Fens 2100+

Lower Welland

Natural capital register and account

2025

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Executive Summary

Natural capital refers to the elements of the natural environment that provide valuable goods and services to people [1]. *These include food, water, flood alleviation, thriving wildlife and places to enjoy. Natural capital underpins our wellbeing and economic prosperity, providing multiple benefits to society.*

This Natural Capital Baseline Report provides an assessment of the natural capital assets within the Lower Welland catchment[1]. The report highlights the importance of natural capital in supporting economic activity and human wellbeing through the provision of ecosystem services. The assessment was conducted using the Environment Agency's Natural Capital Register and Account Tool (NCRAT) and includes both quantitative and qualitative analysis undertaken through desk-based research, spatial analysis using Geographical Information Systems (GIS) and engagement with key stakeholders.

The catchment comprises 473km^2 (47,299ha) of terrestrial and coastal habitats, including urban land; agricultural land; coastal margins; freshwater habitats; and woodlands. The catchment also contains local, national and international designated sites such as The Wash, Baston Fen and Cowbit Wash.

The key ecosystem services from natural assets in the catchment can be categorised into provisioning, regulating, cultural and supporting / bundled services, the estimated natural capital values of these are summarised below:

- Agriculture, water supply, timber, and renewable energy generation are key **provisioning services.** In the catchment, agriculture alone contributes an estimated £41.15 million annually, while water supply is valued at approximately £8.42 million per year.
- Climate regulation, air quality improvement, hazard regulation, and pollination are critical **regulating services.** Air quality improvement is worth an estimated value of £627,000 per year in the catchment. However, the cost of climate regulation in the catchment is £20.77 million, reflecting the fact that the catchment emits 76,083 more tonnes per year of carbon dioxide equivalent than it sequesters. This cost significantly reduces the total value of natural capital in the catchment. Enclosed farmland, saltmarsh and woodlands play a significant role in carbon draw-down and climate regulation. However, this is counteracted by the fact that over a quarter (25.3%) of peatland in the catchment is categorised as 'actively eroding', and thus emits far more carbon than is sequestered by other habitats, producing a negative carbon balance overall.
- Recreation, physical health, and aesthetic value are important **cultural services**. Despite land-use being primarily agricultural, it is estimated that the catchment attracts approximately 2.71 million adult visitors to open spaces each year, with an estimated annual value of £10.42 million[2]. This contributes to natural capital value through improvements to physical and mental health (welfare) and can boost the local

[1] The Lower Welland catchment is not strictly a hydrological catchment as there are movements of water both into and out of the area defined, that are not being considered in this report. However, the term 'catchment' has been used throughout the dialogue with the Environment Agency during establishment of the study areas and these areas are being defined for water management purposes. Therefore, the term catchment is used to describe the study area.

[2] Open spaces considered within ORVal include publicly accessible green spaces within the catchment, for example, public parks, doorstep greens and nature reserves.

economy. Wellbeing gains from sites and areas are often derived from a combination of the heritage, biodiversity and geodiversity aspects.

- **Supporting / bundled ecosystem services** in the catchment include water quality and biodiversity, which allow other ecosystem services to function and often involve multiple services or non-use values. The catchment hosts 12 designated sites that support biodiversity conservation; five of these are international designations, including The Wash (Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR), Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar Site) and Baston Fen (SAC). There is 9.4ha of internationally designated land in the catchment. In 2019, Natural England produced a natural capital account of all National Nature Reserves managed by Natural England (of which The Wash is just one), and highlighted the value of National Nature Reserves for biodiversity protection and landscape enhancement [2].

Ecosystem services that have not been valued, but are important for the catchment include pollination and seed dispersal; control of pests and diseases; regulation of soil quality and erosion; biodiversity; and cultural services through the contribution of ecosystems to aesthetics, the historic environment, and a sense of place. Other ecosystem services that have not been valued but are important include volunteering and education. These ecosystem services have not been included due to a lack of data or because they are too complex to accurately determine with the information available. Since there is no marine habitat within the catchment study area, the provision of food from fish and shellfish landings has not been included as it is not appropriate to attribute these benefits to the study area. It should also be noted that the estimated value for agricultural activities does not include the negative impacts it can have on the other ecosystem service (for example water quality, carbon sequestration, hazard regulation and biodiversity) through pollution, biodiversity loss, erosion and peat degradation. Figure 1 provides an overview of the natural capital value of the catchment.

The natural capital assets in the catchment are at risk from drivers such as climate change; intensive agricultural practices; urban development; poor water resource management; pollution; and invasive species. In turn these create risks for the delivery of ecosystem services. If not managed, these risks will degrade the quantity and quality of natural capital assets in the catchment and prevent the provision of ecosystem services that our societies economy and wellbeing rely on.

Conversely, there are many opportunities to enhance natural capital assets in the catchment, thereby increasing the provision of ecosystem services, and boosting local and global natural capital value. These opportunities include restoration of natural habitats including peatland, woodland and wetland; habitat creation and growth; implementing Nature-based Solutions (NbS); adopting sustainable practices in agriculture and water management; regenerative farming; and strengthening policy and governance that enables the conservation of natural capital assets and supports sustainable development. These interventions would deliver multiple benefits across a range of ecosystem service types.

The report highlights the critical role of natural capital in supporting the local community's resilience and wellbeing in the catchment, and the value of considering natural capital in strategic decision-making. Through addressing the identified risks and leveraging the opportunities, the Fens 2100+ programme, and future investment projects should look to sustainably manage existing natural capital assets and look for opportunities to enhance ecosystem service delivery for future generations.

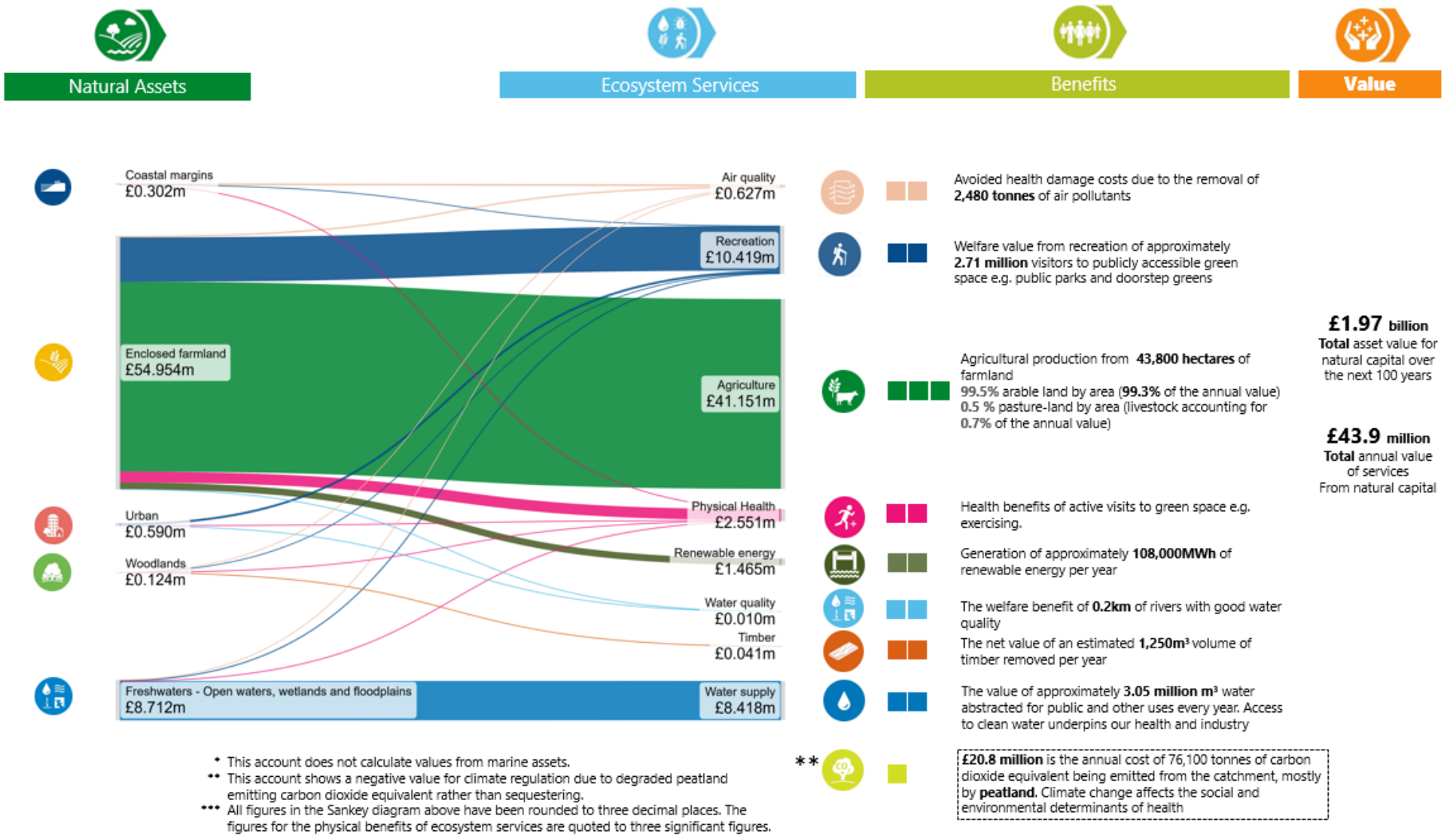

Figure 1: Summary of the NCRAT results for the catchment, showing the flow of ecosystem services and their benefits from natural assets

1. Introduction

1.1 Aim and purpose of this document

This report presents a catchment-scale natural capital baseline for the Fens2100+ Lower Welland catchment (hereafter referred to as the 'catchment'). It provides an insight into the provision of ecosystem services by natural capital assets across the catchment, highlighting the wider benefits this has on society, such as the importance of natural capital in supporting economic activity and human wellbeing, as well as the risks and opportunities. This report aims to provide decision makers with evidence to support future choices, investments and actions for the Fens2100+ programme.

The assessment was conducted using the Environment Agency's Natural Capital Register and Account Tool (NCRAT) suite of tools[3] and includes an estimated total quantifiable natural capital value (£m) in the catchment, supported by qualitative evidence and analysis. More information on the importance of using a natural capital approach is provided in Section 2.2.

1.2 Usage statement

This report should be read alongside the Lower Welland baseline evidence report[4] and the Lower Welland environmental and agricultural baseline appendix[5]. This document provides a proportionate level of detail required for a strategic catchment-scale baseline. A detailed baseline analysis may be required at project level to align with the Environment Agency's Minimum Technical Requirements for Environmental Impact Assessment.

1.3 Catchment context

The catchment[6] is located in south-east Lincolnshire, and covers an area of 47,299ha (473km^2), as shown in Figure 2. It is bordered to the south by the Lower Nene catchment and to the north by the South Forty Foot catchment, which is a sub-catchment of the River Witham. The River Welland is the primary watercourse draining the catchment, flowing north-east from Market Deeping towards Fosdyke and its outfall into The Wash. This reach of the River Welland encompassed by the catchment is approximately 54km long.

The Environment Agency has permissive powers to carry out flood and coastal risk management activities on Main Rivers. In addition, the Environment Agency is responsible for producing a national strategy for Flood and Coastal Erosion Risk Management (FCERM). The latest strategy published in 2020 contains 'Measure 1.5.4'. This requires development of a long-term plan for managing future flood risk in the Fens. IDBs play a vital role in managing water levels and drainage across the catchment for agricultural and environmental purposes. The IDB's are responsible for managing the complex network of drains that feed into Main Rivers by pumps. They also regulate water levels on non Main Rivers (ordinary watercourses).

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[3] Environment Agency NCRAT includes: Environment Agency Natural Capital Register and Account Tool version 1.2, Workbook; and Environment Agency natural capital scorecard version 1.2

[4] Fens 2100+ (2025) Lower Welland Baseline Evidence Report

[5] Fens 2100+ (2025) Lower Welland Environment and Agriculture baseline appendix

[6] The Lower Welland catchment is not strictly a hydrological catchment as there are movements of water both into and out of the area defined, that are not being considered in this report. However, the term 'catchment' has been used throughout the dialogue with the Environment Agency during establishment of the study areas and these areas are being defined for water management purposes. Therefore, the term catchment is used to describe the study area.

The ‘Main Rivers’ within the catchment include the River Welland and its tributaries such as the River Glen, Folly River and the Bourne Eau. The Crowland and Cowbit Washes, a reservoir under the Reservoirs Act 1975, is also located within the catchment. It provides flood water storage at time of high flow in the Welland between Peakirk and Spalding.

The Welland and Deepings, North Level District and South Holland IDBs own and are responsible for managing water levels within the network of subsidiary drains that discharge into the catchment by pumps. Most of the pumped drainage system is managed by Welland and Deepings IDB. The IDBs have a complicated task of managing flood risk whilst balancing agricultural water demands for irrigation and maintaining water supply rights to nature reserves.

The catchment’s low-lying terrain is typical of the wider Fens with most of the land lying just above sea level at approximately 3m Above Ordnance Datum (AOD). Approximately 93% (44,000ha) of the catchment is classified as the highest Grade 1 or 2, according to the Agricultural Land Classification [3].

The catchment is located almost entirely within National Character Area (NCA) 46 “The Fens”. The Fens is a distinctive, historic and human influenced wetland landscape lying to the west of The Wash, the largest estuarine system in the UK. The NCA is notable for its large-scale, flat, open topography with extensive vistas to level horizons. Land use is predominately arable agriculture. A very small part (c.10ha) of the southwestern edge of the catchment close to Peterborough is located within NCA 88 Bedfordshire and Cambridgeshire Claylands. This is described as a broad, gently undulating, lowland plateau dissected by shallow river valleys that gradually widen as they approach The Fens.

The largest urban area in the catchment is the historic market town of Spalding in the centre of the catchment. There are several other villages concentrated in the north of the catchment, including Holbeach, Pinchbeck, Surfleet, Deeping Saint Nicholas, Gosberton and Fosdyke. The southern half of the catchment is more sparsely populated, with the largest village being Deeping St Nicholas. Adjacent to the south-western catchment boundary, there are several much larger settlements, including Bourne, Market Deeping and the northern suburbs of Peterborough.

There are four Local Planning Authority (LPA) areas within the catchment: South Holland District Council covers the majority (72%) of the catchment. Boston Borough Council covers a small area of the northern catchment; South Kesteven District Council covers an area in the far south-west; and Peterborough City Council covers the most southerly portion.

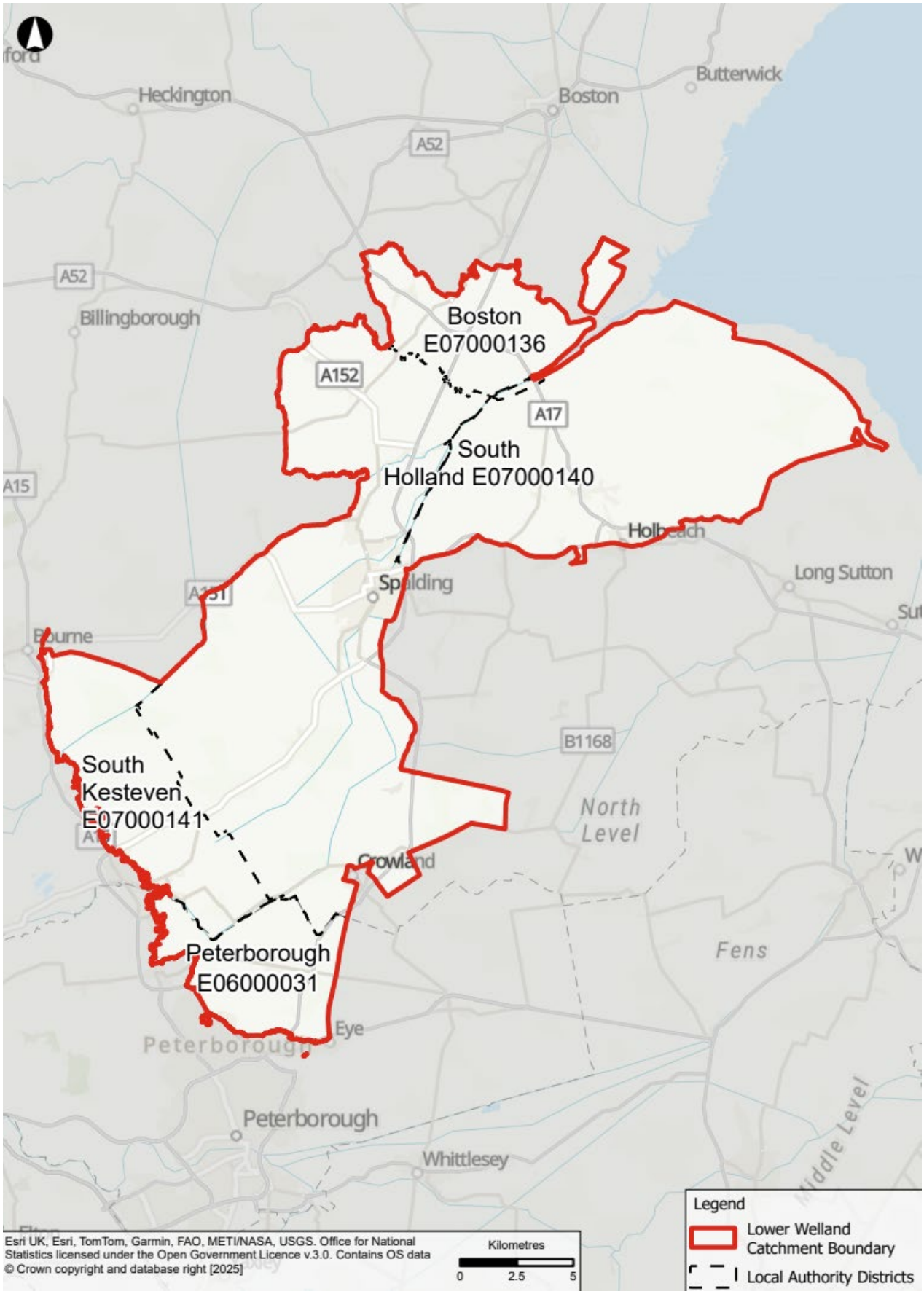

Figure 2: Catchment boundary

2. Understanding natural capital

2.1 An introduction to natural capital

Natural capital refers to the renewable and non-renewable natural resources that combine to provide valuable goods and services to people [1]. All aspects of the natural environment - including soils; geological formations; habitats; and ecosystems - are natural capital assets which provide ecosystem services, from which flow benefits to society.

There is a growing awareness of the role of natural capital in delivering quality of place, and in enhancing health and wellbeing. Some benefits of natural capital can be measured and valued, but many are difficult to define and quantify. Taking a natural capital approach facilitates comparability between environmental and economic costs and benefits and can help organisation, planners and policy makers assess needs, identify dependencies on natural assets, and translate this into relevant information for decision making, which can in turn facilitate better design and achievement of policy, strategies, programmes and projects.

A natural capital framework

A natural capital framework, such as that shown in Figure 3, provides a coherent, comprehensive and consistent mechanism to analyse key ecosystem services and benefits provided by nature and is recognised by the HM Government's Green Book as a way to improve appraisal of a range of environmental benefits and effects [4].

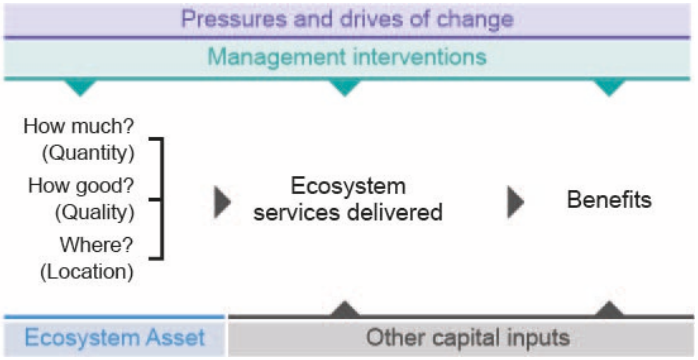

Figure 3: A Natural Capital Framework, adapted from Enabling a Natural Capital Approach Guidance [5]

Natural capital / ecosystem assets

Natural capital assets are aspects of the natural environment. This includes but is not limited to:

- Habitats that serve as natural environments for living organisms such as woodland, heathland, marine and intertidal habitat, scrub, agricultural land, hedgerows, semi-natural grassland and urban trees;
- All living organisms including animals, plants, fungi, and bacteria;
- Green infrastructure, which comprises multifunctional green spaces such as parks and green walls;
- Geological features and processes including rocks, soils and minerals; and
- The water environment, including rivers, lakes, aquifers, and oceans.

The quality, quantity, location and connectivity of these natural capital assets impacts the ecosystems services and benefits they provide. These in turn can be affected by background pressures, management practices and drivers of demand, therefore impacting their natural capital value.

Ecosystem Services

The benefit and contribution of nature to our society is a product of the various ecosystem services it provides, which can be grouped into four categories [6]:

- **Provisioning:** Material outputs from nature (e.g., seafood, water, fibre, genetic material);
- **Regulating:** Indirect benefits from nature generated through regulation of ecosystem processes (e.g., mitigation of climate change through carbon sequestration, water filtration by wetlands, erosion control and protection from storm surges by vegetation, crop pollination by insects);
- **Cultural:** Non-material benefits from nature (e.g., spiritual, aesthetic, recreational, and others); wellbeing gains from sites and areas are often derived from a combination of the heritage, biodiversity and geodiversity aspects; and
- **Supporting/bundled services** [6]**:** Fundamental ecological processes that support the delivery of other ecosystem services (e.g., nutrient cycling, primary production, soil formation). Bundled services may include: Amenity, Biodiversity, Soil Quality, Water Quality, Landscape and non-use benefits.

Benefits

Ecosystem services provide a wealth of benefits to society and the economy, for example:

- Improved physical health through the supply of clean air, water and food; as well as regulation of temperature and flood protection.
- Improved mental health through provision of green and blue space for recreation;
- Improved economy through the availability and quality of commercial activities such as arable farming, aquaculture, timber production, and pastoral farming.

Each ecosystem service will have numerous benefits to society and the economy. For example, erosion control benefits human physical health by reducing the risk of dangerous landslides; mental health by improving access to nature; and benefits the economy by improving soil health for agriculture and reducing the cost of repairing infrastructure after a landslide. Sometimes, other economic inputs are required to enable ecosystem services to provide a benefit to society. For example, the health and wellbeing benefits of recreation requires providing accessibility, including functional gateways and path maintenance.

Value

The value of the benefits provided from ecosystem services in an area can be estimated using quantitative and qualitative information about the quantity, quality and location of natural capital assets, as well as information on how local natural assets are used by society – both locally and globally, and for private and public sectors.

- Quantitative valuation is best used to provide information on the marginal value of incremental changes in impacts or dependencies, either at a point in time or over a given period and is usually monetised in units (£). It can also be used to estimate the economic value of a range of ecosystem services that affect economic performance

and human wellbeing - some of which are commonly unpriced and not considered in economic metrics such as Gross Domestic Product (GDP).

- Qualitative valuation, describing the natural capital impacts, is therefore also important as it can be used to take into account the importance, worth, or usefulness of the impact and/or dependency by taking into account the context, to give equal values to any monetary figures presented.

Where products are directly or indirectly linked to ecosystem services and are traded in markets, valuation can be carried out using market prices - this is often the case for provisioning services such as timber production [5]. For other services that are not typically traded in markets, such as improved water quality or climate regulation, non-market based approaches are used. These typically involve measuring the price individuals are willing to pay to secure positive impacts or avoid negative impacts, through stated preference or cost-based approaches [5].

It should be noted that the representation of natural capital in monetary accounts will only ever be partial as a number of ecosystem services remain difficult to quantify and value. Some are highly location specific, for example water flow and impact on flood risk, and some are intangible or difficult to even place a monetary value on, for example cultural services, such as aesthetic experiences and sense of place.

Through valuing natural capital benefits, their importance to society and the economy can be better represented and accounted for in decision making about future place-based planning and investment.

2.2 The importance of considering natural capital within flood risk and water management infrastructure investment

The concepts of natural capital and ecosystem services are widely supported; the challenge, however, is in implementing the approach and embedding it in working practices, so that the value from the natural environment becomes an integral component of investment decision making. This is recognised in the State of Natural Capital Report for England 2024 [7], which explores the relationship between natural capital and infrastructure. Two key outcomes of the report that highlight the importance of natural capital include:

- Infrastructure, such as flood risk and water management infrastructure can deliver benefits for natural capital, such as through the provision of protected natural habitats and connecting corridors for species along linear infrastructure. In addition, the environment affects infrastructure as changes in the environment such as the climate emergency can increase the costs of infrastructure (e.g. cost of damages caused by flooding). In some cases, natural capital approaches may reduce the demand for hard engineered infrastructure, such as coastal defences, by supporting the use of green engineering or NbS.
- There are significant risks to natural capital that must be considered. The degradation of natural capital can lead to the loss of ecosystem services that are vital for human well-being and economic stability. For instance, the destruction of wetlands can increase the risk of flooding, while deforestation can exacerbate climate change by reducing carbon sequestration. Ignoring these risks can result in increased costs for disaster management and recovery, loss of biodiversity, and diminished quality of life.

The consideration and implementation of natural capital approaches in planning future flood risk and water management infrastructure investment can provide a wide range of benefits [8]:

- Reducing risk of not fully considering the value of the natural environment (whether monetised or not) in decision making.
- Enabling a holistic cost to benefit analysis and risk assessment.
- Identifying how economic and social activity is dependent on the natural environment.
- Facilitating an innovative approach to identifying policy solutions and managing risk.
- Helping to identify priorities for investment.
- Providing a basis for systematic accounting of changes to natural capital assets over time.

2.3 Key accounting methods

2.3.1 Natural capital accounting

Natural capital accounting is an approach that can be used to provide a systematic and repeatable exercise to collate information on natural capital, the ecosystem services that they provide and the associated market value (if appropriate) [5]. These accounts can be used to measure, value, monitor and communicate the stock and condition of natural assets and the flows of services that they provide. By understanding the state of natural capital this can help ensure that the value of natural assets is considered as part of the decision-making process.

There are a variety of approaches that can be used in natural capital accounting depending on the scale and purpose of the exercise, however the key considerations in each are the extent, condition, physical flow, monetary flow and asset accounts.

2.3.2 Environment Agency Natural Capital Register and Account Tool

The Environment Agency NCRAT Tool was developed to help estimate the flow of services from natural assets and understand the value and benefits that the natural environment provides.

NCRAT requires information on the habitat extent and condition to be provided alongside other local data and uses this information to calculate flows of services and associated monetary values. This information is then summarised in a benefits statement showing the flows of ecosystem services from assets and the calculated monetary values of selected services including present value over time. Figure 4 outlines the types of input data that is required, process that are undertaken and outputs that are provided by the NCRAT [9].

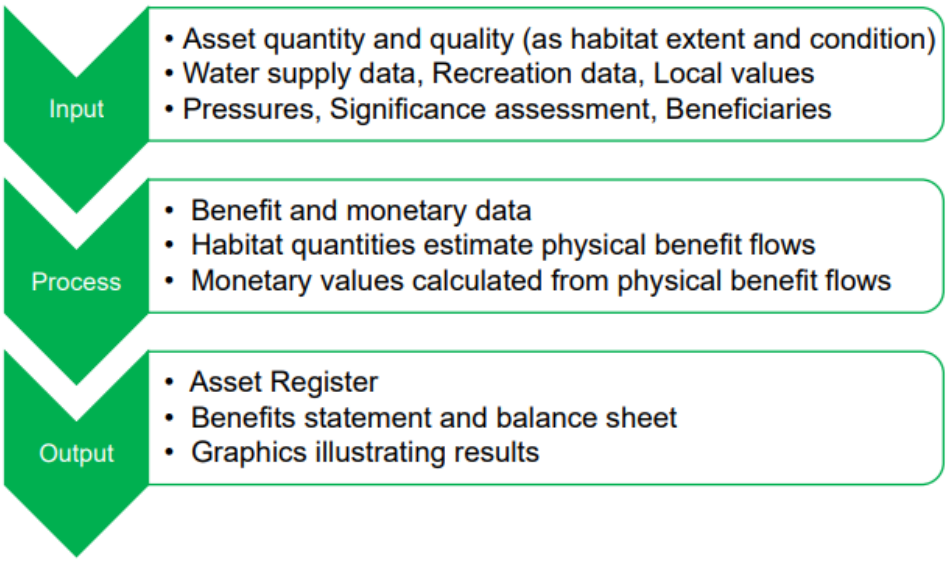

Figure 4: NCRAT Flow Chart

The NCRAT does not include valuation of supporting services (such as nutrient cycling) as this has the potential to lead to double counting as they underpin cultural, provisioning and regulating services. There are also ecosystem services that are not captured by the current version of the NCRAT due to a lack of robust data. This includes pollination, noise mitigation and soil quality and erosion. Where ecosystem services have been identified as being important, but are not captured by NCRAT, qualitative commentary has been provided to ensure that key benefits are captured.

3. Our approach to understanding the benefit and value of natural capital

3.1 Developing our evidence base

This section outlines the methodology used to assess the baseline natural capital value within the catchment.

3.1.1 Methodology

The natural capital assessment was conducted in six distinct stages, broadly aligned with the Natural Capital Protocol [10] and guidance set out within the Enabling a Natural Capital Approach guidance [5]:

1. Desk-based research on natural capital assets, ecosystem services, benefits and plans.
2. An initial materiality assessment to scope in/out relevant ecosystem services based on the wider context of the catchment, use of resources and how people interact with habitats (see section 3.1.3 for more information).
3. Baseline analysis using the Environment Agency's Natural Capital Register and Account Tool (NCRAT), qualitative analysis of additional ecosystem services not quantified within the NCRAT assessment, and spatial GIS analysis.
4. Natural Capital Scorecard and associated narrative (including ecosystem services and benefits that were not assessed in the NCRAT but were scoped in during the materiality assessment).
5. Presenting outcomes of spatial analysis, and natural capital assessment. Contextualisation of results by incorporating outcomes of stakeholder engagement and spatial analysis. Qualitative narrative on wider ecosystem services not assessed in monetary or biophysical terms to provide a holistic perspective on natural capital value generated.
6. Interpret results and identify limitations in the assessment.

3.1.2 Desk-based research: Data Sources

The data sources used for the desk-based assessment of natural capital assets and ecosystem services are listed below.

- Corine Land Cover 2018 [11]
- Statutory Main Rivers [12]
- OS Open Rivers [13]
- OpenStreetMap Waterways [14]
- National Forest Inventory woodland [15]
- England Peat Status GHG and C Storage [16]
- Ancient Woodland Inventory [17]
- Priority Habitat Inventory [18]
- Water Framework Directive/ Water Environment Regulations (WFD/WER) catchment data – waterbody classifications and extent (rivers, surface waters and groundwaters) [19]

- WFD/WER waterbody extent (rivers, surface waters, transitional and coastal waterbodies, lakes and groundwater bodies) [20] [21] [22]
- Felling Licence Applications [23]
- Surface Water Availability for Water Resource Charging [24]
- Groundwater Management Units coloured according to water resource availability [25]
- Bathing waters data [26]
- Sites of Special Scientific Interest [27]
- Special Protected Areas [28]
- Special Area of Conservation [29]
- Ramsar Sites [30]
- National Nature Reserves [31]
- Local Nature Reserves [32]
- Natural England Green Infrastructure Map [33]
- Outdoor Recreation Valuation (ORVal) Tool [34]
- NCRAT Data Support Package[7]

3.1.3 Materiality assessment

The NCRAT requires a range of local information to be entered into the tool to support the assessment. There are instances where the level of effort required to gather the data for a specific input is disproportionate to the scale of the study and relevance of the data to the scheme. In these instances, the information is excluded from the tool. There are also ecosystem services that are not quantified or given a monetary value by the NCRAT but that may be of importance in the catchment (e.g. pollination or soil erosion/ retention) and therefore require additional analysis to capture the potential benefits and provide a more well-rounded account.

An initial materiality assessment was undertaken to determine which ecosystem services are of direct relevance to the catchment and should be considered as part of the baseline natural capital account (e.g. the ecosystem services that are provided currently). The list of ecosystem services outlined in the Natural England Accounting for National Nature Reserves report [35] was used as the basis to scope services in/out of the assessment.

The results of the materiality assessment, including an overview of the ecosystem services that have been scoped in/out is provided in section 4.1.1.

3.1.4 NCRAT

The Environment Agency's NCRAT has been used to develop a baseline of the condition and extent of natural capital assets and help understand and quantify the value and benefits that they provide to society. The NCRAT has been selected as it provides a consistent methodology to develop natural capital registers and accounts for each of the catchments within the Fens2100+ project. The NCRAT is also best suited for use at the strategic scale (above 10,000 ha) and therefore is most suitable for the size of catchments that are considered as part of Fens2100+. An overview of the NCRAT is provided in 2.3.2 and further guidance on the tool can be found in The Natural Capital Register and Account Tool, Version 1.2 – Technical Report [9].

[7] This package was provided by the Environment Agency and is not publicly available.

3.1.5 Confidence Ratings

The NCRAT considers thirteen key ecosystem services as shown below in Figure 5.

Figure 5: Ecosystem services quantified and valued in the NCRAT. Environment Agency © [8]

A natural capital register and account will only ever reveal a partial value of nature, however the benefits statement provides an overview of the flows of ecosystem services from assets and the calculated monetary values of selected services including present value over time. Monetary values have been provided for annual flows and for asset value over a 100-year period (minimum and maximum values also provided where data is available).

Confidence ratings have then been assigned to the monetary values presented for each of the ecosystem services to highlight where the data used to calculate a monetary value is considered to be of greater quality or more appropriate. These confidence intervals are assigned based on a Red-Amber-Green (RAG) rating in line with the NCRAT methodology and are illustrated in Table 1 [9].

As highlighted in Section 3.1.1, the number of ecosystem services and benefits provided by a place vary, and not all of them can be quantified. This means that not all services are currently represented within NCRAT.

Table 1: Confidence rating definitions

Confidence rating	Definition
Green	High confidence in results. Input data and assumptions are based on statistical reports, peer reviewed values or industry standard methodologies
Amber	Moderate confidence in results. Input data and/or assumptions from single source/not peer reviewed or based on sources that are not specifically tailored to this context. Some assumptions or estimations may be open to question. Accuracy is expected to better than plus or minus 50%.
Red	Low confidence in results. Input data and/or parameters from a single source and low level of transferability from original context. It is expected that estimate is in the right order of magnitude. Order of magnitude implies that, for example, for an estimate of 5 the 'real' figure is within the range 0.5 to 50.

Confidence rating	Definition
No number provided	It is not possible to provide a result that can be judged to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. Currently limited to qualitative assessment only.

3.1.6 Stakeholder Engagement

Stakeholder engagement is valuable to help determining the input data and interpreting the results from the register and account. Other organisations and local stakeholder groups such as The Wildlife Trusts may be able to provide (or have access to) locally specific data, as well as providing different perspectives to qualitative assessments such as risks, pressures, and the significance of benefits in a place.

The qualitative aspects of the assessment, such as the significance assessment, have been based on professional judgement and understanding of the catchment. It is recommended that this be refined through engagement with stakeholders as part of any future update and project progression.

3.1.7 Limitations and assumptions

The following assumptions should be noted, in addition to those provided in the NCRAT [8].

- All values within the analysis were expressed in 2024 prices and British Pound (GBP).
- The 'Risk Register,' 'Significance Assessment,' and 'Beneficiaries Assessment' tabs in the NCRAT spreadsheet tool have been completed without detailed stakeholder engagement having been undertaken. It is recommended that this be refined through engagement with stakeholders as part of any future update and project progression. However, the inputs for these assessments do not impact the overall natural capital value calculated for the study area.
- The widths of Statutory Main Rivers and ordinary watercourses, which are mapped using both the OS Open Rivers and OpenStreetMap datasets, were estimated using aerial imagery of the catchment. It should be noted that there are a large number of man-made drainage ditches and channels across the catchment that are not accounted for in this analysis.
- Surface water operational catchments with less than 1% of their total area intersecting with the catchment area have been excluded from NCRAT calculations.
- Woodland areas under management are assumed to be areas with a felling licence expiry dated after 31st March 2015, this is based on the Forest Commission's definition of 'Woodland area under management' having had a felling licence in the past ten years, being owned by government organisations, or having a management plan [36].
- Peatland condition classifications are assigned based on the estimated rate of GHG flux (named 'newghgr' in the 'England Peat Status GHG and C storage dataset') and the closest emission factor provided in the Peatland Code Field Protocol [37].
- To calculate input values for water supply and renewable energy, local authority data was used and adjusted in proportion to size of the catchment. This assumes that the distribution of renewable energy and water supply is even across the local authority.

- To estimate the number of recreational visits in the catchment and the associated value of this, ORVal data was used for each of the Middle layer Super Output Areas (MSOAs) in the catchment. Where an MSOA is only partially within the catchment, the number of visits and associated value was scaled down relative to the area within the catchment – this assumes that the distribution of recreational visits for each welfare group is even across the MSOA.
- Groundwater management units that have been identified by the Environment Agency as having water available for consumptive abstraction on a 'case-by-case' basis have been considered as 'water not available for licensing'.
- Surface water operational catchments with less than 1% of their total area intersecting with the catchment area have been excluded from NCRAT calculations.

The following limitations should also be considered:

- Data resolution is generally low; with the majority of habitat data being derived from remote sensing datasets such as CORINE Land Cover or the Centre for Ecology and Hydrology Land Cover Maps being the main data sources for the assessment. Datasets such as the National Forest Inventory, EA Statutory Main Rivers and OS Open Rivers were used to supplement habitat type data and reduce this limitation.
- The provision of biodiversity benefits is currently not quantifiable within the tool (for example when comparing arable land to more biodiverse semi-natural habitats).
- Since there is no marine habitat in the catchment, the provision of food from fish and shellfish landings has not been included. This is because there is no port recording any fish or shellfish landings, and it is not possible to attribute these benefits to the study area.
- The net carbon sequestration rate for arable land is based on Christie et al. 2011 at 0.107tCO_2e/ha/yr[8], resulting in a net sequestration of carbon [38]. More recent data collated in the Natural England report 'Carbon Storage and Sequestration by Habitat 2021 (NERR094)' uses figures from a study by Muhammed et al. 2018 which showed a net emission rate of 0.290tCO_2e/ha/yr for arable land and a net sequestration rate of 0.360tCO_2e/ha/yr for improved grasslands [39]. There is variation in carbon fluxes on arable land based on a variety of factors, including production and application of fertilisers, vegetation type, catchment topography, weather, and land use. However, it is likely that the 0.107tCO_2e/ha/yr figure does not provide an accurate picture of carbon fluxes within the catchment.
- The area of freshwater habitats is likely to be underrepresented in this study due to the large number of drainage channels in the catchment that are not captured in the EA Main River, OS Open Rivers or OpenStreetMap datasets.
- The NCRAT uses values from the Outdoor Recreation Valuation (ORVal) Tool [34] to estimate welfare values. Welfare values for an existing site are estimated by calculating how much each individual's welfare would fall if they were no longer able to access that site and then converting that welfare quantity into an equivalent monetary amount. These values may represent an undervaluation as it is based on a travel cost method.

[8] Tonnes of carbon dioxide equivalent per year. This is a measure of how much carbon dioxide would have to be released to have an equivalent warming impact to the amounts of other greenhouse gases.

- The NCRAT uses national data to calculate the natural capital value for agriculture. This is based on the average of the John Nix Farm management units Editions 49-52, years 2019-2022 [40]. The natural capital value is updated for the 2024 accounting price year which takes account of inflation to the price base. Local deviations from the national average may lead to the value of local agriculture being misrepresented. In the catchment, there is a higher proportion of arable agriculture and fruit / vegetable crops than the national average, meaning that the NCRAT is likely to underestimate the value of food production.
- The NCRAT values water quality based on all the Water Framework Directive/Water Environment Regulations (WFD/WER) surface water bodies in the operational catchments that the catchment intersects ('Glens', 'Welland Lower', and South Forty Foot Drain'. There are 12 surface water bodies within the catchment boundary. Seven of these waterbodies score 'moderate' for ecological status for the River Basin Management Plan Cycle 3. Three waterbodies score 'poor', one scores 'bad. Kirton Marsh Drain is the only waterbody to score 'good' for ecological status in the catchment.
- The 'England Peat Status GHG and C storage dataset' is expected to be an overestimate of peatland extent in the Fens2100+ study area, based on a comparison with more recent data published by Natural England [41]. This indicates the amount of carbon dioxide emitted as a result of actively eroding or degraded peatland has also been overestimated, so the monetary value of climate regulation in the catchment is expected to be greater than calculated for this baseline.
- It is likely that these limitations lead to an underestimate of the benefits provided by semi-natural habitats and furthermore underestimate the negative impacts of arable land while overemphasising the wider benefits of arable land, beyond food production.
- This baseline assessment has not been informed or verified by any field surveys or site visits conducted by Arup.
- This baseline assessment is currently limited to the catchment boundary that has been defined for the Fens2100+ project by the Environment Agency. There is no official data boundary that matches the catchment study area.
- The baseline information collated comprises a proportionate level of detail from publicly available data sources and it is reported at the geographical basis relevant to the data availability. Therefore, this report reviews and provides commentary of existing reports written by others. Arup accept no responsibility for any error or omission in this report which is due to an error or omission in the original documentation we refer to. Arup have not independently verified the information and have assumed it to be accurate, complete, reliable, and current as of the date of such information.

4. The natural capital register and account for the catchment

4.1 Materiality Assessment

A summary of ecosystem services to be scoped in/out of the assessment is provided in Table 2. The initial materiality assessment highlighted that the majority of ecosystem services are of significance and should therefore be scoped into the assessment. Of those services that have been scoped out, this is predominantly due to lack of ports and fish/ shellfish landings within the catchment, predominance of cultivated farmland and lack of woodland. Of those that have been scoped into the assessment, six are not quantified by NCRAT and require additional qualitative analysis. These are indicated using '*' in Table 2.

Please note:

- Ecosystem services related to wild plants, algae & their outputs, wild animals & their outputs, and aquaculture have been scoped out due to lack of reliable data on gathering rates and/or lack of suitable habitat for these benefits to materialise (e.g. availability of coastal waters for fishing and/or aquaculture, presence of ports that record fish landings, availability of land used for commercial hunting, datasets on foraging rates).
- Noise regulation benefits were scoped out of the assessment, as most approaches to quantifying benefits are based on complex modelling that requires significant collection of location-specific data.

Table 2: Materiality Assessment summary

Scoped in	Scoped out
• Materials from plants, animals & algae • Cultivated crops • Water supply • Reared animals & their outputs • Water quality • Air quality • Mass stabilisation and control of erosion rates* • Flood protection • Global, regional & local climate regulation • Pollination & seed dispersal* • Maintenance of nursery populations and habitats* • Pest & disease control* • Global, regional & local climate regulation • Experiential and physical use • Scientific and educational use • Aesthetic* • Spiritual*	• Wild animals & their outputs • Wild plants, algae and their outputs • Aquaculture • Noise regulation

4.2 Natural Assets

4.2.1 Land cover types in the catchment

This section focuses on providing an overview of the quantity, quality and location of natural capital assets within the catchment, which contains approximately 47,299ha of terrestrial and coastal habitats. The vast majority of the catchment is made up of non-irrigated arable land, with the remaining land comprising smaller areas of discontinuous urban fabric, watercourses, waterbodies, mineral extraction sites, and sport and leisure facilities (see Figure 6).

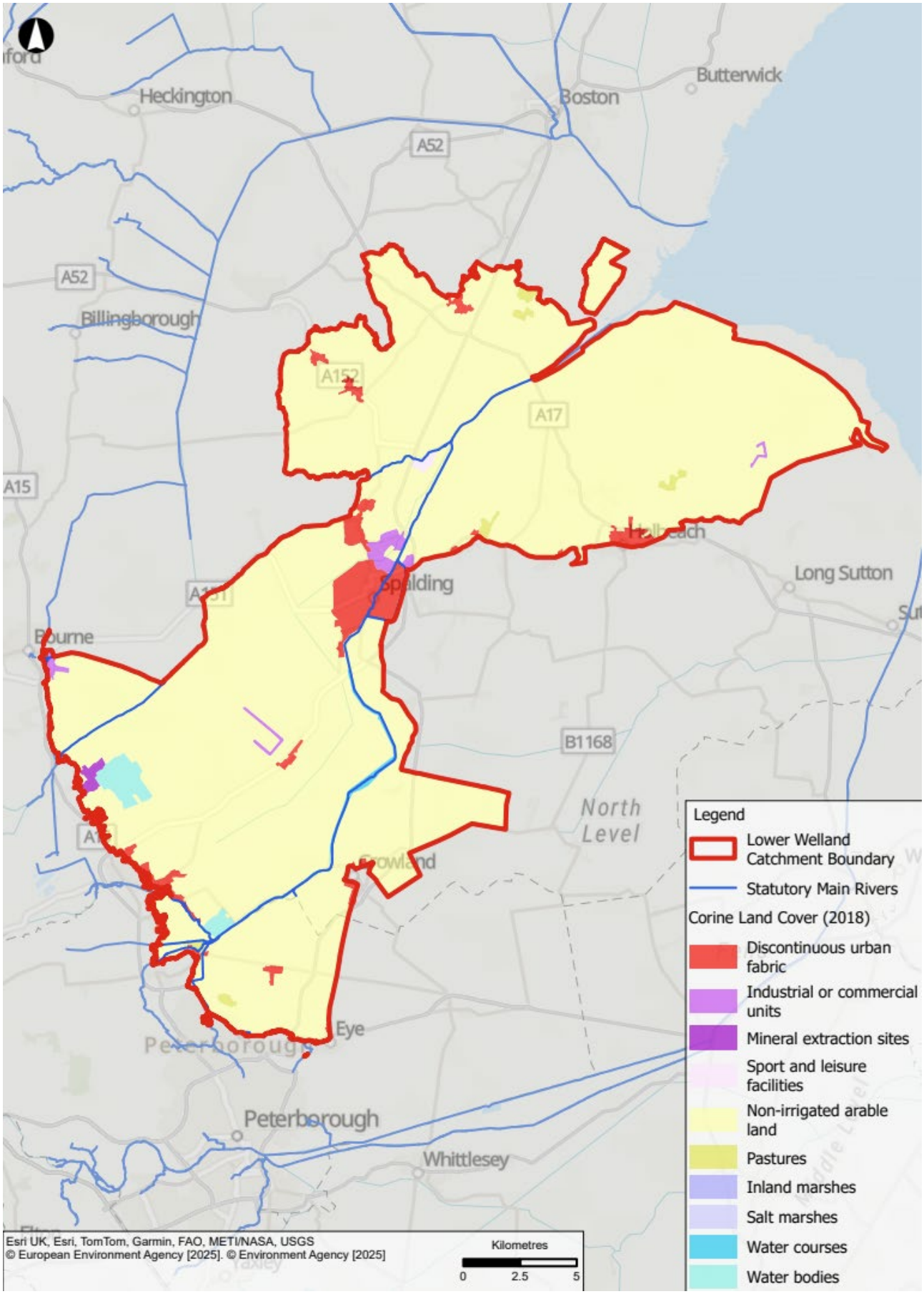

Figure 6: Overview of Corine Land Cover for the catchment

For the purpose of this report, the natural capital assets in the catchment have been grouped according to UK National Ecosystem Assessment (UKNEA) broad habitat types. The quantity of each habitat type in the catchment is shown in Figure 7. The Office for National Statistics UK Natural Capital Accounts methodology guide provides further detail on habitat types and the methods used to estimate habitat extent, ecosystem services and asset value in the UK[9].

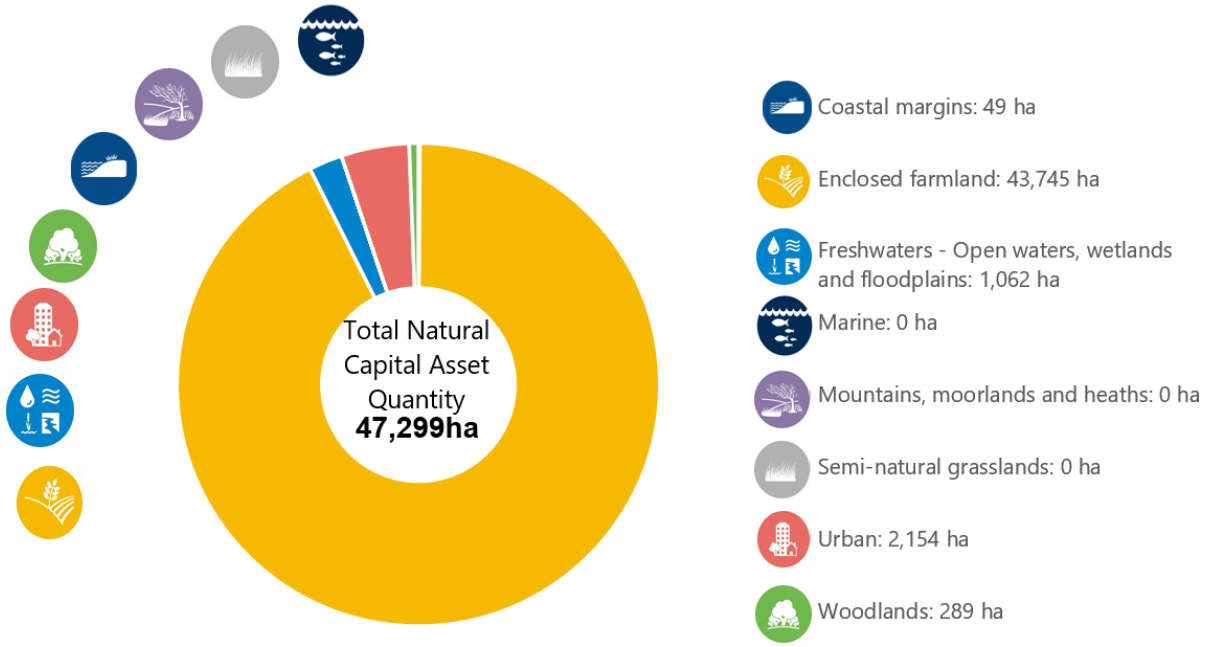

Figure 7: Natural capital asset quantity within the catchment. Based on the UK Natural Capital Ecosystem Assessment broad habitat types / land cover data

4.2.1.1 Coastal margins

The catchment has approximately 19.7km of coastline along the North Sea and 49ha of coastal saltmarsh. The catchment intersects with the south-western coastline of The Wash, an intertidal embayment designated as a Ramsar site, Special Protection Area, National Nature Reserve, Special Area of Conservation, and Site of Special Scientific Interest. The coastal habitats just beyond the catchment boundary are of significant importance due to habitats such as sublittoral sandbanks, sandflats, mudflats, shallow inlets and reefs which attract a range of wildlife including wintering waterbirds; passage birds; waders; breeding birds; harbour seal *Phoca vitulina*; and shellfish [42] [43] [44].

These coastal margins in the catchment are constituted by a mixture of priority habitats: coastal saltmarsh, saline lagoons, and mudflats [45]. These coastal habitats protect against erosion and flooding by dissipating waves, trapping sediment, and creating buffer zones that store water during storms. Additionally, they provide various other ecosystem services, including water quality improvement, carbon sequestration, biodiversity, recreation and tourism, cultural and historic value, and serve as nurseries for many commercial fish species.

[9] Office for National Statistics. (2024). UK natural capital accounts methodology guide: 2024. Available at: https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/uknaturalcapitalaccountsmethodologyguide2024/pdf [Accessed 14 March 2025].

4.2.1.2 Enclosed farmland

Enclosed farmland or agricultural land is essential for food production and provides local employment. Additionally, it can support a variety of wintering and breeding birds, as well as provide habitat connectivity through hedgerow and ditch networks for a variety of other species.

By far the most abundant land cover type in the catchment is enclosed farmland, covering an area of 43,745ha – 92.5% of the catchment. Approximately 24,249 hectares (51.3%) of the catchment is classified as Grade 1 land using the Agricultural Land Classification, making the Lower Welland the only catchment within the wider Fens2100+ study area to be majority Grade 1[10]. Approximately 20,000 hectares (42%) is rated as Grade 2. Therefore, more than 93% or 44,000 hectares of the catchment is Grade 1 or 2, the second highest level, after the Witham South Forty Foot catchment of any catchment in the wider Fens2100+ study area [46]. Figure 8 shows the distribution of these grades across the catchment.

According to 2018 Corine Land Cover, 99.5% (43,508ha) of farmland is used for arable agriculture or horticulture (includes cereal crops, fruit and vegetables and other arable crops), including the limited production of some higher value crops in rotation such as brassicas. In 2022, this was estimated to be approximately 85.8% based on estimated land use, crop areas and livestock populations on commercial agricultural holdings [3][11]. Approximately 0.5% (237ha) of farmland is modified grassland, used for the keeping of livestock, with a number of farms producing beef cattle and/or sheep. In 2022, the total population of cattle, sheep and pigs on commercial agricultural holdings in the catchment was estimated to be 11,483, and poultry at a further 1.1 million [46].

It should be noted that since 2019 there has been significant change and market disruptions in agriculture and the food supply, notably the Agricultural Transition following UK exit from the EU. The Agricultural Transition includes the phase out of subsidies such as the Basic Payment Scheme, and the introduction of the Environmental Land Management Scheme and associated pilots which are influencing the type and extent of cropping across the catchment and beyond. Additionally, cropping regimes and agricultural output per hectare on an annual basis is also extremely variable from crop to crop and farm to farm, with impacts such as climate change and extreme weather also influencing agriculture in the catchment.

[10] Grade 1 agricultural land is excellent quality agricultural land with no or very minor limitations for growing agricultural and horticultural crops.
Grade 2 agricultural land is very good quality land with minor limitations that affect crop yield, cultivations or harvesting.
Grade 3 agricultural land is good quality land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of other crops including oilseed rape, potatoes and sugar beet.

[11] Refer to section 4.2 of Fens 2100+ (2025) Lower Welland Environment and Agriculture Appendix

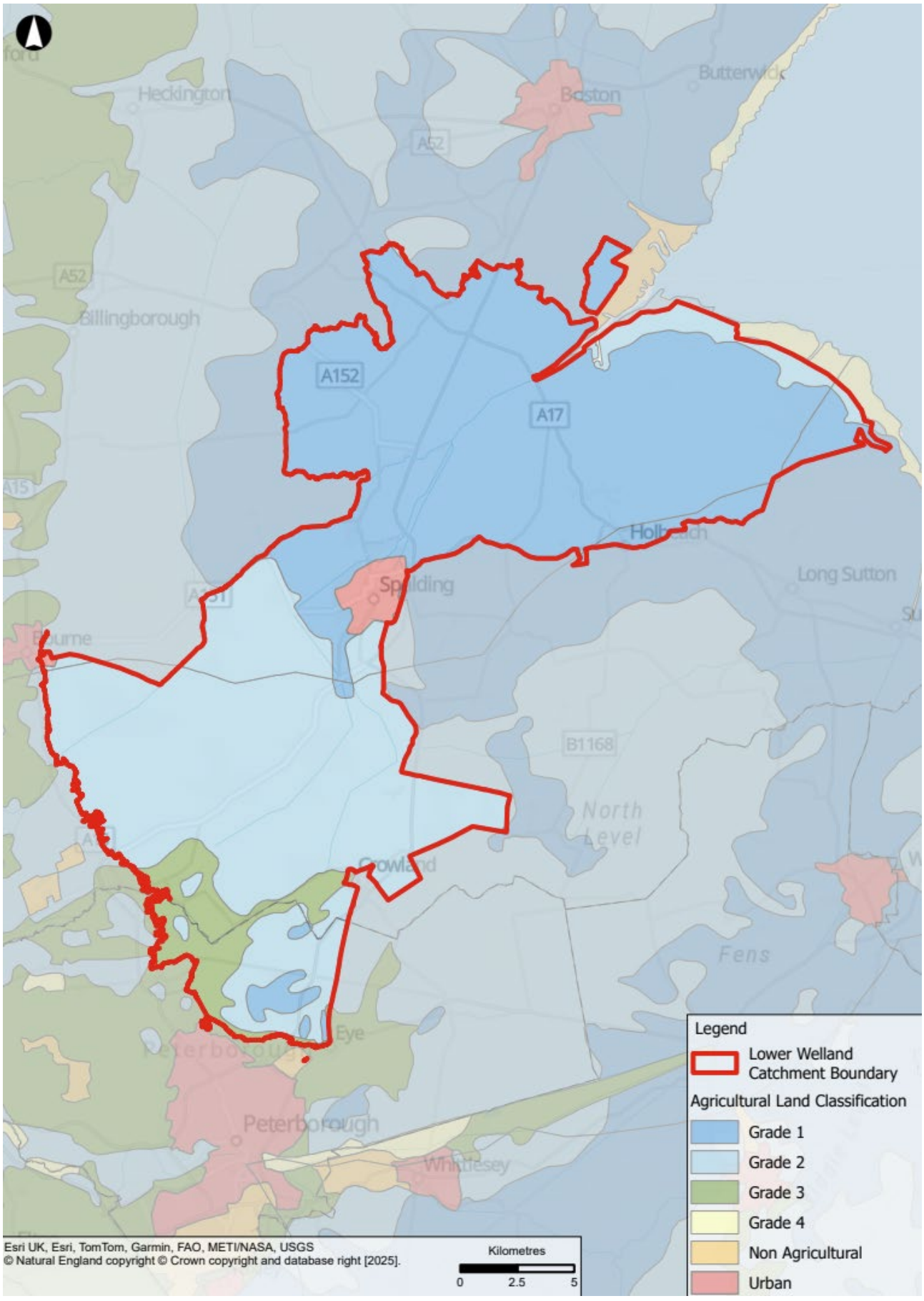

Figure 8: Overview of the Agricultural Land Classification within the catchment

4.2.1.3 Urban areas

Urban land is generally characterised by significant alteration from semi-natural habitats caused by humans. Nonetheless, urban land can contain a variety of natural and/or semi-natural natural capital assets in the form of blue or green urban infrastructure. Most commonly, these consist of parks, urban trees, gardens, and allotments. Certain types of green infrastructure such as parks are generally open to the general public and can be crucial in providing a variety of cultural ecosystem services, such as benefits for health and wellbeing, providing aesthetic value and cultural heritage.

There are a number of designated heritage assets located within the vicinity of urban areas. In the catchment there are 389 designated assets, including 9 conservation areas, 26 scheduled monuments, and 14 Grade I listed buildings. Additionally, a large number of non-designated heritage assets are present throughout the catchment such as yet undiscovered archaeological remains, which are likely to be particularly well preserved within peat soils. For the historic environment, natural capital benefits can be attributed to aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora. Key benefits associated with historic environment assets include amenity, landscape and non-use values, with beneficiaries likely to include local communities and wider society that visit.

The largest urban area in the catchment is the historic market town of Spalding in the centre of the catchment. There are several other villages concentrated in the north of the catchment, including Algarkirk, Gosberton, and Surfleet. The southern half of the catchment is more sparsely populated, with the largest village being Deeping St Nicholas.

4.2.1.4 Woodlands

Woodlands are essential for carbon sequestration, biodiversity, recreation, and economic value, significantly contributing to the country's natural capital. They also provide other vital ecosystem services such as soil formation, water regulation, and air purification. These services not only support environmental health but also enhance human well-being by improving air quality and reducing the impacts of climate change. Additionally, woodlands offer recreational opportunities that promote physical and mental health, and they support various economic activities, including timber production and tourism.

The catchment contains approximately 289ha of woodland, predominantly made up of broadleaved woodland (209ha). There are approximately 5ha of commercial woodland that is actively managed with a felling licence valid within the last 10 years [15]. There is also a small amount of coniferous woodland in the catchment (17ha). No ancient woodland is present in the catchment.

4.2.1.5 Freshwaters and groundwaters

Freshwater habitats are crucial for supplying drinking water; managing flood risk; supporting a wide variety of activities that benefit health, wellbeing, and economic activity; and can be a significant carbon sink. The east of England is also particularly reliant on water for the irrigation of crops, particularly in the months between June and August; agriculture in this region accounts for approximately 10% of the total water demand [47].

To the west of the catchment is an area of higher ground underlain by the Lincolnshire Limestone. Flow from the highland areas is conveyed into the catchment by the upper

course of the River Welland, and the East Glen River and West Glen River which converge just upstream of the catchment boundary to form the River Glen. No part of the catchment study area is underlain by a WFD/WER groundwater body, so the availability of water is determined by the potential storage of surface water in the drainage system. This is influenced by level management in the area and the amount of surface runoff into the system. Given the lack of groundwater bodies within the catchment, there is little to no groundwater available for abstraction within the catchment. Consequently, users requiring significant irrigation throughout the catchment have invested in irrigation reservoirs, to store winter abstracted water for summer irrigation use.

Freshwater habitats, including rivers and streams, comprise 1,062ha of the catchment, however this is likely to be under representative due to the large number of drainage channels managed by land-owners and IDBs that are not captured in the EA Main River, OS Open Rivers or OpenStreetMap datasets.

The southern half of the catchment predominately falls within the ‘Vernatt’s Drain’ river water body catchment, with the northern half of the catchment split between several smaller river water bodies, the largest being the Whaplode River water body south of the Welland. A portion of the north-eastern catchment falls within ‘Wash Inner’ transitional water body extent, which is located within The Wash Transitional and Coastal (TraC) operational catchment, as part of the wider Anglian TRaC management catchment area. Section 4.4 of the Fens2100+ Lower Witham: Environment and Agriculture Appendix provides an overview of the Cycle 3 (2022) status classifications for surface waterbodies within the catchment. The location and extent of these surface water body catchments is shown in Figure 9.

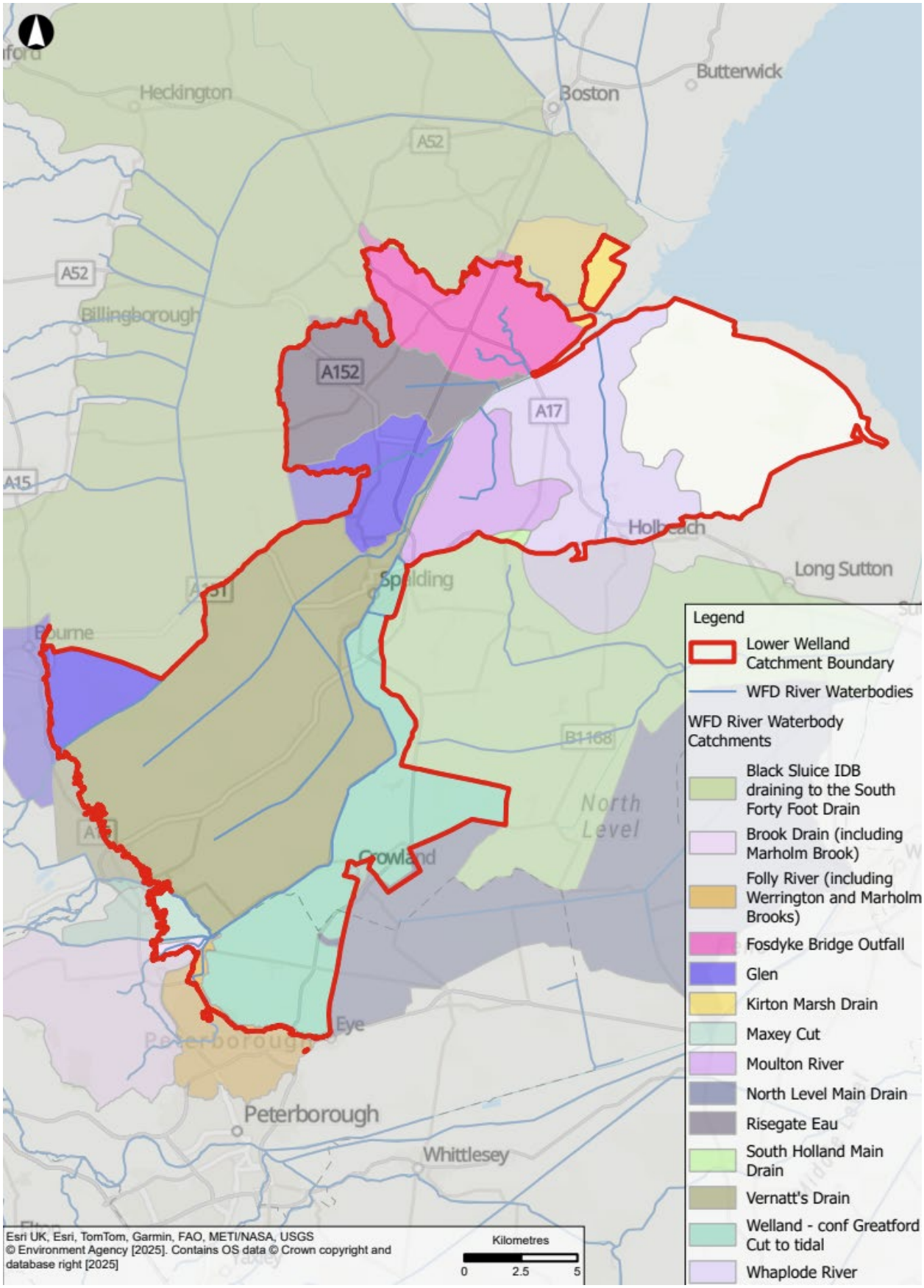

Figure 9: Water Environment Regulations / Water Framework Directive surface waterbodies in the catchment

4.2.2 Peatland in the catchment

Peatlands are wetland areas with a natural layer of peat soils, formed from carbon rich dead and decaying plants under waterlogged conditions. They provide a variety of crucial services to society [48]. Firstly, peatlands represent an important carbon sink globally and have the potential to regulate atmospheric carbon when in a healthy waterlogged condition. However, once peats are in a degraded condition they become carbon sources – this is the case for the majority of peatlands in the UK [49]. Peatlands also provide habitat for a diverse range of species, from *Sphagnum* mosses to butterworts and the common crane. Healthy peatlands provide flood management by retaining water and slowing the flow, and provide important sources of high-quality water that can be easily treated for drinking water [48].

According to Natural England's dataset 'England Peat Status GHG and C storage', approximately 8,804ha of peatland is present within the catchment. Corine Land Cover data classifies areas with indicative peat presence as 'modified grassland' and 'arable and horticulture', which is indicative of peat degradation.

Furthermore, there is uncertainty and inconsistencies in data available on extent and condition across the wider Fens. Holman and Kechavarzi estimate that less than 32,000 hectares of peatland (thick peat, peat at depth, or thin peat), was still extant in the Fens as a whole, compared to c.150,000 hectares identified as such by the peaty soils locations layer [50]. The Fens for the Future report [51] explains how peatland in the Fens has been degraded through drainage for arable cultivation. Once degraded, peatland emits CO_2 and methane; a report on peatland natural capital by the Office for National Statistics estimates that 7,600 kilotons of carbon dioxide equivalents per year are emitted as a result of arable practices on peatland [52].

Peatland condition classifications are assigned based on the estimated rate of GHG flux (named 'newghgr' in the 'England Peat Status GHG and C storage dataset') and the closest emission factor provided in the Peatland Code Field Protocol [35].

The baseline condition of this peatland is categorised as 'actively eroding' (approximately 25.3%) or 'drained' (74.7%) using the peatlands emission factor ($tCO_2e/ha/yr$), in accordance with the Peatland Code Field Protocol [37] (see Section 3.1.7 for limitations of this method). For peatland in an 'actively eroding' condition, the assumed emission factor is 23.8 $tCO_2e/ha/yr$, over five times larger than for peatland in 'drained' condition, for which the assumed emission factor is 4.54 $tCO_2e/ha/yr$ [37].

Natural England recently released the 2025 England Peat Map [41]. This provides a more accurate and detailed picture of the current state of peatland when compared to the 'England Peat Status GHG and C storage' dataset [16] that has been used for this Natural Capital Baseline. The new peat map has been developed using machine learning, satellite imagery, LiDAR, and updated field surveys to detect peat soils that were previously unmapped or misclassified. The new 2025 peat map shows both gains in mapped extent (due to better detection) and losses or degradation (due to environmental change).

The 2025 England Peat Map suggests that the peatland extents used in this baseline (based on the 2008 England Peat Status dataset) are an overestimation. The new peat map shows approximately 78,000ha of deep peaty soils across all catchments in the Fens2100+ study area, whereas the 2008 dataset shows approximately 155,000ha. There is approximately 70,000ha of intersecting peatland extents between the two datasets, highlighting that the new peat map has identified roughly 8,000ha of previously unmapped peatland across the Fens2100 study area. For climate regulation, this indicates the amount of carbon dioxide emitted as a result of actively eroding peatland has also been

overestimated, so the value of climate regulation is expected to be greater than calculated for this baseline.

As the Natural Capital baseline assessment uses the 2008 ‘England Peat Status GHG and C storage’ dataset, percentage coverages of peat are not directly comparable with the catchment summary report (which uses the 2025 England Peat Map).

4.2.3 Protected areas for biodiversity

There are twelve statutory internationally or nationally designated nature conservation sites within or partially within the catchment, some of which overlap with other designations. These comprise:

- **The Wash** – Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Ramsar site and National Nature Reserve (NNR);
- **The Wash & North Norfolk Coast** – SAC;
- **Deeping Gravel Pits** – SSSI;
- **Cowbit Wash** – SSSI;
- **Cross Drain** – SSSI;
- **Baston and Thurlby Fens** – SSSI;
- **Surfleet Lows** – SSSI;
- **Baston Fen** – SAC;
- **Vernatts** – Local Nature Reserve (LNR).

The location of each designated site is shown in Figure 10, and a summary of each site is provided below.

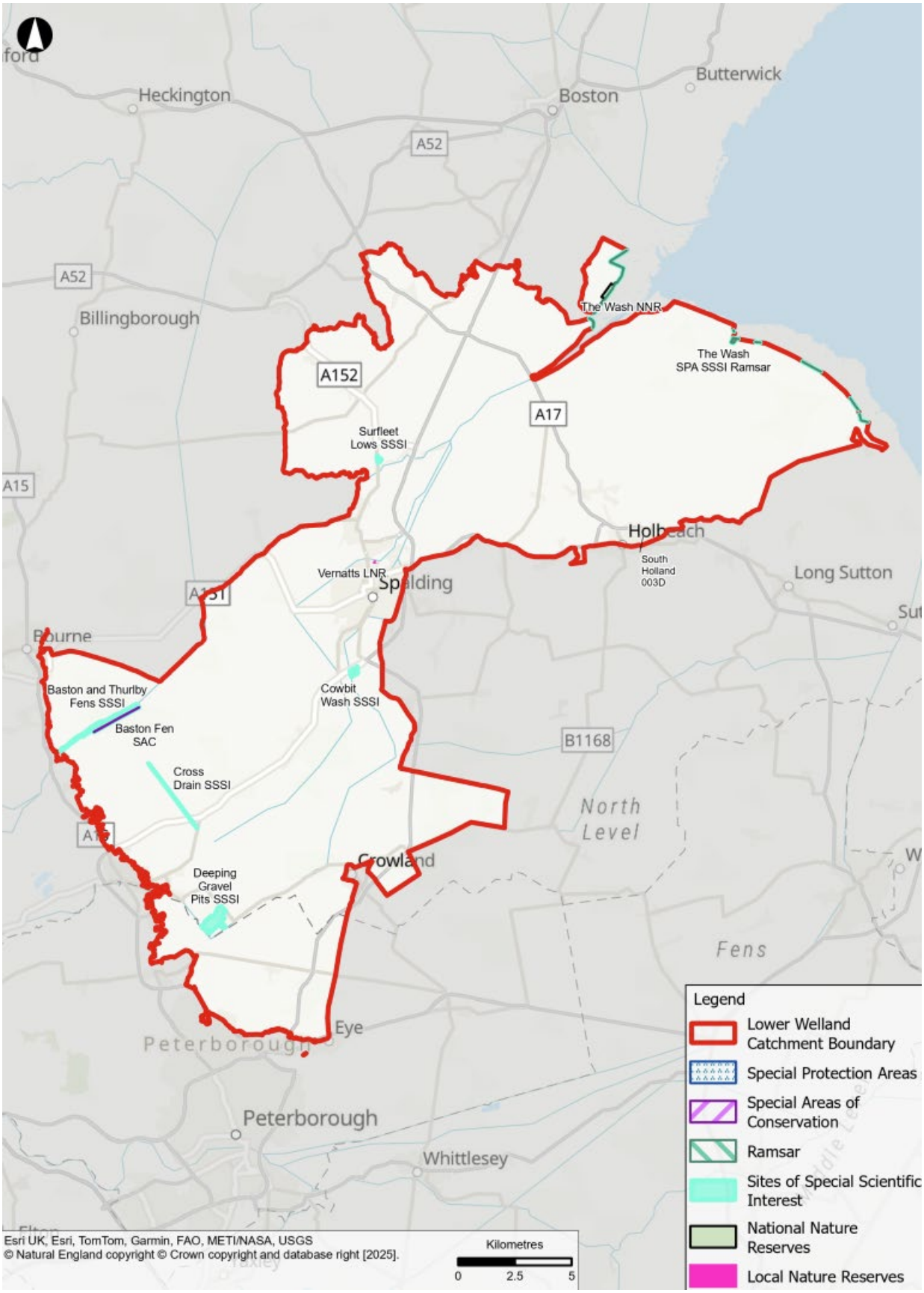

Figure 10: Overview of Designated sites for nature conservation within the catchment

4.2.3.1 The Wash (SPA, Ramsar site, NNR and SSSI)

The Wash covers a very small area of the catchment (approximately 7.2ha). The Wash SPA forms part of the larger Wash and North Norfolk Coast Special Area of Conservation which encompasses the largest embayment in the UK, as well as extensive intertidal sand and mudflats, subtidal sandbanks, biogenic and geogenic reef, saltmarsh and a barrier beach system unique in the UK. The Wash SPA supports a large number of non-breeding bird species such as bar-tailed godwit; Bewick's swan and black-tailed godwit [43].

The Wash Ramsar site is Britain’s largest estuarine system, fed by four rivers and has extensive saltmarshes, intertidal banks, and deep channels. This aspect of the site is crucial for wildfowl and wading birds, supports a shellfish fishery, and hosts large populations of common and grey seal [44] [53].

4.2.3.2 Deeping Gravel Pits (SSSI)

This 57.6ha site in the south of the catchment is an important ornithological site due to its variety of habitats and undisturbed nature. It supports the largest heronry in Lincolnshire with over seventy occupied nests and hosts a diverse community of wintering wildfowl and breeding birds. The site also features rich aquatic and fen vegetation.

4.2.3.3 Cowbit Wash (SSSI)

Cowbit Wash covers 9ha and is designated for its geological significance. It provides valuable data on post-glacial sea level changes through the analysis of marine sediments and freshwater peat layers.

4.2.3.4 Cross Drain (SSSI)

Cross Drain covers 5.7ha and is one of the best remaining areas of open water typical of fenland, supporting an exceptional beetle fauna, including two national rarities, and a diverse aquatic flora with nationally scarce plants. The water flows slowly over a gravelly, sandy bed, hosting species like lesser water plantain and fen pondweed. This habitat holds over 20% of all British water beetles, reflecting its low nutrient status and unpolluted nature, which is exceptional in an arable environment.

4.2.3.5 Baston and Thurlby Fens (SSSI)

This 55ha site is designated as a Site of Special Scientific Interest (SSSI) due to it being the best remaining examples of wild wetland to be found in the northern half of the Fens. This washland habitat features flooded borrow pits and marshes, supporting diverse wetland plant communities. The site is a stronghold for the spined loach and hosts an exceptionally rich dragonfly and damselfly fauna, including species like the hairy dragonfly and ruddy darter.

4.2.3.6 Surfleet Lows (SSSI)

Surfleet Lows has been designated as a Site of Special Scientific Interest (SSSI) as a rare example of a wet alluvial meadow in Lincolnshire, largely untouched by agricultural improvement. This unique habitat supports a diverse range of meadow and coastal plant species. The meadow's high salinity, a remnant of its coastal creek origins, fosters the growth of brackish marsh plants, while winter flooding attracts various waterfowl and other bird species.

4.2.3.7 Baston Fen (SAC)

Baston Fen is a small 2.2ha site designated for the Annex II species, spined loach. The Counterdrain (a large drainage channel alongside Baston Fen) hosts high densities of this species, showcasing one of the few significant populations in the Welland catchment. The submerged plants provide excellent habitat, making this one of only four outstanding localities for the spined loach in the United Kingdom.

4.2.3.8 Vernatts (LNR)

Vernatts LNR is a small 1.6ha site within the urban fabric of northern Spalding, which was once used by British Sugar employees as a fishing and shooting ground. The wildflower meadow habitat attracts damselflies and small copper butterflies and a mixture of wetland habitats include reedbeds, marsh and a large pond. This is home for the elusive water vole, reed warblers, and many insect species.

4.2.4 Risk Register

The NCRAT includes a Risk Register that highlights how drivers of environmental change may present risks to the quality and quantity of natural assets in the study area. This can be used to highlight which ecosystem services are under pressure and limited in their capacity to continue to provide future benefits.

The assessment of risk is qualitative and informed by the prevalence of the driver of environmental change, as well as the extent and condition of the natural asset in the study area. The drivers of change assessed in the NCRAT are described in Table 3.

Table 3: Drivers of environmental change considered in the Risk Register

Driver of change	Definition
Land-use change (incl. habitat loss)	This can be the result of a number of drivers including development and coastal erosion as well as hazards (e.g. forest fires). Land-use change is usually permanent but it could also be temporary. It is likely to affect the extent of natural capital asset rather than condition.
Climate change	This includes drivers on habitats from changing climatic conditions including temperature, precipitation, soil aridity and storminess. Assessments of the likely impact of climate change over this century are provided in UK Climate Projections[12]
Resource extraction (incl. over-exploitation)	Over-exploitation of resources can impact natural assets through both direct physical damage and additional stress on the resources on which they rely (e.g. water availability).
Population growth	Driver which comes from the demands of a higher population on natural resources and the environment.

[12] UK Climate Projections are available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

	Note that the impact of population growth may be through future land-use change, resource extraction, and pollution.
Pollution	Includes both diffuse sources (e.g. agriculture, urban run-off, atmospheric deposition) and point sources (e.g. sewer overflows, wastewater treatment, abandoned mines).
Invasive species/diseases/pathogens	Invasive species/diseases/pathogens can have significant impacts on ecosystems, threatening the abundance and health of native species.

For this catchment, the natural assets under most pressure are coastal margins; enclosed farmland; freshwaters; and woodland. The primary drivers of this are land-use change (including habitat loss), climate change, and resource extraction. Figure 11 shows which ecosystem services are most at risk due to strain on a natural asset.

Level of pressure categories	Description
High	High likelihood the pressure will affect natural asset(s) and high risk of loss of ecosystem service.
Medium	Medium likelihood the pressure will affect natural asset(s) and medium risk of loss of ecosystem service.
Low	Low likelihood the pressure will affect natural asset(s) and low risk of loss of ecosystem service.
None	The pressure is not expected to affect the natural asset(s) nor ecosystem service.
No data	No data available to assess likelihood of pressure and affect on natural asset(s) nor ecosystem service.
Not assessed	Risk rating not completed
	No viable benefit-asset attribution

	Natural capital assets (NEA Broad habitat type)							
Ecosystem Services Group	Coastal margins	Enclosed farmland	Freshwaters - Open waters, wetlands and floodplains	Marine	Mountains, moorlands and heaths	Semi-natural grasslands	Urban	Woodlands
Agriculture		High			None	None		
Fish and shellfish landings	High			None				
Water supply			High					
Timber								High
Renewable energy		High	High		None			
Climate regulation	High	High			None	None		High
Air quality	High	High	High		None	None		High
Hazard regulation								
Recreation	High	High	High		None	None	Medium	High
Physical Health	High	High	High		None	None	Medium	High
Education		High	High		None	None	Medium	High
Volunteering		High	High		None	None	Medium	High
Water quality		High	High		None	None	Medium	High

Figure 11: Natural Capital Risk Register.

4.3 Ecosystem Services

The type and significance of ecosystem services in the catchment are shown in Figure 12. More information about each of these services is provided in the sections below.

As shown in Figure 12, the most significant ecosystem services in the catchment are water supply, arable agriculture, renewable energy, and climate regulation. The significance is based on a desk-top assessment of the relative provision of ecosystem service and the amount of people it will impact. The definition of each significance rating is shown in Table 4.

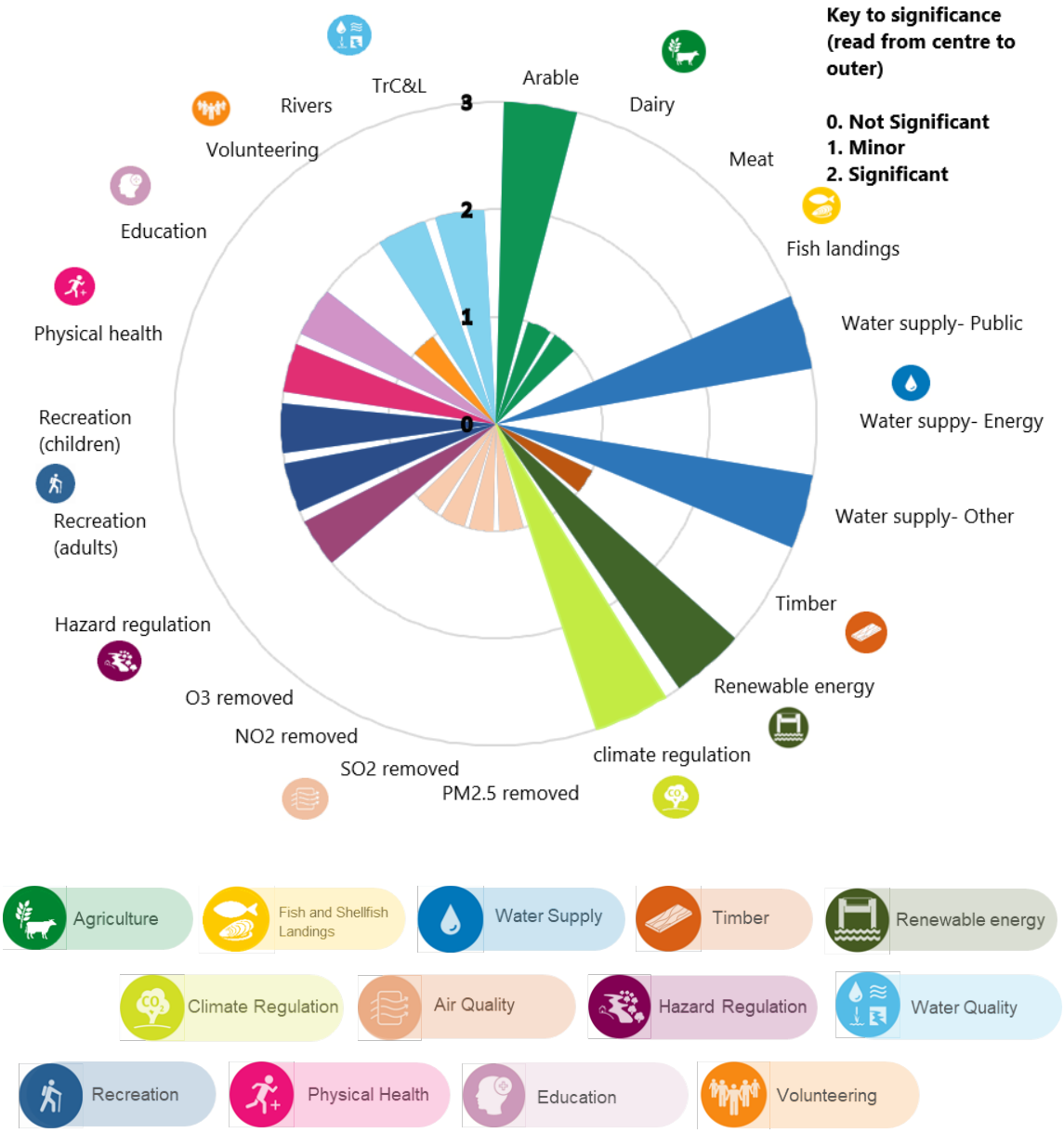

Figure 12: Rose diagram showing the significance of ecosystem services in the catchment.

Table 4: The definition of the ecosystem service significance ratings used in the NCRAT.

Significance rating	Definition
Highly significant	The benefit flow is (very) important to the place in relative terms* because it impacts the wellbeing of a significant proportion (and possibly a wide variety) of people and businesses and/or due to wider social and cultural aspects.
Significant	The benefit flow is of material importance in relative terms* because it impacts the wellbeing of a sizeable proportion of people and businesses.
Minor	The benefit flow is of minor importance in relative terms* because it does not impact most people and business. Note: it may, though, still be highly important to a small number of specific individuals or groups.
Not significant	There is very little or no provision of this benefit and it impacts only a very small number of people and businesses.

*Relative to the provision of other services/benefits within the catchment.

4.3.1 Provisioning Services

Food production

Agriculture plays an important role as an ecosystem service and land-use in the catchment. The majority of terrestrial habitat is comprised of arable fields and agricultural grasslands. Agricultural practices, such as arable farming and livestock rearing, contribute to national food security and support the local economy.

Water supply

Water abstraction for irrigation throughout the Welland catchment is managed by the Welland catchment abstraction management strategy (CAMS) [54].

The most recent CAMS reports that at Q30 flows the catchment has restricted water available[13]. The CAMS also shows that the southern extreme of the Welland catchment around Market Deeping is underlain by Lincolnshire limestone which has an aquifer, however this has no water remaining available for further abstraction.

There are three assessment points included in the CAMS within the Welland catchment at Surfleet, Kates Bridge, and Marsh Road Sluice, all of which have restricted water available. The catchment has just over 17.5 million tonnes of water available on average for abstraction per annum, with this abstractable volume however only available over a

[13] The Environment Agency's Water Resources Geographical Information System provides a snapshot in time on water availability at four flow snapshots. From high to low, these are: Q30 (i.e. the flow of a river which is exceeded on average for 30% of the time, therefore you would expect the river flow to be lower than Q30 on 256 days in an average year, i.e. a higher flow), Q50, Q70 and Q95. These are calculated for each integrated Water Framework Directive waterbody and looks at the balance between the flow in the river, the quantity needed to support the ecology and the water that can be licensed for abstraction.

limited period of the year, associated with peak flows primarily across the winter. Therefore, to ensure that high value crops can be irrigated, many farms throughout the catchment have constructed on-farm reservoirs to store winter abstracted water for summer irrigation use.

The catchment has a long history of flooding which impacts both properties and farming. A recent event includes Storm Henk – during which Crowland and Cowbit Washes stored water following a breach in the Cradge Bank. This occurred during high flows after heavy rain on an already saturated catchment.

Flooding has major impacts on crops and to a lesser extent areas of land utilised for livestock grazing. Flood events can restrict the ability to establish new crops, reduce crop yields and quality, or can destroy crops once ready for harvest leading to direct agricultural damages and wider economic consequences for landowners.

Renewable energy

Many natural processes provide a renewable energy source that can be harnessed to produce electricity. Solar power (photovoltaics) and onshore wind generation are the main sources of onshore renewable energy generation in the catchment.

Timber

Woodlands play a fundamental role in providing timber and wood fuel in the UK. There is only a small proportion of woodland cover in the catchment, with only approximately 289ha of woodland. There are approximately 5ha of commercial woodland that is actively managed with a felling licence valid within the last 10 years [15].

4.3.2 Regulating Services

Climate regulation

Ecosystems regulate a wide range of atmospheric processes that control our climate, including the greenhouse effect, precipitation, the ozone layer, the albedo effect, and atmospheric chemical composition [55]. Locally, this can help reduce urban temperatures and remove air pollutants. Globally, the most significant example of climate regulation by ecosystems is the absorption of greenhouse gases [55].

Some of most significant habitats for carbon sequestration in the catchment are located along the coastline, such as saltmarshes and intertidal mudflats. A major source of carbon emissions identified in the NCRAT are habitats located on degraded peatland, such as agricultural fields on deep peat soils. These habitats emit more carbon dioxide equivalent than habitats elsewhere in the catchment can sequester and ongoing soil and water management will likely impact on the future carbon sequestration potential.

As outlined in section 3.1.7, the net carbon sequestration rate for arable land is based on Christie et al. 2011 at 0.107tCO_2e/ha/yr, resulting in a net sequestration of carbon [38]. More recently, it has been estimated that arable land may in fact emit 0.290tCO_2e/ha/yr [39]. Therefore, it is possible that the assessment of the carbon balance for the catchment is significantly different from the true figure.

Air quality

Most urban areas in England experience significant levels of air pollution which can contribute to adverse health impacts including premature mortality from cardiovascular and

respiratory causes. Studies have shown that vegetation can play an important role in removing air pollutants and improving air quality. There are no air quality management areas (AQMAs) within the catchment study area. The closest AQMA is AQMA No.1, located approximately 4km south of the catchment boundary. It was declared in 2007 by Peterborough Council due to exceedances of 15-minute mean sulphur dioxide SO_2.

Air pollution removal by vegetation occurs through dry deposition, a mechanism by which pollutants are accumulated on leaf surfaces. Gaseous pollutants can also be removed through leaf stomata uptake.

Hazard regulation

Many habitats can act as buffers to reduce the effect of natural hazards, such as flooding. Relative to bare soil or paved surfaces, natural habitats reduce flooding risk to downstream populations by buffering peak rainfall flows entering rivers. Likewise, coastlines with intact seagrass and kelp beds, coastal wetlands or mudflats are better protected from flooding and coastal erosion.

The coastal habitat (saltmarsh) present in the catchment and beyond the catchment boundary dissipates wave energy and provides a barrier, reducing risk of damage to coastal defences, low lying land, and infrastructure further inland [56]. If unimpeded by coastal development, natural intertidal habitats such as saltmarsh are likely to migrate with rising sea levels predicted under future climate scenarios, thereby providing resilience to future sea level rise.

Disease and pests

Pests can be responsible for agricultural losses and encourage the use of pesticides. Natural pest control, such as by bats, birds and insects, can enhance crop production by reducing herbivorous insects that damage or use parts of crops. Provision of habitats such as semi-natural grasslands and woodlands, can support species which prey on pests. Given the high cover of agricultural land in the catchment natural pest control of infestations is an important regulating service.

Pollination and seed dispersal

Semi-natural habitats such as grasslands, woodlands, hedgerows, and scrub support insect populations that pollinate crops growing on agricultural land. Seed dispersal allows plants to colonise new areas where the species may not already be present, ensuring genetic diversity and supporting other species by providing food, shelter, and habitat.

Soil retention and erosion

Soil retention is required for the maintenance of healthy ecosystems and delivery of other ecosystem services such as food and timber production. Soil resources in the catchment are degraded and eroded due to drainage and tillage of land for agriculture. Tree planting and increased diversity of vegetation structure and cover can help increase soil retention. However, poor placement of trees on some peatland can actually lead to further degradation and drying of the peat through water uptake, inadvertently increasing greenhouse gas emissions and hastening peat wasting [57].

4.3.3 Cultural Services

Our cultures, knowledge systems, religious beliefs, social interactions and amenity have been shaped by our interaction with natural ecosystems. Cultural ecosystem services

represent a suite of benefits related to amenity and culture, that can have a significant impact on society as a whole and are therefore often difficult to quantify or value.

Recreation

The catchment has approximately 19.7km of coastline. The King Charles III England Coast Path National Trail follows the entire coastline of the catchment, along the northern bank of the River Welland to Fosdyke Bridge, following the estuary back to the coast and then south-eastwards along the shore of The Wash to Gedney Drove End. Route 1 and Route 12 of the National Cycle Network pass through the catchment, connecting Holbeach with Fosdyke Bridge to the north-east of the catchment and Spalding with Peterborough to the south14. The section of Route 12 between Crowland and Glinton route is traffic free, with the rest of the network in the catchment following minor roads.

Based on datasets used for ORVal, the catchment contains a total of 66 recreational sites. The most common type of recreational site is recreation ground (22 sites). Other sites include four allotments, five amenity parks, six cemeteries, one golf course, 11 grave yards, 10 nature parks, and seven parks. ORVal data also shows that the catchment contains 100 paths.

These sites, along with the protected and designated sites, attract a range of visitors to the local area which contributes to the local economy.

Physical health

Approximately half of the visits made to the local area are likely to involve participation in activities that are beneficial for the physical health of those visitors. Improvements to health improve the quality of life for individuals and reduce the pressure on healthcare systems.

Education and volunteering

Visits to the catchment for scientific and educational purposes are difficult to quantify, but can create benefits for human society as a whole. The protected areas and heritage sites within the catchment have the potential to enable insights about past and future changes which the area. Cowbit Wash, on the south-eastern edge of the catchment is designated as an SSSI because it has the potential to provide valuable data on post-glacial sea level changes through the analysis of marine sediments and freshwater peat layers. The site has considerable potential for future studies of these deposits.

Designated sites provide an opportunity for public volunteering, which provides benefits to recipient organisations and their stakeholders, to wider society, and to the volunteers themselves [35].

Aesthetic / sense of place

The concept of sense of place in the context of natural capital refers to the emotional and symbolic meaning that the environment holds for individuals or communities. Intrinsically, it is difficult to measure, as it describes how people perceive, feel about, and interact with their environment.

[14] Sustrans (2024). National Cycle Network 2024. Available at: https://data-sustrans-uk.opendata.arcgis.com/. [Accessed 08/01/2025]

In the context of this study, aesthetic / sense of place benefits of natural capital assets is based on the character of the landscape which includes historic villages, agricultural fields, drainage channels and sparse tree cover, providing wide vistas across the landscape.

4.3.4 Bundled services

Bundled services are benefits provided by nature that are not easily attributable to specific ecosystem services as they provide multiple types of benefits. Some of the bundled services can also be classified as supporting services, they are crucial to the functioning of ecosystem processes and therefore support the provision of other ecosystem services. Bundled services are typically difficult to quantify as their primary benefit is the underpinning of all other ecosystem services, and therefore do not provide a direct measurable benefit.

Water quality

Ecosystems and vegetation can improve water quality in variety of ways, including through the absorption of excess nutrients; slowing the flow of water which increases water (and pollutant) retention in the soil, helping to prevent sewer overload; providing shade and reducing algae growth; and helping to stabilise river banks and beds with root systems, which reduces sediment runoff [58].

The bundled ecosystem service for water quality entails a range of benefits related to ecosystems functioning to remediate polluted water, the value of good-quality water for economic activities, recreation, education, and for healthy plant and animal populations.

Biodiversity

Biodiversity is defined by the Convention of Biological Diversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” [59]. Biodiversity is an integral characteristic of stable and resilient ecosystems, and is vital for the continued delivery of all other ecosystem services.

As described in Section 4.2.3, there are twelve designated sites in the catchment that are internationally and nationally important for biodiversity. These areas include a variety of rare habitats and species.

4.4 Benefits

4.4.1 Natural capital benefits

Figure 13 shows the flow of ecosystem services from natural assets in the catchment. For each of the ecosystem services shown, data on the physical flow of benefits is used to estimate a monetary value. Sections 4.4.2 - 4.4.5 below describe the physical benefits from the ecosystem services in the Catchment. It should be noted that the benefits of ecosystem services impact different groups of people differently, depending on the service and location. Often, ecosystem services will deliver direct benefits to local people, for example through improved health, and indirect benefits to the wider population, for example by reducing cost to health services.

The monetary values shown have been calculated from the NCRAT.

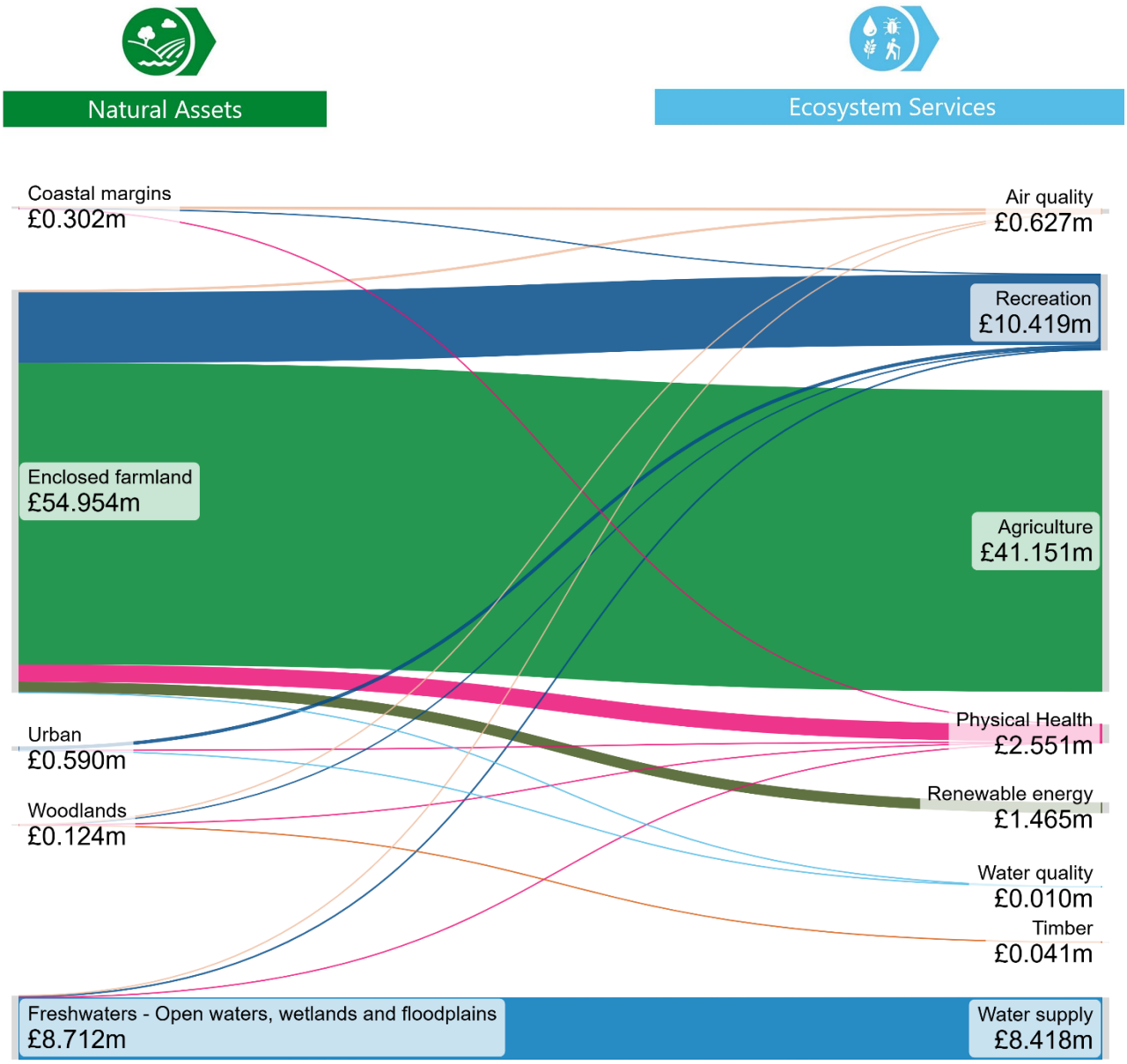

Figure 13: Sankey diagram showing the flow of ecosystem services from natural assets in the catchment.

Some of the benefits that are not included in Figure 13 but are significant to the catchment include:

- Increased pollination and the control of pests and diseases, which promote healthy ecosystems and improve agricultural productivity;
- the cultural, historical and aesthetic value ecosystems provide to places; and
- the provision of all other ecosystem services through biodiversity and biosphere integrity.

These benefits are not assessed with the NCRAT; however, a qualitative assessment of their benefit is provided below.

4.4.2 Provisioning Services

Food production

Agricultural practices, such as arable farming and livestock rearing, contribute significantly to national food security and support the local economy. The estimated annual arable yield is over 375,258 tonnes. Yield of livestock for meat production is 64 tonnes per year, and for milk production is 2,010 litres per year.

Water supply

In 2018, it is estimated that over 10 billion m^3 of water was abstracted from non-tidal surface waters and groundwater in England for public supply, agriculture, industry and energy generation [60]. Overall, the volume of water abstracted from the catchment is approximated to be 3.04 million m^3 per year. The vast majority (78.5%) of this abstracted water is used for public water supply.

Renewable energy

According to the Department for Energy Security and Net Zero, roughly 117 megawatts (MW) electricity was generated from onshore wind and 247MW from solar power in the four local authorities that intersect with the catchment in 2023 [61]. In comparison, in 2023 across England it was estimated that 3,094MW of electricity was generated from onshore wind, 43MW from hydro generation and 13,976MW from photovoltaics. Approximate figures for each local authority within the catchment are shown in Table 5.

Table 5: The installed generation capacity of onshore wind and solar power for the Local Authority Districts within the catchment

Local Authority District (LAD)	Proportion of the Local Authority District within the catchment	Installed onshore wind generation capacity (MW)		Installed solar generation capacity (MW)	
		Total capacity in LAD	Estimated capacity within catchment	Total capacity in LAD	Estimated capacity within catchment
Boston Borough Council	10.3%	26.0	2.68	42.0	4.33
Peterborough City Council	10.3%	46.1	4.75	38.6	3.98
South Holland District Council	42.0%	44.0	18.5	90.0	37.80
South Kesteven District Council	5.7%	1.0	0.06	76.0	4.33

Since catchment-specific data is not available, the renewable energy generation value for these local authority areas has been scaled to the catchment according to the relative size difference (see Table 4). Using this method, it is estimated that approximately 107,500MWh/year is generated in the catchment from renewable sources, which is equivalent to an installed generation capacity of approximately 77MW.

From desk-based research, notable renewable energy projects in the catchment include the following:

- Decoy Farm Solar farm, Crowland, 5MW;
- Deeping St Nicholas wind farm, 16.4MW;
- Gedney Marsh wind farm, 12MW; and
- Three farm-fed anaerobic digestion units [62]:
    - Manor Farm AD plant, Holbeach, 1,427kW;
    - Decoy Farm AD plant, Crowland, 2,600kW;
    - Barr Farm AD plant, Deeping St Nicholas, 146kW;

There are also several active proposals for solar energy developments in the catchment:

- The Meridian Solar Farm, South of Holbeach, is proposed for 900ha of farmland within both the Lower Nene, and Lower Welland catchments. This development as such is one of the UK's largest proposed solar developments and will have a generating capacity of 750MW, and associated battery storage;
- The Caudwell Solar Farm, at Holbeach Marsh, across 120ha, with a generating capacity of 49.9MW.

It is therefore considered that the 107,498MWh/year could be an underestimate of the overall contribution that renewable energy projects the catchment provides to the wider renewable energy provision of these four local authority areas.

Timber

Woodlands play a fundamental role in providing timber and wood fuel in the UK. There are approximately 289ha of woodland in the catchment, and only 5ha of commercial woodland that is actively managed with a felling licence valid within the last 10 years [15]. While there are data limitations in relation to actual rates of timber extraction in woodlands within the catchment, national data can be applied to estimate a yearly volume of 1,250m^3.

4.4.3 Regulating Services

Climate regulation

Data presented in the Climate Change Strategy for South Holland, Boston and East Lindsey District Councils suggests that land use, land use change and forestry (LULUCF) is the third largest source of greenhouse gas emissions in South Holland District Council at approximately 109,200tCO_2e/yr[15] [63]. In Boston, LULUCF is a smaller source, emitting only 8,300tCO_2e/yr. For the catchment (which is 42.0% of South Holland District and 10.3% of Boston Borough), the NCRAT presents net greenhouse gas fluxes as emitting roughly 76,083tCO_2e/yr. This is calculated using the extent of different habitat types in the catchment and their average carbon sequestration rates, included in the NCRAT tool [64].

The catchment is underlain by approximately 8,804ha of peatland, or 18.6% of the catchment area. This peat is predominantly in a 'drained' condition (76.6% of the total peatland area) and the remaining peatland area is in an 'actively eroding' condition (23.4% of the total peatland area). None of the peatland area in the catchment is considered to be in a 'near natural' condition.

[15] Tonnes of carbon dioxide equivalent per year. This is a measure of how much carbon dioxide would have to be released to have an equivalent warming impact to the amounts of other greenhouse gases.

Enclosed farmland, saltmarsh and woodland in the catchment is calculated to sequester approximately 4,681tCO2e/yr, 254tCO_2e/yr and 1,938tCO_2e/yr, respectively.

It is important to note that the NCRAT assumes all agricultural land (i.e. arable and pastoral) is delivering net sequestration, which is likely incorrect (see limitations in Section 3.1.7). At a national scale, agriculture is a net emitter of greenhouse gases and it is likely this pattern is similar in the catchment; in 2021, approximately 48 MtCO_2e were emitted from as a result of agricultural land management across Great Britain.

Air quality

The NCRAT considers the removal of three air pollutants, Particulate matter ($PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), and Ozone (O_3). Overall, approximately 2,482 tonnes of air pollutants are removed by vegetation each year in the catchment. The removal of these air pollutants provides health benefits to the local population in the catchment. Given that the catchment is predominantly rural with a low population density outside of the town of Spalding, the health benefits of improved air quality are likely to be less significant than in more urban and densely populated areas.

It is important to note that air pollution is likely to be distributed unevenly across the catchment, however the NCRAT tool assumes an even distribution of air pollutant abatement across the whole catchment rather than modelling variable impact or value across the catchment. Therefore, both the impacts of poor air quality and the benefits of air pollutant removal may vary when measured on the ground.

Hazard regulation

The NCRAT only quantifies and values the cumulative yearly water storage capacity of woodlands in their canopy and soils. The annual volume of potential flood storage within areas of woodland in the catchment is approximately 47,813m^3 of floodwater.

Disease and pests

The NCRAT does not quantify benefits relating to disease and pest control. It is estimated that globally 35–40% of potential crop yields are destroyed by pests [65]. Natural pest control, such as by bats and birds, can enhance crop production by reducing herbivorous insects that damage or use parts of crops.

Pollination

The NCRAT does not quantify benefits relating to pollination. Pollination plays a crucial role in promoting healthy ecosystems and supporting the provision of other ecosystem services. Approximately 80% of British wildflower species and 37% of crops grown in the UK benefit from insect pollination, including beans and oilseed rape; additionally, a further 37% of crops grown in the UK, such as carrots and onions, require insect pollination to create viable seeds.

Within the catchment, the crop areas have been estimated based upon commercial agricultural holdings [66] as follows:

- Cereals – 20,959ha (approximately 44.3% of the catchment land use overall)
- Arable crops (excluding cereals) – 10,784ha
- Fruit and vegetables – 3,929ha

Many cereal and arable crops are wind-pollinated [67], whereas many fruit and vegetable crops (particularly oilseed rape, orchard fruit, soft fruit and field beans) make use of insects to transfer pollen. Without the pollinating insects these plants would likely have overall reduced quality and yields, resulting in a direct economic value impact. They also contribute to the diversity of wild plant species, habitats and wildlife in England, as well as its resilience and natural beauty. Pollination is therefore an essential ecosystem service which maintains biodiversity and supports other vital ecosystem functions, including soil protection, flood control and carbon sequestration.

The quantification of pollination benefits heavily relies on complex modelling, which is outside the scope of this assessment. Currently the direction and magnitude of changes in pollinator biodiversity, the value and functional relationship of pollinators to agriculture from farm to national scales and how this biodiversity and linked ecosystem service is only partly understood [68].

Soil erosion and retention

The NCRAT does not quantify benefits relating to soil erosion and retention. Soils provide many essential services including an environment for food production, filtering and absorbing water, reducing pollutants, regulating climate and providing habitat for organisms. It is estimated that over 2 million hectares of soil are at risk of erosion in England and Wales and almost 4 million hectares are at risk of soil compaction. This has implications for water resources, flooding and soil quality and food production [69].

4.4.4 Cultural Services

The NCRAT quantifies and values only four cultural ecosystem services: recreation, physical health, education, and volunteering.

Recreation

Access to open green spaces can provide a range of benefits to local economies. Based on data from the University of Exeter's ORVal [34], approximately 2.71 million visits by adults are made to open green spaces in the catchment every year which supports the growth of local economies.

Physical health

Out of the 2.71 million yearly visits to open green spaces within the catchment, roughly 1.39 million are active visits, involving participation in physical activities that are beneficial for the physical health of those visitors.

Education and volunteering

For this assessment, education and volunteering benefits were not possible to quantify due to lack of data availability. Although visits to the catchment for scientific and educational purposes are difficult to quantify, they do create benefits for human society as a whole. The protected areas and heritage sites within the catchment have the potential to enable insights about past and future landscape changes in the area. Cowbit Wash is designated as an SSSI for its geological significance, providing valuable data on post-glacial sea level changes through the analysis of marine sediments and freshwater peat layers. The site has considerable potential for future studies of these deposits.

Volunteering visits are similarly difficult to quantify, but can provide benefits to recipient organisations and their stakeholders, to wider society and to the volunteers themselves.

Volunteering in nature and outdoor activities can have many positive benefits for the participants such as improving physical health, mental health and social connectedness. This not only provides a direct benefit to those participating in the activity but can have follow-on benefits by reducing national health care costs. Mental health improvements include reduced stress and anxiety and increased positive mood, self-esteem and resilience [70].

Aesthetic / sense of place

The aesthetic and sense of place benefits from nature are intrinsically difficult to measure, as it describes how people perceive, feel about, and interact with their environment. One means of measuring this benefit is through house prices, which tend to increase in areas where there is greater access to green and blue space due to improved local aesthetics.

4.4.5 Bundled services

Bundled services may not produce measurable benefits but are essential for ecological processes to function and facilitate the provision of all ecosystem services. Supporting services are typically not assessed on their own, as their importance underpins all individual ecosystem services discussed as part of this assessment.

Water quality

The bundled ecosystem service for water quality entails a range of benefits related to ecosystems functioning to remediate polluted water, the value of good-quality water for economic activities, recreation, education, and for healthy plant and animal populations.

The NCRAT applies non-market valuation approaches to quantify the value of good water quality within the catchment, mainly by applying data on people's willingness to pay for good water quality in combination with the ecological status of inland and coastal waterbodies and 2019 bathing water status. Of the twelve surface water bodies within the catchment, seven score 'moderate' for ecological status for the River Basin Management Plan Cycle 3. Three waterbodies score 'poor', one scores 'bad. Kirton Marsh Drain is the only waterbody to score 'good' for ecological status in the catchment, and thus is the only waterbody which informs the value of good water quality in the catchment.

Biodiversity

The variety of living organisms in the catchment is important at a local level for increasing resilience to pests and diseases and supporting healthy ecosystems. At a global level, it is important for maintaining genetic diversity, which in turn is required for biosphere integrity, one of the nine planetary boundaries [71]. At both a local and a global level, Biodiversity enables the functioning of ecosystem services that are critical to all life of Earth. In recognition of these benefits, there are twelve statutory internationally or nationally designated nature conservation sites within or partially within the catchment. The six SSSIs are nationally important, and the two SACs and SPA of The Wash are considered internationally important.

While there are some ways to measure aspects or indicators of biodiversity (e.g. through Biodiversity Metrics, indices or indicator species), the NCRAT does not currently include this.

4.4.6 Beneficiaries Assessment

A qualitative Beneficiaries Assessment has been undertaken that explores who benefits from each ecosystem service, either directly or indirectly. The assessment considers who

the beneficiaries of each ecosystem service are (i.e. the local population, wider society, public sector or private sector) and whether they are primary, secondary or indirect beneficiaries. The outputs of this are presented in Appendix A: Output - Benefits Statement.

The local population – including local communities and households (residents) – were identified as the primary beneficiary for most ecosystem services except provisioning services such as agriculture, water supply, timber and renewable energy. For these, as well as pollination, they have been identified as the secondary beneficiary.

The wider society – meaning those who live outside of the study area and include non-governmental organisations – has been identified as an indirect beneficiary for the majority of ecosystem services, specifically regulating and cultural services. For provisioning services and bundled services, the wider society is considered a secondary beneficiary. For climate regulation, the wider society is considered a primary beneficiary.

The public sector – referring to national and local government bodies – has been identified as an indirect beneficiary for the majority of ecosystem services, particularly provisioning services. The public sector is considered a secondary beneficiary of climate regulation, hazard regulation, disease and pest regulation, all bundled services and cultural services including recreation, health, volunteering and education. The public sector is considered the primary beneficiary of the mediation of wastes.

The private sector – including commercial enterprises, farming and industry – is considered a primary beneficiary for provisioning services such as agriculture, water supply, timber, and renewable energy as well as the regulation of disease and pests, pollination, soil condition and erosion, and mediation of wastes. The private sector is considered a secondary beneficiary of all bundled services, climate regulation and hazard regulation. For the remaining services, including cultural services and air quality regulation, the private sector is considered an indirect beneficiary.

4.5 Value

4.5.1 Natural capital value

The total natural capital value that has been estimated for the ecosystem services in the catchment is estimated to be £43.9 million per year, with a 100-year asset value of £1.97 billion.

Figure 14 shows how this figure can be broken down into the different benefits from ecosystem services. This value will be an underestimate of the real value of natural capital assets as some benefits have not been valued, including biodiversity which underpins the functioning of all other ecosystem services. More information on the value of ecosystem service benefits is provided in the subsequent sections.

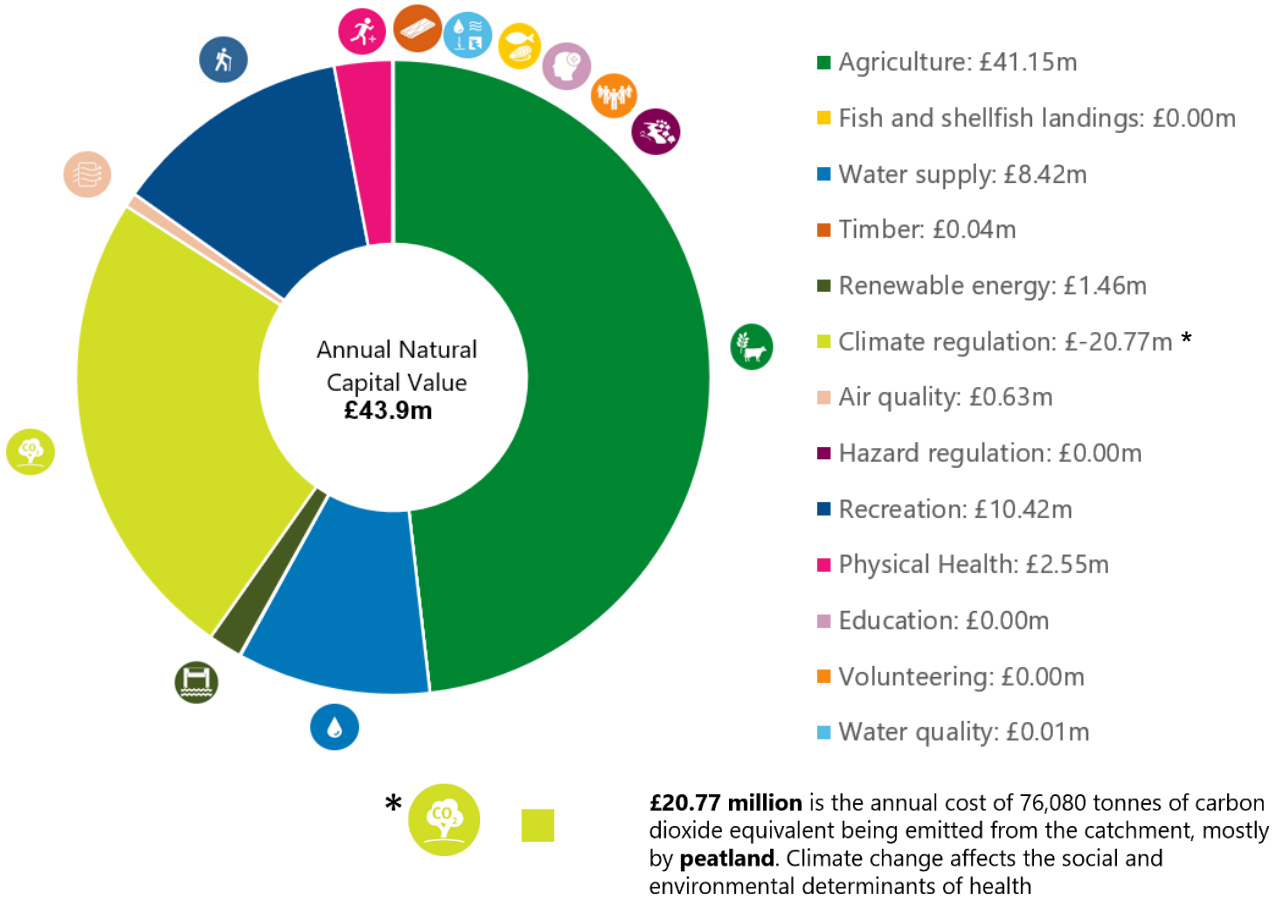

Figure 14: Pie chart showing the natural capital value of different ecosystem services in the catchment (£ million).

Not all ecosystem services have been quantified into a monetary value and so show a value of £0 on Figure 14. Volunteering and education have not been included in the assessment because there is not enough data available to calculate a value. Since there is no marine habitat within the catchment, the provision of food from fish and shellfish landings has not been included as it is not appropriate to attribute these benefits to the study area. The NCRAT does not provide a monetary value for hazard regulation as the valuation methodology is not sufficiently robust. Other ecosystem services not included are those that are particularly hard to quantify, including biodiversity, pollination, regulation of disease and pests, regulation of soil quality and erosion, and cultural benefits relating to amenity, aesthetics and spirituality. Consequently, the total values of assets and services in a natural capital account will always be an underestimate.

4.5.2 Provisioning services

Food production

The estimated annual arable yield is over 375,258 tonnes. Yield of livestock for meat production is 64 tonnes per year, and for milk production is 2,010 litres per year. Together these agricultural yields have a combined worth of over £41.2 million each year. The asset value over the next 100 years for agriculture is approximately £1.23 billion. As noted in section 3.1.7, the natural capital values do not include the potential costs from carbon

emissions associated with agricultural activities (e.g. cost of carbon emissions from land management, fertiliser production, machinery etc.).

Water supply

Overall, the volume of water abstracted from the catchment is approximated to be 3.04 million m^3 per year, equating to £8.42 million each year and £251 million over the next 100 years – these are the central values. The minimum and maximum annual values for water supply are £0.77 million and £10.44 million respectively.

Renewable energy

The renewable energy generated in the catchment is estimated to be 107,498MWh per year, which has been valued at approximately £1.46 million per year and £43.67 million over the next 100 years.

Timber

The national value of timber and fuel extracted from woodlands is estimated at almost £15 billion. National data can be applied to the catchment to estimate a yearly timber production volume of 1,250m^3, which is valued at approximately £41,100 per year. The 100-year asset value of this is £1.23 million.

A key consideration for this figure is that, in order to provide a constant benefit, woodlands need to be managed sustainably. As such, timber harvest rates should not negatively impact the health and therefore the wider ecosystem service provision within a woodland.

4.5.3 Regulating Services

Climate regulation

Based on the extent of habitat types in the catchment, the NCRAT presents the net greenhouse gas flux as a release of roughly 76,083tCO_2e/yr for a central value, costing £20.77 million annually. Over a 100 year period, the total discounted value is estimated at £90.43 million.

The NCRAT provides maximum and minimum values for climate regulation which should also be considered given the amber confidence interval for climate regulation (see Table 1 for confidence interval definitions) and uncertainty in the results. The maximum annual volume of carbon released is 76,222tCO_2e/yr (costing £20.81 million per year) and the minimum is 75,944tCO_2e/yr (£20.73 million per year).

The estimated value for climate regulation is based on the extent of different habitat types in the catchment. The majority of the catchment is agricultural land, which has a relatively low carbon sequestration rate. The value for climate regulation would be higher if the area of woodland, wetlands or saltmarsh was increased, as these have a higher carbon sequestration rate. As explained in section 4.2.2, the majority of peatland in the catchment is in a ‘drained’ condition and is a net emitter of carbon, which significantly reduces the value for climate regulation. Nearly a quarter of the peatland area is categorised as ‘actively eroding’, and emits carbon five times faster than the rate for peatland which is categorised as ‘drained’.

Air quality

The removal of 2,482 tonnes of air pollutants by vegetation each year leads to an estimated avoided cost of treatment and productivity loss of £625,900 per year and £19.05 million over the next 100 years.

Hazard regulation
In the catchment, an estimated 47,813m^3 of floodwater is temporarily stored in areas of woodland identified. The NCRAT does not provide a monetary value for this benefit, however the cost of creating a flood storage reservoir to store a similar amount of water is estimated at £23,571 per year.

Disease and pests
The NCRAT does not provide a monetary value for the benefits associated with disease and pest control in the catchment. There is not sufficient information to calculate the precise economic impact of pests and disease. The spread of invasive and non-native species more broadly is estimated to cost the UK economy £1.8 billion each year [7].

Pollination
The NCRAT does not provide a monetary value for the benefits associated with pollination in the catchment. Pollination by insects and other animals has been estimated to be worth £500 million annually in the UK [7].

Soil erosion and retention.
The NCRAT does not provide a monetary value for the benefits associated with soil erosion and retention in the catchment. As peat is drained it shrinks; becoming lighter, friable and vulnerable to erosion. Production losses due to soil erosion are estimated to cost £40 million per year in England and Wales [7].

4.5.4 Cultural Services

Recreation
The value of approximately 2.7 million visits by adults (aged 16 or older) to open green spaces in the catchment every year is worth approximately £10.42 million each year and has a 100-year asset value of approximately £257.4 million. The welfare value of a further 690,000 visits made by children each year cannot be quantified but is likely to be significant.

Physical health
By applying a valuation approach to measuring the improvements in ‘quality adjusted life years’ (QUALYs), the NCRAT estimates that £2.55 million in healthcare treatment costs can be avoided every year due to improved physical health as a result of 1.39 million active visits to green spaces. The 100-year asset value of this is £257.39 million.

Aesthetic / sense of place
The NCRAT does not provide a monetary value for the benefits associated with aesthetics and sense of place. Recreation and aesthetic values are in part captured by house prices as there is value associated with proximity to green and blue spaces for recreation (free trips to nature) and the visual amenity (aesthetic) value provided by being able to view green and blue spaces. In 2021, the combined aesthetic and recreation value of these services in the UK was estimated to be worth £4 billion [72].

Education and volunteering
Although education and volunteering have been valued at £0 due to lack of data availability, they are nonetheless valuable ecosystem services. The number of volunteer hours and educational visits can be used to calculate the value of education and

volunteering in a catchment. It is likely that the protected areas and heritage sites within the catchment enable valuable volunteering and educational opportunities. All 141 National Nature Reserves managed by Natural England have a total volunteering value of £1.8 million (for 150,000 hours of work) and a total educational value of £123,000 [2].

4.5.5 Bundled services

Water quality

Based on a willingness to pay approach, the river water quality is worth an estimated £10,434 per year as an alternative to having poorer water quality. This value is the central value for river water quality, the minimum and maximum annual values are £8,563 and £12,306 respectively. The NCRAT only provides an annual value of good or high water quality per km, so these values are based on the quality of water in the Kirton Marsh Drain which is the only river waterbody to score 'good' for ecological status in the catchment.

The central 100-year asset value for river water quality is £366,870, and the minimum and maximum 100-year asset values are £255,287 and £311,079 respectively.

Biodiversity

The NCRAT does not assess the value of biodiversity. However, the value of biodiversity to our economy and society should not be overlooked as it underpins the value of all other ecosystem services.

The Dasgupta Review provides a thorough assessment into the value of biodiversity to our economy and society [73]. The Report distinguishes six sources of biodiversity's value including human existence, human health, amenity, the provision of ecosystem services from Nature's goods and services, species existence, and the intrinsic value of nature itself [73]. The twelve designated sites in the catchment have been listed due to their significance to wider society and biodiversity, but ecosystems outside of these designated areas still provide significant benefit to human society.

4.5.6 Monetary value confidence intervals

Table 6 shows a RAG rating of confidence in the monetary values assigned to the annual and 100-year flow of benefits [35]. Definitions for confidence intervals are provided in section 3.1.4.

Table 6: The natural capital values calculated using the NCRAT colour coded according to the confidence interval.

Ecosystem Service	Annual value (central) £m	Asset value (PV; 100 yr) (low) £m	Asset value (PV; 100 yr) (high) £m	Asset value (PV; 100 yr) (central) £m
Agriculture - Arable	40.85	-	-	1,217.97
Agriculture - Livestock (dairy)	0.28	-	-	8.29
Agriculture - Livestock (meat)	0.02	-	-	0.54

Fish and shellfish landings	0.00	-	-	0.00
Water supply (public)	2.81	-	-	83.82
Water supply (energy generation)	-	-	-	-
Water supply (all other)	5.61	-	-	167.14
Timber	0.04	-	-	1.23
Renewable energy	1.46	-	-	43.67
Climate regulation	-20.77	88.60	92.26	90.43
Air quality - PM2.5	0.29	-	-	8.46
Air quality - SO2	0.00	-	-	0.12
Air quality - NO2	0.21	-	-	1.71
Air quality - O3	0.13	-	-	8.76
Hazard regulation	-	-	-	-
Disease and pests				
Pollination				
Soil quality / erosion				
Noise mitigation				
Waste remediation				
Recreation (adults)	10.42	-	-	257.39
Recreation (children)	-	-	-	-
Physical Health	2.55	-	-	76.06
Education	0.00	0.00	0.00	0.00
Volunteering	0.00	-	-	0.00

Amenity				
Aesthetic / sense of place				
Spiritual				
Water quality - rivers	0.01	0.26	0.37	0.31
Water quality - transitional, coastal waters and lakes	0.00	0.00	0.00	0.00
Biodiversity				

5. Summary and next steps

5.1 Summary of the NCRAT results for the catchment

The flow of ecosystem services that are derived from natural assets within the catchment were estimated, which was used to calculate the value of the benefits those services provide. This process is summarised in Figure 15. The analysis is not exhaustive and does not include all assets, services and benefits, therefore the natural capital values shown are an underestimate. Figure 15 indicates the confidence in the valuation provided as High (3 coloured squares), Medium (2 coloured squares), or Low (1 coloured square).

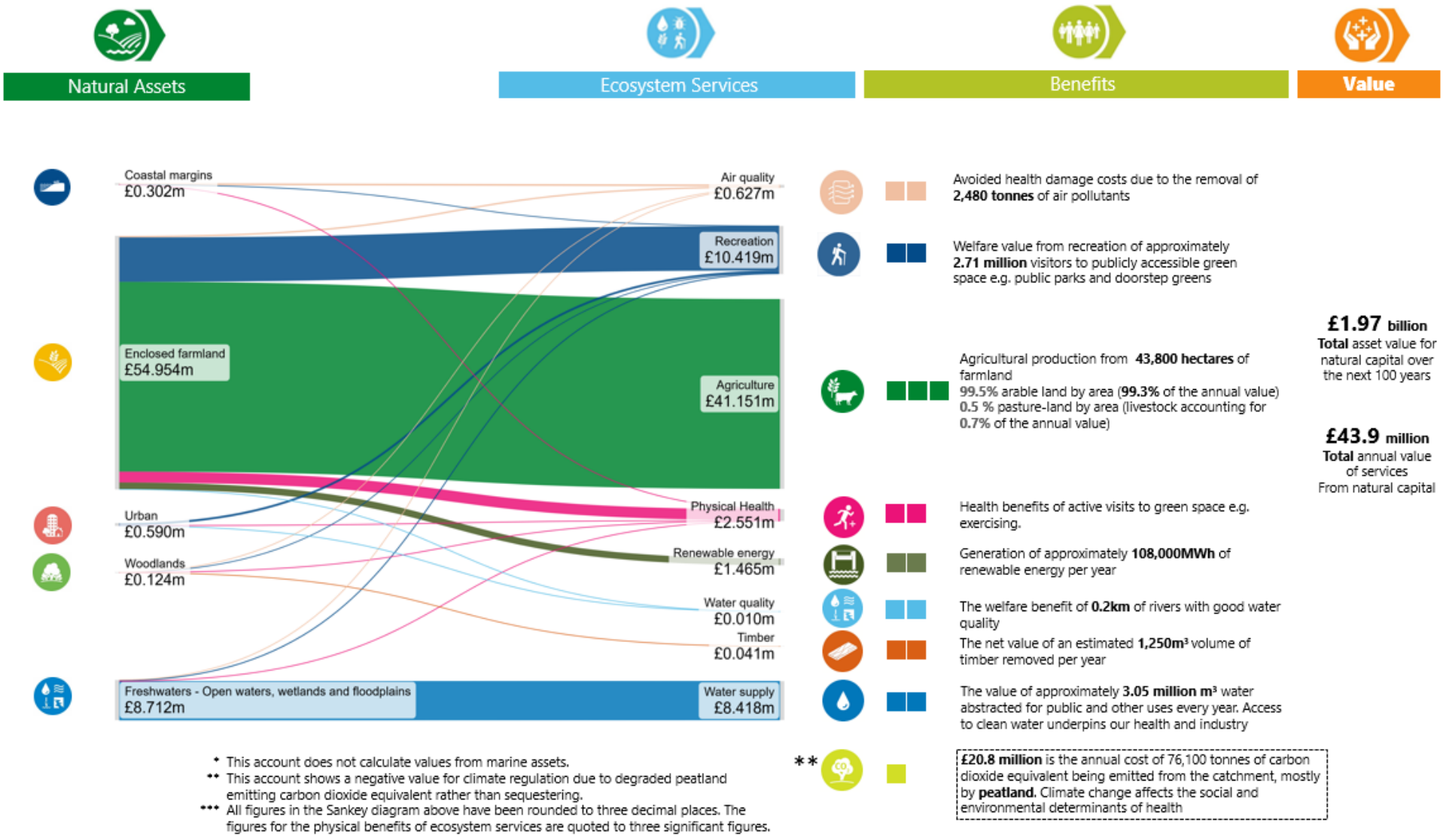

Figure 15: Summary of the NCRAT results for the catchment

5.2 Strengths, weaknesses, opportunities and threats

5.2.1 Strengths

The key natural capital strengths in the catchment include:

- **Statutory designations:** There are twelve statutory internationally or nationally designated nature conservation sites within or partially within the catchment. The coastal margins in the catchment all sit within at least one statutory designated site; namely The Wash (SPA, Ramsar site, NNR and SSSI), The Wash and North Norfolk Coast Special Area of Conservation. There are seven further sites outside the coastal area, including Cowbit Wash and Baston Fen. These designations provide legal protection to critical habitats - ensuring the conservation of valuable natural resources, supporting biodiversity, protecting the continuous provision of ecosystem services, and enabling further scientific and educational investigations into these habitats.

- **Fertile soils:** By far the most abundant land cover type in the catchment is enclosed farmland, covering an area of 43,745ha – 92.5% of the catchment. Approximately 46,500 hectares (98.5%) of the catchment is classified as Grade 1 land using the Agricultural Land Classification, making the Lower Welland the only catchment within the wider Fens2100+ study area to be majority Grade 1. Approximately 20,000 hectares (42%) is rated as Grade 2. Therefore, more than 93% or 44,000 hectares of the catchment is Grade 1 or 2, the second highest level, after the Witham South Forty Foot catchment of any catchment in the wider Fens2100+ study area [46].
  Overall, the catchment has an estimated annual arable yield of over 375,200 tonnes. Yield of livestock for meat production is 64 tonnes per year, and for milk production is over 2 million litres per year. Together these agricultural yields have a combined worth of over £41.1 million each year. Agriculture supports food production, provides employment, and helps to maintain the landscape character of the Fens National Character Area.

- **Water environment:** The catchment contains important surface water bodies that are crucial for human water supply and local ecosystem functioning. The natural capital value of water supply in the catchment is estimated at £8.42 million annually.

- **Renewable energy**: The catchment contains several operational anaerobic digestion units, solar farms and wind turbines, and there are several active proposals for additional energy developments currently underway, as renewable energy investment in the area expands. The renewable energy generated for the catchment is estimated to be 107,498MWh/year, which has been valued at approximately £1.46 million per year and £43.67 million over the next 100 years.

- **Education and recreation:** In 2023, Spalding Reconnected was launched as a collaboration across arts, heritage, environmental initiatives in celebrating the historic market town of Spalding and its uniquely picturesque riverside. As part of the national effort to save the European Eel (Anguilla Anguilla), Spalding school children from Ayscoughfee Hall School, St John the Baptist Church of England School and Tulip Academy partook in the ‘Eels in the Classroom’ programme for three weeks, led by East Mercia Rivers Trust (EMRT.) The schoolchildren carefully reared the elvers (juvenile eels) before releasing them into the River Welland.

5.2.2 Weaknesses

The weaknesses of natural capital in the catchment are as follows:

- **Environmental degradation:** The vast majority of the catchment is made up of agricultural land. Whilst this is important for food production, intensive agricultural practices can contribute to soil degradation, habitat fragmentation, and pollution. These activities can also lead to the loss of biodiversity, reduced soil fertility, and increased greenhouse gas emissions, impacting ecosystem health and resilience. Additionally, the use of chemical fertilizers and pesticides can contaminate water bodies and groundwater resources, further degrading the quality of natural habitats and affecting aquatic life. The catchment has no semi-natural grasslands, and only 289ha of woodlands, of which none are classified as ancient woodlands. The condition of peatland in the catchment has been degraded through drainage, with over a quarter in an 'actively eroding' condition, and the rest in a 'drained' condition. This has occurred as a result of historic land use change driven by agricultural intensification.

- **Climate regulation:** Peatland comprises 18.6% of the catchment area and emits approximately 82,956tCO_2e/yr due its poor condition. Given that the other habitats within the catchment (mainly saltmarsh, woodlands and enclosed farmlands) sequester a total of 6,872tCO_2e/yr, the catchment has a net carbon emission of 76,083tCO_2e/yr. This costs approximately £20.77 million a year, and is valued at £92.26 million over the next 100 years. It represents a huge loss to the stock value of the assets within the catchment caused by the degradation of the environment.

- **Vulnerability to climate change:** The saltmarsh habitats on the coast of the catchment are at risk from rising sea levels, increased frequency of extreme weather events, and changing precipitation patterns. These changes can lead to habitat loss, reduced biodiversity, and increased vulnerability to coastal erosion and flooding. Agricultural land is vulnerable to saline intrusion and increased soil erosion during extreme weather events, which can impact food production through damage to crops. The impacts of climate change can also disrupt the balance of marine ecosystems, affecting fish populations and other marine life that are crucial for local fisheries and biodiversity.

5.2.3 Threats

Threats to the condition or quality of natural capital assets in the catchment have been identified, including:

- **Climate change**: The catchment is at risk of flooding, both from the sea given its low-lying coastal topography as well as from the many rivers and drains in the area. These changes can lead to habitat loss and reduced biodiversity (e.g. as a result of salination impacts), and increased vulnerability to coastal erosion and flooding.

  Climate change is causing rising sea levels, increased frequency of extreme weather events, and changing precipitation patterns which increase flood risk. In early January 2024, Storm Henk caused an embankment breach on the River Welland near Crowland and Cowbit, flooding nearby farmland. Deeping St James and Market Deeping further south-west were also affected by flooding during this event.

Rising sea levels and an increased demand for groundwater abstraction increases the risk of saline intrusion to groundwater and soils. This can lead to a variety of issues such habitat loss, reduced agricultural productivity and loss of aquifer water quality [74].

- **Agricultural practices:** Intensive farming practices, particularly on arable land, can lead to degradation of soil and peat; reduced soil fertility; and increased greenhouse gas emissions. The condition of any remaining peatland in the catchment is already poor due to decades of drainage and intensive agriculture.

  The use of nitrogen and phosphorus-based fertilisers can also contribute to waterway pollution. The Environment Agency's reasons for not achieving Good (RNAG) dataset identifies diffuse pollution from agricultural and rural land management and physical modifications associated with flood defence structures, land drainage operations, and agricultural land use as the current RNAGs for the waterbodies within the catchment [75].

- **Water resource management:** Over-extraction of water from aquifers and rivers can lead to reduced water availability for ecosystems and human use, including irrigation for arable crops. This can exacerbate the impacts of droughts and reduce the resilience of freshwater habitats. Section 4.3.1 outlines the abstraction restrictions in the catchment: currently there may only be 98 days per year when abstraction may be available at Surfleet, and only 32 days per year at Marsh Road Sluice.

  According to the Water Resources East, Lincolnshire is projected to have a water supply-demand deficit in the region of 15-40 megalitres per day by 2050 – demonstrating the importance of sustainable water management in the local area and the threat of severe water shortage in the future [47].

  There are trade-offs between the benefits that are obtained from different ecosystem services, especially if natural assets are not managed sustainably. For example, abstraction of water for water supply to provide drinking water, grow crops and livestock may deplete water resource and have knock on negative implications for other ecosystems that rely on sufficient flows and volumes of water being available. This includes other provisioning services (such as timber) regulating services (such as climate regulation and soil quality), cultural services (such as recreation and amenity) and bundled services (such as water quality and biodiversity).

- **Pollution:** Air and water pollution from agriculture and urban areas can degrade natural habitats and reduce their ability to provide ecosystem services. This includes the accumulation of pollutants in vegetation and water bodies, impacting human health and biodiversity.

- **Invasive species:** The introduction and spread of invasive species can disrupt local ecosystems by outcompeting native species for resources, altering habitat structures, and introducing diseases. This can lead to a decline in native biodiversity and negatively affect ecosystem functions and services.

- **Urban development:** Expansion of urban areas and infrastructure can lead to habitat fragmentation, loss of green spaces, and increased pollution. This can negatively impact biodiversity and the provision of ecosystem services such as air quality regulation and recreational spaces. Based on 2018-based population projections, all of

the four local authority districts in the catchment will see population growth at a faster rate than the overall figure for England. Between 2025 and 2043, the South Holland district is predicted to see the largest percentage population increase of the four districts, increasing by 10.2% from 100,043 to 110,272[16].

5.2.4 Opportunities

There is opportunity to improve natural capital in the catchment through:

- **Enhancement of asset quality:** Investing in the restoration and enhancement of natural habitats can improve their condition and resilience. This includes reforestation, wetland restoration, peatland restoration, and the creation of green infrastructure in urban areas such as Spalding and Holbeach.

  Reducing pollution (both from specific and diffuse sources) can also enhance asset quality, addressing sources of excess nutrients, plastics and other pollutants.

- **Habitat creation:** Creating new habitats and extension of existing habitats, such as coastal habitats, grassland habitats and wooded habitats in the areas located in the Wash and Fens Green Infrastructure Plan, can enhance biodiversity and ecosystem service provision [76]. Implementing measures such as river and lake restoration, floodplain reconnection, removing barriers to fish movement, tackling invasive and non-native species and actions to conserve and enhance priority habitats and species can support habitat and species recovery. This can also provide new opportunities for recreation and tourism. Given the topography and high flood risk of the catchment, creating wetland habitat and restoring lowland peatland will be especially important for the future of the catchment to manage flood risk and promote carbon sequestration. There is also an opportunity to manage coastal realignment in order to allow coastal habitats and the benefits they bring, to migrate landward.

  The South Lincolnshire Fenlands Partnership aims to restore and re-create Lincolnshire's lost wild fenlands between Bourne, Spalding and Market Deeping. Centred on the Lincolnshire Wildlife Trust Nature Reserves in Baston and Thurlby Fens, habitat restoration will include areas of wet grasslands, utilised for grazing and hay production, reedbeds, swampland, wet woodlands and open water.

  In March 2022, Lincolnshire Wildlife Trust secured a Biffa Award grant of £750,000 to restore 50ha of wet fenland at Bourne North Fen, which will link up to Willow Tree Fen at Baston. The project aims to enhance sustainable eco-tourism in the area, as well as creating a multi-purpose wetland which will store water for agriculture and improve water quality for consumers.

  The Frampton Marsh habitat creation project - located on the shore of The Wash, 5km south-east of Boston in Lincolnshire - converted 94ha of arable land to coastal grazing marsh to support wintering dark-bellied brent and pink-footed geese. To date, species such as lapwing, wildfowl, waders, snipe, dark-bellied brent and pink-footed geese have been recorded at the site. This was part of the Environment Agency's National Habitat Compensation Scheme.

- **Recreation and tourism:** Improving the recreational value of new or existing green space can significantly enhance community well-being, encourage outdoor activity, and promote environmental awareness. This has benefits for natural capital, such as

[16] Refer to Lower Welland Environment and Agriculture Appendix

improved human health and education. This can be achieved by improving accessibility to green space through well maintained and wheelchair-accessible paths, good public transport links and clear signage. Other opportunities to improve the recreational value of natural assets include improving amenities (e.g. benches, bins, lighting and toilet facilities); adding recreational facilities (e.g. playgrounds and sports areas); and by promoting nature engagement through educational signage and community gardens.

- **Use of Nature based Solutions:** Implementing Nature based Solutions (NbS), such as sustainable agriculture, green engineering, and ecosystem-based adaptation, can deliver multiple benefits. Natural flood management is a type of NbS encompassing a suite of measures which work with natural processes to reduce the risk of flooding. These processes protect, restore, and mimic the natural functions of catchments, floodplains and the coast to slow, spread and store water, and each intervention comes with its own set of multiple benefits. NBS solutions can enhance resilience to climate change, improve water quality, and support biodiversity while providing economic and social benefits.

- **Sustainable land and water management:** Adopting sustainable practices in agriculture and water management can reduce environmental impacts and enhance ecosystem services. This includes practices such as conservation agriculture, agroforestry and integrated water resource management. Planting hedgerows and grassland along the agricultural field margins in the south of the catchment provides an opportunity to improve biodiversity and connectivity, and will support other ecosystem services such as pollination, water quality, flood management and climate regulation.

  The South Lincolnshire Water Partnership was formed in 2016, bringing together a wide range of water management stakeholders recognising the need for a more integrated approach to water management in South Lincolnshire, including the catchment. The Partnership is now working to develop innovative strategies to improve the resilience of the water environment, while simultaneously enhancing the ‘Natural Capital’ that underpins much of the local food, public water resource and visitor economies.

- **Regenerative farming practices:** Implementing regenerative farming practices focuses on restoring soil health, increasing biodiversity, and improving water cycles. These practices can lead to more resilient and productive agricultural systems, enhancing ecosystem services and reducing environmental impacts, especially along key watercourses such as the River Welland, River Glen and Holbeach River, and the Welland and Deeping Internal Drainage Board watercourses. There is also opportunity to support appropriate management of salt marshes and grazing marsh, such as restoration of sustainable grazing.

- **Climate change mitigation and adaptation:** Working collaboratively with catchment stakeholders to deliver integrated solutions in order to mitigate the impact of climate change.

  Tree planting could be considered in locations where it can deliver biodiversity, flood, water quality, water resources and climate adaptation benefits. Consideration should be given to the fact that poor placement of trees on peatland can actually lead to further degradation and drying of the peat through water uptake, inadvertently increasing greenhouse gas emissions [57].

The Landscape Recovery Fund is a long-term, large-scale government project fund with a focus on addressing climate change and habitat creation. The Ouse Washes is a Landscape Recovery Project within the Great Ouse catchment that provides an opportunity to improve climate change mitigation and adaption whilst simultaneously creating and restoring wetland habitat. The project aims to create 1,000ha of target habitat creation and to form a continuous wetland habitat from the Ouse Washes, Fen Drayton, and Ouse Fen to form 1900ha of continuous wildlife rich habitat. This habitat will provide a refuge for an abundance of priority species, improve biodiversity, and contribute to net zero, while mitigating ecological and hydrological threats currently facing the area. By creating a healthier landscape, the project will support local economies, safeguard communities, and deepen the connection between local people and nature [77].

- **Peat restoration and climate regulation**: Currently, the peatland in the catchment is in a poor condition (see Section 5.2.2). Restoring the lowland peatland sites in the Fens is an opportunity to reduce carbon emissions from degrading peatland, benefiting the environment and society. The Fens East Peat Partnership (FEPP) - part of the Fens for the Future Partnership - has recently been awarded a Nature for Climate Restoration Grant to undertake peat restoration at 15 sites in the Fen [78].

- **Policy and governance:** Strengthening policies and governance frameworks to support natural capital conservation and sustainable development can create an enabling environment for positive change. This includes integrating natural capital into planning and decision-making processes and promoting stakeholder engagement and collaboration. One way of implementing this is through Local Nature Recovery Strategies (LNRS) or assessment and enhancement of natural capital through the local plan making process.

  Local Nature Recovery Strategies (LNRS) were introduced through the Environment Act 2021, as new systems of spatial strategies for nature in England. Each LNRS will include a local habitat map and a written statement of biodiversity priorities, outlining practical actions such as creating wetlands, restoring peatlands, planting trees, and managing existing woodlands more sustainably. Farmers and land managers will be able to use the LNRS to understand the potential of their land for strategic nature recovery actions, which in turn could be applicable for funding through Environmental Land Management Schemes and other funding mechanisms. LNRS should be used by plan-makers to inform the way they address the National Planning Policy Framework requirement for plans to protect and enhance biodiversity, which in turn will have positive outcomes for natural capital.

  The Greater Lincolnshire LNRS, which includes the catchment, is in the early stages of project planning and organization, focusing on mapping existing habitats and identifying local priorities for nature recovery. It is due to be published in March 2026 following public consultation in Autumn 2025. Managed by Lincolnshire County Council in partnership with North Lincolnshire Council, North East Lincolnshire Council, and the Greater Lincolnshire Nature Partnership, the strategy includes projects like floodplain meadow restoration and aims for no net loss of priority habitats by 2025.

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Appendix A
Output - Benefits Statement

Natural Capital Benefits Statement

Data sensitivity: OFFICIAL
Place name: Lower Welland

Summary of physical and monetary flows

The **Natural Capital Benefit Statement** reports the provision ('flow') of a range of benefits. It draws on the currently available evidence to quantify the flow of benefits in physical and monetary terms. The quantitative results are accompanied by the **Significance Assessment** that provides a broader qualitative account of benefits, including those not currently assessed in quantitative terms. Each row represents a discreet combination of physical measurement and monetary valuation methods, and therefore this sheet shows the minimum number of unique rows required to cover all the benefits analysed.

Benefits are categorised according to a modified **ecosystem service classification** that incorporates some **abiotic** elements: (i) **provisioning services** (the production of physical goods we consume such as food and water); (ii) **regulating services** (ecosystems processes related to climate, air quality, hazard regulation, etc.); (iii) **cultural services** (aspects of the natural environment that enrich our lives, such as recreational benefits); and (iv) **'bundled' services** (that combine multiple benefits). The contribution of **supporting services** - the ecological processes and functions such as nutrient cycling that maintain the conditions for life on earth and underpin ecosystem service provision - to current benefits flows is embedded within the monetary benefits for provisioning, regulating, cultural and bundled services.

Instruction: The Benefits Statement is automatically populated from the input and process tabs.

	Ecosystem service	Significance	Benefit valued	Benefit type	Beneficiaries				Physical flows		Monetary values					
					Local population	Wider Society	Public Sector	Private Sector	Measure (unit)	Avg unit / year	Valuation basis	Annual value (central) £m	Asset value (PV; 100 yr) (low) £m	Asset value (PV; 100 yr) (high) £m	Asset value (PV; 100 yr) (central) £m	Representation
Provisioning	Agriculture - Arable	+ + +	Food	Market	●	●	◑	●	Yield of arable production (tonnes/yr)	375,258	Gross margin	40.85	-	-	1,217.97	
	Agriculture - Livestock (dairy)	+	Food	Market	●	●	◑	●	Yield of livestock (dairy) production (kL/yr)	2,010	Gross margin	0.28	-	-	8.29	
	Agriculture - Livestock (meat)	+	Food	Market	●	●	◑	●	Yield of livestock (meat) production (tonnes/yr)	64	Gross margin	0.02	-	-	0.54	
	Fish and shellfish landings	- -	Food	Market	○	○	○	○	Volume of fish and shellfish landings (tonnes/yr)	0	Net profit	0.00	-	-	0.00	
	Water supply (public)	+ + +	Water supply	Market	●	●	◑	●	Abstracted raw water quantity (m3/yr)	2,387,929	Resource rent	2.81	-	-	83.82	
	Water supply (energy generation)	- -	Water supply	Market	○	○	○	○	Abstracted raw water quantity (m3/yr)	0	Not valued	-	-	-	-	
	Water supply (all other)	+ + +	Water supply	Market	●	●	◑	●	Abstracted raw water quantity (m3/yr)	655,433	Marginal value	5.61	-	-	167.14	
	Timber	+	Timber	Market	◑	◑	●	●	Volume of timber removals (m3/yr)	1,250	Stumpage price	0.04	-	-	1.23	
	Renewable energy	+ + +	Renewable energy	Market	●	●	◑	●	Renewable energy generation (MWh/yr)	107,498	Resource rent	1.46	-	-	43.67	
Regulating	Climate regulation	+ + +	Climate	Non-market	●	●	●	●	Net CO2eq sequestered (tonnes/yr)*	-76,083	Abatement cost	-20.77	88.60	92.26	90.43	
	Air quality - PM2.5	+	Health	Non-market	●	◑	◑	◑	PM2.5 removed (tonnes/yr)	2	Avoided cost (treatment and productivity) plus welfare value	0.29	-	-	8.46	
	Air quality - SO2	+	Health	Non-market	●	◑	◑	◑	SO2 removed (tonnes/yr)	73	Avoided cost (treatment and productivity) plus welfare value	0.00	-	-	0.12	
	Air quality - NO2	+	Health	Non-market	●	◑	◑	◑	NO2 removed (tonnes/yr)	58	Avoided cost (treatment and productivity) plus welfare value	0.21	-	-	1.71	
	Air quality - O3	+	Health	Non-market	●	◑	◑	◑	O3 removed (tonnes/yr)	2,349	Avoided cost (treatment and productivity) plus welfare value	0.13	-	-	8.76	
	Hazard regulation	+ +	Flood risk reduction	Non-market	●	◑	●	●	Annual volume of potential flood storage by woodlands (m3/yr)	47,813	Not valued	-	-	-	-	
	Disease and pests	+ +			●	◑	●	●								
	Pollination	+ + +			●	◑	◑	●								
	Soil quality / erosion	+ + +			●	◑	◑	●								
	Noise mitigation	+ +			●	◑	◑	○								
	Waste remediation	+			●	◑	●	●								
Cultural	Recreation (adults)	+ +	Recreation	Non-market	●	◑	●	◑	No. visits to open spaces (visits/yr)	2,706,123	Welfare value	10.42	-	-	257.39	
	Recreation (children)	+ +	Recreation	Non-market	●	◑	●	◑	No. visits to open spaces (visits/yr)	686,398	Not valued	-	-	-	-	
	Physical Health	+ +	Health	Non-market	●	◑	●	◑	No. active visits to open spaces (visits/yr)	1,393,653	Avoided treatment cost	2.55	-	-	76.06	
	Education	+ +	Educational benefits	Non-market	●	◑	●	◑	No. educational visits (visits/yr)	0	Exchange value	0.00	0.00	0.00	0.00	
	Volunteering	+	Volunteering	Non-market	●	◑	●	◑	No. volunteering days (days/yr)	0	Opportunity cost	0.00	-	-	0.00	
	Amenity	+ +			●	◑	◑	◑								
	Aesthetic / sense of place	+ +			●	◑	◑	◑								
	Spiritual	+ +			●	◑	◑	◑								
Bundled	Water quality - rivers	+ +	Various	Non-market	●	●	●	●			Welfare value of good water quality	0.01	0.26	0.37	0.31	
	Water quality - transitional, coastal waters and lakes	+ +	Various	Non-market	●	●	●	●			Welfare value of good water quality	0.00	0.00	0.00	0.00	
	Biodiversity	+ + +			●	●	●	●								
	Total market benefit value (£m)											51.07			1,522.66	
	Total non-market benefit value (£m)											-7.16			443.23	
	Total quantifiable value (£m)											**43.91**			**1,965.89**	

Notes:

* Net carbon dioxide equivalent sequestration is estimated taking into account both carbon sequestration by habitats and green house gas sequestration and emissions from peatland

- Annual value is estimated flow at base year (Year 0)
- Asset value calculated as discounted flow of benefits (present value terms; 100 years). Future flows are discounted in accordance with HM Treasury Green Book guidance. This is an estimate of the gross asset value since it does include (net) costs of maintaining asset condition.
- Where available low - high ranges are reported for (gross) asset value; otherwise the cell has been left blank (-)

Significance key

Highly significant (+ + +)	The benefit flow is (very) important to the place in relative terms* because it impacts the wellbeing of a significant proportion (and possibly a wide variety) of people and businesses and/or due to wider social and cultural aspects.
Significant (+ +)	The benefit flow is of material importance in relative terms* because it impacts the wellbeing of a sizeable proportion of people and businesses.
Minor (+)	The benefit flow is of minor importance in relative terms* because it does not impact most people and business. Note: it may, though, still be highly important to a small number of specific individuals or groups.
Not significant (- -)	There is very little or no provision of this benefit and it impacts only a very small number of people and businesses.
Not assessed (•)	Significance rating not completed.

See "Input - Significance Assessment" tab for more details

Beneficiaries key

●	Direct (primary and secondary) beneficiary from the ecosystem service provision.
◑	Indirect beneficiary from the ecosystem service provision.
○	Beneficiary does not benefit from the ecosystem service provision.
Not assessed (•)	Beneficiaries rating not completed.

See "Input - Beneficiaries" tab for more details

Monetary valuation confidence key

Green	High confidence in results. Input data and assumptions are based on statistical reports, peer reviewed values or industry standard methodologies
Amber	Moderate confidence in results. Input data and/or assumptions from single source/not peer reviewed, or based on sources that are not specifically tailored to this context. We have used some assumptions or estimation and some of these may be open to question. Accuracy is better than +/- 50%
Red	Low confidence in results. Input data and/or parameters from single source and low level of transferability from original context. We are confident that the number is in the right order of magnitude. Order of magnitude implies that for an estimate of 5 that we are confident that the real figure is within the range 0.5 to 50
No value (-)	Not valued or it is not possible to provide a result that can be judged to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. Currently limited to qualitative assessment only.

Representation key

	The benefit flow is substantially represented in the monetary valuation process, with only minor elements not included.
	The benefit flow is partially represented in the monetary valuation process.
	The benefit flow is not represented in the monetary valuation process.
Not assessed (•)	Representation rating not completed.

See "Input - Significance Assessment" tab for more details