

The Canterbury Climate Partnership Plan

Action 4: Nature–based Solutions

Blue–Green Network Literature Review

Local government climate actions for Canterbury 2024–2027

It's time, Canterbury
Our climate change conversation

CANTERBURY
Mayoral Forum



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1. Introduction

The Canterbury Climate Partnership Plan is a collaboration between the Councils in the Canterbury region with the aim of understanding potential climate impacts and mitigating and adapting to the changes which may occur.

The Waimakariri District Council is leading the task of exploring, creating and delivering nature–based solutions to climate change issues with the precise action being:

Action 4.2
Develop a blue–green network plan for Canterbury and accompanying guidance to support locally led implementation.

Action 4.2a
Maximise opportunities to collaborate with key stakeholders to provide guidance on blue–green infrastructure placement and hazard resilience investment.

Action 4.2b
Collaborate and align with Greater Christchurch Partnership and key stakeholders to deliver a blue–green network.

Action 4.2c
Investigate the feasibility of establishing blue–green infrastructure on council–owned land, including identifying priority locations for implementation across Canterbury.

The first stage in achieving the goals is to define the terms which are being used, explore what is already being done nationally and internationally and use this information to inform the scope of the work. This literature review embodies the first stage in the process, to define terms and explore what is being achieved within and outside of the region.



Honda Forest, Kaiapoi, Canterbury

2. What Are Nature-based Solutions?

As a society, we face many changes in the coming years. Issues of water and food security, human health, disaster risk and climate change all pose significant threats for human populations and the natural world (Cohen-Shacham et al., 2016).

To address these challenges, the theory of Nature-based Solutions (NbS) has been developed. Nature-based Solutions represent the ways that we can work with the natural world to enhance their working and produce solutions to the issues we face (Seddon et al., 2019).

NbS are closely related to and developed from other, earlier concepts, such as the "ecosystem approach" introduced to the Convention on Biological Diversity in 1995 as a central principal of the work and ethos (Secretariat of the Convention on Biological Diversity, 2004). This concept defined a strategy to integrate management of land, water and living resources to enable conservation, sustainability and equity of use of natural resources. It was one of the first times that governments began to integrate ecosystem services into planning documents rather than focus on protection of areas of high species diversity (Parliamentary Office of Science and Technology, 2011).

The ecosystem approach established the concept of ecosystem services (ES). In 2005, the International Union for Conservation of Nature (IUCN) conducted and published a report authored by the Millenium Ecosystem Assessment (2005) in which the benefits, goods and services obtained directly and indirectly from ecosystems were outlined.

These were divided into four areas:

- **Provisioning** which includes the supply of consumables such as food, timber, biochemicals and medicines
- **Regulating** relating to services such as climate, air and water regulation as well as pest and disease control
- **Supporting** indicating photosynthesis, soil creation and nutrient cycling
- **Cultural services** which provide a sense of place and meaning, spirituality, recreation, aesthetic values, and physical and mental health.

Ecosystem theory is integrated into Nature-based Solutions, however, although linked, it is important to highlight that the theories are not nested, but instead interact (Remme et al., 2024). This is an important distinction which shapes the research of both concepts and the integration of these into policy. The main way these concepts interact is via the mechanisms of the NbS that can alter the flow of ES from the ecosystem to the socio-economic system (Seddon et al., 2019, Figure 1).

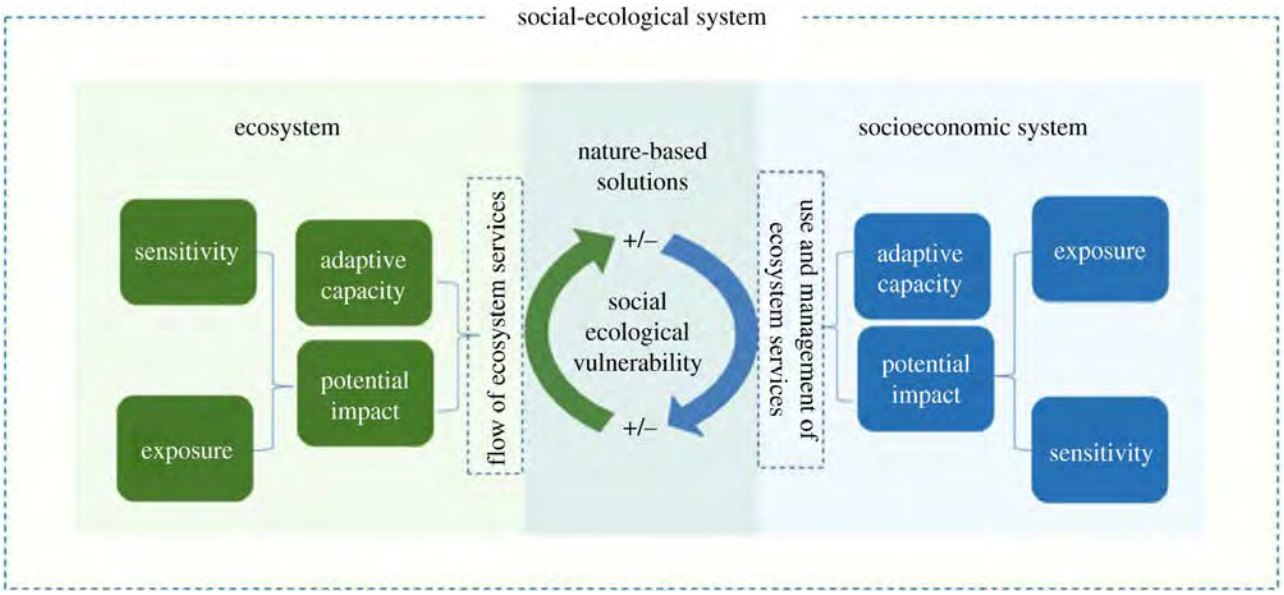


Figure 1. NbS mediate the flow of ecosystem services from ecosystem to the socio-economic system to gain improvements to societal challenges (Seddon et al., 2019).

Whilst the underlying concept of NbS has been discussed for decades by organisations such as IUCN and research institutions, the practice is relatively young. This reflects the lack of a single, distinct definition for NbS, although most are similar, citing the alteration of natural systems to alleviate societal challenges (Table 1). Considering this, the IUCN introduced the Global Standard for Nature–based Solutions document outlining key definitions, and a systematic framework to design solutions and verify NbS outcomes (IUCN, 2020, Figure 2).

The framework sets out the process of designing solutions which starts with understanding societal challenges. It does not define what the NbS could be and as a result NbS can offer green–grey solutions and a range of mechanisms including *"ecosystem–based adaptation such as restoration efforts: ecosystem based management, urban green and blue infrastructure, ecological restoration, ecological engineering, forest landscape restoration, ecosystem–based mitigation, ecosystem–based disaster risk reduction, natural capital and potentially biomimicry (inspiration from natural selection solutions adopted by nature) and biophilic (an approach to architecture that seeks to connect building occupants more closely with nature) design"* (Kiddle et al., 2021).

To simplify the range of actions, Cohen–Shacham et al. (2016) divided nature–based solutions into five categories that can be implemented alone or as an integrated system:

- Ecosystem restoration
- Issue specific ecosystem related approaches such as ecosystem–based disaster risk reduction
- Infrastructure related approaches such as the use of green infrastructure
- Ecosystem–based management approaches such as integrated water management strategies
- Ecosystem protection approaches.

Whilst the IUCN framework has outlined good parameters for ensuring positive outcomes for NbS, there are examples of actions taken under the NbS banner which have not yielded the intended impacts.

Examples include climate change NbS leading to a decrease in biodiversity due to afforestation of monocultures, areas being protected without any partnership or collaboration with the indigenous people living on the land or NbS being used as "greenwashing" (Seddon et al, 2022).

Therefore, NbS should meet the following criteria:

- Be ecology–based
- Be hybrid solutions between green (natural actions and interventions) and grey (engineered actions and interventions)
- Have a fair distribution of benefits such as environmental, societal, and economic
- Include community participation
- Be cost–effective and specific to the challenge and opportunities presented.



Christchurch Central, Canterbury



Rakaia River, Canterbury

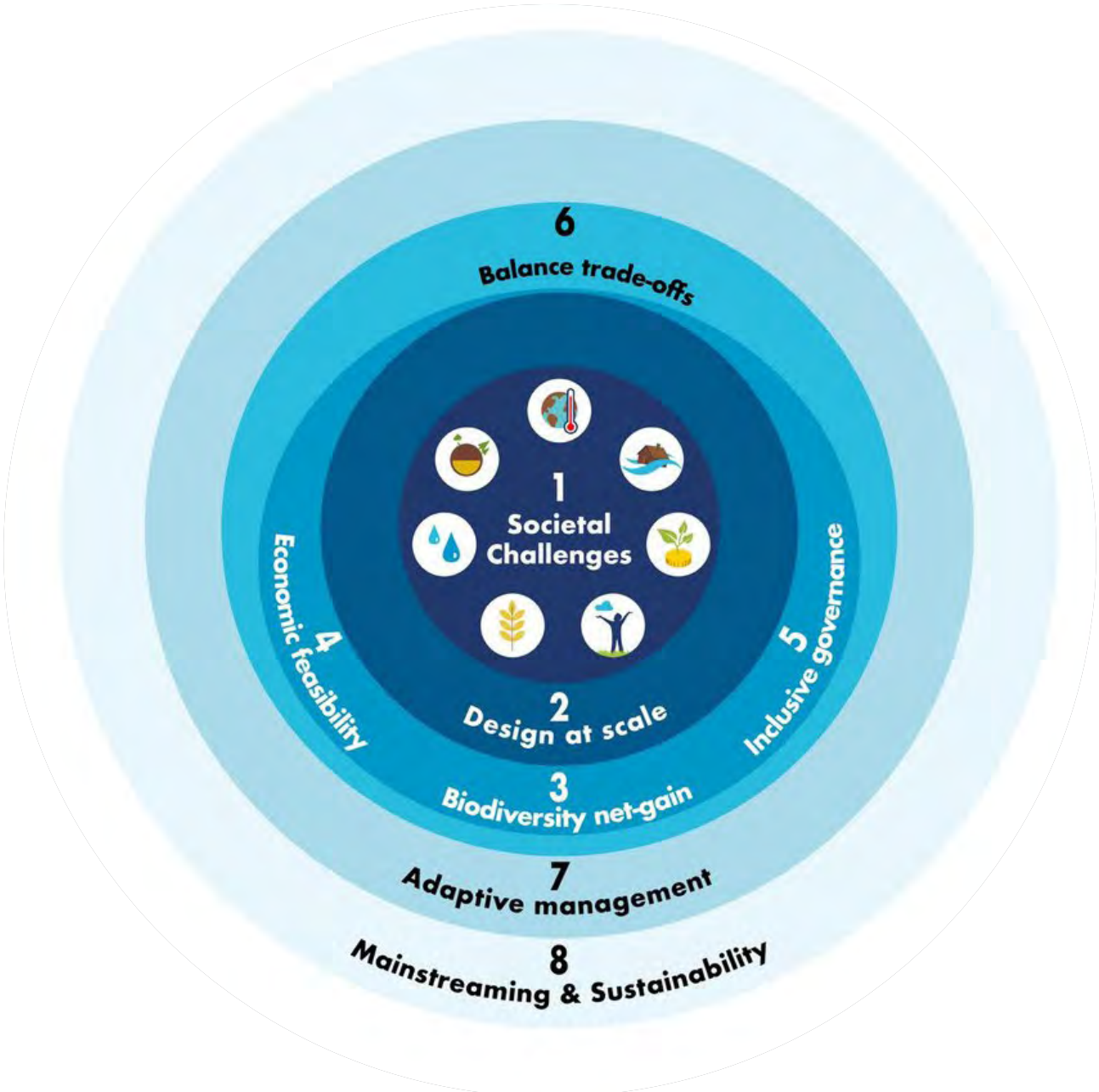


Figure 2. The Eight Standards for NbS as devised by the IUCN framework (2020).

Table 1. Accepted definitions for NbS from different organisations.

Organisation/Researcher	Date	Definition
United Nations	2004	*"Nature-based solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits."*
European Commission	2015	*"Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions."*
IUCN	2016	*"Nature-based solutions are actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits"*
Albert et al	2019	*"We define nature-based solutions as actions that (i) alleviate a well-defined societal challenge, (ii) utilize ecosystem processes of spatial, blue and green infrastructure networks, and (iii) are embedded within viable governance or business models for implementation. In short, nature-based solutions must fulfil the criteria of challenge-orientation, ecosystem process utilization and practical viability."*



Waimakariri River, Canterbury

3. Nature–based Solutions in Aotearoa New Zealand

Aotearoa New Zealand's first national adaptation plan, *"Adapt and thrive: Building a climate–resilient NZ (2022)"*, defines NbS as being...

"Solutions that are inspired and supported by nature and are cost effective, and at the same time provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features (eg, vegetation and water features) and processes into cities, landscapes and seascapes, through locally adapted, resource–efficient and systemic interventions. For example, using vegetation (eg, street trees or green roofs) or water elements (eg, rivers or water–treatment facilities) can help reduce heat in urban areas or support stormwater and flood management".

A recent report released in late 2024 indicated that NbS were being used in different parts of Aotearoa New Zealand but were notably missing from much of the Canterbury area (Figure 3; Boffa Miskell Limited, 2024).

The main climate drivers for the interventions were assessed as being flooding (from rain events, rivers and coastal inundation) and erosion, whilst the societal drivers were mainly strategic and funding alignment. The report highlighted the fact that there was no collective agreement on the terms used or any standards, which prevented information sharing and any comparisons. It also noted that a lack of definition and collective knowledge around application and trade–offs can lead to misuse and misinterpretation.

The Boffa Miskell report identified gaps in the insight and opportunities and proposed a roadmap for the effective creation and delivery of NbS with four action areas: Knowledge, Technical, Policy and Financial. To address these, a community of practice to expand and share the knowledge base with standard methodologies and an engagement strategy was suggested alongside providing policy guidance and integration. Finally, reducing scepticism and increasing support along with public and private investment in NbS creation, research, monitoring was recommended.



Aoraki/Mount Cook National Park, Canterbury

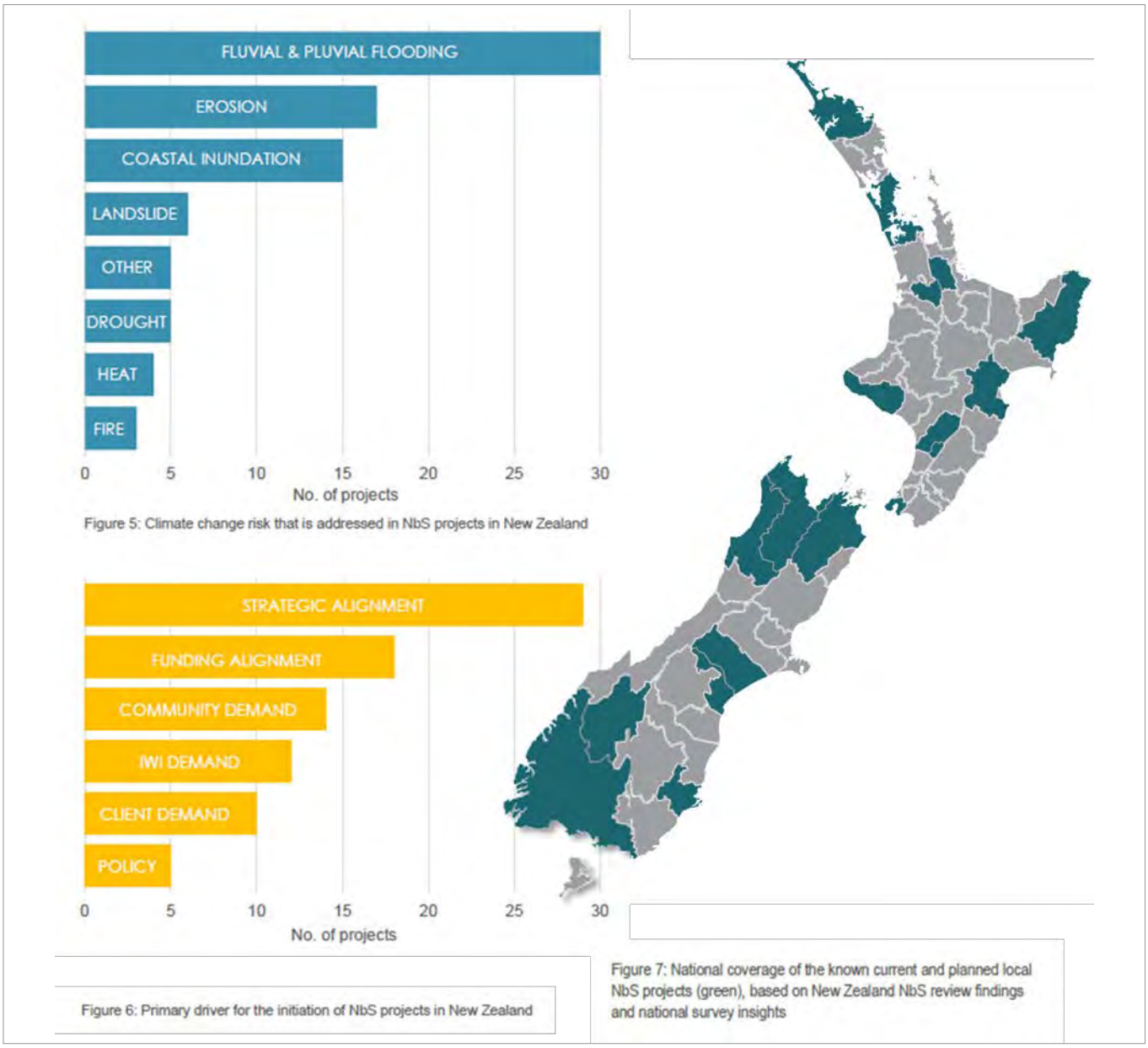


Figure 3. Except from a national report on NbS showing the locations of known NbS and the climate and societal drivers for the projects.



Lake Wanaka, Canterbury

4. The Interaction Between Blue–Green Networks, Nature–based Solutions and Ecosystem Services

NbS involve nature or ecosystems of various scale and type. The precise format of the NbS will be determined by the societal issue being addressed, resources available, and involvement of local community.

This infers that NbS will include local projects tailored to the specific circumstances at play. However, if these NbS can be linked, they can be used to address issues at larger district, regional, and national scales, and create blue–green networks (BGN). Therefore, BGN are not strictly classified as a NbS and are more likely a systems–approach to issues of scale, integrating blue and green infrastructure into planning and design (Xi et al., 2022). They are distinct concepts but can be viewed as closely aligned with similar objectives of working with ecosystem services.

NbS have been stated as being *"integral components of GI [Green infrastructure] networks, providing numerous ecosystem services by replicating natural processes…The significance of strategically siting these solutions throughout urban areas becomes apparent, ensuring equitable access to climate hazards protection"* (Azadgar et al., 2025). Azadgar et al., found that in Rome NbS could exacerbate socio–economic inequities through their placement in wealthier areas. The authors also warn of "eco–gentrification", whereby enhancing the blue and green infrastructure of an area can lead to an increase in house prices and the cost of living over time. This may be mitigated by engaging the community that the NbS are designed to service and reinforces the point that NbS require local input and governance to be legitimate and not just "greenwashing".

There is no universal definition of BGN, and they are known by many synonyms such as green–blue infrastructure, green infrastructure, urban green infrastructure and even extending to biocultural diversity, sponge cities and liveable cities (Mercier, 2023; Pauliet et al., 2019; Box 1). Furthermore, the typologies nestled within BGN such as parks, allotments, rain gardens etc and the types of NbS and ES offered are hugely varied with no universal names, causing issues with verifying the validity or creating guidelines for the development of BGN.

Box 1: Blue, Grey and Green Infrastructure?

Terms such as green infrastructure have been used in research, strategy documents, policy and other guidance documents. If it is understood that NbS are solutions to societal issues which include green and grey infrastructure, we also need to understand those terms. Without unified underpinning definitions, these terms can appear to be "buzz words" and feed into the scepticism referred to in the Boffa Miskell report.

The easiest term to define is grey infrastructure. This refers to traditional built or engineered infrastructure such as sea walls, tsunami alarms and water pipes and pumps (Alves et al, 2019). This appears to be agreed upon internationally, particularly when dealing with water resources.

Green infrastructure has a wealth of definitions such as:

"A strategically planned network of high quality natural and semi–natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings" (UNEP Glossary) or "a strategically planned network of natural and semi–natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services" (European Commission, 2025).

Blue infrastructure can be defined as the water resources which form part of the green infrastructure, the rivers, streams, wetlands, estuaries etc. Sometimes this is extrapolated out into "blue carbon" referring to the increased capacity of wetland areas to store carbon in the sediment.



Christchurch Central City

However, it is understood that the spatial connection of NbS and natural blue and green spaces is particularly important when considering ecosystem services and flow throughout a landscape such as pollinators from agricultural areas having vegetated corridors that enable them to reach urban areas and provide a similar service. Langemeyer & Baro (2021) suggest envisioning NbS as nodes in a larger network or web of connected natural features to enable flow of ES, thereby creating the BGN.

In their research, they held a series of workshops to enable the creation of maps which show the spatial inking of NbS with underpinning data outlining the most relevant NbS to be managed, restored or created. This underpinning data was gathered from a range of stakeholders who listed the most appropriate ES for the area and where provision was lacking.

In recent years, there has been increased attention given to the ES within urban areas to assess quality and quantity and inform the creation of BGN.

Most of the studies have been undertaken in Europe, North America and Asia with very few from Oceania (Veerkamp et al., 2021). Many of the studies focus on the properties of ES rather than expanding research to consider ES supply and demand of certain localities and the benefit of multiple BGN features when compared with grey infrastructure.

Internationally, models have been generated enabling the mapping of various ES across landscapes. Examples are the Artificial Intelligence for Ecosystem Services (Aries) or Land Utilisation Capability Indicator (LUCI) tool (Jackson et al, 2013). Lincoln University, NZ, has studied the mapping of ES, building on the work of these software packages. They realised that the data did not consider the interactions of service provision offered by multiple components on a spatial scale (using the concept of ecological field theory). Their findings indicate that through mapping interactions, landscape design can be improved to increase certain ES and expand their use (Morris et al., 2024).



Waimakariri River, Canterbury

5. Blue–Green Networks in Aotearoa New Zealand

Following multiple flooding events in 2023, many areas of Aotearoa New Zealand began discussing the concept of sponge cities, using green infrastructure to assist in flood mitigation and storm water management (Mercier, 2023).

The theme of connectivity can also be seen in many districts across the country. Significant projects have been formulated in Whangārei and Wellington aiming to protect and enhance ecological significant areas but also restore and connect to provide essential ecosystem services.

5.1 Auckland City Council

An example of BGN which only addresses targeted societal issues in certain areas was developed by the Auckland City Council. The "Making Space for Water" project focussed on mitigating severe weather events in urban areas and increasing the resilience for grey infrastructure (Auckland Council, 2024).

Integrated into this concept was the blue–green network comprising a system of waterways, wetlands and parks that accommodate stormwater and reduce flooding in inhabited areas. Whilst the focus is on flood mitigation, it is recognised that the blue–green areas also offer a range of ancillary benefits such as recreation for communities, wildlife corridors and space for native fauna and flora, as well as opportunities for cultural narrative and education.



Devonport, Auckland



Queenstown

5.2 Queenstown Lakes District Council

Queenstown Lakes District Council has a draft "Blue–Green Network Plan" which maps out the parks, open spaces, trails, and waterways across Priority Development Areas and settlements and identifies what should be protected, enhanced, and better connected as the district grows. The plan was developed in recognition of the importance for areas to be connected, to create ecological resilience, stronger communities, well-designed liveable neighbourhoods, and a healthier environment.

Some of the identified co-benefits include enhanced biodiversity, improved water quality, increased resilience to climate change, more spaces for recreation, sports and social connection, fostering of education and environmental stewardship, sustainable development and enhanced visitor experience.

The plan is built on five key principles:

- Mana o te Wai – Prioritising water as the foundation of healthy environments and communities
- Woven into the context – Tailoring solutions to each place while contributing to the wider network
- Coexistence of nature and people – Designing spaces that benefit both ecosystems and everyday life
- Connecting people and place – Strengthening access and belonging through integrated networks
- Fit for purpose and well serviced – Ensuring open spaces are well-located, well-designed, and multifunctional.

The network plan includes 18 local Blue–Green Plans to help guide future development (figure 4).

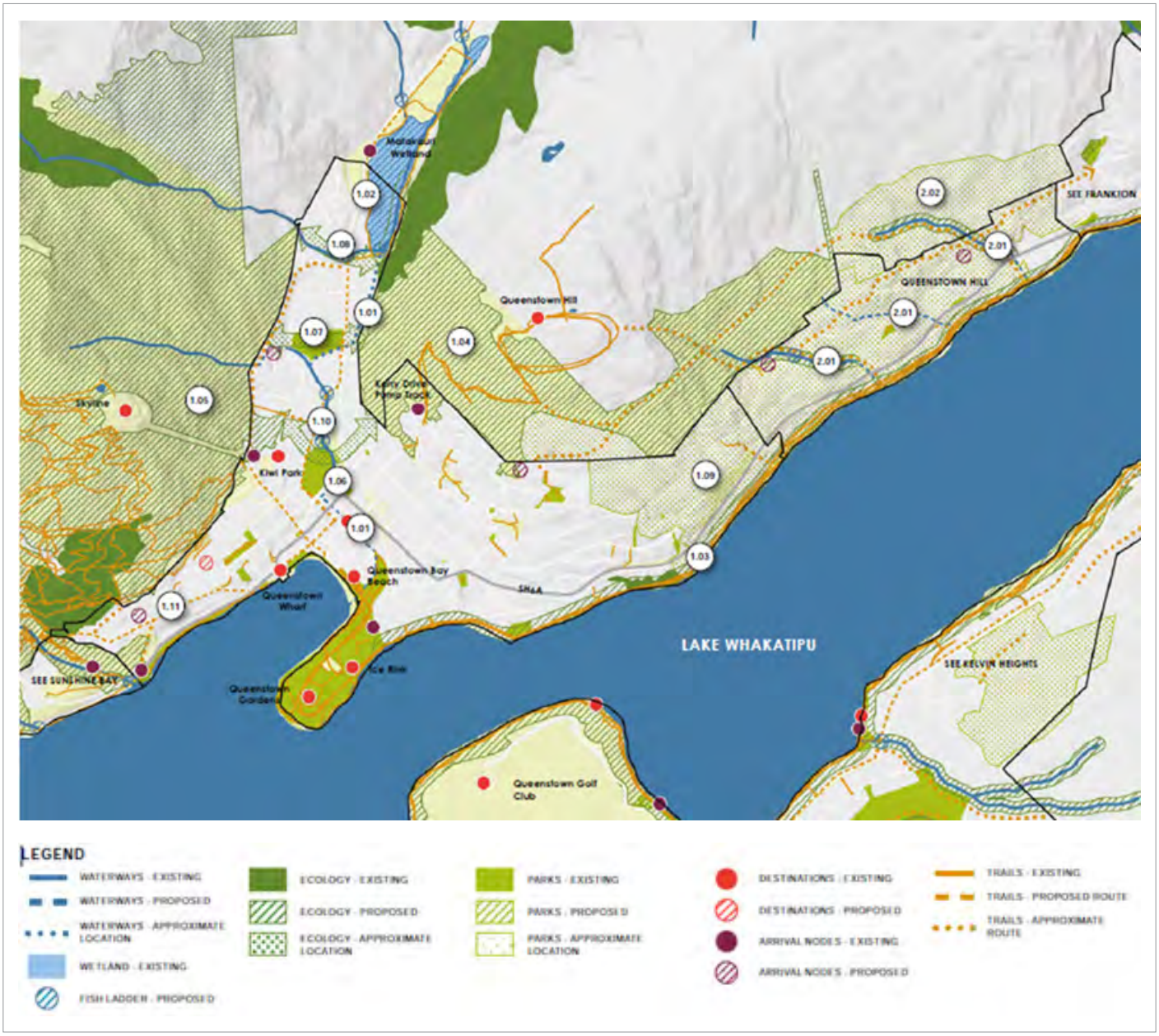


Figure 4. Example of a local network plan (taken from Queenstown Lakes District Council Blue–Green Network Plan, Queenstown Lakes District Council & Boffa Miskell, 2025).



Lake Wakatipu, Queenstown

5.3 Wellington City Council

Wellington City Council has developed a biodiversity strategy and action plan which outline the actions to integrate wildlife corridors through the city, allowing people in urban areas to easily access nature and for biodiversity to be visible both in the living forms and in art (Wellington City Council, 2015).

The Green Network Plan also sets out goals for the city to deliver *"the many ecological, social, economic, cultural and public health benefits to the central city as it grows, enhancing its liveability for residents, workers and visitors"*. This vision incorporates having sufficient quantity of well distributed blue and green spaces of sufficient quality.

In the next ten years, the council aims to have no net loss, double the number of trees, enhance 20 existing urban spaces and deliver 2 new parks offering a *"continuum of diverse green spaces" (Wellington City Council, 2022)*.

5.4 Whangārei District Council

Whangārei District Council has been formulating the blue–green network idea for almost a decade and has produced a comprehensive strategy and accompanying documents. The Council approaches the network with a more people centred view stating that *"urbanisation has led to a disconnect between humans and nature"* (Whangārei District Council, 2016). Other issues such as flooding, heat islands, biodiversity loss and cultural disconnection are also cited as issues which can be addressed through the creation of a blue–green network linking waterways and green areas (parks, gardens, forests, amenity planting etc).



Kelburn, Wellington



Lambton Harbour, Wellington

Whangārei District Council has four themes which have guided the development of their strategy including:

- Enhancing and connecting our communities
- Enhancing ecosystem services and ecological connectivity
- Providing opportunities for economic development
- Protecting our communities from natural hazards.

The blue–green network strategy is a long–term vision with implementation occurring over 50 years as funding becomes available and opportunities such as land availability and infrastructure upgrades are required.

Whangārei has the advantage of natural bush surrounding the city that can be linked up through the urban areas, creating corridors for recreation and biodiversity.

The strategic tools used to create the blue–green network include planning tools and rezoning areas, creation of urban design guidelines, review of bylaws and strategies including for signage, walking and cycling, economic development, stormwater management and open space.

Currently, the blue–green network plan can be viewed on the council website, via the mapping software (Figure 5).

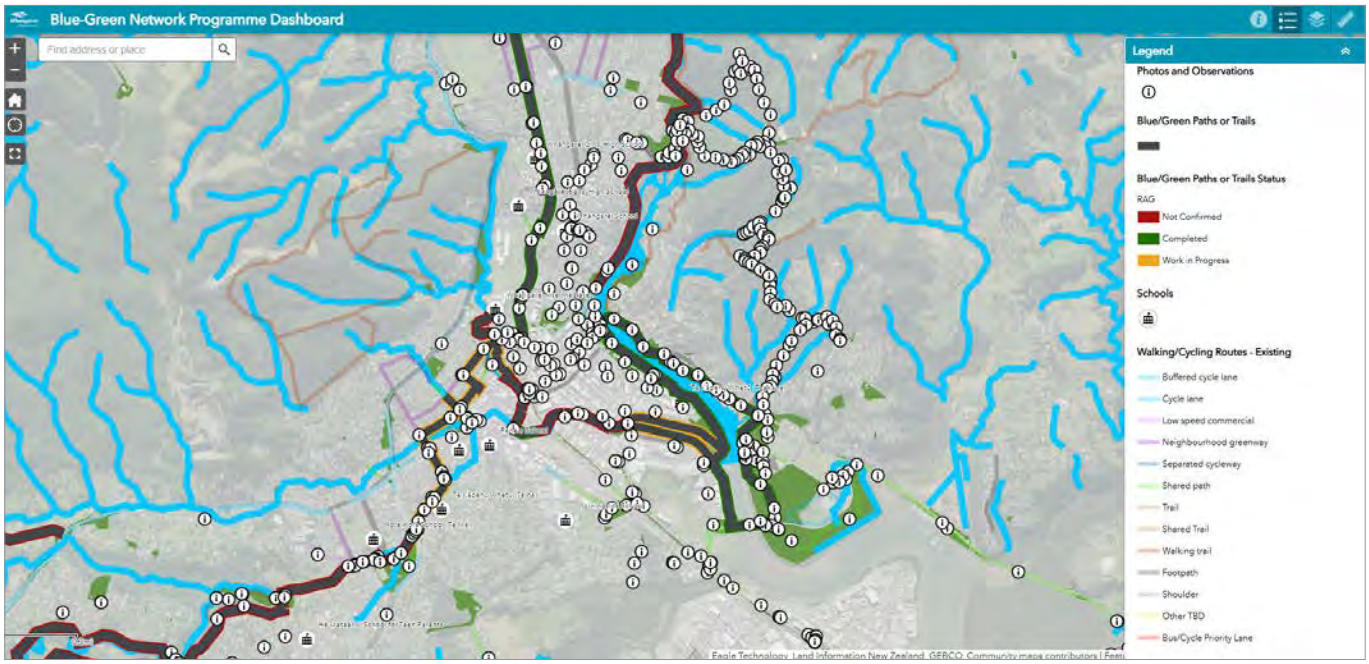


Figure 5. Blue–green network visualised on mapping software provided by Whangārei District Council (Whangārei District Council, 2024).



Matapōuri Beach, Whangārei

6. Blue–Green Networks in Canterbury

6.1 The Greater Christchurch Partnership (GCP)

The Greater Christchurch Partnership Plan (2024) defined the blue–green network as *"a series of spaces and corridors that follow and connect water bodies, parks, green areas and the coast. Blue elements include rivers, streams, storm water drains and basins, wetlands, freshwater, and coastal water; while green elements include trees, parks, forests, reserves and greenways".*

The spatial plan aims to give effect to national policy direction and contribute to a well–functioning urban environment, supporting a low emissions future and healthy environment. The strategy recommends green belts around urban areas to enhance and expand a network of green spaces and protect significant natural areas and productive soils for food production (Figure 6).

The blue–green network has six principles:

- Healthy waterways
- Integration of green infrastructure into urban accessible areas
- Connectivity for people
- Flora and fauna; multi–functionality
- Regenerative including mechanisms for adapting to and mitigating for climate change
- Identity to create a sense of place

Initial high–level design has been created but work is currently pending.

6.2 Christchurch City Council

The Christchurch City Council has developed the Ōtautahi Christchurch Planning Programme (ŌCPP) which aims to work in partnership with the Greater Christchurch Partnership and guide the development of a resilient, liveable city that meets the needs of residents and businesses (Christchurch City Council, 2024).

The plan works on a range of spatial scales from city wide to site level and recognises the need for connections and networks for people and nature is important.

The approach is guided by four outcomes:

- Water valued as taonga
- A greened city
- Strengthened identity; and
- Improved connection and prosperity.

To create the "greened city", the council has recognised that *"It is important that we protect, restore and improve the ecological integrity and mauri (essence) of our natural environment, increasing our resilience to environmental shocks and supporting our health and well–being – including our connection to the land".*

To achieve this goal, the potential connections of green infrastructure have been mapped with the possibility of enhancements such as street tree planting, NbS such as swales and green roofs, and the enhancement of indigenous forest (Figure 7). Although the term blue–green network is not used within the document, the underlying concept is similar.



Heathcote, Christchurch

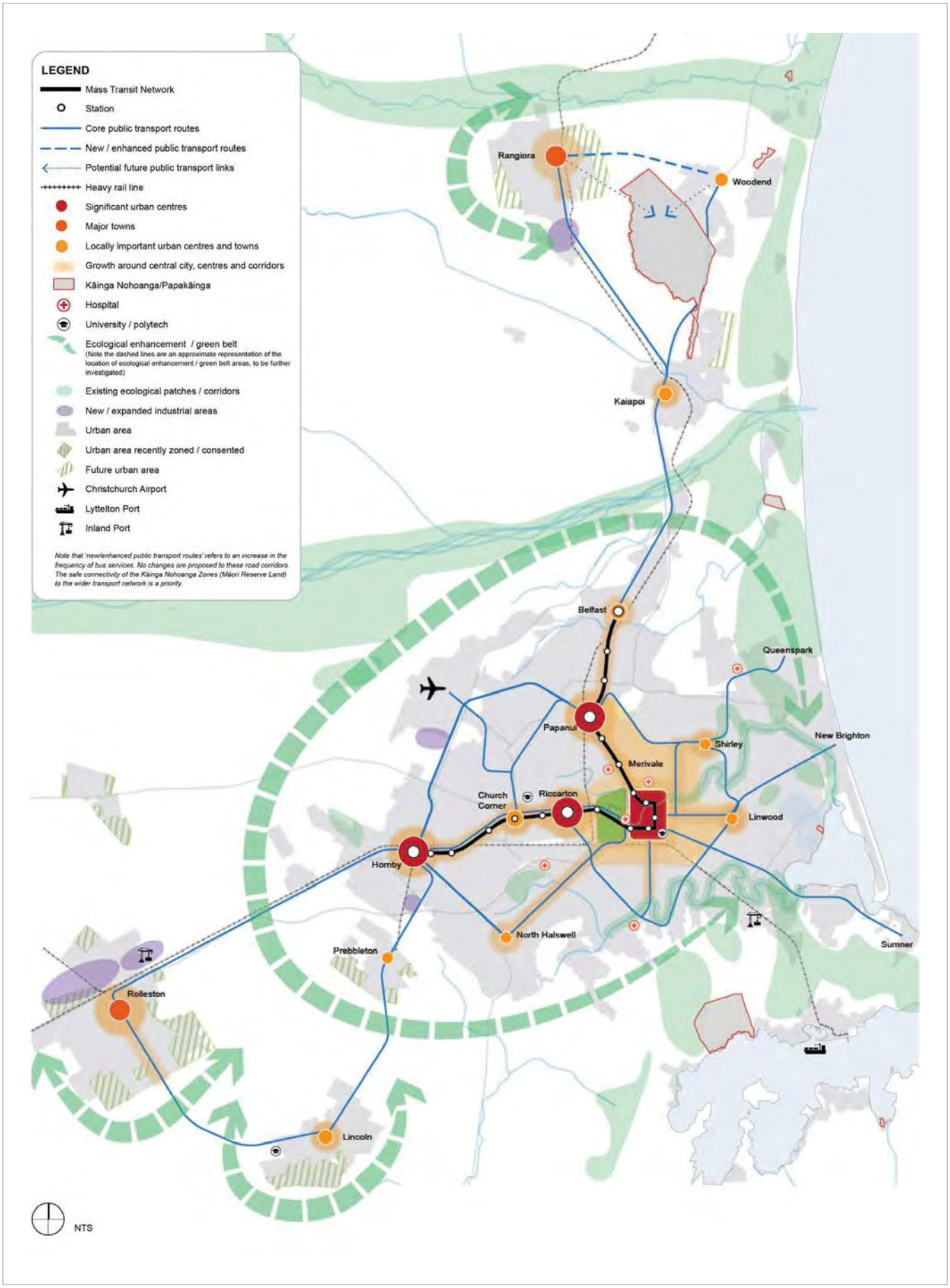


Figure 6. Greater Christchurch Partnership spatial plan showing elements of the blue-green network (taken from Greater Christchurch Partnership, 2024).



Hagley Park, Christchurch

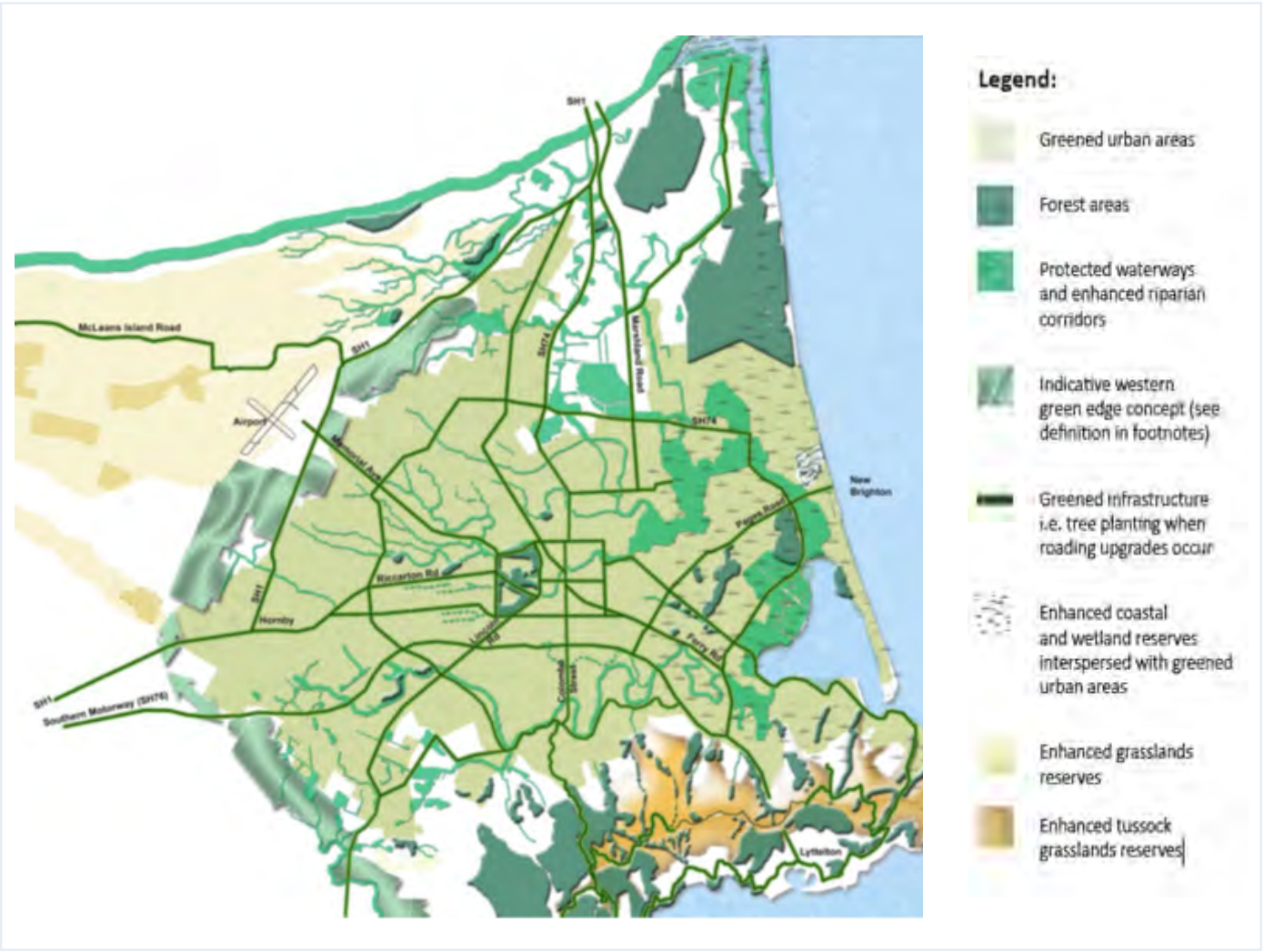


Figure 7. Excerpt from the Ōtautahi Christchurch Planning Programme strategy which aims to create a resilient city and uses the concept of connected green spaces.



Christchurch Central City



Lake Ellesmere, Selwyn District

6.3 Selwyn District Council

As part of the GCP, Selwyn District Council has begun gathering data to inform a blue–green network using the idea of mapping ecosystem services to inform the strategic direction. Partnering with Manaaki Whenua – Landcare Research, the council has commissioned the mapping of ten ecosystems services throughout the district's largest town, Rolleston. The ten services are rainwater retention; carbon stocks in trees; air pollution removal; prevention of soil erosion; tree shade; UV protection from trees; viewshed; number of birds; distance to a large green area; and distance to any greenspace (Figure 8).

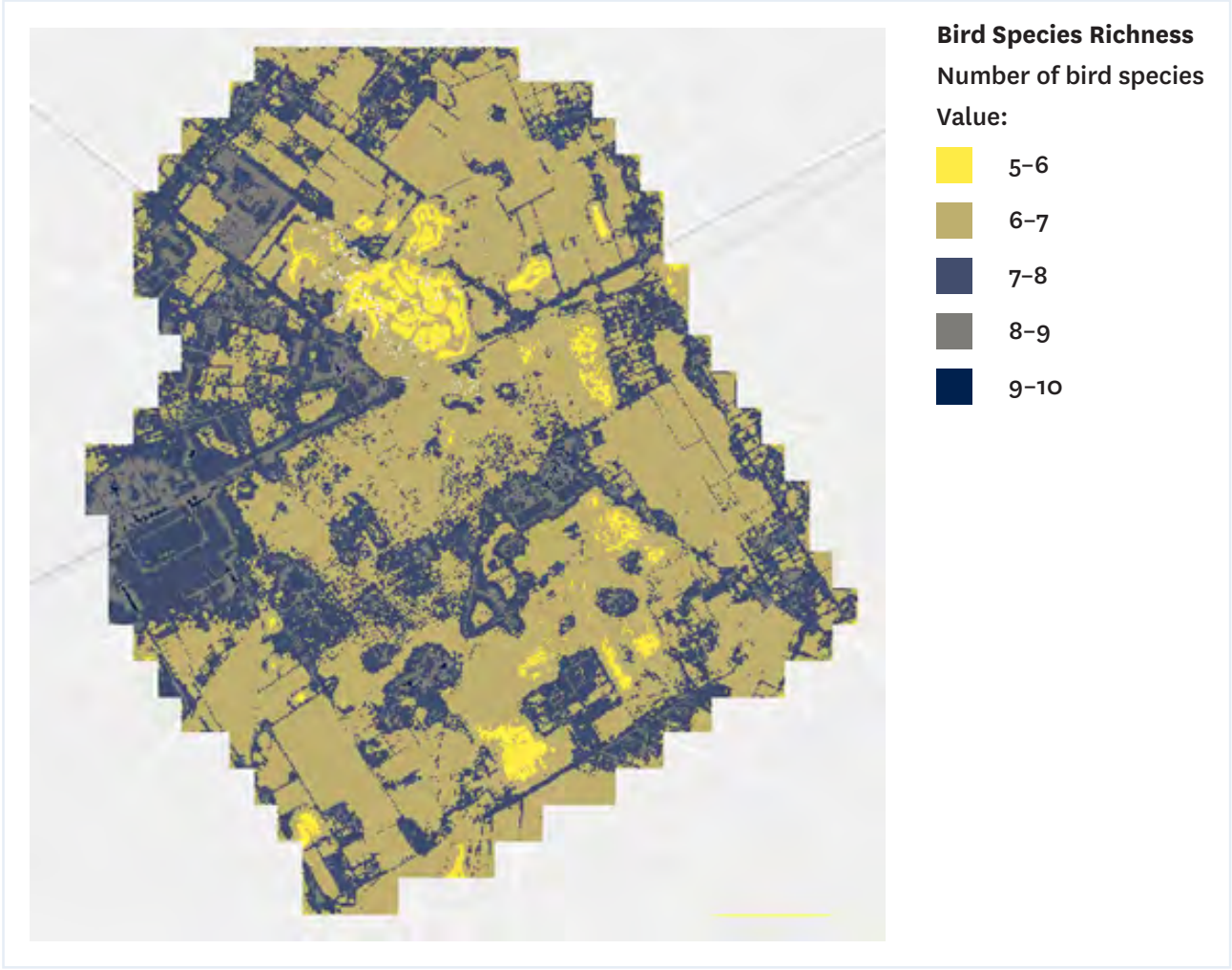


Figure 8. Example of an ES map being developed for Rolleston (taken from Dang, 2024).

6.4 Kaikōura District Council

Kaikōura District Council has developed a spatial plan to continue the "Move Kaikōura Forward" concept. This plan has a vision to create *"a diverse and welcoming intergenerational community with a strong whakapapa and thriving future that sustains nature on the raw edge from tall mountains to deep sea".*

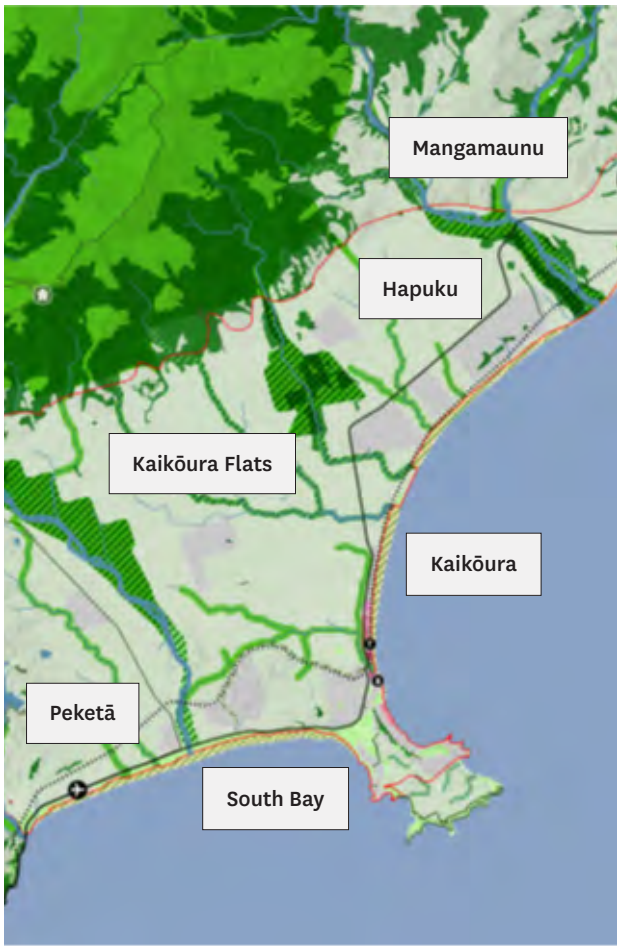
Whilst the plan identifies areas that can continue to be developed, it also highlights development constraints such as landscape (e.g slope of land), natural hazards (e.g flooding potential) and is based on principles of ES such as, *"valued and interconnected landscapes are protected and enhanced".*

Within the plan, the council refers to a BGN as *"a planning and design concept that connects natural water systems (blue) with green spaces to create a sustainable and resilient urban environment. It aims to manage water flow, reduce flooding, improve water quality, enhance biodiversity, and provide recreational and aesthetic benefits to the community".* The concept of "mountains to sea; ki uta ki tai" is referred to as a guiding concept with indigenous vegetation plantings along recreation trails (Kaikōura District Council, 2024; Figure 9).

To collaborate with community and stakeholders, workshops and meetings were held to shape the overall spatial plan, using existing information as a basis to begin discussions.



Kaikōura





BLUE GREEN NETWORK (STUDY AREA)

BLUE GREEN NETWORK (TOWNSHIP AREA)

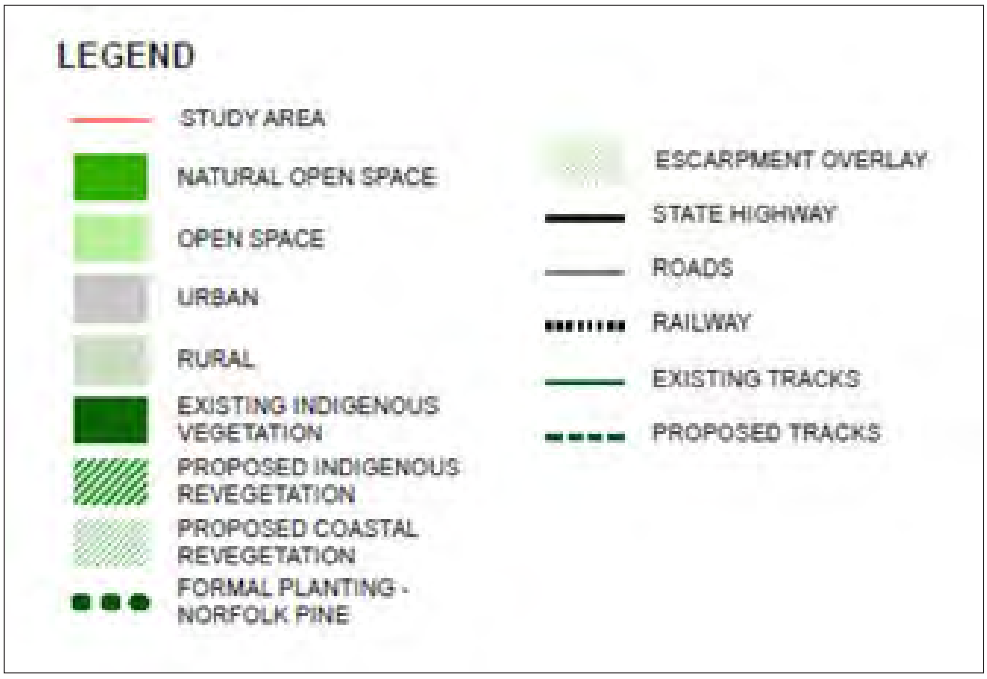


Figure 9. Excerpt from Kaikōura District Council's spatial plan document (2024)

6.5 Ashburton District Council

Ashburton District Council has a biodiversity strategy whose purpose is *"to ensure that our current and future biodiversity is protected, restored and enhanced; and to encourage people to value, care and respect it" (Ashburton District Council, 2024)*.

The term BGN is not used in the document but is supported by Goal 2 which aims to *"restore and interconnect for the benefit of the community"*.

This work builds on the open space strategy that notes that special projects will include a review to assess opportunities to improve connections and relationships between waterways and neighbouring urban areas (Ashburton District Council, 2016).

6.6 Timaru District Council

In Timaru, the town's masterplan outlines a strategic framework including *"Healthy Timaru. Te taiao hei whakamaru. Kaitiaki of natural environment"*.

This outcome along with sustainable mobility and visible identity leads to actions called green weave and coastal connection.

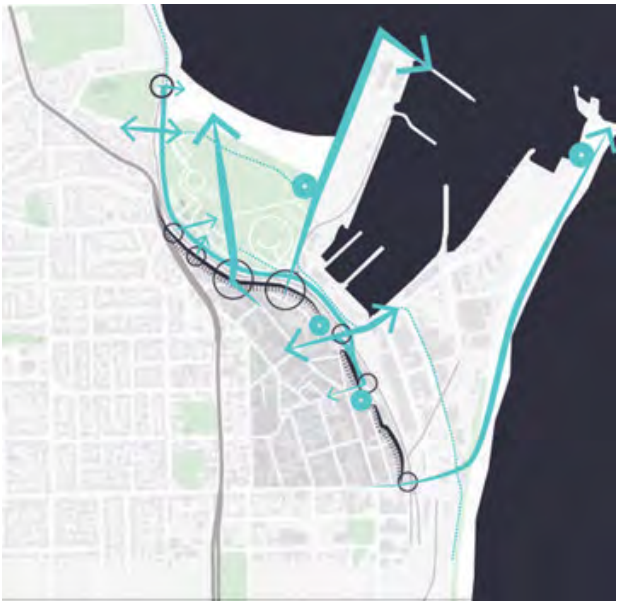
Whilst these are not termed BGN, the underlying concepts remain; connecting people and nature across the landscape via "greenways" to create resilient ecosystems and communities (Timaru District Council, 2024; Figure 10).

The document also discusses a "green edge" or "high amenity green network" making the town more attractive and supporting the natural character.

6.7 Mackenzie District Council

The Mackenzie District Council is currently drafting the Climate Change Strategy and Plan following consultation to discover the vulnerabilities of the area and what can be done, such as increasing health and connection to the natural environment, restoration surrounding river corridors and using floodable green infrastructure (Mackenzie District Council, 2024a; Mackenzie District Council 2024b).

The document will align with other regional actions including those set out by the Canterbury Climate Change Partnership and it is anticipated that a spatial planning component, such as BGN, will be incorporated.



Coastal connection | Ārai te uru

Reconnect with the water edge and celebrate its dual character—both natural and industrious.



Green Weave | Te raranga a Tane

Join and grow the existing network of open spaces to create a soft and inviting green frame around the centre.

Figure 10. Timaru District Council's Masterplan shows the connected green areas across the city (Timaru District Council, 2024).



Caroline Bay, Timaru

6.8 Waimate District Council

Waimate District Council (2024) acknowledges that *"working with nature to build resilience"* when facing the impacts of climate change is an option for mitigation and adaptation.

The council has engaged the community to discuss issues of climate change at several workshops focused on seven action plan topics: transport, water management, land use and the built environment, carbon sequestration and natural restoration, waste and circular economy, education and empowerment and leadership and collaboration.

The results of the workshops informed the development of the Climate Resilience Strategy (2025). Sub-action 4 involves developing a district biodiversity strategy that promotes and enhances native biodiversity across the district. This includes identifying and connecting blue–green networks to improve ecosystem health and strength while ensuring species/ecosystems have room to move and less human pressure.

6.9 Waitaki District Council

Waitaki District Council has a biodiversity strategy which outlines goals for indigenous biodiversity. BGN is not noted within the document but the concept of ki uta ki tai is stated as a guiding principle and the importance of providing connections for ecosystems and preventing fragmentation is discussed.

Action 2.3 mandates a Spatial Biodiversity Protection and Enhancement Plan to be created in conjunction with the regional council and other stakeholders (Waitaki District Council, 2014). The council's spatial plan is mainly a planning tool, but staff considered legislation, census data, soils data, accessibility and community facility locations, natural hazards and climate change predictions and impacts in conjunction with community views to develop a map showing the spatial arrangement of features, including green and blue infrastructure. BGN is not cited in the document but reference to multi-functional corridors, particularly along riparian margins, is discussed (Waitaki District Council, 2022; Figure 11).

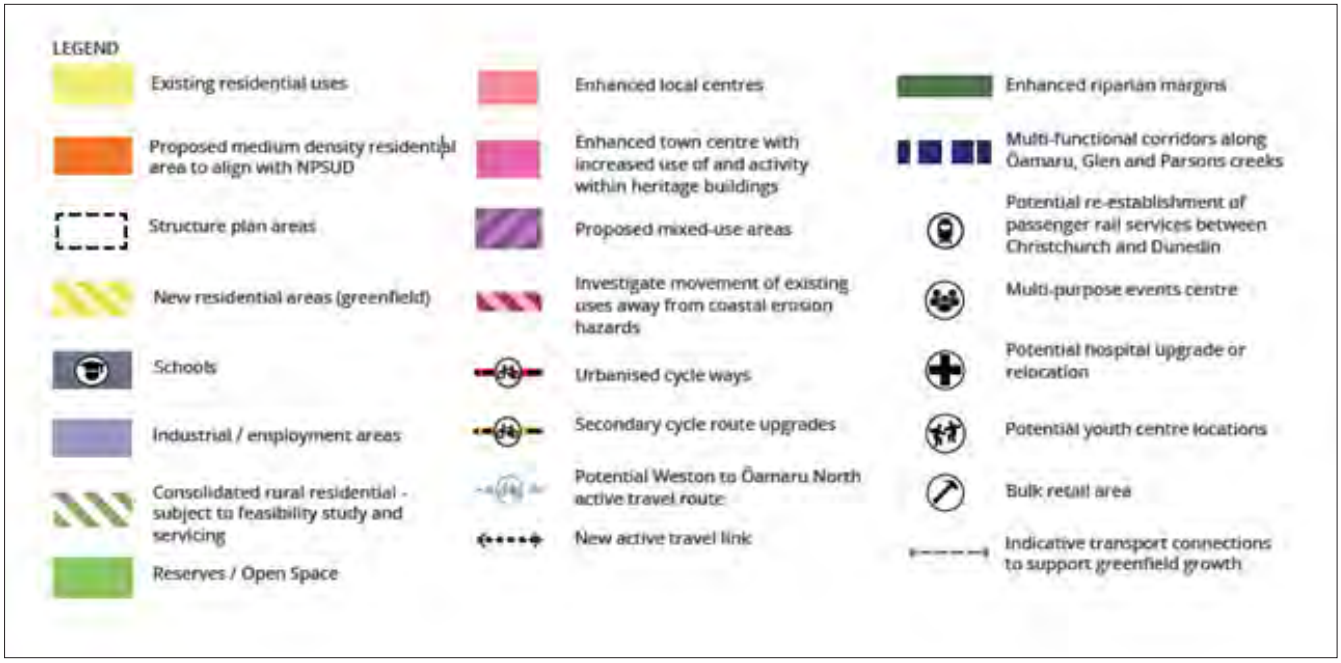




Figure 11. Excerpt from Waitaki District Council's spatial plan showing location of blue and green infrastructure.

6.10 Waimakariri District Council

The Waimakariri District Council adopted a vision for a project based on the concept of BGN in 2021. The Arohatia te Awa – Cherish the River project aims to offer a range of ES across the district by using waterways as corridors.

To enable strategic focus for the project, a "biodiversity project viewer" has been developed to show features of interest on a map and understand how they could link up to form a BGN. The features of interest include protected habitats and ecosystems, pest and rare species records, biodiversity projects, such as restoration projects, existing parks, greenspaces, waterways and so on. The project is ongoing and supported in the council's Waimakariri Natural Environment Strategy (Waimakariri District Council, 2024).

One of the strategy's desired outcomes is that *"The District's natural ecosystems are self-sustaining, healthy, resilient and connected from the mountains to the sea"*. The strategy's Implementation Plan includes several actions aimed at protecting, maintaining, enhancing and restoring the natural environment and providing ES for the district. There is support for the creation of BGN as a mechanism to alleviate fragmentation. Action 4.2.4.1 promotes landscape corridors and ki uta ki tai whilst a number of actions note the importance of ecological linkages in urban areas. Action 4.1.1.4 mandates staff to lead the development of a Canterbury region BGN as part of the Canterbury Climate Change Partnership Plan.

7. Case Study: The United Kingdom

In the UK, work undertaken 15 years ago noted that to enable the health of the environment, ecosystems and people, vast changes were required.

This culminated in the "Lawton Report" documenting the need to make space for nature and create more, bigger, better, joined up natural areas (Lawton, 2010). This work also highlighted that although identification and protection of the most precious areas of natural significance over the last 70 years was admirable and important, it was not enough conserve biodiversity and allow nature to thrive. This realisation enabled the Nature Recovery Network concept and the Government Environmental Improvement Plan (DEFRA, 2023) to link nature conservation with climate change mitigation and adaptation, public health and wealth.

This vision has many goals and actions, one being "Green Infrastructure", a holistic view of reaching ecosystem resilience and the provision of ES including the integration of society with the creation of green jobs, private finance for nature and biodiversity net gain. There are 15 guiding principles of Green Infrastructure, illustrated in Figure 12.

To enable delivery of the principles, Natural England have created 5 Green Infrastructure Standards that aim to *"define what good green infrastructure 'looks like' for local planners, developers, parks and greenspace managers and communities, and how to plan it strategically to deliver multiple benefits for people and nature" (Natural England, 2023a)*. The standards include: S1: Green Infrastructure Strategy Standard; S2: Accessible Greenspace Standard; S3: Urban Nature Recovery Standard; S4: Urban Greening Factor Standard; and S5: Urban Tree Canopy Cover Standard.

The standards are further supported by a Green Infrastructure Design Guide which illustrates how to use the framework, including the principles and standards, how to design areas (such as green roofs, rain gardens etc) and integrate different areas of green infrastructure into a larger network. The document discusses NbS in different urban settings (such as a residential area or commercial area) and within a rural context to build meaningful BGN across the landscape (Figure 13).

Green infrastructure principles wheel

The 15 Principles are based on:

- The 5 benefits of GI or 'Why Principles'
- The 5 Descriptive or 'What' Principles
- The 5 Process or 'How' Principles.

How:
- How to do good GI
- The 5 process Principles.

What:
- What good GI looks like
- The 5 Descriptive Principles.

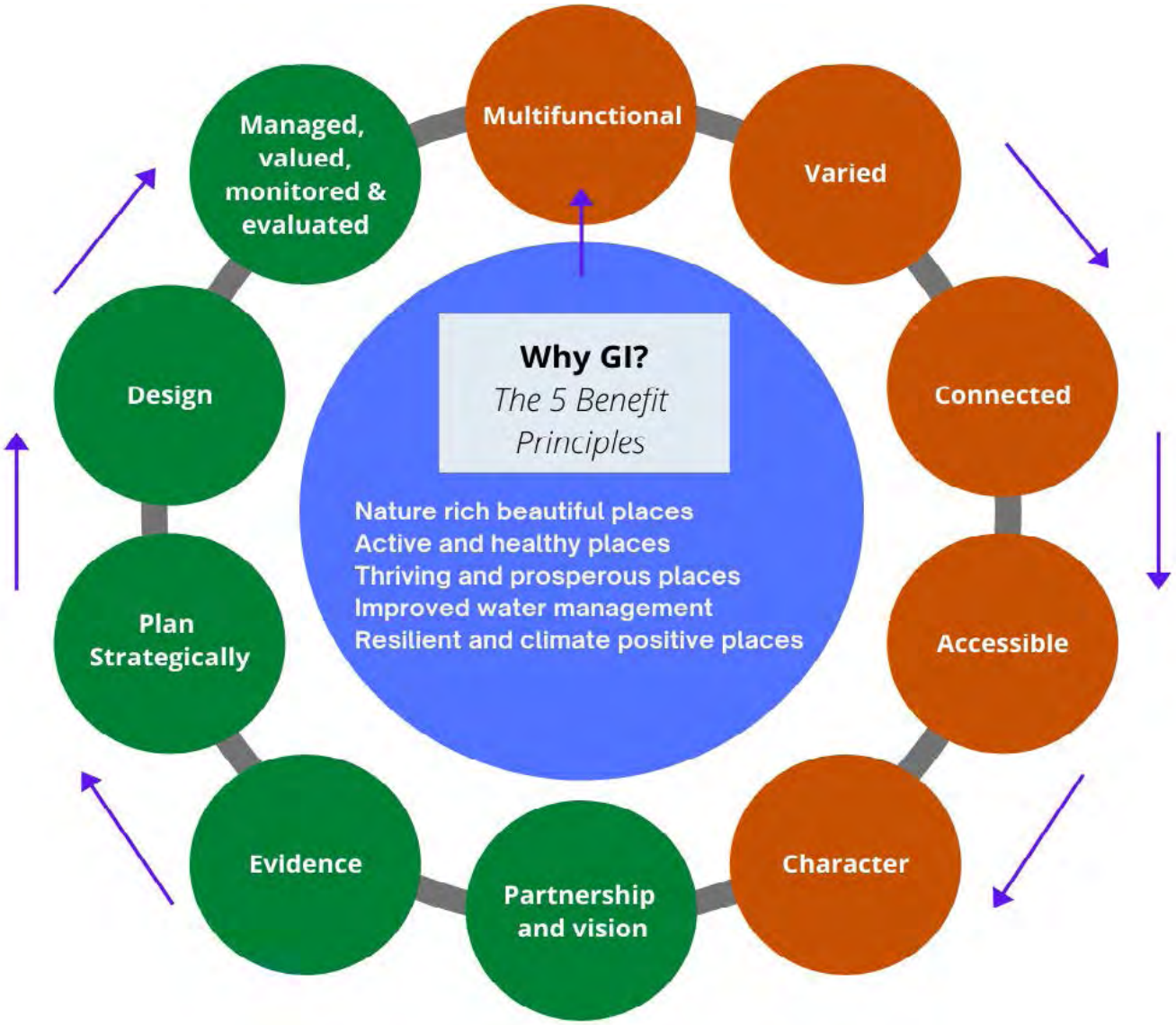


Figure 12. Green infrastructure principles developed in the UK (Natural England, 2023a).

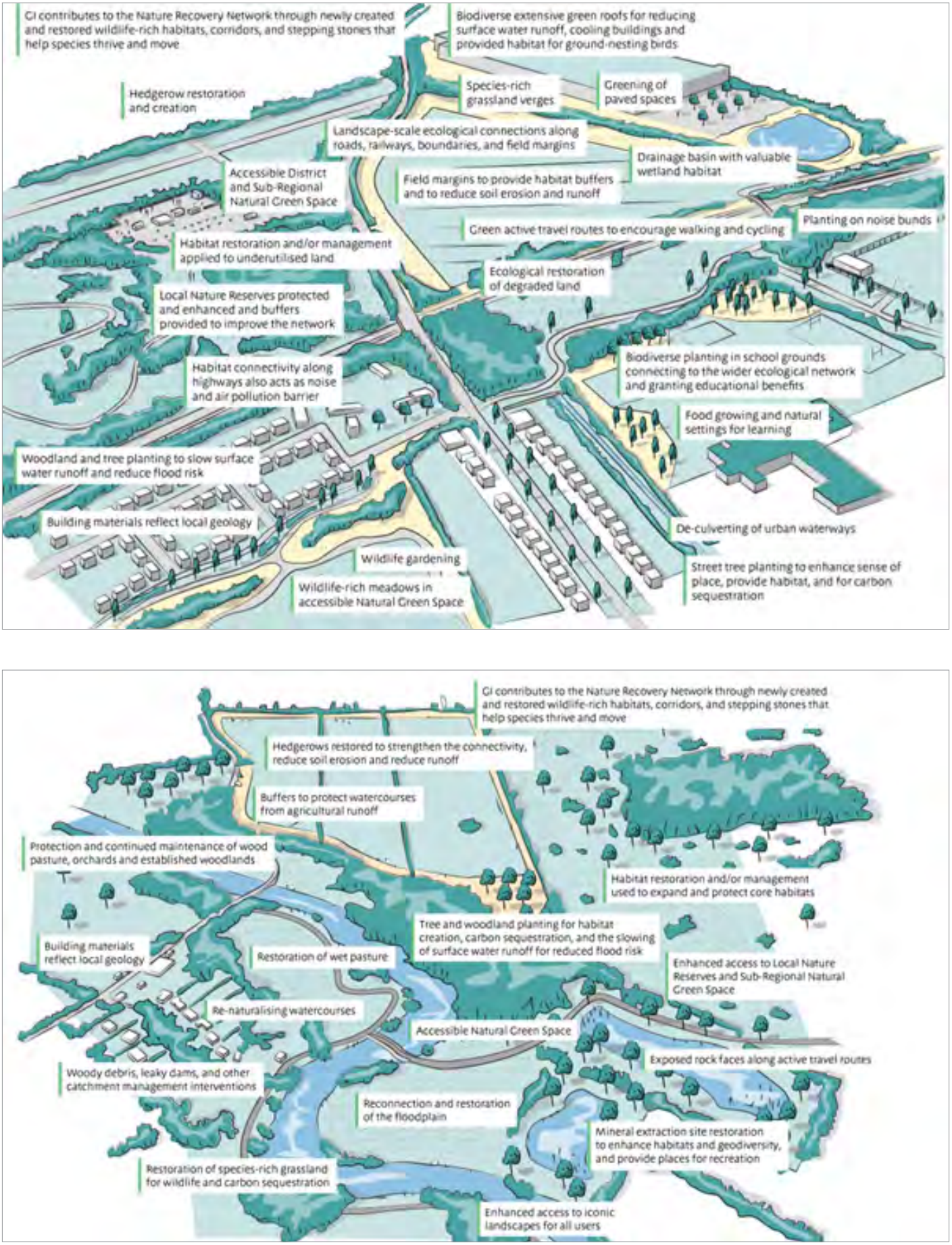


Figure 13. BGN in an urban area (above) and rural area (below) as depicted by Natural England, UK (Natural England, 2023b).

The design guide also includes concepts taken from national policy documents such as the ten characteristics of well–designed places outlined in national governmental documents and how to achieve these (Natural England, 2023b; Figure 14).

There are several tools to assist in the creation and delivery of green infrastructure. One of the tools to implement the ideas of the above plan was the creation of mapping software to guide decisions.

Natural England have commissioned a map to illustrate the blue and green infrastructure across the country (Natural England, 2024; Figure 15).

It includes layers which show publicly accessible land and waterways plus those on private land and layers other data such as air quality, urban flood protection, urban heat management, recreation, food production, urban habitat maps and socio–economic statistics. The map is a key tool to assist with the implementation of the Green Infrastructure Framework which aims to increase the green cover to 40% in urban areas. This framework aims to increase urban greenspace, support urban nature recovery, increase the canopy cover and provide quality, accessible greenspace within 15 minutes' walk.

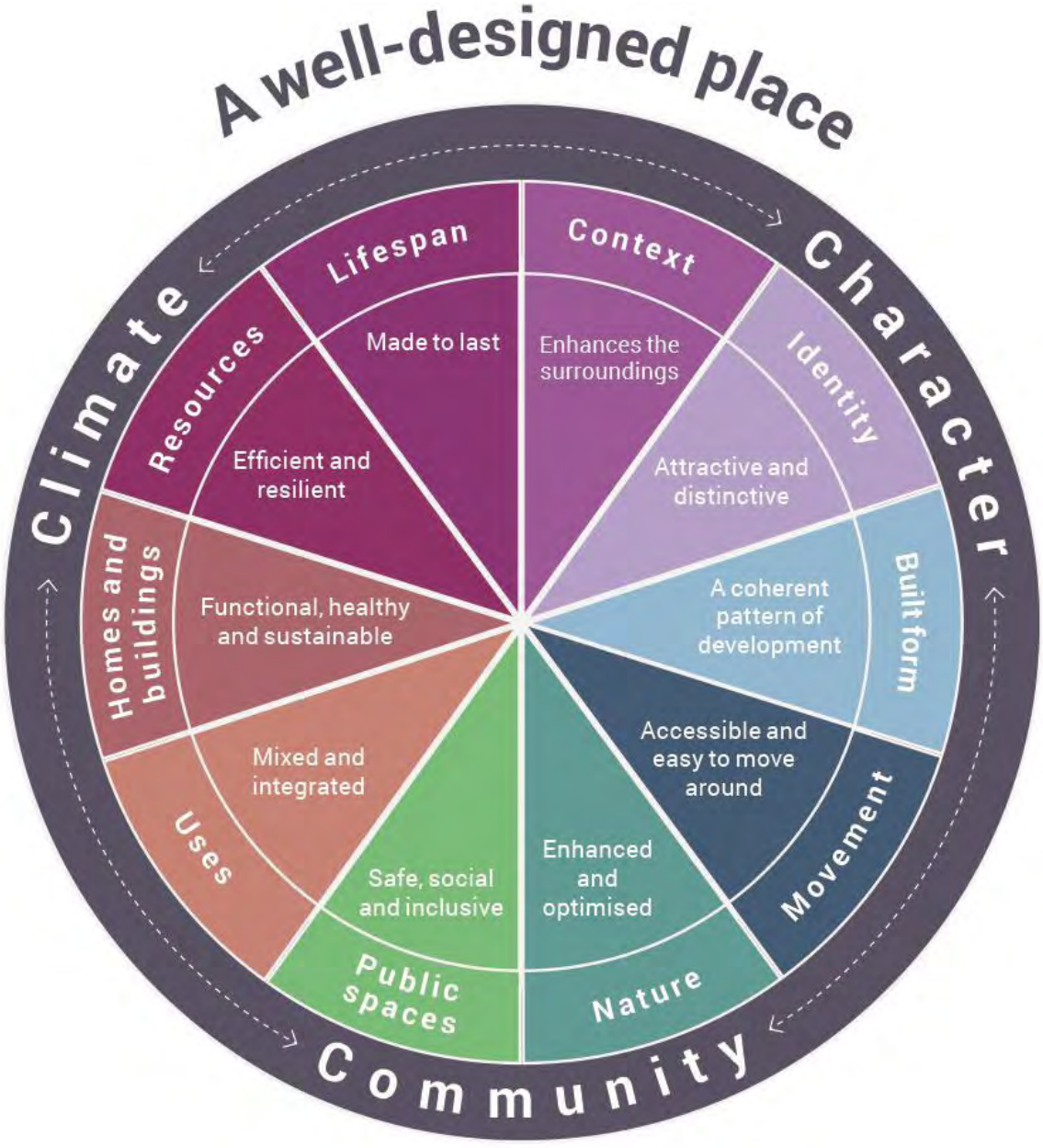


Figure 14. Aspects of a well-deigned place as cited by the UK government (taken from Natural England, 2023b).

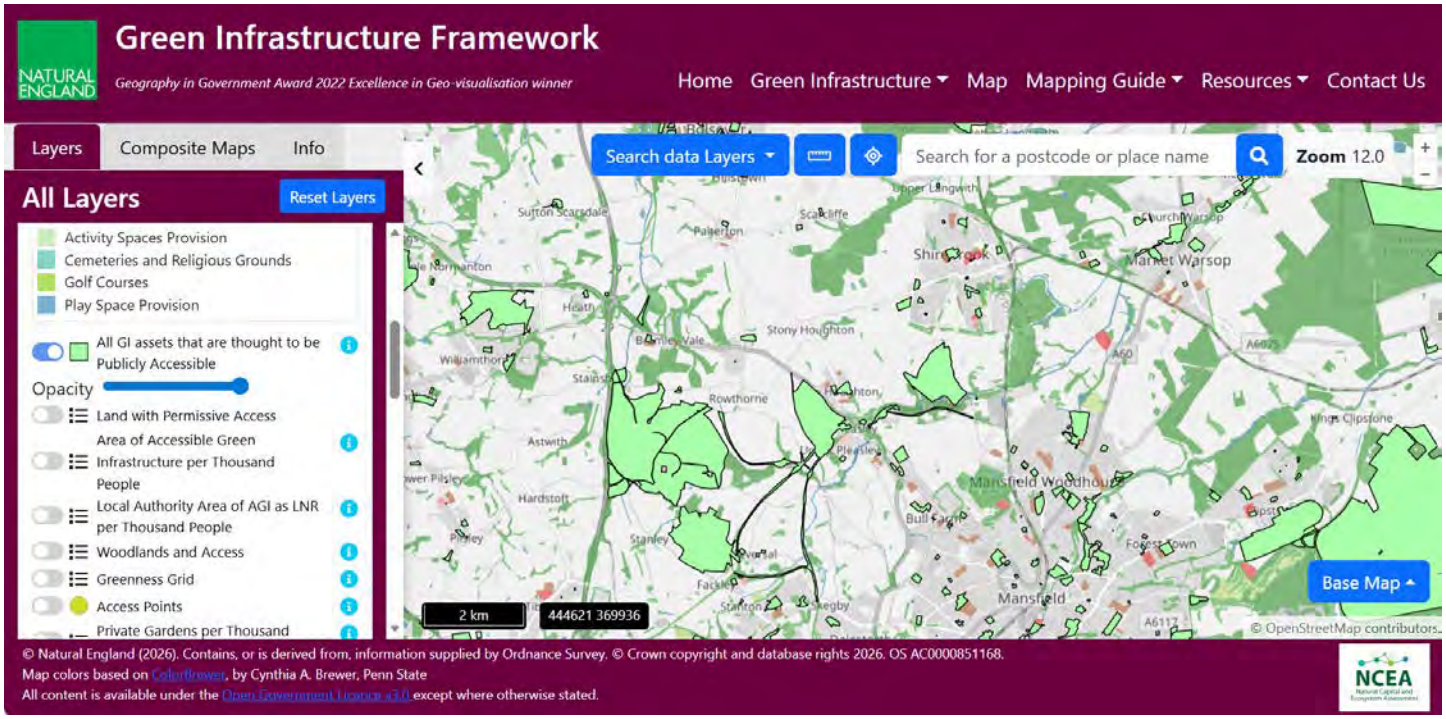


Figure 15. A mapping tool developed by Natural England showing the green and blue infrastructure of the country (Natural England, 2025).



Queen Elizabeth Olympic Park, London, England

Sitting alongside the Green Infrastructure map is the Environmental Benefits from Nature tool (Natural England, 2025). This tool is similar to the Biodiversity Net Gain tool, a designed excel spreadsheet which can calculate the amount of biodiversity net gain or loss of a particular project as set out in the UK's legislation (The Environment Act, 2021 stipulates at least 10% biodiversity net gain for every development to be maintained over 30 years).

This tool uses various data as a proxy for ES (Appendix 1). The user must input the habitats/land use of the site prior to development and post development which yields a results page outlining which ES will decline, remain static or increase (Figure 16).

This allows users to test potential scenarios to ensure that the ES required in an area will be delivered by the proposed development.

At a local level and involving communities directly, local authorities have produced interactive maps where people can log and map their ideas for enhancements in the local area. The Kent Wildlife Trust has this map on their website (Kent County Council, 2025; Figure 17). Individuals, communities and organisations can suggest what actions should be taken and why in various locations under a range of priority types.

Potential impacts of on-site and off-site habitat change at three time points (not cumulative): Whole area

Select area of interest:	Change				
Whole area	**1 year**	**10 year**	**30 year**	**Confidence**	**Interpretation** Expand Collapse
Food production	→	→	→	2	--- Click Expand button for advice on how to improve your results ---
Wood production	→	→	→	2	--- Click Expand button for advice on how to improve your results ---
Fish production	→	→	→	2	
Water supply	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
Flood regulation	→	→	→	1	--- Click Expand button for advice on how to improve your results ---
Erosion protection	→	→	→	1	--- Click Expand button for advice on how to improve your results ---
* **Water quality regulation**	→	→	→	1	--- Click Expand button for advice on how to improve your results ---
* **Carbon storage**	→	→	→	2	--- Click Expand button for advice on how to improve your results ---
Air quality regulation	→	→	→	2	--- Click Expand button for advice on how to improve your results ---
Cooling and shading	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
Noise reduction	→	→	→	2	
Pollination	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
Pest control	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
* **Recreation**	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
Aesthetic value	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
Education	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---
Interaction with nature	→	→	→	1	--- Click Expand button for advice on how to improve your results ---
* **Sense of place**	↘	↘	↘	1	--- Click Expand button for advice on how to improve your results ---

Change in average score per hectare

Large decrease (more than -2.5 points out of 10)	↓
Decrease (-0.25 to -2.5 points out of 10)	↘
Minor change (-0.25 to 0.25 points out of 10)	→
Increase (0.25 to 2.5 points out of 10)	↗
Large increase (more than 2.5 points out of 10)	↑

Confidence ratings for each service

1	The relationship between the provision of the ecosystem service and habitats is complex. Evidence for scoring/multipliers is partial, although may be stronger for some habitats than others. Evidence gaps have been filled by consulting experts and with a degree of subjectivity, particularly for cultural services.
2	We have some suitable evidence to calibrate our range of scores across habitats and multipliers and/ or scoring applied to a limited range of
3	We have a strong evidence base upon which to base scores across the range of habitats and multipliers used for this ecosystem service.

Figure 16. Example of an output page from the Environmental Benefits for Nature Tool developed by Natural England (2025).

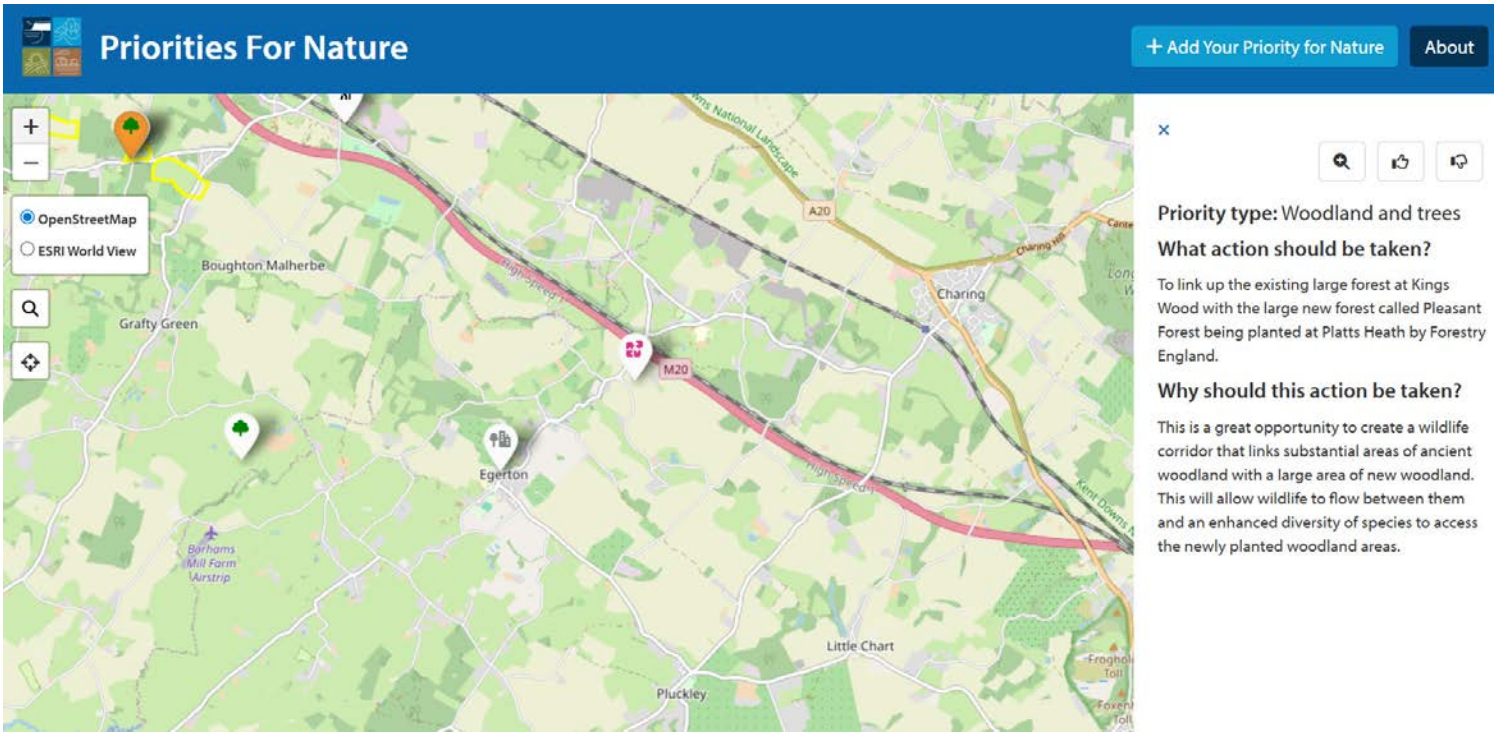


Figure 17. Example of a customisable map where members of the public can log opportunities or threats on a map as suggestions to be added into the BGN. This identifies the local need for NbS (Kent County Council, 2025).



Lake District National Park, Cumbria, England

8. Conclusion

There is no universally agreed definition for NbS or BGN. However, most definitions appear to have similar purpose and meaning. For NbS, there is a need for these to retain the local input and community inclusion to avoid becoming "greenwashing". **Therefore, the recommendation is for the use of the concepts outlined in the IUCN definition, which represents "discreet solutions to societal issues using nature and informed by the local community".**

Similarly, the suite of terms which embody BGN are vast and have slightly different meanings across projects nationally and internationally. **Therefore, it is recommended that BGN is defined as a spatial tool to link NbS across landscapes enabling the flow of ES services and provision within and between individual districts and regions.**

This definition allows for NbS to be tailored to specific localities whilst having the connection of the BGN to provide ES across the landscape and highlight where ES are lacking and required (table 2).

The majority of the BGN projects have incorporated mapping software into their analyses and design. **Therefore, it is recommended that the "design and implementation of a BGN follows best practice from within Aotearoa New Zealand and internationally".** This involves linking up existing natural and semi–natural features (including NbS) which provide ES for the surrounding environment and community whilst confirming areas where certain ES are in demand and require NbS to assist.

Table 2. Recommended definitions for the Canterbury BGN plan

Example Working Definitions	
Blue–green network	The strategic linking of waterways and green infrastructure across the Canterbury region to form corridors and networks that provide for the continued flow of ecosystem services.
Nature–based solutions (NbS)	Solutions that are inspired by and supported by nature, and informed by the local community, that effectively address climate disruption challenges and provide ecosystem services.
Ecosystem services	These describe the benefits, goods and services obtained directly and indirectly from ecosystems. These services are essential to the survival of organisms, including humans. Ecosystem services can be divided into four areas: **Provisioning** Including the supply of consumables such as food, timber, biochemicals and medicines. **Regulating** services such as climate, air quality and water regulation as well as pest and disease control. **Supporting** systems This includes photosynthesis, soil creation and nutrient cycling **Cultural services** Providing a sense of place and meaning, spirituality, recreation, aesthetic values and physical and mental health.

To establish this planning, it is suggested that mapping software uses available data layers to undertake a gap analysis. This can then be workshopped with key stakeholders and local communities to ascertain what NbS would best suit the precise situation in their locality, with an overlay layer to show how these areas link up and help the flow of ES through the landscape. Initial data layers that can be mapped and modelled may include, but are not limited to:

For assessing the exposure and opportunities–

- Existing green and blue infrastructure, both natural and semi–natural, remnant and restored. This data can be gained through local council mapping services of green and blue spaces, mapping of significant natural areas and protected habitats, land use mapping software
- Land ownership to identify where public land can be utilised to offer enhanced ES
- Any sensitive ecosystem data (such as the Ecosystem Climate Change Risk Vulnerability Assessment)
- Cultural importance and features of interest data (as advised by tangata whenua and other community groups)
- ES map layer, using a proxy if needed (as was used in the UK case study) showing where ES are being produced
- Soils data for agricultural production information
- Air pollution data
- Shading data
- Community facility data
- Fish barrier data
- Species distribution data.

For assessing the risk–

- Urban resilience software or flooding, coastal erosion, sea level rise etc data for climate change scenarios
- Socio–economic and census data where available.

Using this data, corridors of ecosystem flow or demand may be perceived and can be used as a starting point for conversations within local communities. Consultation will be of paramount importance to determine what NbS are required, acceptable, and achievable. A series of workshops and/or open access maps to allow local communities to annotate their views, needs and desires would feed into the NbS project. This will enable connected BGN to evolve in a meaningful manner.

Further work to establish principles, standards and design manuals is recommended, as produced in the UK. This would allow for the development and verification of true benefits to local communities and the wider area, linking nature and ES across district and regional boundaries efficiently. This work can be achieved alongside the initial planning work which aims to establish the need for, and hence the location of, BGN and discreet NbS.



Jurassic Coast, Dorset, England

9. References

Albert, C., Schröter, B., Haase, D., Brillinger, M., Henze, J., Herrmann, S., ... & Matzdorf, B. (2019). Addressing societal challenges through nature-based solutions: How can landscape planning and governance research contribute? *Landscape and urban planning*, **182**, 12-21.

Alves A, Gersonius B, Kapelan Z, Vojinovic Z, Sanchez A. (2019). Assessing the Co-Benefits of green-blue-grey infrastructure for sustainable urban flood risk management. *J. Environ. Manage.* **239**, 244–254.

Ashburton District Council (2024) *Our Natural Place: Ashburton District Biodiversity Strategy 2024*. Retrieved January 2025 from: https://www.ashburtondc.govt.nz/__data/assets/pdf_file/0034/94894/22262-Final-Biodiversity-Strategy-webversion.pdf

Ashburton District Council (2016). *Open Spaces Strategy 2016-2026*. Retrieved January 2025 from: https://www.ashburtondc.govt.nz/__data/assets/pdf_file/0015/4353/Open-Spaces-Strategy-2016.pdf

Auckland Council (2024) *Enabling Blue–Green Networks*. Retrieved January 2025 from: https://www.aucklandcouncil.govt.nz/environment/looking-after-aucklands-water/Documents/blue-green-networks.pdf

Azadgar, A., Luciani, G., & Nyka, L. (2025). Spatial allocation of nature-based solutions in the form of public green infrastructure in relation to the socio-economic district profile–a GIS-based comparative study of Gdańsk and Rome. *Land Use Policy*, **150**, 107454.

Boffa Miskell Limited, (2024). *Nature-based Solutions for Climate Adaptation: Roadmap for scaling use in Aotearoa New Zealand*. Ministry for the Environment, Wellington.

Christchurch City Council (2024). *Ōtautahi Christchurch Planning Programme - Draft*. Christchurch City Council, Christchurch.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). *Nature-based solutions to address global societal challenges*. IUCN: Gland, Switzerland, 97, 2016-2036.

Collier, M. J., Frantzeskaki, N., Connop, S., Dick, G., Dumitru, A., Dziubała, A., ... & Xidous, D. (2023). An integrated process for planning, delivery, and stewardship of urban nature-based solutions: The Connecting Nature Framework. *Nature-Based Solutions*, **3**, 100060.

DEFRA (2023). *Environmental Improvement Plan 2023: First Revision of the 25 Year Environment Plan*. Retrieved January 2025 from: https://assets.publishing.service.gov.uk/media/64a6d9c1c531eb000c64fffa/environmental-improvement-plan-2023.pdf

Dang, A. (2024) *Rolleston Ecosystem Services Case Study*. Retrieved January 2025 from: https://storymaps.arcgis.com/stories/a693e0ee284b41a888fa529cb6792ff2

European commission. (2025). *Green infrastructure*. Retrieved January 2025 from: https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure_en (accessed 11/02/2025). European Commission: Directorate-General for Research and Innovation (2015). *Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities – Final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' – (full version)*, Publications Office, https://data.europa.eu/doi/10.2777/479582

Greater Christchurch Partnership (2024). *Greater Christchurch Partnership Spatial Plan*. Retrieved January 2025 from: https://www.greaterchristchurch.org.nz/assets/Documents/Work-Programme/Greater-Christchurch-Spatial-Plan/Greater-Christchurch-Spatial-Plan-2024.pdf

IUCN (2020). *Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition*. Gland, Switzerland: IUCN.

IUCN (2016). *WCC-2016-Res-069-EN Defining Nature-based Solutions*. Retrieved January 2025 from: www.iucn.org/sites/dev/files/content/documents/wcc_2016_res_069_en.pdf

Jackson, B, Pagella, T, Sinclair, F, Orellana, B, Henshaw, A, McIntyre, N, Reynolds, B, Wheater, H, Eycott, A (2013). Polyscape: a GIS mapping toolbox providing efficient and spatially explicit landscape-scale valuation of multiple ecosystem services, *Urban and Landscape Planning* **112**, 74-88.

Kaikōura District Council (2024) *Kaikōura Spatial Plan: Draft for Public Consideration Under the Special Consultative Process of The Local Government Act 2002*. Retrieved January 2025 from: https://www.kaikoura.

govt.nz/repository/libraries/id:2i17fvyhr17q9scmy0d8/hierarchy/Council/Spatial%20Plan%202024/Draft%20Kaikoura%20Spatial%20Plan%20-%20Consultation%20Version.pdf

Kent County Council (2025) *Priorities for Nature Map*. Retrieved January 2025 from: https://webapps.kwtg.uk/priorities_for_nature/

Langemeyer, J., Baró, F. (2021) Nature-based solutions as nodes of green-blue infrastructure networks: A cross-scale, co-creation approach. *Nature-Based Solutions*, Volume 1.

Lawton, J. H., Brotherton, P. N. M., Brown, V. K., Elphick, C., Fitter, A. H., Forshaw, J., ... & Wynne, G. R. (2010). *Making space for nature: a review of England's wildlife sites and ecological network*. Report to Defra. Defra, London, UK.

Mackenzie District Council (2024a). *Responding to Climate Change*. Retrieved January 2025 from: https://letstalk.mackenzie.govt.nz/climate-change-2024

Mackenzie District Council (2024b). *Adapting to the impacts of climate change in the Mackenzie District; Factsheet*. Retrieved January 2025 from: https://letstalk.mackenzie.govt.nz/91957/widgets/429885/documents/287750

Mercier, K. (2023). *Sponge cities: can they help us survive more intense rainfall*? Retrieved January 2025 from: https://helenclark.foundation/publications-and-medias/sponge-cities/

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Current State and trends, Volume 1* (R. Hassan, R. Scholes, & N. Ash Eds.). Washington, United States of America: Island Press.

Ministry for the Environment. (2022). *Aotearoa New Zealand's first national adaptation plan*. Wellington. Ministry for the Environment.

Morris, R., Davis, S., Grelet, G. A., Doscher, C., & Gregorini, P. (2024). A model for spatially explicit landscape configuration and ecosystem service performance, ESMAX: model description and explanation. *Sustainability*, **16**(2), 876.

Natural England (2025). *The Environmental Benefits from Nature Tool - Beta Test Version (JP038)*. Retrieved January 2025 from: https://publications.naturalengland.org.uk/publication/6414097026646016

Natural England (2024) *Green Infrastructure Map*. Retrieved January 2025 from: https://designatedsites.naturalengland.org.uk/GreenInfrastructure/Map.aspx

Natural England (2023a). *Green Infrastructure Standards for England - Summary Green Infrastructure Framework - Principles and Standards for England. Version: 1.1*. Natural England. London UK



North York Moors National Park, North Yorkshire, England

Natural England (2023b). *Green infrastructure planning and design guide*. Designing nature-rich, healthy, climate-resilient, and thriving places. Natural England. London UK

Parliamentary Office of Science and Technology, 2011. *The Ecosystem Approach*. Houses of Parliament Post Note, No. 377. Retrieved December 2024 from: https://www.parliament.uk/globalassets/documents/post/postpn_377-ecosystem-approach.pdf

Pauleit S, Ambrose-Oji B, Andersson E et al. (2019). Advancing urban green infrastructure in Europe: outcomes and reflections from the GREEN SURGE project. *Urban Forestry & Urban Greening*; **40**:4–16.

Queenstown Lakes District Council & Boffa Miskell (2025). Blue Green Network: Draft for Consultation. Retrieved May 2026 from: https://letstalk.qldc.govt.nz/88529/widgets/415958/documents/316213

Remme, R. P., Meacham, M., Pellowe, K. E., Andersson, E., Guerry, A. D., Janke, B., ... & van Oudenhoven, A. P. (2024). Aligning nature-based solutions with ecosystem services in the urban century. *Ecosystem Services*, **66**, 101610.

Secretariat of the Convention on Biological Diversity (2004). The Ecosystem Approach, (*CBD Guidelines*). Montreal: Secretariat of the Convention on Biological Diversity 50 p.

Seddon, N., Turner, B., Berry, P., Chausson, A., & Girardin, C. A. J. (2019). Grounding nature-based climate solutions in sound biodiversity science. *Nature Climate Change*, **9**, 84–87. doi.org/10.1038/ s41558-019-0405-0

Selwyn District Council (2024). *Mapping the blue-green benefits of ecosystem services in Rolleston*. Retrieved January 2025 from: https://www.selwyn.govt.nz/news-And-events/news/mapping-the-blue-green-benefits-of-ecosystem-services-in-rolleston

Timaru District Council (2024). *Timaru City Town Masterplan*. Retrieved January 2025 from: https://static1.squarespace.com/static/629e83e6efaa6a648afcf692/t/66e8a898f72bce10eb65f71b/1726523587249/Timaru+CityTown+Masterplan.pdf

United Nations (2024). *Nature-based solutions*. Retrieved December 2024 from: https://www.unepfi.org/nature/nature/nature-based-solutions/

van Oorschot, J., Slootweg, M., Remme, R.P. et al. (2024) Optimizing green and gray infrastructure planning for sustainable urban development. *Urban Sustain*, **4**, 41.

Veerkamp, C. J., Schipper, A. M., Hedlund, K., Lazarova, T., Nordin, A., & Hanson, H. I. (2021). A review of studies assessing ecosystem services provided by urban green and blue infrastructure. *Ecosystem Services*, **52**, 101367.

Waimakariri District Council (2024). *Waimakariri Natural Environment Strategy; Implementation Plan*. Retrieved January 2025 from: https://www.waimakariri.govt.nz/__data/assets/pdf_file/0030/167691/240607092509-FINAL-Natural-Environment-Strategy-Implementation-Plan-Print-version-saved-as-rendition.pdf

Waimate District Council (2024). *Climate Resilience Strategy Pathway*. Retrieved January 2025 from: https://www.waimatedc.govt.nz/repository/libraries/id:21r92ide017q9sg7je9s/hierarchy/Documents/Community/Climate%20change/WDC%20Climate%20Resilience%20Strategy%20Pathway%202024-03.pdf

Waitaki District Council (2022). *Ōamaru Weston & Kakanui Spatial Plan*. Retrieved January 2025 from: https://www.waitaki.govt.nz/files/assets/public/v/2/files/our-district/spatial-plan/final-oamaru-spatial-plan-may-2022.pdf

Waitaki District Council (2014). *Waitaki District Biodiversity Strategy 2014 – 2017*. Retrieved January 2025 from: https://www.waitaki.govt.nz/files/assets/public/v/1/files/our-council/plans-reports-and-strategies/our-strategies/waitaki-district-indigenous-biodiversity-strategy.pdf

Whangārei District Council (2016) *Blue/Green Network Strategy For Whangārei City*. Retrieved January 2024 from: https://www.wdc.govt.nz/files/assets/public/v/1/documents/council/strategies/blue-green-network-strategy.pdf

Whangārei District Council (2024) *Blue-Green Network Programme Dashboard*. Retrieved January 2025 from: https://wdc.maps.arcgis.com/apps/webappviewer/index.html?id=4b62c3ac661a4ca6aa9c019c731cc50f

Wellington City Council (2022). *Wellington Central City Green Network Plan*. Retrieved January 2025 from: https://wellington.govt.nz/-/media/your-council/plans-policies-and-bylaws/plans-and-policies/a-to-z/green-network/wellington-city-council-green-network-plan.pdf?la=en&hash=B228FD7F2F5FA8A67AA5B84F4D4ADE35923913D1

Wellington City Council (2015). *Our Natural Capital. Wellington's biodiversity strategy and action plan 2015*. Retrieved January 2025 from: https://wellington.govt.nz/-/media/your-council/plans-policies-and-bylaws/plans-and-policies/a-to-z/biodiversity/our-natural-capital.pdf?la=en&hash=86A79DC5100753D9C36A32B6C02A68EEA55C88C7

Xi, C., Ding, J., Wang, J., Feng, Z., & Cao, S. J. (2022). Nature-based solution of greenery configuration design by comprehensive benefit evaluation of microclimate environment and carbon sequestration. *Energy and Buildings*, **270**, 112264.



Ashburton Lakes, Canterbury

10. Appendix 1

The data sets used as a proxy for ES used by the UK's Environmental Benefit for Nature tool (adapted from Natural England, 2025).

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
1	Agricultural land class	Basic	Food provision	Supply	Online map	Natural England Green Infrastructure data portal	Agricultural Land Class is displayed as a data layer under EBNT Supply/Demand Data layers at the bottom of the left menu. Mapped ALC classes can be seen by clicking on the EBNT data layers to open the data list and activating the toggle. Higher grades are shown in green, lower grade land in red.
2	Surface water availability	Basic	Water supply	Demand	Online map	Natural England Green Infrastructure data portal	Environment Agency Water resource availability and abstraction reliability cycle 2 data is displayed as a data layer under EBNT Supply/Demand Data layers at the bottom of the left menu. Areas of high surface water availability are shown green, low in red. If your site is in more than one different category, either choose the most restricted of those categories, or assign different categories to different parts of the site.
3	Groundwater availability	Basic	Water supply	Demand	Online map	Natural England Green Infrastructure data portal	Environment Agency Groundwater availability is displayed as a data layer under EBNT Supply/ Demand Data layers at the bottom of the left menu. Areas categorised high or good under quantitative categorisation are shown in green. Those rated poor in red. If your site is in more than one different category, either choose the most restricted of those categories, or assign different categories to different parts of the site.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
4	Natural flood management priority	Basic	Flood regulation	Demand	Online map	Natural England Green Infrastructure data portal	Spatial Prioritisation of catchments suitable for using Natural Flood management is displayed as a data layer under EBNT Supply/Demand Data layers. Determine the NFM priority that applies to your project area (High, Medium, or Low). If no priority is shown mark as NK (Not Known) or follow the instructions below (as appropriate). Enter this in the EBN dropdown box. If your area is within two or more different sub–catchments, enter the relevant option for each habitat parcel.
7	Water quality: wfd status	Basic	Fish production	Supply	Online map	Natural England Green Infrastructure data portal	Water framework directive (wfd) ecological status is displayed as a joint data layer under ebnt supply/ demand data layer at the bottom of the left menu. Note this replaces previous instruction to consider overall status.
8	Water quality management area	Basic	Water quality regulation	Demand	Online map	Natural England Green Infrastructure data portal	Water quality management area data is displayed as a data layer under ebnt supply/demand data layer at the bottom of the left menu. Note this version only includes high areas.
9	Rainfall	Basic	Soil erosion protection	Demand	Online map	Natural England Green Infrastructure data portal	Met office rainfall data is as a data layer under ebnt supply/demand data layers at the bottom of the left menu. Note the information displayed differs from the beta version which requested days of winter rainfall, which this supersedes.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
10	Slope	Advanced	Water supply (not yet) erosion protection	Supply demand	Online map	UK Soil Observatory	Find your site on the UK Soil Observatory website. Click on the plus button in the top right of the screen to add layers to the map. Scroll down to the bottom of the list of layers to find the 'Surface' group and add 'OS Terrain 50 Slope'. Click on the darkest shaded pixel to find the maximum slope, then enter the appropriate range. You can autofill the whole column unless the slope band varies across the site, in which case GIS will probably be needed.
11	Soil drainage	Basic	Water supply (flood regulation– not yet)	Supply and demand	Online map	LANDIS soilscapes	LANDIS Soilscapes. Zoom into your project area and click on the map to display a summary of soil characteristics. Drainage categories are Freely draining/ Slightly impeded drainage / Impeded drainage / Surface wetness (peat) / Naturally wet (high groundwater) / Impermeable / sealed.
12	Soil erodibility	Standard	Erosion protection	Demand	Online map	LANDIS soilscapes	If you have access to NSRI NATMAP (not free) or a hardcopy soil map, find the soil association on your site then check erodibility in Appendix 2 of the Data Catalogue. For very high or high susceptibility enter 'high'; for very low or low enter 'low'; for moderate enter medium. Otherwise, refer to Landis to see if erosion is mentioned as a problem in the section on Water Protection: if mentioned, enter high, otherwise moderate.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
13	Soil compaction	Advanced	Water supply Flood regulation Water quality regulation	Supply and demand	Site survey or local knowledge	N/A	Site survey, looking for signs of soil compaction such as bare, hard ground that does not absorb water when poured from a bottle, or vehicle tracks. Compaction could be inferred from land use to some extent, e.g. grazing density, use of heavy machinery / vehicles. Select from: Good condition / slightly compacted or locally compacted / highly compacted.
14	Soil management	Advanced	Erosion protection Water quality regulation	Supply	Local knowledge	N/A	Enter 'yes' if soil erosion management practices are used on arable land (e.g. cover crops, crop residue, contour ploughing, no-till).
15	Peat quality	Standard	Carbon storage Water quality Erosion protection	Supply	Site survey	N/A	Site survey (or pre-existing local knowledge) to determine whether peat is actively growing or degraded. Natural England also hold data on moorland peat but it is not freely available.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
17	Canopy cover	Standard	Flood regulation Carbon storage Air quality regulation Shading and cooling	Supply	Aerial photos	Google Earth or up to date aerial photos	Rough estimate of % canopy cover (<25%, 25–50%, 50–75%, >75%) either from site visit or from quadrat analysis of a grid of points overlaid on aerial photos / Google Earth. Could also use: https://www.blueskymapshop.com/products/national-tree-map (crown diameter, approx. £90/km2). For new planting enter the intended canopy cover after 40 years.
18	Tree size	Standard	Carbon storage Shading and cooling Aesthetic value Education Interaction with nature	Supply	Site survey (non-expert)	N/A	For existing woodland, identify the largest class of trees present on site: Saplings <7cm diameter at breast height (dbh) Poles 7–35cm (larger than a can of beans) Mature 35–80cm (hides a thin person) Veteran >80cm (larger than a hug) Coppice The National Forest Inventory identifies areas of young or coppiced trees and felled woodland (separate habitat type). Individual trees outside woodland should be identified separately (at least for veteran trees). For new (created) woodland, enter 'saplings' and the tool will assume that these grow into poles after 30 years.
19	Ground cover	Advanced	Flood regulation Erosion protection Water quality regulation	Supply	Site survey (non-expert)	N/A	Estimate the rough percentage of ground that is covered by vegetation or thick leaf litter as opposed to bare patches (ignoring small bare patches a few cm wide). Select from the options: <30%; 30–70%; 70–100%; bare in winter (e.g. for arable land).

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
20	Tall or tussocky grasses	Advanced	Flood regulation Erosion protection Water quality regulation Interaction with nature	Supply	Site survey (non-expert)	N/A	Estimate whether cover by tall or tussocky grasses is absent (<5% cover), present (5–33%) or extensive (>33%).
21	Shrub layer	Advanced	Flood regulation Erosion protection Interaction with nature	Supply	Site survey (non-expert)	N/A	Estimate the extent of any shrubby layer (understorey in woodland habitats; scattered shrub in open habitats such as grassland or heathland). Select from absent (<5% cover), present (5–33%) or extensive (>33%).
22	Flowers	Advanced	Pollination Pest control Aesthetic value Interaction with nature	Supply	Site survey (expert)	N/A	The estimate should be based on a site survey in summer, or prior knowledge of the site. Enter 'High' if the abundance or diversity of flowering plants are greater than expected for a typical UK example of this type of habitat, or 'Low' if lower than expected. Otherwise enter 'Medium'. We are aware that these are not very precise instructions and will try to make them more precise in due course.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
23	Invertebrate nest sites	Advanced	Pollination Pest control Interaction with nature	Supply	Site survey (non–expert)	N/A	Enter 'high' if at least one of the following applies: Standing or fallen dead wood is visible from at least half of the walkover route (this includes dead trees or stumps over 1m tall and 20cm diameter, fallen logs or large dead branches at least 50cmm long and 20cm diameter and dead wood on live trees, following the Forestry Commission Woodland Condition Survey criteria): • Beetle banks or dry earth are visible from at least a quarter of the walkover route • The site includes one or more veteran trees (larger than a hug) with cavities, hollow trunks, crevices or loose or flaking bark • Tall or tussocky grasses cover at least 33% of the site • A shrub layer covers at least 33% of the site. Enter 'medium' if some of these features are present but they do not meet the abundance criteria, and enter 'low' if none apply.
24	Resources for local species	Advanced	Interaction with nature Sense of place	Supply	Site survey or local knowledge	N/A	Presence and abundance of specific resources for characteristic local species, e.g. larval food plants for specialist butterflies and other invertebrates; nesting sites for bats and birds associated with sense of place. Establish which species are important locally, and what their habitat requirements are. Establish whether these requirements are present on the site, through a survey or through asking local experts & provide assessment whether association is weaker or stronger. New developments might want to consider including these requirements in order to increase the value of their sites.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
25	Position for water quality regulation	Advanced	Water quality regulation	Supply and Demand	Site survey (non–expert), Local knowledge, GIS, online map.	Environment Agency Catchment Data Explorer website	Is the habitat located on the flow path between a pollution source (arable field or road) and a water course? See criteria in Data Catalogue. GIS analysis may be needed. Catchment Data Explorer shows watershed boundaries, whether habitat is upstream of a water course, and 'reasons for not achieving good status' to confirm whether agricultural and land management or urban / transport runoff is causing pollution.
26	Position for erosion prevention	Advanced	Erosion protection	Supply and Demand	Site survey (non–expert), Local knowledge, GIS, online map.	Environment Agency Catchment Data Explorer website	Enter 'Yes' if the habitat is on the downwards side of (or level with) a habitat susceptible to erosion (arable field, improved grassland, horticulture, felled woodland, intensive orchard, biofuel crops, flower bed) AND it runs alongside part of the boundary with this erodible habitat or cuts across it roughly parallel to the contours of the slope, so that it is capable of trapping sediment washed off the field. Enter 'Partial ability' if the habitat is does not meet this criteria but you have another good reason to believe it is playing some role in reducing erosion. Otherwise enter 'No'.
27	Air pollution barrier	Advanced	Air quality regulation	Supply and Demand	Site survey (non–expert)	N/A	Enter 'Yes' if the habitat forms a barrier at least 3m tall and at least 3m wide, with reasonably thick vegetation, between a pollution source (e.g. a busy road) and an area used by people (homes, schools, offices, footpaths, parks etc). Enter 'Partial ability' if the barrier does not meet these criteria but you still think it has some value as a pollution barrier. Otherwise enter 'No'.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
28	Shading ability	Advanced	Cooling and shading regulation	Supply and Demand	Site survey (non-expert)	N/A	Enter 'Yes' if the habitat is located on the east, south or west side of a building exposed to sun, and close enough for the shadow to fall on the side of the building at least to half the height of the ground floor windows (assume 30m for trees and woodland; 3m for shrubs and hedges). Enter 'Partial ability' if this does not apply but you have another reason to believe that the habitat provides better shading and cooling ability than a typical habitat of this type, due to its position. Otherwise enter 'N'.
29	Noise barrier	Advanced	Noise reduction	Supply and Demand	Site survey (non-expert)	N/A	Enter 'Barrier' if the vegetation is dense, at least 10m tall and at least 10m wide, and sited between a noise source (e.g. road or rail) and an area used by people. Enter 'Partial barrier' if the vegetation is reasonably thick, at least 3m tall and at least 3m wide, and sited between a noise source (e.g. road or rail) and an area used by people. Enter 'Not barrier but tree/shrub near people' if the habitat is trees or shrubs near people but is not dense enough or is not in the right position to form a barrier. This can include scattered trees, e.g. in parks and gardens or cemeteries. Enter 'Low vegetation near people' for low vegetation (anything that is not trees or shrubs, e.g. grass, heath, marsh, or suburban mosaic, as that includes grass) near people, or beach / dunes. This captures the damping effect of vegetation or soft surfaces that do not form a physical barrier. If the habitat is not near people enter 'Not near people'. Any other habitats that are near people but are not vegetated (e.g. sealed surface, bare ground, rock, or water) score zero and are not applicable for this service, so enter 'NA'.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
30	Population density	Basic	Recreation Education	Demand	Online data	Natural England Green Infrastructure data portal	ONS LSOA population density information is as a data layer under EBNT Supply/Demand Data layers at the bottom of the left menu. Where location overlaps multiple categories use the greatest value shown.
31	Nature designation	Basic	Education Interaction with nature Sense of place	Supply	Online map	Natural England Green Infrastructure data portal	Nature designations are displayed under a single heading under EBNT Supply/Demand Data layers at the bottom of the left menu. The different constituent layers can then be seen with different shading including: SSSIs, SPAs, SACs, National and Local Nature Reserves, National Parks, RAMSAR sites. Marine Protection Zones. Ask Local authorities for District/Local Wildlife Sites. Check presence of priority species within last three years in LERC, NBN or local surveys. Enter the number of designations in the dropdown box: 0, 1, 2, 3 or more (is automatically calculated by the search functionality).
32	Ancient habitat	Basic	Interaction with nature Sense of place	N/A	Online map	Natural England Green Infrastructure data portal	Ancient habitat is displayed under a single heading under EBNT Supply/Demand Data layers at the bottom of the left menu. At present only an ancient woodland inventory is available. Veteran tree (see Woodland Condition Survey criteria are also in Data Catalogue for manual assessment).

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
33	Cultural or historic importance	Basic	Education Sense of place	Supply	Online map and local authority	Natural England Green Infrastructure data portal	Cultural or historic importance data sets are displayed under a single heading under EBNT Supply/Demand Data layers at the bottom of the left menu: Individual datasets search National Parks, AONBs; Historic statutory: Scheduled ancient monuments.; Heritage Coast. Registered battlefields; Registered parks and gardens are displayed. Community Forests and Green Belt are also relevant but are not yet available. Ask Local Authorities for archaeological constraint areas (see also http://www.heritagegateway.org.uk/gateway/chr/default.aspx) Add National Trust areas. Enter the number of designations in the dropdown box: 0, 1, 2, 3 or more (this is automatically calculated by the tool, scores should be manually updated should further information be provided).
34	Special recreation value	Basic	Recreation	Supply	Online map	Natural England Green Infrastructure data portal	Special recreation value data sets are displayed under a single heading under EBNT Supply/Demand Data layers at the bottom of the left menu. Under this heading AONB, National Park and Heritage Coast are displayed if present. If either are present the search tool will enter YES. Enter 'Yes' if it is, or if you have another good reason to believe that it is strategically important for recreation (beyond the typical characteristics of the habitat that would already be taken account of in the basic scores and the other multipliers).

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
35	Public access	Basic	Recreation Interaction with nature	Supply	Online map and local authority	Natural England Green Infrastructure aata portal	Public data sets are displayed under a single heading under EBNT Supply/Demand Data layers at the bottom of the left menu. This shows both public rights of way and Open access areas are identified within the Accessible Green infrastructure dataset. private access (private gardens), no access for recreation (e.g. farmland) are not shown.
36	Educational use	Basic	Education	Supply	Local authority	Natural England Green Infrastructure aata portal	Does the site have special educational value, e.g. use by school groups, use for scientific research, or an information centre? If so, enter 'Special educational value', even if use is restricted to certain groups or to organised visits. If not, enter 'Public access' if it is accessible by the public, or 'No public access' if not.
37	Managed for nature	Basic	Pollination Pest control Education Interaction with nature	Supply	Local knowledge	Natural England Green Infrastructure Data Portal	Agri-environment displayed under a single heading under EBNT Supply/Demand Data layers at the bottom of the left menu. In additional Local enquiries may provide additional information. Is the site managed to preserve or enhance nature? This would include management by a wildlife trust or others outside of Countryside Stewardship or other type of active management with a formal plan to boost biodiversity. Enter Yes or No.

Data set		Level	Used for which ecosystem services	Demand or supply?	Data source type	Link (England)	Guidance for manual entry
38	Local distinctiveness	Standard	Sense of place	Supply	Local authority and local knowledge	LCA Database	Consult the relevant local Landscape Character Assessment (by entering in details to the project details tab) to determine whether the relationship between habitats provided and set out in the LCA is stronger or weaker. Ideally, consult local communities to establish whether the area contains any habitats or natural features of particular local significance, or to which local people are strongly attached. Designation as a Local Green Space reflects special local value even for generic habitats such as amenity grassland.
39	Landscape diversity	Basic	Aesthetic value	Supply	Site plans	N/A	Assess the Landscape diversity of site/proposed work (ideally working with Landscape professionals) to determine whether it is Uniform, Complex, Diverse, Simple (using definitions provided in the Data Catalogue) – uplifts to score will be provided where this matches what is deemed appropriate for the setting (see project details tab).
43	Fish barriers	Advanced	Fish production Interaction with nature	Supply	Site survey (non-expert)	N/A	Presence of fords, culverts, weirs or dams, classified as impassable to fish, passable high-impact or passable medium-impact (see criteria in Data Catalogue, based on the height of any vertical drop, or the length and angle of sloping structures).
44	Water body naturalness	Standard	Fish production Sense of place Interaction with nature Aesthetic value Flood protection Water quality regulation	Supply	Site survey	Environment Agency Catchment Data Explorer	Enter whether the river is salmonid, near natural, modified, heavily modified or has an artificial substrate or flows in a culvert. Catchment Data Explorer will tell you whether or not it is heavily modified. See Data Catalogue for more info.



Arthur's Pass National Park, Canterbury

