

Swansea Central Area - Regenerating Our City for Wellbeing and Wildlife

August 2019

CONSULTATION DRAFT





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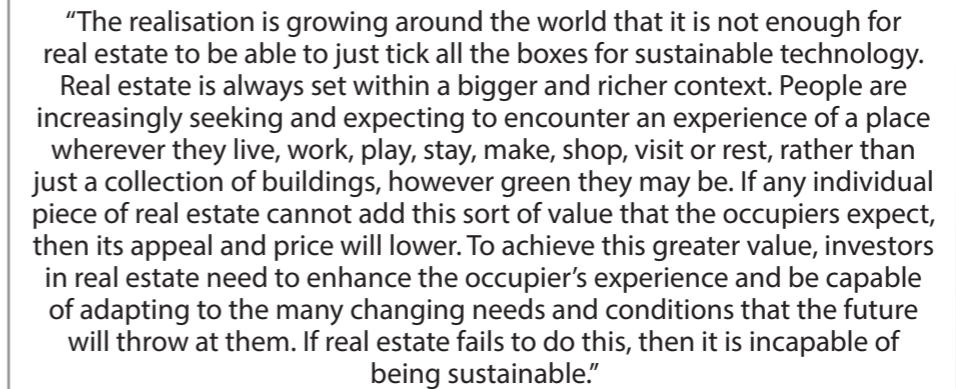
SUMMARY

This strategy sets out Swansea Council and Natural Resources Wales vision of:

“A city with high quality multi-functional green infrastructure delivering resilience, prosperity, nature, health, well-being and happiness to the citizens and visitors of Swansea.”

We know from the landmark report by the UN Intergovernmental Panel on Climate Change (IPCC)¹ that by 2050 the Swansea Central Area will have periods of intense heavy rainfall, droughts and rising temperatures. In this strategy Swansea Council and Natural Resources Wales send a powerful message that failure to adapt to and mitigate for climate change is no longer an option, if we are to provide an economically prosperous hub for the Swansea Bay City Region. Environmental sustainability is the basis for a resilient and prosperous Swansea. It requires current generations to choose how they meet their needs without compromising the ability of future generations to be able to do the same.

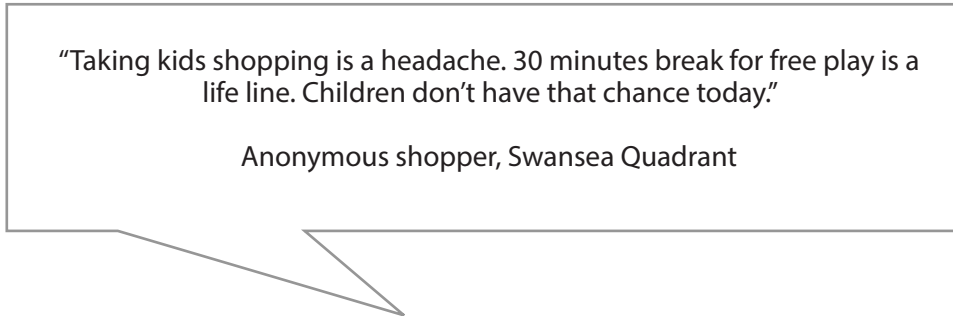
The benefits and cost-effectiveness of green infrastructure are now well studied and include reduced flood risk, summer cooling, cleaner air and water, reductions in noise, better mental and physical health, gains in biodiversity and a strengthened economy. Wales now has legislation, including the Statutory SuDS Standard 2019, Well-being of Future Generations (Wales) Act 2015 and Environment (Wales) Act 2016, which requires that people work together to protect and enhance nature for the long-term benefit of all. The provision of green infrastructure will enable us to meet these requirements. This Strategy aims to create investor confidence in green infrastructure by describing how it will be applied in the Swansea Central Area.



“The realisation is growing around the world that it is not enough for real estate to be able to just tick all the boxes for sustainable technology. Real estate is always set within a bigger and richer context. People are increasingly seeking and expecting to encounter an experience of a place wherever they live, work, play, stay, make, shop, visit or rest, rather than just a collection of buildings, however green they may be. If any individual piece of real estate cannot add this sort of value that the occupiers expect, then its appeal and price will lower. To achieve this greater value, investors in real estate need to enhance the occupier’s experience and be capable of adapting to the many changing needs and conditions that the future will throw at them. If real estate fails to do this, then it is incapable of being sustainable.”

Professor Yolanda Barnes of the Bartlett, UCL

The development of this strategy included over 634 face to face conversations with members of the public, including residents and visitors to the Swansea Central Area, about what nature in the city means to them. We also held workshops with businesses, developers, architects, landscape architects, public sector staff and Swansea Councillors. The overwhelming message from our engagement was that #citynature is very important to people and will increase their enjoyment and therefore their dwell time in the city centre.



“Taking kids shopping is a headache. 30 minutes break for free play is a life line. Children don’t have that chance today.”

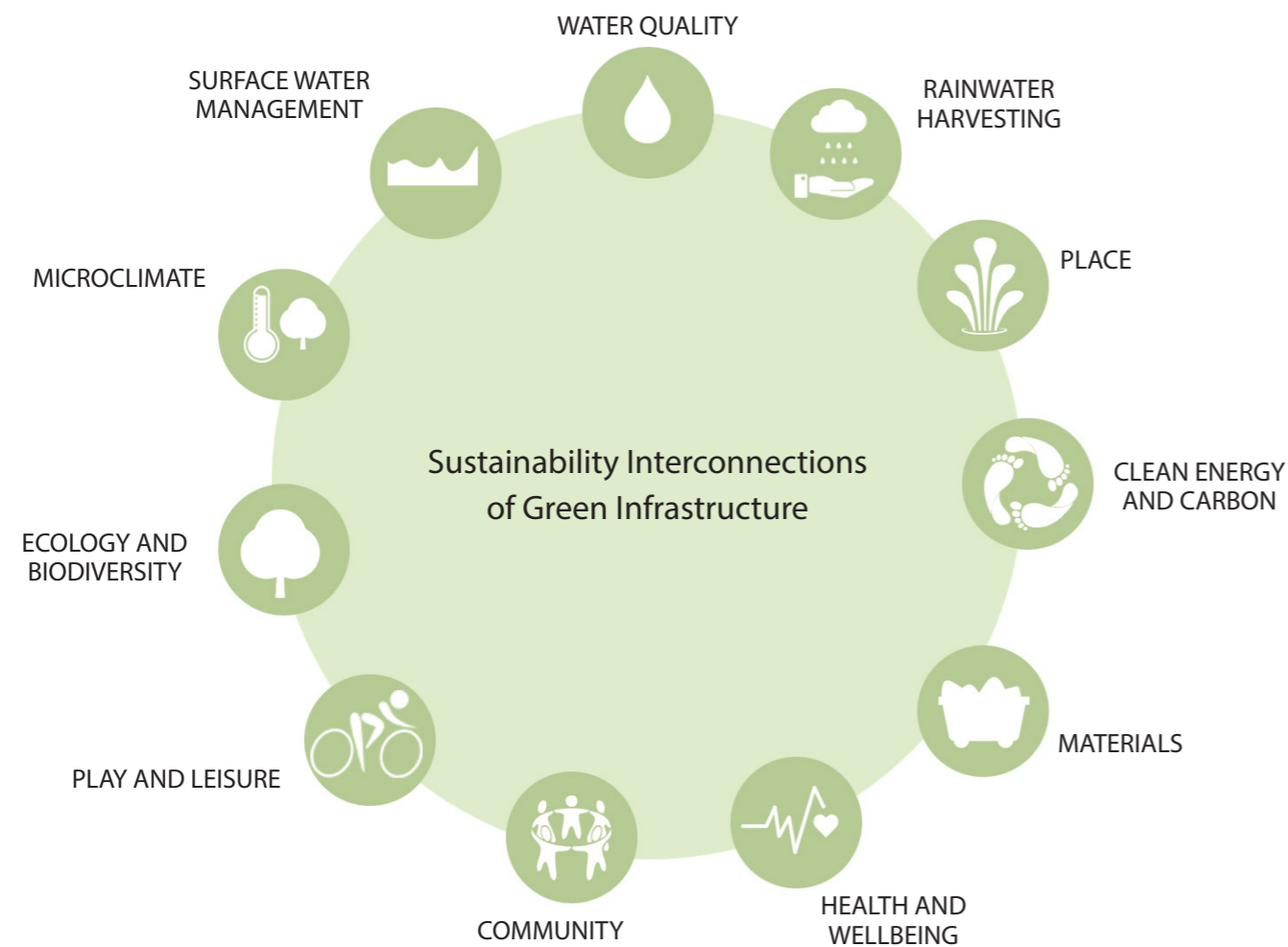
Anonymous shopper, Swansea Quadrant

1. IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)

Swansea Central Area is in an attractive setting, with the beach and bay, the river, hills and woods all within sight, however within the urban area, with the exception of churchyards, the marina and a few locations where there are street trees, sealed surfaces dominate. There are plans however to increase the amount of green infrastructure in new schemes outlined in the Swansea Central Regeneration Framework (SCARF), which will make the area more vibrant and attractive.

This strategy considers how green infrastructure can be increased in area and quality in the central area of Swansea in order to make it better adapted to climate change and better for people and wildlife. Green infrastructure is a term used to describe all the greenspace, soil, vegetation and water (ranging from parks to roof gardens) that provide the ecosystem services that make our cities liveable.

Figure 1.



This strategy sets out a vision for the central area in Swansea to be much greener, creating green spaces and using a combination of street-level features like street trees and rain gardens as well as vegetation on buildings, including green roofs and green walls. The intention is to double the amount of green infrastructure (with the exception of open water) within 10 years. The focus will be to create a green infrastructure network, centred on a Green Artery that will connect Swansea Station in the north, with the beach and marina in the south and the wider area, via existing, improved greenspaces including churchyards and Castle Square. Green infrastructure will be planned and designed to be multi-functional and will involve a partnership approach, using innovative solutions, including Supplementary Planning Guidance for green infrastructure and a Green Space Factor tool (GSF). Swansea Council is committed to using the GSF tool, designed for the Swansea Central Area, as a measure for the quantity and functionality of green space in developments. The GSF tool is described in Appendix 2.

1 INTRODUCTION

Background & Purpose

This Swansea Central Area Green Infrastructure Strategy, has been prepared by the Green Infrastructure Consultancy in collaboration with Swansea Council and Natural Resources Wales. The nature of development in Swansea Central Area and its importance as a key driver for economic prosperity in the Swansea Bay City Region requires a focused approach. Whilst this strategy is for the Swansea Central area, it forms part of a green infrastructure (GI) strategy for the whole of the County of Swansea. Implementation requires a cross-disciplinary approach across services in Swansea Council, Natural Resources Wales and partners. This strategy demonstrates how the provision of more multifunctional green infrastructure will enable us to meet the requirements of relevant Welsh legislation and policy including the Well-being of Future Generations (Wales) Act 2015, Environment (Wales) Act 2016 and the Statutory SuDS Standard 2019 (part of Schedule 3 of the Flood and Water Management Act 2010). The strategy is intended to be used by all stakeholders involved in the redevelopment of refurbishment of the Swansea Central Area.

The purpose of the strategy is to outline how GI can restore nature and contribute to improving the economy, culture and health & wellbeing in the Swansea Central Area. It describes existing green infrastructure assets and sets out a vision for future development of green infrastructure. Climatologists predict that by 2050, the Swansea Central Area will have periods of intense heavy rainfall, droughts, and rising temperatures.¹ In this strategy Swansea Council and Natural Resources Wales send a powerful message that failure to adapt to climate change is no longer an option and that it will be necessary if the Swansea is to continue to be an economically prosperous hub for the city-region. Maintaining existing and creating new high-quality green infrastructure is an important part of the work that Swansea Council and Natural Resources Wales will be undertaking to adapt to climate change and halt and reverse biodiversity losses. Green infrastructure is essential

for the health and well-being of Swansea' visitors and residents and to the vibrancy and viability of the city centre as the economic driver and key leisure destination of the Swansea Bay Region.

The intention is to bring about a cultural change so that a collaborative, cross-disciplinary, multifunctional approach to the planning, design, construction and maintenance of green infrastructure is adopted. The strategy sets out guiding principles and a framework for implementation. The implementation of the Strategy is supported by the use of the Swansea Green Space Factor (GSF) tool, designed to increase the quantity and functionality of green infrastructure schemes (Appendix 2). The strategy is also supported by a catalogue of green infrastructure interventions (Appendix 1). Swansea Council, together with Natural Resources Wales is committed to referring to these appendices, and encourages others, particularly when considering the design of proposals and associated green infrastructure schemes.

The GSF tool will help translate policy objectives into practice. The GSF is usually applied to high-density zones or districts, such as the Swansea Central Area, where large-scale urban renewal is planned, where rapid development is expected, or where particular problems (including, for example, biodiversity losses, surface water flooding or deficiency of accessible green space) could be exacerbated by inappropriate development. It must be used in combination with an awareness of the full suite of policies that relate to amenity, green infrastructure and biodiversity. These policies are usually applied in concert with combinations of green infrastructure and biodiversity strategies, district plans, neighbourhood plans, landscape plans, masterplans and design codes. The GSF scheme will not replace policies, strategies, plans or codes, but will help planners and designers to understand how designs interpret these.

1. IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)

Conventional GI planning is usually characterised by ground-level mapping that overlooks the potential to green the roofs, terraces and facades of buildings. With high-rise developments with green roofs and walls located on multiple levels and aspects it will be increasingly important that not only GSF schemes, but all policies related to green infrastructure, biodiversity and climate change adaptation, take account of the challenges and opportunities associated with denser developments and taller buildings.

In those cities where they have been adopted, GSF schemes have been shown to increase the amount of green space within developments, as well as increasing functionality, particularly with respect to surface water drainage. GSF schemes are supported by a wealth of evidence and experience, highlighted in Appendix 2. Depending on how they are operated, GSF schemes may also have the aim of requiring, or encouraging, more developers to take specialist advice (usually from landscape architects) in order to ensure that their plans meet the community's and the planning authority's requirements. With most GSF schemes, the purpose is easily explained and understood and the calculation of the overall score is a relatively straightforward and inexpensive process. Schemes allow flexibility with respect to plot layout and landscape design and are not prescriptive. Scores for particularly desirable features can be increased in order to encourage use.

The benefits of GSF schemes include:

- a) A reported increase in the use of multifunctional green infrastructure features
- b) Urban greening on restricted sites in densely developed areas
- c) A simple mechanism, easily understood by non-specialists
- d) Facilitation of conversations between developers and planners
- e) Empowerment of local authorities, who may successfully argue the case for more greening
- f) Flexibility: scores and targets can be adjusted to reflect local priorities

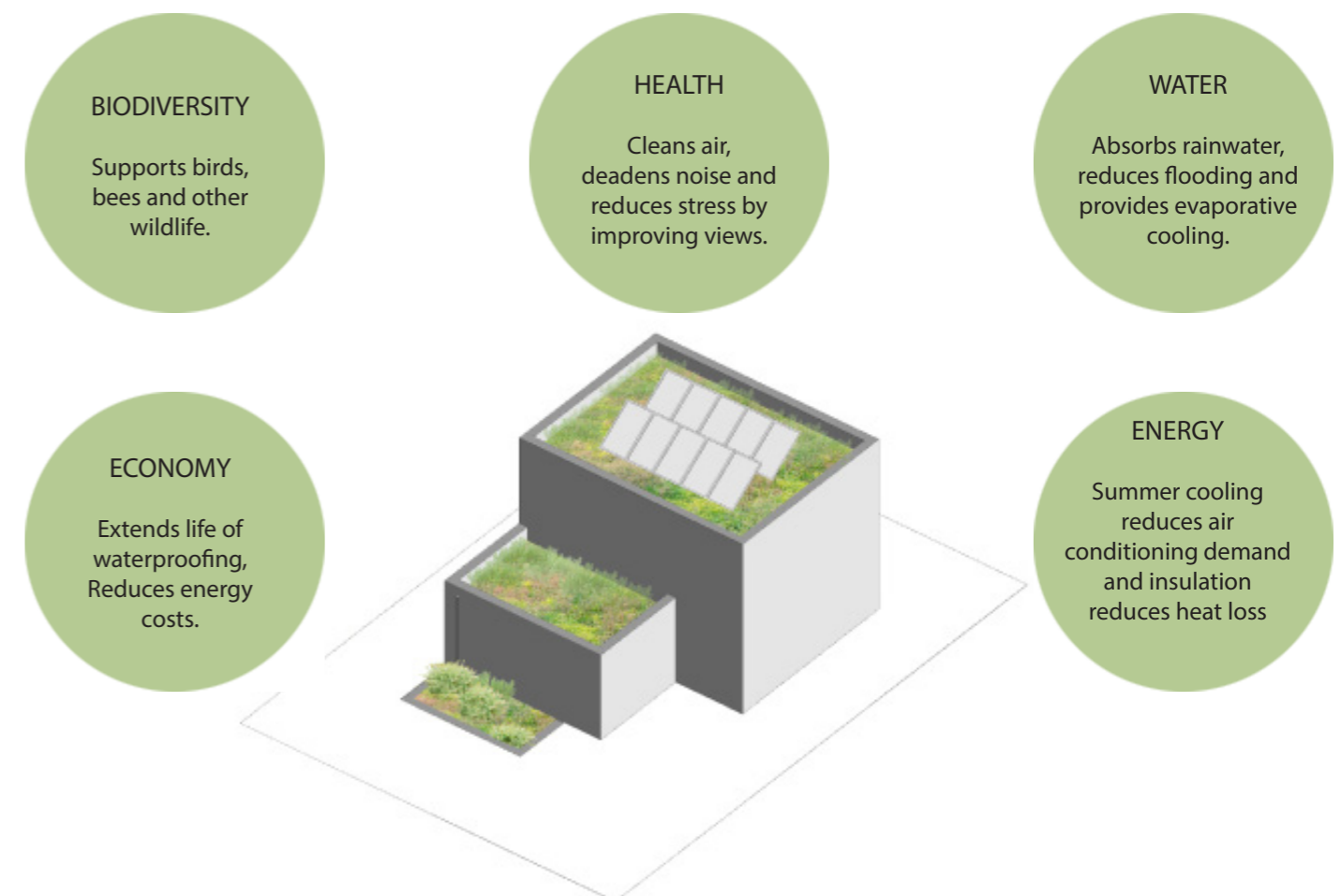


Figure 2. Benefits of green roofs, which enable developers to reach GSF targets

What is Green Infrastructure?

Green infrastructure (GI) is a catch-all term used to describe all the features of the natural environment between and within our towns and cities. By providing GI we are able to enjoy the many “ecosystem services” that these features provide, part of a sustainable approach to the management of natural resources where multi-functionality becomes a key objective of good design. Ecosystem services are the benefits that people derive from nature.²

GI features range from woodlands to parks, gardens, street trees, rain gardens, green roofs and green walls. GI can be accessible or inaccessible, publicly or privately owned, managed or unmanaged, designated as open space or for nature conservation or not. Green infrastructure is all soil, vegetation and water. It does not include paved or sealed surfaces or buildings, but it does include features on buildings including green roofs and green walls. The term green infrastructure as used here, includes “blue” features such as docks, watercourses and beaches.

Nature-based Solutions (NbS) is a term used by the International Union for Conservation of Nature (IUCN) to describe actions that protect or restore nature for human wellbeing or biodiversity. NbS features are part of the green infrastructure network. Green infrastructure can be defined as the “network of green (soil and vegetation) and blue (water) spaces that provide ecosystem services.”³

Multi-functionality is linked to spaces that provide the broadest range of ecosystem services. Between 2009 and 2011 the UK National Ecosystems Assessment (UK NEA) analysed the natural environment in terms of the benefits it provides for society.

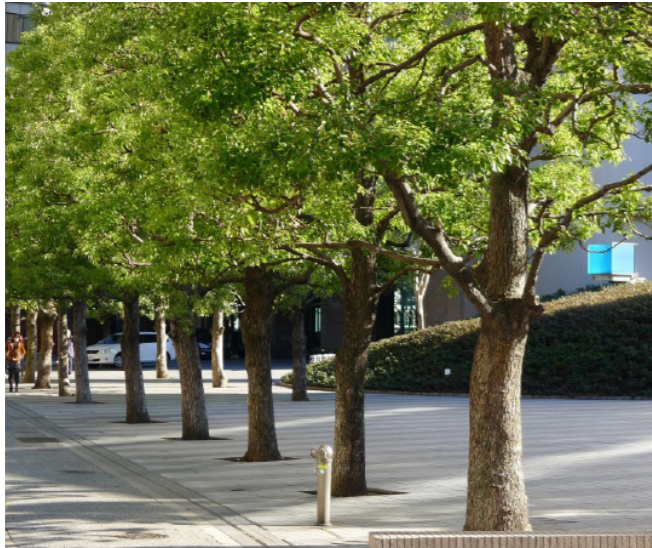
It was found that our economy, health and wellbeing depend on the range of services provided by ecosystems and their components. These include:

- Supporting services – those necessary for all others, including nutrient cycling and photosynthesis
- Provisioning services – food, fibre and fuel
- Regulating services – including clean water, clean air and climate
- Cultural services – recreational, wellbeing, beauty and sense of place

The green infrastructure, ecosystem services, approach to land use planning, design, creation and maintenance enables us to gain more from the built environment, by conserving and restoring natural features and thinking about the widest range of functions. Benefits can be maximised. Sections 4 and 5 set out how that can be brought about. Green infrastructure must be part of a shared vision, requiring an integrated approach that embraces many disciplines and all stakeholders. It must be considered at every level of the planning, design and management process for all departments and disciplines, and is relevant at every scale of development, from major regeneration projects to individual buildings or tree pits. A positive and proactive approach enables the city to make best use of its air, land and water, providing a better return on investment and happier and healthier residents and visitors.

2. Ecosystem Services <https://www.iucn.org/commissions/commission-ecosystem-management/our-work/cems-thematic-groups/ecosystem-services>

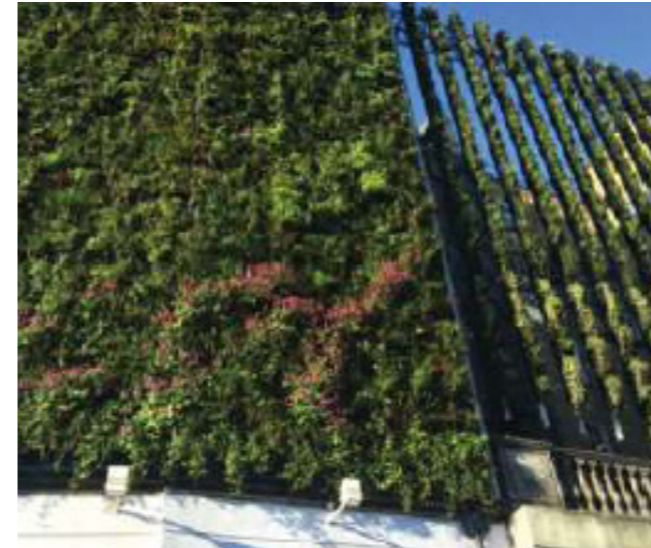
3. Nature-based Solutions <https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions>



Street tree



Biodiverse extensive green roof



Green wall



Rain garden



Roof terrace



Allotment



Woodland



Beach

Figure 3. Various types of green infrastructure

There is a considerable, and rapidly growing, body of evidence that green infrastructure is essential for human health and wellbeing, provides habitat for wildlife and will help us to adapt to climate change. For a full review of the benefits of green infrastructure and key references and sources of information, see the Ecosystems Knowledge Network website.⁴

Given the range of benefits provided, the protection, creation, enhancement and maintenance of GI, should be a concern for everyone. Green infrastructure is multi-functional and operates at different spatial scales, which means that its importance is often underestimated. The provision and maintenance of GI is the responsibility of many different authorities and landowners, which means that coordination, cooperation and collaboration is essential. There is also a wide spectrum of green infrastructure types, many of which are not included in conventional classifications of greenspace or nature conservation sites, which can lead to confusion about what should be prioritised. Green infrastructure is rising up the agenda, not only because of the burgeoning body of evidence for its benefits, but also because policies require or support the provision of GI (see Chapter 2 for more detail on policy).

It is important that green infrastructure provides the widest range of benefits (ecosystem services). This means that ecosystems must be protected and restored along with the microbes, plants and animals (biodiversity) that make ecosystems work. Biodiversity loss is now a major concern for civilization.⁵ The European Commission and the UK government are looking to halt overall biodiversity loss and are seeking biodiversity net gain/benefit in development.⁶ Green infrastructure forms a strong part of the Planning Policy Wales: Edition 10 and Welsh Government's Natural Resources Policy and is a key mechanism for delivering the aspirations for ecological networks and creating natural and distinctive places.

Investment in GI benefits communities provides and a financial return. The prioritisation of green spaces in regeneration schemes can seem at odds with delivery of housing and growth targets, yet renewal and development can be an opportunity to "create places with more nature afterwards than before."⁷ Across Swansea, we see the proponents of new developments viewing GI as a valuable, multi-functional asset, supporting the delivery of quality homes and neighbourhoods. Everyone from developers to those working at the grass roots, therefore, has a responsibility to use the full palette of green infrastructure options to demonstrate how they are addressing this issue and ensuring biodiversity net benefit.

Benefits of Green Infrastructure

Green infrastructure is defined by the UK government as a network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities. As a network it includes parks, open spaces, playing fields, woodlands, but also street trees, allotments and private gardens. It can also include rivers, streams, canals, beaches and other water bodies and features such as green roofs and walls.⁸ It is the urban elements of GI which are of particular relevance to this study.

The components of GI have traditionally been valued for the amenity that they bring to the urban environment, that is, the way that they make peoples' surroundings more pleasant and their living and working environments more attractive. There has been a realisation in recent years, however, that GI brings a wider range of benefits and there is now a considerable, and growing, body of evidence that GI can assist with climate change adaptation, can improve mental and physical health, provide habitat for wildlife, improve air and water quality and can have economic benefits.

4. Ecosystems Knowledge Network <https://ecosystemsknowledge.net/resources/tools-guidelines/green-infrastructure>

5. Stockholm Resilience Institute on biodiversity loss <https://www.stockholmresilience.org/research/research-news/2018-10-30-natures-steep-decline.html>

6. UK Government consultation on biodiversity net gain <https://consult.defra.gov.uk/land-use/net-gain/>

7. Berkeley Group on biodiversity net gain https://www.berkeleygroup.co.uk/media/pdf/0/k/The_Nine_Concepts_-_Making_space_for_nature_and_beauty.pdf

8. Landscape Institute on GI <https://www.landscapeinstitute.org/policy/green-infrastructure/>

These benefits are considered in turn in the paragraphs that follow.



Figure 4. Benefits of Green Infrastructure

Climate change is predicted to increase the frequency and intensity of both heatwaves and heavy downpours.⁹ Heavy rain can cause surface water flooding. GI has been shown to reduce the severity of these problems by providing summer cooling and by absorbing rainwater that might

otherwise exacerbate surface water flooding.

The Urban Heat Island (UHI) effect occurs when summer sunshine beats down upon the dense materials (including asphalt, concrete, masonry and brick) that make up the built environment. Energy is absorbed into dense materials and is re-radiated at night, which is the main cause of the UHI effect, which can make the centre of a city up to 10 degrees Centigrade warmer than its rural hinterland in the middle of a summer day.¹⁰ The UHI effect exacerbates heatwaves and leads to an increase in energy consumption, through the increased intensity of use of air conditioning. The UHI also exacerbates air pollution and risks to health.

The soil, vegetation and water in GI prevents heat islands from developing by reflecting sunlight and providing shade. Water evaporating from soil and water bodies and transpiring from leaves provides evaporative cooling. On hot summer days, the ambient temperature of vegetated areas can be up to 4 degrees Centigrade cooler than those areas of the city where there is no vegetation. The difference in surface temperature between conventional roofs and green roofs on hot summer days is even more marked, with the temperature difference often exceeding 20 degrees Centigrade.¹¹

The soil in GI is important as a store of water, which can provide evaporative cooling, as has been described, however soil (whether in the guise of green roofs, tree pits, rain gardens or other planted features) is also important as a sponge for rainwater, which would otherwise go straight into downpipes and drains, which may be overwhelmed during extreme rainfall events, causing surface water flooding. Extensive green roofs, for example, have been shown to absorb the

9. Met Office climate change projections <https://www.metoffice.gov.uk/research/collaboration/ukcp/derived-projections>

10. EPA on UHI <https://www.epa.gov/heat-islands>

11. GI and the urban heat island <http://www.vcccar.org.au/sites/default/files/publications/VCCCAR%20Urban%20Heat%20Island%20-WEB.pdf>

first 5mm of rain that falls upon them. Approximately half of the rain that falls on a typical extensive green roof over the course of a year is retained within the substrate (soil) and subsequently lost through evapo-transpiration.¹² Rain gardens and tree pits at street level can be designed to intercept and store large volumes of stormwater.¹³



Figure 5. Roof gardens are an effective source control element in sustainable drainage systems

The economic and monetary valuation of GI is subject to various methods of assessment (necessary because of the wider spectrum of benefits) and the process can be difficult and controversial (because it is argued that some attributes of nature cannot, meaningfully, have a value assigned to them), however work has been undertaken to place monetary values on green infrastructure assets in London. London's public parks have a gross asset value in excess of £91 billion and the GLA estimates that for every £1 invested in parks, Londoners reap £27 in benefits.¹⁴

Another example of the monetary valuation of GI is the iTrees method, developed in the US, which has been used to estimate the value of trees in Swansea's River Tawe Catchment 2015, which includes the Swansea Central Area.¹⁵ The study concludes that trees:

- intercept an estimated 252 million litres of water every year, equivalent to an estimated £333,900 in sewerage charges avoided,
- remove an estimated 136 tonnes of airborne pollutants each year, worth more than £715,500 in damage costs,
- remove an estimated 3,000 tonnes of carbon from the atmosphere each year, this amount of carbon is estimated to be worth £671,000,
- store an estimated 102,000 tonnes of carbon, estimated to be worth £23.1 million.)

In addition to these various indirect economic benefits, the planning, design, installation and maintenance of GI is an economic activity in itself. For example, the UK annual expenditure for extensive green roofs, which is centred on London, exceeded £26m for 2017.¹⁶

GI is associated with improved health and wellbeing and the mechanisms for this include:

- access to greenspace whereby people maintain good health through exercise
- exposure to vegetation and natural features which facilitates social interaction, lowers stress and improves mental health and wellbeing
- reduction in pollutants that can cause disease

12. Green roofs rain Livingroofs.org on green roofs and stormwater <https://livingroofs.org/storm-water-run-off/>

13. Rain Garden Guide <https://raingardens.info/wp-content/uploads/2012/07/UKRainGarden-Guide.pdf>

14. London Natural Capital Accounts <http://www.vivideconomics.com/wp-content/uploads/2017/11/Natural-Capital-Accounts-Report-GLA-NT-HLF.pdf>

15. iTrees <https://naturalresources.wales/media/680678/revised-english-wales-urban-canopy.pdf>

16. London Living Roofs and Walls 2019 https://www.london.gov.uk/sites/default/files/2019_london_living_roofs_walls_report.pdf

The evidence for these effects is considered in turn and summarised in the paragraphs that follow.

Epidemiological studies have shown that access to nearby greenspace encourages increased physical activity, lowers rates of obesity and lowers morbidity.¹⁷ The reasons for this are complex, however an important factor is that a greener environment increases the prevalence of walking and other physical activity. The importance of exercise in preventative medicine is now being emphasised by health professionals, who recognise that easy, local access to GI is essential if prescriptions for exercise are to be effective.¹⁸

The sight of vegetation, outside as well as inside, lowers stress and blood pressure and helps concentration.¹⁹ Cognitive development in children and the recuperation of patients are also reported to be improved when vegetation is visible. Productivity is increased and the symptoms of conditions including Alzheimer's disease, dementia, depression and ADHD (Attention Deficit Hyperactivity Disorder) may be alleviated.²⁰ This was reflected in the engagement findings for this strategy; with emotional benefits of green spaces in the city centre a clear theme for residents and visitors of all ages (see figure 6). Green infrastructure can be very important in child development. Research in Barcelona, using brain imaging techniques, which compared children growing up in areas without vegetation with children in areas with vegetation, found that children in the areas with vegetation had beneficial structural changes in their brains, which were permanent.²¹

Green spaces, gardens and even shaded spots beneath trees have been shown to encourage informal multi-generational social interaction and cohesion and creative play. These interactions are especially important for the lonely, elderly and other more vulnerable groups. Green and open spaces are also valued and enjoyed by many of the workers who commute into urban areas each

day. Overall, social interaction reduces stress and improves mental health and wellbeing.²²

Health is also improved when noise is reduced, and air quality is improved. Soil and vegetation may dampen noise, in contrast with man-made surfaces, which tend to reflect it. Trees and shrubs have been shown to reduce sound by 6dB over a distance of 30m. Green roofs and green walls have been shown to be particularly effective at shielding people in buildings and building courtyards from traffic noise.²³



Figure 6. Word cloud from wellbeing theme from community engagement carried out for this strategy. Members of the public were asked, "What is nature in the city to you?"

Health is also impacted by poor air quality. Air pollutants of particular concern in cities are particulates and nitrogen dioxide. In Wales, more specifically, for the latest year for which data are available (2017), the long-term mortality burden attributable to air pollution (fine particulate matter and nitrogen dioxide combined) is an estimated effect equivalent to 996 to 1,417 deaths.²⁴ The vegetation that makes up green infrastructure has been shown to improve air quality by filtering particulates and absorbing gases. Studies have shown that planting on buildings in

17. Links between natural environment and health <http://eprints.gla.ac.uk/4767/1/4767.pdf>

18. Walking for Health <https://www.walkingforhealth.org.uk/>

19. Chang, C.Y., and P.K. Chen. 2005. Human Response to Window Views and Indoor Plants in the Workplace. *Hortscience* 40, 5: 1354-59.

20. Nature and mental health https://depts.washington.edu/hhwb/Thm_Mental.html

21. <https://www.childinthecity.org/2018/03/28/childhood-exposure-to-green-space-may-help-brain-development/?gclid=accept>

22. Health Council of the Netherlands. 2004. Nature and Health: The Influence of Nature on Social, Psychological and Physical Well-Being. Health Council of the Netherlands and RMNO, The Hague.

23. Van Renterghem, T. et al. (2013). The potential of building envelope greening to achieve quietness. *Building and Environment*, 61, 34– 44. DOI:10.1016/j.buildenv.2012.12.001

24. Public Health Wales on air pollution https://public.tableau.com/views/Nationallong-termannualairpollutionconcentrationsanthropogenicandmortalityburdenranges/Dashboard1?:embed=y&:displaycount=yes&:publish=yes&:origin=viz_share_link

23. Van Renterghem, T. et al. (2013). The potential of building envelope greening to achieve quietness. *Building and Environment*, 61, 34– 44. DOI:10.1016/j.buildenv.2012.12.001

24. Public Health Wales on air pollution https://public.tableau.com/views/Nationallong-termannualairpollutionconcentrationsanthropogenicandmortalityburdenranges/Dashboard1?:embed=y&:displaycount=yes&:publish=yes&:origin=viz_share_link

street-canyons reduces street-level concentrations by as much as 40% for nitrogen dioxide and 60% for particulate matter.²⁵

The various benefits provided by GI combine to provide economic benefits in terms of energy savings, fewer insurance claims (for example, after flooding), fewer working days lost, preventative health measures, reductions in crime, increased productivity, increased property values, increased footfall for businesses and increased inward investment. The health benefits of urban GI, in terms of reductions in provision by the health service are estimated at £2.1 billion in the UK.²⁶



Figure 7. Pupils at Ysgol Bryn y Mor telling us what nature in the city #citynature #natyrynyddinas means to them.

Opportunities for local food production, in allotments, community gardens and orchards or even through temporary projects, increases access to healthy, locally sourced and distinctive food and provides education and training opportunities. It also contributes to food security and reconnects communities with their local environment. One example is 'Vetch Veg', located at Swansea City's old football ground. This green oasis in the middle of an urban area has enhanced the community

spirit, has people sharing experiences, swapping recipes and tasting and sampling new dishes. This reflects the diverse cultures of Swansea. Allotments have been shown to be greater for biodiversity than parks, gardens, roadside verges and the countryside due to the wide variety of plants found here than in more rural locations.²⁷

Another example is the Swansea Community Green Spaces project to create green spaces for social interaction and cohesion including the site at Seaview Green Space, Mount Pleasant. This is a food growing project working with asylum seekers and refugees, in collaboration with the African Community Centre. It has encouraged local residents to become involved by actively engaging with people passing by. As a result, the community have formed their own successful growing project and have leased the site from the Council. This project has contributed to bringing the community together and has improved the physical and mental wellbeing of individuals.



Figure 8. Vetch Veg (Credit: Kathryn Campbell Dodd)

25. GI and air quality in street canyons <https://pubs.acs.org/doi/abs/10.1021/es300826w>

26. Health and GI: Evidence of benefits <http://nhsforest.org/evidence-benefits>

27. Veg Vetch, Swansea <http://www.vetchveg.co.uk/> <http://www.sustainableswansea.net/vetch-veg.html>

2 KEY DRIVERS

National

There is legislation, policy and guidance which supports the creation and maintenance of GI at both national and local levels. The benefits of GI (as described in the previous section) and their relationship to national guidance and legislation are outlined in the table below.

Table 1. National Legislation, Policy and Guidance

Health and Wellbeing of Future Generations Act 2015	Environmental Wales Act 2016	Schedule 3 Flood & Water Management Act 2010 Statutory Standards	Active Travel Wales Act Manual for Streets	Planning Wales Act 2015 Planning Policy Wales 2019
<ul style="list-style-type: none"> • All public bodies have a duty to improve well-being • Green infrastructure contributes to all well being goals <ul style="list-style-type: none"> - Globally responsive - Prosperous - Resilient - Healthier - Cohesive communities - Vibrant culture • Healthy environments is a key principle of GI 	<ul style="list-style-type: none"> • The Council has a legal duty to protect and enhance biodiversity and maintain resilient ecosystems (the Section 6 Duty) • Ecosystems services approach must be used in the consideration of all development • Key principles are connectivity, scale and biodiversity of ecosystems and their adaptability and resilience to climate changes 	<ul style="list-style-type: none"> • SuDS required to demonstrate how Biodiversity taken into account. • Design SuDS to create green infrastructure with multiple benefits delivering the 6 standards • Green infrastructure provides an opportunity to consider the multifunctional benefits of drainage solutions • The SuDS Approving Body (SAB) and has duties to approve, adopt and maintain SuDS • Developers of sites of 1 or more dwellings or 100 square metres or more are required to implement sustainable urban drainage solutions. 	<ul style="list-style-type: none"> • Green infrastructure provides an opportunity to consider the multifunctional benefits of active travel proposals • The Active Travel Wales Act places a duty on the Council to promote more active travel and to include provision for walkers and cyclists in new road provision. encourages sustainable development to be considered • Manual for Streets promotes multifunctional streets and recognises that streets that are good quality places achieve active travel, health, carbon reduction, air quality improvements, community pride and sense of ownership. • Well designed streets/active travel routes have "a crucial role to play in the delivery of sustainable communities where people want to live and work now and in the future" 	<ul style="list-style-type: none"> • Planning Wales Act clearly links land management to sustainable management of natural resources. • Green infrastructure is key to delivery of placemaking and sustainable development which is at the heart of PPW. • Green infrastructure plays a fundamental role in shaping our places and our sense of well being and is intrinsic to the quality of the spaces we live work and play in...the quality of the built environment should be enhanced by integrating green infrastructure into development through appropriate site selection and use of creative design. (PPW 6.2.4) • The development of green infrastructure is an important way for local authorities to deliver their section 6 duty (PPW 6.2.2)

In addition to complying with the legislation described in the table, improving the quantity, quality and variety of GI in the city will contribute to compliance with other legislation which addresses air and water quality, climate change, surface water run-off, resilience planning, biodiversity, health and wellbeing (including mental and physical health) and social exclusion.

GI Drivers in Swansea

Swansea Council and Natural Resources Wales Corporate Plans both recognise that our city faces a number of challenges in the years ahead, one of which is climate change (with more heatwaves and surface-water flooding, air quality problems and biodiversity losses predicted). Locally appropriate, good quality GI will help to mitigate these challenges and reduce future costs. The national legislation shown in table 1 is supported by local strategy, policy and guidance, as outlined in table 2 below.

Table 2. Local Legislation, Policy and Guidance

Swansea PSB Well Being Plan	Swansea Council Corporate Plan	Swansea Local Development Plan and Emerging SPG	Swansea Council Strategies	Swansea Designations and Evidence
<ul style="list-style-type: none"> The PSB has embedded the Section 6 duty into the Wellbeing plan. "working with nature" is one of the Well Being objectives. 	<ul style="list-style-type: none"> The Council has embedded the s6 duty into the Corporate Plan Improving green infrastructure is one of the steps of the "Resilience" well being objective 	<ul style="list-style-type: none"> Policy ER 3 - requires provision of green infrastructure through the protection and enhancement of existing green spaces. Development is required to take opportunities to maintain and enhance the County's multifunctional green infrastructure network The LDP contains a framework which promotes sustainable development and placemaking. A suite of Supplementary Planning Guidance provides further details on the implementation of LDP policies. 	<ul style="list-style-type: none"> Biodiversity Action plan/NRP Swansea Flood Risk Management Plan 2015 Air Quality Management Area Action Plans (2004) 	<ul style="list-style-type: none"> Quiet Areas (designated under Noise Action Plan for Wales) Open Space Assessments (FiT and ANGs provision) and emerging Open Space Strategy Air Quality Management Areas Natural Resources Wales South West Wales Area Statement

3 VISION & PRINCIPLES

Vision

A city with high quality multi-functional green infrastructure delivers resilience, prosperity, nature, health, well-being and happiness to the citizens and visitors of Swansea.

“A city that is green is a City where I want to be seen.
A City that is bare is a city that does not care”

Anonymous member of the public 2019 Swansea City Green Infrastructure community engagement.

Objectives

The following strategic objectives were developed through engagement with the community, Councillors, businesses and public sector staff.

Our over-arching strategic objectives are:

- Provide a high-quality environment
- Creating a distinctive destination city
- Adapt to climate change by becoming a:
 - Sponge City²⁸
 - Mitigating urban heat island effect
 - Maintaining and enhancing Swansea City’s natural resources and biodiversity
- Involve, engage and educate communities
- Lead by example
- Attain wildlife and well-being friendly city status, such as;

- Biophilic City
- National Park City
- UNESCO Biosphere Reserve
- Woodland City

We will achieve this by:

- Increasing terrestrial green infrastructure to 26% by 2030.
- Increasing canopy cover to 25% by 2044 by planting species which provide the most effective mix of multiple benefits
- Expecting developers to meet the UK Green Roof Code of Practice 2014,²⁹ which sets minimum standards for the design, installation and maintenance of green roofs.
- Expecting developers and planners to use tools such as the Green Space Factor and CAVAT to demonstrate compliance with our ambitious targets and relevant legislative requirements
- Become a Trees in the Townscapes champion by officially endorsing the 12 Trees in the Townscape principles in Swansea City.
- Develop resilient communities by creating champions through high level engagement

An action plan will be drawn up between Swansea Council and Natural Resources Wales to jointly deliver the strategic objectives with our partners and stakeholders. The intention is for the City of Swansea to be much greener. Currently, terrestrial green cover is estimated to be 13% of the area and the target is for this will be

28. World Future Council on Sponge Cities <https://www.worldfuturecouncil.org/sponge-cities-what-is-it-all-about/>

29. GRO Green Roof Code 2014 <https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf>

doubled (that is, increased to 26%) by 2030 and tree canopy cover increased to 25% by 2044. The increase in green cover will be achieved by extending and strengthening the existing ground level network, as well as providing vegetation on built structures, including green roofs and green walls. It is estimated that roof and ground level greening which will form part of the various proposed Regeneration Projects within the Green Artery will deliver much of this increase, however there will be many other projects outside of the Green Artery where Green infrastructure will be planned, designed, delivered and maintained to be green biodiverse, locally appropriate, multi-functional and to provide the widest possible range of ecosystem services.

The intention is to bring resilience, prosperity, health, wellbeing and happiness to citizens and visitors and to ensure that the green infrastructure network complements and improves the existing natural and built environment. This vision contributes to delivering the Swansea's Local Well-being Plan, Local Development Plan (LDP) and Swansea Central Regeneration Framework.

Green Artery

At the heart of the Swansea Central Area's GI network will be the Green Artery. The proposal is set out in the Swansea Central Area Regeneration Framework (2016).³⁰ The Green Artery will be a GI corridor connecting Swansea Station in the north to the Maritime Quarter in the south, making the centre of Swansea more permeable to both people and wildlife. Within the Green Artery, pedestrians and cyclists will have priority.

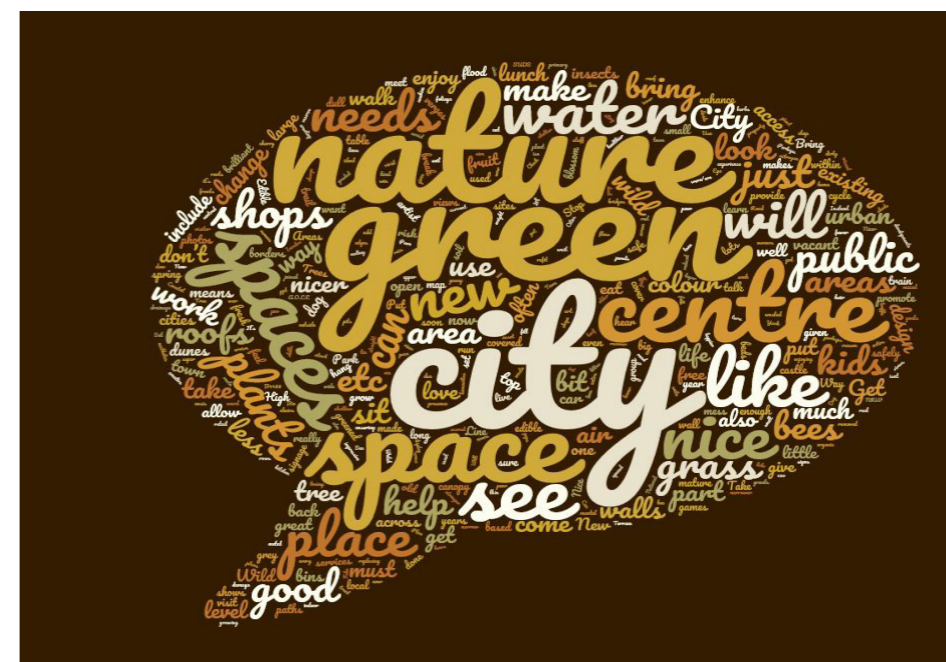


Figure 9. Word cloud of comments from the community engagement for the Opportunities theme

Interventions along the High Street will connect the station with Castle Square, where there will be an overall reduction in sealed surfaces. Heading south from Castle Square, connections will be made with St Mary's Church, St David's Church and across Oystermouth Road to the new Coastal Park. From the Coastal Park it will be a short walk to other destinations in the Maritime Quarter, the beach and Waterfront. The Green Artery will be a primary focus, however green links will be made with Oxford Street and Kingsway to the west and Parc Tawe and the River Tawe to the east, with other arms of the GI network extending to the natural environment on the outskirts of the city, including, for example the Tawe riverside, the hillside wildlife corridor and the beach.

30. Swansea Central Area Regeneration Framework 2016 <https://swansea.gov.uk/citycentreframework>



Figure 10. Proposed Green Artery

Castle Square is a key central multi-functional green space within the Green Artery. Castle Square was the most frequently mentioned public space referred to during our urban greening engagement process.



Figure 11. Word cloud highlighting people’s thoughts on Castle Square and the opportunities it may present through the redevelopment process.

As well as the Green Artery itself, GI interventions can be made anywhere in the city, as opportunities arise as the result of redevelopment but also through routine repair and maintenance or by retrofitting features. There may also be locations, identified through future GI audits or ecosystem services analyses, where small interventions can be identified that can have a disproportionately large impact, including, for example, tree and wildflower planting, rain gardens, green roofs and green walls.

Principles

The five principles (See figure 12) should be considered by all, who plan, design, build, vegetate and maintain green infrastructure. By following these principles, interventions maximise the number and intensity of benefits for people and wildlife.

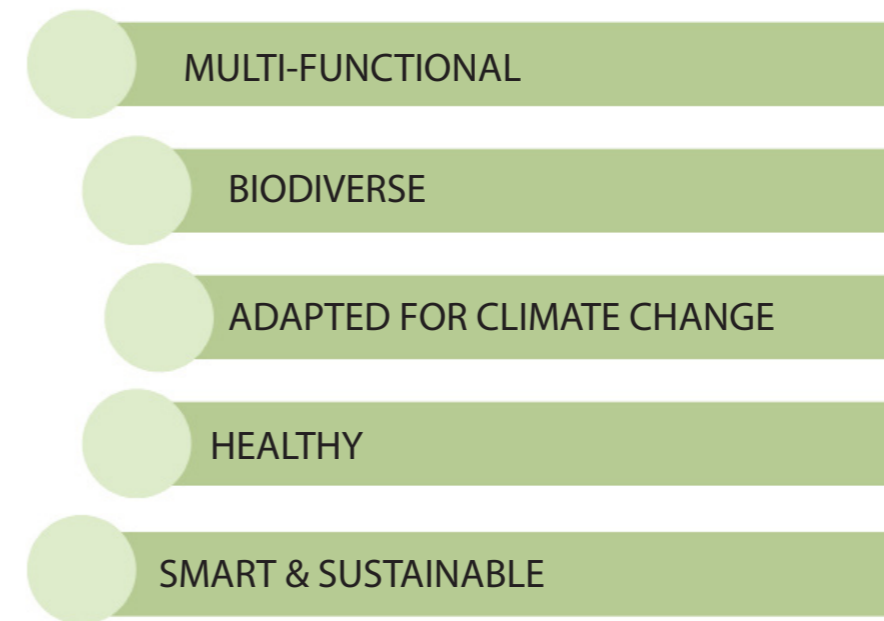


Figure 12. Principles of GI

Multi-functional

Nature itself is multi-functional. A natural area simultaneously provides a full range of ecosystem services. Humans tend to modify land use for limited purposes – for example, an arable field produces food, or a car park stores cars. The conventional approach is for specialist individuals or organisations or departments to provide a facility that does one thing well, however it is important, given the scale of the difficulties facing urban areas, which are likely to be exacerbated by climate change and biodiversity loss, that every effort is made not to miss opportunities to make features multi-functional. Although there can be trade-offs, more often than not, extra provision of green infrastructure elements does not interfere with the primary purpose and the return on any extra investment is positive.

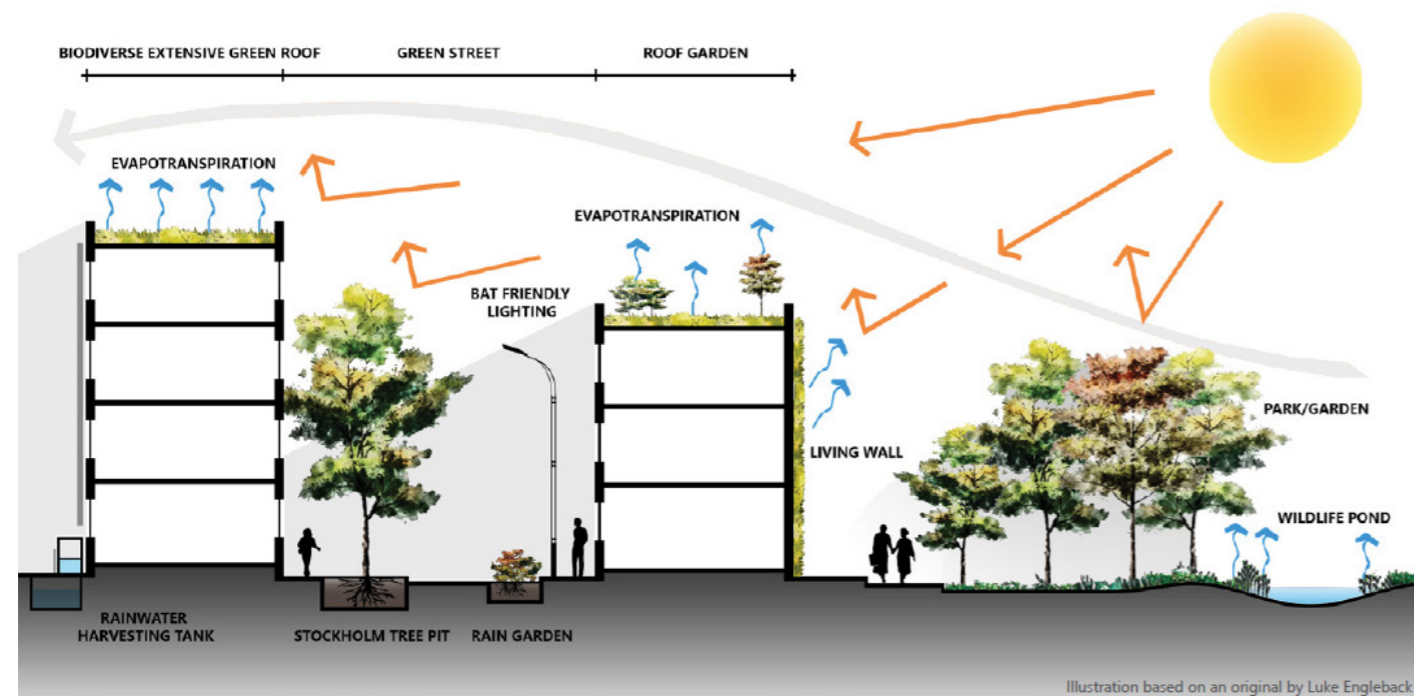


Figure 13. Green infrastructure improves microclimate

A cycle path can be an ecological as well as a transportation corridor. Extra tree planting in a car park can improve amenity, provide summer shade, sustainable drainage and biodiversity. Sometimes there are synergistic effects. An example is a biosolar roof (photovoltaics combined with a green roof) where a cooler microclimate increases the output of the photovoltaics.

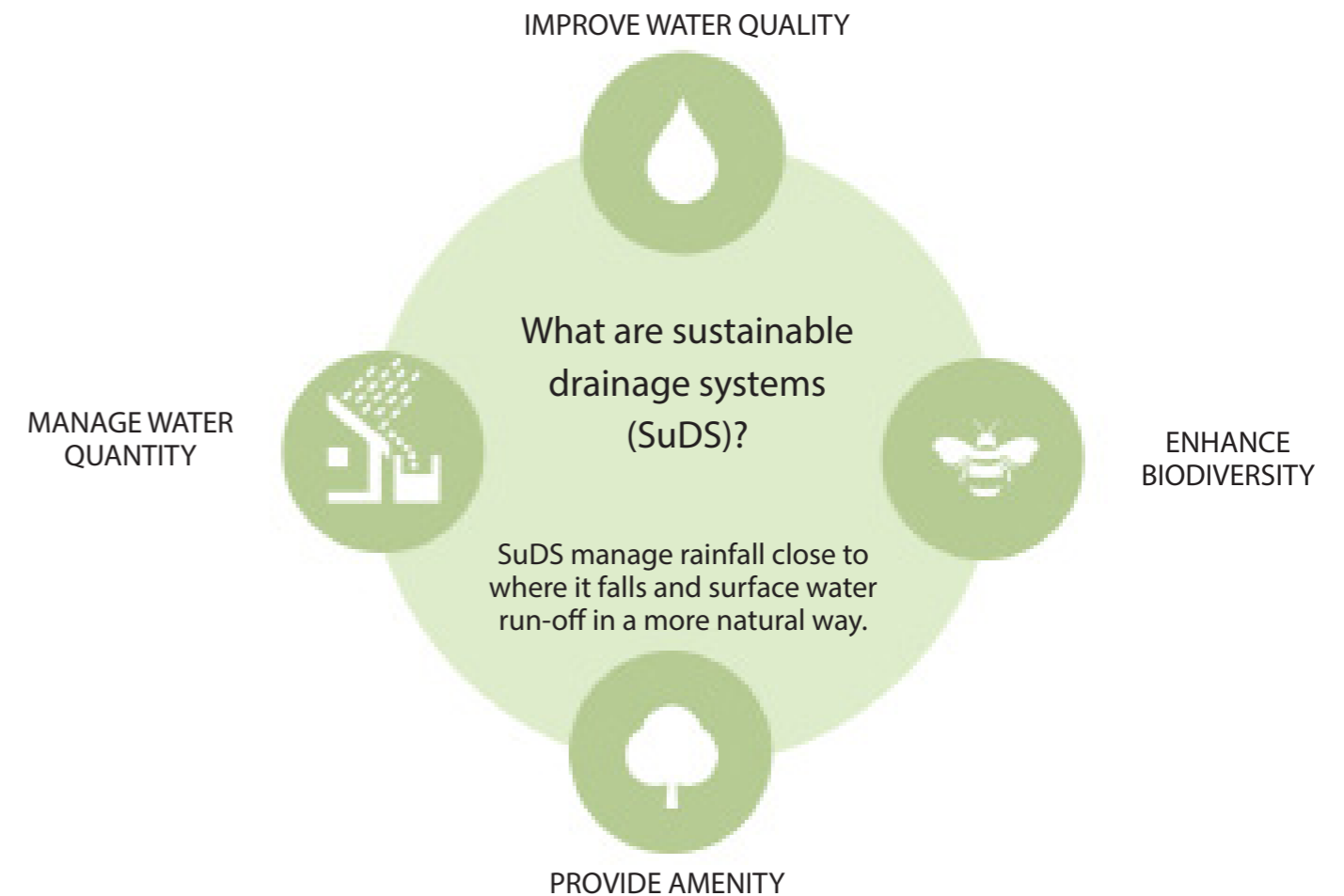


Figure 14. What are SuDS?

Multi-functionality is also illustrated in Appendix 1 in the petal diagrams, designed to demonstrate the contribution of various ecosystem services in GI typologies. The more balanced and bigger the petals the more multi-functional the GI type.

Adapted for Climate Change

According to the Met Office Hadley Centre Climate Programme, climate change is predicted to lead to sea level rises, warmer and wetter winters and hotter and drier summers.³¹ Summer heatwaves are likely to be more frequent and more intense. Heavier downpours, even in summer, are likely to lead to flash flooding. Even if greenhouse gas emissions and associated global warming can be limited, some increases in heatwaves and surface water flooding will occur.



Figure 15. Infra-red image of masonry wall (left) and green wall (right).

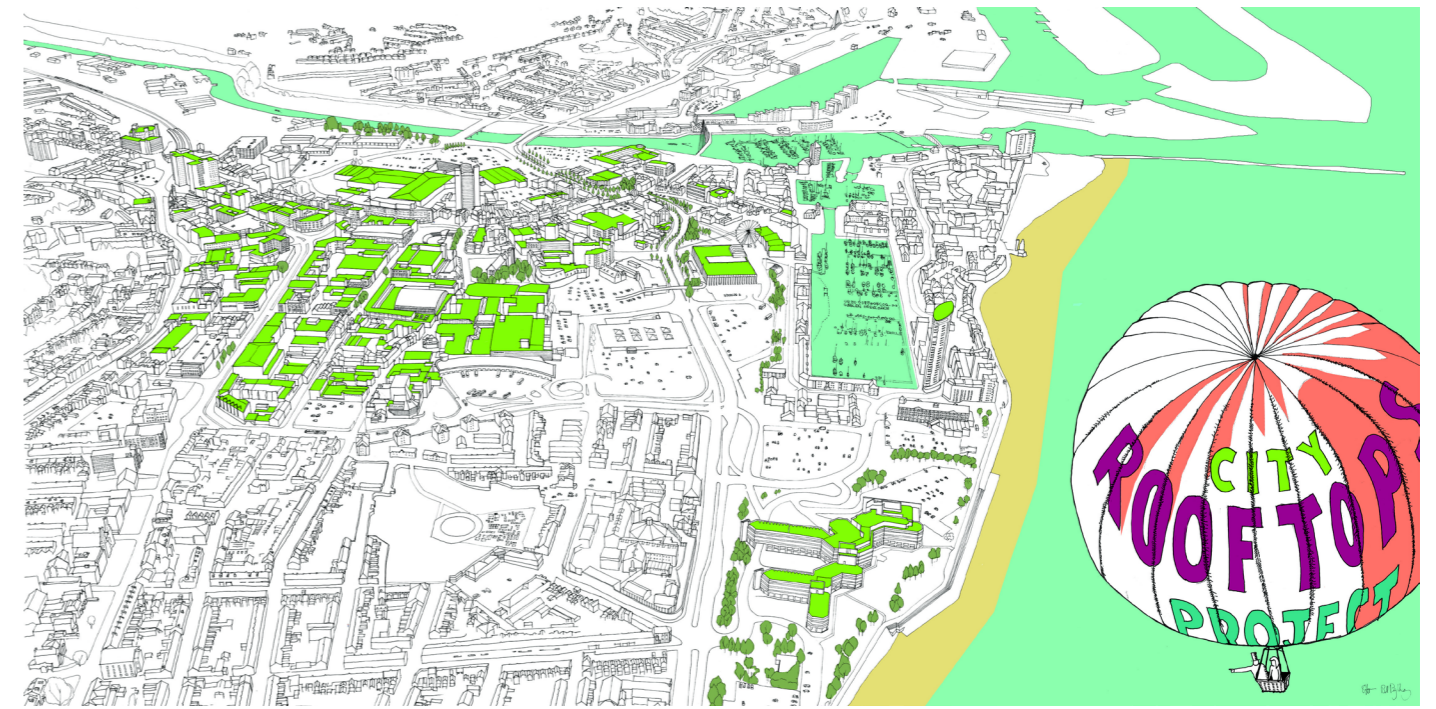


Figure 16. Green roofs across Swansea city centre produced by Andrew Nixon/PowellDobson Architects for the CIVIC 2014 Exhibition at the Mission Gallery.

In general, an increase in green infrastructure will be a cost-effective way of adapting to these changes. More specifically, features that provide shade and evaporative cooling in summer, close to where people live and work and features that intercept and filter rainwater and surface water run-off, should be incorporated into schemes.

Healthy

For good health and a sense of wellbeing, people need clean air, clean water, food, exercise, contact with nature and places to socialise, play and learn. Green infrastructure can provide these benefits.

Conventional, readily accessible

31. <https://www.metoffice.gov.uk/research/collaboration/ukcp/derived-projections>



Figure 17. Cycle path as a green corridor

greenspace is important, however other GI features, even if simply overlooked like green walls, can be important for mental health. Unseen features, like extensive green roofs for example, may be providing relief in a heatwave, filtering water, or absorbing air pollution. The precise location and specific design of green infrastructure can be an important factor with respect to providing health benefits.

Biodiverse

Biodiversity is the whole range of living things and systems on earth, it includes animals, plants, microbes, genes and ecosystems. All life depends on other creatures and plants and ecosystems function better when high biodiversity is maintained. In responses to continuing losses, Natural Resources Wales has recently set out a fresh approach to conserving biodiversity, named 'Vital Nature'.³²

Swansea has a Local Biodiversity Action Plan (LBAP).³³ There is a strong emphasis on partnership, engagement and learning in the LBAP. Urban wildlife referred to includes bats, song thrush, bumble bees, mason bees, butterflies and stag beetle, amongst others. Wherever green infrastructure occurs in Swansea, consideration should be given to how biodiversity can be improved. With planting schemes, native species or species with a documented value for wildlife, where justified, should be used, along with appropriate habitat features like decaying logs, nesting and roosting boxes for birds and bats and refugia for invertebrates (bug hotels) and wildflowers.



Figure 18. Mason bees using bee hotel

Smart & Sustainable

A transition in the economy, away from fossil fuels, in order to avoid the worst effects of climate change, is essential. The Welsh Government has a decarbonisation programme.³⁴ In addition, reductions in pollution and waste, with more recycling and waste increasingly used as a raw material (for example, the circular economy)

32. <https://naturalresources.wales/about-us/news-and-events/news/nrw-sets-out-a-fresh-approach-to-wildlife-in-wales/?lang=en>

33. Swansea LBAP <https://www.swansea.gov.uk/article/10113/Swansea-Local-Biodiversity-Action-Plan>

is sought.³⁵ The provision and maintenance of urban GI should support these efforts, helping to save energy, working alongside efforts to provide energy from renewable sources (for example solar and biogas from green waste) and using recycled materials and recycled green waste for growing media. Vehicles and equipment used to build and maintain GI should wherever possible run on renewable energy. Green infrastructure should be, wherever possible, low maintenance. Wherever possible, green infrastructure should not rely on artificial irrigation and where irrigation is required, consideration should be given to using harvested rainwater. Smart technologies should be used to monitor and share data with practitioners, the community and education institutions. This information might include energy and water consumption and biodiversity records. Staff working on the maintenance of GI will receive appropriate training and support.

Cross-Disciplinary Working

Tackling the causes and effects of issues like biodiversity loss and climate change requires a radical step change in approach across all sectors, and this step change must occur in the short term. The conversations required to deliver quality green infrastructure, provide a well-timed opportunity to increase in skills and knowledge capacity needed to achieve this. Culture change will be required across organisations and our partners to work together in an innovative and collaborative way to ensure that development is resilient and adaptable to climate change. Achieving cross-sector agreement to the principles in this green infrastructure strategy is key to the delivery of the joint vision for Swansea Central Area of Swansea Council and Natural Resources Wales.

The Green space Factor Tool promoted in this document (see Appendix 2) provides a useful and simple way to explore the function and benefits of green infrastructure proposed and ensure that this approach and the principles are embedded into the early stages of the development and design process. It provides a simple and clear way to navigate the many overlapping and interrelated issues.

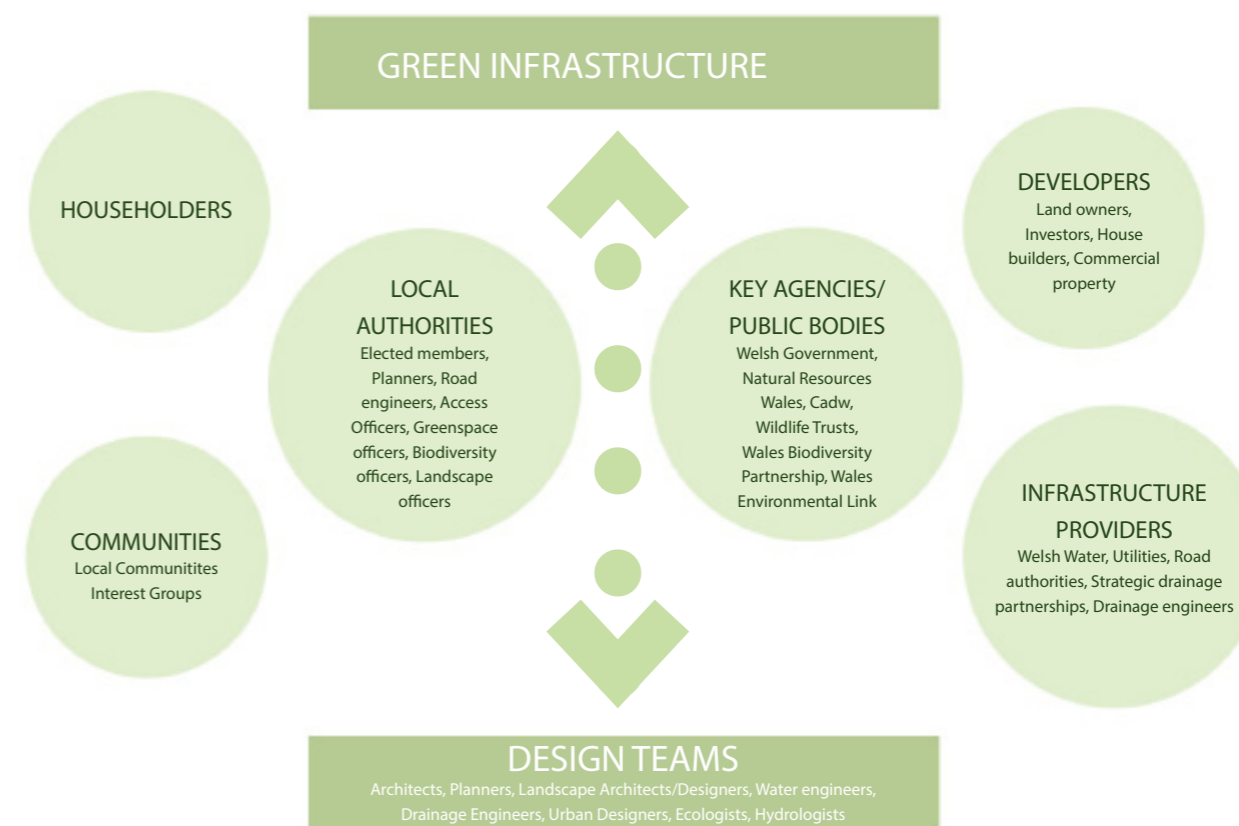


Figure 19. Cross-disciplinary and partnership working required to deliver the vision for quality GI.

34. <https://gov.wales/topics/environmentcountryside/climatechange/emissions/?lang=en>
 35. Circular economy <https://www.ellenmacarthurfoundation.org/circular-economy/concept>

4 SWANSEA'S GREEN INFRASTRUCTURE

Setting

The City of Swansea lies in an attractive coastal area. It is bordered by three wildlife corridors: The Swansea Bay Wildlife Corridor, the River Tawe Wildlife Corridor and the Hillside Wildlife Corridor. Swansea Bay, which sweeps for 8 kilometres to the west, is to the immediate south of the City. The promenade is accessible to pedestrians and cyclists, who enjoy splendid views and fresh air. The whole bay is a Site of Importance for Nature Conservation.³⁶ Blackpill Beach and the western half of the bay is a Site of Special Scientific Interest (SSSI), is an important intertidal habitat for migratory waterbirds.

The eastern boundary of the Swansea Central Area is marked by the River Tawe Wildlife Corridor, which has had a barrage at the river mouth since 1992. Across the Tawe to the immediate south east is the SA1 Swansea Waterfront district. Along the northern edge of the docks are new commercial and education facilities.



Figure 20. Swansea Bay Wildlife Corridor

North of the Fabian Way, which is the main highway access to the east of the city, is a residential area. To the north of that is Kilvey Hill, which provides good views of the city centre. Kilvey Hill is covered with plantation woodland, grassland, heathland and wetlands. Part of it is managed as Community Woodland. To the immediate east of Kilvey Hill, is Crymlyn Bog National Nature Reserve, a SSSI.³⁷

To the north west of the city centre, are hillside residential suburbs, including Mayhill. The Hillside Wildlife Corridor connects Bryn-y-Don Park³⁸ with the Rosehill Quarry Community Park.³⁹ To the west and south-west of the city centre is Sandfields and the Vetch Veg allotments and open space close to the city centre sited on the former Swansea City FC ground.⁴⁰



Figure 21. River Tawe Wildlife Corridor, with the City in the distance

36. Swansea Bay SINC <https://www.swansea.gov.uk/swanseabay>

37. Crymlyn Bog <https://sac.jncc.gov.uk/site/UK0012885>

38. Bryn Y Don Park <https://www.swansea.gov.uk/brynydon>

39. Rosehill Quarry <https://www.opengreenmap.org/greenmap/swansea-green-map/rosehill-quarry-1288>

40. Veg Vetch <http://www.sustainableswansea.net/vetch-veg.html>



Figure 22. Existing Assets

Existing Assets

Swansea City Centre was badly damaged by bombing in 1941. The 1950s and 1960s saw a period of significant post-war reconstruction, which has left a legacy of spaces dominated by sealed surfaces, including many large car parks. This makes it vulnerable to surface water flooding and the urban heat island effect. There are street trees, with large trees in selected locations (church yards and Castle Square) however tree canopy cover is patchy. There is very little semi-natural vegetation, with ground cover, where it occurs, usually dominated by amenity grassland and non-native shrubberies, although there is semi-natural vegetation around the dunes along the beach front and scrub and other rough vegetation along the River Tawe. The southern part of the City Centre is very different, with the large area of open water of the former dock in the Maritime Quarter and the lawn and trees surrounding the Civic Centre. Table 3 shows cover of various categories of green infrastructure in Swansea central area. Overall terrestrial GI cover in Swansea Central Area is 13%.



Figure 23. Castle Square

Table 3. Green Infrastructure in Swansea central area by category

Category of Green Infrastructure	Area (hectares)	%
Amenity greenspace	9.3	7
Cemeteries & Churchyards	0.4	<1
Civic greenspace	3.3	2
Semi-natural	4.5	3
Total terrestrial GI (total of areas listed above)	17.5	13
Water (marina)	7	5
Total GI (including marina)	24.5	18
Total Swansea Central Area	134.6	100



Figure 24. Swansea at dusk

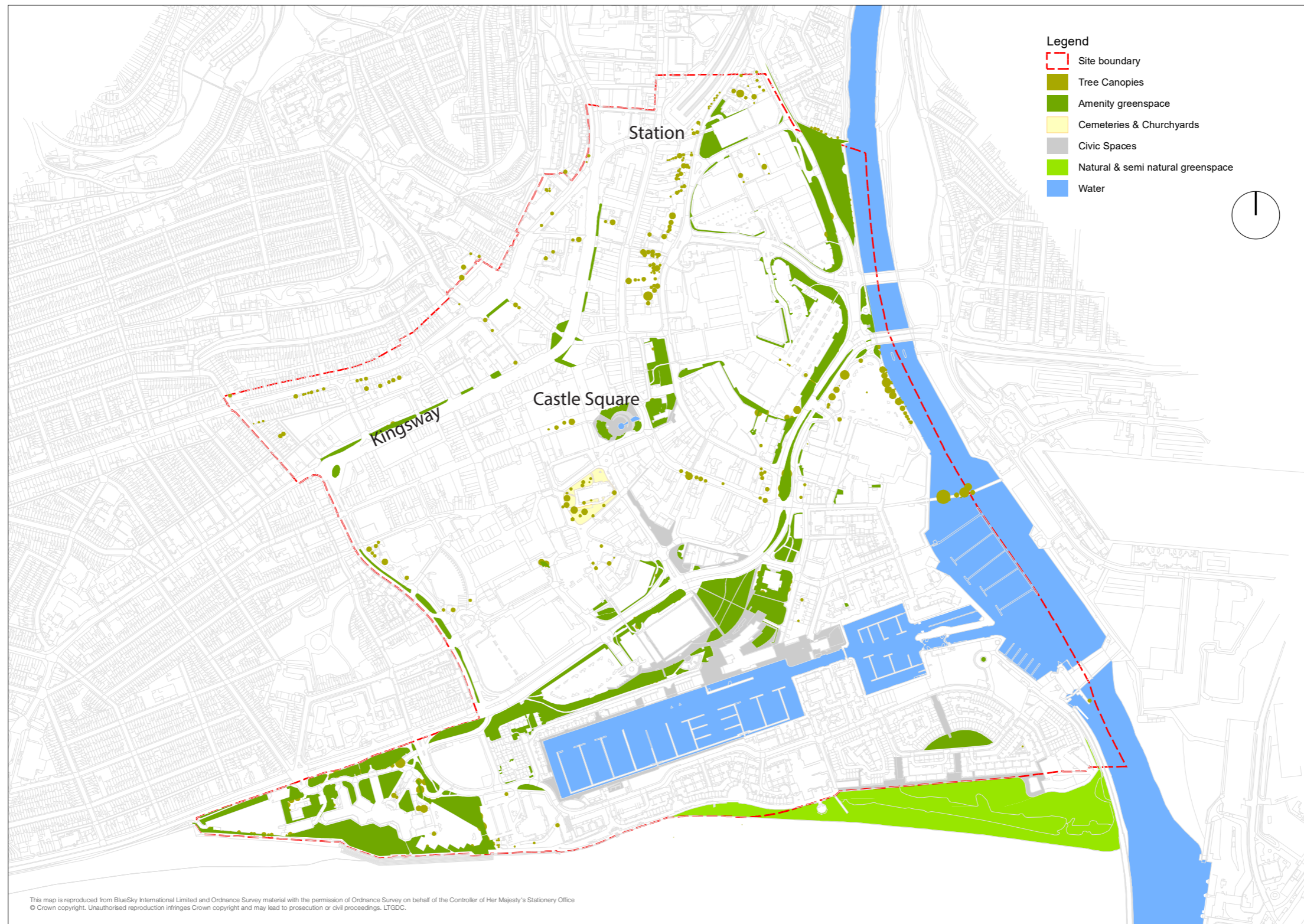


Figure 25. Existing green infrastructure in Swansea's Central Area

The Swansea Central Area Regeneration Framework divides the central area into 10 districts, as shown in figure 26. The districts and opportunities for greening in each, are described in the paragraphs that follow:

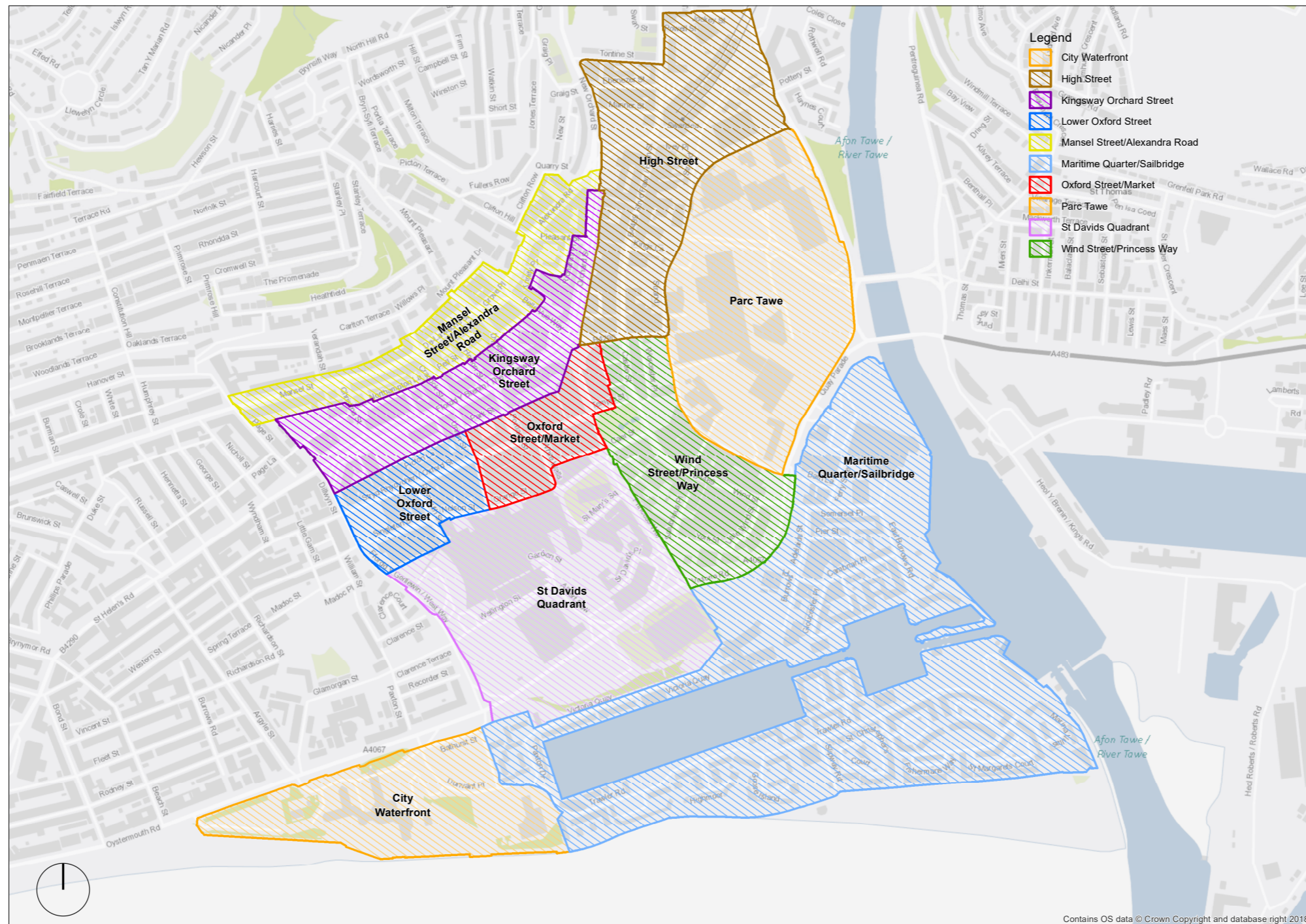


Figure 26. The 10 Swansea Districts

The High Street area is the key route from the railway station south towards Kingsway to the west and Wind Street to the south east. Its importance as a retail street has declined over the years following the establishment of the Quadrant. There are improvements underway associated with the Urban Village scheme,⁴¹ and permission for development has been granted at the Mariner Street surface car park site. The High Street area is heavily built-up - there are a few pockets of vegetation, including 'wasteland' vegetation of self-established trees and shrubs at the rear of the Grand Hotel. There are street trees along some sections of the High Street. There are also occasional ornamental planters and amenity tree plantings elsewhere, including a lawn where the Strand runs past the multi-storey car park and lawns and trees outside of Alexandra House.

Wind Street and Princess Way continue south from the High Street. This is a densely developed commercial and residential area with bars, clubs and restaurants. Wind Street itself has an almost continuous avenue of London plane trees, planted on the eastern side of the street. At the northern end of this area is Castle Square and Swansea Castle. Castle Square is paved with a large water feature, however there are approximately twenty mature trees around the perimeter of the square, including Norway maple, birch and cherry with amenity grassland and shrubberies beneath. Swansea Castle has amenity grassland within its curtilage. There are hanging baskets and ivy is growing on the castle walls in a few places.

Parc Tawe is a retail park to the south-east of the High Street. It is dominated by large retail buildings with car parks. The car parks have shrubberies planted with non-native ornamental species and there are lines of trees, mainly maples, with some lime and whitebeam. Where Parc Tawe meets the River Tawe, there are two highway crossings and the river bank is urban, however semi-natural vegetation occurs on the river banks to the north beyond the city centre.

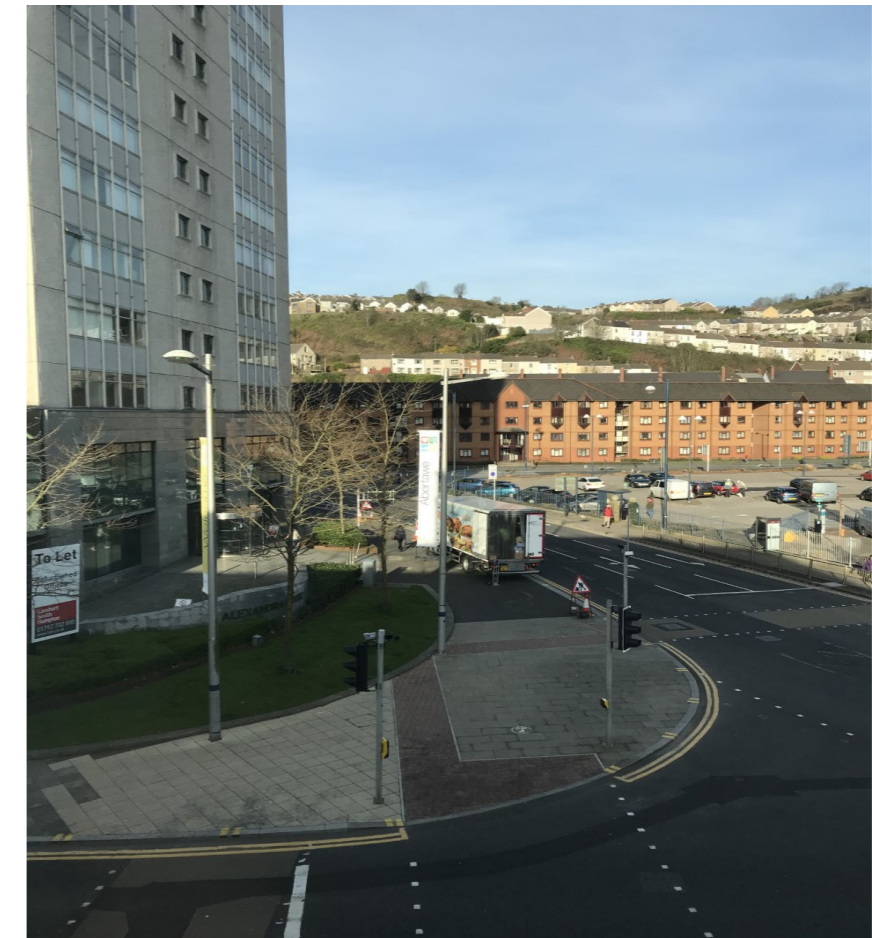


Figure 27. Green suburbs in the distance (view from close to Swansea Station)

To the south of Parc Tawe, across the Oystermouth Road, is the Maritime Quarter. This is the largest area within the city centre, consisting of residential and commercial development around the Tawe Basin, formerly part of the Swansea Docks and now used as a marina. There are shrubberies and trees (including pines) around the Sainsbury's supermarket car park. The largest green space consists of amenity grassland and birch trees in the curtilage of the National Waterfront Museum. In addition, there are tree plantings along Oystermouth Road and amenity grassland and ornamental plantings by Fisherman's Way. Just outside the Maritime Quarter, to the south and close to the river mouth, is a small area of sand dunes managed as a nature reserve.

41. Urban Village <https://www.coastalha.co.uk/Pages/Next-phase-of-Urban-Village-development-given-green-light.aspx>

The west of the Maritime Quarter, is the City Waterfront. This consists of the Civic Centre, library, hotel and associated car parks. The landscape around the Civic Centre is amenity grassland, mature stone pines, maples and shrubberies alongside.

The Promenade. Just beyond the Civic Centre, on the beach, is an artificial dune project,⁴² designed to create habitat and to reduce the amount of sand blowing onto the promenade.

St Davids and the Quadrant is a commercial area to the north of Oystermouth Road and the Maritime Quarter. It is dominated by car parks and commercial buildings. There is amenity grassland and shrubberies by the pedestrian bridge which crosses Oystermouth Road and there are trees and amenity planting by Oystermouth Road. To the north of the Tesco supermarket and around the edges of the Tesco car park are lines of trees. Other greenspaces in this area are the lawns and trees around St David's Priory Church and St Mary's Churchyard, which includes a number of fine mature trees, including London plane, and amenity grassland. The churchyard pre-dates the commercial development that surrounds it.

To the north of St David's Church is the Oxford Street and Market area. This is another commercial and retail area. Green infrastructure is limited to street trees (mostly London plane). The Lower Oxford Street area is a continuation of the commercial and residential development associated with Oxford Street. There are street trees, including Norway maple and London Plane in a few locations, although canopy cover is fragmented.

Kingsway and Orchard Street is another commercial and retail area to the north of Oxford Street. There are street trees in a few locations, however canopy cover is patchy here also. There are mature trees Mount Pleasant Baptist Church. Mansel Street and Alexandra Road is to the north of Kingsway and Orchard Street. This is a residential area with small shops lining the streets. Although most rear gardens are covered with extensions, there are some that retain vegetation. There are street trees, including lime and whitebeam, however canopy cover is intermittent.

Swansea has experienced losses in greenspace, a decline in biodiversity, poor air quality and poor water quality in the Lower Tawe and Swansea Bay. People living next to major highways suffer from noise pollution.⁴³ People living in the city centre north of Oystermouth Road do not live within easy reach (300m or a 5-minute walk) of a substantial accessible greenspace as defined by Fields In Trust. Countryside Council for Wales (now part of Natural Resources Wales), recommended that no person should live more than 300m from their nearest natural greenspace. This is roughly the equivalent of a six-minute walk. The proposals outlined in this strategy will help the city to meet this objective. Swansea City Centre's resident population of approximately 10,000 (swollen daily by workers and visitors), includes some of the most deprived and vulnerable people in Wales.⁴⁴

Proposals

The Swansea Central Area Regeneration Framework (2016) and the Local Development Plan (2019) includes proposals and redevelopment initiatives which have the potential to include green infrastructure.

These are described in brief here and shown in figure 30 (on page 34) . These proposals were preliminary at the time they were described and will be subject to design development.

42. Sand dune project, Swansea Bay <https://www.coastalha.co.uk/Pages/Next-phase-of-Urban-Village-development-given-green-light.aspx>

43. Environmental challenges in Swansea <https://www.swansea.gov.uk/article/30953/The-natural-environment-is-healthy-and-resilient>

44 . PPW Technical Advice Note 16 Sport Recreation and Open Space <https://gov.wales/sites/default/files/publications/2018-09/tan16-sport-recreation-open-space.pdf>

A number of these locations are essential elements of the proposed Green Artery and wider green infrastructure network. It is important that every opportunity is taken to maximise the area of soil, water and vegetation created both at ground level, but also on buildings. This suggests potential GI enhancements which should be considered into any redevelopment and refurbishment.

Through St. Davids and the Quadrant, the Swansea Central phases 1 and 2 schemes will make a substantial contribution towards green infrastructure. Swansea Central Phase 1 includes the construction of a new digital arena, adjacent car park with a rooftop coastline park and green walls. A Digital Bridge connects to the north side Oystermouth Road and Swansea Central Phase 2. Phase 2 incorporates mixed use development to complement the St Mary's and St David's Church and to connect to Whitewalls and Castle Square (via Caer Street).

In Oxford Street there will be opportunities for urban greening on the Oxford Street School site. There will be new public spaces, and pockets of public realm along the street with opportunities for greening.

The redevelopment of Castle Gardens will include an enhanced public realm. One of the key objectives are that it should adopt an overall principle of retaining and enhancing public access and contributing to a greener Central Area with no loss of useable greenspace. The enhancement of the Square will play an important role in connecting greenspace around the historic Castle, to St Mary's church and contributing towards the creation of the City's green artery.

The key objective for Wind Street is to realise the full potential as a focus for the city's dining, drinking and entertainment economy. In the context of proposals to reduce carriageway widths

and widen pedestrian space and being enhancements and redevelopments there be scope for urban greening interventions.



Figure 28. Oxford Street

Along Alexandra Road and Mansel Street, there may be opportunities for the planting of street trees and private owners and tenants could be involved in greening through the establishment of rain gardens and wildlife gardens.

Along Kingsway and Orchard Street, plantings of street trees and the creation of new planters, including rain gardens, will be complemented by pockets parks in courtyards and rooftop gardens and green roofs on new developments such as the Digital Village on the former Oceana site. The southern aspect of the Digital Village on the former Oceana site will include significant new GI. A

new multifunctional green public space space will be created on Picton Yard.

Along the High Street, there are developments such as Coastal's Urban Village including roof top gardens and courtyards. On street parking and relatively narrow pavements means that space is generally limited, however there are opportunities to enhance exiting urban greening to increase multi-functionality and more biodiverse vegetation. Additional connecting linkages may come forward for properties between High Street and the Strand and Parc Tawe.

In Parc Tawe, the edge of centre retail park may offer opportunities to green car parks through de-paving and when buildings are re-developed green roofs and green walls can be included in the plans. In the longer term the site could accommodate extensive green infrastructure forming part of strategic connections to adjacent areas, and blue (water space) which symbolise the former pre industrial river alignment along the Strand.

The Civic Centre and City Centre Waterfront sits within a swathe of existing greenspace on the city side of Swansea Bay. In the medium to long term, redevelopment of this site is envisaged with mixed leisure and residential uses set within a layout with a key north/south route which is part of the Green Artery, and which encourages walking and cycling between the Central area and the Swansea Bay seafront. Public spaces and thoroughfares in the scheme will incorporate rain gardens and street trees offering shade and shelter, and buildings will incorporate green walls and roofs.

In the adjacent Maritime Quarter and its conservation area, there are pockets of street trees, and limited formal landscaped areas within the largely hard-surfaced areas focused around the former South Dock. The Swansea Point dunes are an area of natural habitat and a significant area of green infrastructure on the seaward frontage of the Maritime Quarter. There are also several development sites where targeted urban greening can be brought forward as part of future new development, including vacant development sites adjacent to Swansea Point, and the Sailbridge site adjacent to the River Tawe.



Figure 29. Maritime Quarter

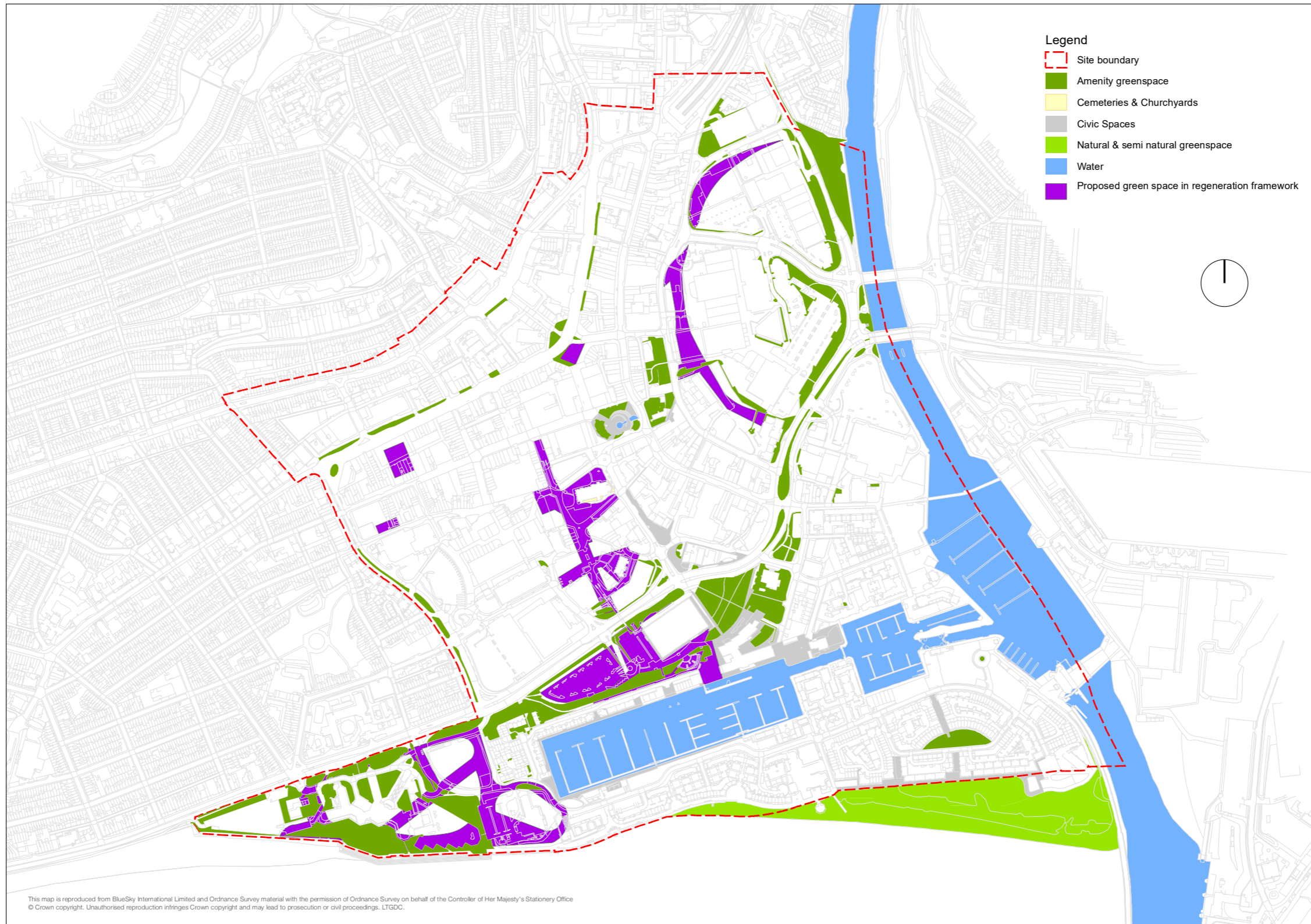


Figure 30. Opportunities for Greening

5 IMPLEMENTATION

Working Together

Green infrastructure benefits all and the provision of green Infrastructure is already the responsibility of many. Although national and local government can coordinate and set direction by producing policies, strategies and guidance, it is important that organisations and individuals who are not traditionally involved with soil, water and vegetation, are aware of opportunities for them to contribute. A communication network should be developed that promotes partnership working and shares information and experiences through social media, training and events. Time should be taken to acknowledge and celebrate progress.

Feasibility

All of the urban green infrastructure typologies described in this strategy (see appendix 1) are proven, even though some of the techniques are relatively new in the UK. At ground level, the planting of trees and the provision of ornamental planters is already standard practice in the public realm and private gardens are popular. With proposals submitted for planning permission, applicants would normally expect to be required to include some green infrastructure, in line with Policy ER03 and the Green Infrastructure SPG. The challenges are to maximise the area of green infrastructure provided, to ensure that as many ecosystem services as possible are provided and to ensure a net gain in biodiversity.

Impact

Green infrastructure can play a useful role wherever it is located, however it is often helpful to prioritise particular locations for the most appropriate interventions. The report on Green Infrastructure Opportunity Mapping and Multi-Scale Delivery

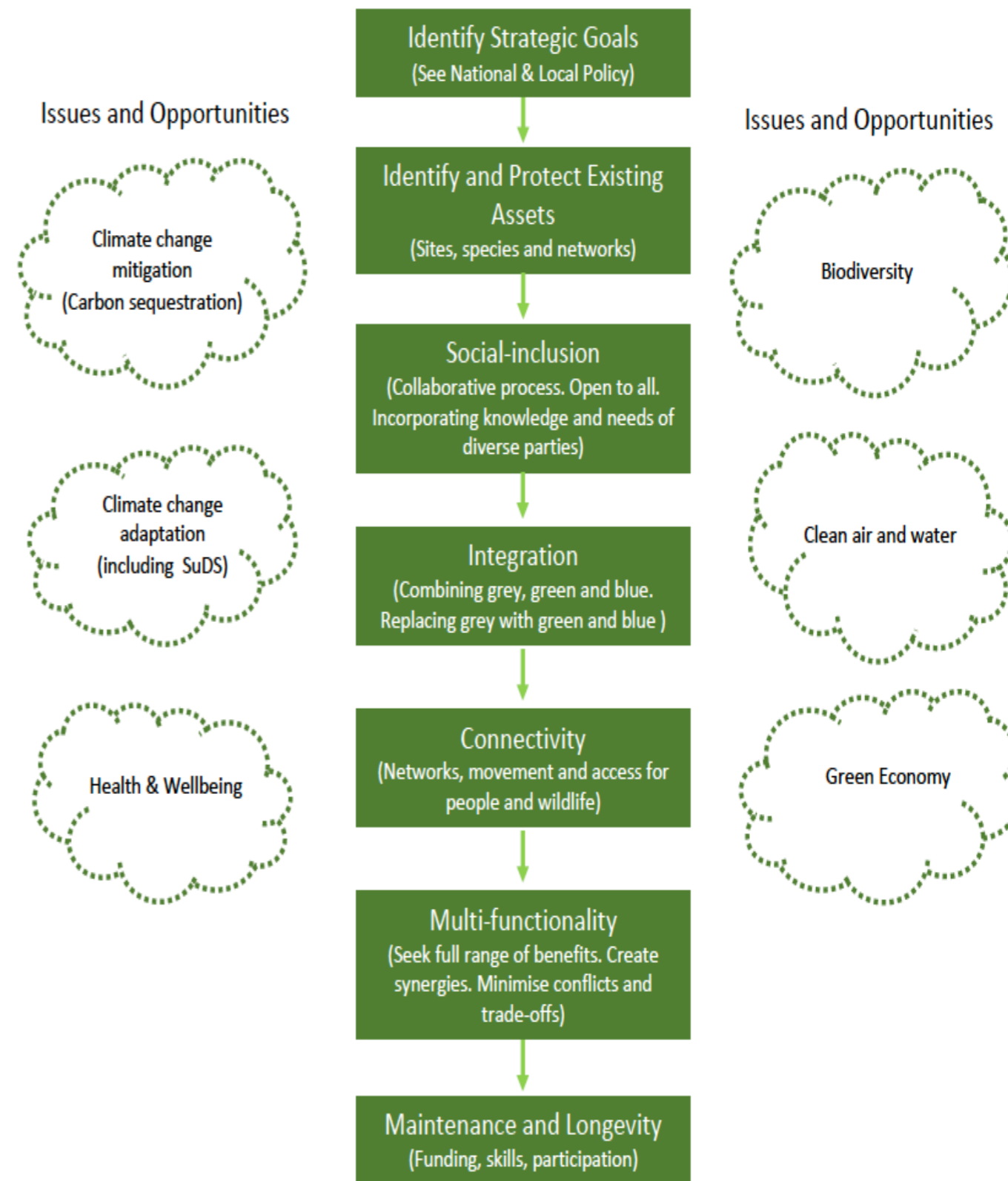


Figure 31. Planning and implementing green infrastructure



Figure 32. Planting a raingarden

Swansea Castle Ward Case Study (2018) shows locations where there are demands for reduction in air pollution, standing water and pluvial (surface water) flooding, improvements in water quality and where there is an absence of accessible green space.⁴⁶

This strategy should be strengthened by more detailed green infrastructure audits, which identify issues and opportunities at a smaller scale and include specific proposals which can be taken forward for detailed design and delivery.

Swansea Council will apply the Green Space Factor Tool (GSF) in consideration of all development in the Swansea Central Area (see Appendix 2). This is a simple method for measuring the area and likely effectiveness (in providing various ecosystem services) for various green infrastructure types included in project proposals. The Swansea Council will use this tool to assess the quantity and

quality of green infrastructure and may choose to set minimum targets in the city centre where redevelopment is proposed. Software that can model microclimates and identify priority areas for the location of green infrastructure (including for example Greenpass⁴⁷) can be used by planners and designers of large-scale developments to ensure development maximise their contribution to the 5 GI Principles. The GSF tool is considered the effective measure for looking at how much permeable green space is needed across a development. Natural Resources Wales and Swansea Council see the GSF tool as best practice for planning the enhancement of GI in the city centre, delivering the Green Artery as set out in the SCARF and meeting obligations of the statutory SuDS standards for Wales under Schedule 3 to the Flood and Water Management Act 2010.

Value

The challenge of linking the provision of infrastructure to specific economic benefits is not unique to GI. Like all other infrastructure needed to support development, effective GI is essential to support a healthy and economically successful city. GI can make an important contribution to the attractiveness of cities and neighbourhoods for investors, residents and visitors. This contribution is well described and understood by many city planners and developers and increasingly supported through good practice.⁴⁸ The evidence shows that increasing the attractiveness of an area through investment in high quality multifunctional GI increases inward investment and property values, visitor dwell time and spend, and can reduce the long-term cost burden on public services. Development costs can also be reduced as traditional equivalent grey infrastructure, is often more expensive to design and install. For example the Welsh Government Analysis of the Evidence for SuDS, concludes:⁴⁹

46. Environment Systems (2018) Green Infrastructure Opportunity Mapping and Multi-Scale Delivery. Swansea Castle Ward Case Study

47. Greenpass - modelling urban green infrastructure for climate change adaptation. See greenpass.at

48. DEFRA & Natural England 2013. Green Infrastructure's contribution to economic growth: A Review http://sciencesearch.defra.gov.uk/Document.aspx?Document=11406_GI_Economic_Catalyst_Final_Report_July2013.pdf

49. Welsh Government 2017. Sustainable Drainage Systems on new developments. Analysis of evidence including costs and benefits of SuDS construction and adoption Final Report.

- The overall capital costs of well-designed, good quality landscaped SuDS solutions are always less than those for conventional solutions. In most cases, overall operational and maintenance costs are also lower.

- SuDS are not just an alternative to conventional drainage solutions. They can provide significant and multiple benefits and have particular potential to help Wales meet well-being and wider sustainability goals. Although the arrangements for the way in which water and surface water systems are managed in Wales has evolved in the last decade and there are still many players with diverse responsibilities, all key stakeholders support the role that SuDS can play in achieving these aims.

- Across the 110,000 new homes planned for Wales by 2021, analysis suggests that the use of landscaped SuDS on new developments that are compliant with required standards could save Wales nearly £1 billion in capital construction costs and generate benefits of over £20 million per year.



Figure 33. SuDS should be multifunctional (Credit: Robert Bray Associates)

Budgetary constraints and competing cost demands on development schemes mean that greening is often an element that is considered at the end of the design process and is often scaled back and compromised. Given the proven positive returns on investment from green infrastructure, it is anticipated that a more positive forward-thinking approach should be applied to GI. Now that SuDS are mandatory for new development in Wales, more money will be spent on green infrastructure, however it is important that water quality, biodiversity and amenity are considered in such schemes, as well as the volume of water being stored or attenuated. Sustainable drainage, the use of the Green Space Factor tool and the planning process will require green infrastructure to be provided to meet planning authority requirements. In turn budgets for construction projects should include an allowance so that these new expectations can be met. Green infrastructure is typically a very small proportion of the total cost of construction, and good planning, with the principles set out in this strategy, embedded in schemes at an early stage in the design process, will ensure that GI is given due consideration in any assessment of viability.

“Much has been discussed and documented about the bottom-line benefits of green infrastructure but planting trees, building rain gardens or using porous paving alone are not enough to create sustainable real estate. To be truly sustainable, green infrastructure must add value, enhance the occupier experience and be flexible enough to adapt and respond to changing social, economic and technological conditions.”

Professor Yolanda Barnes of the Bartlett, UCL

With existing interest rates low and stable, Professor Barnes of the Bartlett, UCL predicts a transition from capital growth to rental growth in real estate. Rental growth is much more about what people want, rather than just capital growth. Today, the rising costs of energy and maintenance are eroding returns. There is also a realisation that green (and blue) infrastructure will become a fundamental component to the success of real estate. The demand for fixed income assets is growing rapidly and is unlikely to abate anytime soon, contributing to global interest rates falling and remaining low. Resulting real estate assets are now under pressure to create income streams (so investor institutions can pay pensions) rather than just grow in value. Resilient and sustainable buildings with lower maintenance costs will result in a better long-term income stream. The success of real estate will depend on its interaction with green infrastructure investment and its impact on returns, local economy and culture and popular appeal. What we have learned from the 21st century to date is that we need to understand the whole-place and to focus on interventions which are not prescriptive, but which encourage innovation and holistic solutions.

Maintenance

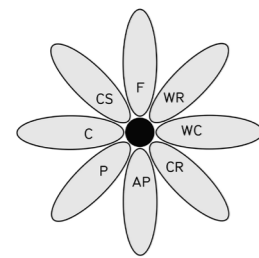
Greenspace, trees, sustainable drainage features, green roofs and green walls all require regular maintenance. Whenever green infrastructure is proposed, a maintenance plan (which identifies responsibilities, purpose, regular upkeep and contingency for remedial measures and budget), should be prepared. As well as the requirement to follow conventional best practice, there should be consideration of how ecosystem services can continue to be provided and how biodiversity can be maintained over the long term. It is expected that we need to be more innovative and sometimes less conventional in our approaches to maintaining our green infrastructure. For example, the early community engagement in developing this strategy highlighted a clear strong desire to be involved in future maintenance.

Monitoring

Outside of academic research, relatively little information is available from the UK on how urban green infrastructure continues to function after installation and how it continues to support wild plants and wild animals. Provision for the monitoring and evaluation of green infrastructure in the Swansea Central Area will be set out in a future action plan. This includes green infrastructure mapping by remote sensing at 5-year intervals, with appropriate ground-truthing. The green infrastructure elements of approved developments as well as the results of detailed green infrastructure audits and habitat mapping, will be retained by Swansea Council and Natural Resources Wales.

APPENDIX 1 - URBAN GREEN INFRASTRUCTURE TYPOLOGIES

The purpose of this note is to describe the range of urban green infrastructure types referred to in the Green Space Factor tool and to consider the ecosystem services (benefits) that are likely to be provided. It is not intended to be encyclopaedic (other types and features are available) and does not consider the biodiverse sub-types included in the Swansea Green Space Factor scoring system.



Petal Diagram Key


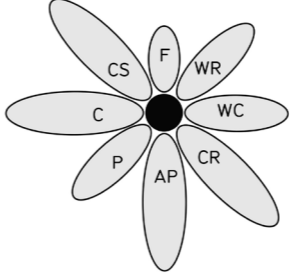

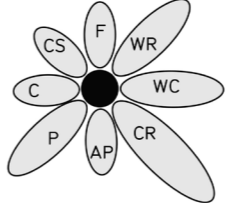

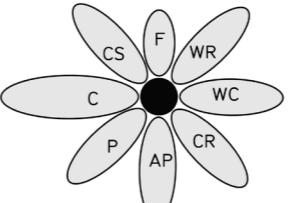

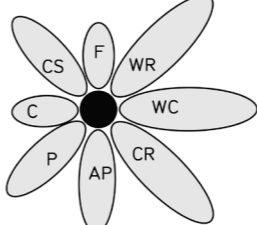
- F Food
- WR Water Regulating
- WC Water Cleansing
- CR Climate Regulation
- AP Air Pollution Abatement
- P Pollination

Each petal represents a different category ecosystem service provided by the green infrastructure type. The size of the petal gives an approximate measure of the relative strength of that ecosystem service.


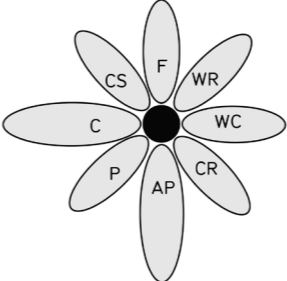

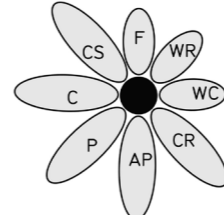

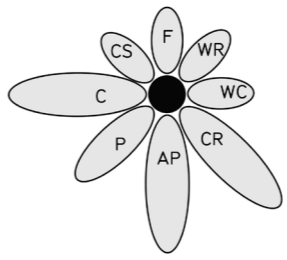

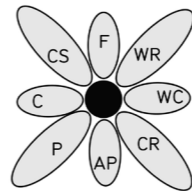
Urban Green Infrastructure Type	Comments	Image	Ecosystem Services	Biodiversity Value	GSF Score
Semi-natural vegetation (e.g. woodland, flower-rich grassland)	Although unusual to have semi-natural vegetation with native species in urban areas, this can occur and is desirable in terms of biodiversity and the range and ecosystem services provided. An example in Swansea is the sand dune habitat close to the river mouth as well as woodland associated with the River Tawe corridor.			High	1
Wetland or open water created on site	Usually limited opportunities in urban areas, however extremely valuable where it does occur.			High	1
Intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm – See livingroofs.org for descriptions.[i]	Extremely variable, important amenity space in locations where greenspace may be limited. Biodiversity can be boosted by following wildlife gardening advice.[ii]			Low-Moderate	0.8

i. <https://livingroofs.org/intensive-green-roofs/>

ii. <https://www.wildlifetrusts.org/gardening> <https://www.rspb.org.uk/birds-and-wildlife/advice/gardening-for-wildlife/>

Urban Green Infrastructure Type	Comments	Image	Ecosystem Services	Biodiversity Value	GSF Score
Standard trees planted in natural soils or in connected tree pits with a minimum soil volume equivalent to at least two-thirds of the projected canopy area of the mature tree - see Trees in Hard Landscapes for overview. [iii]	Important that tree pits are designed to receive surface water runoff by using soil cells of Stockholm tree pits. Biodiversity value will depend on species selection.			Low-High	0.8
Extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014.[iv]	Essential that adequate substrate depth is provided to absorb rainfall and store water for subsequent evapo-transpiration. Biodiversity value will depend on species selection.			Moderate-High	0.7
Flower-rich perennial planting – see Centre for Designed Ecology. [v]	Can include species to attract pollinating insects.			Moderate	0.7
Rain gardens and other vegetated sustainable drainage elements – See CIRIA for case studies.[vi]	Careful design required to ensure levels are correct, that soil has been amended to be free-draining and water-absorbent and that overflow route is created in event that capacity of rain garden is exceeded. Biodiversity value will depend on size and planting palette.			Moderate-High	0.7


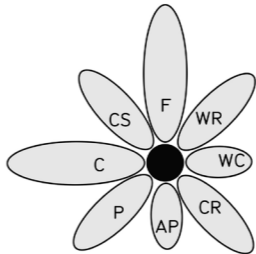

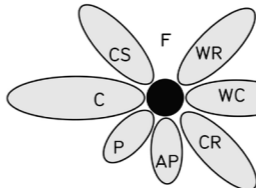

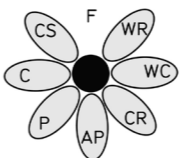

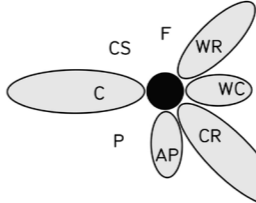
iii. <http://www.tdag.org.uk/trees-in-hard-landscapes.html>
iv. <https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf>
v. <https://cfde.co.uk/front-page/about/case-studies/>

Urban Green Infrastructure Type	Comments	Image	Ecosystem Services	Biodiversity Value	GSF Score
Hedges (line of mature shrubs one or two shrubs wide) – see RHS for guidance [vii]	Hedge should be large enough (width and height) to provide cover for nesting birds. Value for larvae food plants will be increased if native species are used.			Moderate-High	0.6
Standard trees planted in pits with soil volumes less than two thirds less than the projected canopy area of the mature tree.	Ideally larger tree pits will be used, however sometimes available space is limited. Biodiversity value depends on species selection.			Low-Moderate	0.6
Green wall – modular system or climbers rooted in soil – see NBS Guide to Façade Greening for overview. [viii]	Wide range of systems and planting methods. Wherever possible should use climbers rooted in soil. Where irrigation is required harvested rainwater should be used if feasible. Biodiversity value will depend on plant species selection.			Moderate-High	0.6
Groundcover planting – see RHS Groundcover Plants for overview [ix]	Wherever feasible, planter beds should be designed to received surface-water run (see rain garden). Planting should be native or of documented value for wildlife in order to maximise biodiversity value.			Low-Moderate	0.5

vi. <http://www.susdrain.org/>


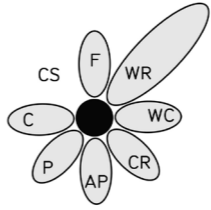

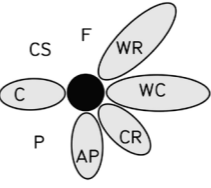


vii. <https://www.rhs.org.uk/advice/profile?pid=351>

viii. <https://www.thenbs.com/knowledge/the-nbs-guide-to-facade-greening-part-two>

Urban Green Infrastructure Type	Comments	Image	Ecosystem Services	Biodiversity Value	GSF Score
Allotments or raised beds for food growing	Although growing food is the main focus, consideration should be given to providing flowers for pollinating insects and avoiding the use of biocides that harm wildlife			Low-Moderate	0.5
Amenity grassland (species-poor, regularly mown lawns)	This is the default vegetation type with urban greening (often combined with tree planting). Unless there is a specific requirement for a lawn for amenity or recreational purposes, this should be avoided. Where possible, lawns should be planted with a range of low-growing wild flowers (e.g birds foot trefoil) to attract pollinating insects.			Low-Moderate	0.4
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014. [x]	To be avoided			Low	0.3
Open water (chlorinated)	Although this feature may form part of an amenity landscape, it receives a low GSF score because of its low biodiversity value. Most important ecosystem services are cultural (aesthetic, recreational) and evaporative cooling			Low	0.2

ix. <https://www.rhs.org.uk/advice/profile?PID=818>

x. <https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf>

Urban Green Infrastructure Type	Comments	Image	Ecosystem Services	Biodiversity Value	GSF Score
Unplanted detention basins	Although this feature may form part of a sustainable drainage system, it receives a low GSF score because of its low biodiversity value.			Low	0.2
Permeable paving - see CIRIA for overview [xi]	Although this feature may form part of a sustainable drainage system, it receives a low GSF score because of its low naturalness/ biodiversity value.			Low	0.1
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	Sealed surface should be avoided unless there is a requirement for hard wearing surfaces or smooth surfaces for cycles, wheelchairs etc			Negligible	0
Bird boxes, bat boxes, bug hotels etc	Although these are not landscape typologies, applicants will be encouraged to include these features in their plans.			High	n/a

xi. <http://www.susdrain.org>

SWANSEA CENTRAL AREA GREEN SPACE FACTOR TOOL

August 2019

1 INTRODUCTION

1.1 Green Space Factor (GSF) tools are used by planners, designers and planning authorities to make an assessment of the quantity and functionality of green infrastructure included in planning applications. Planting types within a site are measured and scored, and an overall score for a site (between 0 and 1) is calculated. A minimum target for a scheme to meet can be set. (See section 2 for more details of how the measurements are undertaken). GSF schemes have been applied in a number of cities around the world, beginning with Berlin in the 1990s. Similar schemes spread to other German cities (including Hamburg) and then overseas, including Sweden (Malmö), the United States (including Seattle and Washington DC) and Canada (Toronto). The City of Southampton was the first UK planning authority to develop a GSF scheme. A partnership led by the Red Rose Forest developed a GI Toolkit based on a GSF approach for England's North-West region in 2008. More recently the Greater London Authority has proposed the use of a GSF scheme as part of its urban greening policy in the draft New London Plan¹. The City of London was the first local planning authority in London to promote the approach.²

1.2 Swansea Central Area is undergoing significant re-development and there is growing awareness of, and an associated body of evidence for, the multiple benefits of green infrastructure, including measurable net positive impacts on physical health and mental wellbeing. Swansea Council and Natural Resources Wales are committed to realising these benefits. It is also the case that green infrastructure will have a critical role in improving the City's capacity to adapt to climate change. Natural Resources Wales, Swansea Council and Green Infrastructure Consultancy have

developed a GSF tool. It assists developers and planners to determine the appropriate level of urban greening required for development in the Swansea Central Area, in order to achieve the vision set out in the Swansea Central Area Regeneration Framework (SCARF) and the Swansea Central Area Regenerating Our City for Wellbeing and Wildlife Strategy. Multifunctionality is illustrated in the Appendix 1 petal diagrams, designed to demonstrate the contribution of GI typologies. The more balanced and larger the petals the more effective and multifunctional the GI type is.

1.3 Natural Resources Wales and Swansea Council are committed to using this GSF tool as a way of increasing the quantity and quality of green infrastructure in the Swansea Central Area with a special emphasis on schemes that contribute to the establishment of a 'Green Artery'. There are numerous opportunities to add greenery to new buildings and refurbished buildings, and where options to add more vegetation to certain buildings (e.g. Listed Buildings) may be limited, the tool can still be used to ensure all opportunities are explored. The GSF will be used as a planning tool and to facilitate pre-application discussion. It is to be used in combination with the Council's Local Development Plan (LDP) and the suite of Supplementary Planning Guidance (SPG) documents relating to amenity, green infrastructure and biodiversity. The tool will also help developers to demonstrate how they are integrating Sustainable Urban Drainage (SuDS) into their schemes. SuDS is now required by legislation.

1. <https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/chapter-8-green-infrastructure-and-natural-environment/policy-g5>

2. <https://www.architectsjournal.co.uk/news/all-schemes-in-square-mile-to-include-urban-greening-under-new-20-year-plan/10036754.article>

1.4 Whilst it will not be compulsory for the GSF tool to be applied to all proposals within the Swansea Central Area, applicants are expected to submit a GSF calculation in support of their plans. Where a GSF calculation is not provided applicants will need to provide extensive evidence demonstrating how the application meets the vision of the Green Infrastructure Strategy and supporting legislation. GSF scores may be calculated for application sites, buildings, buildings and their ground-level curtilage or street-level public realm for new building and refurbishment.

1.5 The benefits of the GSF tool include:

- increase in the use of multifunctional green infrastructure features
- urban greening on restricted sites
- a simple calculation mechanism, easily understood by non-specialists
- facilitation of conversations between developers and planners
- flexibility: scores and targets can be adjusted to reflect specific priorities

1.6 GSF schemes are part of a response to the problems associated with the increasing density of cities. They are usually applied in locations that tend to be dominated by multi-storey developments. Achieving a satisfactory GSF score

in developments with limited or no ground level greenspace (where a building covers most or all of a site) will normally require green roofs and green walls to be included.

1.7 GSF schemes may be perceived as an unnecessary additional administrative burden. This is more likely to be the case in cities, like those in the United States for example, where the attainment of a particular score is a pre-requisite of the permitting process. It has been suggested that fragile landscape features (like intensive green walls for example) could be included in plans for the purpose of meeting a target, with those features subsequently failing if not properly installed or maintained. It should be noted that artificially engineered features tend to require more maintenance and are more vulnerable to failure than retained existing features or more traditional planting in natural soils.

1.8 Although scoring schemes are relatively simple, the score assigned to any particular surface cover may vary from city to city and the assignment of a particular score to a particular landscape treatment can be subject to debate. There is the potential for low quality features (for example green roofs with inadequate substrate depth) to be used to formulate unsatisfactory schemes that meet the target score. These difficulties can be overcome by providing good definitions and

accurate descriptions of the various types of surface cover. If necessary, scoring schemes can be reviewed to address persistent shortcomings.

1.9 GSF schemes have been confused with certification or benchmarking methods designed to measure the sustainability or environmental performance of developments. BREEAM, for example, which assesses the sustainability of building and infrastructure projects, includes five assessment categories included under the themes of landscape and ecology. These categories are: site selection; ecological value of sites and protection of ecological features; mitigating ecological impact; enhancing site ecology and long-term impact on ecology. In contrast with the GSF calculation process, these BREEAM assessments require detailed baseline surveys, calculations and reports, which must be undertaken by suitably qualified persons. BREEAM schemes may also incur substantial costs. Although BREEAM is a valuable way of measuring environmental performance and encouraging designers to strive for excellence, it has not been devised as a tool for planners and could not be readily applied to the task of improving green infrastructure provision across entire planning zones or neighbourhoods.

1.10 Potential issues (depending on how a GSF is implemented) can include the following:

- given that a GSF determines only the quantum of broadly described categories, the design quality of each treatment cannot be assessed in detail;
- there is a possibility of the GSF scheme being too rigidly interpreted, with proposals meeting, but not exceeding, targets;
- Not promoting green roof and green walls could result in insufficient green infrastructure being created in schemes with tall buildings and a small ground-level curtilage.

1.11 In light of these issues, it will be essential to be clear and precise about how a GSF relates to the full suite of policies that influence greenspace planning and design. The GSF is the assessment tool promoted by Swansea Council and Natural Resources Wales. However, it will not be the sole method of assessing GI proposed as part of a development scheme and cannot be a replacement for good design. The GSF should be seen as a tool to complement and help deliver policies and standards on, urban greening, wellbeing, biodiversity and climate change adaptation, including summer cooling and sustainable drainage.

3. <http://www.breeam.com/>

2 SWANSEA CENTRAL AREA GREEN SPACE FACTOR TOOL

2.1 The tool is aimed primarily at new developments and refurbishments. It can be used to establish a baseline for retrofit projects and used to measure the associated improvements.

Minimum target scores will be an expectation and will be as follows:

- 0.3 for predominantly commercial developments and;
- 0.4 for predominantly residential developments.

These scores are based on experience of successful GSF schemes and will drive up standards. The scores can be increased in the future where there is the potential for further gains, as well as an appetite, to extend the scheme. GSF scores may be calculated for application sites, buildings, buildings and their ground-level curtilage or street-level public realm. Designs for taller buildings can easily meet the 0.3/0.4 target scores by including green roofs and green walls or by vegetating balconies and other features on upper floors.

2.2 The tool should be used from the conception, setting the tone of the scheme. For example, for schemes going through the RIBA stages, the tool should be used from RIBA Stage 0 and be revised and amended throughout the process.

2.3 In calculating an overall GSF score for any given proposed development it

is necessary to measure the overall area of the site and then to map and measure the coverage of various surface cover types within the site (see Figure 1). Surface covers include sealed surfaces, permeable paving, amenity grassland, trees and shrubs, extensive green roofs, roof gardens and green walls. Once the various parcels have been measured and categorised, then the total coverage of each surface cover can be quantified. Scores are then assigned to each surface cover. Then the calculation of the overall green space factor can begin. The score for each surface cover within a site is multiplied by its area. This generates a series

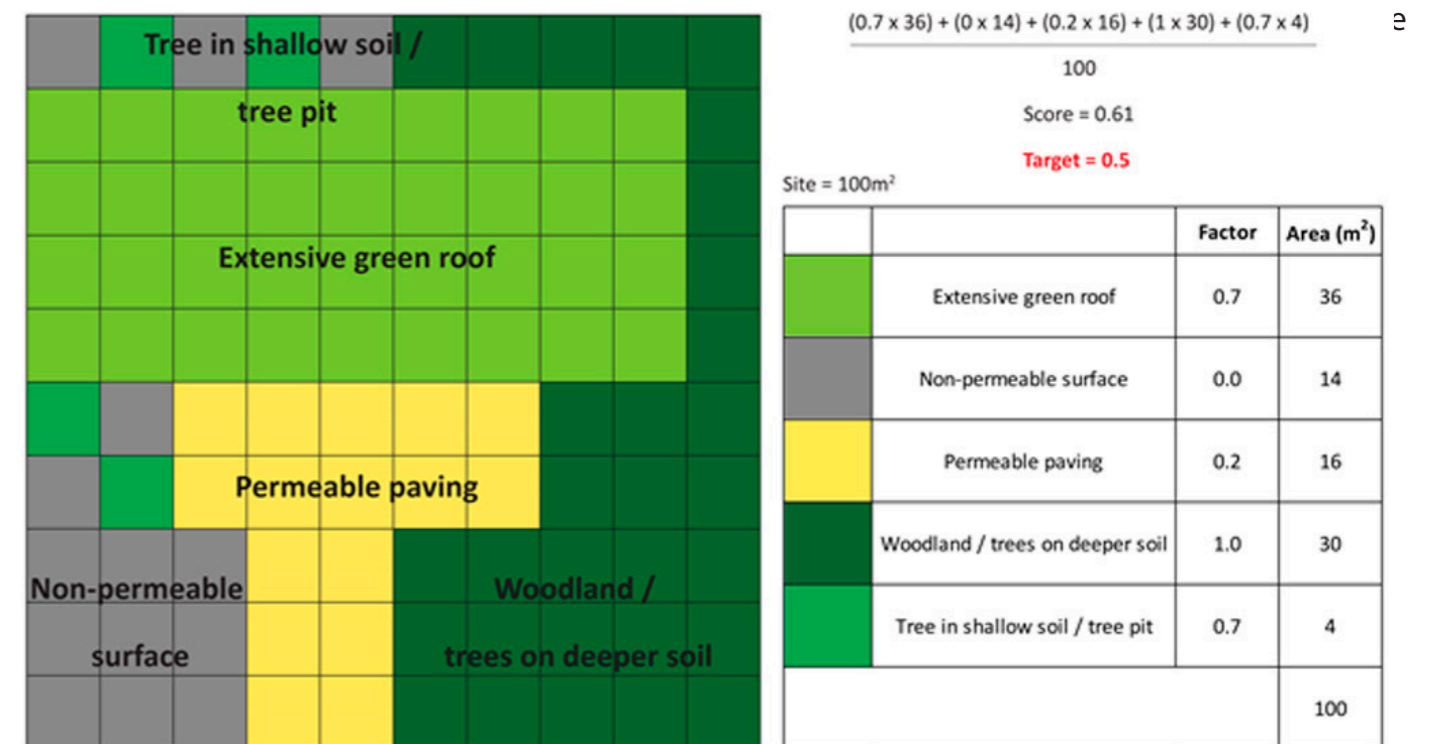


Figure 1. Diagram of simplified theoretical development site to demonstrate how the GSF works (modified from Southampton City Council's Guidance notes).

The diagram and table show a theoretical square development site of 100 square metres, explaining how the site has been analysed in terms of surface cover and areas of each type.

$$\frac{(\text{Score A} \times \text{Area}) + (\text{Score B} \times \text{Area}) + (\text{Score C} \times \text{Area}) + (\text{Score D} \times \text{Area}) \text{ etc.}}{\text{Total Site Area}}$$

Total Site Area

Figure 2. Formula for calculating the overall GSF score

A completed GSF score spreadsheet should be submitted in support of an application (such as SuDS or planning applications).

2.4 Scores are assigned according to the rate of infiltration of rainwater for each landscape element in a development.⁴ This basis in infiltrations highlights that the GSF tool is useful in demonstrating compliance with the Welsh Government statutory SuDS Standard 2019. In effect, scores are a simplified measure of the various benefits (ecosystem services) provided by soils, vegetation and water and are usually assigned on the basis of potential for rainwater infiltration. This is because the water-holding capacity of surface cover and associated soil is a good proxy for their ability to provide the range of benefits associated with natural systems. Ecosystem services

provided by urban landscapes include supporting services, provisioning and cultural services (particular therapeutic benefits), however there is a special interest in regulating services (notably climate regulation and the cleaning of water and air). Scores between 0 and 1 (in increments of 0.1) are allocated to each surface cover type, with impermeable surfaces such as concrete and asphalt assigned a score of 0 and the most natural surface cover such as open water/trees or woodland on deeper soils, awarded a score of 1. (See Table 1 listing all types between 1 and 0) The scoring system takes into account existing land cover, encourages retention of existing natural features and requires an overall increase in score compared with the existing condition. The performance requirements for surface cover types are not prescribed.

2.5 Table 1 lists the surface cover type and their corresponding scores for the Swansea Central Area and should be used to achieve the overall score. The table covers most eventualities, however, if a surface cover type is encountered which is not listed, it should be assigned the same score as the category in the table that is most functionally similar. An increase in scoring is specified for biodiverse versions of landscape typologies, in order to encourage efforts to ensure net gain/benefit in biodiversity value.

4. http://www.stadtentwicklung.berlin.de/umwelt/landschaftsplanung/bff/index_en.shtml

Table 1: Swansea Central Area Proposed GSF Scores

Surface Cover Type	Score
Semi-natural vegetation (e.g. woodland, flower-rich grassland) created on site	1
Wetland or open water (semi-natural; not chlorinated) created on site	1
Biodiverse intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm – See livingroofs.org for descriptions. ^[5] Planting to be with native species and/or species with documented value for biodiversity.	0.9
Intensive green roof or vegetation over structure. Vegetated sections only. Substrate minimum settled depth of 150mm – See livingroofs.org for descriptions. ^[6]	0.8
Standard trees planted in natural soils or in connected tree pits with a minimum soil volume equivalent to at least two-thirds of the projected canopy area of the mature tree -see Trees in Hard Landscapes for overview. ^[7]	0.8
Biodiverse extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014. ^[8] For advice on attracting invertebrates to extensive green roofs see BugLife. ^[9]	0.8
Biodiverse rain gardens and other vegetated sustainable drainage elements – See CIRIA for case studies. ^[10] Planting to be with native species and/or species with documented value for biodiversity.	0.8
Extensive green roof with substrate of minimum settled depth 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014. ^[11]	0.7
Flower-rich perennial planting – see Centre for Designed Ecology. ^[12]	0.7
Rain gardens and other vegetated sustainable drainage elements – See CIRIA for case studies. ^[13]	0.7
Biodiverse green wall – modular system or climbers rooted in soil – see NBS Guide to Façade Greening for overview. ^[14]	0.7
Native hedges (line of mature native shrubs one or two shrubs wide)	0.7
Hedges (line of mature shrubs one or two shrubs wide) – see RHS for guidance ^[15]	0.6
Standard trees planted in pits with soil volumes less than two thirds less than the projected canopy area of the mature tree.	0.6
Green wall – modular system or climbers rooted in soil – see NBS Guide to Façade Greening for overview. ^[16]	0.6
Native groundcover planting	0.6
Groundcover planting – see RHS Groundcover Plants for overview ^[17]	0.5
Species-rich lawns (species-rich – with at least 5 species of low-growing wildflowers – regularly mown lawns)	0.5
Allotments or raided beds for food growing (exclude paved areas)	0.5
Amenity grassland (species-poor, regularly mown lawns)	0.4
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014. ^[18]	0.3
Open water (chlorinated)	0.2
Unplanted detention basins	0.2
Permeable paving – see CIRIA for overview ^[19]	0.1
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	0

5. <https://livingroofs.org/intensive-green-roofs/>

6. <https://livingroofs.org/intensive-green-roofs/>

7. <http://www.tdag.org.uk/trees-in-hard-landscapes.html>

8. <https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf>

9. https://www.buglife.org.uk/sites/default/files/Creating%20Green%20Roofs%20for%20Invertebrates_Best%20practice%20guidance.pdf

10. <http://www.susdrain.org/>

11. <https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf>

12. <https://cfde.co.uk/front-page/about/case-studies/>

13. <http://www.susdrain.org/>

14. <https://www.thenbs.com/knowledge/the-nbs-guide-to-facade-greening-part-two>

15. <https://www.rhs.org.uk/advice/profile?pid=351>

16. <https://www.thenbs.com/knowledge/the-nbs-guide-to-facade-greening-part-two>

17. <https://www.rhs.org.uk/advice/profile?PID=818>

18. <https://livingroofs.org/wp-content/uploads/2016/03/grocode2014.pdf>

19. <http://www.susdrain.org>

3 REVIEW OF GREEN SPACE FACTOR SCHEMES

3.1 GSF schemes are well established - they have been used in various countries and cities in Europe and North America for more than 20 years. well established around the world. The following examples show the history, range, type and success of GSF schemes.

3.2 City of Berlin - has operated the Biotop Flächenfaktor or Biotope Area Factor (BAF) since 1994. The BAF is applied, in combination with Landscape Plans, in a number of Berlin's inner-city neighbourhoods. Landscape Plans address spatial issues and opportunities and the BAF ensures that adequate green space is provided within each development parcel. BAF targets are adjusted according to land use, with sites with educational use, for example, requiring the highest scores. Minimum scores for sites within neighbourhoods covered by the scheme vary between 0.3 and 0.6. Problems with surface water flooding and an overall lack of green space were the catalysts for the BAF initiative, and surface cover types are assigned scores (between 0 for impermeable surfaces and 1 for vegetated surfaces completely connected with the soil below) based on their ability to infiltrate, store and evaporate water. The BAF is viewed positively by city planners, architects and developers, who have praised its simplicity and flexibility, however, it is recognised that it cannot be used to assess the environmental impact of a scheme.

3.3 Malmö, Sweden - A complex GSF scheme was trialled in 2001 in a new residential development in the post-industrial Western Harbour area of Malmö. The original purpose was to ensure that adequate green space was provided on every plot and that sealed surfaces were

minimised. A minimum score of 0.5 was set. The quality of some of some development did not match the planning authority's expectations so the scheme was subsequently revised to include a Green Points System. The system was designed to improve the quality of landscape design and to encourage the inclusion of features that increase biodiversity. The scheme is now being applied to a wider area within Malmö as well as the neighbouring town of Lund.²⁰

3.4 Seattle, USA – Seattle, in the State of Washington, adopted a GSF scheme in 2006 and expanded it in 2009. It was modelled on the Berlin BAF. The three priorities of Seattle's scheme were: live-ability; ecosystem services; and climate change adaptation. As with other schemes, Seattle's has a catalogue of landscape elements, each with its own score, and a requirement for project proposals to meet a minimum overall score. Minimum scores vary according to zones, with residential zones requiring the highest scores and commercial and industrial areas, lower scores. To qualify for certain scores, landscape features must comply with detailed standards set by the city. For example, bio-retention facilities must include adequate soil volumes.²¹ Increased diversity of planting is also encouraged. The scheme includes a provision for bonus credits for drought tolerance, irrigation with harvested rainwater, landscape features visible to passers-by and food cultivation. For a scheme to be awarded a score, it must be submitted with a landscape plan and landscape management plan and submitted by a licensed landscape professional. A landscape professional must also verify that the landscape scheme has been installed in conformance with the approved plan. Since the scheme was adopted, Seattle's Department of Planning and

20. Annika Kruuse (2011) GRaBS Expert Paper 6 the green space factor and the green points system
21. City of Seattle (2015) Director's Rule 30-2015: Standards for Landscaping, including Green Factor.

Development has noted higher quality and better-integrated landscape design, with increased use of permeable paving, green roofs, and green walls.

3.5 Washington DC, USA – Washington DC has the Green Area Ratio (GAR).²² It was introduced in 2013 and revised in 2016 and is very similar to the Seattle scheme. It has been established by regulation and applies to all applications for building permits for new buildings and major renovations (with a few exemptions). The satisfactory implementation of a landscape scheme, that has met the minimum GAR score, must be demonstrated by a Certified Landscape Expert, before a certificate of occupation may be granted. The scheme gives high scores for trees (measured by canopy size), intensive green roofs and the conservation of existing soil. Target scores vary according to planning zones, with differentiation between residential, mixed use and downtown (city-centre) areas.

3.6 Helsinki, Finland - Helsinki considered a GSF scheme as part of its Climate-Proof City – Tools for Planning (ILKKA) project (2012-2014).²³ The approach was to test the operation of a tool and to use the tool to assess design options in two new development sites (Kuninkaantammi and Jätkäsaari). A unique scoring system was developed by a panel of local experts. Issues considered were ecology, functionality, amenity and maintenance, with the ecological and functional goals prioritised over amenity and maintenance. Minimum scores were set for various land use classes, including residential (0.5), office (0.4), commercial (0.3) and industrial/logistics (0.2), with an

expectation that higher targets would be met. These targets reflect the typical differences in the extent of greenspace provided within these development types in Helsinki.

3.7 Singapore – Singapore, which has promoted the ‘City in a Garden’ vision, has explored a Green Plot Ratio (GnPR), which measures overall leaf area and compares this with site area. Typical leaf area indices for trees, palms, shrubs and grasses are used in the calculations and it is hoped that the intention is for the GnPR approach to assist in evaluating green infrastructure on tall buildings.²⁴ Singapore has also been at the forefront of promoting green roofs and green walls on tall buildings through its Skyrise Greenery scheme of incentives and awards.²⁵ Singapore is also noted for promoting high-rise bridges and gardens, which provide opportunities to exercise and relax without descending to the ground (e.g the Pinnacle@Duxton skybridge).²⁶

3.8 London - The Greater London Authority (GLA) included the Urban Greenspace Factor (UGF) tool as part of its Urban Greening policy in the draft New London Plan.²⁷ The UGF tool follows the approach first developed in Berlin, with some uplift of scores to encourage good quality green roofs and larger tree pits. Following on from the approach advocated by the GLA, the City of London’s planning department has endorsed the use of a GSF tool as part of its approach to urban greening. Urban greening is now part of its draft City Plan 2036.²⁸

3.8 Southampton - Using a GSF tool is a requirement for applications within Southampton’s

22. Washington DC zoning codes <http://handbook.dcoz.dc.gov/> and map <http://maps.dcoz.dc.gov/zr16/map.html#l=14&x=8565251.499999998&y=4709970.999999999&mms=18!26!21!24!22!19!4!8!1!2&dcb=0>

23. http://ilmastotyokalut.fi/files/2014/11/Developing_Helsinki_Green_Factor_Summary_13032014.pdf

24. <http://global.ctbuh.org/resources/papers/download/286-greening-the-urban-habitat-singapore.pdf>

25. <https://www.nparks.gov.sg/skyrisegreenery>

City Centre Action Plan (AP 12), which in 2015, required 'all developments (and especially key sites) to assess the potential of the site for appropriate green infrastructure improvements by using the Council's Green Space Factor tool, and to improve the score for the site.'²⁹ For other sites not within the City Centre, the council encourages, but does not require, use of the tool. Scores are assigned according to the rate of infiltration of rainwater for each landscape element.³⁰ The scoring system takes into account existing land cover, encourages retention of existing features and requires an overall increase in score compared with the existing condition. Performance requirements for surface cover types are not prescribed (as they are in the US for example). A completed spreadsheet is submitted as part of an application; however, there is no requirement for a suitably qualified professional to do this and no mechanism for verifying that a scheme has been implemented satisfactorily.

3.9 All schemes allocate scores to various categories of surface cover included in planning proposals. Depending on how a scheme is operated by an authority, failure to meet the target can result in rejection of a planning application, or an indication that a proposal needs to be amended, to include a larger area of green infrastructure overall, or elements with higher functionality. Cities usually set a minimum score that must be met and some have targets to encourage developers to be more ambitious and innovative, or they may have requirements which relate to the delivery of a specific function or outcome (e.g. stormwater management).

26. <https://www.timeout.com/singapore/things-to-do/the-pinnacle-duxton-skybridge>

27. <https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/chapter-8-green-infrastructure-and-natural-environment/policy-g5>

28. <https://www.cityoflondon.gov.uk/services/environment-and-planning/planning/planning-policy/Pages/Local-Plan-Review.aspx>

29. Southampton City Centre City Centre Action Plan, Adopted Version 18 March 2015.

30. <https://www.southampton.gov.uk/policies/Green-Space-Factor-tool.xls>

