



Essex & Suffolk Water - Water Resources Management Plan 2024 Environmental Report

Appendix H - Natural Capital Assessment (NCA)
and Biodiversity Net Gain (BNG)

October 2023

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Mott MacDonald
Spring Bank House
33 Stamford Street
Altrincham WA14 1ES
United Kingdom

T +44 (0)161 926 4000
mottmac.com

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Appendix H - Natural Capital Assessment (NCA)
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1 Introduction

1.1 Overview

This appendix supports the Environment Report that accompanies the Essex & Suffolk (ESW) revised Water Resource Management Plan (rdWRMP) 2024 submission to regulators. The appendix presents the findings of the Natural Capital Approach (NCA) and Biodiversity Net Gain (BNG) assessments applied to the ESW WRMP24 options.

1.2 Essex & Suffolk Water rWRMP24

The rWRMP24 is an adaptive plan to deal with uncertainties and future scenarios that will require further investment (e.g., further future sustainability reductions). As part of the regional plan and WRMP processes, a Best Value Plan (BVP), which forms the preferred revised WRMP, and three alternative plans (a Least Cost Plan (LCP), Ofwat Core Plan, and Best Environment and Societal Plan (BESP)) were developed in line with the Water Resources Planning Guidelines (WRPG).

An adaptive planning approach was used to take account of future uncertainties. WRE and ESW, in line with this approach, have also provided four adaptive Programmes (High Environmental Destination (HED) Programme, High Per Capita Consumption (PCC) Programme, North Suffolk Reservoir (NSR) Programme, and the Habitat Regulations Sustainability Reductions (HRSR) Programme). These programmes were derived based on different environmental and social drivers, as alternatives to the preferred plan BVP.

NCA and BNG assessments have been undertaken for the ESW supply-side options selected for the rWRMP24 alternative programmes. These supply options include transfers, effluent reuse, groundwater source, desalination and treatment upgrade options. Table 1.1 summarises the 17 supply-side options, providing a general overview of the activities associated with each of them. For the other option types considered within the rWRMP24, including the demand management options, these options have been scoped-out of NCA and BNG assessment given the early stage of design development and available option information at the time of assessment.

Table 1.1: Essex & Suffolk Water rWRMP24 options

Option name	Description overview
ESW-ABS-003C	New Linford WTW. Reinstatement of abandoned artesian well, no network upgrade should be required. 10 Ml/d provided overall.
ESW-TRA-001	Transfer from Barsham WTW to Saxmundham Water Tower. Transfer consists of multiple sections: A. Barsham WTW to Shadingfield Tower – construction of new pipeline next to an existing main, length approximately 5.6km Micro-tunnelling required for one railway crossing. B. Shadingfield Tower to Holton WTW - length approximately 7.4km. Tunnelling not required. C. Holton WTW to Saxmundham Tower - length approximately 19.2km. Tunnelling (micro-tunnelling/horizontal directional drilling) likely to be required as route passes under one railway, three major roads (A144, A1120, A12), three minor roads (B1124, B1123, B1119), two river crossings (River Blyth, River Yox), and two drainage channels. The route also runs along roads (B1119) for the last section to reach Saxmundham Tower. D. Connection to Walpole WTW, taken off Transfer C - approximate length of 1.4km. This transfer joins Transfer C not long after the railway crossing. No tunnelling required.

Option name	Description overview
ESW-TRA-019	Transfer from Holton WTW to Eye Airfield. Transfer approximately 30.6km long. Transfer mainly follows roads. Critical crossings include a railway crossing in Halesworth (route follows road bridge therefore trenchless techniques not possible), and the River Dove.
ESW-NIT-004	Nitrate treatment extension on Barsham WTW's existing site. Additional electro dialysis reversal nitrate removal plant plus a discharge stream pipeline.
ESW-NIT-005	Nitrate treatment extension on Langford WTW's existing site. Additional electro dialysis reversal nitrate removal plant plus a discharge stream pipeline.
ESW-UVC-001	Langford UV (Crypto). Additional Ultraviolet treatment contactors to treat for cryptosporidium.
ESW-NIT-006	Nitrate treatment extension on Langham WTW's existing site. Additional electro dialysis reversal nitrate removal plant plus a discharge stream pipeline.
ESW-PMP-001A	Langford WTW upgrade + Abberton RWPS Pump Replacement. Replacement, enhanced pumping capacity of two existing pumps, motors, and controls at Abberton Reservoir Raw Water Pumping Station. Upgrade the treatment at Langford WTW to accommodate the introduction of source water from Abberton raw water reservoir.
ESW-TRA-023	Broome to Barsham Transfer. New raw water main from Broome to Barsham Bores Works.
ESW-TRA-018	Transfer from Bungay Wells to Broome WTW. Transfer is approximately 3.6km long. Route follows roads.
ESW-03b0478B	16.4Ml/d Effluent reuse at Caister pump lane WRC transfer via River Wensum to Heigham WTW.
ESW-EFR-002A	Effluent Reuse Plant (11.1Ml/d DO). Intake from Lowestoft/Corton WRC (Anglian Water owned asset), discharge to point near Ellingham Mill. Two transfers required: Lowestoft/Corton WRC to new effluent reuse plant (Transfer 1, length approximately 200m), new effluent reuse plant to Ellingham Mill on the River Waveney (Transfer 2, length approximately 26.3km).
ESW-RES-002C1	North Suffolk winter storage reservoir + Barsham River Works Upgrade. New winter storage reservoir to be built. Intake comes from the River Waveney when there's no spare capacity at Barsham WTW. When supplies are short at Barsham WTW, water is taken from the reservoir and transferred to the WTW.
ESW-DES-008	Seawater Desalination Plant. Abstraction from beach wells to a desalination plant. Transfer to discharge to Barsham WTW.
ESW-DES-001	Abstraction from the Thames Estuary with discharge to Hanningfield Service Reservoir. Transfer length between plant and reservoir approximately 20.7km. Tunnelling (micro-tunnelling/horizontal directional drilling) likely to be required as route passes under three railway lines, multiple major roads (A130, A13, A127, A129, A132), one minor road (B1464), eight river crossings (including the River Crouch) and five drainage channel crossings. First part of the route passes through Canvey Wick Nature Reserve however has been routed to avoid as much of this area as possible. An extension to the pipeline to Holton is under consideration (EFR-002B) but was not available at time of writing. This assessment will be updated in the final plan.
ESW-EFR-001	Intake from Southend-on-Sea WRC (Anglian Water owned asset), discharge to Hanningfield Service Reservoir. Two transfers required: Southend-on-Sea WRC to new effluent reuse plant (Transfer 1), new effluent reuse plant to Hanningfield reservoir (Transfer 2). Transfer 1: Transfer length approximately 991m. Route runs under an industrial estate road, no need for tunnelling. Pump station required at existing STW – located where the two existing outfalls meet. Transfer 2: Transfer length approximately 23.1km. Tunnelling (micro-tunnelling/horizontal directional drilling) required as route passes under one railway line, multiple major roads (A130, A132), two large river/estuary crossing (River Roach and River Crouch), three smaller river crossings, and one drainage channel crossing.
ESW-DES-004*	Seawater Desalination Plant. Abstraction from the North Sea, discharge to Barsham WTW. Service reservoir located off site. Two transfers required. Transfer 1 from beach wells/infiltration galleries to the desalination plant (raw water), approximately 1.8km. Transfer 2 from the desalination plant to Barsham WTW (treated water), approximately 37km.

*Option not part of the Best Value Plan, Alternative Plans and Adaptive Programmes, it is reported in the Assessment of Emerging WRMP24 chapter upon request from ESW.

2 Methodology

2.1 Natural Capital Assessment Methodology

2.1.1 Guidance

Water companies have a statutory obligation to produce a WRMP, which sets out how a company intends to maintain the balance between supply and demand for water over a minimum 25-year period. In the development of a WRMP, companies must follow the Environment Agency (EA) Water Resource Planning Guidelines¹ (WRPG) and consider broader government policy objectives. The WRPG recommends that companies must consider the environment and society when developing the WRMP, stating that natural capital assessments and biodiversity net gain should be used to inform decision-making. The natural capital approach is similarly supported by the Government's ambition to deliver environmental net gain, as set out in the 25 Year Environment Plan² and Defra's Guiding Principles.

The WRMP24 should therefore provide a reliable NCA which aligns with the WRPG, provides a framework to be built upon within the individual water company WRMP's and is suitable for the Water Resource East (WRE) regional plans. To ensure that a natural capital approach is incorporated in a consistent way across the WRE Regional Plan this method statement outlines a recommended approach to the regional NCA, the quantification of impacts and the valuation of benefits and impacts. The NCA and BNG have been produced in line with best practise and guidance available at the time the assessments were undertaken, including:

- DEFRA (2021) Enabling a Natural Capital Approach (ENCA)³
- HM Treasury and government finance (2020) The Green Book: appraisal and evaluation in central government (the 'Green Book')
- Natural England (2021) The Biodiversity Metric 3.0 auditing and accounting for biodiversity (JP039)
- Natural England (2020) NERR076 Natural Capital Indicators: for defining and measuring change in natural capital⁴
- Environment Agency, Natural Resources Wales, Ofwat (2023) Water Resources Planning Guidelines (WRPG)¹
- Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making (ESDMSG)⁵

¹ Environment Agency, Natural Resources Wales, Office for Water Services (2023). Water resources planning guideline. Available at: [Water resources planning guideline - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/publications/water-resources-planning-guideline)

² GOV.UK 2018. Policy Paper, 25 Year Environment Plan. Available at: <https://www.gov.uk/government/publications/25-year-environment-plan>

³ DEFRA 2021. Enabling a Natural Capital Approach (ENCA): Guidance. Available at: <https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance>

⁴ Natural England 2020. Natural Capital Indicators: for defining and measuring change in natural capital (NERR076). Available at: <https://publications.naturalengland.org.uk/publication/6742480364240896>

⁵ Environment Agency 2020. Water resources planning guideline supplementary guidance - Environment and society in decision-making (ESDMSG):

Since the assessments were undertaken, a number of the guidance documents listed above have been updated, including the Green Book⁶ (2022), the Biodiversity Metric 4.0⁷ (2023), and Defra's ENCA guidance⁸ (2023). However, the guidance available at the time of the assessments is considered appropriate to inform ESW's rWRMP24 decision-making process.

2.1.2 Principles of the WRE Natural Capital Approach

Regional water resource plans taking a long-term view of water planning to 2100 are currently being prepared for each region. The ESW rWRMP24 SEA was undertaken in the context of these plans and falls within the WRE regional plan. In line with the EA guidance on Environment and Society in Decision-making⁹ the WRE regional plan NCA methodology has been developed in accordance with the following principles:

- The assessment will include the valuation of natural capital assets and ecosystem services within the footprint of each option and their zone of influence (see Section 2.2).
- The assessment methodology uses the most relevant qualitative, quantitative and/or monetary valuation approaches for the NCA. The assessment of the option's impact on the natural capital metrics will be undertaken in a sequential manner with an initial qualitative assessment, followed by a quantitative analysis and finally a monetised assessment if enough confidence exists in the values.
- Not all ecosystem services can be monetised within the NCA however those that are will be assessed against a consistent methodology. The monetised natural capital metrics will be incorporated into the cost benefit ratio as a discreet input. This monetised value will be a single figure defined by the maximum natural capital benefit. The cost of the option will not be considered within this assessment as it is captured elsewhere within the multi criteria assessment.
- Ecosystem services that are not monetised will be quantified and incorporated into the regional plan decision-making process within the SEA assessment.
- The NCA will be undertaken using open-source data in accordance with the guidance for regional assessments and to ensure that the approach is consistent across the entire study area.
- The WRE NCA methodology aims to align WRMPs' natural capital and ecosystem services which have previously been undertaken using separate approaches. It is hoped that the united methodology will enable joint investment in strategic and catchment-based options.
- The assessment criteria have been designed to enable the maximisation of the potential benefits from the regional plan.

2.1.3 ESW rWRMP24

The supply-side options that have been selected as part of the ESW rWRMP24 BVP have fed into the decision-making process and associated investment modelling for WRE's regional plan. The NCA methodology developed for the regional planning process has been reviewed by ESW and is considered suitable for undertaking assessments to inform the rWRMP24.

⁶ HM Treasury and Government Finance Function 2020. Guidance, The Green Book: appraisal and evaluation in central government. Available at: <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>

⁷ Defra and Natural England 2023. The Biodiversity Metric 4.0 (JP039). Available at: <https://publications.naturalengland.org.uk/publication/6049804846366720>

⁸ DEFRA 2023. Enabling a Natural Capital Approach (ENCA): Guidance. Available at: <https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance>

⁹ Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making.

2.2 Stage 1: Defining the Natural Capital Baseline

2.2.1 Zone of influence for option level assessment

The zone of influence (ZoI) for each option is defined as the area likely to be altered or changed as a result of the option, resulting in a potential change to the environmental benefits that are currently being provided. To assess the likely temporary impacts from construction within the ZoI, it has been assumed that below ground infrastructure will require a working width of approximately 10m from the option footprint to facilitate construction, while above ground infrastructure will require a working width of approximately 5m from the option footprint. It is assumed that the natural capital stocks located within the option footprint for above ground infrastructure will be permanently lost as a result of option construction.

2.2.2 Developing a natural capital baseline

As part of the NCA of the feasible options within the regional plan a natural capital baseline will be developed for the study area. This baseline will be developed using open-source data as described in NECR285¹⁰ to generate a natural capital account of the stocks within the E&S region. The list of stocks considered within the accounts and the methodology for mapping them are shown in Appendix H.1. The methodology used to map natural capital utilises the same breakdown of stocks as the National Natural Capital Atlas where possible. However, the list has been supplemented with additional abiotic stocks and key habitats that are vital to the E&S region such as chalk streams and rivers.

The natural capital baseline will report the total quantity of each stock within the study area, and where suitable, an indication of natural capital condition. Monetary valuation of the natural capital baseline will not be included within the Regional natural capital Baseline due to the availability of data.

2.3 Stage 2: Option level assessment

2.3.1 Natural Capital Assessment

A natural capital assessment has been undertaken on the options in accordance with the WRPG¹¹ and ENCA¹² requirements. ENCA is recommended for use by the Green Book (2020) and represents supplementary guidance to the Green Book.

The ENCA 2021 guidance includes updated values within the associated Asset Databook and Service Databook that are provided as supporting documents to the guidance. Within the Service Databook, the carbon reduction tab was updated to the Government's Department for Business, Energy and Industrial Strategy (BEIS) 2022 carbon values - a set of values produced by the government to be used in policy appraisal and evaluation, reflecting the latest evidence. The climate regulation section of the assessment has been updated in line with this.

The impact of the options on the natural capital stocks was reported for each option quantitatively. This impact was reported for during-construction and post-construction to give an

¹⁰ Natural England, (2020) National Natural Capital Atlas: Mapping Indicators (NECR285). Available at: <https://publications.naturalengland.org.uk/publication/4578000601612288>

¹¹ GOV.UK. 2020. Water resources planning guideline. [online] Available at: <https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline> [Accessed March 2022].

¹² GOV.UK. 2021. Enabling a Natural Capital Approach guidance. Available online at: <https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance> [Accessed April 2022].

estimation of the impact of the options' whole lifecycle. The results of the stock assessment were reported in total losses and gains within each option's zone of influence.

The results of the change in natural capital stocks informed the assessment against the eight natural capital metrics (ecosystem services) listed below using the Natural England logic chains (Figure 2.1). The cost / benefit assessment was informed by the option type, option description and any embedded mitigation. The outputs of the NCA were compared to the pre-construction provision of impacted services to assess the impact of the options. Five ecosystem services were monetised (subject to the screening process set out below), and the results of the assessment reported as a discreet monetary figure, water purification and water regulation were assessed qualitatively, and biodiversity has been assessed via the Biodiversity 3.0 Metric¹³.

Figure 2.1: Ecosystem Services valuation logic chain



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

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

Both natural capital assessment strategies, as outlined in the WRP and ENCA guidance, discuss taking a proportionate approach to the assessment. It is therefore important to accommodate this when integrating a natural capital approach within the options. A natural capital approach has the potential to inform concept design and aid decision making, by quantifying the relative cost benefits and disbenefits of the options to aid the initial assessment of the identified strategic solutions.

2.4 Ecosystem services screening

During the initial phase of the NCA, the seven ecosystem services listed above (excluding Biodiversity and Habitat, assessed by the Biodiversity Metric 3.0) were reviewed and scoped-in or -out due to the geographical or socio-economic context of the option and its zone of influence. Specific guidance on the screening process for individual metrics is provided below.

¹³ Natural England, 2021. Available at: [ARCHIVE SITE for the Biodiversity Metric 2.0 and the Biodiversity Metric 3.0 \(nepubprod.appspot.com\)](#) [Accessed: May 2022]

2.4.1 Climate regulation

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

The assessment was determined by land management within each option ZoI which influence the carbon store for prolonged periods of time and result in changes to net emissions. The estimate of the carbon stocks for each option footprint was based on the area of broad land use types according to literature and research. The estimated carbon sequestration rates for broad habitat types are presented in Table 2.1.

Table 2.1: Carbon sequestration rates for broad habitat types (JBA Consulting) ^{14 12}

Land use type	C Seq rate (tCO ₂ e/ha/yr)
Woodland - (deciduous)	4.97
Woodland – (coniferous)	12.66
Arable Land	0.107
Pastoral land	0.397
Peatland - Undamaged	4.11
Peatland - Overgrazed	-0.1
Peatland - Rotationally burnt	-3.66
Peatland - Extracted	-4.87
Grassland	0.397
Heathland	0.7
Shrub	0.7
Saltmarsh	5.188
Urban	0
Green Urban	0.397

The carbon sequestration rates were converted to monetary values using standard methods, by multiplying the estimated quantity of carbon sequestered by the monetary rates, and the BEIS Interim Non-Traded Carbon Values which sets out a revised approach to valuing greenhouse gas emissions in policy appraisal, following a cross-government review during 2020 and 2021. These monetary values are set out in Table 2.2 below. The NCA is based on a 2022 price year; however, it is assumed that adjustments for inflation from 2020 (year of BEIS publication) to 2022 have been accounted within the annual projections provided by BEIS and therefore the 2022 value presented below has not been adjusted. High series values were used to reflect a conservative estimate for the price of carbon.

Table 2.2: BEIS updated short-term traded sector carbon values for policy appraisal, £/tCO₂e (£2020)

Year	Low series	Central series	High series
2020	120	241	361
2021	122	245	367
2022	124	248	373

¹⁴ Alonso, I., Weston, k., Gregg, r. & Morecroft, M. 2012. Carbon storage by habitat - Review of the evidence of the impacts of management decisions and condition on carbon stores and sources. Natural England Research Reports, Number NERR043.

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

The methodology outlined above meets the minimum requirement for the qualitative and quantitative approach, respectively, and best practice for the monetisation approach in accordance with the ESDMSG⁵.

2.4.2 Natural hazard regulation

Different habitat types have intrinsic flood risk management values by intercepting, storing, and slowing water flows. This is known as natural flood management (NFM) and is listed as a policy within the Government’s 25 Year Environment Plan². The capacity of habitats to achieve this was quantified, and then a monetary value assigned based on the damage-costs avoided from flooding or replacement costs due to their capacity to regulate flood waters. The capacity for a given natural capital asset to provide a flood regulation service will depend on two factors:

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

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

Options have been assessed on their ability to positively or negatively impact flood risk through the comparison of pre & post construction natural capital stocks and the catchment in which it is located. The assessment is restricted to catchment areas which drain to downstream communities impacted by flooding. These communities were identified using the Environment Agency's Indicative Flood Map¹⁵, which overlays areas at risk of fluvial flooding and the National Receptor Database. The ecosystem service was scoped in for assessment as where it was identified that an option would have a temporary or permanent impact upon the relevant natural capital stocks, such as areas of woodland, located within the floodplain.

Reduced flood damage to downstream or coastal settlements as a result of reduced magnitude / frequency of flood / storm events; and / or lower sewer capacity or water storage costs have been valued in line with the "valuing flood regulation services of existing forest cover to inform natural capital accounts" methodology set out by Broadmeadow et al, 2018¹⁶. This assessment was developed to provide indicative national estimates of water regulation services of woodland to inform natural capital accounts, this is based on modelling to estimate the potential volume of flood water avoided by woodland ecosystems in flood risk catchment. The methodology adopts a replacement-cost (rather than damage cost) approach to valuing the flood regulation service of woodland by applying annualised average capital and operating costs of flood reservoir storage that would be required in the absence of the ecosystem service.

Central estimate of the average annual costs of reservoir floodwater storage is £0.42 / m³. The range is from £0.10 to £1.19 /m³ per year. The central estimate was used to derive an annual average estimate for the flood regulation service of woodland in Great Britain, which was then uplifted to a 2022 price year. These "replacement costs" can be considered a lower bound of the benefit if it can be assumed that such expenditure would be deemed value for money by the flooding authorities within flood risk catchments in terms of avoided flood damage costs.¹²

Within these assessments in this report, it has been assumed that such expenditure was deemed value for money by the flooding authorities within flood risk catchments in terms of avoided flood damage costs.

The methodology outlined above meets the minimum requirement for the qualitative approach and the quantitative approach in accordance with the ESDMSG⁵.

2.4.3 Water purification

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

To account for the provision of this service within the NCA the impact of an option associated with the provision or removal of woodland and semi-natural grassland was assessed qualitatively and with consideration of the NEVO¹⁷ tool. The tool defines the resulting changes for the following water quality variables:

- Dissolved oxygen concentration

¹⁵ Flood map for planning - GOV.UK (flood-map-for-planning.service.gov.uk)

¹⁶ Broadmeadow, S., Thomas, H., Nisbet, T. and Valatin, G., 2018. Valuing flood regulation services of existing forest cover to inform natural capital accounts. Forest Research.

¹⁷ Luizzo, L., (2019) Natural Environment Valuation Online Tool - Chapter 6a: Water Quantity & Quality Model

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

This approach follows the methodology that if an area of woodland were to be lost, the resultant impacts on water quality can be quantified within the option’s zone of influence and qualitatively considered for their potential impact upon water purification services. Any negative changes to the natural capital stocks in theory, reflects the loss of this service within each option’s ZoI.

The results of this assessment have informed the SEA assessment and been incorporated within the environmental metrics.

The methodology outlined above meets the minimum requirement for the qualitative approach in accordance with the ESDMSG⁵.

2.4.4 Water regulation

Water flow regulation is a key ecosystem service that can be directly impacted by both changes in land use and the implementation of supply options. Land uses such as agriculture are direct consumers of the water supply, while forests are known to promote higher rates of evapotranspiration and infiltration, which can affect local hydrologic cycles and change the amount of available water. The same natural capital stocks that provide the water supply, such as freshwater lakes and rivers, can also provide other services such as recreation and amenity, especially when near residential and urban communities. In addition to land use changes, water resource options both impact and benefit from water flow regulation. Options benefit by abstracting and providing water supply to customers, but supply options can also have varying effects on existing natural capital stocks, which in turn can affect the amount of available water. A qualitative assessment will be used to compare the positive and negative effect of each option on water flow regulation. Water regulation has been considered qualitatively to avoid the potential double accounting of benefits with capacity-based and financial assessments, and to align with Environment Agency supplementary guidance⁹ that recommends not including monetisation of water regulation benefits in decision making.

The following key (Table 2.3) is used to demonstrate the scale of effect caused by the option on the ecosystem service.

Table 2.3: Scale of effect key on water regulation ecosystem services.

Colour	Scale of Effect	Description
+++	Major Positive	The option would result in a major improvement to the provision of water flow regulation.
++	Moderate Positive	The option would result in a moderate improvement to the provision of water flow regulation.
+	Minor Positive	The option would result in a minor improvement to the provision of water flow regulation.
0	Neutral	The option would not result in any effects on the provision of water flow regulation.
-	Minor Negative	The option would result in a minor decrease to the provision of water flow regulation.
--	Moderate Negative	The option would result in a moderate decrease to the provision of water flow regulation.
---	Major Negative	The option would result in a major decrease to the provision of water flow regulation.
?	Uncertain	From the level of information available, the effect that the option would have on the provision of water flow regulation is uncertain.

The methodology outlined above meets the minimum requirement for the qualitative approach in accordance with the ESDMSG⁵.

2.4.5 Air pollutant removal

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

- The surrounding area of the natural capital assets with regards to background pollution, especially particulate pollutant
- The quantity and type of natural capital asset, woodland is the major service provider
- The density of population potentially benefiting from reduced exposure, because pollutants are transported, beneficiaries may be downwind of the ecosystem¹²

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

The value provided by natural capital assets was taken from the UK government’s air quality economic assessment methodology¹⁸. The assessment embeds these values (based on the damage cost approach, i.e., damage to health avoided from reductions in air pollution) and estimates the present value automatically based on the quantitative estimates provided.

Indicative average values for air pollution removal in 2015 for different habitats air pollutant removal calculated from aggregate UK values. published in February 2019 as shown in Table 2.4.

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

Table 2.4: Air pollutant value by habitat type

Habitat group	Value (£ per hectare per year)
Urban Woodland	771
Rural Woodland	245
Urban grassland	149
Enclosed farmland	14
Coastal margins	26

2.4.6 Recreation and amenity

The recreational value of green spaces can be significant. This value reflects both the natural setting and the facilities on offer at the site and often has a strong non-market element. It varies with the type and quality of habitat, location, local population density and the availability of substitute recreational opportunities. Recreational values can be beneficially affected by enhancements in green spaces, or adversely affected by new developments or infrastructure.

¹⁸ Jones L., Vieno M., Morton Dan et al. (2019) Developing Estimates For The Valuation Of Air Pollution Removal In Ecosystem Accounts. Final Report For Office Of National Statistics - NERC Open Research Archive.

The wider tourism and outdoor leisure sector are also dependent upon nature to varying degrees.

This metric depends on the extent to which the natural capital stocks the option provides will enhance the opportunity for recreation.

The key parameter needed to estimate in this category is the number of additional or enhanced recreational visits created because of the option. This has been estimated using the Outdoor Recreation Valuation Tool¹⁹ (ORVal). ORVal is referenced for use in the Green Book. Random utility / travel cost model of recreational demand for all sites in England and Wales and generates probabilistic predictions of visitor numbers for any publicly accessible outdoor recreation park, path, or beach. It takes account of scarcity of sites and substitution possibilities, as well as travel distances to sites and their attributes. This is useful for baseline initial assessment, accounting, and multiple sites. This should be seen as an estimation in the absence of site-specific data on visitor numbers.

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

2.4.7 Food production

Food in its various forms is produced by a range of ecosystems in some cases, the food for human consumption is effectively the same as the ecosystem service (for example, wild fruit, capture fishing). More often the provisioning service is a raw material (for example, crops) that is harvested and processed by humans into added value processed food (for example, bread). The boundary between what is provided by natural capital and the contribution of other forms of capital is often a grey area. For example, crops require agricultural management; livestock depends upon grassland ecosystems¹².

Food production has been calculated using the NEVO agricultural model, this is a structural model of agricultural land use and production for Great Britain estimated using Farm Business Survey (2005 – 2011) and June Agricultural Census data (covering ten unevenly spaced years from 1972 to 2010). The agricultural land use component in NEVO builds upon the approach developed by Fezzi and Bateman²⁰.

NEVO has been used to assess the impact of the creation or removal of agricultural land for each option. The change in value of food provision for the footprint of each option has been calculated using this online tool and reported within the NCA metric.

2.4.8 Price uplifts

A consistent uplifted price reporting year of 2022 was used for all the ecosystem services that have been quantitatively assessed to a consistent price reporting year of 2022 using GDP Deflator prices. It has been assumed that the BEIS values for carbon sequestration have been uplifted and therefore, these values provided by BEIS have not been adjusted.

2.5 Biodiversity Net Gain Assessment Methodology

Biodiversity net gain or net loss must be considered at both the option and programme level. Each option should look to maximise biodiversity net gain and any required mitigation should be

¹⁹ ORVal, Land, Environment Economics and Policy Institute. University of Exeter. Available online at: <<https://www.exeter.ac.uk/research/leep/research/orval/>> [Accessed April 2022]

²⁰ Fezzi, C., Bateman, I., Hadley, D. & Harwood, A. 2019. Natural Environment Valuation Online Tool - Chapter 1: Agriculture Model

included in the option cost. The Environment Agency supplementary guidance⁵ states that if there would be a significant additional cost for an option to get significant extra benefit, this could be included as a separate option for consideration.

A biodiversity baseline has been developed from spatial data sets of habitats inventories (see Table H.1) and assessed in line with the Defra's Biodiversity Metric 3.0 which can be used to calculate BNG change through land use of each option. The natural capital account has been used to identify the biodiversity value of the footprint of each option prior to construction. The post construction land use including agreed mitigation has been used to calculate the post construction biodiversity score. Demand options have not been assigned a biodiversity net gain and any impacts have been incorporated within the SEA assessment.

As this assessment has been carried out using only open-source data a precautionary approach will be applied, presuming that where not specifically known, habitats will be assigned the moderate habitat score. This is recommended as a suitable methodology, given the early stages of design of the majority of the rWRMP24 supply-side options.

Updates to the methodology for mapping natural capital stocks and therefore subsequent NCA and BNG assessments was undertaken to account for the primary habitats that occur in the same location as, and were represented in the existing assessment by, active floodplain. The update to the methodology adheres to the same principles and approach for the NCA and BNG assessments, using previously identified datasets where possible, and supplementing the method with a new land use/land cover (LULC) dataset to identify any habitats that are currently represented as active floodplain that cannot be identified using the previously identified datasets. The update has ensured that primary habitat that was previously represented by active floodplain within the natural capital mapping, specifically pasture and arable land which have been categorised as lower priority in the development of the baseline map, have been fully accounted in the options-level assessments.

The update to the assessment methodology is outlined below:

The area of active floodplain identified in the NCA / BNG assessment for each option was identified and selected using the same environmental datasets previously identified within section 2.2.3 above.

Where areas of active floodplain were overlapping with habitats mapped by the previously identified datasets, those areas were updated with those habitat areas identified by those datasets.

ESW aims to deliver the statutory requirement for projects requiring planning permission (once BNG becomes mandatory by law) and no net loss for all other construction projects. ESW has a longer term aim by 2050 to deliver a minimum of 10% BNG from all construction activities, based on feedback from customer research that was undertaken by ESW. An associated estimated cost to achieve a 10% BNG has also been provided for each option, representing an estimate of £25,000 per BU. It should be noted that Defra has recently released guidance²¹ on the statutory biodiversity credit prices, as well as guidance on calculating costs for developers buying statutory credits. The preliminary £25,000 per BU figure used to inform this assessment should be refined and updated in later stages of option design development, as the guidance and biodiversity credit market continues to develop.

²¹ Defra 2023. Guidance, Statutory biodiversity credit prices. Available online at: <https://www.gov.uk/guidance/statutory-biodiversity-credit-prices>

2.6 Stage 3: Cumulative effects assessment

2.6.1 Introduction

The final task in ESW's option appraisal process is the programme appraisal. Fundamentally, the aim of the programme appraisal process is to find the 'best value' programme of supply and/or demand management options to secure a supply-demand balance across the ESW supply region.

Section 4 provides a summary of the outputs of the NCA and BNG for ESW's programme appraisal for the selected options that were considered to inform the development of the rWRMP24.

2.6.2 Methodology

For NCA and BNG, the cumulative (intra-plan) effects assessment considers the Best Value Plan, OFWAT Core Plan, Best Environment and Society Plan, and Adaptive Programmes. The in-combination effects assessment for these plans considers the option assessments as a whole and the habitat units that would be required to be purchased in order to achieve a 10% net gain in BNG, which is the aim of ESW. This provides an estimate of the value of the potential mitigation or enhancement opportunities that will need to be developed further to achieve the 10% BNG required within the options. Additionally, where possible, the plans could aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall Biodiversity Net Gain in line with regulatory requirements for BNG (at the time of the project consenting) as stated as a mandatory requirement within the Environment Act 2021²². The latter could be achieved by identifying local sites of ecological interest and proposing measures which enhance these features.

The cumulative (inter-plan) effects assessment for NCA and BNG also considers the major planning applications, allocations, and major projects, which have been reviewed as part of the project, in conjunction with the plans.

2.7 Stage 4: Reporting of results

The permanent changes in natural capital stocks have been reported for each option with the results of the ecosystem services screening and detailed assessment.

The natural capital metrics have been aggregated into a single metric that were considered within the WRE investment model. The results for each option have been summarised in proforma that will demonstrate the results of the assessment and the justification behind the assessment.

The results of the NCA and BNG assessments will be incorporated into WRE decision making process through the conversion of the results into metrics as described below:

- **Natural capital metric:** A single discreet monetised value reported in £/year generated by combining the outputs of each of the five monetised natural capital metrics to provide a single cost / benefit figure.
- **Biodiversity net gain metric:** A single score for each option showing the percentage change in biodiversity net gain units for each option according to the metric.

The results of the NCA and BNG assessments for the supply-side options identified in the ESW rWRMP24 have been presented in Section 3 and Appendix H.3 below.

²² [Environment Act 2021 \(legislation.gov.uk\)](https://www.legislation.gov.uk)

- Where areas of active floodplain did not overlap with the previously identified environmental datasets, habitats were identified using the Corine Land Cover (CLC) dataset from 2018²³.
- The CLC dataset is considered appropriate for the assessment, as the CLC products are based on the analysis of satellite imagery by national teams of participating countries - the EEA member and cooperating countries - following a standard methodology and nomenclature and include 44 classes of habitat.
- The habitats identified by both the previously identified environmental datasets and the CLC dataset were converted to the corresponding category of natural capital stock, with the full list of natural capital stocks set out in Appendix H.1.
- The NCA and BNG assessments were updated with the new areas of natural capital stocks identified.
- The NCA assessments are expected to indicate a larger area than the total area within the option boundary, given that areas of both active floodplain and areas of co-existing habitat will be identified. However, any risk of double counting has been avoided as active floodplain is not included within the ecosystem services assessment and works in synergy with the co-existing primary habitats.
- The BNG assessment includes the areas of new stocks identified as part of the update. The update has resulted in the total area located within the option boundary to be included in the BNG 3.0 Metric²⁴, as the existing calculations do not currently include areas of active floodplain as a habitat.

The update to the methodology ensures that impacts upon primary habitat, specifically pasture and arable land, are not underrepresented and provides a more holistic view of the potential impacts to the provision of ecosystem services.

2.8 Opportunities

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

The BNG assessments can be revisited, and mitigation or enhancement opportunities developed further to achieve the 10% BNG required (once mandatory by law) for planning schemes and no net loss for all other non-planning construction schemes. Additionally, where possible, the options could aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall Biodiversity Net Gain in line with regulatory requirements for BNG (at the time of the project consenting) as stated as a mandatory requirement within the Environment Act 2021²⁵. The latter could be achieved by identifying local sites of ecological interest and proposing measures which enhance these features.

2.9 Assumptions and limitations

The methodology for the NCA has been developed in line with Defra's ENCA guidance, as set out in Section 2.1. The methodology for calculating BNG has been developed using Defra and Natural England's Biodiversity Metric, as set out in Section 2.5. The assumptions set out below in relation to these assessments have been developed to align with the stated guidance as far as possible and are considered to be reasonable and proportionate given the level of

²³ UK CEH Environmental Information Data Centre. CORINE Land Cover Map datasets for the UK, Jersey and Guernsey. Available online at: <<https://catalogue.ceh.ac.uk/documents/2fad7f16-6585-438a-9fe3-a7d68ff642f9>>

²⁴ Natural England. ARCHIVE SITE for the Biodiversity Metric 2.0 and the Biodiversity Metric 3.0. Available online at: <<http://publications.naturalengland.org.uk/publication/5850908674228224>>

²⁵ [Environment Act 2021 \(legislation.gov.uk\)](https://www.legislation.gov.uk)

construction and design detail available at the time of reporting. The following assumptions were used within the assessments in this appendix:

For NCAs:

- The costs for constructing, operating, and maintaining the options was not considered within the assessments.
- Natural capital stocks identified within the areas allocated for above ground infrastructure were assumed to be completely lost as a result of the option construction.
- Natural capital stocks presumed temporarily lost were expected to be reinstated/compensated.

For BNG Assessments:

- No enhancement of biodiversity post construction was considered, apart from where this has been explicitly included in the option description/design, for example as part of the SRO Gate 2 designs. BNG habitat units were assigned to the pre-construction land use according to the habitats present within each option boundary. The post construction land use, including standard mitigation for each option, was used to calculate the post construction biodiversity score.
- The desk-based assessment was carried out using open-source data. As such, a precautionary approach was applied, presuming that where not specifically known, habitats were assigned the moderate habitat score. Habitat identification will need to be refined with habitat survey data at later dates to refine the accuracy of the BNG calculations for each option.
- The desk-based assessment was carried out using open-source data. The baseline map does not include the location of hedgerows. Therefore, hedgerow units have not been included at this stage. Habitat identification will need to be refined with habitat survey data at later stages of design to refine the accuracy of the BNG calculations for each option.
- The duration of disturbance and timeline for habitat creation was not included in the assessment. Durations of disturbance, including proposals for creating habitats in advance of disturbance, will need to be refined with greater design detail at later stages to refine the accuracy of the BNG calculations for each option.
- Habitats are assumed to have a low/no strategic significance for the baseline and post development due to the limitation of the open data used to capture this information.
- There is no inclusion of the riparian zone (within 10m of the watercourse) in the watercourse BNG assessments, as the open-source data does not provide enough granularity to identify the top of the riverbank for watercourses. Industry best practice, including the use of directional drilling where possible, is assumed to mitigate and avoid the majority of temporary adverse effects on identified watercourses.

3 NCA and BNG assessment Level 1 outputs

The NCA and BNG outputs for the rWRMP24 supply-side options are summarised within Appendix H.2 of the report. The tables provided in Appendix H.2 include:

- Table H.2.1 - Predicted impacts on natural capital stocks
- Table H.2.2 - Quantitative detailed assessment of the unmitigated predicted impacts on the provision of ecosystem services
- Table H.2.3 – Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation
- Table H.2.4 – Summary of the unmitigated Biodiversity Metric outputs

All stocks reported in Table H.2.1 are expected to be temporarily or permanently lost, apart from the addition of a reservoir within ESW-RES-002C1. All woodland and high-value stocks are expected to be reinstated onsite or offsite through re-planting schemes. These natural capital stocks include:

- Coastal and floodplain grazing marsh
- Ancient woodland *this habitat is presumed irreplaceable once lost and therefore should be avoided
- Woodland priority habitat
- Orchards and top fruit *this habitat are presumed irreplaceable once lost and therefore should be avoided
- Lowland fens
- Hay meadows
- Dwarf-shrub heath
- Broadleaved, mixed and yew woodland
- Coniferous woodland
- Urban woodland
- Saltmarsh

Note:

- Carbon sequestration is scoped out when the option does not cause the temporary and/or permanent loss of associated stocks.
- Natural hazard management is scoped out when the option does not cause the temporary and/or permanent loss of associated stocks within an active floodplain.
- Air pollutant removal is scoped out when the option does not cause the temporary and/or permanent loss of associated stocks within an AQMA or urban area.
- Recreation & amenity value is scoped out when the option does not cause the permanent loss of greenspace.
- Food production is scoped out when the option does not cause the permanent loss of arable and pastoral land.
- At this stage the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the options description.

3.1 Summary of the NCA and BNG assessments

3.1.1 NCA and ecosystem services

All the options are likely to generate the loss of natural capital stocks during construction. However, habitat expected to be reinstated/compensated to pre-construction conditions following best practice technique will likely have no permanent impact to the provision of ecosystem services. Broadleaved, mixed, yew, priority, coniferous, and urban woodland have a significant maturity time with a delay of 30 years. Therefore, this delay is considered within potential future provision of this stock through the ecosystem services assessment. This can be accounted to the tree mortality rate presumed after woodland areas are replanted.

ESW-RES-002C1 is the only option expected to deliver a gain in natural capital associated with the addition of a reservoir.

Construction impacts include the release of CO₂ due to habitat clearance, loss of natural hazard management, a reduction in food production services, loss of air pollutant removal, a reduction in recreational and amenity services, and a reduction in water purification. There is some change anticipated in water flow regulation.

All the options present an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The options cross several Natural England habitats and Network Enhancement Zones and are therefore suitable for the planting of new high value habitats.

3.1.2 BNG

The options, with the exception of EWS-RES-002C1, are expected to cause a net loss in biodiversity (measured via the Biodiversity Metric in Biodiversity Units (BUs)) due to habitat clearance associated with construction.

EWS-RES-002C1 is expected to generate a net gain in biodiversity due to the option type and the creation of modified water habitat post-construction in the form of a reservoir.

4 Cumulative effects assessment

4.1 Best Value Plan

4.1.1 Options selected for the Best Value Plan

Cumulative effects have been assessed for options which fall under the BVP set out by ESW. The options selected as part of the BVP for the ESW rWRMP24 are presented in Table 4.1.

Table 4.1: Essex and Suffolk Water rWRMP24 BVP options

Option ID	Option title	Brief description	Year selected
ESW-ABS-003C	New Linford WTW (10MI/d Option)	Reinstatement of abandoned artesian well, no network upgrade should be required. 10 MI/d provided overall.	2027-2028
ESW-TRA-001	Barsham to Blyth Transfer Main	8 MI/d transfer from Barsham WTW to Saxmundham Water Tower.	2028-2029
ESW-TRA-019	Transfer from Holton WTW to Eye Airfield	8.5 MI/d transfer from Holton WTW to Eye Airfield.	2028-2029
ESW-NIT-004	Barsham EDR Nitrate Removal + Pipeline	Additional Electrolysis Reversal nitrate removal plant plus a discharge stream pipeline.	2029-2030
ESW-NIT-005	Langford EDR Nitrate Removal + Pipeline	Additional Electrodialysis Reversal nitrate removal plant plus a discharge stream pipeline.	2029-2030
ESW-NIT-006	Langham EDR Nitrate Removal + Pipeline	Additional Electrodialysis Reversal nitrate removal plant plus a discharge stream pipeline.	2029-2030
ESW-UVC-001	Langford UV (Crypto)	Additional Ultraviolet treatment contactors to treat for cryptosporidium.	2029-2030
ESW-TRA-018	Bungay Wells to Broome WTW transfer	Transfer from Bungay Wells to Broome WTW. Transfer is approximately 3.6 km long, with 1 MI/d max capacity.	2030-2031
ESW-TRA-023	Broome to Barsham Transfer	Bungay raw water well and transfer pipeline (1MI/d) and Broome WTW capacity upgrade.	2030-2031
ESW-PMP-001A	Langford WTW upgrade + Abberton RWPS Pump Replacement	Replacement, enhanced pumping capacity of two existing pumps, motors, and controls at Abberton Reservoir Raw Water Pumping Station and upgrading Langford WTW storage.	2030-2031
ESW-EFR-002A	Lowestoft water reuse (transfer to River Waveney)	Effluent Reuse Plant (11.1 MI/d DO). Intake from Lowestoft/Corton WRC (Anglian Water owned asset), discharge to point near Ellingham Mill.	2032-2033
ESW-RES-002C1	North Suffolk winter storage reservoir + Barsham River Works Upgrade	New winter storage reservoir to be built. Intake from the River Waveney/River Hundred.	2040-2041

4.1.2 Cumulative (inter-plan) effects assessment with other plans, programmes and projects

The relevant planning applications, major projects or planning allocations which may have impacts on NCA and BNG have been identified within 500m of these options. These are set out in Table 4.2.

Table 4.2: Local planning applications, allocations, and major development projects within 500m of the BVP options

County	Name	Option
Essex	South Maldon Garden Suburb	ESW-NIT-005
Essex	EC2: East Colchester / Hythe Special Policy Area	ESW-NIT-006
Norfolk	Land South of Links Road Housing Allocation	ESW-EFR-002A
Norfolk	North of Lowestoft Garden Village	ESW-EFR-002A
Suffolk	Lower Thames Crossing	ESW-ABS-003C
Norfolk	Extending the Beacon Park development at land south of Bradwell	ESW-EFR-002A

4.1.3 Cumulative (intra-plan) effects assessment

Table 4.3 below lists the stocks of natural capital that are likely to be temporarily or permanently impacted by the BVP. The BVP is likely to generate the loss of natural capital stocks during construction. However, habitat that is expected to be reinstated and/or compensated to pre-construction conditions following best practice technique will likely have no permanent impact to the provision of ecosystem services.

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

Construction impacts include the release of CO₂ due to habitat clearance, loss of natural hazard management, a reduction in food production services and a reduction in water purification (Table 4.4 and Table 4.5). There is some change anticipated in water flow regulation (Table 4.5), however the change is expected to be minimal and subject to further investigation.

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

The BVP is expected to result in an overall biodiversity net gain of 6.02% due primarily to ESW-RES-002C1 option which involves the installation of a new storage reservoir. At this stage, it will not meet the minimum 10% BNG requirement and will require further biodiversity enhancement proposals to be developed in later stages of option design. The BVP will look to deliver a further 3.98% BNG through on-site and off-site mitigation and enhancement opportunities (see Section 4.5 on potential opportunities), which translates to 37.68 biodiversity units required to achieve 10% net gain and will cost an estimated £942,00 to purchase the biodiversity units.

Table 4.3: Predicted temporary and permanent impacts on natural capital stocks for the BVP

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	30.20	30.20	30.20	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Arable	310.82	9.46	210.44	-100.38
Broadleaved, Mixed and Yew Woodland	1.58	0.00	1.58	0.00
Coastal and Floodplain Grazing Marsh	5.55	0.00	5.55	0.00
Coniferous Woodland	1.39	0.00	1.39	0.00
Greenspace	1.32	0.00	1.32	0.00
Hay Meadows	0.05	0.00	0.05	0.00
Lakes and Standing Waters	0.14	0.14	0.14	0.00
Lowland Fens	0.08	0.08	0.08	0.00
Modified Waters (Reservoirs)	0.10	0.10	91.54	91.44
Other Semi-Natural Grassland	1.77	0.00	1.77	0.00
Pastures	39.12	0.00	38.86	-0.26
Ponds & linear features	1.06	1.03	1.03	-0.03
Rivers (length)	1.16	1.16	1.16	0.00
Saltmarsh	0.15	0.00	0.15	0.00
Urban Semi Natural Habitat	0.01	0.00	0.01	0.00
Woodland Priority Habitat	3.54	0.01	3.54	0.00

Table 4.4: Quantitative detailed assessment of the unmitigated predicted impacts on the provision of ecosystem services for the BVP

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£34,844.54	£396.10	-£34,448.45	£26,766.67	-£8,077.87
Natural hazard management	£638.95	£0.98	-£637.97	£478.59	-£160.36
Air pollutant removal	£3,137.18	£164.85	-£2,972.33	£1,286.27	-£1,850.91
Food production	£2,920,608.23	£2,866,750.22	-£53,858.01	£2,866,750.22	-£53,858.01
Total	£2,959,228.90	£2,867,312.15	-£91,916.76	£2,895,281.75	-£63,947.15

Table 4.5: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the BVP

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
BVP	<p>Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.</p>	<p>The provision of services will be lost during construction.</p>	<p>The future provision of the ecosystem service provided by the stocks will likely be reduced.</p>	<p>The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.</p>
Water flow regulation				
BVP	<p>The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.</p>	<p>The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.</p>	<p>The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.</p>	-

Table 4.6: Summary of the unmitigated Biodiversity Metric outputs for the BVP

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
946.80	1,003.83	57.03	6.02%	37.68	£942,000

4.2 Least Cost Plan

The LCP contains same options and selection dates as the BVP. As such there are no different or additional options affected by this plan. Please refer to Section 4.1 above for cumulative effects assessment of the BVP for LCP options.

4.3 Ofwat core plan

4.3.1 Options selected for the Ofwat core plan

The Ofwat Core alternative plan laid out by ESW rWRMP24 has been compared to the BVP. The Ofwat Core plan contains no new options which are not already included in the BVP. However, the BVP contains 1 option that is not included in the Ofwat Core plan. The differences between the two plans are set out in Table 4.7.

Table 4.7: Differences in the options in the BVP Plan and alternative Ofwat Core Plan

Option included in the Ofwat Core Plan but not in the BVP	Option included in the BVP but not in the Ofwat Core Plan
	ESW-RES-002C1

4.3.2 Cumulative (inter-plan) effects assessment

The Ofwat Core plan does not include any options not already considered in the BVP and therefore, no additional cumulative effects are expected.

4.3.3 Cumulative (intra-plan) effects assessment

Table 4.8 below lists the stocks of natural capital that are likely to be temporarily or permanently impacted by the Ofwat Core alternative plan. The results of the quantified and qualitative ecosystem services are summarised in Table 4.9 and Table 4.10. There is some change anticipated in water flow regulation (Table 4.10), however the change is expected to be minimal and subject to further investigation. The Ofwat Core Plan is expected to cause £47,796.28 less of an overall loss in ecosystem services compared to the BVP due to the Ofwat Core Plan containing no new options which are not already included in the BVP. However, the BVP contains 1 option that is not included in the Ofwat Core plan (see Table 4.7).

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

The Ofwat Core Plan is expected to result in an overall -20.85% loss in BNG (Table 4.11) compared to the BVP, which is expected to result in an overall increase in BNG (see Table 4.6). At this stage, the plan will not meet the 10% BNG requirement and will require further biodiversity enhancement proposals to be developed in later stages of option design. The Ofwat Core Plan will look to deliver a further 221.07 habitat biodiversity units through on-site and off-site mitigation and enhancement opportunities to achieve 10% net gain, costing an estimated £5,526,700 (see Section 4.5 on potential opportunities).

Table 4.8: Predicted temporary and permanent impacts on natural capital stocks for the Ofwat Core Plan

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	30.05	30.05	30.05	0
Ancient Woodland	0.01	0	0	-0.01
Arable	204.08	0	200.98	-3.10
Broadleaved, Mixed and Yew Woodland	1.58	0	1.58	0
Coastal and Floodplain Grazing Marsh	4.68	0	4.68	0
Coniferous Woodland	1.39	0	1.39	0
Greenspace	1.32	0	1.32	0
Hay Meadows	0.05	0	0.05	0
Lakes and Standing Waters	0.14	0.14	0.14	0
Lowland Fens	0.08	0.08	0.08	0
Modified Waters (Reservoirs)	0.1	0.1	0.1	0
Other Semi-Natural Grassland	1.77	0	1.77	0
Pastures	37.68	0	37.42	-0.26
Ponds & linear features	1.02	1.02	1.02	0
Rivers (length)	0.99	0.99	0.99	0
Saltmarsh	0.15	0	0.15	0
Urban Semi Natural Habitat	0.01	0	0.01	0
Woodland Priority Habitat	3.53	0	3.53	0

Table 4.9: Quantitative detailed assessment of the unmitigated predicted impacts on the provision of ecosystem services for the Ofwat Core Plan

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£30,352.67	£0.00	-£30,352.67	£26,161.97	-£4,190.70
Natural hazard management	£637.97	£0.00	-£637.97	£477.86	-£160.11
Air pollutant removal	£1,307.87	£0.00	-£1,307.87	£1,122.17	-£185.70
Food production	£2,421,177.47	£2,417,638.55	-£3,538.92	£2,417,638.55	-£3,538.92
Total	£4,906,951.96	£4,835,277.10	-£71,674.87	£4,890,801.09	-£16,150.87

Table 4.10: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the Ofwat Core Plan

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
Ofwat Core Plan	<p>Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.</p>	<p>The provision of services will be lost during construction.</p>	<p>The future provision of the ecosystem service provided by the stocks will likely be reduced.</p>	<p>The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.</p>
Water flow regulation				
Ofwat Core Plan	<p>The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.</p>	<p>The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.</p>	<p>The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.</p>	-

Table 4.11: Summary of the unmitigated Biodiversity Metric outputs for the Ofwat Core Plan

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
716.68	567.28	-149.40	-20.85%	221.07	£5,526,700

4.4 Best Environmental and Societal Plan

4.4.1 Options selected for the BESP

The alternative BESP laid out by ESW has been compared to the BVP. The alternative BESP contains four new options which are not already in the BVP. In addition, the BVP contains four options which are not included in the alternative BESP. The differences between the two plans are presented in Table 4.12.

Table 4.12: Differences in the options included in the BVP and alternative BESP

Options included in the BESP but not in the BVP	Options included in the BVP but not in the BESP
ESW-DES-001	ESW-RES-002C1
ESW-03b0478B	ESW-NIT-005
ESW-EFR-001	ESW-UVC-001
ESW-DES-008	ESW-NIT-006

In addition, the relevant planning applications, major projects or planning allocations which may have impacts on NCA and BNG have been identified within 500m of these options. These are set out in set out in Table 4.13.

4.4.2 Cumulative (inter-plan) effects assessment

Table 4.13: Local planning applications, allocations, and major development projects within 500m of the BVP options

County	Name	Option
Norfolk	Land South of Links Road Housing Allocation	ESW-EFR-002A
Norfolk	North of Lowestoft Garden Village	ESW-EFR-002A
Suffolk	Lower Thames Crossing	ESW-ABS-003C
Essex	Dollymans Farm	ESW-DES-001
Norfolk	Land West of Jack Chase Way Housing Allocation	ESW-03b0478B
Norfolk	Extending the Beacon Park development at land south of Bradwell	ESW-EFR-002A ESW-DES-008

4.4.3 Cumulative (intra-plan) effects assessment

Table 4.14 below lists the stocks of natural capital that are likely to be temporarily or permanently impacted by the alternative BESP.

The results of the quantified and qualitative ecosystem services are summarised in Table 4.15 and Table 4.16. There is some change anticipated in water flow regulation (Table 4.16), however the change is expected to be minimal and subject to further investigation. The BESP is expected to cause £4,096.71 less of an overall loss in ecosystem services compared to the BVP due to the differences in options between the plans (see Table 4.12). Recreation and amenity value was scoped into the assessment for the BESP, due to the option ESW-DES-001.

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

The alternative BESP is expected to result in -29.89% loss of BNG (Table 4.17) compared to the BVP, which is expected to result in an overall increase in BNG (see Table 4.6). At this stage, it will not meet the 10% BNG requirement and will require further biodiversity enhancement proposals to be developed in later stages of option design. The BESP will look to deliver a further 599.19 habitat biodiversity units through on-site and off-site mitigation and enhancement opportunities to achieve 10% net gain, with an estimated cost of £14,979,800 to purchase the BU. (see Section 4.5 on potential opportunities).

Table 4.14: Predicted temporary and permanent impacts on natural capital stocks for the BESP

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	52.38	50.80	40.92	-11.47
Ancient Woodland	0.05	0.00	0.00	-0.05
Arable	344.99	0.00	325.15	-19.84
Broadleaved, Mixed and Yew Woodland	1.79	0.00	1.79	0.00
Coastal and Floodplain Grazing Marsh	19.62	0.00	17.63	-2.00
Coniferous Woodland	1.84	0.00	1.84	0.00
Dwarf Shrub Heath	1.53	0.00	1.53	0.00
Greenspace	5.49	0.00	5.20	-0.29
Hay Meadows	0.10	0.00	0.10	0.00
Lakes and Standing Waters	0.28	0.28	0.28	0.00
Lowland Fens	1.71	0.08	1.71	0.00
Modified Waters (Reservoirs)	0.10	0.10	0.10	0.00
Mudflats	0.00	0.00	0.00	0.00
Other Semi-Natural Grassland	2.23	0.00	2.23	0.00
Pastures	74.99	0.00	73.81	-1.18
Ponds & linear features	2.53	2.53	2.51	-0.01
Rivers (length)	0.71	0.71	0.71	0.00
Saltmarsh	0.29	0.00	0.29	0.00
Sea Cliff	2.23	2.23	2.23	0.00
Urban Semi Natural Habitat	0.22	0.00	0.22	0.00
Urban Woodland	0.39	0.00	0.39	0.00
Woodland Priority Habitat	4.55	0.00	4.55	0.00

Table 4.15: Quantitative detailed assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services for the BESP

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£36,478.36	£0.00	-£36,478.36	£31,839.80	-£4,638.56
Natural hazard management	£635.83	£0.00	-£635.83	£474.12	-£161.71
Air pollutant removal	£805.58	£0.00	-£805.58	£700.29	-£105.29
Recreation and Amenity Value	£113,469.22	£75,555.41	£33,011.00	£75,555.41	-£37,913.81
Food production	£2,004,469.09	£1,987,438.01	-£17,031.08	£1,987,438.01	-£17,031.08
Total	£2,155,858.07	£2,062,993.42	-£21,939.84	£2,096,007.63	-£59,850.44

Table 4.16: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the BESP

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
BESP	Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stocks will likely be reduced.	The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
BESP	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.	The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.	

Table 4.17: Summary of the unmitigated Biodiversity Metric outputs for the BESP and the BNG habitat units required to be purchased to achieve 10% BNG

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
1,502.02	1,053.03	-448.99	-29.89%	599.19	£14,979,800

4.5 Adaptive programmes

An NCA and BNG assessment has been carried out on four adaptive programmes, including the High Environmental Destination (HED), High PCC (low water efficiency), North Suffolk Reservoir (NSR) and the Habitat Regulations Sustainability Reductions (HRSR). Differences between the selected supply-side options within the preferred BVP compared to the adaptive programmes is summarised in Table 4.18 below. In some cases, a smaller variant of an option is selected as part of an Adaptive Programme. Where this is the case, the largest size of the option has been assessed to present a “worst case scenario” for the purposes of the assessment.

Table 4.18: Differences in the options included in the BVP and adaptive programmes

Option	BVP	HED	PCC	NSR	HRSR
ESW-ABS-003C	✓	✓	✓	✓	✓
ESW-TRA-001	✓	✓	✓	✓	✓
ESW-TRA-019	✓	✓	✓	✓	✓
ESW-NIT-005	✓	✓	✓	✓	✓
ESW-UVC-001	✓	✓	✓	✓	✓
ESW-NIT-006	✓	✓	✓	✓	✓
ESW-NIT-004	✓	✓	✓	✓	✓
ESW-PMP-001A	✓	✓	✓	✓	✓
ESW-TRA-018	✓	✓	✓	✓	✓
ESW-TRA-023	✓	✓	✓	✓	✓
ESW-EFR-002A	✓	✓	✓		✓
ESW-RES-002C1	✓			✓*	✓*
ESW-DES-001		✓			
03b0478B		✓	✓	✓	✓
ESW-EFR-001		✓	✓*		
ESW-DES-008		✓	✓		

* Smaller variants of these options are selected in these programmes.

4.5.1 Cumulative (inter-plan) effects assessment

Table 4.19 summarises the differences of the cumulative (inter-plan) effects assessment for the adaptive programmes, compared to the preferred BVP.

Table 4.19: Local planning applications, allocations, and major development projects within 500m of the BVP options

County	Name	Option	BVP	HE D	PCC	NSR	HRSR					
Essex	South Maldon Garden Suburb	ESW-NIT-005	✓	✓	✓	✓	✓					
Essex	EC2: East Colchester / Hythe Special Policy Area	ESW-NIT-006	✓	✓	✓	✓	✓					
Norfolk	Land South of Links Road Housing Allocation	ESW-EFR-002A	✓	✓	✓			✓				
Norfolk	North of Lowestoft Garden Village	ESW-EFR-002A	✓	✓	✓				✓			
Suffolk	Lower Thames Crossing				ESW-ABS-003C		✓	✓	✓	✓	✓	✓
Norfolk	Extending the Beacon Park development at land south of Bradwell				ESW-EFR-002A		✓	✓	✓			✓
Essex	Dollymans Farm				ESW-DES-001			✓				
Norfolk	Land West of Jack Chase Way Housing Allocation				03b0478B			✓	✓			
Norfolk	Extending the Beacon Park development at land south of Bradwell				ESW-DES-008			✓	✓			

4.5.2 High Environmental Destination

The results of the cumulative (intra-plan) effects assessment for the HED are summarised in Appendix H.3.1.

4.5.2.1 NCA

The HED is expected to cause a greater permanent loss of 0.05ha of ancient woodland, compared to the 0.01ha expected for the BVP. Additionally, the HED is expected to cause a permanent loss of -11.47ha of active floodplain, and -2.00ha of coastal floodplain grazing marsh, -0.29ha of greenspace whilst the BVP is expected to cause only temporary loss of these stocks. The HED is also expected to cause temporary loss of urban woodland and sea cliff is expected to be retained, whereas the BVP does not include these stocks. The HED is expected to create no additional reservoir stocks post construction whereas the BVP is expected to create 91.44ha of reservoir, due to the inclusion of the option ESW-RES-002C1.

The HED is expected to cause a greater impact to the provision of ecosystem services, with an expected impact on the overall change in value (-£64,840.10) when compared to the BVP (-£63,947.15).

4.5.2.2 BNG

The HED is expected to result in a loss of -29.79% and would require an expected 615.62 of habitat Bus in order to achieve 10% net gain, with an estimated cost of £15,390,475 to purchase BU, whereas the BVP is expected to create a net gain of 6.02% BNG. This is due to the BVP including the reservoir option ESW-RES-002C1.

4.5.3 High PCC (Low Water Efficiency)

The results of the cumulative (intra-plan) effects assessment for the High PCC are summarised in Appendix H.3.2.

4.5.3.1 NCA

The High PCC is expected to cause less of a permanent loss overall for stocks due to arable land only expected to lose -4.84ha within the High PCC whereas the BVP is expected to cause the permanent loss of -100.38ha of arable land. The High PCC is expected to cause a greater permanent loss of 0.05ha of ancient woodland, compared to the 0.01ha expected for the BVP. The High PCC is expected to create no additional reservoir stocks post construction whereas the BVP is expected to create 91.44ha of reservoir, due to the inclusion of the option ESW-RES-002C1.

The BVP is expected to cause a greater impact to the provision of ecosystem services, with an expected impact on the overall change in value (-£63,947.15) when compared to the High PCC (-£11,079.08).

4.5.3.2 BNG

The High PCC is expected to result in a loss of -25.18% and would require an estimated 407.47 of habitat BU in order to achieve 10% net gain, with an estimated cost of £10,186,700 to purchase BU, whereas the BVP is expected to create a net gain of 6.02% BNG. This is due to the BVP including the reservoir option ESW-RES-002C1.

4.5.4 North Suffolk Reservoir

The results of the cumulative (intra-plan) effects assessment for the NSR are summarised in Appendix H.3.3.

4.5.4.1 NCA

The NSR is expected to cause a greater permanent loss of -0.04ha ancient woodland, compared to the -0.01ha expected for the BVP. Similarly, the NSR is expected to cause a greater loss in active floodplain and a lesser loss in ponds compared to the BVP.

The BVP is expected to cause a greater impact to the provision of ecosystem services, with an expected impact on the overall change in value (-£63,947.15) when compared to the NSR (-£61,665.06).

4.5.4.2 BNG

The NSR is expected to result in a net gain of BNG, similarly to the BVP. The NSR is expected to result in a gain in BNG (+1.80%) when compared to the gain in BNG for the BVP (+6.02%). The estimated BU and cost for the NSR to 10% net gain is 78.37BU and £1,959,226.

4.5.5 Habitat Regulations Sustainability Reductions

The results of the cumulative (intra-plan) effects assessment for the HRSR are summarised in Appendix H.3.4.

4.5.5.1 NCA

The HRSR has similar impacts to that of the NSR with the addition of the option ESW-EFR-002B and as such the same impacts on natural capital reported above apply to the HRSR.

The BVP is expected to cause less of an impact to the provision of ecosystem services, with an expected impact on the overall change in value (-£63,947.15) when compared to the HRSR (-£64,642.19).

4.5.5.2 BNG

The HRSR is expected to result in a loss of -1.68% and would require an expected 135.17 of habitat BU in order to achieve 10% net gain. This is estimated to cost £3,379,250. Whereas the BVP is expected to create a net gain of 6.02% BNG.

4.6 Opportunities

Opportunities should be considered to ensure that the natural environment is left in a better condition than pre-construction conditions for the BVP and alternative plans. This should be achieved by one or both of the following:

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

As a core principle, where possible, the BVP should aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG. The latter could be achieved by identifying local sites of ecological interest and proposing measures. Any habitats that are created or enhanced to achieve BNG are required to be secured for 30 years, through management, maintenance, and monitoring. The natural capital map which is based on the methodology described in the NECR285 (see Section 2) should be utilised, where possible, to assist in identifying opportunities to improve natural capital.

A summary of the potential NCA, BNG mitigation and enhancement measures for each sub-component type of the BVP plan are outlined in Table 4.20. Further explanation into the potential enhancement measures is provided within the sections below.

Table 4.20: Summary of potential net gain mitigation and enhancement opportunities

Option element	Mitigation opportunity	Enhancement opportunity
All option elements	Option layouts to be amended to avoid the permanent loss of high value natural capital assets that once lost, cannot be easily reinstated. Assets include ancient woodland and traditional orchards.	Creation of higher value habitat within grassland, arable and pasture natural capital assets onsite to achieve an increase in Biodiversity Units (BU) and work towards a 10% uplift in BNG.
	Options to identify area for the creation and/or reinstatement of high value natural capital assets, including: Coastal and floodplain grazing marsh Lowland fens Lowland raised bog Reedbeds Blanket bog Hay meadows Dwarf shrub heath Broadleaved, mixed and yew woodland	Habitat creation work within the adjacent priority habitats. Options fall within or are in the vicinity of habitat network zones ²⁶ : Habitat restoration-creation Restorable habitat Fragmentation action zone Network enhancement zones 1 and 2 Expansion zone These areas identify specific locations for a range of actions to help improve the ecological resilience for each of the habitats/habitat networks. The options should look to identify habitat network zones and priority habitats within the near vicinity and look to improve/create/restore habitats which would help to work towards increasing BU and work towards a 10% uplift in BNG.

²⁶ Edwards J, Knight M, Taylor S & Crosher I. E (May 2020) 'Habitat Networks Maps, User Guidance v.2', Natural England

Option element	Mitigation opportunity	Enhancement opportunity
	Coniferous woodland Blue space Greenspace	
	Construction practices to be considered to reduce the amount of clearance required for, especially in areas that include high value natural capital assets (see above for list).	Increase the quality/quantity of freshwater assets, including lakes, ponds located in designated SSSIs, pending detailed assessment of local conditions and available space.
	Directional drilling to be used where possible to avoid loss of high value natural capital assets (see above for list).	Options to identify suitable areas offsite for the creation, enhancement and/or restoration in order to develop off-site net gains, working towards achieving a 10% uplift in BNG.
		Identify areas of local peatland restoration
Option elements located along the canals		Possibly create man-made floating wetland islands, enabling plants and microbes to form and attract wildlife both above and below the water's surface and create biochemical and physical processes to improve things such as water quality.
Wastewater treatment works, abstraction and treatment works, and other option elements that contain above ground infrastructure		Seeding of grassland within footprints of the above ground infrastructure, where possible.

4.6.1 BNG Unit Purchase

As a last resort, BNG can also be achieved via a new statutory biodiversity credits scheme. Credits can be bought by developers as a last resort when onsite and local offsite provision of habitat cannot deliver the BNG required. The price of biodiversity credits will be set higher than prices for equivalent biodiversity gain on the market and are expected to be purchased through a national register for net gain delivery sites. Defra has recently released guidance²⁷ on the statutory biodiversity credit process, as well as information on calculating costs for developers buying credits. As the guidance and biodiversity credit market continue to develop, the preliminary £25,000 per BU figure used to inform this assessment should be refined and updated in later stages of option design. The estimated BU credits that the BVP would be required to purchase to achieve a 10% BNG is 37.69 BU's.

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

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

It is important that, where possible, the BVP starts to consider reaching out to local non-government organisation and planning authorities who may potentially be able to carry out BNG both onsite and offsite. Early engagement may help provide further insight on local opportunities

²⁷ Defra 2023. Guidance, Statutory biodiversity credit prices. Available online at: <https://www.gov.uk/guidance/statutory-biodiversity-credit-prices>

for enhancement, how this can be achieved, local priorities and limiting factors. Furthermore, ESW should consider engaging with local conservation projects to carry out BNG on-site.

5 Conclusions

5.1 Overall Conclusion

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

- **Natural Capital:** The options will cause the permanent loss of natural capital stocks. The BVP is likely to cause the permanent loss of ancient woodland, that once lost cannot be replaced. ESW should seek to avoid this by diverting the route to avoid this high-value natural capital stock.
- **Ecosystem services:** The plan presents opportunities to improve the existing habitats along the route through post construction remediation and the replacement of low value habitats with higher value habitats. The potential permanent loss of ancient woodland, active flood plain, coastal and floodplain grazing marsh, arable and pastoral habitat could result in the permanent loss of several ecosystem services that the stock provides in synergy, including carbon sequestration, natural hazard management, and food production. The potential permanent loss of arable and pastoral stock could result in the permanent loss of food production.
- **BNG:** The BVP is likely to result in a gain of BNG habitat units associated with the gain in units from reservoirs, however the net gain does not achieve the minimum requirement of 10% BNG. Mitigation and enhancement opportunities for the scheme have been suggested within Section 4, which can work in tandem to achieve 10% BNG and introduce environmental net gain.

5.2 Next Steps

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

The BVP could consider some opportunities to create and improve habitat on-site and off-site through local schemes, NRNs and wildlife corridors in order to achieve a 10% net gain in biodiversity units and increase the provision of ecosystem services, therefore aiding in developing more resilient options for the future provision of water for ESW rWRMP24.

H.1. Natural capital stocks and mapping methodology

H.1.1 Natural capital stocks and mapping methodology

Table H1.1: Sources for the mapping methodology of natural capital stocks

Broad Natural Group	Subgroup	Mapping Methodology
Freshwater	Active flood plain	Areas at high or medium risks within the Environment Agency (EA)'s Risk of Flooding from Rivers and Sea dataset.
	Blanket Bog	Area of blanket bog mapped using Natural England's Priority Habitat Inventory.
	Chalk Rivers*	Mapped using the EA chalk rivers dataset and mapping intersections with OS watercourse polygons
	Coastal and floodplain grazing marsh	Area of coastal floodplain and grazing marsh mapped using Natural England's Priority Habitat Inventory
	Lakes and standing waters	Area of lakes and reservoirs mapped using the Centre for Ecology and Hydrology (CEH)'s UK Lakes Portal dataset.
	Lowland Fens	Area of lowland fens mapped using Natural England's Priority Habitat Inventory.
	Lowland raised bog	Area of lowland raised bog mapped using Natural England's Priority Habitat Inventory
	Modified waters e.g., reservoirs	Area of reservoirs mapped by selecting Ordnance Survey (OS) surface water polygons (Vector Map District) that coincide with CEH's Inventory of UK reservoirs (points).
	Other semi-natural habitats	Area of other semi-natural habitat mapped using Natural England's Priority Habitat Inventory (including upland and lowland grasslands, heathland, and saltmarsh).
	Ponds and ditches	Mapped by selecting surface waterbodies (from OS Vector Map District) that do not intersect rivers, are smaller than 2ha in size.
	Reedbeds	Area of reedbed habitat mapped using NE's Priority Habitat Inventory
	Rivers	Length of rivers mapped using EA's Water Framework Directive (WFD) river waterbodies dataset (cycle 1, to include coastal streams
Mountain, Moor and Heath	Blanket bog	Area of blanket bog mapped using Natural England's Priority Habitat Inventory.
	Dwarf shrub heath	Mapped using Natural England's Priority Habitat Inventory ('fragmented heath', 'lowland heathland' and 'upland heathland')
	Inland rock, scree and pavement (AML*)	Area of inland rock and limestone pavement above the moorland line, mapped using CEH's LCM2015 ('inland rock'), Natural England's Priority Habitats Inventory ('limestone pavement') and the Rural Payment Agency (RPA)'s Moorland Line dataset.
	Lakes and Reservoirs	Area of lakes and reservoirs above the moorland line, mapped using CEH's UK Lakes dataset, CEH's Inventory of UK reservoirs dataset and RPA's Moorland Line dataset.
	Mountain heath and willow scrub	Area of mountain heath and willow scrub mapped using Natural England's Priority Habitat Inventory.
	Rivers (AML)	Length of rivers mapped using EA's WFD river waterbodies dataset and RPA's Moorland Line dataset.

Broad Natural Group	Subgroup	Mapping Methodology
	Semi-natural grassland (AML*)	Area of semi-natural grassland above the moorland line, mapped using Natural England's Priority Habitat Inventory and RPA's moorland line dataset.
	Upland flushes fens and swamps	Area of upland flushes, fens and swamps, mapped using Natural England's Priority Habitat Inventory.
	Wood pasture (AML*)	Area of wood pasture above the moorland line, mapped using Natural England's provisional Wood-Pasture and Parkland BAP Priority Habitat Inventory and RPA's Moorland line dataset.
	Woodland (AML*)	Area of woodland above the moorland line, mapped using FC's National Forest Inventory and RPA's moorland line dataset.
Urban	Blue space	Mapped by intersecting OS Vector Map District Surface Water with the Office for National Statistic (ONS)'s Built-Up areas dataset.
	Green space – not semi-natural	Area of urban green space (not semi-natural), mapped using the OS Open Greenspace Layer.
	Open mosaic habitats	Area of open mosaic habitats on previously developed land, mapped using Natural England's draft Open Mosaic Habitat dataset
	Woodland, scrub, and hedge	While urban scrub and hedge are difficult to map at a national scale, the area of urban woodland is mapped here by intersecting FC's National Forest Inventory with ONS Built-Up Areas.
	Semi-natural habitats	Mapped by intersecting Natural England's Priority Habitat Inventory habitats (excluding woodland, good quality semi-improved grassland and traditional orchards) with ONS Built-Up Areas
Farmland	Arable and rotational leys	Area of arable and rotational leys, and horticulture individually, this map shows the area of arable, and horticulture combined. Mapped using UK Land Cover 2018 Sub Classes.
	Horticulture	Area of arable and rotational leys, and horticulture individually, this map shows the area of arable, and horticulture combined. Mapped using CEH's Land Cover Map 2015 (LCM2015).
	Improved grassland	Area of improved grassland mapped using CEH's LCM2015.
	Orchards and top fruit	Area of orchards and top fruit mapped using Natural England's Priority Habitat Inventory ('traditional orchards')
Woodland	Ancient Woodland	Mapped using Natural England's Ancient Woodland dataset.
	Broadleaved, mixed and yew woodland	Mapped using FC's National Forest Inventory.
	Coniferous woodland	Area of coniferous woodland mapped using FC's National Forest Inventory
	Woodland priority habitats	Mapped using Natural England's Priority Habitat Inventory ('deciduous woodland').
Grasslands	Hay meadows	Area of hay meadow mapped using Natural England's Priority Habitat Inventory ('upland meadow' and 'lowland meadow').
	Other semi-natural grasslands	Area of other semi-natural grassland, mapped using Natural England's Priority Habitat Inventory ('upland calcareous', 'lowland calcareous', 'lowland dry acid', 'good quality semi-improved', 'grass moorland' and 'purple moor grass and rush pasture').
Coastal	Beach	Area of beach mapped using OS Vector Map District ('foreshore'). Note that this dataset includes areas of intertidal sediment as well as beaches.

Broad Natural Group	Subgroup	Mapping Methodology	
	Coastal lagoons	Area of coastal lagoons mapped using Natural England's Priority Habitat Inventory ('saline lagoons').	
	Mudflats	Area of intertidal mudflats mapped using the EMODnet (Natural England) Intertidal Mudflats dataset.	
	Salt marsh	Area of saltmarsh mapped using EA's Saltmarsh Extent dataset.	
	Sand dunes	Area of sand dunes mapped using Natural England's Priority Habitat Inventory ('coastal dunes')	
	Sea Cliff	Area of sea cliff habitat mapped using Natural England's Priority Habitat Inventory ('maritime cliff and slopes').	
	Shingle	Area of shingle mapped using Natural England's Priority Habitat Inventory ('coastal vegetated shingle').	
	Marine	Intertidal rock	Area of intertidal rock mapped using Natural England's Open Marine Evidence Base (EUNIS code A1).
		Maerl beds	Area of maerl beds mapped using Natural England's Open Marine Evidence Base (EUNIS code A5.51).
		Reefs	Area of potential reefs mapped using JNCC's Potential Annex 1 Reefs
		Sea grass beds	Area of seagrass beds mapped using Natural England's Open Marine Evidence Base (EUNIS code A2.61)
Shallow subtidal sediment		Area of shallow subtidal sediment mapped using JNCC's UK Sea Map 2018 (biozone = shallow circalittoral or infralittoral and substrate = sediment, sand, or mud).	
Shelf subtidal sediment		Area of shelf subtidal sediment mapped using JNCC's UK Sea Map 2018 (biozone = deep circalittoral and substrate = sediment, sand, or mud).	
Subtidal rock		Area of subtidal rock mapped using JNCC's UK Sea Map 2018 (substrate = rock).	
Soils	Nutrient Status of Soil	Mean estimates of total nitrogen concentration in topsoil (0-15cm depth) - % dry weight of soil, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016).	
	Soil Carbon/Organic Matter	Mean estimates of carbon density in topsoil (0-15cm depth) – tonnes per hectare, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016)	
	Soil Biota	Mean estimates of total abundance of invertebrates in topsoil (0-8 cm depth), mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016)	
Indicators of condition	Natural Aquifer Function	Area of groundwater catchment with 'good' quantitative status for WFD 2016, mapped using EA's WFD data and groundwater catchment boundaries (C2).	
	Naturalness of Flow Regime	The WFD hydrological regime classification describe the naturalness of river flows. This map shows the length of river with 'high' WFD hydrological status in 2016, mapped using EA's WFD data and river water bodies (C2)	
	Lack of Physical Modifications of Water Bodies	Lack of physical modification of rivers, mapped using EA's Reasons for Not Achieving Good Status data (SWMI = 'physical modification'), 2013-2016.	
	Presence and Frequency of Pollinator Food Plants	Mean estimates of number of nectar plant species for bees per 2x2m plot, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016)	
	Chemical status of water bodies	River chemical status for WFD 2016, mapped using EA's WFD data and river water bodies (C2)	

* The list of natural capital stocks as described in NERC285 have been supplemented with additional abiotic stocks and key habitats that are vital to the SWW region.

H.2. NCA and BNG outputs – Level 1 assessments

Table H.2.1: Predicted impacts on natural capital stocks

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present within option boundary during construction (Ha)	Stocks present within option boundary post construction (Ha)	Change (Ha)
ESW-TRA-023				
Active Flood Plain	0.29	0.29	0.29	0
Arable	5.85	0	5.53	-0.32
Broadleaved, Mixed and Yew Woodland	0.05	0	0.05	0
Coastal and Floodplain Grazing Marsh	2.13	0	2.13	0
Greenspace	0.01	0	0.01	0
Pastures	3.9	0	3.9	0
Ponds & linear features	0.11	0.11	0.11	0
Rivers (length)	0.15	0.15	0.15	0
Woodland Priority Habitat	0.01	0	0.01	0
ESW-ABS-003C				
Active Flood Plain	2.12	2.12	2.12	0
Arable	16.44	0	16.2	-0.24
Greenspace	0.04	0	0.04	0
Pastures	3.1	0	3.1	0
Ponds & linear features	0.03	0.03	0.03	0
Rivers (length)	0.06	0.06	0.06	0
Saltmarsh	0.15	0	0.15	0
Woodland Priority Habitat	0.06	0	0.06	0
ESW-TRA-019				
Active Flood Plain	4.071	4.071	4.071	0
Arable	54.888	0	54.888	0
Broadleaved, Mixed and Yew Woodland	0.115	0	0.115	0
Coastal and Floodplain Grazing Marsh	0.154	0	0.154	0
Greenspace	0.043	0	0.043	0
Pastures	5.585	0	5.585	0
Ponds & linear features	0.131	0.131	0.131	0
Rivers (length)	0.164	0.164	0.164	0

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present within option boundary during construction (Ha)	Stocks present within option boundary post construction (Ha)	Change (Ha)
Woodland Priority Habitat	0.595	0	0.595	0
ESW-UVC-001				
Arable	0.05	0	0	-0.05
ESW-NIT-006				
Active Flood Plain	3.12	3.12	3.12	0
Arable	9.91	0	9.91	0
Broadleaved, Mixed and Yew Woodland	0.25	0	0.25	0
Coniferous Woodland	0.16	0	0.16	0
Greenspace	0.05	0	0.05	0
Pastures	2.31	0	2.05	-0.26
Ponds & linear features	0.03	0.03	0.03	0
Rivers (length)	0.02	0.02	0.02	0
Urban Semi Natural Habitat	0.01	0	0.01	0
Woodland Priority Habitat	0.21	0	0.21	0
ESW-PMP-001A				
Active Flood Plain	0.33	0.33	0.33	0
Arable	0.47	0	0.3	-0.17
Coniferous Woodland	0.09	0	0.09	0
Modified Waters (Reservoirs)	0.1	0.1	0.1	0
Pastures	0.08	0	0.08	0
ESW-NIT-005				
Active Flood Plain	10.45	10.45	10.45	0
Arable	1.97	0	1.65	-0.32
Broadleaved, Mixed and Yew Woodland	0.09	0	0.09	0
Coastal and Floodplain Grazing Marsh	0.08	0	0.08	0
Coniferous Woodland	0.09	0	0.09	0
Greenspace	0.06	0	0.06	0
Other Semi-Natural Grassland	0.05	0	0.05	0
Pastures	0.03	0	0.03	0
Ponds & linear features	0.01	0.01	0.01	0
Rivers (length)	0.43	0.43	0.43	0
Woodland Priority Habitat	0.19	0	0.19	0
ESW_TRA-001				
Active Flood Plain	1.005	1.005	1.005	0

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present within option boundary during construction (Ha)	Stocks present within option boundary post construction (Ha)	Change (Ha)
Arable	58.1	0	58.1	0
Broadleaved, Mixed and Yew Woodland	0.224	0	0.224	0
Coastal and Floodplain Grazing Marsh	0.398	0	0.398	0
Coniferous Woodland	0.18	0	0.18	0
Greenspace	0.302	0	0.302	0
Other Semi-Natural Grassland	0.163	0	0.163	0
Pastures	8.183	0	8.183	0
Ponds & linear features	0.016	0.016	0.016	0
Rivers (length)	0.041	0.041	0.041	0
Woodland Priority Habitat	0.835	0	0.835	0
ESW-RES-002C1				
Active Flood Plain	0.15	0.15	0.15	0
Arable	106.74	9.46	9.46	-97.28
Coastal and Floodplain Grazing Marsh	0.87	0	0.87	0
Modified Waters (Reservoirs)	0	0	91.44	91.44
Pastures	1.44	0	1.44	0
Ponds & linear features	0.04	0.01	0.01	-0.03
Rivers (length)	0.17	0.17	0.17	0
Woodland Priority Habitat	0.01	0.01	0.01	0
ESW-DES-001				
Active Flood Plain	12.024	12.024	2.139	-9.885
Arable	30.815	0	21.405	-9.41
Broadleaved, Mixed and Yew Woodland	0.071	0	0.071	0
Coastal and Floodplain Grazing Marsh	8.131	0	6.428	-1.703
Greenspace	0.75	0	0.46	-0.29
Mudflats	0	0	0	0
Pastures	12.376	0	11.491	-0.885
Ponds & linear features	0.213	0.213	0.202	-0.011
Saltmarsh	0.032	0	0.032	0
Woodland Priority Habitat	0.209	0	0.209	0

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present within option boundary during construction (Ha)	Stocks present within option boundary post construction (Ha)	Change (Ha)
ESW-TRA-018				
Active Flood Plain	0.788	0.788	0.788	0
Arable	0.04	0	0.04	0
Broadleaved, Mixed and Yew Woodland	0.137	0	0.137	0
Coastal and Floodplain Grazing Marsh	0.964	0	0.964	0
Greenspace	0.234	0	0.234	0
Other Semi-Natural Grassland	1.234	0	1.234	0
Pastures	1.78	0	1.78	0
Ponds & linear features	0.003	0.003	0.003	0
Rivers (length)	0.043	0.043	0.043	0
Woodland Priority Habitat	0.059	0	0.059	0
ESW-EFR-002A				
Active Flood Plain	7.633	7.633	7.633	0
Ancient Woodland	0.008	0	0	-0.008
Arable	54.011	0	52.01	-2.001
Broadleaved, Mixed and Yew Woodland	0.408	0	0.408	0
Coastal and Floodplain Grazing Marsh	0.953	0	0.953	0
Coniferous Woodland	0.873	0	0.873	0
Greenspace	0.12	0	0.12	0
Hay Meadows	0.051	0	0.051	0
Lakes and Standing Waters	0.139	0.139	0.139	0
Lowland Fens	0.082	0.08	0.082	0
Other Semi-Natural Grassland	0.327	0	0.327	0
Pastures	12.698	0	12.698	0
Ponds & linear features	0.684	0.684	0.684	0
Rivers (length)	0.081	0.081	0.081	0
Woodland Priority Habitat	0.846	0	0.846	0
ESW-EFR-001				
Active Flood Plain	5.28	5.28	5.28	0
Arable	30.278	0	24.32	-5.958
Coastal and Floodplain Grazing Marsh	2.571	0	2.571	0
Greenspace	0.042	0	0.042	0

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present within option boundary during construction (Ha)	Stocks present within option boundary post construction (Ha)	Change (Ha)
Mudflats	0.004	0	0.004	0
Pastures	17.8	0	17.8	0
Ponds & linear features	0.086	0.086	0.086	0
Rivers (length)	0.029	0.029	0.029	0
Saltmarsh	0.112	0	0.112	0
Woodland Priority Habitat	0.084	0	0.084	0
ESW-DES-008				
Active Flood Plain	5.88	5.88	5.88	0
Arable	37.454	0	35.716	-1.738
Broadleaved, Mixed and Yew Woodland	0.365	0	0.365	0
Coastal and Floodplain Grazing Marsh	2.323	0	2.03	-0.294
Coniferous Woodland	0.649	0	0.649	0
Dwarf Shrub Heath	1.533	0	1.533	0
Greenspace	0.055	0	0.055	0
Hay Meadows	0.051	0	0.051	0
Lakes and Standing Waters	0.139	0.139	0.139	0
Lowland Fens	1.628	0	1.628	0
Other Semi-Natural Grassland	0.129	0	0.129	0
Pastures	8.499	0	8.205	-0.294
Ponds & linear features	0.852	0.852	0.852	0
Rivers (length)	0.124	0.124	0.124	0
Sea Cliff	2.227	2.227	2.227	0
Woodland Priority Habitat	0.494	0	0.494	0
ESW-NIT-004				
Active Flood Plain	0.24	0.24	0.24	0
Arable	2.35	0	2.35	0
Broadleaved, Mixed and Yew Woodland	0.31	0	0.31	0
Greenspace	0.46	0	0.46	0
Pastures	0.01	0	0.01	0
Ponds & linear features	0.01	0.01	0.01	0
Woodland Priority Habitat	0.72	0	0.72	0

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present within option boundary during construction (Ha)	Stocks present within option boundary post construction (Ha)	Change (Ha)
03b0478B				
Coastal and Floodplain Grazing Marsh	2	0	2	0
Arable	54.29	0	54.29	0
Pastures	0.98	0	0.98	0
Other Semi-Natural Grassland	0.38	0	0.38	0
Broadleaved, Mixed and Yew Woodland	0.11	0	0.11	0
Woodland Priority Habitat	0.64	0	0.64	0
Coniferous Woodland	0.05	0	0.05	0
Ancient Woodland	0.04	0	0	-0.04
Greenspace	3.43	0	3.43	0
Urban Semi Natural Habitat	0.22	0	0.22	0
Urban Woodland	0.39	0	0.39	0
Active Flood Plain	12.72	11.14	11.14	-1.58
Rivers (length)	0.02	0.02	0.02	0
Ponds & linear features	0.39	0.39	0.39	0
ESW-DES-004				
Coastal and Floodplain Grazing Marsh	3.44	0.00	3.14	-0.30
Lowland Fens	0.60	0.00	0.60	0.00
Arable	74.40	0.00	71.25	-3.15
Pastures	7.09	0.00	6.79	-0.30
Other Semi-Natural Grassland	0.19	0.00	0.19	0.00
Dwarf Shrub Heath	0.27	0.00	0.27	0.00
Broadleaved, Mixed and Yew Woodland	0.002	0.00	0.002	0.00
Woodland Priority Habitat	0.05	0.00	0.05	0.00
Coniferous Woodland	0.02	0.00	0.02	0.00
Greenspace	0.04	0.00	0.04	0.00
Active Flood Plain	13.23	13.23	12.94	-0.29
Lakes and Standing Waters	0.09	0.09	0.09	0.00
Rivers (length)	0.09	0.09	0.09	0.00
Ponds & linear features	1.14	1.14	1.14	0.00
Sand Dunes	3.32	0.00	3.32	0.00
Sea Cliff	2.40	2.40	2.40	0.00

Table H.2.2 Quantitative detailed assessment of the unmitigated predicted impacts on the provision of ecosystem services

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
ESW-TRA-023					
Carbon storage	£922.22	£0.00	-£922.22	£881.65	-£40.58
Natural hazard management	£5.88	£0.00	-£5.88	£4.41	-£1.47
Air pollutant removal	£118.05	£0.00	-£118.05	£108.09	-£9.97
Food production	£560,366.61	£559,924.25	-£442.37	£559,924.25	-£442.37
Total	£561,412.77	£559,924.25	-£1,488.52	£560,918.39	-£494.38
ESW-ABS-003C					
Carbon storage	£1,516.69	£0.00	-£1,516.69	£1,479.30	-£37.39
Natural hazard management	£5.88	£0.00	-£5.88	£4.41	-£1.47
Air Pollutant Removal	£304.01	£0.00	-£304.01	£295.42	-£8.60
Food Production	£586,245.00	£585,913.23	-£331.77	£585,913.23	-£331.77
Total	£588,071.58	£585,913.23	-£2,158.35	£587,692.35	-£379.23
EWS-TRA-019					
Carbon storage	£4,332.18	£0.00	-£4,332.18	£4,003.54	-£328.64
Natural hazard management	£69.48	£0.00	-£69.48	£52.11	-£17.37
Total	£4,401.66	£0.00	-£4,401.66	£4,055.65	-£346.01
EWS-UVC-001					
Carbon storage	£2.00	£0.00	-£2.00	£0.00	-£2.00
Air Pollutant Removal	£0.86	£0.00	-£0.86	£0.00	-£0.86
Food Production	£97,652.20	£97,320.43	-£331.77	£97,320.43	-£331.77
Total	£97,655.06	£97,320.43	-£334.63	£97,320.43	-£334.63
ESW-NIT-006					
Carbon storage	£2,347.37	£0.00	-£2,347.37	£1,906.79	-£440.58
Natural hazard management	£60.75	£0.00	-£60.75	£45.56	-£15.19
Air Pollutant Removal	£356.97	£0.00	-£356.97	£310.57	-£46.40
Food Production	£510,489.89	£510,047.53	-£442.37	£510,047.53	-£442.37
Total	£513,254.98	£510,047.53	-£3,207.45	£512,310.45	-£944.53
EWS-PMP-001A					
Carbon storage	£455.60	£0.00	-£455.60	£342.57	-£113.03
Natural hazard management	£8.82	£0.00	-£8.82	£6.61	-£2.20
Air Pollutant Removal	£34.98	£0.00	-£34.98	£25.34	-£9.64
Food production	£97,652.20	£97,320.43	-£331.77	£97,320.43	-£331.77

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Total	£98,151.61	£97,320.43	-£831.18	£97,694.95	-£456.66
EWS-NIT-005					
Carbon storage	£1,034.53	£0.00	-£1,034.53	£785.75	-£248.79
Natural hazard management	£36.25	£0.00	-£36.25	£27.19	-£9.06
Air Pollutant Removal	£144.46	£0.00	-£144.46	£111.30	-£33.16
Food production	£283,445.75	£283,003.39	-£442.37	£283,003.39	-£442.37
Total	£284,661.00	£283,003.39	-£1,657.61	£283,927.62	-£733.38
EWS-TRA-001					
Carbon storage	£6,369.19	£0.00	-£6,369.19	£5,665.50	-£703.69
Natural hazard management	£121.46	£0.00	-£121.46	£91.09	-£30.37
Total	£6,490.65	£0.00	-£6,490.65	£5,756.59	-£734.06
EWS-RES-002C1					
Carbon storage	£4,491.87	£396.10	-£4,095.78	£604.70	-£3,887.18
Natural hazard management	£0.98	£0.98	£0.00	£0.73	-£0.24
Air Pollutant Removal	£1,829.31	£164.85	-£1,664.46	£164.11	-£1,665.21
Food production	£499,430.75	£449,111.67	-£50,319.09	£449,111.67	-£50,319.09
Total	£505,752.92	£449,673.60	-£56,079.33	£449,881.21	-£55,871.72
ESW-DES-001					
Carbon storage	£3,642.61	£0.00	-£3,642.61	£3,006.40	-£636.21
Natural hazard management	£27.41	£0.00	-£27.41	£20.56	-£6.85
Recreation & Amenity Value	£113,469.22	£75,555.41	£33,011.00	£75,555.41	-£37,913.81
Food production	£425,002.74	£421,021.45	-£3,981.29	£421,021.45	-£3,981.29
Total	£542,141.98	£496,576.86	£25,359.69	£499,603.82	-£42,538.16
ESW-TRA-018					
Carbon storage	£811.70	£0.00	-£811.70	£720.73	-£90.97
Natural hazard management	£19.23	£0.00	-£19.23	£14.42	-£4.81
Total	Total	£830.93	£0.00	-£830.93	£735.15
ESW-EFR-002A					
Carbon storage	£10,556.50	£0.00	-£10,556.50	£8,848.82	-£1,707.68
Natural hazard management	£209.31	£0.00	-£209.31	£156.36	-£52.94
Food Production	£285,325.81	£284,109.30	-£1,216.51	£284,109.30	-£1,216.51
Total	£296,091.61	£284,109.30	-£11,982.31	£293,114.48	-£2,977.13
ESW-EFR-001					
Carbon storage	£4,149.28	£0.00	-£4,149.28	£3,877.02	-£272.26
Natural hazard management	£8.23	£0.00	-£8.23	£6.17	-£2.06
Food production	£112,029.09	£101,080.54	-£10,948.55	£101,080.54	-£10,948.55
Total	£116,186.59	£101,080.54	-£15,106.06	£104,963.73	-£11,222.87

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
ESW-DES-008					
Carbon storage	£7,433.53	£0.00	-£7,433.53	£6,157.16	-£1,276.37
Natural hazard management	£147.64	£0.00	-£147.64	£110.73	-£36.91
Food Production	£223,173.44	£222,178.12	-£995.32	£222,178.12	-£995.32
Total	Total	£230,754.61	£222,178.12	-£8,576.49	£228,446.01
ESW-NIT-004					
Carbon storage	£2,004.70	£0.00	-£2,004.70	£1,527.34	-£477.36
Natural hazard management	£100.92	£0.00	-£100.92	£75.69	-£25.23
Air Pollutant Removal	£348.53	£0.00	-£348.53	£271.45	-£77.08
Total	£2,454.14	£0.00	-£2,454.14	£1,874.48	-£579.67
03b0478B					
Carbon storage	£4,840.66	£0.00	-£4,840.66	£4,178.60	-£662.06
Natural hazard management	£120.89	£0.00	-£120.89	£87.92	-£32.97
Total	£4,961.55	£0.00	-£4,961.55	£4,266.51	-£695.04
ESW-DES-004					
Carbon storage	£4,234.33	£0.00	-£4,234.33	£4,017.42	-£216.91
Natural hazard management	£7.03	£0.00	-£7.03	£5.28	-£1.76
Food production	£271,059.52	£268,737.10	-£2,322.42	£268,737.10	-£2,322.42
Total	£275,300.88	£268,737.10	-£6,563.79	£272,759.80	-£2,541.09

Table H.2.3: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
03b0478B ESW-ABS-003C ESW-DES-001 ESW-DES-008 ESW-EFR-001 ESW-EFR-002A ESW-NIT-004 ESW-NIT-005 ESW-NIT-006 ESW-PMP-001A ESW-RES-002C1 ESW-TRA-001 ESW-TRA-018 ESW-TRA-019 ESW-TRA-023 ESW-DES-004	The stock likely provides a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stocks will likely be reduced	The provision of water purification provided by the stocks will likely be reduced due to the option.
ESW-UVC-001	Scoped out	Scoped out	Scoped out	Scoped out
Water flow regulation				
03b0478B ESW-ABS-003C ESW-DES-008 ESW-EFR-001 ESW-EFR-002A ESW-NIT-004 ESW-NIT-005 ESW-NIT-006 ESW-PMP-001A ESW-RES-002C1 ESW-TRA-001 ESW-TRA-018 ESW-TRA-019 ESW-TRA-023 ESW-DES-004	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the stock will likely remain.	0

ESW-DES-001	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely reduce slightly.	-
ESW-UVC-001	Scoped out	Scoped out	Scoped out	Scoped out

Table H.2.4: Summary of the unmitigated Biodiversity Metric outputs

Option	On-site Baseline (BU*)	On-Site Post Intervention (BU)	Total Net Unit change (BU)	Total Percentage Change	Habitat units to be purchased to achieve 10% (BU)	Cost for 10% BNG (Assumpti on £25,000 per unit)
03b0478B	189.44	145.46	-43.98	-23.22%	62.92	£1,573,100
ESW-ABS-003C	48.20	42.94	-5.36	-10.92%	10.18	£254,500
ESW-DES-001	216.84	102.87	-113.97	-52.56%	135.65	£3,391,350
ESW-DES-008	230.38	171.87	-58.51	-25.40%	81.55	£2,038,700
ESW-EFR-001	165.87	117.11	-48.75	-29.39%	65.34	£1,633,425
ESW-EFR-002A	200.82	161.79	-39.03	-19.43%	59.11	£1,477,800
ESW-NIT-004	17.78	8.61	-9.17	-51.57%	10.95	£273,700
ESW-NIT-005	9.3	4.72	-4.58	-49.21%	5.51	£137,750
ESW-NIT-006	34.07	28.34	-6.36	-18.32%	9.77	£244,175
ESW-PMP-001A	2.42	1.78	-0.64	-26.44%	0.88	£22,050
ESW-RES-002C1	230	435.89	205.89	89.52%	N/A	N/A
ESW-TRA-001	169.56	145.60	-23.96	-14.13%	40.92	£1,022,900
ESW-TRA-018	36.26	13.88	-22.39	-61.73%	26.02	£650,400
ESW-TRA-019	143.06	128.15	-14.91	-10.42%	29.22	£730,400
ESW-TRA-023	54.30	31.27	-23.03	-42.41%	28.46	£711,500
ESW-UVC-001	0.10	0.00	-0.10	-100%	0.11	£2,750
ESW-DES-004	313.25	222.45	-90.80	-28.99%	122.13	£3,053,125

*BU = Biodiversity Unit

H.3. Adaptive programmes cumulative effects assessment

H.3.1 HED

H.3.1.1 NCA

Table H.3.1.1: Predicted temporary and permanent impacts on natural capital stocks for the HED

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	65.95	64.37	54.49	-11.47
Ancient Woodland	0.05	0.00	0.00	-0.05
Arable	356.92	0.00	336.71	-20.21
Broadleaved, Mixed and Yew Woodland	2.13	0.00	2.13	0.00
Coastal and Floodplain Grazing Marsh	19.70	0.00	17.71	-2.00
Coniferous Woodland	2.09	0.00	2.09	0.00
Dwarf Shrub Heath	1.53	0.00	1.53	0.00
Greenspace	5.60	0.00	5.31	-0.29
Hay Meadows	0.10	0.00	0.10	0.00
Lakes and Standing Waters	0.28	0.28	0.28	0.00
Lowland Fens	1.71	0.08	1.71	0.00
Modified Waters (Reservoirs)	0.10	0.10	0.10	0.00
Other Semi-Natural Grassland	2.28	0.00	2.28	0.00
Pastures	77.33	0.00	75.89	-1.44
Ponds & linear features	2.57	2.57	2.55	-0.01
Rivers (length)	1.16	1.16	1.16	0.00
Saltmarsh	0.29	0.00	0.29	0.00
Sea Cliff	2.23	2.23	2.23	0.00
Urban Semi Natural Habitat	0.23	0.00	0.23	0.00
Urban Woodland	0.39	0.00	0.39	0.00
Woodland Priority Habitat	4.95	0.00	4.95	0.00

Table H.3.1.2: Quantitative detailed assessments of the unmitigated predicted permanent impacts on the provision of ecosystem services for the HED

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£50,418.75	£0.00	-£50,418.75	£43,381.16	-£7,037.60
Natural hazard management	£942.14	£0.00	-£942.14	£703.24	-£238.90
Air pollutant removal	£1,307.87	£0.00	-£1,307.87	£1,122.17	-£185.70
Recreation and Amenity Value	£113,469.22	£75,555.41	£33,011.00	£75,555.41	-£37,913.81
Food production	£3,181,382.74	£3,161,918.66	-£19,464.09	£3,161,918.66	-£19,464.09
Total	£3,347,520.72	£3,237,474.07	-£39,121.84	£3,282,680.62	-£64,840.10

Table H.3.1.3: Qualitative assessments of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the HED

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
HED	<p>Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.</p>	<p>The provision of services will be lost during construction.</p>	<p>The future provision of the ecosystem service provided by the stocks will likely be reduced.</p>	<p>The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.</p>
Water flow regulation				
HED	<p>The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.</p>	<p>The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.</p>	<p>The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.</p>	-

H.3.1.2 BNG

Table H.3.1.4: Summary of the unmitigated Biodiversity Metric outputs for the HED and the BNG habitat units required to be purchased to achieve 10% BNG

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
1,547.09	1,086.18	-460.91	-29.79%	615.62	£15,390,475

H.3.2 High PCC

H.3.2.1 NCA

Table H.3.2.1: Predicted temporary and permanent impacts on natural capital stocks for the High PCC

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	48.65	47.07	47.07	-1.58
Ancient Woodland	0.05	0.00	0.00	-0.05
Arable	295.82	0.00	290.98	-4.84
Broadleaved, Mixed and Yew Woodland	2.06	0.00	2.06	0.00
Coastal and Floodplain Grazing Marsh	9.00	0.00	8.71	-0.29
Coniferous Woodland	2.09	0.00	2.09	0.00
Dwarf Shrub Heath	1.53	0.00	1.53	0.00
Greenspace	4.80	0.00	4.80	0.00
Hay Meadows	0.10	0.00	0.10	0.00
Lakes and Standing Waters	0.28	0.28	0.28	0.00
Lowland Fens	1.71	0.08	1.71	0.00
Modified Waters (Reservoirs)	0.10	0.10	0.10	0.00
Other Semi-Natural Grassland	2.28	0.00	2.28	0.00
Pastures	47.16	0.00	46.60	-0.55
Ponds & linear features	2.27	2.27	2.27	0.00
Rivers (length)	1.13	1.13	1.13	0.00
Saltmarsh	0.15	0.00	0.15	0.00
Sea Cliff	2.23	2.23	2.23	0.00
Urban Semi Natural Habitat	0.23	0.00	0.23	0.00
Urban Woodland	0.39	0.00	0.39	0.00
Woodland Priority Habitat	4.66	0.00	4.66	0.00

Table H.3.2.2: Quantitative detailed assessments of the unmitigated predicted permanent impacts on the provision of ecosystem services for the High PCC

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£42,626.86	£0.00	-£42,626.86	£36,497.73	-£6,129.13
Natural hazard management	£906.50	£0.00	-£906.50	£676.51	-£229.99
Air pollutant removal	£1,307.87	£0.00	-£1,307.87	£1,122.17	-£185.70
Food production	£2,644,350.91	£2,639,816.67	-£4,534.25	£2,639,816.67	-£4,534.25
Total	£2,689,192.14	£2,639,816.67	-£49,375.48	£2,678,113.06	-£11,079.08

Table H.3.2.3: Qualitative assessments of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the High PCC

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
High PCC	Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stocks will likely be reduced.	The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
High PCC	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.	The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.	-

H.3.2.2 BNG

Table H.3.2.4: Summary of the unmitigated Biodiversity Metric outputs for the High PCC and the BNG habitat units required to be purchased to achieve 10% BNG

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
1,158.08	866.42	-291.66	-25.18%	407.47	£10,186,700

H.3.3 NSR

H.3.3.1 NCA

Table H.3.3.1: Predicted temporary and permanent impacts on natural capital stocks for the NSR

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	35.28	33.70	33.70	-1.58
Ancient Woodland	0.04	0.00	0.00	-0.04
Arable	311.10	9.46	212.72	-98.38
Broadleaved, Mixed and Yew Woodland	1.29	0.00	1.29	0.00
Coastal and Floodplain Grazing Marsh	6.60	0.00	6.60	0.00
Coniferous Woodland	0.57	0.00	0.57	0.00
Greenspace	4.63	0.00	4.63	0.00
Modified Waters (Reservoirs)	0.10	0.10	91.54	91.44
Other Semi-Natural Grassland	1.83	0.00	1.83	0.00
Pastures	27.40	0.00	27.14	-0.26
Ponds & linear features	0.77	0.74	0.74	-0.03
Rivers (length)	1.10	1.10	1.10	0.00
Saltmarsh	0.15	0.00	0.15	0.00
Urban Semi Natural Habitat	0.23	0.00	0.23	0.00
Urban Woodland	0.39	0.00	0.39	0.00
Woodland Priority Habitat	3.33	0.01	3.33	0.00

Table H.3.3.2: Quantitative detailed assessments of the unmitigated predicted permanent impacts on the provision of ecosystem services for the NSR

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£29,128.70	£396.10	-£28,732.61	£22,096.45	-£7,032.25
Natural hazard management	£550.53	£0.98	-£549.56	£410.15	-£140.38
Air pollutant removal	£3,137.18	£164.85	-£2,972.33	£1,286.27	-£1,850.91
Food production	£2,635,282.42	£2,582,640.91	-£52,641.51	£2,582,640.91	-£52,641.51
Total	£2,668,098.84	£2,583,202.84	-£84,896.00	£2,606,433.78	-£61,665.06

Table H.3.3.3: Qualitative assessments of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the NSR

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
NSR	Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stocks will likely be reduced.	The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
NSR	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.	The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.	-

H.3.3.2 BNG

Table H.3.3.4: Summary of the unmitigated Biodiversity Metric outputs for the NSR and the BNG habitat units required to be purchased to achieve 10% BNG

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
955.72	972.92	17.20	1.80%	78.37	£1,959,226

H.3.4 HRSR

H.3.4.1 NCA

Table H.3.4.1: Predicted temporary and permanent impacts on natural capital stocks for the HRSR

Natural capital stock	Area within option boundary pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Active Flood Plain	42.92	41.34	41.34	-1.58
Ancient Woodland	0.05	0.00	0.00	-0.05
Arable	365.11	9.46	264.73	-100.38
Broadleaved, Mixed and Yew Woodland	1.69	0.00	1.69	0.00
Coastal and Floodplain Grazing Marsh	7.55	0.00	7.55	0.00
Coniferous Woodland	1.44	0.00	1.44	0.00
Greenspace	4.75	0.00	4.75	0.00
Hay Meadows	0.05	0.00	0.05	0.00
Lakes and Standing Waters	0.14	0.14	0.14	0.00
Lowland Fens	0.08	0.08	0.08	0.00
Modified Waters (Reservoirs)	0.10	0.10	91.54	91.44
Other Semi-Natural Grassland	2.15	0.00	2.15	0.00
Pastures	40.10	0.00	39.84	-0.26
Ponds & linear features	1.45	1.42	1.42	-0.03
Rivers (length)	1.18	1.18	1.18	0.00
Saltmarsh	0.15	0.00	0.15	0.00
Urban Semi Natural Habitat	0.23	0.00	0.23	0.00
Urban Woodland	0.39	0.00	0.39	0.00
Woodland Priority Habitat	4.18	0.01	4.18	0.00

Table H.3.4.2: Quantitative detailed assessments of the unmitigated predicted permanent impacts on the provision of ecosystem services for the HRSR

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£39,685.20	£396.10	-£39,289.11	£30,945.27	-£8,739.93
Natural hazard management	£759.84	£0.98	-£758.86	£566.51	-£193.33
Air pollutant removal	£3,137.18	£164.85	-£2,972.33	£1,286.27	-£1,850.91
Food production	£2,920,608.23	£2,866,750.22	-£53,858.01	£2,866,750.22	-£53,858.01
Total	£2,964,190.45	£2,867,312.15	-£96,878.31	£2,899,548.26	-£64,642.19

Table H.3.4.3: Qualitative assessments of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the HEP

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
HRSR	Scoped in as the option causes the temporary loss of associated stocks. Stocks are expected to be replaced/compensated through inset re-planting schemes. However broadleaved, coniferous, priority, and urban woodland have significant maturity time with a delay of 30 years. As a result, the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stocks will likely be reduced.	The provision of water purification provided by the stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
HRSR	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.	The loss of contributing stocks has the potential to impede water flow on site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.	-

H.3.4.2 BNG

Table H.3.4.4: Summary of the unmitigated Biodiversity Metric outputs for the HRSR and the BNG habitat units required to be purchased to achieve 10% BNG

On-site habitat units Baseline (BU)	On-Site habitat units Post Intervention (BU)	Total habitat units Net Unit change (BU)	Total habitat units Percentage Change	BNG habitat unit purchase to achieve 10% net gain (BU)	Cost for 10% BNG (Assumption £25,000 per BU)
1,157.30	1,137.86	-19.44	-1.68%	135.17	£3,379,250

