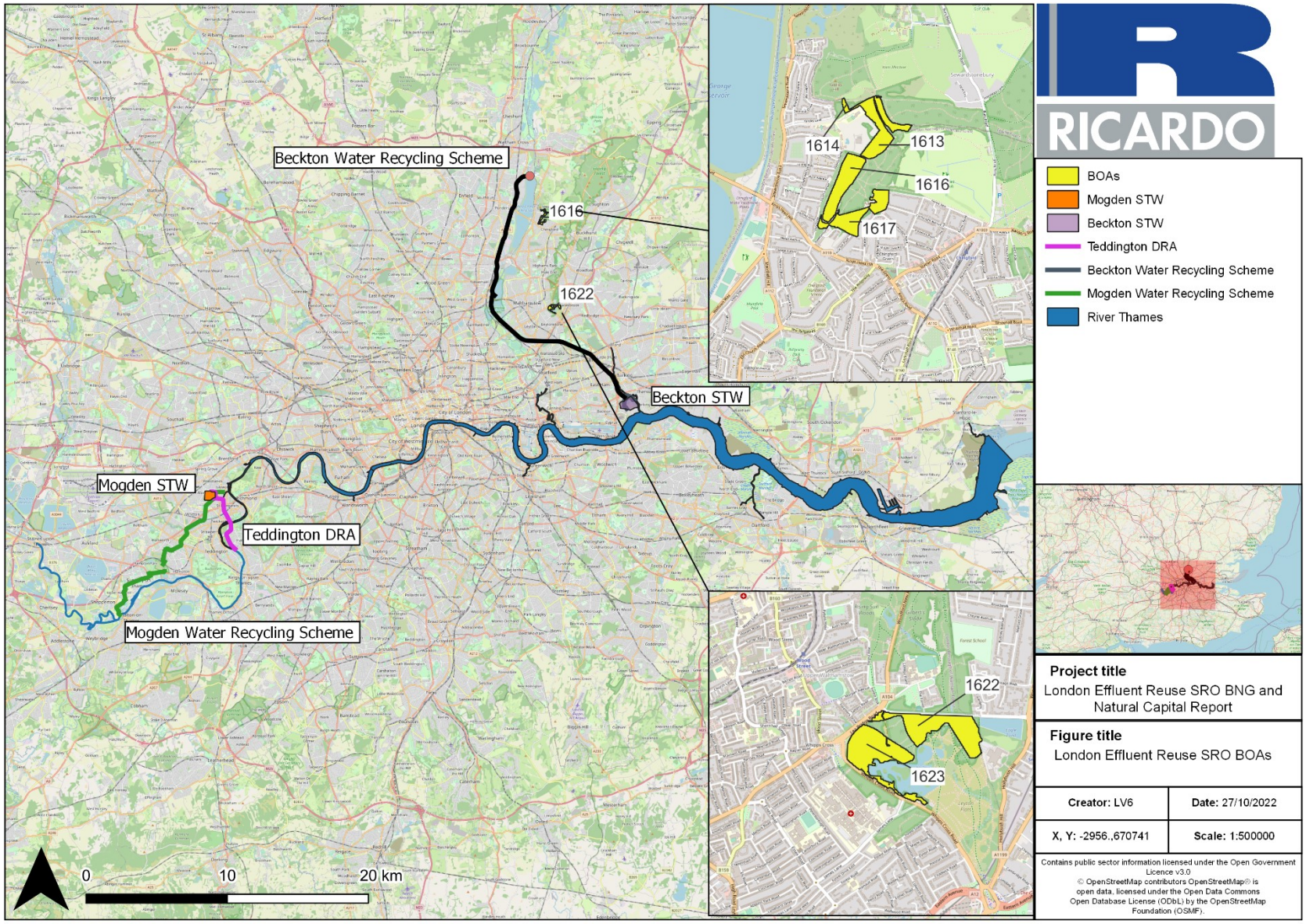
The results of the terrestrial habitat biodiversity opportunity areas mapping exercise for the Beckton water recycling scheme within the London area are presented in Table 4-7. The outputs at this stage are high level but are proportionate to this assessment stage, more detailed assessment will be required at Gate 3 which will support identification of specific extents and nature of key sites. As identified above a total of 18.3 ha of off-site habitat enhancement may be required to achieve a minimum of 10% net gain for both permanent and temporary terrestrial habitat loss within Greater London and Essex.

Out of >1600 identified PBOs, the six highest scoring PBOs identified are summarised in Table 4-7 with the location of each PBO shown on Figure 4-1 . The 6 highest scoring PBOs identified had a total area of 46.57 ha. The required off-site mitigation may require only three of the PBOs shown in Table 4-7 (which would provide 22.42 ha) to provide sufficient area to achieve 10% net gain based on the enhancements shown in Table 4-2 and Table 4-5.

Table 4-7 The six highest scoring PBOs identified within 5km of the proposed Beckton water recycling scheme.

ID	Total score	Area (ha)	Distance to scheme	Within pipeline county	Common land	Statutory site proximity	Ancient woodland proximity	Strategic significance designation	Non statutory designation	X coordinate	Y coordinate	Area score
1613	23	7.92	<1km	yes	no	<2km	<300m	no	yes	538436.8	195529.0	3
1614	23	7.92	<1km	yes	no	<2km	<300m	no	yes	538436.7	195528.9	3
1616	23	6.58	<1km	yes	no	<2km	<300m	no	yes	538175.3	195068.2	3
1617	23	6.19	<1km	yes	no	<2km	<300m	yes	yes	538302.2	194827.8	3
1622	23	8.76	<1km	yes	no	<2km	<300m	yes	yes	539468.4	188989.6	3
1623	23	9.19	<1km	yes	no	<2km	<300m	yes	yes	539050.9	188805.8	3

Figure 4-1 Map showing six of the highest scoring PBOs within Greater London



4.4 BIODIVERSITY NET GAIN – RIVERS

4.4.1 BNG – rivers and streams – temporary construction impacts

The Beckton water recycling scheme is not anticipated to result in temporary construction impacts. No pipelines are proposed to be constructed through open cut of watercourses, as part of the scheme. The Beckton water recycling scheme include two Recycled Water Transfer Tunnels and one Waste Stream Return Pipeline to be located within Beckton STW, away from any watercourses.

Therefore, the temporary construction impacts of the Beckton water recycling scheme in relation to BNG will not be further assessed.

4.4.2 BNG – rivers and streams – permanent construction impacts

A total of one watercourse was identified within the construction footprint of the proposed discharge at River Lee Diversion associated with the London Effluent Reuse SRO. This will result in permanent loss of riverine habitat. The WFD waterbody, river type, ecological condition, length of reach impacted based on assumptions listed in Section 3.3.7.1 and river units lost are provided below in Table 4-8.

Due to the location of the final effluent abstraction within Beckton STW, the abstraction point is not considered to be located within a river or stream and will rather be located within a manmade ditch associated with the STW.

Table 4-8 Beckton water recycling scheme permanent loss of river units

WFD Waterbody name	Waterbody ID	River type	WFD ecological condition	Length potentially impacted (km)	River units lost
Lea Navigation Enfield Lock to Tottenham Locks Water Body	GB106038027950	Other rivers and streams	Poor	0.015	0.04

4.4.3 BNG – rivers and streams – operational impacts

Based on outputs from the Physical Environment Assessment Report[4], the physical condition of waterbodies present within the ~100m reach of heavily modified channel of the Enfield Island loop between Beckton water recycling outfall and the existing intake to King George V Reservoir, could be impacted by major increase in flow, increased velocities within the channel and increases in wetted channel width where the bank is not constraining the hydraulic response to increased flow.

Furthermore, the Beckton water recycling scheme may result in impacts in the remaining ~500m heavily modified reach of the Enfield Island Loop downstream to the confluence with the Lee Diversion Channel but the effects cannot be quantified as they are entirely dependent on the abstraction regime operated for the Thames Water intakes.

The Beckton water recycling scheme would not associate with effects on the Thames Tideway from reductions in Beckton STW final effluent input into the middle Tideway.

The impacted reach of 100m was identified between the Beckton water recycling outfall (OS grid reference TQ 37323 98110) and the existing intake to King George V Reservoir (OS grid reference TQ 37375 98050). Within the Enfield Island Loop reach, one WFD waterbody has been identified: Lea Navigation Enfield Lock to Tottenham Locks Water Body. A summary is provided in Table 4-9 below. However, it should be noted that while operational activities may have an impact, the river condition is not considered to drop from 'fairly poor' due to the artificial structure of the watercourse. Therefore, no mitigations are considered necessary at this stage.

Table 4-9 Baseline information of the reach impacted by Beckton water recycling scheme

WFD Waterbody name	Waterbody ID	WFD ecological condition	MoRPh survey reference	MoRPh final condition	Length potentially impacted (km)	River units
Lea Navigation Enfield Lock to Tottenham Locks Water Body	GB106038027950	Poor	TR_09	Fairly Poor	0.1	0.39

4.4.4 BNG – mitigation requirements

Considering only permanent construction impacts and in order to deliver a minimum of 10% net gain, a section of 1.2km of river assessed as 'poor condition', with major watercourse and riparian encroachment, and located outside the catchment would need to be enhanced to 'moderate condition' with a reduction to watercourse encroachment (from major to minor), to deliver a net gain, off site of 0.08 units (3.11 off-site baseline units and 3.19 off-site post-intervention units) and therefore an overall net change of 0.05 units as per workbook calculation. Therefore, the enhancement of 1.2km of poor river condition off-site would result in a 11.95% net gain of river units which would compensate only the permanent construction impacts. A minimal section of 0.03km within the waterbody directly impacted would be required to deliver a minimum of 10% net gain.

4.5 NATURAL CAPITAL

4.5.1 Biodiversity and habitat

The habitats impacted by the Beckton water recycling scheme used for the natural capital assessments can be found in Table 4-10. It is assumed that all habitat falling within the zone of influence will be temporary lost during the construction period and replaced following construction. Therefore, loss of associated ecosystem services will occur only for the period of construction and habitat reinstatement. Habitats lost due to permanent structures, will be mitigated off-site or on-site. Table 4-10 also presents the permanent habitat loss, area planned for habitat creation and area planned for habitat improvement including consideration of required mitigation for BNG which have been used in the natural capital assessments.

Detailed NC calculations summarised in the sections below are shown in Appendix 2A.

Table 4-10 Summary of broad habitats impacted

Broad habitat	Temporary habitat lost during construction (ha)	Permanent habitat loss (ha)	On-site re-instatement/ creation (ha)	Off-site enhancement baseline (ha)	Off-site enhancement proposed new habitat (ha)
Arable land	-2.84	-0.35	2.84	3.00	0.00
Freshwater	-0.05	-0.02	0.05	0.00	0.00
Semi-natural grassland	-1.36	-1.26	1.36	4.00	6.30
Heathland and shrub	-0.17	-3.88	0.17	10.50	10.50
Marine	0.00	0.00	0.00	0.00	0.00
Urban	-3.41	-0.58	9.57	0.00	0.00
Woodland (coniferous)	0.00	0.00	0.00	0.00	0.00
Woodland (deciduous)	-0.25	-0.08	0.24	0.00	1.00
Wetlands	-0.03	0.00	0.03	0.50	0.50
Sparsely vegetated land	0.00	0.00	0.00	0.00	0.00
Pasture	0.00	0.00	0.00	0.00	0.00

4.5.2 Climate regulation

Table 4-11 summarises the momentary value of the climate regulation ecosystem services they provide. It also presents the change in carbon sequestration including consideration of required mitigation for BNG. The results show a loss of carbon sequestration for some options, even with BNG mitigation in place. Detailed NC calculations summarised in the sections below are shown in Appendix 2A.

Table 4-11 Summary of non-traded carbon sequestration values

Climate Regulation Values (£2022 / year)		
	Cumulative area (ha)	**Total BEIS carbon price (£2022)**
Temporary loss	-4.61	-£570
Permanent loss	-5.56	-£949
On-site re-instatement	4.60	£553
Off-site habitat succession	3.30	£1,448
Net impact	**£482**	
30-year NPV	**£7,489**	
80-year NPV	**£17,126**	

4.5.3 Natural hazard regulation

There is a potential risk to flooding as the proposed sites are currently within Flood Zone 2 and 3 (Figure 4-2). The amount of land impacted is negligible in terms of flood storage as mainly heathland and shrub and semi-grassland areas (based on Table 4-10). A detailed flood risk assessment is summarised in Section 7.3.1.3 in the Initial Environmental Appraisal[54] for Beckton water recycling scheme and is highly likely to flood surrounding arable and seminatural grassland areas (based on Table 4-10). The monetised baseline assessment of natural hazard regulation net impact is presented in Table 4-12. A benefit transfer value has not been identified at this stage for agricultural land, therefore this has not been accounted for in the baseline assessment. Detailed NC calculations summarised in the sections below are shown in Appendix 2A.

The CAMS data for River Thames shows the water availability at pre-drought conditions (Q70) and at drought conditions (Q95) is not available[55]. The scheme will not abstract additional water and potentially have an overall benefit on the catchment as it could potentially reduce abstraction elsewhere. The risk of drought is high, however, as Beckton is an water recycling scheme the impact is assessed to be neutral impact on natural capital stocks.

[54] Ricardo (2022) London Reuse Strategic Resource Option, Gate 2 Initial Environmental Appraisal Report.
[55] Environment Agency (2019) Thames Abstraction Licensing Strategy (publishing.service.gov.uk)

Figure 4-2 Flood risk zones within the Beckton water recycling scheme zone of influence

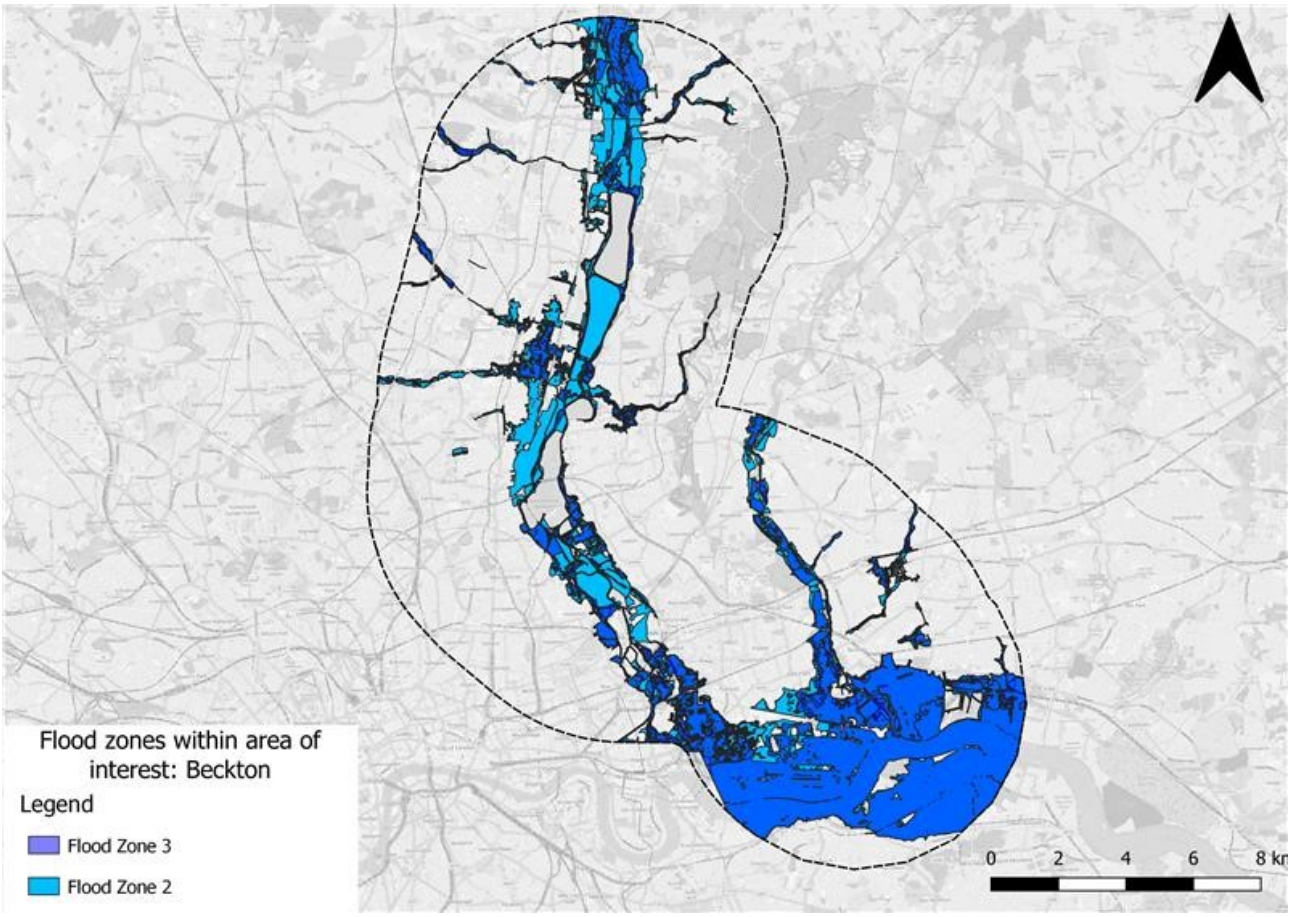


Table 4-12 Summary of natural hazard regulation impacts

Natural Hazard Regulation Values (£2022 / year)		
	Cumulative area (ha)	**£2022 / year**
Temporary loss	-1.65	-£359
Permanent loss	-1.36	-£305
On-site re-instatement	1.64	£358
Off-site habitat succession	7.00	£1,541
Net impact	**£1,234**	
30-year NPV	**£14,710**	
80-year NPV	**£26,366**	

4.5.4 Water purification

A brief summary of the baseline and potential change is included below in Table 4-13.

Table 4-13 Summary of baseline and potential change to water purification service provision

	Water purification ecosystem service provision assessment	**RAG rating**
Beckton water recycling scheme	The change in land will impact heathland and shrubs and semi natural grassland. The water purification services provided by these habitats are minor and the land permanently impacted is small and as such pollutant store opportunities would not be heavily impacted.	No change

	Water purification ecosystem service provision assessment	RAG rating
	As the Beckton water recycling scheme does not involve abstraction or discharge, this scheme is likely to have negligible impacts on water purification services. There may be minor benefits for water purification when treated water is released, however, this benefit is likely to be negligible as this water will be abstracted for drinking water. NEVO tool has no water quality data available for River Thames near Beckton. The opportunities to further improve water purification and consider wider beneficiaries will be assessed at Gate 3, where wider stakeholder engagement will be feasible when specific BNG mitigation areas are identified.	

4.5.5 Water Regulation

The water availability in River Thames based on the CAMS, water is not available during pre-drought conditions (Q70). As the Beckton water recycling scheme does not involve abstraction or discharge, there will be a neutral impact. The maximum deployable output for Beckton water recycling scheme assessed is 300Ml/d and will benefit 676,600 households[56] around the Beckton water recycling scheme area. Wider stakeholder engagement has not been carried out at this stage. Therefore, assessment of current abstractors, water left for other existing and future users will be reviewed during stakeholder engagement and will be considered at Gate 3 and refined during the planning process.

4.5.6 Tourism and recreation

Table 4-14 depicts the baseline welfare value for the recreation assets affected by the Beckton water recycling scheme.

It has not been possible to monetise the recreation and tourism benefits of the component with BNG uplift as the details of the habitat creation opportunities have not been agreed, therefore these cannot be assessed using the ORVal tool. It is unknown whether new habitat creation sites will provide additional recreation facilities as public access is unknown. The types of recreation areas impacted are detailed in the NC workbooks shown in Appendix 2A.

Table 4-14 ORVal outputs – Welfare values and estimated visits for affected recreation sites

Recreation value (£2022 / year)		
	Temporary loss	Visitor numbers
Beckton water recycling scheme	-£95,474	-23,858

4.5.7 Air quality regulation

A brief summary of the baseline and potential change is included below in Table 4-15. Detailed NC calculations summarised in the sections below are shown in Appendix 2A.

Table 4-15 Summary of air quality impacts

Air quality values (£2022 / year)			
	Temporary loss	Permanent loss	Net impact
Beckton water recycling scheme	-£519	-£304	£1325

4.5.8 Agriculture

Table 4-16 depicts the baseline agriculture value for the Beckton water recycling scheme. The values below represent the annual value of provisioning services that support agricultural production for the estimated area of each component. For pipeline routes, it is assumed that this value will be lost during the construction period

[56] Office for National Statistics (2021) Census 2021. P04. Available at: https://census.gov.uk/census-2021-results

only as agricultural land will be reinstated. Detailed NC calculations summarised in the sections below are shown in Appendix 2A.

Table 4-16 Baseline assessment of agriculture ecosystem service provision

Agriculture values (£2022 / year)		
	Cumulative area (ha)	**Estimated agriculture value (£2022) /year**
Temporary loss	-2.84	-£1,004
Permanent loss	-0.35	-£122
Net impact	**-£122**	
30-year NPV	**-£1,456**	
80-year NPV	**-£2,610**	

4.6 SUMMARY OF BIODIVERSITY AND NATURAL ASESSMENT: BECKTON WATER RECYCLING SCHEME

The BNG assessment of Beckton water recycling scheme has identified that 6.14 ha of habitat will be lost permanently, requiring a total area of 15.5 ha of off-site habitat enhancement to provide 11.39% BNG. 8.05 ha of habitat will be lost temporarily through construction zones, however since it is reinstated post-construction, the area of off-site habitat enhancement required to achieve 10% BNG is much smaller at 2.8 ha. As the majority of permanently lost habitat is mixed scrub, enhancement of mixed scrub areas will contribute the largest area towards mitigation.

A total of -0.04 river unit losses were estimated for the installation of permanent infrastructure such as pumping stations and abstraction and outfall locations associated with Beckton water recycling option, with operational impacts of increased water flow creating a further loss of -0.23 river units within the Lea Navigation Enfield Lock to Tottenham Locks Water Body.

Mitigation measures to enhance off-site sections of river would be required to deliver a minimum of 10% net gain. The operational impacts of Beckton water recycling scheme have not been considered to impact the river condition at this stage and therefore, mitigation would be required only to compensate the permanent construction impacts. In that case, 1km of ‘other river and stream’ is recommended to be enhanced off-site and outside the catchment. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh survey will inform the enhancement measures required to enhance the river from ‘poor to moderate condition’.

The overall environmental benefits for Beckton water recycling scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £40,883. Water purification benefits will be negligible. The NC methodology does not take into account the monetary cost of land acquisition and management for the required mitigation due to lack of information of mitigation sites and can be assessed further in Gate 3. As the larger scheme sized (300Ml/d) has been assessed, it will require more land and associated management costs compared to the smaller scheme variations. The current buffer area for the assessed components extends to the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be necessary following stakeholder engagement, refinement of design and surveys to determine current habitat conditions as part of further scheme development.

5. BIODIVERSITY NET GAIN AND NATURAL CAPITAL ASSESSMENT: MOGDEN WATER RECYCLING SCHEME

5.1 INTRODUCTION

The results for Mogden water recycling scheme for BNG and NC are summarised below. The scheme variation assessed in this report is 200ML/d as this would result in the most significant land use change and therefore require greater areas for mitigation. Hence, the benefits relating to natural capital would be greater. If less infrastructure is required related to lower required Ml/d, there would be more opportunity to mitigate on-site or nearer to the site. This is better for biodiversity net gain as less off-site mitigation will be required.

5.2 BIODIVERSITY NET GAIN – TERRESTRIAL HABITATS

The survey baseline data, scope and detailed assessment methodology is used in this report are presented in the London Effluent Reuse SRO Gate 2 Terrestrial Ecology Assessment report as stated in section 1.2.1. The survey baseline and the habitat condition assessment used in this section provided in Tables 5-1, 5-2 and 5-4 below.

5.2.1 BNG permanent impacts

The permanent habitat loss from the construction across the Mogden water recycling scheme would result in the loss of 4.5 ha of baseline habitats.

Table 5-1 Mogden water recycling scheme permanent habitat loss during construction

Habitat	Area (ha)	Condition	Biodiversity units
Modified grassland	0.03	Moderate	0.13
Artificial unvegetated, unsealed surface	0.04	N/A - Other	0.00
Developed land; sealed surface	0.04	N/A - Other	0.00
Other woodland; broadleaved	2.95	Moderate	25.93
Other woodland; mixed	0.01	Moderate	0.05
Lowland calcareous grassland	0.12	Moderate	1.53
Other neutral grassland	0.02	Moderate	0.18
Mixed scrub	0.94	Moderate	98.23
Lowland mixed deciduous woodland	0.37	Moderate	4.88
Total Area (ha)	**4.50**		**40.93**

5.2.2 BNG – offsetting required to achieve a minimum of 10% net gain for permanent habitat loss

A toal of 4.09 additional units would be required in additional to the baseline of 40.93 units to achieve a 10% net gain. A total of 45.6 habitat units from off-site mitigation would be required to achieve an 11.40% net gain for permanent habitat loss from the proposed works within Mogden water recycling scheme. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint, this could require a total of 29 hectares of off-site habitat. The off-site habitats required to achieve a minimum 10% net gain for temporary habitat loss in Mogden water recycling scheme are shown in Table 5-2.

Table 5-2 Mogden water recycling scheme off-site mitigation to achieve a minimum of 10% net gain for permanent habitat loss

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Modified grassland	Poor	2	Enhancement	Lowland calcareous grassland	Moderate	2.98
Modified grassland	Poor	5	Creation	Lowland mixed deciduous woodland	Moderate	-16.03
Other neutral grassland	Medium	10	Enhancement	Other neutral grassland	Good	32.21
Modified grassland	Poor	6	Creation	Other woodland; broadleaved	Moderate	3.34
Mixed scrub	Poor	6	Enhancement	Mixed scrub	Moderate	23.1
Total		**29**				**45.6**

Table 5-3 Mogden water recycling scheme construction permanent loss BNG summary post mitigation

Total net unit change (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	4.66
	Hedgerow units	0.00
Total on-site net % change plus off-site surplus (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	11.40%
	Hedgerow units	0.00%

5.2.3 BNG temporary impacts

The temporary habitat loss from the construction across the Mogden water recycling scheme would result in the loss of 32.40 ha of baseline habitats. This loss would be mitigated for in the first instance by reinstating baseline habitats.

Table 5-4 Mogden water recycling scheme temporary loss during construction

Habitat	Area (ha)	Habitat condition	Biodiversity units
Modified grassland	6.65	Moderate	29.25
Traditional orchards	0.06	Moderate	0.78
Artificial unvegetated, unsealed surface	5.55	N/A - Other	0.00
Developed land; sealed surface	11.51	N/A - Other	0.00
Other woodland; broadleaved	6.11	Moderate	54.87
Other woodland; mixed	1.22	Moderate	10.72
Lowland calcareous grassland	0.03	Moderate	0.35
Other neutral grassland	0.20	Moderate	1.76
Other neutral grassland	0.22	Poor	0.98
Modified grassland	0.01	Poor	0.02
Bramble scrub	0.28	Poor	1.25
Developed land; sealed surface	0.05	N/A - Other	0.00
Developed land; sealed surface	0.07	N/A - Other	0.00
Built linear features	0.16	N/A - Other	0.00
Lowland mixed deciduous woodland	0.16	Moderate	2.13

Habitat	Area (ha)	Habitat condition	Biodiversity units
Other woodland; broadleaved	0.13	Moderate	1.12
Total Area	**32.40**		**102.10**

5.2.4 BNG – offsetting required to achieve a minimum of 10% net gain for temporary habitat loss

In order to achieve a 10% net gain an additional 46.81 units are required as 65.5 units were delivered through habitat reinstatement. A total of 46.86 habitat units from off-site mitigation would be required to achieve a 10.03% net gain for temporary habitat loss from the proposed works within Mogden water recycling scheme. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint this would require a total of 29.5 hectares of off-site habitat. The off-site habitats required to achieve a 10% net gain for temporary habitat loss in Mogden water recycling scheme are shown in Table 5-5.

Table 5-5 Mogden water recycling scheme off-site mitigation to achieve a 10% net gain for temporary habitat loss

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Modified grassland	Moderate	3	Enhancement	Lowland calcareous grassland	Moderate	4.47
Other neutral grassland	Moderate	10	Enhancement	Other neutral grassland	Good	32.21
Modified grassland	Moderate	6	Creation	Other woodland; broadleaved	Moderate	3.34
Modified grassland	Moderate	3	Creation	Other woodland; mixed	Moderate	-4.73
Modified grassland	Moderate	1	Enhancement	Traditional orchards	Moderate	3.02
Mixed scrub	Moderate	0.5	Enhancement	Mixed scrub	Good	2.07
Modified grassland	Moderate	2	Creation	Lowland mixed deciduous woodland	Moderate	-6.41
Modified grassland	Moderate	4	Enhancement	Other neutral grassland	Moderate	12.89
Total		**29.5**				**46.86**

Table 5-6 Mogden water recycling scheme construction temporary loss BNG summary pre mitigation

Total net unit change (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**10.24**
	Hedgerow units	**0.00**
Total on-site net % change plus off-site surplus (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**10.03%**
	Hedgerow units	**0.00%**

5.3 POTENTIAL BIODIVERSITY OPPORTUNITIES

The results of the terrestrial habitat biodiversity opportunity areas mapping exercise for the Mogden water recycling scheme within the London area are presented in Figure 5-1 as identified in Table 5-2 and Table 5-5, a total of 58.5 ha of off-site habitat enhancement may be required to achieve a minimum of 10% net gain for both permanent and temporary terrestrial habitat loss within Greater London.

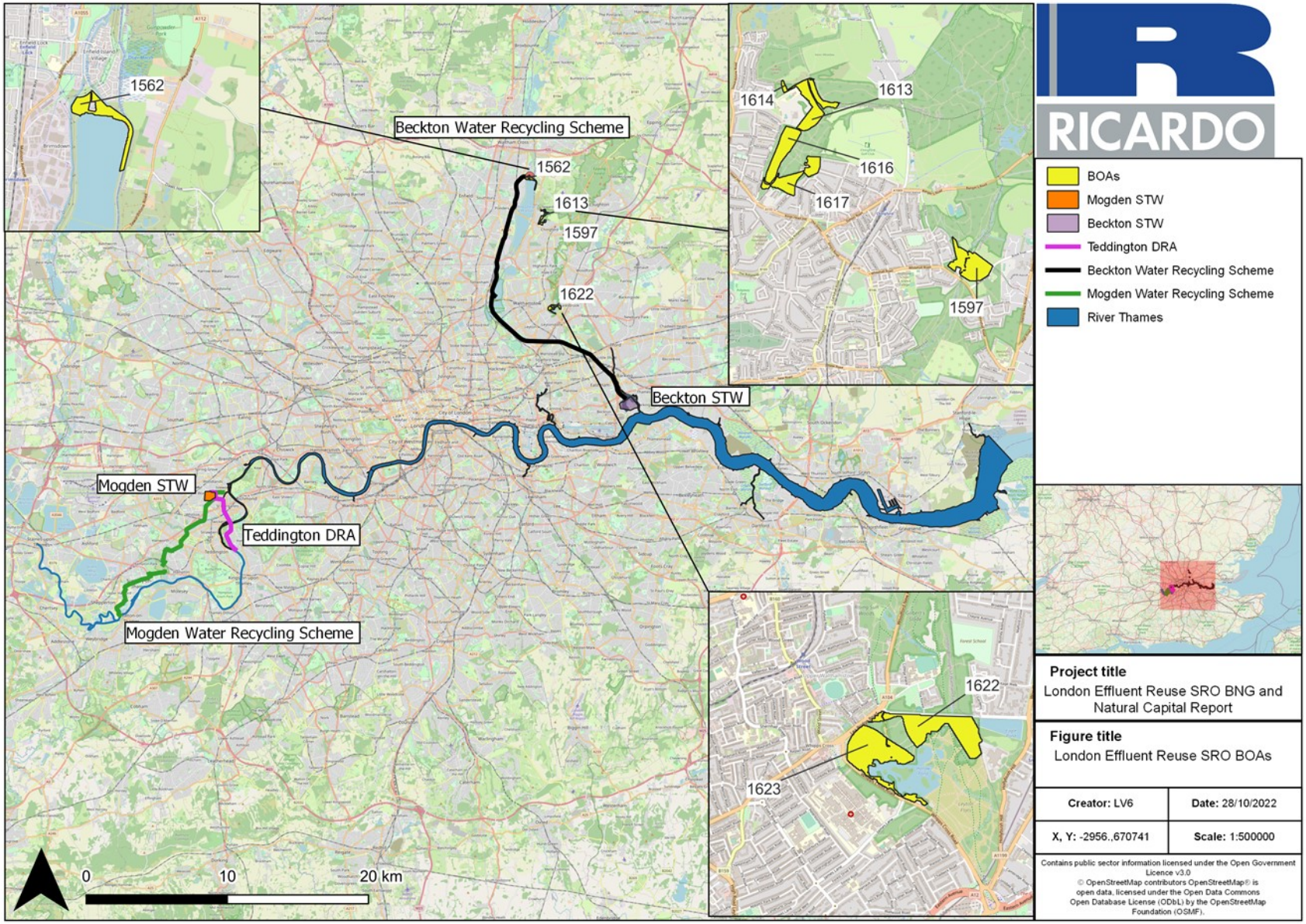
The eight highest scoring PBOs identified are summarised in Table 5-7 with the location of each PBO shown on Figure 5-1. The eight highest scoring PBOs identified had a total area of 69.72 ha. The required off-site

mitigation would therefore require the top eight highest scoring PBOs shown in Table 5-7 to provide sufficient area to achieve 10% net gain based on the enhancements shown in Table 5-2 and Table 5-5.

Table 5-7 The 8 highest scoring PBOs identified within 5km of the proposed Mogden water recycling scheme

ID	Total score	Area (ha)	Distance to scheme	Within pipeline county	Common land	Statutory site proximity	Ancient woodland proximity	Strategic significance designation	Non statutory designation	X coordinate	Y coordinate	Area score
1613	23	7.92	<1km	yes	no	<2km	<300m	no	yes	538436.8	195529.0	3
1614	23	7.92	<1km	yes	no	<2km	<300m	no	yes	538436.7	195528.9	3
1616	23	6.58	<1km	yes	no	<2km	<300m	no	yes	538175.3	195068.2	3
1617	23	6.19	<1km	yes	no	<2km	<300m	yes	yes	538302.2	194827.8	3
1622	23	8.76	<1km	yes	no	<2km	<300m	yes	yes	539468.4	188989.6	3
1623	23	9.19	<1km	yes	no	<2km	<300m	yes	yes	539050.9	188805.8	3
1597	22	8.21	<1km	yes	no	<2km	<300m	no	yes	539998.4	194040.9	3
1562	21	14.95	1 – 3km	yes	no	<2km	<300m	no	yes	537419.7	197791.5	3

Figure 5-1 Map showing eight of the highest scoring PBOs within Greater London



5.4 BIODIVERSITY NET GAIN – RIVERS

5.4.1 BNG – rivers and streams – temporary construction impacts

The Mogden water recycling scheme is not anticipated to result in temporary construction impacts, based on the current design. While a Recycled Water Transfer Pipeline is proposed to be built between Hydes Field and the River Thames, the pipeline is proposed to be trenchless at the crossing point of the Surrey Ash River. The Mogden water recycling scheme also include one Final Effluent Transfer and Waste Stream Return Tunnel which is not anticipated to result in open cut of watercourses.

Therefore, the temporary construction impacts of the Mogden water recycling scheme in relation to BNG will not be further assessed within this report. Further BNG assessment may be required at a more detailed stage.

5.4.2 BNG – rivers and streams – permanent construction impacts

A total of one watercourse was identified within the construction footprint of the proposed discharge at River Thames associated with Mogden water recycling scheme. This will result in permanent loss of riverine habitat. The WFD waterbody, river type, ecological condition, length of reach impacted based on assumptions listed in Section 3.3.7.1 and river units lost are provided below in Table 5-8.

Since the abstraction point is located within Mogden STW and drawing effluent rather than in a water course, it is not considered to be located within a river or stream.

Table 5-8 Mogden water recycling scheme permanent loss of river units

WFD Waterbody name	Waterbody ID	River type	WFD ecological condition	MoRPh survey reference	Length potentially impacted (km)	River units lost
Thames (Egham to Teddington)	GB106039023232	Other rivers and streams	Poor	TR_02	0.015	0.04

5.4.3 BNG – rivers and streams – operational impacts

While the Mogden water recycling schemes may lead to up to moderate impacts on flows when compared to the baseline conditions in the River Thames, these changes are considered negligible when assessing impacts to water level depth and average flow velocities[4]. Additionally, the data indicates that there are negligible impacts on fish pass barrier potential, negligible impacts on the Richmond Pound and on wetted habitat, water level and suspended sediment concentration in the Thames Tideway.

Therefore, no operational impacts have been considered for the BNG with regards to rivers and streams for the Mogden water recycling schemes.

5.4.4 BNG – mitigation requirements

In order to deliver a minimum of 10% net gain, a section of 0.6km of river assessed as ‘poor condition’, with major watercourse and riparian encroachment, and located outside the catchment would need to be enhanced to ‘moderate condition’ with a reduction to watercourse encroachment (from major to minor), to deliver a net gain, off site of 0.05 river units (1.55 off-site baseline units and 1.60 off-site post-intervention units) and therefore an overall net change of 0.01 river unit (+15.74%), as per workbook calculation. A minimal section of 0.06km within the waterbody directly impacted would be required to deliver a minimum of 10% net gain.

5.5 NATURAL CAPITAL

5.5.1 Biodiversity and habitat

The habitats impacted by the Mogden water recycling scheme used for the natural capital assessments can be found in Table 5-9. It is assumed that habitats falling within the zone of influence will be temporary lost during the construction period and replaced following construction via reinstatement. Therefore, loss of associated ecosystem services will occur only for the period of construction and habitat reinstatement. Habitats lost due to permanent structures, will be mitigated off-site or on-site. Table 5-9 also presents the permanent

habitat loss, area planned for habitat creation and area planned for habitat improvement including consideration of required mitigation for BNG which have been used in the natural capital assessments.

Detailed NC calculations summarised in the sections below are shown in Appendix 2B.

Table 5-9 Summary of broad habitats impacted

Broad habitat	Temporary habitat lost during construction (ha)	Permanent habitat loss (ha)	On-site re-instatement/ creation (ha)	Off-site enhancement baseline (ha)	Off-site enhancement proposed new habitat (ha)
Arable land	-6.66	-0.03	6.66	32.00	0.00
Freshwater	0.00	0.00	0.00	0.00	0.00
Semi-natural grassland	-0.51	-0.14	0.51	13.00	30.00
Heathland and shrub	0.00	-0.94	0.00	3.50	6.50
Marine	0.00	0.00	0.00	0.00	0.00
Urban	-17.34	-0.08	21.84	0.00	0.00
Woodland (coniferous)	0.00	0.00	0.00	0.00	0.00
Woodland (deciduous)	-7.61	-3.32	7.61	0.00	22.00
Wetlands	0.00	0.00	0.00	0.00	0.00
Sparsely vegetated land	0.00	0.00	0.00	0.00	0.00
Pasture	0.00	0.00	0.00	0.00	0.00

5.5.2 Climate regulation

Table 5-10 summarises the momentary value of the climate regulation ecosystem services they provide. It also presents the change in carbon sequestration including consideration of required mitigation for BNG. The results show a loss of carbon sequestration for some options, even with BNG mitigation in place. Detailed NC calculations summarised in the sections below are shown in Appendix 2B.

Table 5-10 Summary of non-traded carbon sequestration values

Climate Regulation Values (£2022 / year)		
	Cumulative area (ha)	Total BEIS carbon price (£2022)
Temporary loss	-14.78	-£10,121
Permanent loss	-4.42	-£4,502.74
On-site re-instatement	14.78	£10,121
Off-site habitat succession	32.00	£28,775
Net impact	**£24,273**	
30-year NPV	**£388,965**	
80-year NPV	**£889,552**	

5.5.3 Natural hazard regulation

There is a potential risk to flooding as the proposed sites are currently within Flood Zone 2 and 3 (Figure 5-2). The amount of land impacted is negligible in terms of flood storage and is assessed as medium risk as mainly woodland and semi-grassland areas are impacted (based on Table 5-9). A detailed flood risk assessment is summarised in Section 8.3.1.3 in the Initial Environmental Appraisal[57] for Mogden water recycling scheme and is highly likely to flood surrounding arable and seminatural grassland areas (based on Table 5-9). The

[57] Ricardo (2022) London Reuse Strategic Resource Option, Gate 2 Initial Environmental Appraisal Report.

monetised baseline assessment of natural hazard regulation net impact is presented in Table 5-10. A benefit transfer value has not been identified at this stage for agricultural land, therefore this has not been accounted for in the baseline assessment. Detailed NC calculations summarised in the sections below are shown in Appendix 2B.

The CAMS data for River Thames shows the water availability at pre-drought conditions (Q70) and at drought conditions (Q95) is not available[58]. The scheme will not abstract additional water and potentially have an overall benefit on the catchment as it could potentially reduce abstraction elsewhere. The risk of drought is high, however, as Mogden is a water recycling scheme, the impact is assessed to be neutral impact on natural capital stocks.

Figure 5-2 Flood risk zones within the Mogden water recycling scheme zone of influence

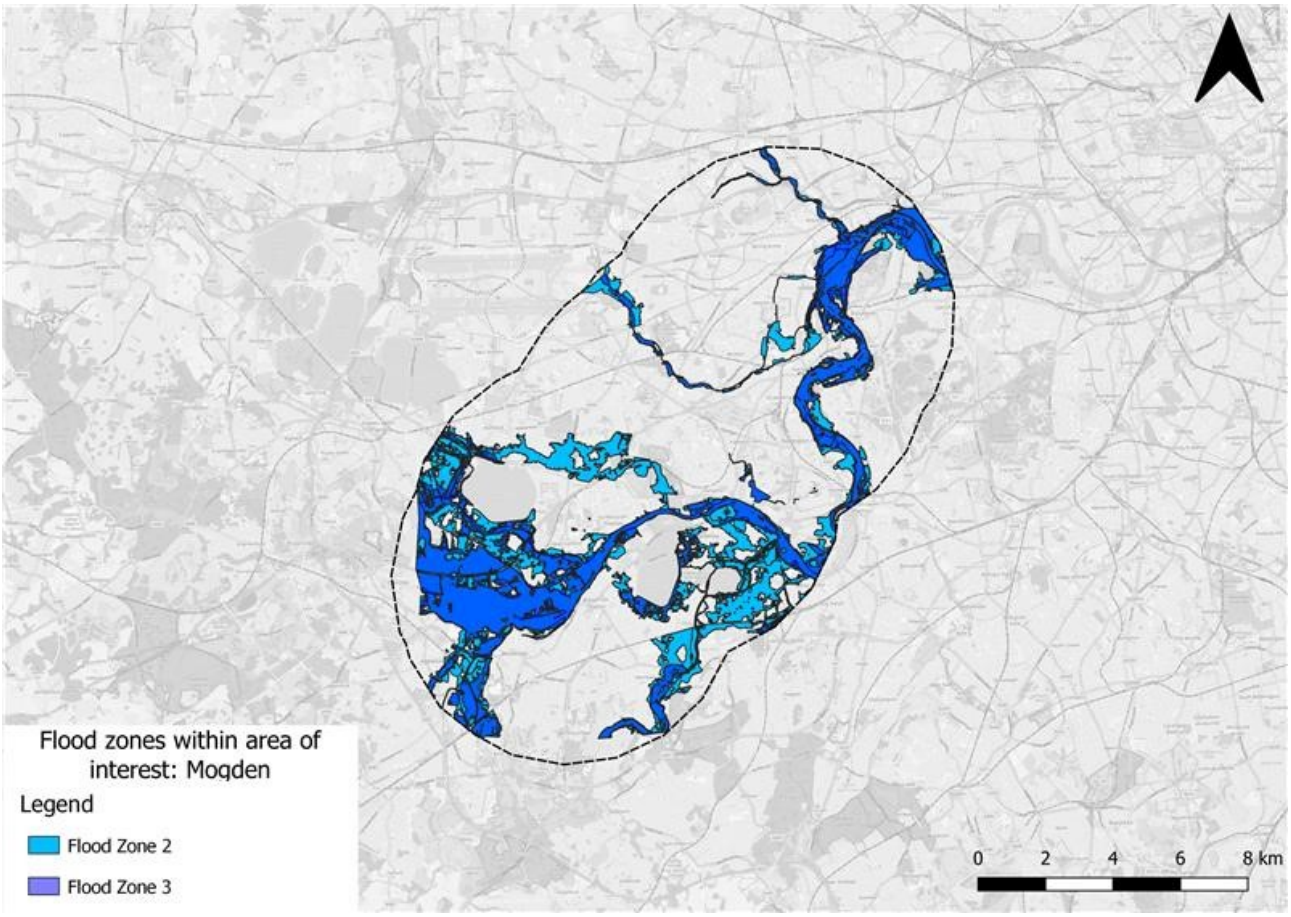


Table 5-11 Summary of natural hazard regulation impacts

Natural Hazard Regulation Values (£2022 / year)		
	Cumulative area (ha)	**£2022 / year**
Temporary loss	-8.13	-£1,057
Permanent loss	-3.46	-£441
On-site re-instatement	8.13	£1,057
Off-site habitat succession	52.00	£9,465
Net impact	**£9,024**	
30-year NPV	**£107,583**	
80-year NPV	**£192,830**	

[58] Environment Agency (2019) Thames Abstraction Licensing Strategy (publishing.service.gov.uk)

5.5.4 Water purification

A brief summary of the baseline and potential change is included below in Table 5-12.

Table 5-12 Summary of baseline and potential change to water purification service provision

	Water purification ecosystem service provision assessment	RAG rating
Mogden water recycling scheme	The change in land will impact woodland and heathland and shrubs. The water purification services provided by these habitats are moderate, however, the land permanently impacted is small and as such pollutant store opportunities would not be heavily impacted. As Mogden water recycling scheme will discharge treated effluent at Walton, there may be minor benefits for water purification when the treated water is released into the River Thames, however, this benefit is likely to be negligible as this water will be abstracted for drinking water downstream. The NEVO tool has no water quality data available for River Thames at Mogden. The opportunities to further improve water purification and consider wider beneficiaries will be assessed at Gate 3, where wider stakeholder engagement will be feasible when specific BNG mitigation areas are identified.	No change

5.5.5 Water Regulation

The water availability in River Thames based on the CAMS, water is not available during pre-drought conditions (Q70). As the Mogden water recycling scheme will discharge treated effluent at Walton, there will be a more water available for downstream abstraction. The maximum deployable output for Mogden water recycling scheme assessed is 200Ml/d and will benefit 586,200 households[59] around the Mogden water recycling scheme area. Wider stakeholder engagement has not been carried out at this stage. Therefore, assessment of current abstractors, water left for other existing and future users will be reviewed during stakeholder engagement and will be considered at Gate 3 and refined during the planning process.

5.5.6 Tourism and recreation

Table 5-13 depicts the baseline welfare value for the recreation assets affected by the Mogden water recycling scheme.

It has not been possible to monetise the recreation and tourism benefits of the component with BNG uplift as the details of the habitat creation opportunities have not been agreed, therefore these cannot be assessed using the ORVal tool. It is unknown whether new habitat creation sites will provide additional recreation facilities as public access is unknown. The types of recreation areas impacted are detailed in the NC workbooks shown in Appendix 2B.

Table 5-13 ORVal outputs – Welfare values and estimated visits for affected recreation sites

	Recreation value (£2022 / year)	
	Temporary loss	Visitor numbers
Mogden water recycling scheme	-£1,325,783	-334,606

5.5.7 Air quality regulation

A brief summary of the baseline and potential change is included below in Table 5-14. Detailed NC calculations summarised in the sections below are shown in Appendix 2B.

[59] Office for National Statistics (2021) Census 2021. P04. Available at: https://census.gov.uk/census-2021-results

Table 5-14 Summary of air quality impacts

Air quality values (£2022 / year)			
	Temporary loss	Permanent loss	Net impact
Mogden water recycling scheme	-£7,192	-£3,074	£22,667

5.5.8 Agriculture

Table 5-15 depicts the baseline agriculture value for the Mogden water recycling scheme. The values below represent the annual value of provisioning services that support agricultural production for the estimated area of each component. For pipeline routes, it is assumed that this value will be lost during the construction period only as agricultural land will be reinstated. Detailed NC calculations summarised in the sections below are shown in Appendix 2B.

Table 5-15 Baseline assessment of agriculture ecosystem service provision

Agriculture values (£2022 / year)		
	Cumulative area (ha)	Estimated agriculture value (£2022) /year
Temporary loss	-6.66	-£2,353
Permanent loss	-0.03	-£11
Net impact	**-£11**	
30-year NPV	**-£126**	
80-year NPV	**-£227**	

5.6 SUMMARY OF BIODIVERSITY AND NATURAL ASESSMENT: MOGDEN WATER RECYCLING SCHEME

The BNG assessment of the Mogden water recycling scheme has identified that 4.5 ha of habitat will be lost permanently, requiring a total area of 29 ha of off-site habitat enhancement to provide 11.4% BNG. 32.4 ha of habitat will be lost temporarily through construction zones, however since it is to be reinstated post-construction, the mitigation effort required to achieve 10.03% BNG is 29.5 ha. The majority of permanently lost habitat is broadleaved woodland, with a large proportion of temporarily lost habitat also being broadleaved woodland. As a result of this, habitat enhancement from modified grassland to moderate condition broadleaved woodland will require the largest area for mitigation to achieve a minimum of 10% net-gain.

Design changes since the UKHab survey at Mogden STW site were undertaken meant that shaft/ compound 1 is now outside of the surveyed area and so, no baseline UKHab data was available. The datasets identified in Section 3.2.2 were able to provide habitat data instead but did not provide details on habitat condition. Where no survey data was available habitats have therefore been assumed to be of moderate condition.

Mogden water recycling scheme has no temporary construction impacts of river units but does create a permanent loss of -0.04 river units. However, it has negligible effect on water flow, so no operational impacts are expected. Mitigation measures to enhance off-site sections of river would be required to deliver a minimum of 10% net gain. Permanent construction impacts from Mogden water recycling scheme will require respectively the enhancement of 0.6km of 'other river and stream' located outside the catchment. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh survey will inform the enhancement measures required to enhance the river from 'poor to moderate condition'.

The overall environmental benefits for Mogden water recycling scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £1,082,155. The NC methodology does not take into account the monetary cost of land acquisition and management for the required mitigation due to lack of information of mitigation sites. This can be assessed further in Gate 3. As the larger scheme sized (200Ml/d) has been assessed, it will require more land and associated management costs compared to the smaller scheme variations. The current buffer area for the assessed components extends to the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be necessary following

stakeholder engagement, refinement of design and surveys to determine current habitat conditions as part of further scheme development.

6. BIODIVERSITY NET GAIN AND NATURAL CAPITAL ASSESSMENT: TEDDINGTON DRA SCHEME

6.1 INTRODUCTION

The results for Teddington DRA scheme for BNG and NC are summarised below. The scheme variation assessed in this report is 75ML/d as this would result in the most significant land use change and therefore require greater areas for mitigation. Hence, the benefits relating to natural capital would be greater. If less infrastructure is required related to lower required Ml/d, there would be more opportunity to mitigate on-site or nearer to the site. This is better for biodiversity net gain as less off-site mitigation will be required.

6.2 BIODIVERSITY NET GAIN – TERRESTRIAL HABITATS

The survey baseline data, scope and detailed assessment methodology is used in this report are presented in the London Effluent Reuse SRO Gate 2 Terrestrial Ecology Assessment report as stated in section 1.2.1. The survey baseline and the habitat condition assessment used in this section provided in Tables 6-1, 6-2 and 6-4 below.

6.2.1 BNG permanent impacts

The permanent habitat loss from the construction across the Teddington DRA scheme would result in the loss of 1.94 ha of baseline habitats.

Table 6-1 Teddington DRA scheme permanent loss during construction

Habitat	Area (ha)	Habitat condition	Biodiversity units
Modified grassland	0.13	Moderate	0.56
Modified grassland	0.05	Poor	0.10
Other neutral grassland	0.01	Good	0.15
Other neutral grassland	0.04	Moderate	0.39
Artificial unvegetated, unsealed surface	1.62	N/A - Other	0.00
Mixed scrub	0.01	Good	0.19
Lowland mixed deciduous woodland	0.04	Good	0.77
Other woodland; broadleaved	0.03	Poor	0.18
Total Area	**1.94**		**2.35**

6.2.2 BNG – offsetting required to achieve a minimum of 10% net gain for permanent habitat loss

In order to achieve a 10% net gain an additional 0.235 units are required in additional to the units lost. A total of 2.67 habitat units from off-site mitigation would be required to achieve a 13.52% net gain for permanent habitat loss from the proposed works within Teddington. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint this could require a total of 3.65 hectares of off-site habitat. The off-site habitats required to achieve 13.52% net gain for permanent habitat loss in Teddington are shown in Table 6-2.

Table 6-2 Teddington DRA scheme off-site mitigation to achieve a 10% net gain for permanent habitat loss

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Modified grassland	Moderate	1.65	Enhancement	Other neutral grassland	Moderate	5.32

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Modified grassland	Moderate	1	Creation	Lowland mixed deciduous woodland	Moderate	-3.21
Modified grassland	Moderate	1	Creation	Other woodland; broadleaved	Moderate	0.56
Total		**3.65**				**2.67**

Table 6-3 Teddington DRA scheme construction permanent loss BNG summary with mitigation

Total net unit change (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**0.32**
	Hedgerow units	**0.00**
Total on-site net % change plus off-site surplus (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**13.52%**
	Hedgerow units	**0.00%**

6.2.3 BNG temporary impacts

The temporary habitat loss from the construction across the Teddington DRA scheme would result in the loss of 5.13 hectares of baseline habitats. This loss would be mitigated for in the first instance by reinstating baseline habitats.

Table 6-4 Teddington DRA scheme temporary loss during construction

Habitat	Area (ha)	Condition	Biodiversity units
Modified grassland	1.01	Moderate	4.44
Modified grassland	0.40	Poor	0.88
Other neutral grassland	0.21	Good	2.76
Other neutral grassland	0.05	Moderate	0.44
Artificial unvegetated, unsealed surface	0.00	N/A - Other	0.00
Developed land; sealed surface	3.07	N/A - Other	0.00
Bramble scrub	0.00	Poor	0.01
Lowland mixed deciduous woodland	0.22	Good	4.27
Lowland mixed deciduous woodland	0.03	Moderate	0.43
Other woodland; broadleaved	0.12	Moderate	1.05
Other woodland; broadleaved	0.02	Poor	0.07
Total Area	**5.13**		**14.37**

6.2.4 BNG – offsetting required to achieve a minimum of 10% net gain for temporary habitat loss

In order to achieve a 10% net gain an additional 7.56 units are required as 8.25 units were delivered through habitat reinstatement. A total of 8.17 habitat units of from off-site mitigation would be required to achieve a 14.27% net gain for temporary habitat loss from the proposed works within Teddington. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint this could require a total of 13 hectares of off-site habitat. The off-site habitats required to achieve a minimum 10% net gain for temporary habitat loss in Teddington are shown in Table 6-4 and Table 6-5.

Table 6-4 Teddington DRA scheme off-site mitigation to achieve a 10% net gain for temporary habitat loss

Baseline Habitat	Baseline Condition	Hectarage	Habitat Creation or Enhancement	Proposed Habitat	Proposed Condition	Habitat Units Delivered
Modified grassland	Moderate	2	Enhancement	Other lowland acid grassland	Moderate	6.44
Other neutral grassland	Moderate	4	Enhancement	Other neutral grassland	Good	12.89
Modified grassland	Moderate	4	Creation	Lowland mixed deciduous woodland	Moderate	-12.83
Modified grassland	Moderate	3	Creation	Other woodland; broadleaved	Moderate	1.67
Total		**13**				**8.17**

Table 6-5 Teddington DRA scheme construction temporary loss BNG summary pre mitigation

Total net unit change (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**2.05**
	Hedgerow units	**0.00**
Total on-site net % change plus off-site surplus (including all on-site & off-site habitat retention, creation & enhancement)	*Habitat units*	**14.27%**
	Hedgerow units	**0.00%**

6.3 POTENTIAL BIODIVERSITY OPPORTUNITIES

The results of the terrestrial habitat biodiversity opportunity areas mapping exercise for the London Effluent Reuse SROs within the London area are presented in Figure 4-1 (Section 4.3). As identified in Table 6-2 and Table 6-4 a total of 16.65 ha of off-site habitat enhancement could be required achieve a minimum of 10% net gain for both permanent and temporary terrestrial habitat loss within Teddington.

The six highest scoring PBO identified are summarised in Table 6-6 with the location of each PBO shown on in Figure 4-1 (Section 4.3). The 6 highest scoring PBOs identified had a total area of 46.57 ha. The required off-site mitigation would therefore require only the top three highest scoring PBO shown in Table 6-6 to provide sufficient area to achieve a minimum of 10% net gain based on the enhancements shown in Table 6-2 and Table 6-4.

Table 6-6 The 6 highest scoring PBOs identified within 5km of the proposed Teddington DRA scheme

ID	Total score	Area (ha)	Distance to scheme	Within pipeline county	Common land	Statutory site proximity	Ancient woodland proximity	Strategic significance designation	Non statutory designation	X coordinate	Y coordinate	Area score
1613	23	7.92215	<1km	yes	no	<2km	<300m	no	yes	538436.8	195529	3
1614	23	7.922149674	<1km	yes	no	<2km	<300m	no	yes	538436.7975	195528.9967	3
1616	23	6.581797654	<1km	yes	no	<2km	<300m	no	yes	538175.3074	195068.2086	3
1617	23	6.189185	<1km	yes	no	<2km	<300m	yes	yes	538302.2	194827.8	3
1622	23	8.762316	<1km	yes	no	<2km	<300m	yes	yes	539468.4	188989.6	3
1623	23	9.194957	<1km	yes	no	<2km	<300m	yes	yes	539050.9	188805.8	3

6.4 BIODIVERSITY NET GAIN – RIVERS

6.4.1 BNG – rivers and streams – temporary construction impacts

The Teddington DRA scheme is not anticipated to result in temporary construction impacts, based on the current design. No pipelines are proposed to be constructed through open cut of watercourses, as part of the scheme. The Teddington DRA scheme include a Recycled Treated Effluent Transfer Tunnel between Mogden STW and Teddington which will require trenchless crossing of the River Thames

Therefore, the temporary construction impacts of the Teddington DRA scheme in relation to BNG will not be further assessed within this report. Further BNG assessment may be required at a more detailed stage.

6.4.2 BNG – rivers and streams – permanent construction impacts

A total of one watercourse was identified within the construction footprint of the proposed Recycled Water Discharge into River Thames and river abstraction in the River Thames, associated with the Teddington DRA scheme. This will result in permanent loss of riverine habitat. The WFD waterbody, river type, ecological condition, length of reach impacted based on assumptions listed in Section 3.3.7.1 and river units lost are provided below in Table 6-7.

Due to the location of the Final Effluent Abstraction within Mogden STW, the abstraction point is not considered to be located within a river or stream.

Table 6-7 Teddington DRA scheme permanent loss of river units

WFD Waterbody name	Waterbody ID	River type	WFD ecological condition	MoRPh survey reference	MoRPh final condition	Length potentially impacted (km)	River units lost
Thames (Egham to Teddington)	GB106039023232	Other rivers and streams	Poor	TR_08	Fairly poor	0.030	0.12

6.4.3 BNG – rivers and streams – operational impacts

While the Teddington DRA schemes may lead to up to moderate reduction in flows when compared to the baseline conditions in ~250m of the River Thames between the intake and the outfall, these changes are considered negligible when assessing impacts to water level depth and average flow velocities[4]. Additionally, the data indicates that there are negligible impacts on fish pass barrier potential, negligible impacts on the Richmond Pound and on wetted habitat, water level and suspended sediment concentration in the Thames Tideway.

Therefore, no operational impacts have been considered for the Biodiversity Net Gain with regards to rivers and streams for the Teddington DRA scheme.

6.4.4 BNG – mitigation requirements

In order to deliver a minimum of 10% net gain, a section of 1.8km of river assessed as ‘poor condition’, with major watercourse and riparian encroachment, and located outside the catchment would need to be enhanced to ‘moderate condition’ with a reduction to watercourse encroachment (from major to minor), to deliver a net gain, off-site of 0.13 river units (4.66 off-site baseline units and 4.79 off-site post-intervention units) and therefore an overall net change of 0.02 river unit (+15.74%), as per workbook calculations. A minimal section of 0.05km within the waterbody directly impacted would be required to deliver a minimum of 10% net gain.

6.5 NATURAL CAPITAL

6.5.1 Biodiversity and habitat

The habitats impacted by the Teddington DRA scheme used for the natural capital assessments can be found in Table 6-8. It is assumed that all habitat falling within the zone of influence will be temporary lost during the

construction period and replaced following construction. Therefore, loss of associated ecosystem services will occur only for the period of construction and habitat reinstatement. Habitats lost due to permanent structures, will be mitigated off-site or on-site. Table 6-8 also presents the permanent habitat loss, area planned for habitat creation and area planned for habitat improvement including consideration of required mitigation for BNG which have been used in the natural capital assessments.

Detailed NC calculations summarised in the sections below are shown in Appendix 2C.

Table 6-8 Summary of broad habitats impacted

Broad habitat	Temporary habitat lost during construction (ha)	Permanent habitat loss (ha)	On-site re-instatement/ creation (ha)	Off-site enhancement baseline (ha)	Off-site enhancement proposed new habitat (ha)
Arable land	-1.41	-0.06	1.41	12.65	0.00
Freshwater	-0.02	-0.01	0.02	0.00	0.00
Semi-natural grassland	-0.26	-0.17	0.26	4.00	7.65
Heathland and shrub	0.00	-0.01	0.00	0.00	0.00
Marine	0.00	0.00	0.00	0.00	0.00
Urban	-3.07	-1.62	5.01	0.00	0.00
Woodland (coniferous)	0.00	0.00	0.00	0.00	0.00
Woodland (deciduous)	-0.38	-0.07	0.38	0.00	9.00
Wetlands	0.00	0.00	0.00	0.00	0.00
Sparsely vegetated land	0.00	0.00	0.00	0.00	0.00
Pasture	0.00	0.00	0.00	0.00	0.00

6.5.2 Climate regulation

Table 6-9 summarises the momentary value of the climate regulation ecosystem services they provide. It also presents the change in carbon sequestration including consideration of required mitigation for BNG. The results show a loss of carbon sequestration for some options, even with BNG mitigation in place. Detailed NC calculations summarised in the sections below are shown in Appendix 2C.

Table 6-9 Summary of non-traded carbon sequestration values

Climate Regulation Values (£2022 / year)		
	Cumulative area (ha)	Total BEIS carbon price (£2022)
Temporary loss	-2.05	-£563.56
Permanent loss	-0.31	-£108.28
On-site re-instatement	2.05	£564
Off-site habitat succession	12.65	£11,738
Net impact	£11,630	
30-year NPV	£186,375	
80-year NPV	£426,234	

6.5.3 Natural hazard regulation

There is a potential risk to flooding as the proposed sites are currently within Flood Zone 2 and 3 (Figure 6-1). The amount of land impacted is negligible in terms of flood storage as mainly arable and semi-grassland areas are impacted. A detailed flood risk assessment is summarised in Section 9.3.1.3 in the Initial Environmental

Appraisal[60] for Teddington DRA scheme and is highly likely to flood surrounding arable and seminatural grassland areas (based on Table 6-8). The monetised baseline assessment of natural hazard regulation net impact is presented in Table 6-9. A benefit transfer value has not been identified at this stage for agricultural land, therefore this has not been accounted for in the baseline assessment. Detailed NC calculations summarised in the sections below are shown in Appendix 2C.

The CAMS data for River Thames shows the water availability at pre-drought conditions (Q70) and at drought conditions (Q95) is not available[61]. The scheme will not abstract additional water and potentially have an overall benefit on the catchment as it could potentially reduce abstraction elsewhere. The risk of drought is high, however, as Mogden is an effluent re-use scheme the impact is assessed to be neutral impact on natural capital stocks.

Figure 6-1 Flood risk zones within the Teddington DRA scheme

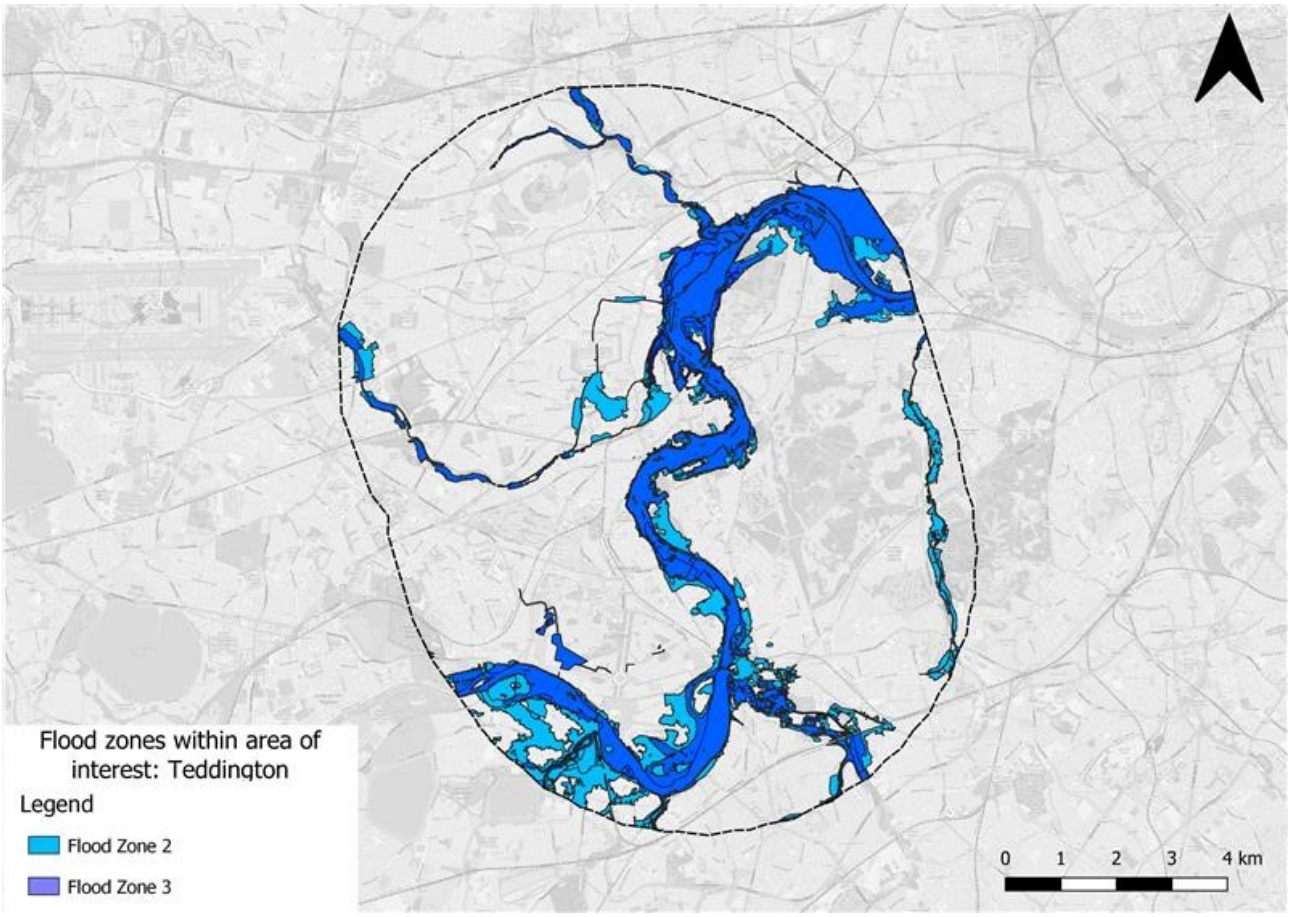


Table 6-10 Summary of natural hazard regulation impacts

Natural Hazard Regulation Values (£2022 / year)		
	Cumulative area (ha)	**£2022 / year**
Temporary loss	-0.67	-£118.23
Permanent loss	-0.25	-£49.86
On-site re-instatement	0.67	£118
Off-site habitat succession	16.65	£2,832
Net impact	**£2,783**	

[60] Ricardo (2022) London Reuse Strategic Resource Option, Gate 2 Initial Environmental Appraisal Report.
[61] Environment Agency (2019) Thames Abstraction Licensing Strategy (publishing.service.gov.uk)

Natural Hazard Regulation Values (£2022 / year)	
30-year NPV	**£33,172**
80-year NPV	**£59,457**

6.5.4 Water purification

A brief summary of the baseline and potential change is included below in Table 6-11.

Table 6-11 Summary of baseline and potential change to water purification service provision

	Water purification ecosystem service provision assessment	RAG rating
Teddington DRA scheme	The change in land will impact urban areas which provides no water purification service. An area of land that provides water purification services on the Thames bank will be permanently lost for the intake and outfall structures but this will create negligible impacts due to their small size. Teddington DRA scheme involves abstraction, however, the distance between the outfall and intake is 100m therefore water discharged will be abstracted and will have a neutral impact. There may be minor benefits for water purification when the treated water is released into the River Thames, however, this benefit is likely to be negligible as this water will be abstracted for drinking water downstream. The NEVO tool has no water quality data available for River Thames at Teddington. The opportunities to further improve water purification and consider wider beneficiaries will be assessed at Gate 3, where wider stakeholder engagement will be feasible when specific BNG mitigation areas are identified.	No change

6.5.5 Water Regulation

The water availability in River Thames based on the CAMS, water is not available during pre-drought conditions (Q70). The distance between the outfall and intake is 100m therefore water discharged will be abstracted and will have a neutral impact. The maximum deployable output for Teddington DRA assessed is 75Ml/d and will benefit 651,200 households[62] around the Teddington DRA scheme area. Wider stakeholder engagement has not been carried out at this stage. Therefore, assessment of current abstractors, water left for other existing and future users will be reviewed during stakeholder engagement and will be considered at Gate 3 and refined during the planning process.

6.5.6 Tourism and recreation

Table 6-12 depicts the baseline welfare value for the recreation assets affected by the Teddington DRA scheme. The types of recreation areas impacted are detailed in the NC workbooks shown in Appendix 2C.

It has not been possible to monetise the recreation and tourism benefits of the component with BNG uplift as the details of the habitat creation opportunities have not been agreed, therefore these cannot be assessed using the ORVal tool. It is unknown whether new habitat creation sites will provide additional recreation facilities as public access is unknown.

Table 6-12 ORVal outputs – Welfare values and estimated visits for affected recreation sites

Recreation value (£2022 / year)		
	Temporary loss	**Visitor numbers**
Teddington DRA scheme	-£525,270	-122,998

[62] Office for National Statistics (2021) Census 2021. P04. Available at: https://census.gov.uk/census-2021-results

6.5.7 Air quality regulation

A brief summary of the baseline and potential change is included below in Table 6-13. Any woodland identified in the zone of influence area has been classified as urban woodland for the air quality assessment as urban woodland is defined as "woodland within the boundary of a town or city[39]", thus all woodland found here meets this definition. Furthermore, classifying any possible urban woodland as rural woodland would significantly underestimate the benefit of this habitat. Detailed NC calculations summarised in the sections below are shown in Appendix 2C.

Table 6-13 Summary of air quality impacts

Air quality values (£2022 / year)			
	Temporary loss	**Permanent loss**	**Net impact**
Teddington DRA scheme	-£423	-£93	£8,695

6.5.8 Agriculture

Table 6-14 depicts the baseline agriculture value for the Teddington DRA scheme. The values below represent the annual value of provisioning services that support agricultural production for the estimated area of each component. For pipeline routes, it is assumed that this value will be lost during the construction period only as agricultural land will be reinstated. Detailed NC calculations summarised in the sections below are shown in Appendix 2C.

Table 6-14 Baseline assessment of agriculture ecosystem service provision

Agriculture values (£2022 / year)		
	Cumulative area (ha)	**Estimated agriculture value (£2022) /year**
Temporary loss	-1.41	-£498
Permanent loss	-0.06	-£20
Net impact	**-£20**	
30-year NPV	**-£236**	
80-year NPV	**-£423**	

6.6 SUMMARY OF BIODIVERSITY AND NATURAL ASESSMENT: TEDDINGTON DRA SCHEME

The BNG assessment of Teddington DRA Scheme has identified that 1.94 ha of habitat will be permanently due to construction of new above ground infrastructure, requiring a total area of 3.65 ha off-site habitat enhancement to provide 13.52% BNG. A total of 5.13 ha of habitat will be lost temporarily through creation of construction compounds, however since it is to be reinstated post-construction, the mitigation effort required to achieve 14.27% BNG is 13 ha.

The Teddington DRA will create a loss of -0.12 river units through the creation of permanent structures, but has no temporary or operational disbenefits. Mitigation measures to enhance off-site sections of river would be required to deliver a minimum of 10% net gain. Permanent construction impacts from Teddington DRA will require the enhancement of 1.8km of 'other river and stream' located outside the catchment. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh survey will inform the enhancement measures required to enhance the river from 'poor to moderate condition'.

The overall environmental benefits for Teddington DRA scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £485,268. The NC methodology does not take into account the monetary cost of land acquisition and management for the required mitigation due to lack of information of mitigation sites. This can be assessed further in Gate 3. As the larger scheme sized (200Ml/d) has been assessed, it will require more land and associated management costs compared to the smaller scheme variations. The current buffer area for the assessed components extends to the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be necessary following stakeholder

engagement, refinement of design and surveys to determine current habitat conditions as part of further scheme development.

7. RENEWABLES ASSESSMENT

7.1 INTRODUCTION

There will be carbon emissions associated with the construction and operation of these schemes and as such these emissions will need to be mitigated. As stated in Jacobs' Greenhouse Gas Assessment report[63] currently all of Thames Water's electricity is purchased from renewable energy sources, but that on-site generation should be maximised if viable. Furthermore, Thames Water must meet a 9.3% increase in renewable energy produced from the company's operational business by 2024-25 to meet its Performance Commitment for Renewable Energy generated[64]. One option for on-site renewable energy generation option is via solar photovoltaic (PV) fitted on rooftops, on top of large water-storage tanks and carparks as these options do not take up space on the ground.

This renewables assessment has looked at the carbon emissions associated with the sub-options of the possible schemes, the available area for PV, and the generation of renewable electricity by the panels. It has performed a simple assessment to ascertain whether the potential electricity generated would match the emissions associated with the schemes. Finally, this assessment has used the BNG assessment to identify areas where ground mounted solar array could be sited that would also offer biodiversity benefit.

7.2 APPROACH AND DATA SOURCES

Firstly, the estimated embodied and operational carbon (per year) emission data was extracted from the Jacobs Greenhouse Gas Assessment report[63]. Within this report, the emissions associated with the different sub-options of the possible schemes were calculated; these sub-options are outlined in Table 7-1. As only these sub-options have an associated emissions calculation in the Jacobs report, only these sub-options feature in this renewable energy assessment.

Table 7-1 Sub-options of schemes assessed for renewables

Scheme	Sub-option(s)
Beckton water recycling	100 Ml/d AWRP
Mogden water recycling	50 Ml/d AWRP
Mogden water recycling	100 Ml/d AWRP
Teddington Direct River Abstraction (DRA)	50 Ml/d TTP
Teddington Direct River Abstraction (DRA)	75 Ml/d TTP

Next, the UK grid average electricity emission conversion factor[65] was used to calculate the equivalent power consumption (kWh) to the emissions, on the assumption that all emissions arising were caused by power consumption, using electricity from the National Grid. In reality, this is not the case: a large range of materials and fuel will be used in the construction and operation of a reuse scheme, or indeed any capital works, each with its own emission factor and greenhouse warming potential. However, no such information is available, thus necessitating the simplistic approach taken here. This is because Thames Water's carbon curves were used to derive the estimated emission from the scheme which are high level and appropriate for this stage.

Then, an estimate was calculated of the annual electricity that could be generated from PV panels located on rooftops of the reuse buildings. This was done by calculating the potential area available for solar deployment, using the Conceptual Design Reports[6] for each scheme, in which gives the total building area in m^2. Professional judgement has been applied to identify those buildings that will have a flat roof as possible sites for solar PV. Following the calculation of roof area, the number of PV panels that could be fitted onto the roofs

[63] Jacobs (2022), London Effluent Reuse SRO – Greenhouse Gas Assessment and Mitigation Recommendations. Document no: j698-GN-DOC-002047-0A, Revision no: Rev A

[64] Ofwat, (2019), PR19 final determinations: Thames Water final determination. Accessible via: PR19-final-determinations-Thames-Water-final-determination.pdf (ofwat.gov.uk) [last accessed 26/07/2022]

[65] UK Government (2021), Greenhouse gas reporting conversion factors 2021. Accessible via Greenhouse gas reporting: conversion factors 2021 - GOV.UK (www.gov.uk) [last accessed 25/07/2022]

was calculated using GIS software, assuming the deployment of a standard PV panel[66] with a 0.1m gap in-between panels. Then the annual estimated renewable generation was then calculated using the method set out by the Microgeneration Certification Scheme (MCS)[67] that takes into account the peak performance, local solar irradiance, pitch and shading factors. Data for these factors were derived from the PV product specification, lookup tables produced by MCS[68] and robust assumptions.

In addition, the same method was applied to estimate the generation of renewable electricity using bifacial PV panels should there be an option to incorporate a carport-type structure covering the car park in the Beckton water recycling scheme, using a standard product[69].

The BNG assessment has identified sites with both low and high biodiversity. For this renewables assessment, the lowest scoring sites have been examined for their potential to support a ground mounted solar array where there may be a co-benefit to increasing the site's biodiversity, these sites would provide both renewable energy and biodiversity benefits[70]. Lower scoring sites are selected as possibly suitable sites, as if a site is functionally linked to a designated site and as such has a higher biodiversity score, installing a solar farm could potentially have a negative effect, instead of a positive one. CORINE Land Cover data[71] was used to identify the habitat type of the sites with low biodiversity, ensuring that they would be suitable for a ground mounted solar array i.e., that sites were fields or poor-quality grassland and not woodlands or other unsuitable habitat. As the panels are raised above the ground, it could be possible to increase biodiversity through wildflower planting.

7.3 RESULTS

In this section the results of the renewables assessments are presented. Table 7-2 presents the scheme emissions and the equivalent power consumption, and Table 7-3 presents the annual kWh generation of the panels on the roofs. Teddington DRA 50 Ml/d TTP had no suitable rooftops and as such has an estimated 0 kWh output.

Table 7-2 Operational and embodied emissions and equivalent power associated with the schemes

Scheme and sub-option	Operational (tCO2e/year)	Embodied carbon (tCO2e)	Equivalent operational electricity use from Nat Grid per year (kWh/yr)	Equivalent embodied electricity use from Nat Grid (kWh)
Beckton water recycling 100Ml/d AWRP	2,008	55,176	9,456,977	259,859,652
Mogden water recycling 50Ml/d AWRP	1,004	37,006	4,728,489	174,285,311
Mogden water recycling 100Ml/d AWRP	2,009	49,475	9,461,687	233,009,937
Teddington DRA 50 Ml/d TTP	269	36,211	1,266,896	170,541,139
Teddington DRA 75 Ml/d TTP	403	41,301	1,897,989	194,513,258

[66] Thames Water does not have a particular or preferred PV product, so the Jinko Solar (2021) Tiger N-Type 66TR 395–415 Watt Mono-Facial All Black product was used. Accessible via: JKM385-405N-6RL3-B-D1-EN.ai (shwebspace.com) [last accessed 27/08/2022]

[67] Microgeneration Certification Scheme (MCS), (2012), Guide to the Installation of Photovoltaic Systems. Accessible via: PV-Book-ELECTRONIC.pdf (mcscertified.com) [last accessed 27/07/2022]

[68] MCS (2013), Irradiance Datasets. Accessible via: https://mcscertified.com/standards-tools-library/ [last accessed: 27/07/2022]

[69] Jinko Solar (2021), Tiger Neo N-type 72HL4-BDV 550-570 Watt Bifacial Module with Dual Glass. Accessible via: JKM550-570N-72HL4-BDV-F1-EN(IEC 2016).ai (shwebspace.com) [last accessed 27/07/2022]

[70] Bre (2014), Biodiversity Guidance for Solar Developments. Eds G E Parker and L Greene

[71] Copernicus (2018), CORINE Land Cover. Accessible via: https://land.copernicus.eu/pan-european/corine-land-cover [last accessed 28/07/2022]

Table 7-3 Estimated annual kWh output from the PV panels associated with each sub-option

Scheme and sub-option	Annual kWh
Beckton water recycling100Ml/d AWRP	1,113,217
Mogden water recycling 50Ml/d AWRP	915,711
Mogden water recycling 100Ml/d AWRP	1,113,217
Teddington DRA 50 Ml/d TTP	0
Teddington DRA 75 Ml/d TTP	0

In addition to the kWh produced by the PV panels on rooftops, an extra 653,499 kWh per year could be produced by bifacial PV panels if fitted to a car-port structure on top of the (relocated) Beckton water recycling car park. When comparing Table 7-2 and Table 7-3, it is clear that the inclusion of PV into the scheme design can help offset some of the emissions associated with the scheme, but is insufficient to cover all of them.

It may be possible to install ground mounted PV arrays to increase renewable energy production and to mitigate the emissions produced by the schemes. Such sites have been identified through the BNG assessment, based on their low biodiversity score, land cover, and habitat type. It is recommended that the potential for these sites to for both renewable energy production and biodiversity improvements be further explored if this is a desirable objective for the scheme.

7.4 CONCLUSIONS AND FURTHER WORK

The assessment has produced an estimation of the possible PV generation through deployment of PV panels on rooftops, ground arrays, and via carport structures. PV panels are an option to be explored further.

As mentioned, due to data availability, this assessment was only able to assess some of the smaller sub-options for Beckton water recycling and Mogden water recycling. The results show that the deployment of PV panels can help to cover between 10-20% of the expected operational emissions of the schemes. A very large area would need to be needed to generate further renewable solar energy in order to meet all operational emissions. The area required is likely to be in excess of that available within the footprint of each scheme.

This is a very simplistic assessment to give an indication of the renewable energy that would need to be generated to match the emissions associated with the scheme, using various assumptions. The approach taken is very high level and appropriate for this stage and so it is recommended that further work involves a bottom-up estimate of materials and quantities so the greenhouse gas emissions associated with the construction and operation of the schemes can be better defined and reduced through scheme design as much as possible. This would also help better understand the potential for different types of renewable energy that could be deployed other than solar PV. Further development of the assessment should address technical feasibility and other potential barriers to the deployment of PV panels which have not been covered in the assessment. The embodied emissions associated with the PV panels has not been included in the assessment, and no assessment has been made of the weight of the panels for rooftop installation, the feasibility of ground sites for panels, nor the potential for grid connections. The possibility of installing energy storage to match periods of electricity production and the need for power has not been examined.

A site visit should be conducted to validate the assumptions made. This assessment has used realistic but assumed values for array orientation, inclination and absence of shading. A site visit is required to collect data and recalculate the emissions to increase accuracy and to have more confidence in the estimation: the actual performance may be lower or higher than stated in this assessment when actual data are used. More detailed designs of the scheme buildings would allow for improved calculations. Site visits are also important for any site that may be considered for ground mounted solar arrays to help identify what type of biodiversity enhancement may be suitable.

Another improvement to the approach could be to use the forecasted grid electricity emission factor dataset[72] over the lifetime of the schemes. Currently a static number representing grid electricity emissions has been

[72] UK Government, (2021), Electricity emissions factors to 2100 gCO_2e/kWh. Accessible via: Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal - GOV.UK (www.gov.uk) and data-tables-1-19.xlsx (live.com) [Last accessed 25/07/2022)

used over the assumed 80 years of the scheme, which is considered appropriate for the very high-level nature of this assessment. Using the forecast grid electricity emission dataset[72] would be more robust, and best suited when a more granular understanding of the scheme emissions footprint is available.

8. BIODIVERSITY NET GAIN AND NATURAL CAPITAL CONCLUSIONS AND RECOMMENDATIONS

8.1 SUMMARY OF THE FINDINGS

8.1.1 BNG terrestrial assessment

The mitigation required to achieve a minimum of 10% BNG was calculated for each of the three London Effluent Reuse SROs. Between the three options, mitigation for Mogden water recycling scheme will provide the greatest BNG, resulting in a net increase of 14.9 units. Implementing the Beckton water recycling option will create a net increase of 7.92 units, and Teddington DRA will provide a net increase of 2.37 units.

Areas of land which may be suitable for mitigation have been identified using scoring criteria with the highest scoring sites potentially offering more effective, functioning mitigation. Due to the relative closeness of the three options, the areas identified can be used regardless of which option is chosen, however due to the differing sizes of habitat loss, Mogden water recycling scheme will require the top five of the identified areas for full mitigation and BNG whereas Beckton water recycling will require the top three and Teddington DRA require only the topmost identified area. Subject to planning and wider stakeholder engagement, details of timelines for implementation will strengthen the confidence of the assessment at future stages.

8.1.2 BNG rivers assessment

A total of -0.04 river units losses were estimated for the installation of permanent infrastructure such as pumping stations and abstraction and outfall locations associated with Beckton water recycling scheme option, with operational impacts of increased water flow creating a further loss of -0.23 river units within the Lea Navigation Enfield Lock to Tottenham Locks Water Body. Mogden water recycling scheme also results in a permanent loss of -0.04 river units, but has negligible effect on water flow, so no operational impacts are expected. The Teddington DRA will create a loss of -0.12 river units through the creation of permanent structures, but also has no temporary or operational disbenefits.

Mitigation measures to enhance off-site sections of river would be required to deliver a minimum of 10% net gain. Permanent construction impacts from Mogden water recycling scheme and Teddington DRA will require respectively the enhancement of 0.6km and 1.8km of ‘other river and stream’ located outside the catchment. With regards to the Beckton water recycling scheme option, operational impacts have not been considered to impact the river condition at this stage and therefore, mitigation would be required only to compensate the permanent construction impacts. In that case, 1km of ‘other river and stream’ is recommended to be enhanced off-site and outside the catchment. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh survey will inform the enhancement measures required to enhance the river from ‘poor to moderate condition’. Subject to planning and wider stakeholder engagement, details of timelines for implementation will strengthen the confidence of the assessment at future stages.

Table 8-1 Summary of the BNG benefits for the London Effluent Reuse schemes

London Effluent Reuse Schemes	BNG – Terrestrial	BNG – Rivers*
Beckton water recycling scheme	7.92 units	-0.23 units
Mogden water recycling scheme	14.9 units	-0.04 units
Teddington DRA scheme	2.37 units	-0.12 units

*Mitigation measures to enhance off-site sections of rivers will be assessed at Gate 3.

8.1.3 NC assessment

The overall environmental benefits in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 30 and 80 years for the London Effluent Reuse scheme is summarised in Table 8-2. As the larger schemes have been assessed, there will be more land and associated management costs as it is not accounted in the NC methodology. The current buffer area for the assessed components extends to just the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be

necessary following stakeholder engagement, agreed engineering specification etc as part of further scheme development.

Table 8-2 Summary of the NPV benefits for the London Effluent Reuse schemes

London Effluent Reuse Schemes	30-year NPV benefits	80-year NPV benefits
Beckton water recycling scheme	£20,743	£40,883
Mogden water recycling scheme	£496,421	£1,082,155
Teddington DRA scheme	£219,311	£485,268

8.2 CONCLUSIONS AND RECOMMENDATIONS FOR GATE 3

The following recommendations are made for Gate 3 based on the data gaps identified in this assessment of the London effluent reuse schemes:

- Mogden water recycling scheme:
  - Design changes since the UKHab survey at Mogden STW site were undertaken meant that shaft/ compound 1 is now outside of the surveyed area and so, no baseline habitat data was available.
  - UKHab surveys and BNG habitat condition surveys should be undertaken to provide a complete baseline data set to inform the Biodiversity Metric calculations and reduce the assumptions required to determine the impacts and off-site mitigation requirements. This data will be included in the re-run of the Biodiversity Metric to ensure 10% uplift is being delivered.
- Teddington DRA
  - UKHab survey required at Shaft/ Compound 1 to determine the type of habitat present within the area of permanent loss for Teddington DRA scheme.
  - UKHab surveys and BNG habitat condition surveys should be undertaken to provide a complete baseline data set to inform the Biodiversity Metric calculations and reduce the assumptions required to determine the impacts and off-site mitigation requirements. This data will be included in the re-run of the Biodiversity Metric to ensure 10% uplift is being delivered.

Due to the data gap, a large portion of this option is derived from Corine Land Cover 2018 (CLC) which has a lower resolution. CLC also does not provide information regarding habitat condition, as a result of this the habitats have been assumed to be moderate. This may result in an over-estimation of habitat units lost as poor habitats will not be portrayed accurately and are more frequent than good condition habitats.

As the potential biodiversity opportunities (PBOs) areas have been identified, the habitat type and condition should be ground-truthed. Furthermore, stakeholder engagement will be required to ensure PBO areas are available for mitigation. Therefore, a stakeholder engagement plan to support development and opportunities should be developed with planning authorities to identify ambitions after 2030, and wider stakeholder to identify any mitigation opportunities. It is recommended that this stakeholder engagement is started between Gate 2 and 3 to ensure synergy of ideas, additional data collection and mapping.

Currently, at this early stage, all sizes of the schemes are being considered. Refinement will be necessary at Gate 3, this will include a wider benefits assessment of the shortlisted mitigation sites and schemes should be undertaken using the six-capitals or similar approach. This is to account for societal, financial, human, intellectual and manufactured capital in addition to other natural capital indicators. This approach will identify areas that can provide the widest range of benefits.

In addition, to support the wider benefits assessment it will be necessary to:

- Carry out stakeholder engagement to understand what other abstractors may be planning to use the water that could have an impact on water regulation status.
- Refine benefits related to agriculture based on more detailed farm business surveys. This will provide a more detailed assessment of the values of different agricultural natural capital related assets.
- Identify land holding for Thames Water and other key land owners to identify key opportunity areas.

- Review any natural hazard regulation assessment based on shortlisted mitigation sites and to reassess the net benefit.
- Following more detail as planning progresses and identification of net gain sites, it will be possible to use the forest research data and other local datasets to better ascertain flood regulation opportunities and assessment related to woodland (e.g., canopy interception, soil storage and roughness).
- As part of the benefit work, areas will be identified that would support water purification via habitat mitigation.
- Water regulation will be reviewed in the context of rent value once associated date is available to ascertain benefits.
- Recreation benefits will be assessed subject to location of migitigation areas, planning and wider stakeholder engagement.

APPENDIX 1 – BIODIVERSITY NET GAIN WORKBOOKS

The BNG metrics for terrestrial and rivers used in this assessment are as follows:

Terrestrial metric workbooks:

- Appendix 1A – Beckton water recycling scheme – permanent
- Appendix 1B – Beckton water recycling scheme – temporary
- Appendix 1C – Mogden water recycling scheme – permanent
- Appendix 1D – Mogden water recycling scheme – temporary
- Appendix 1E – Teddington DRA scheme – permanent
- Appendix 1F – Teddington DRA scheme – temporary

River metric workbooks:

- Appendix 1G – Beckton water recycling scheme
- Appendix 1H – Mogden water recycling scheme
- Appendix 1I – Teddington DRA scheme

APPENDIX 2 - NATURAL CAPITAL WORKBOOKS

The calculations within the natural capital workbooks, summarised in sections 4.5, 5.5 and 6.5 are detailed in this appendix.

- Appendix 2A – Beckton water recycling scheme
- Appendix 2B – Mogden water recycling scheme
- Appendix 2C – Teddington DRA scheme

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