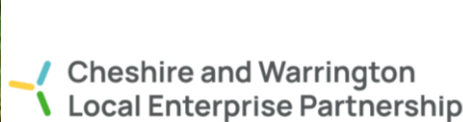
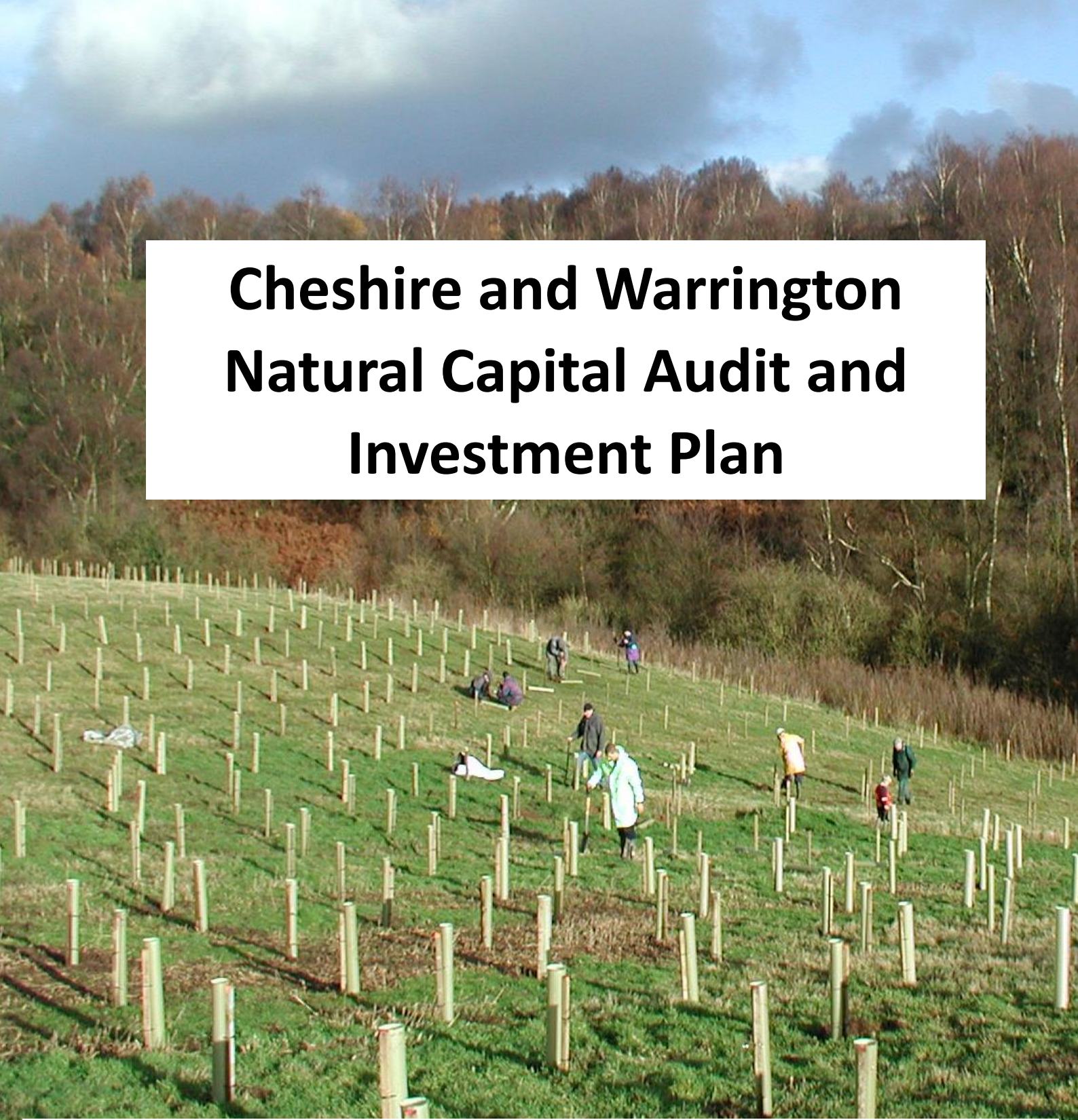




Cheshire and Warrington Natural Capital Audit and Investment Plan





Morris Resource
Economics Ltd



Cheshire and Warrington Natural Capital Audit and Investment Plan

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Cover image: Woodhouse Hill planting event (Mersey Forest)

Executive summary

Natural capital underpins our wellbeing and economic prosperity, providing multiple benefits to society, yet is consistently undervalued in decision-making. Natural capital refers to the stock of assets provided by the natural environment with capacity to produce goods and services that are of value to people. Elements of natural capital are liable to be overused, degraded, depleted and eventually lost, with consequences for long term welfare and the sustainability of economic systems. There is now much greater awareness of the role of natural capital in the design and achievement of economic and social development strategies, with strong links to business and enterprise. Furthermore, the central role of natural capital in delivering quality of place is being increasingly recognised. Natural capital is also becoming embedded across multiple policy domains, including the mandatory requirement for biodiversity net gain for all new developments, the new Environmental Land Management Scheme (ELMs), and the requirements for action on climate change and commitments to go carbon neutral.

The Cheshire and Warrington Local Enterprise Partnership (C&W LEP) have identified the need for an assessment of the interrelationship between natural capital and its economic and social development ambitions for the area. This is driven by the need not only to manage risks to the natural environment associated with economic development, but also to explore the opportunities to tap into new funding sources and mechanisms for innovative investments that can achieve substantial gains for people and the natural world. The audit and investment plan covers the three local authority areas of Cheshire West and Chester, Cheshire East, and Warrington and has been produced by Natural Capital Solutions, RPA, Morris Resource Economics, and Liverpool John Moores University.

The report begins by assessing the baseline situation, by modelling and mapping the natural capital assets present across the region, the benefits that flow from those assets and the monetary value of those benefits. Key policy drivers influencing decision making across the area are then outlined, before objectively identifying opportunities to enhance natural capital to deliver a range of objectives. A number of emerging funding mechanisms that could be used to deliver such projects are then identified and described. This is all brought together using a strategic framework and illustrated using a number of case studies. Benefits, recommendations and actions for taking this plan forward are presented. An extensive evidence base has been built to support the development of the Natural Capital Audit and Investment Plan (NCAIP) presented here. This document provides a summary of the key evidence, but much more detail is provided in the form of five technical reports that accompany this document.

The baseline – natural capital assets

This project has produced a detailed habitat basemap using the best available data to assign Phase 1 habitat types to each plot of land and building across the whole of Cheshire and Warrington (1.97M polygons covering 230,000 ha). It provides the most comprehensive and detailed coverage that is possible at this time and should have a wide range of applications. The Cheshire and Warrington region is dominated by improved (agricultural) grassland, along with significant amounts of arable land. Tree and woodland categories take up 7.8% of the county, which is below the national average. Semi-natural habitats such as mire (bogs) and swamp, heathland and semi-natural and marshy grasslands together make up 3.5% of the region. Built up areas, infrastructure and gardens make up a combined 14.5% of the area.

Modelling and mapping ecosystem services (benefits)

The ecosystem service maps demonstrate the spatial pattern of provision of ten different ecosystem services, and the demand for four. The maps demonstrate that the woodland asset is important for

high levels of provision of carbon storage, carbon sequestration, air quality, noise, local climate and water flow regulation, and timber/woodfuel production benefits. The mapping also shows that many of these woodlands provide hotspots of access to nature and overall ecosystem service delivery is especially high around Delamere Forest and Macclesfield Forest. The upland heathland and bog habitats in the east (in the Peak District), are important areas for carbon storage, but also have a high level of provision for access to nature. They are currently a source of GHG emissions due to degradation of the peat, but this can be reduced significantly through restoration. Food production is clearly dominant in the region, spread throughout most of lowland Cheshire.

The demand maps of air quality, noise, local climate regulation, and accessible nature show clearly the importance of ecosystem service delivery to the urban centres in Cheshire and Warrington. Urban areas adjacent to the road network are also hotspots for demand. The capacity to provide these services can be quite high where woodland and other semi-natural habitats occur on the outskirts of urban areas, and these areas should be protected and expanded even if not important for biodiversity. Street trees in urban centres can also be important. However, in many areas there is a mismatch between demand and supply.

Economic value of natural capital

The monetary value of the benefits provided by natural capital are large: £465 million per annum across the whole of Cheshire and Warrington, representing an asset value (present value) of £13.4 billion over 50 years. Benefits in terms of air quality regulation, recreation and physical health are particularly large, along with mineral extraction and recreational fisheries (angling). Overall values are larger for Cheshire East and Cheshire West and Chester, but if calculated on a per hectare basis are highest for Warrington, where publicly accessible greenspace will be providing benefits of high value, particularly for recreation and physical health. When carbon sequestration is balanced against agricultural emissions, Cheshire and Warrington as a whole is a net emitter of carbon dioxide of 441,000 tonnes per year, at a cost of £30.5 million annually. This high figure is driven by the large amount of dairy and other livestock across the area. Note that this does not include greenhouse gas emissions from other sectors, such as transport, manufacturing and construction.

Policy analysis

The policy analysis focused on eight sectors: agriculture; skills and education; energy, clean growth, housing and construction; manufacturing, logistics and services; minerals and waste management; environmental management; health, wellbeing and tourism; and transport. At the same time, quality of place has been identified as an important cross-cutting aspect of all sectors, and key to attracting and retaining talent in the Cheshire and Warrington region. The sector analysis shows that there are opportunities across all sectors that could enhance natural capital and help deliver the LEP's economic and social targets. Key opportunities include the development of forests and urban green spaces, the transition to clean growth and supporting local communities to develop digital skills.

The analysis also highlights some policies and plans that could lead to negative effects on natural capital. The most significant threats are housing developments on the green belt, the stimulation of the economy attracting more workers and putting additional pressure on services and emphasising road development. Now the opportunities and threats have been identified, the policy analysis, along with the natural capital baseline, provides an evidence-based approach to assessing where future interventions need to be targeted to ensure opportunities can be maximised while threats are minimised.

Habitat opportunity mapping

Habitat opportunity maps have been created showing where new habitats could be created for biodiversity enhancement for five broad habitat types, as well as for six different ecosystem services. Note, however, that the maps have not been ground-truthed or checked against other data, and so individual locations will need to be assessed further before being taken forward. The maps should be considered as a resource to highlight potential locations for habitat creation or restoration projects, rather than as an end in themselves. The maps are best examined on a Geographic Information System (GIS), and GIS layers have been provided to project partners.

The opportunity maps for biodiversity highlight areas that are best located in terms of their connectivity with existing habitat patches and are, therefore, most appropriate from an ecological point of view. Enhancing connectivity and expanding habitat networks is a key priority for biodiversity conservation and climate change adaptation at present, and these maps can be used as the basis for creating a Nature Recovery Strategy across the county. They also highlight areas where biodiversity offsetting should be focussed, under the forthcoming requirement (proposed in the Environment Bill) to achieve at least 10% biodiversity net gain for all new developments.

The opportunity maps for ecosystem services highlight the best areas to create habitats to enhance the delivery of each ecosystem service in turn, based in most cases on where demand is high and capacity is currently low. These can be used to identify project locations to meet each particular need or can be combined to show areas where new habitat can deliver multiple objectives. If combined with the biodiversity opportunity maps, they can be used in offsetting projects to deliver additional benefits. Access to greenspace for people can be highly beneficial for physical and mental health and well-being and the monetary value of these benefits can be extremely high. Habitats for biodiversity and green infrastructure (GI) in general can also make important contributions to all the other ecosystem services mapped in this report. Maps are available highlighting the multiple benefits delivered by each objective or by combining all opportunities together. Semi-natural habitats are multi-functional, meaning that an investment focussing on one benefit (e.g. natural flood risk management), can deliver multiple additional benefits, hence offering excellent value for money. Applications of the opportunity mapping are briefly outlined.

Priorities

Maps showing priority areas across a range of environmental, social and economic policy themes were also produced, building on previous GI planning work. These maps were overlain to show areas where multiple policy priorities coincided and can be used to highlight optimal locations for investments in natural capital, from a policy perspective.

Stakeholder workshop

Embedding a natural capital approach and plan across the region requires stakeholder support and an initial stakeholder workshop was held to that effect. This enabled stakeholders to gain a shared understanding of the approach used, involved them in a discussion on decision making/choices regarding prioritisation, and generated interest and buy-in to the process moving forward. A summary of the workshop outcomes is included in Section 5 of this report. Further stakeholder engagement is recommended going forwards.

Funding mechanisms

Natural capital investment draws from public and increasingly private finance to fund projects which increase or enhance natural capital. Blended finance options are also beginning to be developed, which

incorporate funding from more than one source. This is a rapidly growing field, with new opportunities emerging as markets are starting to develop. Private markets for carbon and biodiversity net gain are the most advanced, but markets are also emerging for a range of other ecosystem services.

A wide range of funding mechanisms have been reviewed as potential sources of investment into natural capital in the Cheshire and Warrington region. The funds have been assessed in terms of their potential application to different ecosystem services and detailed information on each funding mechanism is provided in an accompanying Technical Report. This information is then used as the basis for a spreadsheet that enables the most appropriate funds to be identified, depending on the ecosystem services that are the main focus of a project, programme or policy.

Strategic framework

The study has provided a series of outputs, including opportunity maps, demand maps, policy analysis, cost and benefit estimates, and a review of emerging funding mechanisms. These outputs need to be brought together in a logical and structured process in order that the potential for change due to investment in a natural capital plan can be investigated at the strategic (whole Cheshire and Warrington) scale. The framework is designed around the 'fund selector' spreadsheet and encourages users to consider what needs to be achieved (objectives and location) and what needs to happen for this to be achieved (fund selection and management).

Case studies

Five illustrative case studies were developed to demonstrate how the evidence base can be used to identify locations for natural capital projects, the costs and benefits of such projects and how funding requirements and potential funding sources can be identified. Each case study focused on a different policy objective. The opportunity maps were used to highlight the most appropriate locations to create new habitats and the most suitable habitat to create in each place. An analysis of the impact of the proposed changes showed that ecosystem service delivery would increase if the proposals were implemented for almost all services. Hence each project can deliver multifunctional benefits even if chosen for a more specific objective. A cost benefit analysis revealed that all five case studies were beneficial and cost effective, with benefit-cost ratios ranging between 2.4 and 5.7. These were robust to a range of cost and benefit assumptions. Benefits were highest where public access was also enhanced, giving rise to significant benefits for recreation and physical health, alongside air quality, carbon sequestration and other benefits. The fund selector spreadsheet was used to select the most appropriate funding sources for each case study.

Benefits, recommendations and actions

The report has showcased a spatial natural capital approach. Key benefits of a natural capital approach are that it:

- is an integrated approach that draws together numerous environmental and socio-economic considerations;
- demonstrates that the natural environment is an important asset providing benefits to society, rather than a constraint or hindrance to development;
- highlights that investments in natural capital and green infrastructure are multi-functional;
- explicitly considers wider aspects of development, including public goods and factors that underpin wellbeing and quality of life;
- provides a framework to integrate national and local policies and priorities;
- identifies resource based constraints, opportunities and a consistent framework for decision making;

- enables the location and type of natural capital investment to be related to demand;
- provides a basis for bringing together diverse stakeholders with common interests;
- links through to funding and financing;
- provides explicit links to the Green Economy, something that has particular importance and resonance in driving post Covid recovery.

The natural capital audit and assessment has pointed to some key areas where action can be taken to increase the quality and extent of the natural capital assets of Cheshire and Warrington. Key areas of focus should be to:

- Move to sustainable agriculture – a key aim of the new Environmental Land Management scheme (ELMs) is to promote sustainability and incentivise land management for the provision of public goods. Emissions reduction from farming is important, especially given the dominance of livestock farming in the region, so a focus on this and simultaneously increasing the sequestration capacity of the farmed landscape will be vital. Interventions that will improve water quality, slow the flow of water, and provide increased access to nature will also be important in these areas.
- Expand woodland – woodland provides multiple benefits, and opportunities to create woodland to connect up existing core habitat, to ameliorate air and noise pollution, to help slow the flow of water, to increase water quality and enhance opportunities for recreation should be taken up. The role of woodland and trees in the urban centres of the region is also vital, but the right species of tree need to be planted in the right locations.
- Restore grassland habitats – improved agricultural grassland is the dominant habitat type across the region. A move away from intensively managed fields to a more diverse grass sward with reduced inputs would increase the biodiversity value of these fields. In combination with lower livestock densities these habitats will be able to sequester more carbon, and increase water quality and water flow capacity.
- Restore bog (mire) habitats – restoration will significantly reduce GHG emissions from these habitats. It will also be important for slowing the flow of water and increasing water quality.
- Create new natural and biodiverse green spaces and encourage use – these should be created in areas where access is currently low. This will be important for increasing recreational opportunities and enhancing health and well-being. Health and recreational benefits have a high economic value. Programmes that encourage use of greenspaces are also required.
- Enhance biodiversity – through habitat creation in the areas identified by the opportunity mapping. Woodland is the habitat that tends to offer a wider range of benefits provision, however, there is a need to create a diversity of habitats, and this will require broad stakeholder engagement. The linking of biodiversity strategies and the need to provide important ecosystem service benefits from the natural capital of Cheshire and Warrington can come together in a Local Nature Recovery Strategy (LNRS) for the region.

It is important to ensure that the Natural Capital Audit and Investment Plan, and the large evidence base on which it is built, is taken up and used in decision-making. Key actions include:

1. Viewing and sharing data – this project has generated a large evidence base, with numerous maps and GIS layers. Use of the data will be much more effective using a GIS based system or portal. It is therefore important to establish a data sharing protocol and it is recommended that a mapping portal is developed for viewing and querying the data. A mapping service could also be set up to provide natural capital information to developers.

2. Develop a communications strategy and user-friendly outputs - there is a strong need to produce outputs that are tailored to different stakeholders, and which present the findings in a user-friendly manner, with images and infographics and with messages tailored to each audience.
3. Develop portfolio of costed projects – this can include projects that are already being considered by stakeholders, or new projects based on the opportunity mapping presented here. Proposals need to be fully planned and costed so that they can then be brought forward for funding.
4. Set up an Investment Readiness Fund / Environment Fund – this is a mechanism to support investment in the natural environment and to help develop markets. It also allows links to be made between natural capital buyers/investors and natural capital projects. An IRF is being set up for the Bollin catchment funded by the Environment Agency’s Natural Environment Investment Readiness Fund. It is hoped that this will act as an exemplar, and set up processes that can then be rolled out across the Cheshire and Warrington region.
5. Embed the natural capital approach within local policy – with the forthcoming requirement to deliver biodiversity net gain for all new developments, local policies and guidance will need to be developed on how to deliver this. In addition, it would be beneficial if local policy required natural capital (or environmental) net gain to be delivered, alongside biodiversity net gain. This would enable Cheshire and Warrington LAs to become national leaders in this field. Further policies can be advanced by the LAs to encourage the uptake of natural capital investments, for example by enabling stacking of benefits, linking with climate change policies and developing verification and governance processes. National and local priorities can be aligned, thereby attracting policy support and funding for local initiatives that in turn can lever further benefits at the local scale.
6. Link with delivery mechanisms – the evidence base presented here provides key evidence to support the delivery of multiple emerging natural capital and biodiversity-based strategies and schemes. For example, identifying opportunities to enhance biodiversity, but to also deliver additional benefits, is the key function of a Local Nature Recovery Strategy (LNRS) and the opportunity maps developed here can be used for that purpose. Similarly, the opportunity maps can be used for Environmental Land Management scheme (ELMs) targeting, to identify the best sites for biodiversity offsetting, for carbon schemes, and for health initiatives and enhancing access to natural spaces. Hence it is important that the evidence base developed here is linked to and informs these emerging schemes.
7. Training and workshops – there is a need to hold training sessions and workshops to embed the ideas presented here in working practices. Sessions can be held with LA planners and with other sectors such as local businesses, health boards, and potential investors.
8. Updating the evidence base – the natural capital evidence base will need updating periodically, probably every 3-5 years, or when it is considered that substantive land cover change may have occurred. This will also enable change to be tracked compared to the baseline presented here. With additional resource it would also be possible to update the evidence base as projects are undertaken, to present a live record of what has changed, the location and the benefits delivered.
9. Map habitat quality and ground-truth basemap – the basemap is based on the best available data, but has not been ground-truthed and does not include an assessment of habitat quality (condition). It is recommended that work is undertaken, potentially engaging local volunteers, to visit and assess sites to address this issue. The basemap could then be updated, condition data could be embedded within it and a habitat condition map could be created. Mapping habitat quality would provide a more complete understanding of Cheshire and Warrington’s natural capital assets by highlighting requirements for habitat restoration, alongside the opportunities for habitat creation presented here. The data could also be used to create a baseline biodiversity

assessment using the Biodiversity Metric tool to enable the local authorities to monitor whether they are achieving net gain in biodiversity.

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1. Introduction

The Cheshire and Warrington Local Enterprise Partnership (C&W LEP) have identified the need for an assessment of the interrelationship between natural capital and its economic and social development ambitions for the area. Natural capital is the stock of natural assets (e.g. soils, water, biodiversity) that produces a wide range of ecosystem services that provide benefits to people (See Section 1.2). These benefits include food production, regulation of flooding and climate, pollination of crops, and cultural benefits such as aesthetic value and recreational opportunities.

Natural capital supports all other forms of capital on which human systems depend, whether man-made, human or social. However, many of the outputs produced by natural capital, such as the regulation of flooding and atmospheric gases by forest lands, are not included in the decisions of private individuals or organisations. This is because they often involve non-priced public goods that are not traded in the market place and are not subject to formal property rights and entitlements (TEEB, 2010¹). Elements of natural capital are therefore liable to be overused, degraded, depleted and eventually lost, with consequences for long term welfare and the sustainability of economic systems. There is now much greater awareness of the role of natural capital in the design and achievement of economic and social development strategies, with strong links to business and enterprise². The C&W LEP's interest in natural capital assessment is also set within its commitment to develop quality of place as a platform for sustained growth.

Natural capital is also becoming embedded across multiple policy domains, including the mandatory requirement for biodiversity net gain for all new developments, as set out in the Environment Bill, with an ambition to move towards environmental and natural capital net gain in the future, backed by changes to the National Planning Policy Framework and the new Planning White Paper. The Environment Bill also sets out the requirement for nature recovery networks and strategies, while the recently enacted Agriculture Act paves the way for a new Environmental Land Management Scheme (ELMs), with a central tenet of farmers and land managers being paid public money for public goods, based on natural capital principles. Further policy alignment is achieved through the requirements for action on climate change and commitments to go carbon neutral, including the planting of large areas of new woodland.

The C&W LEP have commissioned this project to produce a Natural Capital Audit and support the development of a Natural Capital Investment Plan for the area. This is driven by the need not only to manage risks to the natural environment associated with economic development that could undermine successful achievement, but also to explore the opportunities to tap into new funding sources and mechanisms for innovative investments that can achieve substantial gains for people and the natural world. In this respect, there is a need to develop a strategic network of natural capital oriented projects to support and extend C&W LEP's strategy through to 2040, engaging key stakeholder interests in the process. The audit and investment plan covers the three local authority areas of Cheshire West and Chester, Cheshire East, and Warrington. It has been undertaken by Natural Capital Solutions, Risk and Policy Analysts (RPA), Morris Resource Economics, and Liverpool John Moores University.

¹ TEEB. 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, Oxford & NY.

² TEEB. 2012. The Economics of Ecosystems and Biodiversity in Business and Enterprise. Earthscan, Oxford & New York.

1.1 Aims and objectives

In accordance with the terms of reference, the study objectives and intended outcomes were to:

- (i) Produce, drawing on existing data, a map-based register of natural capital assets and associated services flows in the study area, together with economic values where possible. This formed a baseline from which future development and change can be assessed (**Baseline assessment**).
- (ii) Identify existing and potential interactions between the above natural capital assessment and development initiatives and plans, and emerging policies at the local and national scale (**Policy analysis**).
- (iii) Identify investment opportunities in natural capital to deliver single or multiple objectives across a range of benefits, and to identify priority themes and geographic areas where actions can be taken to safeguard natural capital and maximise its potential contribution to economic and social development (**Intervention and investment opportunities**).
- (iv) Review new and emerging financing options to deliver natural capital projects, and to develop an approach to identifying the most appropriate funding mechanism for different projects (**Future financing**).
- (v) Engage with key stakeholders to provide a shared understanding of the approach used, to engage stakeholders in choices about prioritisation, and to generate interest and buy-in to the process moving forward (**Stakeholder workshop**).
- (vi) Develop a series of case studies to illustrate the identification of locations to deliver different policy objectives, to assess the costs and benefits of natural capital investments, and to show how potential funding sources can be identified (**Case studies**).
- (vii) Summarise the above into a **Natural Capital Audit and Investment Plan** and associated outputs (including GIS layers), to provide the evidence base to protect, maintain and enhance Cheshire and Warrington's natural capital assets into the future.

1.2 The natural capital and ecosystem services framework

Natural Capital is defined as:

"..elements of nature that directly or indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions" (Natural Capital Committee 2014³).

These benefits (often referred to as ecosystem services) include food production, regulation of flooding and climate, pollination of crops, and cultural benefits such as aesthetic value and recreational opportunities. Different types of ecosystem service are shown in Figure 1 and key attributes of natural capital are illustrated in Figure 2.

There is growing evidence that the natural environment not only delivers multiple ecosystem services, but also enhances the health and wellbeing of local residents and visitors. Greenspaces are also important components of 'place-making' providing local landscape identities to residents and businesses. Quality green spaces deliver a range of benefits that have real value to society, create community well-being, and enhance liveability and sense of place.

³ Natural Capital Committee 2014. Towards a Framework for Defining and Measuring Changes in Natural Capital. Working Paper 1, Natural Capital Committee.

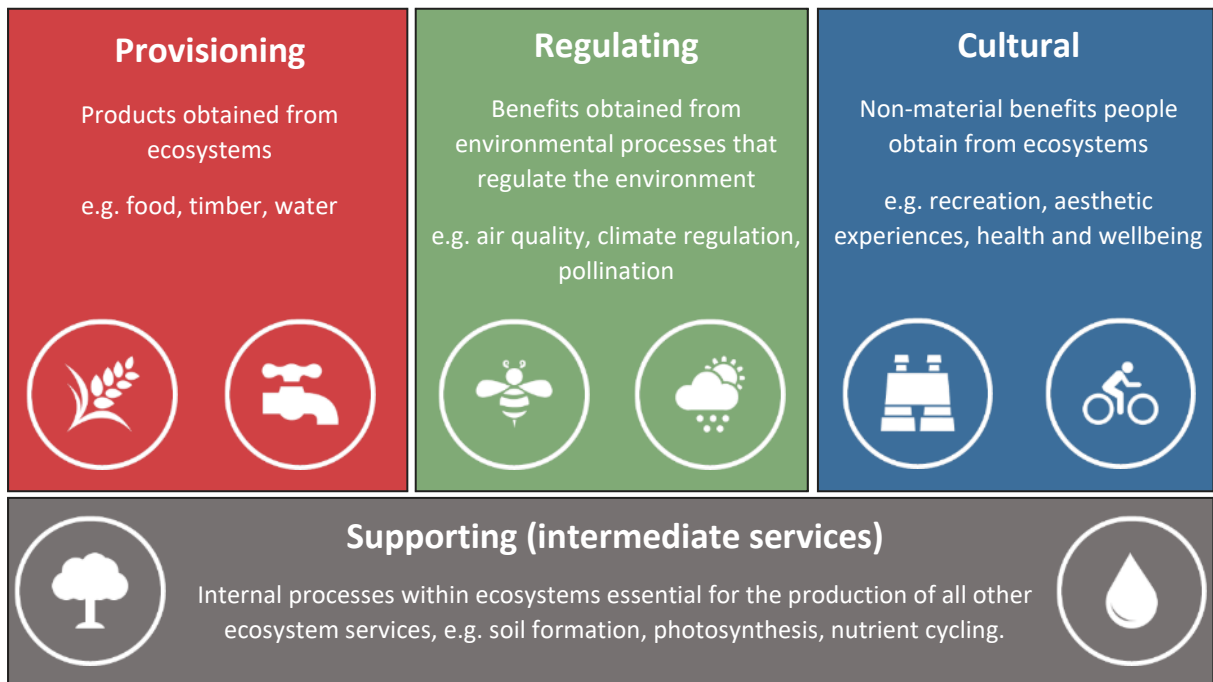


Figure 1 Key types of ecosystem services (based on MA 2005 and EEA 2016).

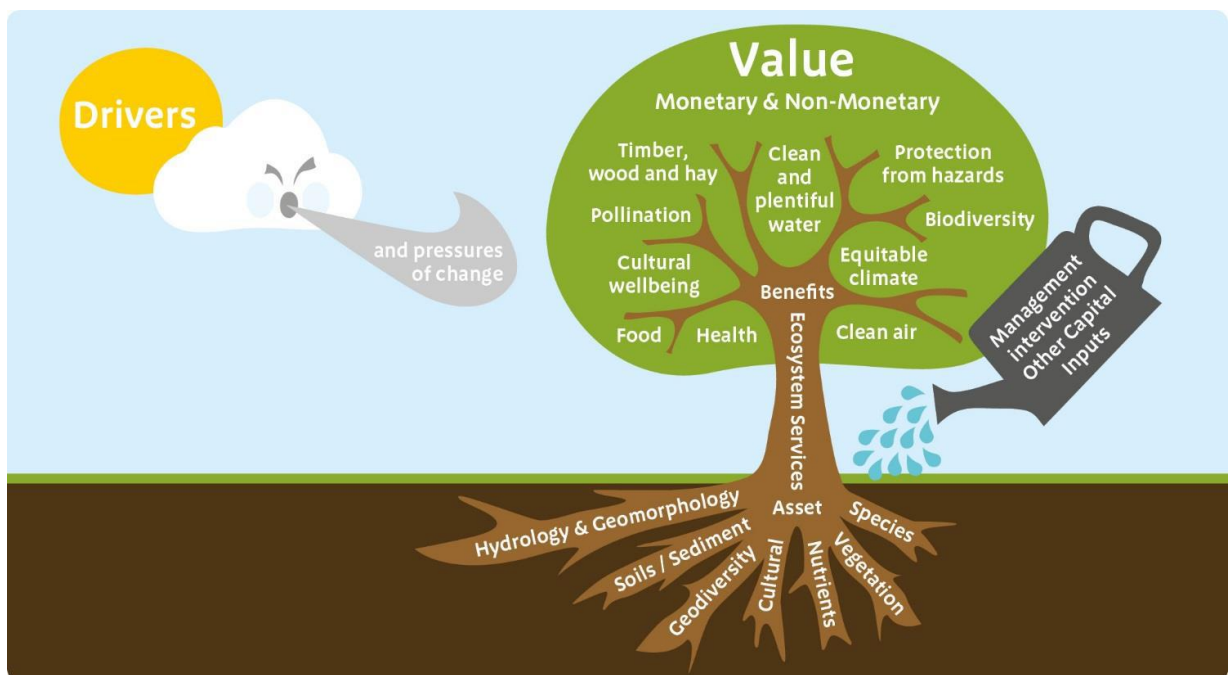


Figure 2 Key attributes of natural capital (from Natural England 2019⁴)

The environment is being increasingly regarded as ‘multi-functional’, delivering a range of environmental, social and economic benefits to society. Green spaces and well-planned developments can reduce carbon emissions, downstream flood risk and water quality problems, as well as providing

⁴ Sunderland, T., Waters, R.D., Marsh, D. V. K., Hudson, C., And Lusardi, J. (2019). Accounting for National Nature Reserves: A natural capital account of the National Nature Reserves managed by Natural England. Natural England Research Report, Number 078.

quality space for recreation and biodiversity gain, demonstrate how multi-functional benefits can be delivered. Locating these in optimal locations can further enhance the benefits delivered.

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 it becomes an integral component of decision making. Progress is being made on how to deliver the approach on the ground and how to use it to inform and influence management and decision-making.

Methods for quantifying and valuing natural capital benefits are becoming increasingly robust and additional insight can be gained by taking a spatial perspective on the variation in natural capital assets and the benefits that they deliver across the study area using a Geographic Information System (GIS). Maps are able to highlight hotspots and coldspots of ecosystem service delivery, highlight important spatial patterns that provide much additional detail, and are inherently more user friendly than non-spatial approaches. They can also be used to objectively identify areas where natural capital can be created to enhance benefits, often in areas where demand is currently high and supply low, in a process known as opportunity mapping.

At the same time, new markets are emerging focussed on delivering natural capital projects for particular benefits, with most attention focussed on carbon and biodiversity net gain, although markets are beginning to develop across a wide range of potential benefits and innovative financing mechanisms are emerging.

All of these factors can be brought together in a Natural Capital Audit and Investment Plan, which begins by assessing the baseline situation and key policy drivers influencing decision making across the area, before objectively identifying opportunities to enhance natural capital and the funding mechanisms that could be used to deliver such projects. This is all brought together using a strategic framework and illustrated using a number of case studies.

1.3 Outline of approach and report structure

The approach taken is shown in Figure 3. Section 2 summarises the natural capital baseline assessment or the current situation across Cheshire and Warrington. This maps the current natural capital assets, the benefits (ecosystem services) that flow from these assets, the demand for some of these services and the monetary value of these benefits. Section 3 then describes the policy analysis undertaken, examining local and national policy drivers that are influencing or will be likely to influence natural capital and quality of place over the coming years.

Section 4 considers opportunities to enhance natural capital across the area to meet a range of objectives and priority areas for doing so, and Section 5 summarises a prioritisation workshop held with stakeholders in November 2020. Section 6 examines sources of funding, focussing on new and emerging options for financing projects that enhance natural capital, before Section 7 presents a strategic framework for identifying and funding natural capital projects in Cheshire and Warrington.

A number of the themes of the report are brought together through five illustrative case studies in Section 8. These show the application of the approach across different policy objectives and the type and magnitude of benefits, costs and potential economic performance that could typically be achieved. Finally, the report ends by presenting recommendations and actions to take this work forward in Section 9.

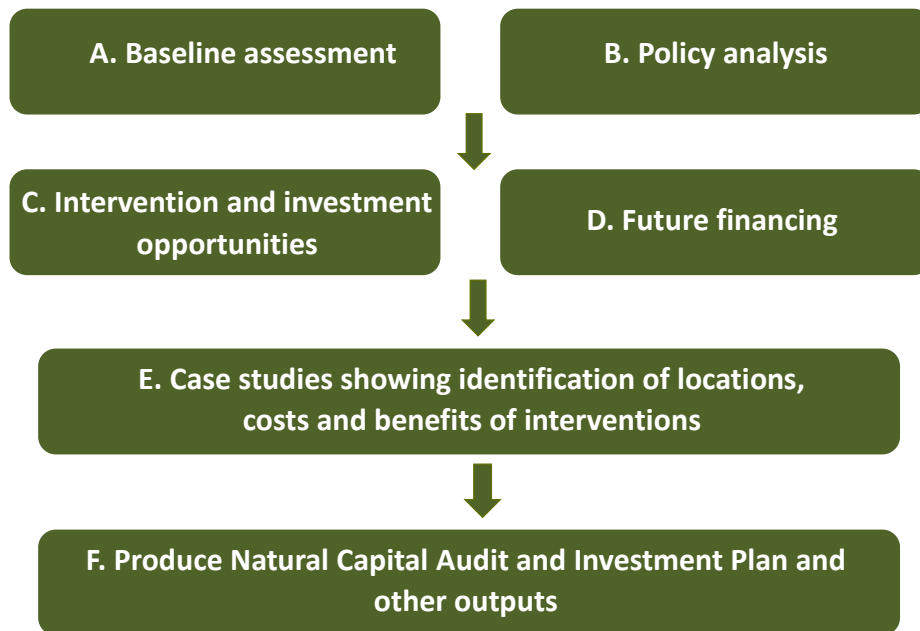


Figure 3 Outline of approach.

An extensive evidence base has been built-up to support the development of the **Natural Capital Audit and Investment Plan (NCAIP)** presented here. This document provides a summary of the key evidence, but much more detail is provided in the form of five technical reports that accompany this document:

1. **Natural capital audit and policy analysis** – a baseline assessment of the natural capital assets currently present across Cheshire and Warrington, the benefits that flow from those assets and their monetary value, together with an analysis of policies at the local and national scale that effect natural capital, and an identification of priority themes and sectors.
2. **Intervention and investment opportunities report** – habitat opportunity mapping to identify the best locations to deliver specific or multiple objectives, along with mapping of strategic themes based on local policies, to prioritise locations for investment.
3. **Workshop report** – write-up of stakeholder workshop to present the approach used to map natural capital opportunities, and to discuss key priorities across C&W.
4. **Future financing report** – review of emerging financing options, including a typology of different funding opportunities, the ecosystem services and habitats covered by each, and an approach to identifying the most appropriate funding mechanism for different projects.
5. **Case studies report** – presentation of five case studies to demonstrate how the opportunity maps can be used to identify habitat creation potential based on different objectives, to highlight the benefits of such projects, and to show how funding requirements and potential funding sources can be identified.

One of the key outputs from this project are the numerous GIS maps and layers. These are being supplied to project partners and a mapping portal is currently being developed (see Section 9).

Please note that the maps presented here are based on existing data and have not been extensively ground-truthed, so will be prone to some error. They do, however, provide the most comprehensive and detailed information that is possible at this time. Note also that the opportunity mapping identifies areas based on landscape-scale ecological principles and ecosystem services models and does not

consider local site-based factors that may impact on suitability. Any areas suggested for habitat creation will require ground-truthing before implementation. The maps should be seen as a tool to highlight key locations and to guide decision making, rather than an end in themselves. In addition, the case studies presented in Section 8 are illustrative and have not been ground-truthed. A more detailed assessment would be required to confirm details and to support decision making for investment.

2. Natural capital baseline assessment

2.1 Basemap

The first and key part of any assessment of natural capital and the benefits that it provides is to produce a detailed map of the current habitats present across the area. This is an important component of any assessment of natural capital assets, and is required before an assessment of the benefits (ecosystem services) or opportunities for enhancing those benefits (Section 4) can be undertaken. To do this we used Ordnance Survey MasterMap polygons as the underlying mapping unit and then a series of different data sets to classify each polygon to a detailed habitat type, and to associate a range of additional data with each polygon. Full methodological details are provided in Technical Report 1.

Polygons were classified into detailed (Phase 1) habitat types and were also classified into broader habitat groups. The final basemap covered the whole of Cheshire and Warrington, and covers an area of 230,000 ha or 2,300 km². It contained 1.97M polygons, each of which was classified to an appropriate habitat type.

Note that the basemap provides the best approximation of habitat types that can be achieved based on available data. But it has not been ground-truthed further and will inevitably contain errors. A particular challenge was classifying polygons where more than one habitat was present and not all combinations of habitats could be accommodated in detail.

Figure 4 shows the key habitats across the Cheshire and Warrington region, with area and percentage cover shown in Table 1 (further detail and breakdown by Local Authority provided in Technical Report 1). The region is dominated by improved grassland that covers 51.3% of the area, along with significant areas of arable land (17.4%). Woodland and tree categories comprise 7.8% of the total area, while semi-natural and marshy grasslands comprise 2.8%. Built-up areas and infrastructure make up around 8.5% of the area, with gardens occupying an additional 6.0%.

Table 1 Area and percentage cover of broad habitat types across Cheshire and Warrington.

Broad habitat	Area (Ha)	% cover
Cultivated / disturbed land	39,951	17.4
Improved grassland	117,762	51.3
Semi-natural and marshy grassland	6,407	2.8
Heathland	393	0.2
Mire and swamp	1,233	0.5
Scrub	351	0.2
Trees / Parkland	1,163	0.5
Broadleaved woodland	10,802	4.7
Coniferous woodland	1,749	0.8
Mixed woodland	3,776	1.6
Water	3,962	1.7
Coastal	3,931	1.7
Built-up areas and infrastructure	19,569	8.5
Garden	13,720	6.0
Rock, exposure and waste	521	0.2
Unclassified (land currently under development)	950	0.4
Mixed / other / uncertain (including hedgerows)	3,256	1.4
TOTAL	229,496	100.0

Natural capital basemap

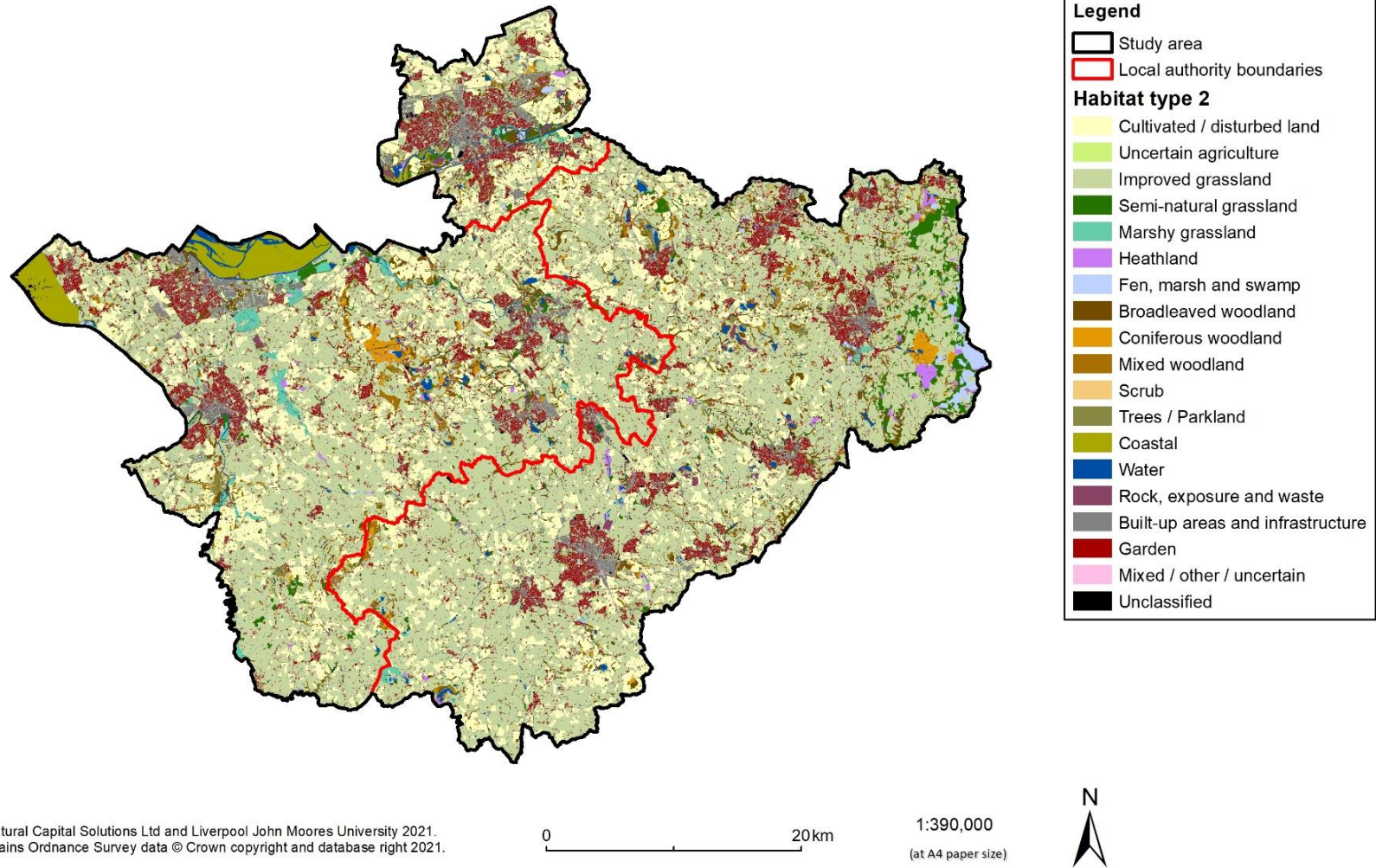


Figure 4 Natural capital basemap, showing broad habitats across Cheshire and Warrington.

2.2 Modelling and mapping ecosystem services (benefits)

Once a detailed habitat basemap had been created for Cheshire and Warrington, it was then possible to quantify and map the benefits that these habitats (natural capital) provide to people. The ecosystem services mapped are outlined in Box 1, with all maps included in Technical Report 1.

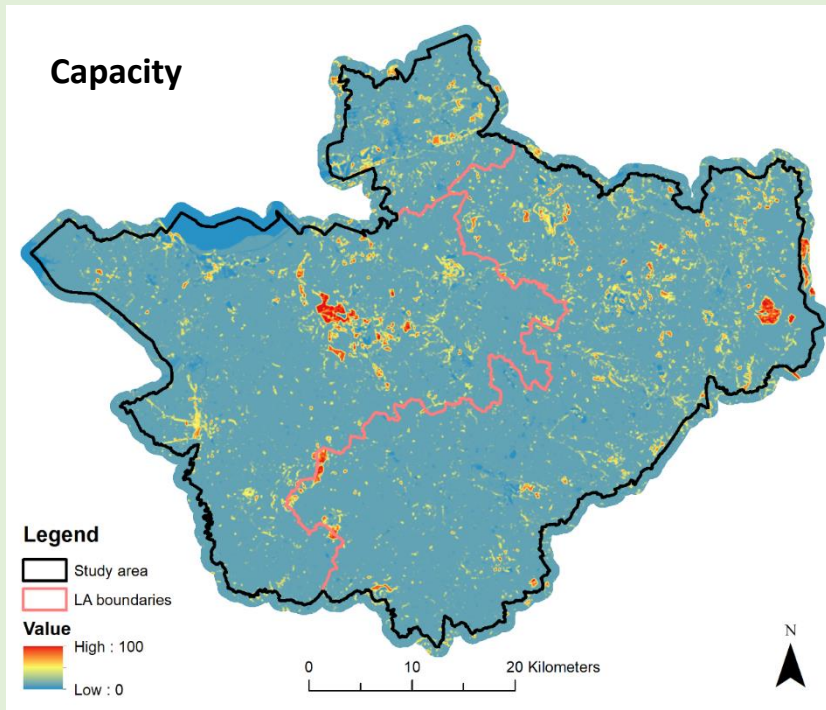
Box 1: Ecosystem services mapped

- **Carbon storage capacity** estimates the amount of carbon stored in each habitat type based on average values for vegetation and the first 30 cm of soil.
- **Carbon sequestration** calculates the amount of carbon taken up (sequestered) by trees and woodland each year, so is an annual flow of benefits (like the other ecosystem services below), whereas carbon storage indicates a stock of carbon.
- **Air purification** (air quality regulation) estimates the relative ability of vegetation to trap airborne pollutants or ameliorate air pollution. Woodland habitats are by far the most effective habitat type at providing this service, but all woody habitats including hedgerows and scattered trees have some effect.
- **Noise regulation** is the capacity of the land to diffuse and absorb noise pollution. Complex vegetation cover, such as woodland, trees and scrub, is considered to be most effective, and the effectiveness of vegetation increases with width.
- **Local climate regulation** estimates the capacity of an ecosystem to cool the local environment and cause a reduction in urban heat maxima. Natural vegetation, especially trees / woodland and water bodies, are able to have a moderating effect on local climate, making nearby areas cooler in summer and warmer in winter.
- **Pollination capacity** measures the capacity of the land to provide pollination services by estimating the probability that wild insect pollinators will visit.
- **Water flow regulation** is the capacity of the land to slow water runoff and thereby potentially reduce flood risk downstream.
- **Water quality (soil erosion) regulation** maps the risk of surface runoff becoming contaminated with high sediment loads before entering a watercourse, with a higher water quality capacity indicating that water is likely to be less contaminated. The model focuses on sedimentation risk from agricultural land, rather than urban diffuse pollution.
- **Food production** models the capacity of the land to produce food under current farming practices, based on habitat type and agricultural land classification.
- **Timber / woodfuel production** models the potential of trees and woodland to provide wood-based products, based on average yield.
- **Accessible nature capacity** maps the availability of natural areas and scores them by their perceived level of naturalness.

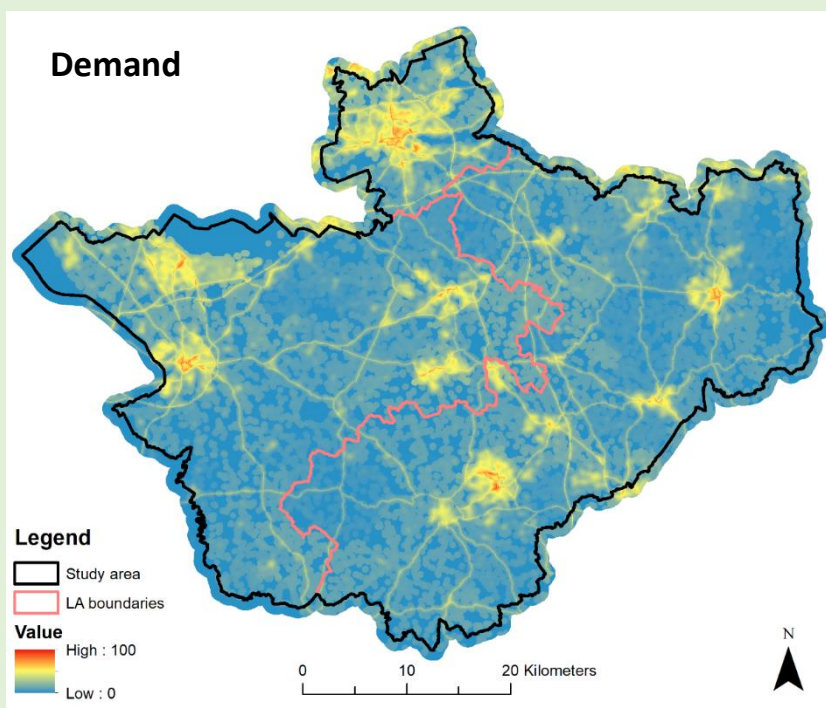
In all cases the models were applied at a 10m by 10m resolution to provide fine scale mapping across the area. The models are based on the detailed habitat information determined in the basemap, together with a variety of other external data sets (e.g. digital terrain model, UK census data, open space data, and many other data sets and models). Note, however, that many of the models are indicative (showing that certain areas have higher capacity or demand than other areas) and in all cases the capacity and demand for ES is mapped relative to the values present within the study area.

Box 2: Mapping supply and demand

For every ecosystem service listed in Box 1, the capacity of the natural environment to deliver that service – or the current supply – was mapped. For air quality regulation, noise regulation, local climate regulation, and accessible nature, it was also possible to map the local demand (the beneficiaries) for these services. The importance and value of ecosystem services can often be dependent upon its location in relation to the demand for that service, hence capturing this information provides useful additional insight. Mapping demand was not, however, possible, for the other services where there was no obvious method to apply, or local demand is not relevant.



Estimates the relative ability of vegetation to ameliorate air pollution



Models air pollution sources and societal need for air quality regulation

Air quality regulation capacity (top) and demand (bottom) across Cheshire and Warrington.

2.2.1 Key findings

The ecosystem service maps demonstrate the spatial pattern of provision of ten different ecosystem services, and the demand for four. The maps demonstrate that the woodland asset is important for high levels of provision of carbon storage, carbon sequestration, air quality, noise, local climate and water flow regulation, and timber/woodfuel production benefits. The mapping also shows that many of these woodlands provide hotspots of access to nature and overall ecosystem service delivery is especially high around Delamere Forest and Macclesfield Forest. The upland heathland and bog habitats in the east (in the Peak District), are important areas for carbon storage, but also have a high level of provision for access to nature. They are currently a source of GHG emissions due to degradation of the peat⁵, but this can be reduced significantly through restoration. Food production is clearly dominant in the region, spread throughout most of lowland Cheshire.

The demand maps of air quality, noise, local climate regulation, and accessible nature show clearly the importance of ecosystem service delivery to the urban centres in Cheshire and Warrington. Urban areas adjacent to the road network are also hotspots for demand. The capacity to provide these services can be quite high where woodland and other semi-natural habitats occur on the outskirts of urban areas, and these areas should be protected and expanded even if not important for biodiversity. Street trees in urban centres can also be important. However, in many areas there is a mismatch between demand and supply.

2.3 What is the economic value of this natural capital?

A suite of ecosystem services that are provided by the natural capital assets of Cheshire and Warrington were quantified (physical flow) in order for them to be valued (monetary flow). Annual monetary flows of ecosystem services have been calculated based on the latest valuation techniques available in the scientific literature and approaches adopted by the Office for National Statistics (ONS 2017⁶), and recent Defra guidance to standardise approaches to the valuation of ecosystem services⁷.

Key physical flows and monetary values across Cheshire and Warrington each year are shown here:

- Vegetation sequesters (take up) 122,000 tonnes of CO₂ worth £8.5M
- But agriculture emits 563,000 tonnes of CO₂e with a damage estimate of £39M
- Vegetation absorbs 884 tonnes of fine particulate matter (PM_{2.5}) with an avoided damage costs worth £146M
- There are 49.7M visits made to the natural environment every year providing welfare benefits of £159M and 800,000 fishing trips are made valued at £56M
- Active visits to the natural environment provide 3,700 QALYs providing health benefits valued at £55M
- 133,000 ha are farmed (arable & livestock) providing benefits worth £9.4M after subsidies are stripped out
- Woodlands have the potential to provide 132,000 m³ of timber and woodfuel, valued at £2.4M
- 3.3M tonnes of sand, gravel and rock are extracted worth £68M

In addition, 61,000 residential properties are within 500m of a greenspace over 2.5 ha in size, increasing house prices by £246M.

⁵ Cheshire Wildlife Trust (2021) Peatlands of Cheshire East: An Assessment of Greenhouse Gas Emissions and Biodiversity.

⁶ ONS (2017) Principles of Natural Capital Accounting. Office for National Statistics

⁷ Defra (2020). [Enabling a Natural Capital Approach \(ENCA\)](#).

The breakdown for each local authority area is shown in Table 2, along with the asset value (Present Value) over 50 years. **The overall value of the benefits delivered by the natural capital assets across the Cheshire and Warrington region** (that we were able to quantify) **is £465 million annually, with a present value of £13.4 billion over 50 years.** The total value delivered by the natural capital of each local authority ranges from £63.3 million to £149 million annually, with a present value over 50 years ranging from £1.95 billion to £4.34 billion. Overall values are larger for Cheshire East and Cheshire West and Chester, but if calculated on a per hectare basis are highest for Warrington, where publicly accessible greenspace will be providing benefits of high value, particularly for recreation and physical health. Please see Technical Report 1 for full methodological details, a more detailed breakdown of the results and further analysis.

Table 2 Annual monetary flows of ecosystem services and the present value calculated over 50 years for Cheshire East, Cheshire West and Warrington local authorities, and across the whole region.

Ecosystem service	Annual monetary flow (2020) and present value over 50 years (£ million)							
	Cheshire East		Cheshire West		Warrington		Full region C&W	
Air quality regulation	71.3	2,640	57.9	2,140	16.3	603	146	5,380
Carbon sequestration	4.44	259	3.16	184	0.879	51.3	8.48	494
GHG emissions from agriculture	-23.8	-1,390	-12.9	-751	-2.34	-136	-39.0	-2,270
Recreation	67.0	1,710	56.3	1,440	35.7	912	159	4,060
Physical health	23.3	862	20.1	744	11.9	441	55.4	2,050
Agricultural production	5.71	146	3.09	78.9	0.562	14.3	9.37	239
Timber/woodfuel production	1.29	32.9	0.918	23.4	0.221	5.64	2.43	62
Mineral extraction	-	-	-	-	-	-	68.0	1,740
Recreational fisheries (angling)	-	-	-	-	-	-	55.7	1,420
Visual amenity	-	83.6	-	99.1	-	63.1	-	246
TOTAL VALUE	149	4,340	129	3,960	63.3	1,950	465	13,400

NB. All figures displayed to 3 significant figures; any discrepancies due to rounding.

Benefits are greatest for air quality regulation, recreation and physical health, along with mineral extraction and recreational fisheries (angling). When carbon sequestration is balanced against agricultural emissions, Cheshire and Warrington as a whole is a net emitter of carbon dioxide of 441,000 tonnes per year, at a cost of £30.5 million annually. This high figure is driven by the large amount of dairy and other livestock across the area. This greenhouse gas balance is an important figure as it represents the agriculture and land use, land use change and forestry (LULUCF) sector for which national emissions information is collected. Note that this does not include greenhouse gas emissions from other sectors, such as transport, manufacturing and construction.

3. Policy analysis

Cheshire and Warrington's Local Enterprise Partnership's (C&W LEP) strategic economic plan identifies an aim to grow to £50 billion in Gross Value Added by 2040, creating an additional 120,000 jobs and building 127,000 new homes. It is recognised that there needs to be investment in the environment to attract people with the right skills, while transitioning to a low carbon economy. One of the keys to balancing the growth ambitions with the desire for Cheshire and Warrington to be the best place to live in the UK is to identify opportunities to build on the existing value of natural capital, drawing together policies to provide a coordinated approach to development.

The importance of the natural environment is increasingly promoted through national and local planning policy, such as the UK Government 25 Year Environment Plan, and the National Planning Policy Framework. We therefore reviewed the national and local policy and institutional frameworks that will drive investment. The policy analysis involved collating and analysing existing local initiatives, plans, policies, and strategies. While a wide range of policies and initiatives were reviewed, only the impact on ecosystem services of the main strategies were assessed; behavioural issues or other aspects that are not linked to natural capital were excluded. Full details of the policy analysis are presented in Technical Report 1 (Natural capital audit and policy analysis), with a summary provided here. The analysis has been undertaken for eight sectors:

1. Agriculture;
2. Skills and education;
3. Energy, clean growth, housing and construction;
4. Manufacturing, logistics and services;
5. Minerals and waste management;
6. Environmental management;
7. Health, wellbeing and tourism; and
8. Transport.

Quality of place is identified as an important aspect that cuts across all sectors, being one of the key factors to attracting and retaining talent in the C&W LEP area.

The analysis shows that there are many existing initiatives, policies, plans and strategies that present opportunities to deliver an improvement to natural capital and so help deliver quality of place, and deliver the LEP's economic and social targets. Key opportunities include the development of forests and urban green spaces, and the transition to clean growth. However, there are also some policies and plans that could lead to negative effects on natural capital and threats facing each sector that could reduce the condition or extent of habitats. Leading threats include: the significant housing developments, some of which are located on the green belt, the stimulation of the economy attracting more workers to the area which puts pressure on services, and the emphasis on the development of roads. By identifying both these opportunities and threats, the policy analysis provides an evidence-based approach to assessing where future interventions need to be targeted to ensure opportunities can be maximised while threats are minimised.

Table 3 shows how and where the sectors could interact with each other: where there may be synergies between sectors and where there may be antagonisms. In some cases, there could be both synergies and antagonisms, depending on how policies develop moving forwards. These will be key areas for focus in terms of potential interventions to ensure that opportunities are not missed and that threats are avoided. Figure 5 then presents the SWOT analysis. This identifies specific strengths and weaknesses for each sector as well as overall opportunities and threats for Cheshire and Warrington.

Table 3 Potential synergies and antagonisms between sectors.

Sector	Agriculture	Skills and education	Energy, housing and construction	Manufacturing, logistics and services	Minerals and waste management	Environmental management	Health, wellbeing and tourism	Transport
Agriculture		+	-/+	-/+	-/+	-/+	-/+	0
Skills and education	++		+	++	-/+	+	+	+
Energy, housing and construction	--	+		+	++	--	-/+	-/+
Manufacturing, logistics and services	-	+	+		-/+	-/+	-/+	+
Minerals and waste management	--	-/+	-/+	-/+		-/+	-/+	-/+
Environmental management	+	++	-/+	-/+	-/+		++	+
Health, wellbeing and tourism	+	+	-/+	-/+	-/+	++		-/+
Transport	--	+	-/+	-/+	+	-/+	-/+	

The interactions with each sector are shown from left to right, so the impacts of agriculture on education and research is shown as + (potential for stronger relationships between farmers and universities/research originations) while the impacts of education and research on agriculture is shown as ++ (educational and research opportunities for agriculture already in place).

Note that the interaction of energy, housing and construction with environmental management can be offset through biodiversity net gain, thereby reducing negative impact.

Key:

- ++ strong synergies with established initiatives, policies, plans and strategies in place
- + potential for synergies but limited exiting initiatives, or initiatives not yet fully in place
- 0 no identified synergies or antagonisms
- potential antagonisms could arise in the future without interventions that could affect natural capital
- existing antagonisms already identified that are affecting natural capital

<p>Strengths</p> <ul style="list-style-type: none"> • Rural area with well-developed and growing industries (agriculture) • Important colleges and centres of innovation (agriculture, skills and education) • Nationally significant energy cluster with high level of expertise (including low carbon (energy)) • World-leading businesses including digital skills (manufacturing, logistics, services) • Green corridors (environmental management) • Irreplaceable natural habitat (environmental management) • Natural visitor attractiveness (health, well-being, tourism) 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Antagonisms between policies that could discourage some sectors (agriculture) in favour of others (development) • Mismatch between skills needed by employers and those being acquired (skills and education) • Economy with many working on unstable low hours contracts (skills and education) • High level of commuting (transport) • Existing soil, water, air quality issues – Warrington most polluted city in North West according to WHO report (environmental management, transport) • Localised areas of deprivation (health, well-being) • High focus on road network with lack of transport links for rural communities (transport)
<p>Opportunities</p> <ul style="list-style-type: none"> • Support for rural economy • Diversification • Development of innovative approaches • Growth in local markets • Science corridor enterprise zone as catalyst for growth, including digital skills • Transition to clean growth • Climate change and need for adaptation • Restoration of habitats (e.g. urban green space) and new habitats (e.g. forests) • Growth in sustainable/public transport • Focus on delivery of reduction in carbon emissions and carbon sequestration in many policies and strategies 	<p>Threats</p> <ul style="list-style-type: none"> • Market uncertainty • International competition • Demographic challenges including ageing highly skilled workforce (need to replace 230,000 jobs by 2035) • Prioritisation of short-term growth over sustainability • Release of green belt land for housing • Climate change and need for adaptation • In-migration to take up skilled jobs • Real risk in terms of key services such as air quality • Flood risk and water quality also key concerns affecting growth potential • Risk to high quality habitats and biodiversity • Policy uncertainty (uncertain regulatory, planning and incentive regimes e.g. on renewables, transport, climate change policy)

Figure 5 SWOT analysis based on the policy analysis.

4. Opportunities and priorities

4.1 Biodiversity opportunity maps

The importance of landscape-scale conservation and ecological networks has become increasingly recognised over recent years. Many wildlife sites have become isolated in a landscape of unsuitable habitats and efforts are now being directed towards linking existing habitat patches and increasing connectivity. Species are more likely to survive in larger habitat networks, are able to move and colonise new sites, and are more resilient to climate change and other detrimental impacts.

Habitat opportunity mapping to enhance biodiversity follows this ethos by using ecological networks to identify potential areas for new habitats. Identified areas will be ecologically connected to existing habitats, thereby expanding the size of the existing network, increasing connectivity and resilience, and potentially increasing the ecological quality of the new site. It was performed for five key habitat groupings, incorporating the main semi-natural habitats found in Cheshire and Warrington. The broad habitats and their constituent types are shown below:

Broad habitat	Specific habitats included
Semi-natural grassland	Acid, neutral, calcareous, rough and semi-improved grasslands
Wet grassland	Purple moor grass and rush pasture, marshy grassland, floodplain grazing marsh
Woodland	Broadleaved and mixed woodland types (excludes coniferous woodland, parkland or individual trees)
Mire	Bogs and upland flushes, fens and swamps (reedbed)
Heathland	Includes all heathland types (including wet and dry heaths) and grass-heath mosaics

Biodiversity opportunity mapping followed a four-step process, and was based on the approach developed by Catchpole (2006)⁸ and Watts et al. (2010)⁹. It is based on estimating the permeability of the landscape for typical species of each habitat type and the distance that species would move through the landscape. In all cases, constrained areas (areas where new habitat could not be created) were excluded and typically included existing buildings, gardens, infrastructure and water, existing high-quality habitats, heritage features, and gas pipelines and overhead cables (for woodland only). Full methodological details are provided in Technical Report 2 (Intervention and investment opportunities report). Note that opportunity areas for the five broad habitats often overlap. The maps identify three different opportunity zones:

- **Core** – existing areas of habitat, these will provide source populations for new areas of habitat created.
- **Buffer** – areas that are immediately adjacent to existing habitat patches (the Core zones) and will usually be the priority for habitat creation.

⁸ Catchpole, R.D.J. (2006). Planning for Biodiversity – opportunity mapping and habitat networks in practice: a technical guide. *English Nature Research Reports*, No 687

⁹ Watts, K., Eycott, A.E., Handley, P., Ray, D., Humphrey, J.W. & Quine, C.P (2010). Targeting and evaluating biodiversity conservation action within fragmented landscapes: an approach based on generic focal species and least-cost networks. *Landscape Ecology*, 25: 1305–1318.

- **Stepping stone** – areas that are slightly further away from existing habitats, but are close enough to be ecologically connected, and could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.

As the buffer and stepping stone areas identify portions of land in relation to the ecological network for each habitat, it often results in thin slivers of land being identified adjacent to existing habitats, which bear no relationship to existing fields and boundaries. As habitat creation or restoration projects usually operate on whole fields, an additional step was taken to identify those fields that present buffer and stepping stone opportunities.

Figures 6-8 show the field-scale opportunity zones identified for each of the five habitat types.

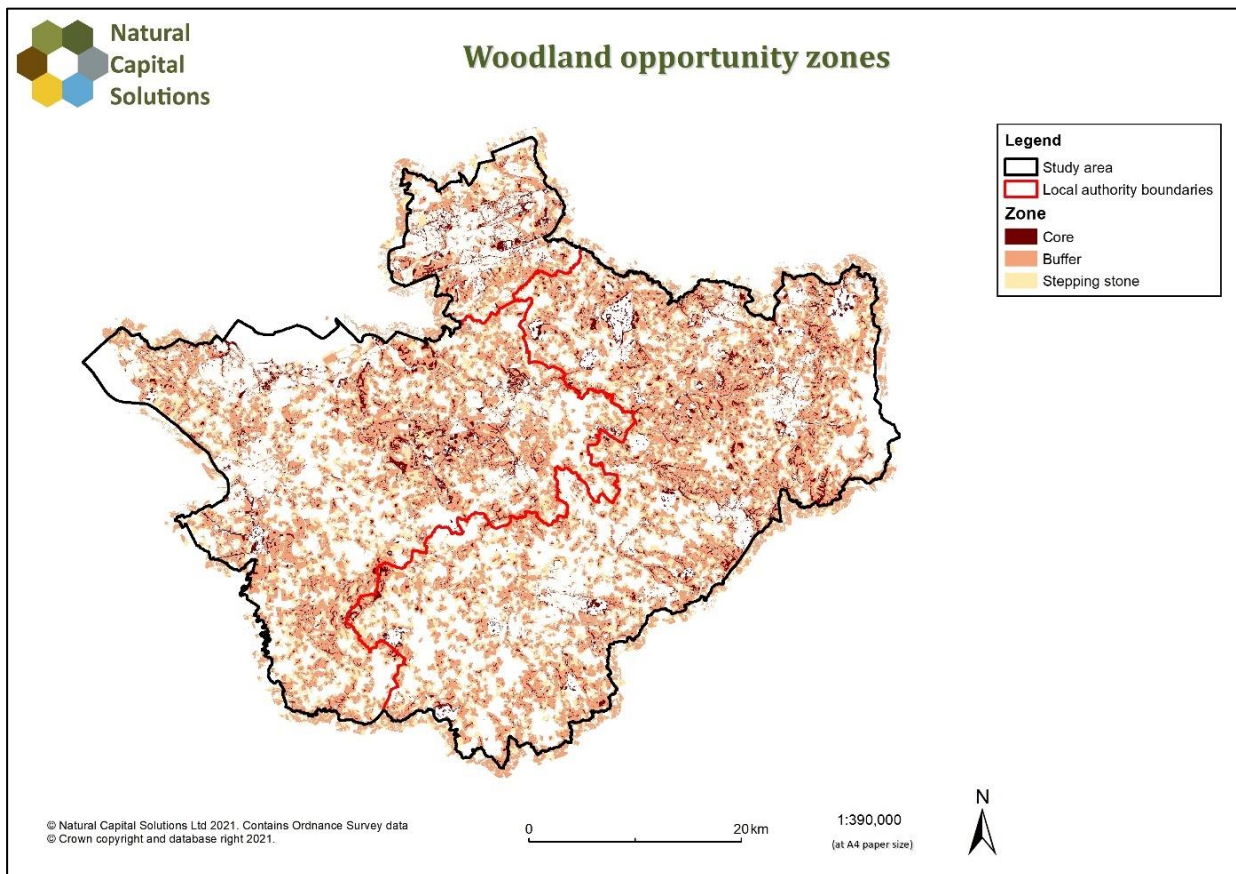


Figure 6 Woodland opportunity zones across Cheshire and Warrington.

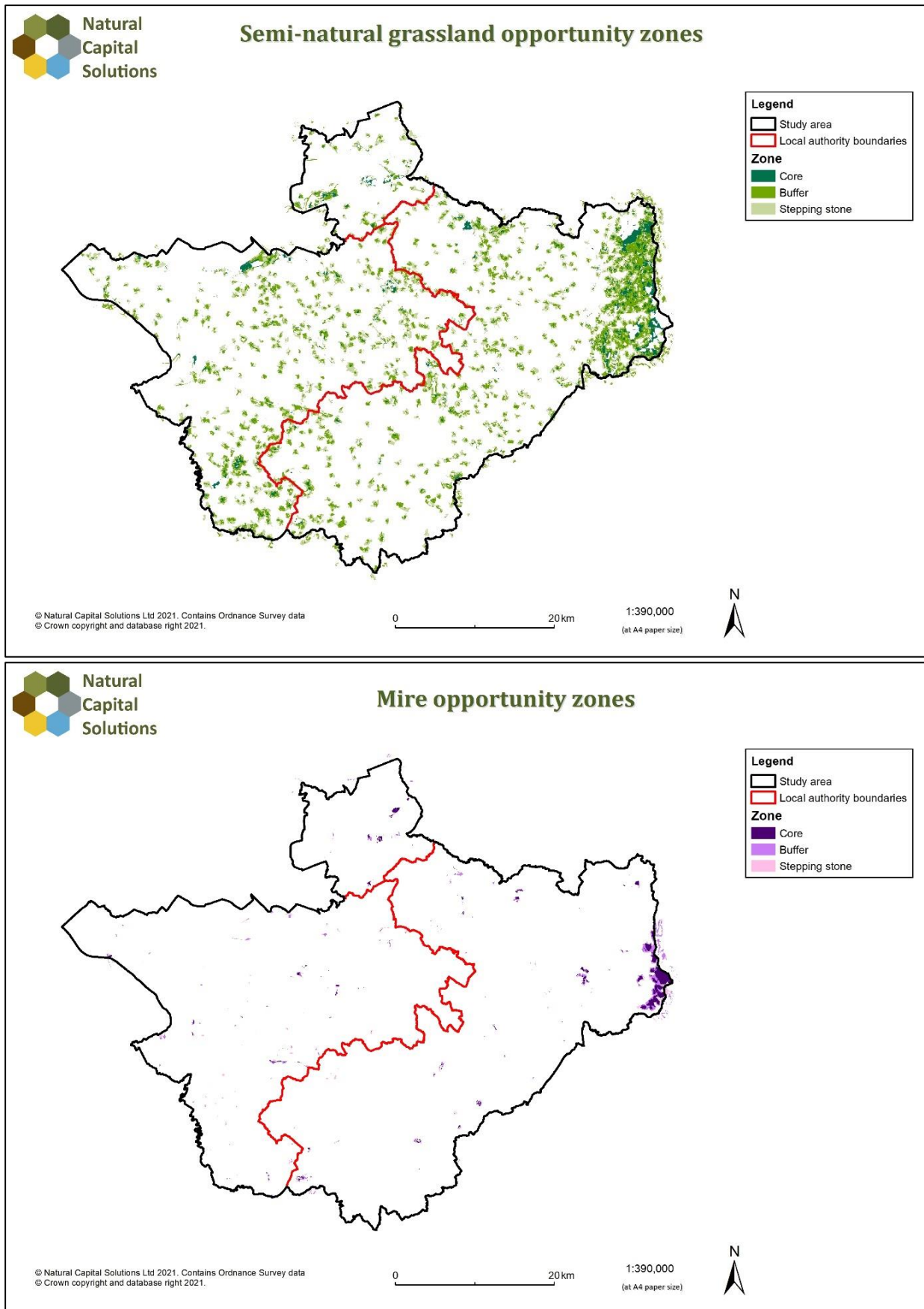


Figure 7 Semi-natural grassland opportunity zones (top) and mire opportunity zones (bottom).

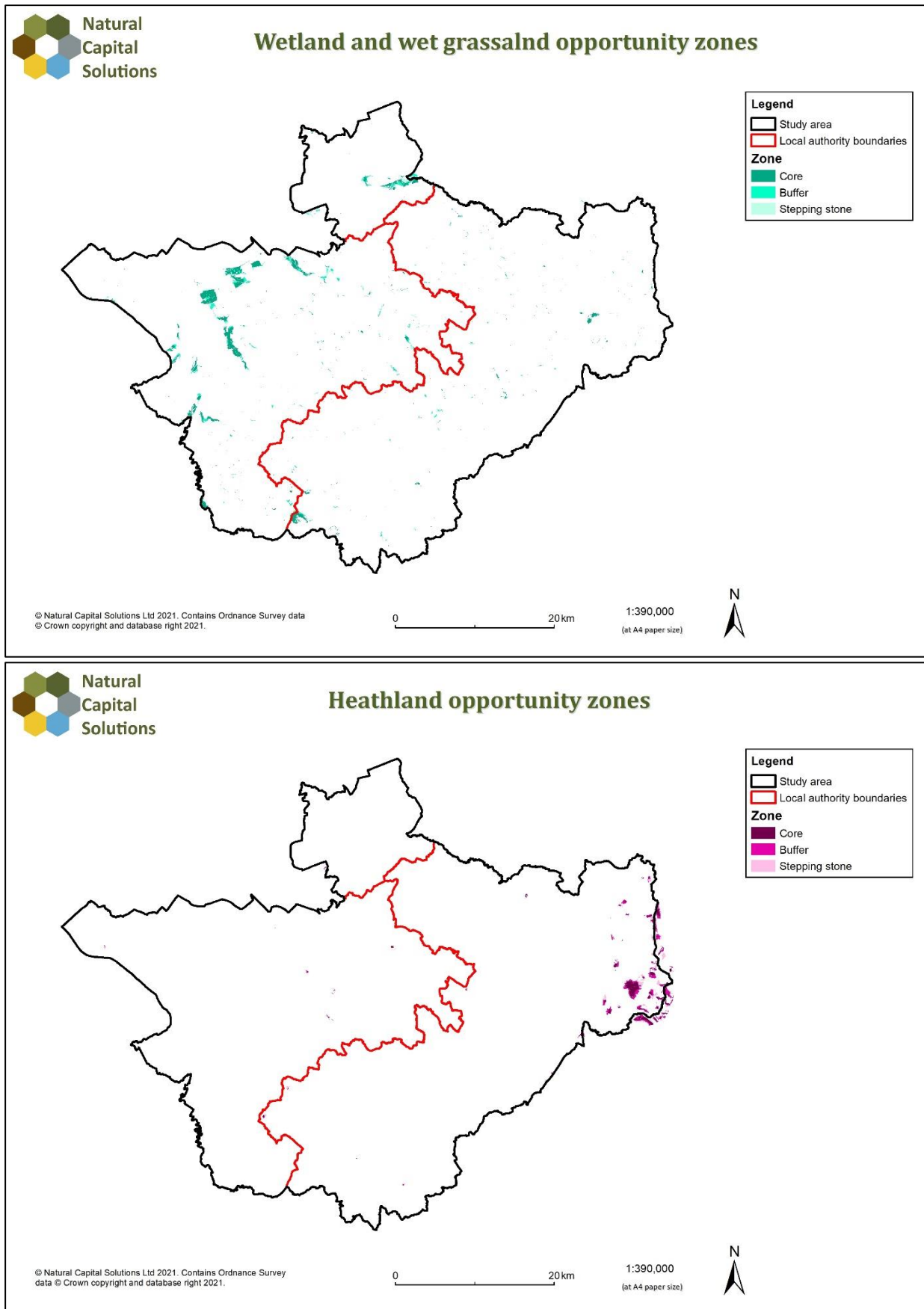


Figure 8 Wet grassland opportunity zones (top) and heathland opportunity zones (bottom).

4.2 Ecosystem services opportunity maps

Ecosystem services opportunity mapping is a Geographic Information System (GIS) based approach used to identify potential areas for the expansion of key habitats to meet different objectives, whilst taking constraints into account. Opportunities have been mapped to:

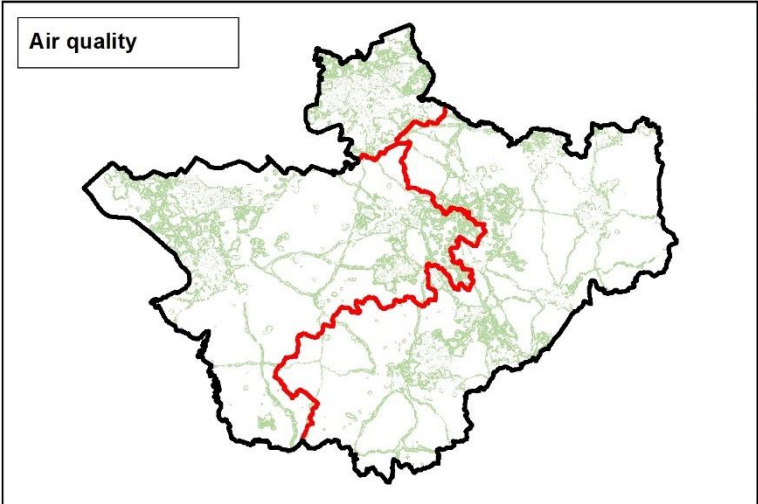
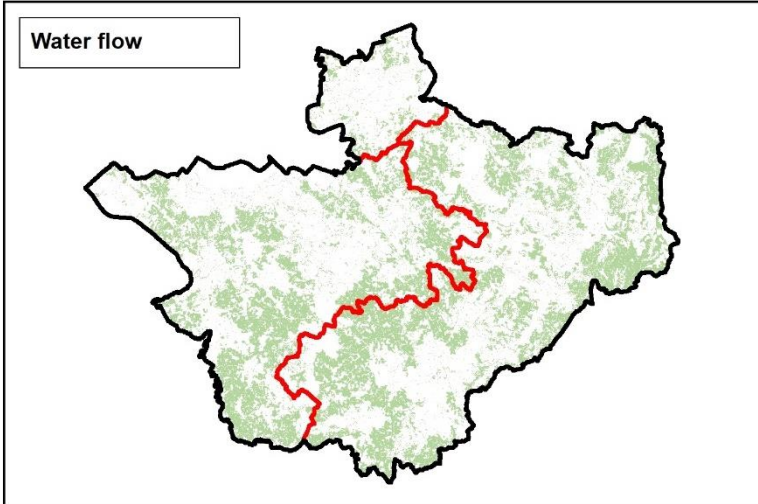
- **reduce surface water runoff** (and hence flood risk),
- **reduce soil erosion and improve water quality,**
- **ameliorate air pollution,**
- **reduce noise pollution,**
- **regulate local climate (reduce urban heat),** and
- **enhance public access to natural greenspace.**

The opportunity maps highlight the top 25% of sites for each respective service, based on the ecosystem services maps (Section 2.2). For four of the ecosystem services, this is demand led, so areas highlighted are those with the highest demand, but currently low supply of each service. Constrained areas are excluded and, as for the biodiversity opportunity maps, consisted of existing buildings, infrastructure, gardens and water, existing areas of high-quality habitats, and listed heritage assets. Initial opportunity layers were converted into field-scale maps. Full details of the methodology and additional maps are presented in Technical Report 2.

Opportunity maps for each ecosystem service are shown in Figure 9. Opportunities for water flow regulation are present over much of the study area, with the majority of opportunities relating to improved grassland and arable land uses in areas with soil types that are not very permeable and seasonally waterlogged. Fields on sloping land also present opportunities to reduce runoff. On the other hand, opportunities to reduce soil erosion and improve water quality are focussed close to watercourses and especially on arable land, which is the most significant source of soil erosion. The best opportunities to ameliorate air pollution were located in and around the main urban areas and along the main road network and a similar pattern was revealed when considering opportunities to reduce noise pollution. Opportunities to regulate local climate (reduce urban heat) are focussed exclusively in and around the larger urban centres. The best opportunities for increasing access to the natural environment were concentrated around the edges of the main urban areas, often in rings around the edges of settlements.

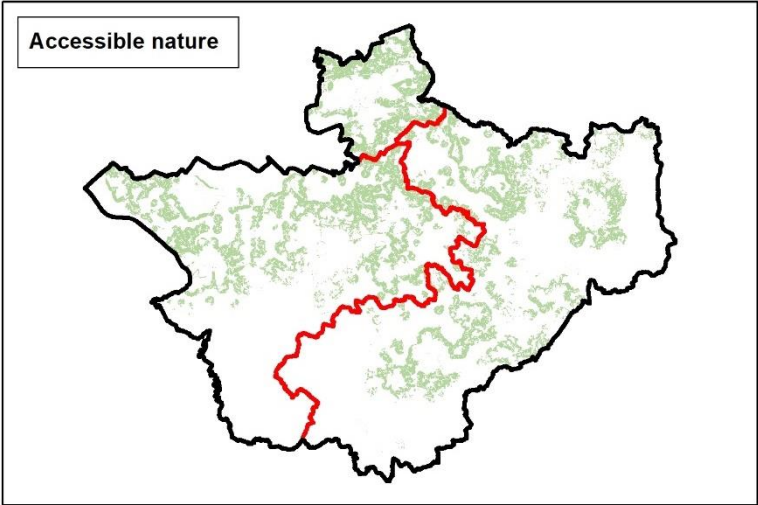
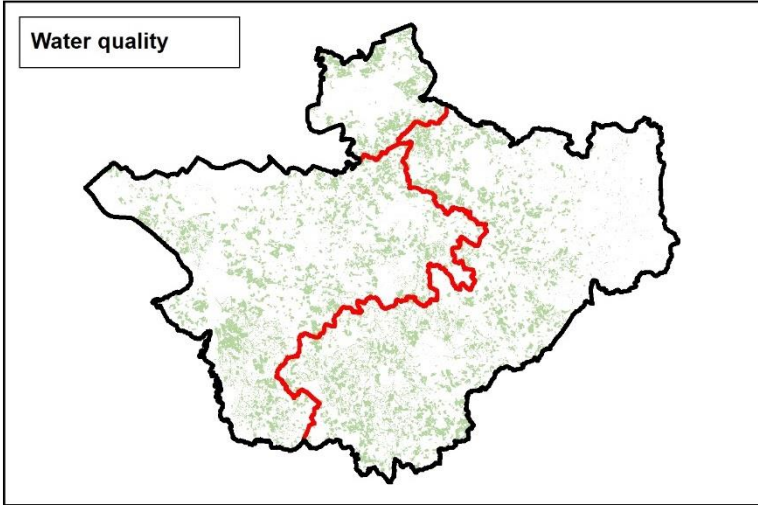


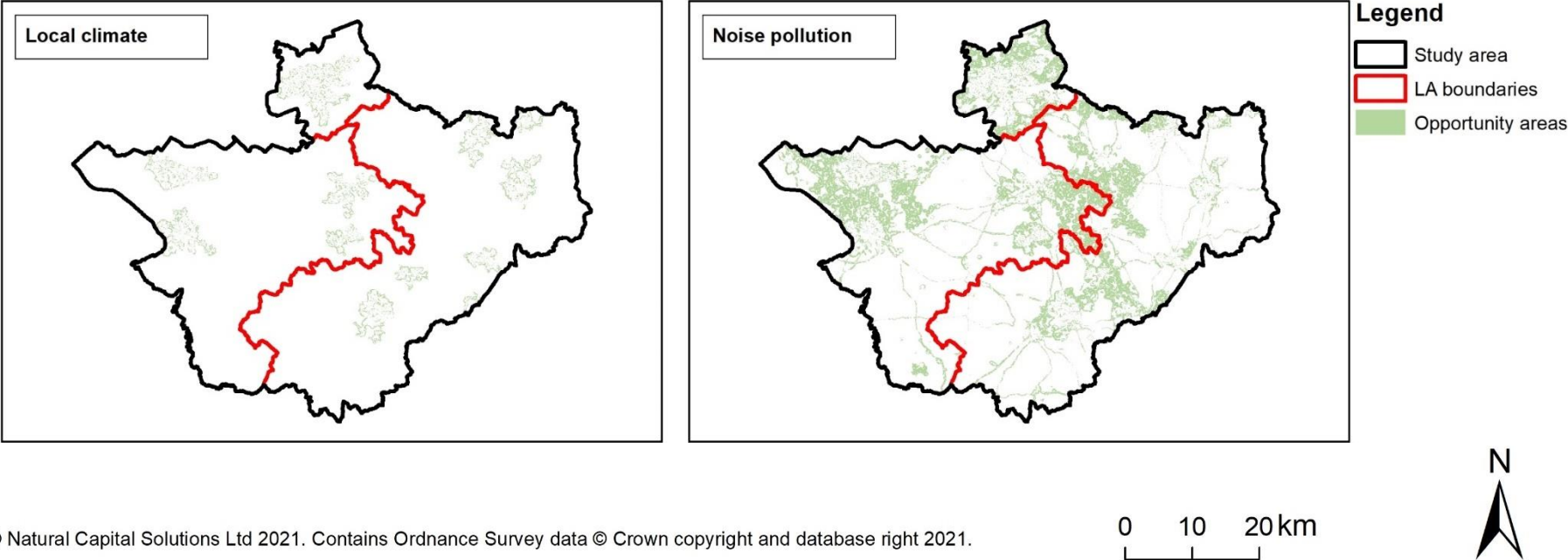
Habitat opportunity map



Legend

- Study area
- LA boundaries
- Opportunity areas





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Figure 9 Opportunity areas across Cheshire and Warrington for water flow regulation, water quality regulation, air quality regulation, enhancing access to nature (first page), local climate regulation and noise regulation (second page). Maps identify the top 25% of areas to enhance each service, whilst removing constrained areas.

4.3 Combined opportunity maps – delivering multifunctionality

In addition to mapping the individual opportunities presented in Sections 4.1 and 4.2, it is also possible to examine multiple opportunities, which are areas where new habitat can be created that provides opportunities to enhance more than one of the services mapped previously. These are areas that could deliver multifunctional outcomes. This is assessed by overlaying individual opportunity maps to determine the degree of overlap. Note that this is focussing on the top 25% of opportunity areas for each ecosystem service (or areas that are ecologically connected to existing habitats), so is only considering the higher levels of service provision. In reality, creating any new habitat for one ecosystem service is likely to provide benefits for other services, even if this does not fall within the top 25%.

The maps can be combined in a number of different ways, depending on the objective and below we explore three examples of how they can be created and used.

4.3.1 Biodiversity focus

In this example biodiversity enhancement is the primary objective and so we have restricted combined opportunities to areas that present a biodiversity opportunity. Hence opportunity areas are only included for locations that are ecologically connected to existing habitats. This follows the ethos of environmental net gain being focused on biodiversity net gain first, and then natural capital net gain as an additional feature. In the example shown (Figure 10), all of the areas on the map provide opportunities for broadleaved woodland creation that would be ecologically connected to existing woodland patches, but at many of these locations further opportunities could be delivered at the same time. Areas that are shown in warmer colours would be able to deliver an increasing number of benefits in addition to the woodland biodiversity benefits that are the primary driver in this example. The areas delivering the greatest number of benefits tend to be located close to urban areas. Maps showing combined opportunities for semi-natural grassland, wet grassland and wetland, mire, and heathland habitats are provided in Technical Report 2.

Note that creating woodland habitats will also deliver benefits in the form of **carbon sequestration**. These have not been mapped separately as location is not especially important for carbon sequestration (although there will be some difference in the growth rate of trees in different places). Hence all of the locations identified in Figure 10 below would also deliver this service.

4.3.2 Ecosystem services focus

A set of maps were produced focussing on each of the ecosystem service opportunity maps shown in Figure 9 in turn, and then overlaying each of the other opportunity maps (including the biodiversity opportunity maps) to determine the number of opportunities that overlap. An example focussed on access to nature, is shown in Figure 11. In this map, all the locations shown provide good (top 25%) opportunities for access to nature, but the colour on the map indicates the total number of opportunities that can be delivered at each location. The yellow, orange and red colours on the maps indicate where 4 to 7 opportunities can be delivered, one of which will be access to nature. These maps therefore demonstrate how multifunctional green spaces can be delivered, the best locations for these, and the number of benefits that could be achieved, even when focussing on one key objective (in this case access to nature). Maps showing combined opportunities for each of the other ecosystem service objectives are shown in Technical Report 2.

4.3.3 All combined opportunities

The last example shows all opportunities combined together to highlight the best locations for delivering multiple benefits. This is assessed by first combining all the biodiversity opportunity maps into one layer, and then overlaying this with each of the individual opportunity map already created, to determine the number of opportunities that overlap across each pixel of the map. Results are shown in Figure 12 and shows that once constrained areas are excluded (the white areas on the map), almost all remaining parts of the map present at least some opportunity for enhancing ecosystem services. However, most areas delivering multiple benefits occur in the urban areas, in rural locations immediately adjacent to the urban areas and adjacent to the road network.

4.4 Discussion and applications of opportunity mapping

Habitat opportunity maps have been created showing where new habitats could be created for biodiversity enhancement for five broad habitat types, as well as for six different ecosystem services. Note, however, that the maps have not been ground-truthed or checked against other data, and so individual locations will need to be assessed further before being taken forward. The maps should be considered as a resource to highlight potential locations for habitat creation or restoration projects, rather than as an end in themselves. The maps are best examined on a Geographic Information System, and GIS layers have been provided to project partners.

The opportunity maps for biodiversity highlight areas that are best located in terms of their connectivity with existing habitat patches and are, therefore, most appropriate from an ecological point of view. Enhancing connectivity and expanding habitat networks is a key priority for biodiversity conservation and climate change adaptation at present, and these maps can be used as the basis for creating a Nature Recovery Strategy across the county. They also highlight areas where biodiversity offsetting should be focussed, under the forthcoming requirement (proposed in the Environment Bill) to achieve biodiversity net gain for all new developments.

The opportunity maps for ecosystem services highlight the best areas to create habitats to enhance the delivery of each ecosystem service in turn, based in most cases on where demand is high and capacity is currently low. These can be used to identify project locations to meet each particular need or can be combined to show areas where new habitat can deliver multiple objectives. When combined with the biodiversity opportunity maps, they can be used in offsetting projects to deliver additional benefits. Access to greenspace for people can be highly beneficial for physical and mental health and well-being and the monetary value of these benefits can be extremely high. Habitats for biodiversity and green infrastructure (GI) in general can also make important contributions to all the other ecosystem services mapped in this report. Semi-natural habitats are multi-functional, meaning that an investment focussing on one benefit (e.g. natural flood risk management), can deliver multiple additional benefits, hence offering excellent value for money

There are a wide range of applications of the opportunity mapping presented here. These include:

- Locating the best places to deliver biodiversity net gain (offsetting) and natural capital net gain.
- Key evidence for a Local Nature Recovery Strategy.
- Environmental Land Management scheme (ELMs) targeting.
- Natural flood risk management and catchment sensitive farming schemes.
- Evidence for Local Plans and green infrastructure strategies.
- Health and wellbeing initiatives.
- Locating carbon sequestration projects (e.g. UK Woodland Carbon Code and Peatland Code projects).



Combined opportunities: woodland (biodiversity focus)

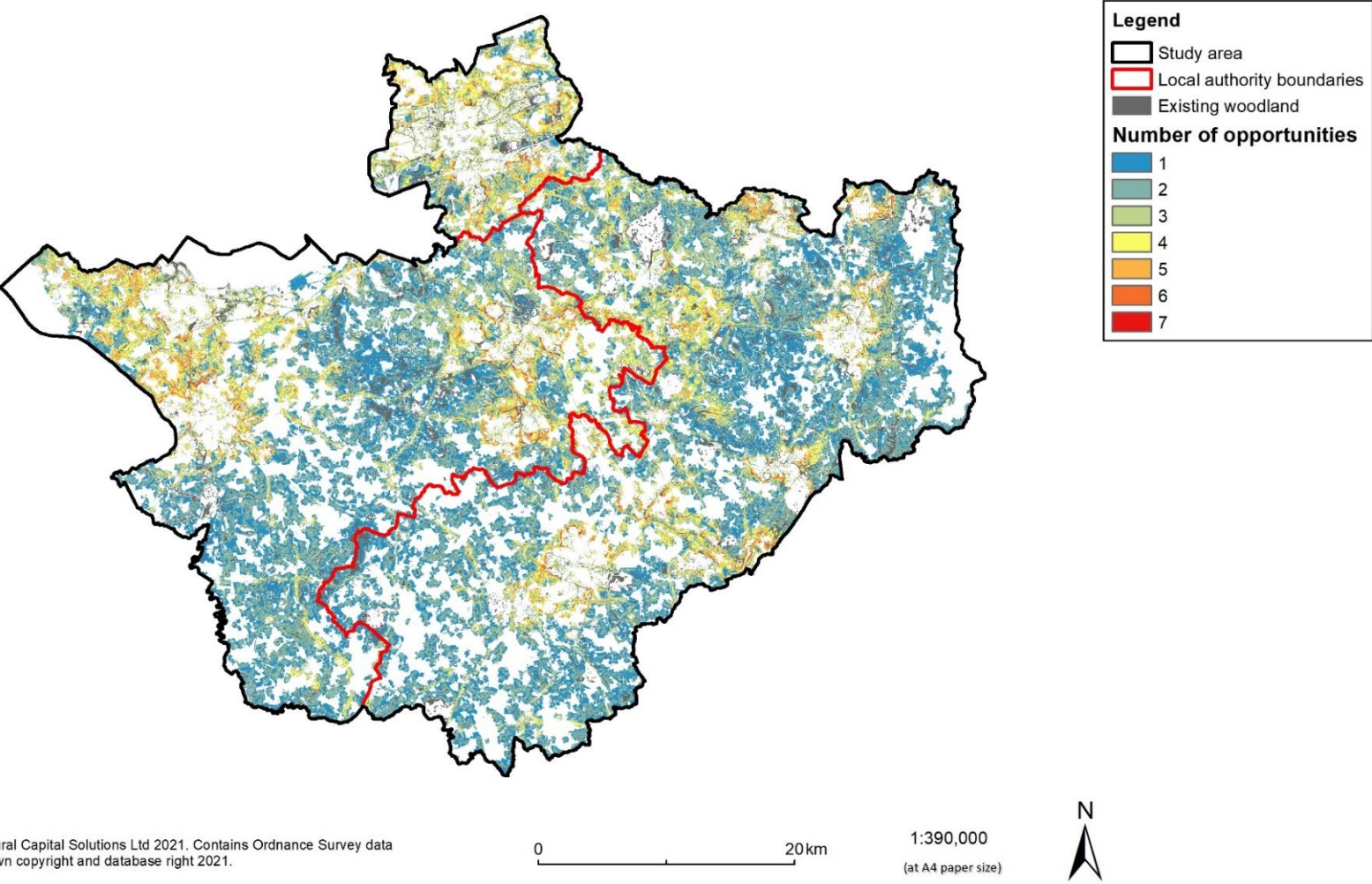


Figure 10 Combined opportunities for new broadleaved woodland, restricted to areas that are ecologically connected to existing woodlands.



Combined opportunities: access to nature

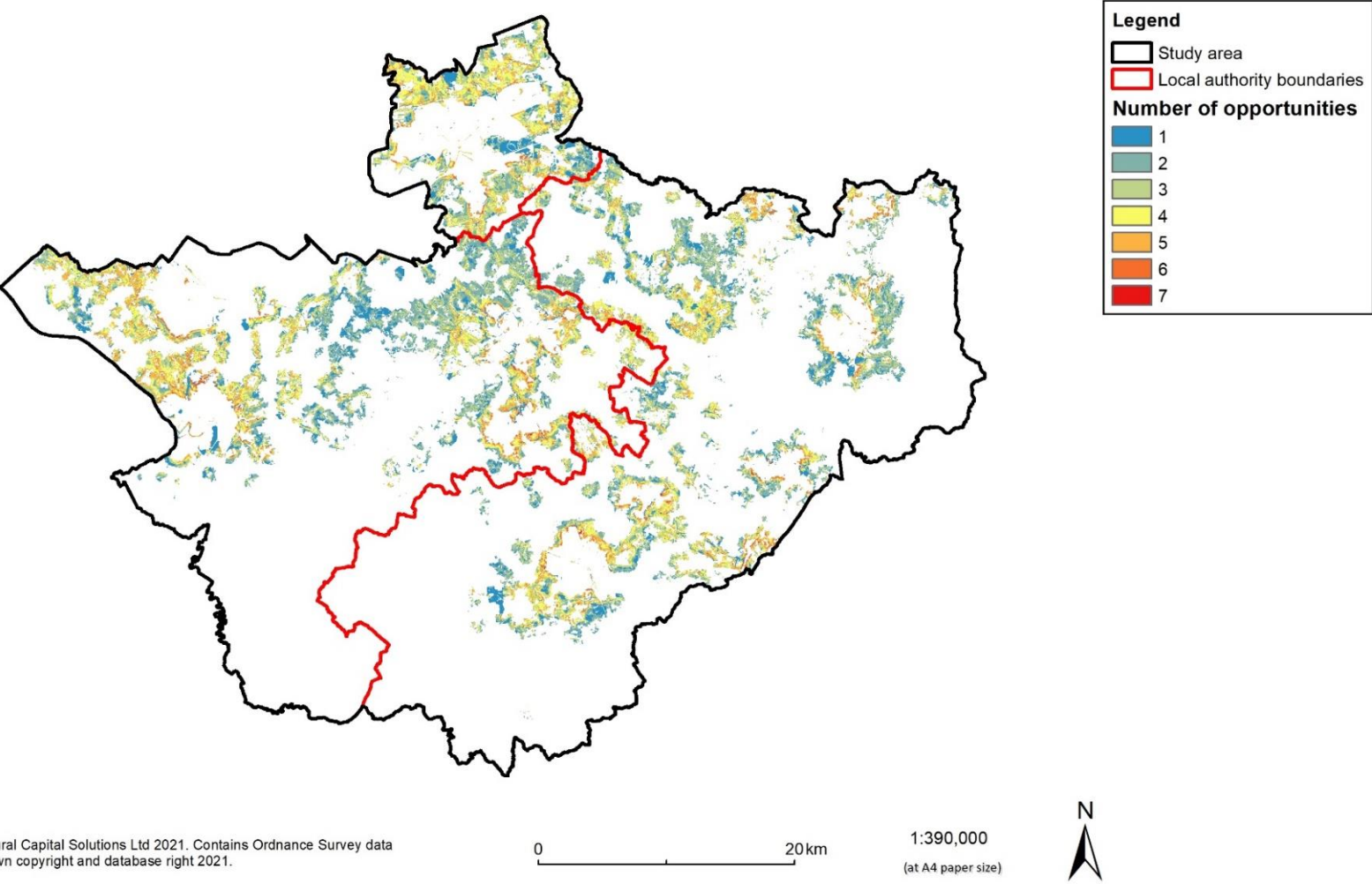


Figure 11 Combined opportunities for access to nature, showing the number of opportunities (benefits) that can be delivered at each location.



All combined opportunities

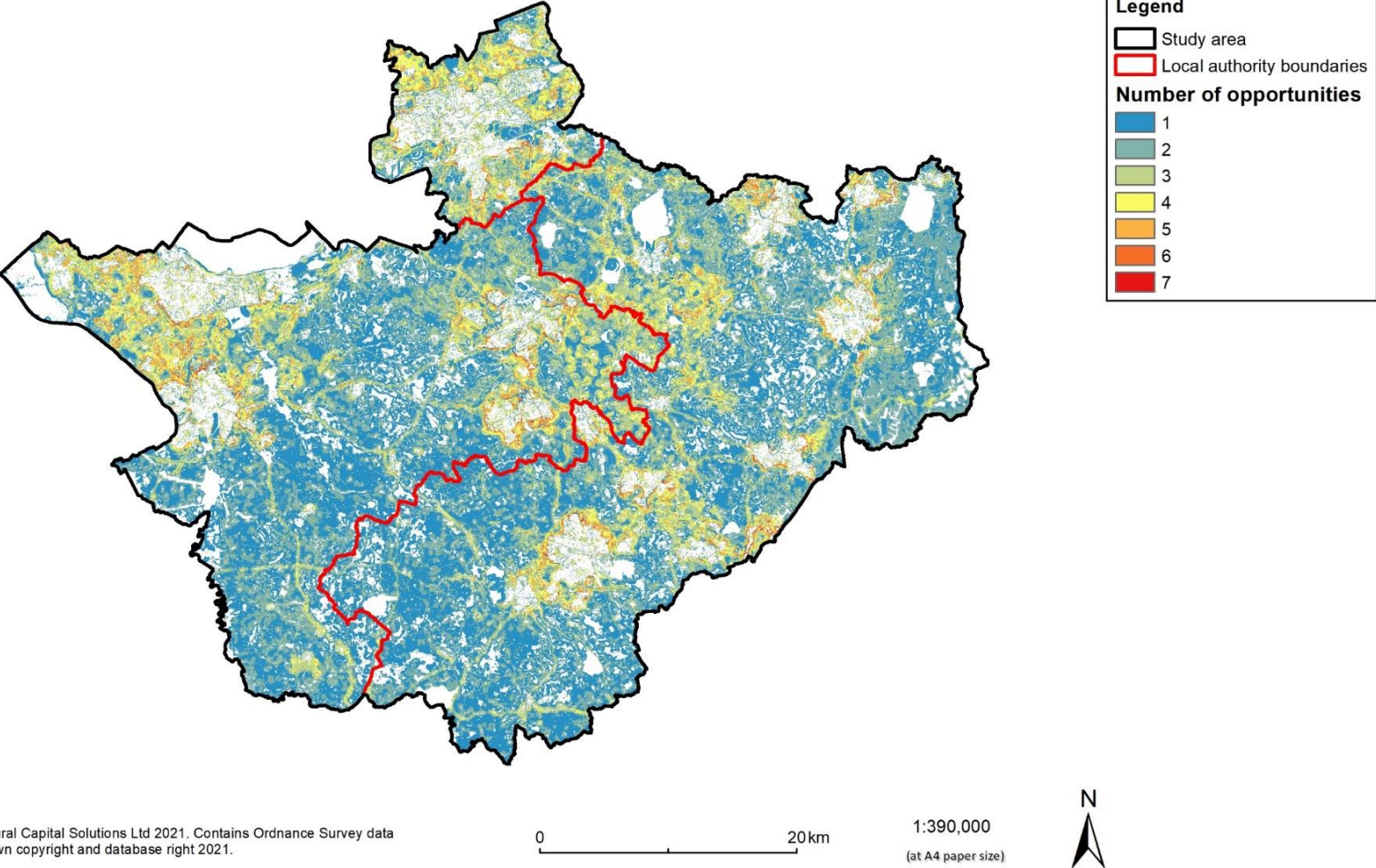


Figure 12 Combined opportunities for creating new habitats across Cheshire and Warrington.

4.5 Priority areas

Sections 4.1-4.3 have identified a large number of opportunity areas that can provide single or multiple benefits. These maps can either be used at a site scale to determine the most suitable locations and habitats to create at a given site, or can be used at a strategic scale, to determine the best locations across the landscape to enhance natural capital for particular objectives. When used at this landscape scale, there is a need to determine which areas are priority locations for investment. One approach to do this would be to focus on the areas delivering the most benefits at the same time, the yellow to red areas on Figures 9 to 12. However, there may be a desire to focus on areas that are priorities across a range of local policies. Hence an approach was developed to prioritise investment based on a range of external environmental, social and economic priority areas.

The approach builds on and extends a method for selecting priority areas for GI investment in Cheshire East, described in the Cheshire East Green Infrastructure Plan (2019)¹⁰. We have identified seven key themes that bring together key environmental, social and economic policy drivers and spatial characteristics of the area. A number of these are based on spatial maps and policies within the Local Plans of the three local authorities (Cheshire East, Cheshire West and Chester, and Warrington), along with indicators of environmental and social need. In each case maps were created in GIS, bringing together a number of data sources to create a single layer for each theme. The seven themes are listed here and are described in more detail in Technical Report 2::

1. Key locations for nature improvement:
2. Green gaps and countryside
3. Connectivity
4. Water environment
5. Life chances and choices
6. Planning for Growth
7. Minerals supply and safeguarding

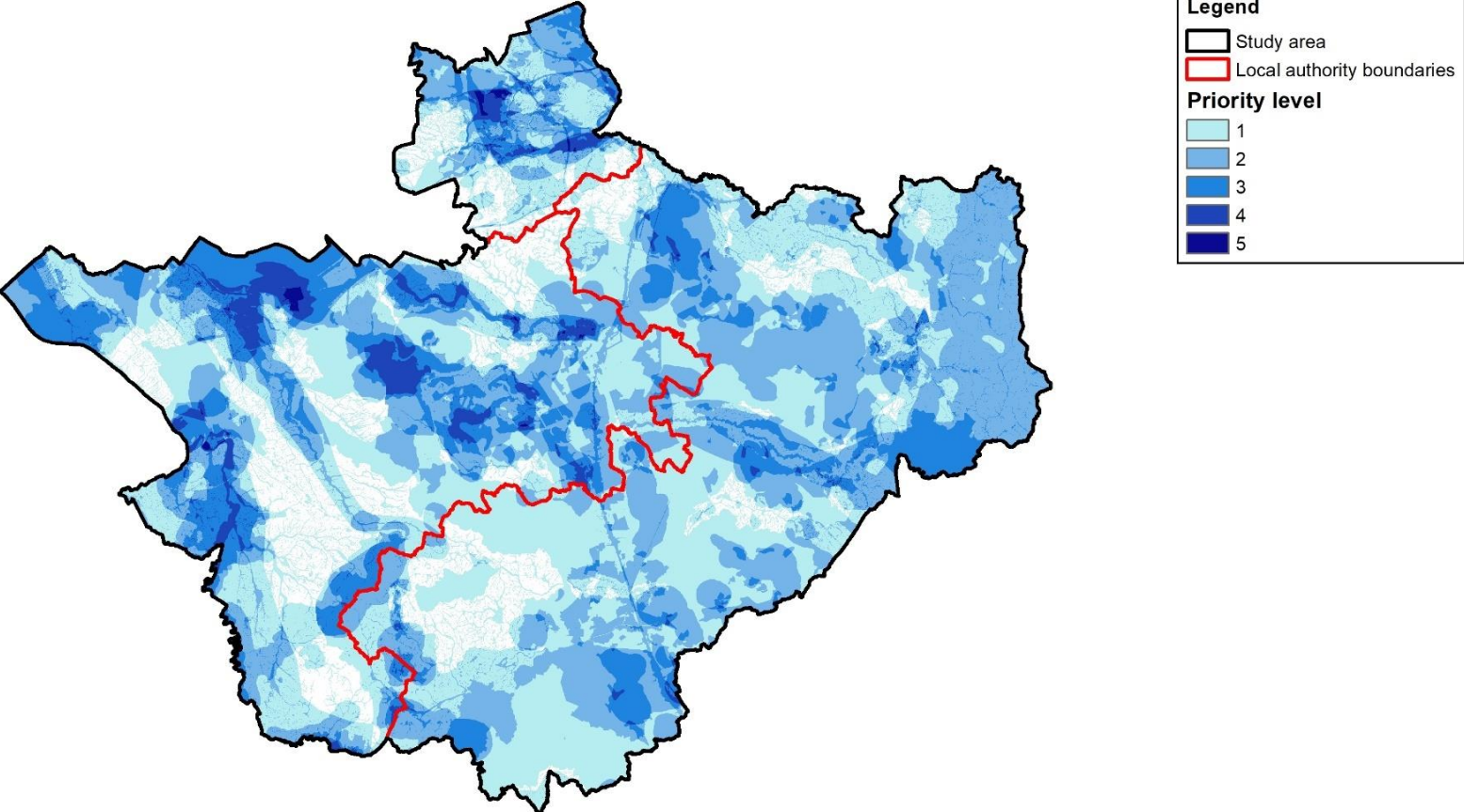
As well as building on an approach already used in the area, the method and an iteration of the outputs were shown at a stakeholder workshop in December 2020 (See Technical Report 3). As a result of feedback received at the workshop and afterwards, some alterations were made to a number of the themes.

Maps of each theme are shown in Technical Report 2. The seven themes were then overlain to provide a map of combined priorities (Figure 13). This showed that themes overlapped in a number of locations, with up to five themes overlapping in any given area. It is suggested that areas where a number of themes overlap, hence areas that are key locations across a range of policy priorities, are the most important areas for investment. Natural capital investments at two of the areas identified in this map, around Northwich and Warrington, were investigated as Case studies 4 and 5 (see Section 7).

¹⁰ TEP (2019) Cheshire East Green Infrastructure Plan. Appendix A - Evidence Base Mapping.



All combined priorities



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Figure 13 Combined priority locations across Cheshire and Warrington, showing the number of themes that overlay (out of 7).

5. Prioritisation workshop

A workshop was held with key stakeholders on the 26th November 2020 to discuss the approach and preliminary findings of the C&W Natural Capital Audit and Investment Plan. A summary is provided below, with a full report included as Technical Report 3: Workshop report.

5.1 Workshop objectives

- A. To provide all invited stakeholders with a shared understanding of the approach used in developing the Natural Capital opportunity maps and its potential advantages and limitations as a tool for supporting development decisions.
- B. To enable all invited stakeholders to be involved in the discussion on decision making/choices regarding prioritisation of Natural Capital initiatives.
- C. To generate interest and buy-in to the process moving forward.

5.2 Key messages from the workshop

- Participants considered that the Natural Capital approach has potential to improve the alignment of development opportunities, needs and funding potential in support of the prosperity and wellbeing of people and of the protection of nature in the Cheshire and Warrington area.
- The Natural Capital approach can help provide a strategic framework for decision support within which local initiatives addressing local issues can fit alongside bigger larger scale projects that target national policy outcomes.
- Preliminary findings are considered compatible with, and add further support to, existing planning and development priorities in the area. The approach can help to integrate national policies regarding, for example, carbon and biodiversity and local needs such as air quality and public health and wellbeing.
- Projects to protect and enhance natural capital and ecosystem services should be prioritised according to objectives and needs (and not exclusively according to opportunities). Benefits, cost-effectiveness (value for money) and funding feasibility are key criteria. A mix of relatively easy short term and more ambitious projects longer term will probably be needed.
- Social acceptance is important. The map-based assessments that are a feature of the Natural Capital approach can help to engage the public and key stakeholders in prioritising and choosing development options, especially at the local scale.
- Location is considered a key factor affecting the demand for and potential to provide different types of benefits, whether economic, social or environmental. In this respect, a spatially focused approach, concentrating on key selected benefits, is considered to offer greatest potential.
- More focus could be placed on funding opportunities by identifying projects that will appeal to potential investors and attract investment funds to the area. The Natural Capital framework can facilitate the assembly of different funding sources and provide a focal point for would-be investors.

6. Funding and funding mechanisms

This section identifies investment opportunities in natural capital to improve the success and reach of existing development plans and initiatives. It further seeks to explore new innovative development investments that build on the area’s natural capital advantage, including promoting quality of life, as determined by the environment and surroundings.

The Government’s 25-year plan for the environment and its aspirations aim to achieve a wide range of complex goals. This includes climate change mitigation and adaption, addressing the decline of biodiversity, as well as the management of opportunities and threats imposed by Brexit. In order to achieve the array of goals, natural capital investment will be vital to make a broader business case for these investments. Natural capital investment draws from public and increasingly private finance to fund projects which increase or enhance natural capital. Public and private funding combined is also known as blended finance, enabling project opportunities and impact investments with varying levels of risk. The diversity of funding streams allows a greater environmental (and social) impact¹¹. Most recently, the Greater Manchester Natural Capital Investment Plan offered insights into suitable finance option for the region to promote a positive impact on natural capital that provides a return to the investor (see Figure 14 for the blended finance model).

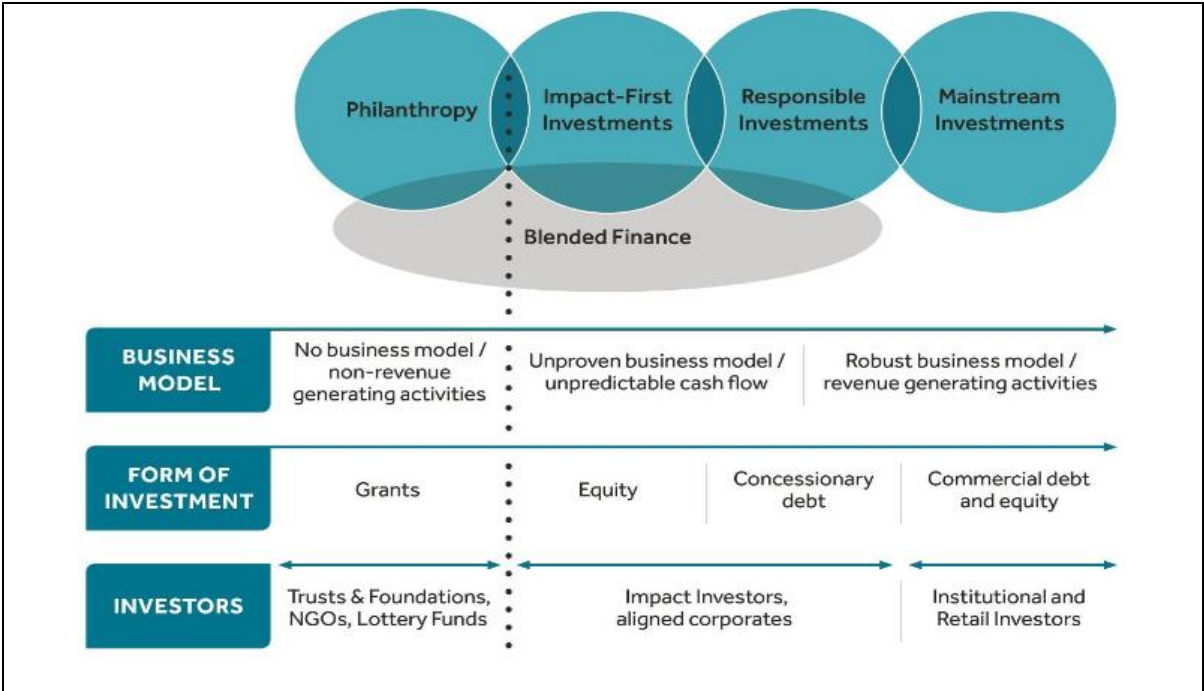


Figure 14: Types of potential investors in natural capital (from efttec 2019¹²)

¹¹ Global Impact Investing Network (2018): A Resource for Structuring Blended Finance Vehicles. Available at: <https://thegiin.org/assets/upload/Blended%20Finance%20Resource%20-%20GIIN.pdf> on 22 December 2020

¹² Efttec et al (2019): Greater Manchester Natural Capital Investment Plan, final report, January 2019, available at: <https://naturegreatermanchester.co.uk/wp-content/uploads/2019/01/GM-Natural-Capital-Investment-Plan-Final180119.pdf>

A wide range of funding mechanisms have been reviewed as potential sources of investment into natural capital in the Cheshire and Warrington region. Funds reviewed initially focussed on those that will support development of mechanisms and structure to enable delivery (e.g. Investment Readiness Fund), but was broadened to also include a number of mechanisms that fund delivery on the ground (e.g. Biodiversity Net Gain). Note, however, that this is a rapidly changing area, with new funds coming out regularly and others passing their deadlines, hence the list is not exhaustive. This then illustrates the variety of opportunities that are available for both directly funding different natural capital interventions as well as generating mechanisms to attract funding:

- Environmental Impact Bond
- Woodland Equity Fund
- Green Bond
- Place-based Portfolio
- Green Improvement District
- Habitat Bank
- SuDS
- ELMs
- Investment Readiness Fund
- Nature for Climate Fund (as announced 18 May 2021)
- Biodiversity Net Gain
- Environmental Net Gain
- Levelling Up
- Woodland Code
- Peatland Code
- Forestry Commission Woodland Creation
- Biodiversity Banking
- Nature Recovery Networks/Strategy

Further details on each of these is provided in Technical Report 4 (Future Financing Report).

Funding mechanisms can help achieve different objectives depending on their underlying suitability criteria. As such, these criteria differ depending on project characteristics, funding needs, sources and models. For example, some projects are long-term, mainly involving non-market public goods and land use change targeting climate change objectives at landscape scale and thus mainly appeal to offsetters, and corporate ESG interests. Other projects focus on green space in local areas, linked to air quality in urban areas, and can be integrated within infrastructure/regeneration projects.

The funds have been assessed in terms of their potential application to different ecosystem services. This information is then used as the basis for a spreadsheet that enables the most appropriate funds to be identified depending on the ecosystem services that are the main focus of a project, programme or policy. Table 4 provides the summary scores assigned to each funding mechanism according to its use in delivering different ecosystem services, with scores ranging from 0 (not applied, ecosystem service is not relevant to the funding mechanism) to 4 (main focus of the funding mechanism). The 'fund selector' spreadsheet is used as part of the strategic framework and has been applied to assess likely funding sources for the case studies. This spreadsheet is available with the Technical Reports.

Table 4 Ecosystem services and habitats covered by funding mechanisms (scores as applied following review of mechanisms and examples in May 2021)

	Environmental Impact Bond	Woodland Equity Fund	Green Bond	Place-based Portfolio	Green Improvement District	Habitat Bank	SuDS	ELMs	Investment Readiness Fund	Nature for Climate Fund	Biodiversity Net Gain	Environmental Net Gain	Levelling Up	Woodland Code	Peatland Code	Forestry Commission Woodland Creation	Biodiversity Banking	Nature Recovery Networks/ Strategy	
Provisioning services																			
Agricultural outputs	2	0	2	0	1	3	0	3	3	0	0	0	0	0	0	0	0	0	2
Timber/wood fuel production	2	4	2	2	0	3	0	3	3	2	0	0	0	4	0	2	0	0	1
Water supply	3	2	4	1	1	3	3	3	3	0	0	1	0	0	2	0	0	0	0
Renewable energy	2	1	3	1	1	0	0	1	2	1	0	0	1	0	0	0	0	0	0
Regulating services																			
Air quality regulation	3	3	4	3	3	3	3	3	4	2	2	2	3	3	0	3	2	2	2
Carbon avoided and sequestration	3	4	2	2	2	3	2	4	4	4	3	1	2	4	4	4	2	2	2
Local climate regulation	3	3	3	3	2	3	2	3	3	3	2	3	1	3	2	3	2	2	1
Water flow regulation	3	3	2	2	2	3	4	3	4	2	1	2	0	2	3	3	2	2	1
Water quality regulation	3	3	2	4	2	3	3	4	4	0	0	1	0	1	2	3	2	2	1
Pollination	3	3	2	3	3	3	1	3	3	2	4	4	1	2	2	2	3	2	2

	Environmental Impact Bond	Woodland Equity Fund	Green Bond	Place-based Portfolio	Green Improvement District	Habitat Bank	SuDS	ELMs	Investment Readiness Fund	Nature for Climate Fund	Biodiversity Net Gain	Environmental Net Gain	Levelling Up	Woodland Code	Peatland Code	Forestry Commission Woodland Creation	Biodiversity Banking	Nature Recovery Networks/ Strategy
Cultural services																		
Access to nature (recreation)	1	3	2	4	4	3	0	2	4	3	3	3	2	2	1	3	2	1
Phys./psych. experiences	3	3	2	3	3	3	1	2	3	3	3	3	3	2	2	3	2	1
Learning and inspiration	3	3	3	3	3	3	3	3	3	2	1	1	2	1	2	2	2	1
Identity and quality of place	3	3	3	3	4	3	3	3	3	4	3	3	3	2	2	3	2	2
Biodiversity	2	2	3	2	2	4	2	2	4	4	4	4	1	3	4	3	4	3
Key	4	Main focus of funding mechanism		3	Good examples of use of funding mechanisms			2	Potential use but not many examples			1	Possible use but no real examples as yet			0	Not applied	

7. Strategic framework

The study has provided a series of outputs, including opportunity maps, demand maps, policy analysis, cost and benefit estimates, and a review of emerging funding mechanisms. These outputs need to be brought together in a logical and structured process in order that the potential for change due to investment in a natural capital plan can be investigated at the strategic (whole C&W LEP area) scale. An approach is needed that can identify:

- What needs to be achieved: what are the ecosystem services that are the key targets for change, linked to policy targets and objectives and the opportunity mapping that shows where those targets and objectives could best be achieved?
- What needs to happen for this to be achieved: what level of change is needed and how can this be delivered through investment in natural capital?

As the framework is designed to be strategic, it does not consider feasibility of individual locations; instead it identifies the idealistic outcome, suggesting large-scale potential projects that could deliver not just the policy targets and objectives, but a suite of additional benefits on top. The framework is designed around the 'fund selector' spreadsheet and is applied as follows:

1. Select up to three core ecosystem services: the main ecosystem services that are being targeted for delivery or improvement.
2. Select up to three secondary ecosystem services: additional services that are good to have but which do not form the primary aim of a natural capital plan.
3. Determine the weight that should be placed on secondary ecosystem services: this is set to 50% in the spreadsheet so that there is greater emphasis on the core ecosystem services.

The spreadsheet will then identify the ranking of the funds and funding mechanisms (this is based on the scores set out in Table 4, so these should be reviewed and updated to take account of new developments, new examples of application of funding mechanisms and likely application of the funding mechanisms to the location in question).

The policy analysis for the C&W LEP area identifies that the three core ecosystem services are:

- Carbon avoided and sequestration
- Air quality regulation
- Water flow regulation (linked to flood risk)

Additional issues are identified with a number of secondary services (although at the local scale these may be as, if not more important, than the core services):

- Water quality regulation
- Biodiversity (linked to existing high-quality habitats and retaining and improving the condition of these and buffer locations)
- Access to nature (linked to encouraging sustainable travel)

A screenshot from the application of the fund selector spreadsheet using these ecosystem services is shown as Figure 15. This shows that the most appropriate funds to deliver these primary and secondary ecosystem services are identified as:

1. Investment Readiness Fund (ranked first)
2. ELMs, Woodland Equity Fund and Forestry Commission Woodland Creation (three ranked equal second).

Combining funds to deliver more and wider outcomes across the Cheshire and Warrington region could be achieved through blended finance. An organisation such as a Special Purpose Vehicle could bring together different sources of funds to deliver a wider range, and potentially more beneficial overall, scale of natural capital change. The recent award of funding through the Investment Readiness Fund (IRF) (initially focused on the Bollin catchment) via Mersey Forest and Cheshire East Council will enable a green “Bollin Bond” to be developed to attract private investment in natural capital benefits across the Bollin catchment. If successful, the approach developed on the back of the IRF application to develop long-term contracts with natural capital buyers, and fixed-term, fixed-rate bonds with natural capital investors could be extended to the full Cheshire and Warrington area. This could then help deliver some of the wider opportunities that have been identified through the mapping.

<i>Choose services to be delivered (select up to three)</i>		
Core services (the main services you are looking to deliver)	Secondary services (additional useful but not core)	Weight on secondary services
Carbon avoided and sequestration	Water quality regulation	50%
Air quality regulation	Biodiversity	
Water flow regulation	Access to nature (recreation)	
Best funding mechanisms to deliver that suite of services:	Rank for core services	Rank for core and secondary services
Environmental Impact Bond	5	6
Woodland Equity Fund	2	2
Green Bond	9	10
Place-based Portfolio	11	6
Green Improvement District	11	10
Habitat Bank	5	5
SuDS	5	8
ELMs	2	2
Investment Readiness Fund	1	1
Nature for Climate Fund	9	12
Biodiversity Net Gain	14	15
Environmental Net Gain	16	16
Levelling Up	16	17
Woodland Code	5	8
Peatland Code	11	13
Forestry Commission Woodland Creation	2	2
Biodiversity Banking	14	14
Nature Recovery Networks/Strategy	16	17

Figure 15 Screenshot from application of the fund selector spreadsheet to the core services identified from Cheshire and Warrington policy analysis.

8. Case studies

Five case studies have been developed by the project team to demonstrate how the evidence base can be used to identify locations for natural capital projects, the costs and benefits of such projects and how funding requirements and potential funding sources can be identified. In particular these case studies aimed to:

- a) Demonstrate how the opportunity maps can be used to develop natural capital investment proposals for a range of different objectives.
- b) Model and map changes in benefits projected to occur due to the proposed investments in each case study.
- c) Calculate the monetary value of the investments and perform an economic appraisal, including cost benefit analysis.
- d) Identify funding requirements and potential funding sources.

Full results of each of the case studies is presented in Technical Report 5: Case studies report, with a summary presented here. **The case studies are illustrative:** the aim is to show the application of the approach across different policy objectives and the type and magnitude of benefits, costs and potential economic performance that could typically be achieved. A more detailed assessment would be required to confirm details and to support decision making for investment.

8.1 Selection of case study sites

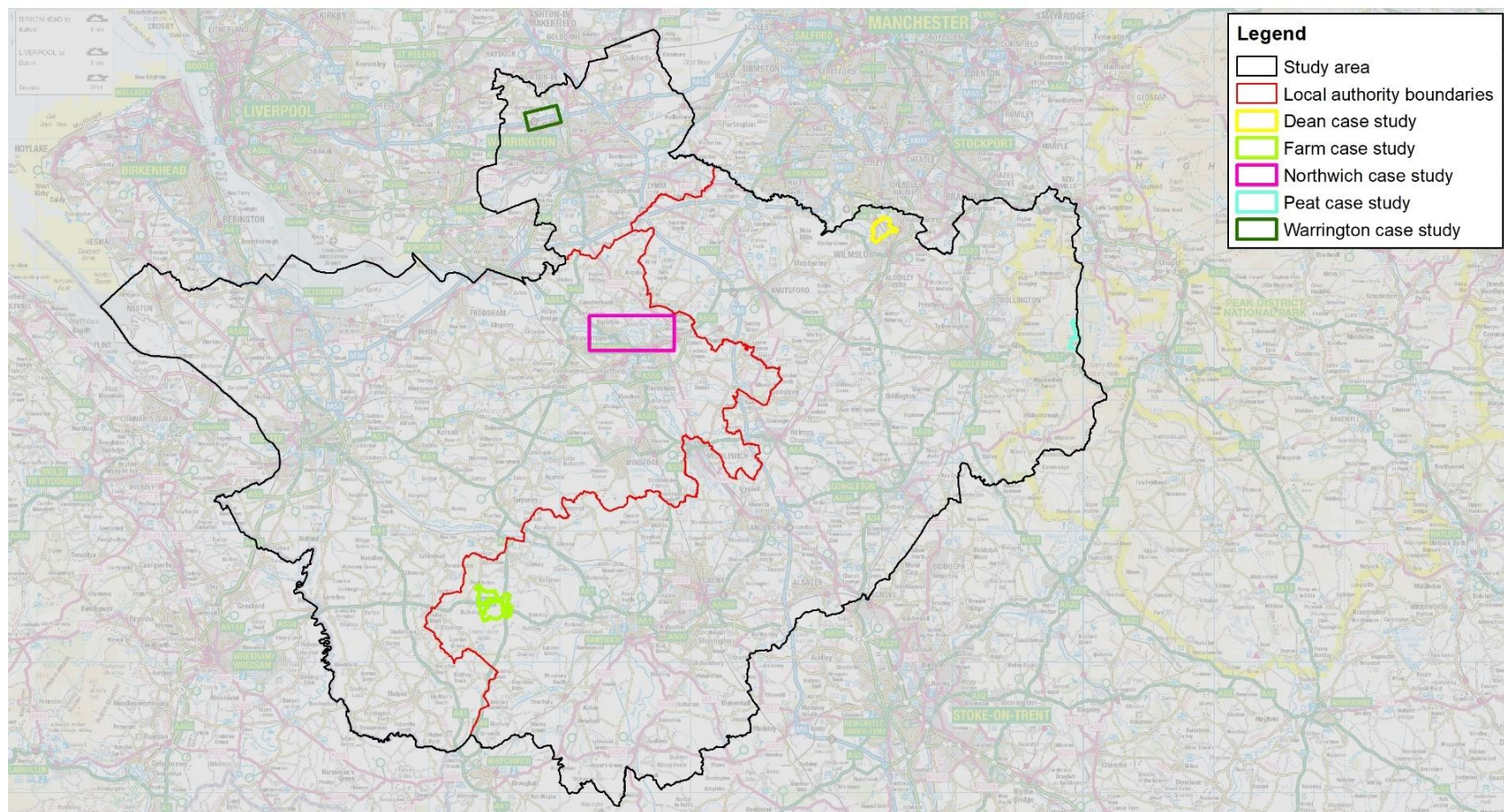
The cases studies were chosen to illustrate the approach for a number of different development objectives. The case studies selected were:

1. **Sustainable agricultural production** – using the opportunity maps to highlight key interventions at the farm scale. The case study site was selected in conjunction with the Cheshire Farms Estate Land Agent. Location = the Ridley Estate, part of the Cheshire Farms Estate.
2. **Carbon sequestration and biodiversity enhancement** – examining the use of peatland restoration to achieve these aims. Location = the Goyt Valley SSSI and around.
3. **Water quality and flow improvements (and biodiversity enhancement)** – predominantly through woodland planting in lowland areas. Location = the lower Dean.
4. **Priorities and opportunities focus 1** – identifying locations where multiple external policy priorities (strategic themes) overlap with the potential to deliver multiple benefits (opportunities) at the same time (as described in Section 4.5). Location = two areas to either side of Northwich.
5. **Priorities and opportunities focus 2** – identifying locations where multiple external policy priorities (strategic themes) overlap with the potential to deliver multiple benefits (opportunities) at the same time. Location = northern edge of Warrington.

The locations of the five case study sites are shown in Figure 16.



Case study locations



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Figure 16 Location of the five case study sites in Cheshire and Warrington.

8.2 Natural capital benefits and economic appraisal

Table 5 summarises each of the five case studies. Each case study explored different objectives and demonstrated how the opportunity maps can be used to highlight the most appropriate location to create new habitats and the most suitable habitat to create in each place.

The impacts of the natural capital interventions proposed for each case study site were assessed using both quantitative ecosystem services models and through a cost-benefit analysis. The models showed that in almost all cases, ecosystem service delivery was greater following the interventions than under the baseline situation. In most cases multiple benefits can be delivered, providing benefits in addition to the targeted primary objective; such interventions are therefore multi-functional. This also has implications for funding, with the possibility of stacking benefits and opening up additional funding sources.

The assessments presented did not attempt to value the biodiversity benefits. Hence biodiversity benefits provide additional benefits achieved by the planned interventions across all the case study sites. Biodiversity benefits are partially represented by agri-environment payments, but these do not reflect the true value. In particular, agri-environment payment rates are generally based on costs of interventions, or income forgone, rather than on payment by outcomes or on any attempt to value biodiversity enhancement.

The case study projects vary in terms of the type and relative importance of benefits and associated costs. Carbon sequestration and/or carbon storage and air quality regulation are important benefits linked particularly to woodland expansion and restoration, and peatland management. Enhanced public access and use delivers important benefits in terms of recreation and physical health. The impacts on the value of agricultural production are small, except for dairy land, reflecting the relatively modest net margins for arable and negative margins for non-dairy grassland (excluding subsidies). It is noted that potential important benefits pertaining to biodiversity and the water environment are not valued here. Indicative extra benefits at full development (not discounted) range between about £220/ha and £1,720/ha (full details in Technical Report 5), highest where air quality benefits are combined with recreation and associated physical health benefits.

The main capital costs are associated with investments in priority habitat expansion and restoration, notably for woodlands and peatland. Investment in infrastructure for improved public access is important where existing provision is limited. Land based initiatives and capital investments to provide full potential for water related benefits are probably under-identified here. Capital costs range between about £800/ha and £2,800/ha, highest where woodland investments occur alongside infrastructure for public access.

8.3 Project feasibility

For the assumptions made, the five illustrative cases appear feasible at the Treasury test discount rates. Benefit:Cost ratios range between 2.4 and 5.7, and annual equivalent yields (internal rates of return) are between 15% and 27%. It is noted that unquantified biodiversity and water related benefits would increase the estimated economic worth of the projects.

The predicted feasibility of the projects appears stable over a wide range of benefit and cost assumptions. The Cheshire Farms Project would remain economically feasible at the test discount rate provided benefit estimates are at least 45% of the best single estimate shown in Table A1, and total costs are no greater than 2.5 times the best estimate. The other projects, returning higher benefit:cost ratios, would remain feasible at benefit and cost estimates at about 25% and 4 times of the best single estimates respectively.

Table 5 Summary of each case study across Cheshire and Warrington, showing land use prior to investment, changes in land use, ecosystem services benefits and estimated economic performance.

£ 2021 values

Case	Dominant land use	Area ha	Main land use changes	PV Benefit at test DR	PV Costs at test DR	NPV at test DR	Benefit: Cost	Internal Rate of Return	Funding requirement	Benefit Types
		(i) total , (ii) non developed (iii) land use change		£000	£000	£000	ratio	%	(i) Capital, (ii) Capital plus Ops costs to year 5 : £'000	(i) primary (ii) secondary
Farm : Ridley Cheshire Farm Estates	Enclosed farmland: mainly dairy	(i) 401, (ii) 374, (iii) 50	arable and improved grass switched to semi natural grassland and woodland	1,824	773	1,051	2.4	15	(i) 319, (ii) 471	(i) carbon and air quality (ii) water quality, biodiversity
Peat	Upland peatland	(i) 89, (ii) 89, (iii) 81	degraded to restored peatland, blanket bog	1,374	309	1,065	4.4	24	(i) 129, (ii) 187	(i) carbon and air quality (ii) recreation
Dean	Arable and improved grass	(i) 190, (ii) 130, (iii) 32	arable and improved grass to woodland and wood pasture	6,102	1,275	4,827	4.8	23	(i) 533, (ii) 740	(i) water quality and flow regulation (monetary value underidentified) (ii) recreation, biodiversity
Northwich	Arable improved grassland and woodlands: (urban context)	(i) 1728, (ii) 1394, (iii) 70	restoration and expansion of woodland	15,960	3,009	12,951	5.3	25	(i) 1,253, (ii) 1,812	(i) recreation and public health, multiple benefits adjacent to urban area (ii) biodiversity
Warrington	Arable and grassland, with woodland, (urban context)	(i)345, (ii) 233, (iii) 41	arable and improved grass to woodland and parkland , and woodland restoration	9,942	1,733	8,209	5.7	27	(i) 725, (ii) 963	(i) air quality and recreation, multiple benefits on urban fringe (ii) biodiversity, water quality and flow regulation

* non developed refers non built land areas

NB. PV = present value, the value of the benefits over 50 years using the Treasury recommended discount rate (DR). NPV = net present value (benefits minus costs, discounted over 50 years).

The individual projects are relatively modest in scale, ranging from about 100 ha to 1,700 ha. Initial capital costs range between £0.13 million and £1.25 million, indicating the scale of possible funding requirements (see Technical Report 5). The estimates are illustrative: a detailed assessment involving site specific enquiry would be needed to provide confident estimates for investment decision making. The estimates are however indicative of potential net benefits and investment opportunities at the larger scale.

8.4 Funding opportunities across all five case studies

The case studies identify a range of different mechanisms that could be applied to deliver the investments needed. However, often these identify that the small scale of the proposed case studies would make use of a specific funding mechanism more restricted. Therefore, consideration has been given as to the potential use of blended finance, where an organisation (such as a Special Purpose Vehicle) could bring together different sources of funds in order to deliver a wider range, and potentially more beneficial overall, scale of natural capital change.

Table 6 summarises the core and secondary services that are driving investment in each of the five case studies. The table also shows the proposed area (in ha) of the suggested change in habitats.

Table 6 Summary of changes across the five case study sites and the core and secondary benefits achieved.

Ecosystem service	Case study				
	1 Sustainable agriculture	2 Peat restoration	3 Water quality and flow	4 Northwich	5 Warrington
Total area of case study (which may benefit from improvements to existing natural capital as well as change in habitats)	401 ha	89 ha	190 ha	1,728 ha	345 ha
Area of land use change to new habitats	50 ha	81 ha	32 ha	70 ha	41 ha
Air quality regulation					
Noise regulation					
Carbon sequestration and reducing (peatland) carbon emissions					
GHG emissions from agriculture					
Recreation					
Physical health					
Local climate regulation					
Agricultural production					
Timber/woodfuel production					
Water quality regulation					
Water flow regulation					
Biodiversity					
Key:		Core ecosystem services		Secondary ecosystem services	

The table shows that carbon sequestration and biodiversity benefits are common across all five case studies. Air quality regulation and water flow regulation are also core or secondary services for four of the five case studies, while recreation is a core service in two case studies. Therefore, a higher-level mechanism that could help fund these services across multiple sites in Cheshire and Warrington may provide the strategic level approach to funding that will help deliver multiple benefits. This suite of ecosystem services compares well to the services identified as priorities from the policy analysis (carbon avoided and sequestration, air quality regulation, water flow regulation as primary services with water quality regulation, biodiversity and access to nature as secondary services). The case studies also illustrate important differences between local priorities according to context. Hence, the need for an approach to funding that can facilitate delivery of a wide suite of services and benefits responsive to local needs and opportunities.

Expansion and restoration of woodland provides carbon sequestration alongside a range of other benefits, including biodiversity, water flow and air quality regulation, and recreational and amenity benefits.

There are numerous funds and applications that could be used, as part of a blended finance scheme, to generate income associated with woodland creation. Many current funds, such as the Local Authority Treescapes Fund or the Woodland Carbon Fund are close to (or beyond) application dates. However, funds for woodland creation are likely to persist, not least to enable the Government to meet its ambitions for woodland creation through the Defra England Tree Action Plan 2021-2024, through the Nature for Climate Fund, and the recently announced Forestry Commission England Woodland Creation Offer.

Peatland restoration is particularly important to arrest carbon loss in degraded peat soils and, like woodlands, can provide a range of benefits for water resources, biodiversity and people enjoying the countryside. A more detailed assessment of peatlands in Cheshire East is provided in Cheshire Wildlife Trust (2021)¹³. The England Peat Action Plan also includes the announcement of the Nature for Climate Peatland Grant Scheme (also through the Nature for Climate Fund) and the aim for immediate restoration of at least 35,000 ha of peatland by 2025¹⁴.

New funding mechanisms to enhance environmental land management are proposed under the new Sustainable Farming Incentive, and the new Local Nature Recovery and Landscape Recovery Systems (Defra 2021). These new measures aim to meet the long-term goals of the 25 Year Environment Plan, providing the opportunity for strategic approaches to woodland creation, peatland restoration and farmed areas across the Cheshire & Warrington LEP area. The potential to deliver landscape scale improvements by working strategically at the LEP level should increase the likelihood that applications for funding are successful.

Indeed, the recently launched project through the Investment Readiness Fund (IRF) (initially focused on the Bollin catchment) via Mersey Forest will provide a mechanism to attract private investment to secure natural capital benefits across the Bollin catchment. The approach being developed through this IRF project to develop long-term contracts with natural capital buyers, and fixed-term, fixed-rate bonds with natural capital investors could be extended to the full Cheshire & Warrington area. This approach could help enable sufficient funds to be secured but allow the flexibility to also deliver local priorities.

¹³ Cheshire Wildlife Trust (2021) Peatlands of Cheshire East: An Assessment of Greenhouse Gas Emissions and Biodiversity.

¹⁴ Defra (2021): England Peat Action Plan, May 2021, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/987859/england-peat-action-plan.pdf on 1 June 2021.

9. Benefits, recommendations and actions

9.1 Benefits of a natural capital approach

This project has improved knowledge about the stocks and flows of natural capital across the Cheshire and Warrington area and their scale and value. It has identified opportunities to enhance the areas natural capital more effectively to support sustainable growth and provide multiple environmental, social and economic benefits. It has identified funding mechanisms and investment opportunities to attract inward investment across the region.

The report has showcased a spatial natural capital approach. Such an approach provides a number of advantages and is supported by Government policy, but is not yet widespread or standardised. Key benefits of a natural capital approach are:

- It is an integrated approach that draws together numerous environmental and socio-economic considerations. Rather than being considered separately and by different teams, the natural capital approach provides a common framework where multiple topics can be considered at the same time, thereby making decision making more joined up.
- It is an asset and services-based approach, that aligns with development and commercial concepts. The natural environment is therefore seen as an important asset providing services and benefits to society, rather than a constraint or hindrance to development.
- It highlights that investments in natural capital and green infrastructure make important contributions to air quality regulation, climate change mitigation, natural flood risk management, water quality enhancements, local climate amelioration, noise screening, biodiversity enhancement, health and wellbeing and other benefits. Green infrastructure is multi-functional, meaning that an investment focussing on one benefit (e.g. natural flood risk management), can deliver multiple additional benefits, hence offering excellent value for money.
- It explicitly considers wider aspects of development, including public goods and factors that underpin wellbeing and quality of life. Public benefits have traditionally been undervalued in decision making, whereas the natural capital approach explicitly recognises, quantifies and values such benefits.
- It provides a framework to integrate national and local policies and priorities. It joins up national strategic commitments and planning around themes such as climate change, biodiversity, water quality, flood risk management, and health and wellbeing, as well as place making and economic development.
- It identifies resource based constraints, opportunities and a consistent framework for decision making. It also presents supply (capacity) and demand for ecosystem services, which can be used to objectively identify the best opportunities to enhance delivery. This bottom-up approach to the identification of key locations can be combined with a top-down policy-based approach to identify priorities for investment.
- It enables the location and type of natural capital investment to be related to demand, which varies considerably across a region (or a town). For example, trees or woodland should be planted close to pollution sources, such as along main roads. Accessible greenspace should be created close to where people live. Mapping the spatial location and distribution of benefits (especially in relation to demand) provides valuable additional information, that is not captured in non-spatial approaches.

- It provides a basis for bringing together diverse stakeholders with common interests. The common framework provided by the natural capital approach enables stakeholders to engage with projects from diverse backgrounds, breaking down silos and encouraging more inclusive and joined-up decision making.
- The approach links through to funding and financing. There is a clear logical pathway from the establishment of objectives and potential natural capital benefits to the identification of funding and financing mechanisms. Natural capital financing is developing rapidly, with new markets emerging across a range of benefits, enabling new sources of funding to be tapped into.
- It provides explicit links to the Green Economy, something that has particular importance and resonance in driving post Covid recovery.

9.2 Recommendations to enhance natural capital

The natural capital audit and assessment points to some key areas where action can be taken to increase the quality and extent of the natural capital assets of Cheshire and Warrington. The recommendations below have been developed on the basis of offering the most significant potential for improving the delivery of ecosystem services, aligning with local and national policy priorities. These recommendations have also been informed by discussions with the Steering Group, and through the prioritisation workshop.

A move to sustainable agriculture: Agriculture, especially livestock production, is dominant in Cheshire and Warrington, impacting on natural capital quality and the range of benefits that can be provided in those areas. Whilst food production is an important service, this needs to be balanced with the provision of other services including habitat for biodiversity. A move to more sustainable practices in both arable and especially livestock farming will be key. This is the aim of the new Environmental Land Management scheme (ELMs) that seeks to promote sustainability and incentivise land management for the provision of public goods. Reducing GHG emissions from farming is key, so a focus on this and simultaneously increasing the carbon sequestration capacity of the farmed landscape will be important. Interventions that will improve water quality, slow the flow of water, and provide increased access to nature will also be important in these areas. The biodiversity and ecosystem services opportunity mapping (Section 4) can be used to identify areas where new habitats can be created to improve the delivery of some of the services just mentioned. The food production map (Technical Report 1, Figure 14) can be used as a guide to identify fields where habitat creation will have least impact on agricultural productivity (as arable and improved grasslands have been weighted by Agricultural Land Class).

Expand woodland: Woodland is a key asset and there is a plan to expand this habitat at the county scale. Using the combined opportunity maps (Section 4.3, Figure 10), it will be possible for woodland to be created to connect existing woodland networks and also to ameliorate air and noise pollution, to help slow the flow of water, to increase water quality and open up opportunities for recreation (and deliver other benefits). Maps have been created that specifically focused on where habitat can be created to slow the flow of water and to reduce soil erosion to improve water quality and these show many opportunities to create new habitat along rivers, where woodland habitats would be particularly beneficial. Case study 3 provides an example of this approach, as well as delivering biodiversity and other benefits. The role of woodland and trees in the urban centres of the region is also vital. Urban trees are key to providing multiple benefits in towns and cities, but the urban tree stock needs to be reviewed to ensure the right species of tree are in the right locations for delivering services where they are needed.

Restore grassland habitats: Improved grassland is the dominant habitat type across the farmed landscapes of the region. A move away from intensively managed fields to a more diverse grass sward that has lower, or no chemical inputs, would increase the biodiversity value of these fields. In combination with lower livestock densities these habitats will be able to emit less carbon, and increase water quality and water flow capacity.

Restore bog (mire) habitats: These habitats, including both upland blanket bogs and lowland raised bogs, are a significant asset, and an important carbon store. It is important to protect this store by ensuring they are in the best condition possible. Bogs that are in a degraded condition will emit significant levels of GHGs and restoration can significantly reduce emissions. Agricultural activity and planting woodland on peat soils should be avoided as the GHG emissions associated with these are very high. A focus on bog restoration is also important for slowing the flow of water and increasing water quality.

Create new natural and biodiverse green spaces and encourage use: There should be a focus on the creation of these in areas where access is currently low. This will be important for increasing recreational opportunities and enhancing the health and well-being of the inhabitants of Cheshire and Warrington. This project also demonstrates that health and recreational benefits have a high economic value. Note, however, that creating new green spaces does not guarantee their use and some existing greenspaces will be underused by local communities. It is important therefore that green spaces are designed in such a way as to encourage their use by all parts of the community. The potential benefits of increased physical activity could be further increased through programmes that actively encourage people to get out of their homes and exercise in the new areas created, and initiatives that tackle some of the social issues around inactivity. It is therefore recommended that such programmes and initiatives are put in place alongside new investments in the physical spaces. The monetary benefits of such initiatives can be very large in terms of savings to the NHS, reduced time off work, and enhanced quality of life.

Enhance biodiversity: The biodiversity opportunity mapping (Section 4.1) shows areas where new habitat can be created to connect up existing core habitat to increase resilience. These sites can be prioritised in a number of ways to meet both existing habitat and species level strategies, and formulate future ones. In addition, using the combined opportunities maps (Section 4.3) allows these strategies to be met at the same time as providing multiple benefits. Woodland is the habitat that tends to offer a wider range of benefits provision, however, there is a need to ensure that there is a diversity of habitats created, and discussion on which to create where will need broad stakeholder input. The linking of biodiversity strategies and the need to provide important ecosystem service benefits from the natural capital of Cheshire and Warrington can come together in a Local Nature Recovery Strategy (LNRS) for the region. This should provide a route to delivering a nature recovery network that enhances biodiversity, at the same time as directing investment into natural capital to deliver key benefits where they are most required. Broadening the remit of the LNRS not just to connecting nature, but also connecting humans to nature, could also go some way to achieving the sustainable connectivity that the policy analysis highlighted will be required in the region.

An LNRS and the existence of a nature recovery network will help direct **biodiversity net gain (BNG)** offsetting opportunities to key sites that can deliver biodiversity and multiple benefits. Once 10% BNG is compulsory in the development sector, Cheshire and Warrington will be able to use the opportunity maps to create a strategically located set of sites for these offsets (this is in effect a Cheshire and Warrington habitat bank). This also allows opportunities for BNG to be packaged up in advance to fit in with any scheme that the local planning authorities develop to facilitate biodiversity net gain delivery.

The detailed **evidence base** for Cheshire and Warrington outlined in this report can be used both at the strategic regional scale, and to meet environmental and socio-economic plans and aspirations at the Local Authority and parish levels. It can be used to move towards a suite of prioritised projects that meet the needs of key issues in the region, different funding priorities and investor interests (see below). The funding mechanisms analysis (Section 6) and selector spreadsheet can help to find the most appropriate funding sources that could apply to these projects, to ensure the delivery of the goals and targets.

9.3 Actions to deliver the Natural Capital Audit and Investment Plan (NCAIP)

Integrating a natural capital approach into the environmental, economic and social development ambitions of Cheshire and Warrington provides advantages (as described in Section 9.1), but delivery will require a number of actions. It requires integrated decision-making based on evidence. This project has delivered the natural capital evidence base, along with information on potential funding sources, a strategic framework, and a series of illustrative case studies as part of a Natural Capital Audit and Investment Plan. It is important to ensure that the NCAIP, and the large evidence base on which it is built, is taken up and used in decision-making. Key actions include:

1. *Viewing and sharing data*

This project has generated a large evidence base, with numerous maps and GIS layers. Use of the data will be much more effective using a GIS based system or portal. It is therefore important to establish a data sharing protocol, regarding who will have access to the data and in what form, and who is responsible for maintenance and updates. It is recommended that a mapping portal is developed, enabling users to view and stack layers over any scale. The portal should also allow for querying of the data, to extract site specific information on locations of choice (e.g. existing sites, Wards, user drawn polygons etc.). Downloading of raw data will need to be restricted to project partners, due to licensing restrictions, but wider viewing of the data would be possible or could be presented in the form of a story map (see below).

It would be possible to develop a fee-based system for private or commercial customers (e.g. developers) to request a natural capital report for a specific site and the surrounding area, in much the same way as occurs for biological information at present. A pdf report would be generated containing all the natural capital, ecosystem services and opportunity maps for the site and buffer, helping to guide developers towards achieving environmental net gain. This service could be delivered by the Biological Records Centre (who operate an equivalent scheme for biological data) or an independent organisation such as Mersey Forest. The fee can then be used to cover admin costs and be directed towards the updating of the evidence base, thereby providing a sustainable funding mechanism to ensure that the evidence base remains up to date.

2. *Develop a communications strategy and user-friendly outputs*

Potentially linked to the above, most of the outputs of the Natural Capital Audit and Investment Plan are technical in nature. There is a strong need to produce outputs that are focussed for different stakeholders, such as local businesses, health boards, potential investors, and the general public. These can present the findings in a more user-friendly manner, with images and infographics and with messages tailored to each audience. As well as creating traditional glossy pdf outputs, it would also be possible to create a story-map to bring together different types of output in an accessible manner.

3. *Develop portfolio of costed projects*

There is a clear need to develop a portfolio of costed projects. This can be projects that are already being considered by stakeholders, or new projects based on the opportunity mapping presented here. Proposals need to be fully planned and costed so that they can then be brought forward for funding. Funding for delivering the costed projects may be through an Investment Readiness Fund (IRF, see below), or potentially through any number of other funding sources. Outside the IRF, there is potential for funders to search the portfolio to find projects that best match their objectives.

4. *Set up an Investment Readiness Fund / Environment Fund*

An Investment Readiness Fund (IRF) is a mechanism to support investment in the natural environment and to help develop markets. It provides seed funding to pay for technical assistance to plan and develop viable investable projects. It also allows links to be made between natural capital buyers and investors with natural capital projects. In Cheshire, an IRF has recently been awarded funding for the Bollin catchment, through the Environment Agency's Natural Environment Investment Readiness Fund. The Fund will use the opportunity mapping presented here to identify suitable project locations, and will then develop the strategic, economic, financial, commercial and management case for investment in these projects. A fund offering green bonds (known as Bollin Bonds) will then be launched through a special purpose vehicle and buyer and investment contracts will be secured. It is hoped that this will act as an exemplar, and set up processes that can then be rolled out across the Cheshire and Warrington region. Note that Greater Manchester Combined Authority has set up an Environment Fund with similar objectives.

5. *Embed the natural capital approach within local policy*

There are a number of areas where natural capital approaches should be embedded into local policy. With the forthcoming requirement to deliver biodiversity net gain for all new developments, local policies and guidance will need to be developed on how to deliver this. For example, the local planning authorities can set up their own offsetting schemes or can rely on external providers and the legal framework underpinning these schemes, along with details such as the cost and location of offsets will need to be set. In addition, it would be beneficial if local policy required natural capital (or environmental) net gain to be delivered, alongside biodiversity net gain. This is the stated ambition of UK Government policy going forwards (although is not yet a mandatory requirement) and would enable Cheshire and Warrington LAs to become national leaders in this field. Further policies can be advanced by the LAs to encourage the uptake of natural capital investments, for example by enabling stacking of benefits, linking with climate change policies and developing verification and governance processes. National and local priorities can be aligned, thereby attracting policy support and funding for local initiatives that in turn can lever further benefits at the local scale.

6. *Link with delivery mechanisms*

The evidence base presented here provides key evidence to support the delivery of multiple emerging natural capital and biodiversity-based strategies and schemes. For example, a Local Nature Recovery Strategy (LNRS) for Cheshire and Warrington will be required under the Environment Bill and the evidence collected here can be used to shape the development of the strategy. Identifying opportunities to enhance biodiversity, but to also deliver additional benefits is the key function of a LNRS and the opportunity maps developed here can be used for that purpose. This will also require a significant stakeholder engagement process and will need to ensure representation and buy-in from a broad range of stakeholder groups. Learning from other

areas in England that have embarked on this process, and the Natural England LNRS pilots will be helpful. Similarly, the opportunity maps can be used for Environmental Land Management scheme (ELMs) targeting, to identify the best sites for biodiversity offsetting, for carbon schemes, and for health initiatives and enhancing access to natural spaces. Hence it is important that the evidence base developed here is linked to and informs these emerging schemes.

7. Training and workshops

There is a need to hold training sessions and workshops to embed the ideas presented here in working practices. For example, sessions with LA planners could explore how the evidence base can be brought into the planning process and how policies and guidance can be updated to support the requirement for offsetting and net gain. Sessions can also be held with other sectors such as local businesses, health boards, and potential investors to demonstrate the principles and practice of natural capital investment and the evidence behind it.

8. Updating the evidence base

The natural capital evidence base will need updating periodically. The natural capital asset map (Figure 3) is the baseline for Cheshire and Warrington, from which change can be tracked. Once updated, the rest of the evidence base, including ecosystem services mapping and valuation or natural capital accounting can be re-run. A collective decision needs to be made on when this data is updated. Usually at this scale, every 3-5 years is sensible, or when it is considered that substantive land cover change may have occurred. A protocol needs to be agreed by the project Steering Group for updates, when they should occur and by whom. The new version can then be issued to all data users. With additional resource it would also be possible to update the evidence base as projects are undertaken, to present a live record of what has changed, the location and the benefits delivered.

9. Map habitat quality and ground-truth basemap

The basemap presented in Section 2 provides a detailed map of habitats across Cheshire and Warrington, enabling an assessment of the type, extent and spatial attributes of habitats. However, it is based on externally provided data and has not been ground truthed. This means that the basemap is as good as it can be given the data, but will contain some errors. In addition, it does not include an assessment of habitat quality (condition). Both of these issues could be addressed by engaging local volunteers in fieldwork to visit and assess sites. The basemap could then be updated and condition data embedded within it. A habitat condition map could also be created based on the data collected, supplemented by existing data on condition of SSSIs, and supported by a number of careful assumptions developed recently for a project for the OxCam Arc Local Natural Capital Plan Project. The opportunity maps presented in Section 4 are focussed on creating new habitats, rather than enhancing existing ones, hence mapping habitat quality would provide a more complete understanding of Cheshire and Warrington's natural capital assets by highlighting requirements for habitat restoration. The data could also be used to create a baseline biodiversity assessment using the Biodiversity Metric tool (that assigns the number of biodiversity units to each habitat parcel based on the condition and distinctiveness of the habitat). This would provide a baseline to enable the local authorities to monitor whether they are achieving net gain in biodiversity.