

Blueprint for a Nature-Positive Adelaide

A background Biodiversity Sensitive Urban Design evidence base to support the development of the Urban Greening Strategy for Metropolitan Adelaide

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Recognition of Kaurna Miyurna and Yarta

We acknowledge and respect the native title holders and traditional owners of the Green Adelaide region – the Kaurna Miiyurna (Kaurna people) – and pay homage to their ancestors who maintained the natural processes of the land we are on and whose spirits still dwell on Yarta (Country).

Kaurna Country spans across the whole of the Green Adelaide region and beyond into the Hills and Fleurieu of the east, and into the Yorke region in the north.

Mutual respect and trust enables us to walk and work side-by-side to restore Yarta.

Executive Summary

Biodiversity underpins human life yet is under threat as never before. Profound human-induced changes to land and water have threatened at least 44,000 plant and animal species with extinction. Cities can be hotspots for threatened species and urbanization remains one of the most significant drivers of biodiversity loss. Hence cities have a unique and important role to play in addressing the global biodiversity extinction crisis.

Adelaide supports remarkably diverse plant and animal life and unique ecological communities. The city also faces substantial challenges, including urban heat, which can be potentially mitigated through urban greening; an agenda that has been pursued enthusiastically by governments, industry and the community. *Biodiverse* greening has the potential to deliver even greater benefits to the people of Adelaide, through enhanced health benefits, generating a unique sense of place and supporting native species, including some that are rare and threatened. But intentional strategies will be required – it is possible to fill a city with trees yet deliver little benefit for biodiversity.

This report offers an approach for Adelaide to better protect and enhance biodiversity and potentially realise a metropolitan-wide goal of becoming nature-positive, delivering significant enhancements to urban biodiversity, and multiple co-benefits to people living within urban areas. This work represents part of the investigation for the draft Urban Greening Strategy for Metropolitan Adelaide.

The goal of this report is to outline the enhanced co-benefits of biodiverse urban greening, and current efforts to protect and conserve biodiversity that may be better supported by the Urban Greening Strategy. The arguments for retaining and restoring biodiversity in cities are reviewed, and consideration given to a range of existing mechanisms that can be built on to better conserve and enhance urban biodiversity. Biodiversity Sensitive Urban Design (BSUD) is described as a mechanism for incorporating considerations for biodiversity into the urban fabric and recommendations on financial mechanisms and other tools to support integration of biodiversity into the Urban Greening Strategy are provided. The barriers to, and opportunities for the conservation and restoration of Adelaide's ecosystems, are also considered, and several actions suggested to help achieve ambitious biodiverse greening goals and present a set of case studies of successful urban biodiversity initiatives.

While Adelaide has targets to increase tree canopy, many suburbs are still going backwards in terms of canopy cover. Current protection mechanisms for remnant vegetation and individual trees are not able to always protect important biodiversity values. There are many inspiring examples of individuals, communities and government organisations achieving extraordinary outcomes for biodiversity within Adelaide's urban boundary. Yet coordinated biodiversity targets and goals for the city are lacking.

Building on this foundation, this report recommends a set of specific intervention points to enhance, protect and create new biodiverse green space in Adelaide and achieve the goal of becoming nature-positive. Of these, six particularly visible and impactful initiatives are proposed for consideration:

- 1 Develop metropolitan-wide and locally specific targets for biodiversity conservation and restoration, with the overarching goal of becoming nature-positive
- 2 Engage with Kaurua to guide urban Caring for Country
- 3 Establish a new program of retrofits for parks and verges, starting with a 'showpiece' biodiverse park and a set of biodiverse streets
- 4 Collaborate with partners to ensure building and infrastructure development is nature-positive through the implementation of Biodiversity Sensitive Urban Design
- 5 Build capacity for the delivery of nature-positive objectives through the appointment of a Chief Nature Officer, appropriate funding mechanisms, and delivery of education and engagement programs
- 6 Strengthen policies and legislation for the protection of Adelaide's trees and remnant vegetation.

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1. Introduction

The motivations for encouraging nature in cities have never been more compelling. The global urban population is projected to increase by 2.5 billion people over the next 30 years, making urbanisation one of the defining transformations of the 21st century (UN 2019). Population growth, extreme weather and a mental wellbeing crisis (Lim et al. 2016) pose unprecedented challenges to city liveability. Nature-based solutions to these problems are being embraced, and urban greening is now an accepted part of town planning. But, despite a looming extinction crisis (IUCN 2023), biodiversity is rarely considered (Butt et al. 2018) and most nature-based solutions fail to demonstrate benefits for biodiversity (Filazzola et al. 2019). Cities are recognised hotspots for threatened species (Ives et al. 2016) and must play a role in addressing the extinction crisis (Oke et al. 2021), yet urbanisation remains one of the most significant drivers of biodiversity loss (Kondratyeva et al. 2020). *Biodiverse* greening delivers enhanced ecosystem services such as increased wellbeing (Fuller et al. 2007), sense of place, and engagement with First Nations culture (Mata et al. 2020). For city dwellers who make up 89% of Australia's population (World Bank 2013), nature in the city provides important experiences, connection and benefits. For biodiversity, including 39 Australian threatened species that only exist in cities, urban areas are critical to survival (Soanes et al. 2019). Therefore, nature must be delivered within the urban fabric of cities, rather than marginalised to remnant areas far from population centres.

With urban greening proliferating in cities, there exists an unprecedented opportunity to deliver nature in cities for the benefits of people and biodiversity.

Urban areas present unique challenges and opportunities for biodiversity conservation. While the reasons for embracing nature in cities are compelling ([Section 3](#)), the pathways to achieve this vision are not always straightforward. A key challenge relates to the balancing of urban growth with biodiversity conservation, and this necessitates a systematic and evidence-based approach to land use planning in both established suburbs and greenfield developments.

An important first step is to reframe the way biodiversity is considered in the planning process. Rather than considering biodiversity as a constraint - a 'problem' to be dealt with - nature can be viewed as an opportunity and a valued resource to be preserved and maximised at all stages of planning and design. To do so requires careful regulation to ensure the protection of remaining natural assets, from remnant patches of vegetation to single trees. Otherwise, current regulation makes it all too easy for vegetation to be whittled away to make way for development, or as a default response to issues such as public safety.

Reframing nature as a positive benefit to be maximised means moving away from 'offsetting' as the primary solution. Under this approach, vegetation that is cleared in urban areas may be offset most cheaply somewhere else, often far from the site of impact (Kalliollavo et al. 2021). This is a poor solution in an urban context, because it fails to ensure that there is nature in the places where people can benefit most from interacting with it (Ives & Bekessy 2015). Serious concerns have been raised over the success of conservation outcomes delivered under offsetting schemes (Victorian Auditor-General's Office, 2020), and their susceptibility to corruption (Cox, 2021).

To reverse trajectories of ecological decline, alternative approaches that seek to protect, enhance and incorporate nature within cities – in the places where people live, work and play – are needed. Such approaches can deliver additional benefits by leveraging the synergies between biodiversity outcomes and co-benefits such as human health and wellbeing, heat and flood mitigation, market benefits to house prices and rental occupancy rates and urban resilience and liveability. These approaches are discussed further in the report.

Biodiversity Sensitive Urban Design (BSUD) is an approach to urban planning and design that aims to embed biodiversity considerations within planning and design frameworks for the benefit of people and nature in urban environments (Garrard et al. 2018). Protecting and enhancing biodiversity assets

and integrating biodiversity into the urban fringe provides for greater conservation opportunities well into the future. This report discusses this approach and opportunities to implement it.

1.1 Purpose and scope

Through the formation of Green Adelaide, and its legislated requirements for Biodiversity Sensitive Urban Design, Adelaide is at a unique advantage amongst Australian cities to become nature-positive and align with global biodiversity and liveability targets as set out in COP15's Global Biodiversity Framework and the Sustainable Development Goals.

This report provides advice on how Adelaide can move towards realising the goal of becoming nature-positive, delivering significant enhancements to urban biodiversity and multiple co-benefits to city dwellers. In particular, the purpose of this report is to provide considerations for implementing BSUD as important background for the *Urban Greening Strategy for metropolitan Adelaide* (the Strategy). The report includes:

- discussion of the enhanced co-benefits of biodiverse urban greening
- a description of Biodiversity Sensitive Urban Design (BSUD) as a mechanism for incorporating biodiversity considerations into the urban fabric, including a set of specific actions to enhance, protect and create new biodiverse green space in Adelaide
- discussion of the key challenges and opportunities affecting urban greening and biodiversity in metropolitan Adelaide, including a summary of current efforts to protect and conserve biodiversity, and opportunities to enhance or better support these initiatives
- an analysis of existing financial mechanisms and new options to finance the implementation of both the Strategy and urban biodiversity projects more generally
- a list of recommendations for Adelaide to potentially realise the goal of becoming nature-positive.

1.2 Methodology and engagement

As BSUD is a relatively new approach in South Australia, Green Adelaide has partnered with the Royal Melbourne Institute of Technology (RMIT University) and the Interdisciplinary Conservation Science Group (ICON Science) to better understand urban biodiversity in the metropolitan Adelaide context and determine how to take BSUD from a conceptual model to practical on ground works/designs across metropolitan Adelaide.

To support development of this report, Green Adelaide established a Technical Working Group, which included experts and representatives from State and local government, utilities, universities, NGOs and consultancies. Engagement with the Technical Working Group involved several workshops, a survey and two all-day site tours of different project sites across metropolitan Adelaide to help develop case studies of different interventions that focused on biodiversity in different scales and contexts (see [Section 5](#) for an outline of the different case study project sites, and **Appendix E** for full case study detail). The culmination of this partnership is the development of this report, which forms one part of a suite of evidence base reports to support the Strategy.

For the purpose of this report, the content is focused within the [Green Adelaide region](#) only. However, the principles and many of the proposed recommendations from the Strategy may apply equally to urban LGAs outside of the Green Adelaide region.

1.3 Key stakeholders

There are many stakeholders who play a role in implementing or influencing urban greening outcomes in metropolitan Adelaide which help or hinder urban biodiversity outcomes. These stakeholders include:

- State Government (including Green Adelaide, Department for Environment and Water, Department for Trade and Investment (Planning and Land Use Services), Office for Design and Architecture SA, Department for Infrastructure and Transport, Renewal SA, Department for Health and Wellbeing (including Wellbeing SA), Department for Education, and the Office for Recreation, Sport and Racing)
- Local government (e.g. metropolitan councils)
- Utilities (e.g. SA Water, SA Power Networks)
- Kurna Yerta Aboriginal Corporation (KYAC)
- Non-government organisations (e.g. Greening Australia, Conservation Council SA, BirdLife Australia, Trees for Life)
- Research institutions (e.g. University of Adelaide, Uni SA, Flinders University)
- Industry Peak Bodies (e.g. Australian Institute of Landscape Architects, Local Government Association SA)
- Professional Networks (e.g. Local Government Biodiversity Network, Local Government Urban Forest Alliance, Adaptation Practitioners Network, Urban Development Institute of Australia)
- Community and community groups

For further information about some of these key stakeholders and the role that they play in influencing biodiversity, refer to [Appendix A](#).

1.4 Relevant legislation and policy

A variety of different types of legislation and policies may impact biodiverse greening outcomes across the Green Adelaide region. For further information about some of these refer to [Appendix B](#). For further details about this, including potential opportunities for improvement, please refer to the separate report titled ***Audit of key legislative policy provisions which impact urban greening*** (available on Green Adelaide's website).

Key concepts and definitions

Key concepts used and referred to in this report are outlined in **Table 1**, along with a definition.

Table 1. Key concepts used in this report and their definitions.

Concept	Definition
Biodiversity	The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes the diversity within species, between species and of ecosystems (UNEP 1992). Biodiversity is further defined by the Department for Environment and Water as: all environments on Earth (on land, in rivers and lakes, and in the seas and oceans), which is recognised at three levels: • genetic diversity – the variety of genetic information contained in individual organisms. At this level species may vary in their tolerance of heat or cold, or resistance to diseases, etc.

Concept	Definition
	- species diversity – the variety of species. At this level, we find the basic types of organisms that most people are familiar with, including wild and domesticated species of plants and animals and wild and laboratory-cultured species of microorganism - ecosystem diversity – the variety of habitats, ecological communities and ecological processes. At the ecosystem level, we can identify aggregations of species within different environmental settings that constitute broad habitat types, ecological communities and ecosystems such as grasslands, woodlands, rivers and estuaries https://www.environment.sa.gov.au/topics/plants-and-animals/threatened-species-and-ecological-communities Within this document, biodiversity is given particular reference to the species assemblages and individual species that are found nowhere else on earth, where local conservation actions are not likely to be replicable elsewhere.
Biodiversity sensitive urban design (BSUD)	BSUD recognises that well designed and managed urban areas can play an important role in the conservation of native flora and fauna through minimising the key impacts of urban development on biodiversity and, at the same time, provide the resources that native species need to survive and thrive in cities (Garrard et al. 2018). In turn, by embedding nature into the built environment, BSUD helps to enhance human health and wellbeing and mitigate the impacts of climate change in cities. BSUD contributes to and enhances urban greening initiatives by improving the quality of habitat to better suit species needs as well as integration of considerations for biodiversity into the built environment more broadly e.g. bat boxes or bird-friendly glass. BSUD projects may target individual species, a group of species and/or entire ecosystems. It can be applied across multiple scales from small-scale site renovations (e.g. green roof retrofits or streetscapes) to precinct-scale planning for new building or infrastructure developments. Importantly, BSUD extends traditional urban conservation frameworks by seeking to incorporate nature and biodiversity into the built environment. Refer to Section 4 of this report for further details about this concept
Ecological community	"An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. Its structure, composition and distribution are determined by environmental factors such as soil type, position in the landscape, altitude, climate and water availability." (from https://www.dcceew.gov.au/environment/biodiversity/threatened/communities)
Ecological connectivity	Ecological connectivity describes the ability of species to move through a landscape. It incorporates both the physical and behavioural ecology of the species, as well the presence and arrangement of landscape elements that impede or facilitate movement. See Box 1 under 4.2.4 Evaluate BSUD for some further information about ecological connectivity.
Ecosystem services	Ecosystem services are the benefits provided to humans through the transformations of resources (or environmental assets, including land, water, vegetation and atmosphere) into a flow of essential goods and services (e.g. clean air, water, and food; Costanza et al. 1997).

Concept	Definition
Extinction debt	Extinction debt refers to future species or ecosystem extinctions that are thought to be inevitable due to ecological losses, harm or damage that has occurred in the past. For example, an old tree may remain in the landscape for hundreds of years, but if recruitment is obstructed or does not occur, the death of the mature tree may result in the local extinction of that species, or any species that rely on it (Hahs & McDonnell, 2014). Many cities around the world have an extinction debt; yet, the delay between historical disturbances and species loss may present opportunities to reverse the trend.
Green bond	Green Bonds are bonds that are used to finance new and existing projects that offer climate change and environmental benefits (Victorian Department of Treasury and Finance, 2023)
Green infrastructure	The network of green spaces and water systems that delivers multiple environmental, social and economic values and services to urban communities (SA Government, 2019). This includes urban parks and reserves, wetlands and stream corridors, street trees and roadside verges, gardens and vegetable patches, bikeways and pedestrian trails, wall and rooftop gardens, orchards and farms, cemeteries and derelict land (CSIRO, 2023).
Habitat analogues	Human constructed habitats (e.g. green walls/roofs) which are reflective of natural habitats in providing ecological functions. They can be either more abiotically and biotically similar to natural habitats to further expand their utility for biodiversity conservation (Lundholm & Richardson 2010)
Nature	In this report, we use the terms 'biodiversity' and 'nature' interchangeably. However, 'nature' is defined slightly differently, as all life on Earth (i.e. biodiversity), together with the geology, water, climate and all other inanimate components that comprise our planet. As 'nature' is a term that is more widely understood than 'biodiversity', it can be useful in communications.
Nature-positive	Halting and reversing nature loss through increasing the health, abundance, diversity and resilience of species, populations and ecosystems so that nature is visibly and measurably on the path of recovery. Key elements include (Milner-Gulland 2022): • A measured biodiversity baseline. • A timeframe. • A target (for example, biodiversity 20% above baseline). • A clear set of actions to be carried out, costed and sequenced. • An analysis of how the actions will add up to get to net gain. • Regular monitoring and disclosure of progress towards the goal.
Novel ecosystem	A novel ecosystem is a functioning ecosystem comprised of an arrangement of species that has no historical analogue. They are modified natural systems that have crossed irreversible socio-ecological thresholds due to human-induced environmental change (Hobbs et al. 2013). In theory, novel ecosystems are distinguished from designed or engineered ecosystems, which may involve intensive intervention to create and maintain (Higgs, 2016).

2. About the Green Adelaide Region

2.1 Geographical area

The Green Adelaide region was established as part of the introduction of the *Landscape South Australia Act 2019*. It extends from the Gawler River in the north, to Sellicks Hill in the south and incorporates sections of the western Hills Face Zone of the Mount Lofty Ranges. The area includes most of the metropolitan Adelaide area – encompassing 127,323 hectares of terrestrial habitats and including about a third of Gulf St Vincent (**Figure 1**).

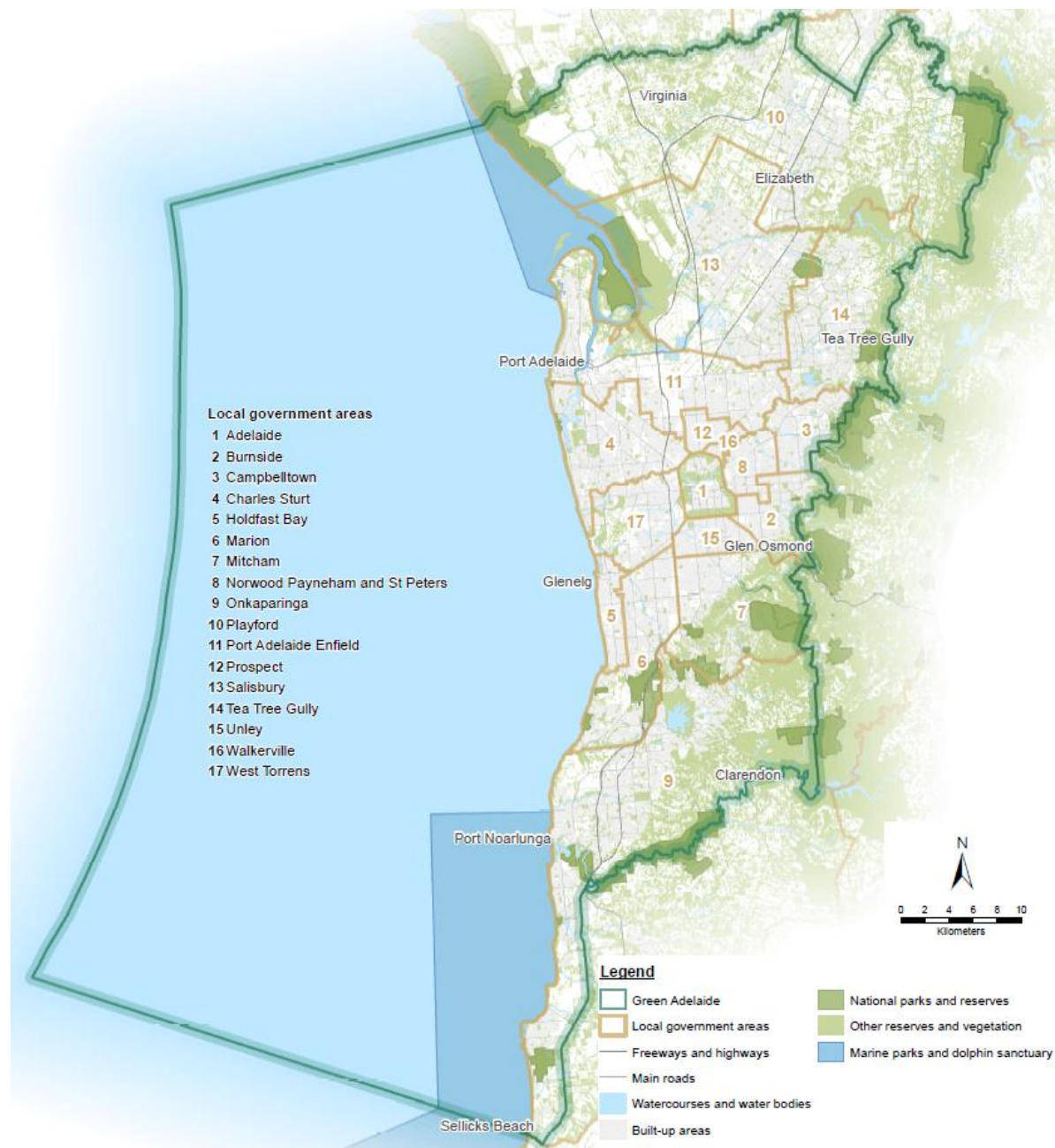


Figure 1. Green Adelaide Region
Source: Green Adelaide

2.2 Pre-European Native Vegetation

Native vegetation is a fundamental component of biodiversity. Understanding type, extent, and condition of native vegetation across a given region provides an important snapshot in time against which biodiversity can be assessed and future changes can be compared.

Prior to European settlement, the terrestrial footprint of the Green Adelaide region contained a diverse array of broad habitat types, including over 50% grasslands and grassy woodlands, along with coastal ecosystems and freshwater (riparian) ecosystems, and areas of heathy forests and woodlands (**Figure 2**). These categories are a simple and high-level way of categorising the type of habitat that would have been present, rather than specific vegetation types. Table 2 outlines broad habitat types and their pre-European extent within what is now the Green Adelaide region (see [Appendix C](#) for descriptions).

Figure 2. Pre-European broad habitat types within the Green Adelaide region (Source: DEW, 2023 <https://data.sa.gov.au/data/dataset/pre-european-vegetation/resource/ab9bbd10-d3b6-4d15-b8f3-e508441140da>)

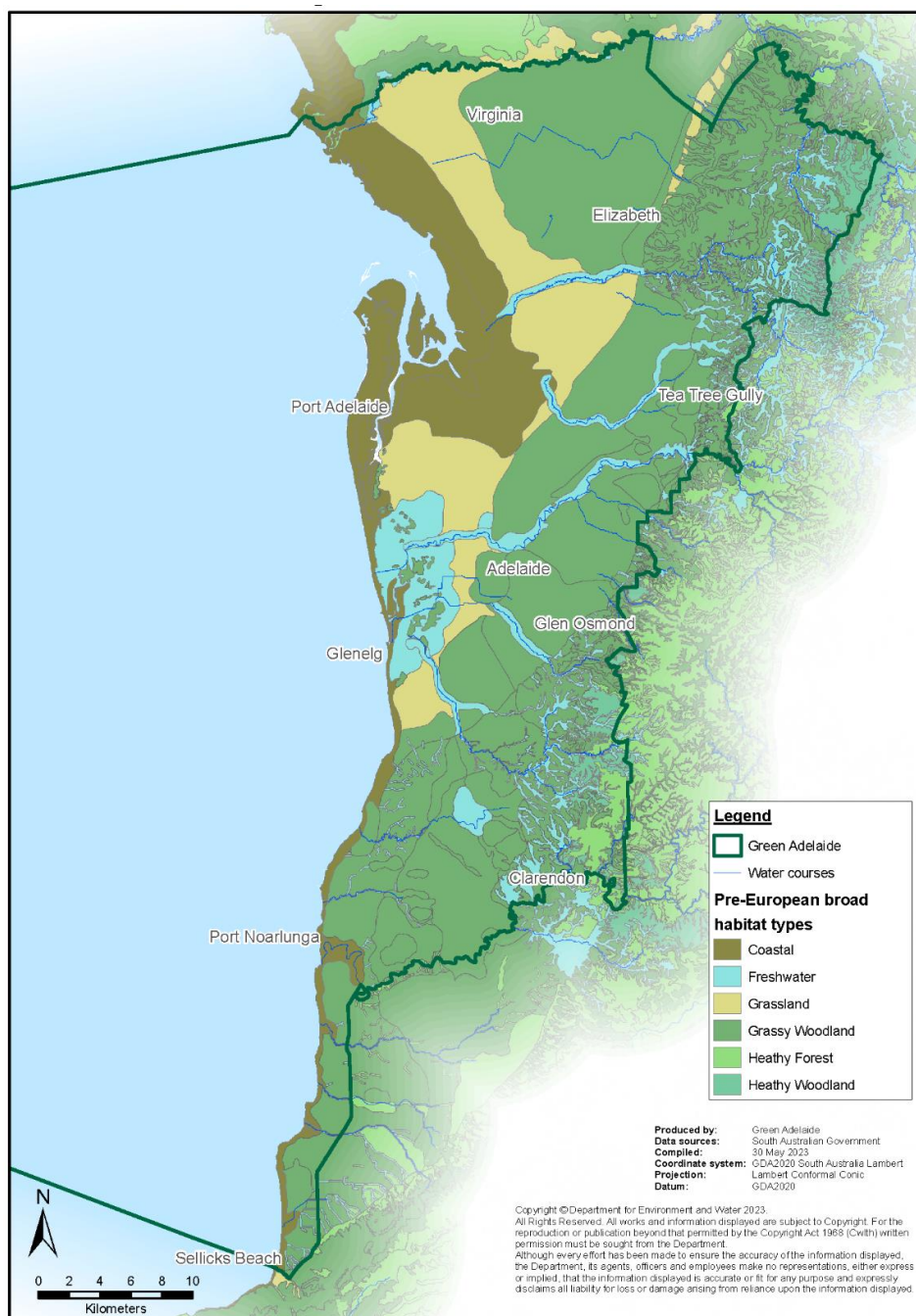


Table 2. Broad habitat types and pre-European extent in what is now Green Adelaide region (Source: DEW, 2023)

Broad Habitat Types [^]	Pre-European extent (ha)
Coastal Ecosystem	17,853
Freshwater Ecosystem	15,098
Grassland	16,051
Grassy Woodland	73,240
Heathy Forest	1,564
Heathy Woodland	3,517
Total	127,323

2.3 Remnant Native Vegetation

Adelaide's natural landscape has changed dramatically. Pre-European Kurna peoples maintained a varied landscape including highly vegetated woodlands, moderately treed grasslands, and sparsely vegetated coastal plains¹. Variability in landscape forms across the Adelaide plains and hills impact the vegetation assemblages, ranging from coastal dunes and wetlands to open grassy woodlands of the foothills and dense eucalypt forests of the hills.

Since settlement, nearly 90% of native vegetation within the Green Adelaide region has been cleared (Bradshaw et al. 2012), and the Green Adelaide region now consists predominantly of a highly urbanised landscape. Ground-truthing has been undertaken to identify and describe scattered remnant vegetation in peri-urban areas, with larger patches remaining along the boundary of the region in the Mount Lofty Ranges foothills. This remnant native vegetation can be classified using a number of different methods, based on general characteristics and dominant species types. **Figure 3** shows the current ground-truthed extent of remnant vegetation in known Major Vegetation Groups¹, however this is likely an underestimate of native vegetation across the Green Adelaide region. Refer to **Appendix C** for the list and descriptions of Major Vegetation Groups found within the Green Adelaide region.

Other larger areas of possible native vegetation have been mapped via satellite (**Figure 4**); however, this is likely to be an overestimate as these areas are yet to undergo the same level of investigation (ground-truthing) to enable definitive classification as native vegetation and detailed assignment of Major Vegetation Groups.

¹ Based on SA Vegetation Dataset

Green Adelaide region

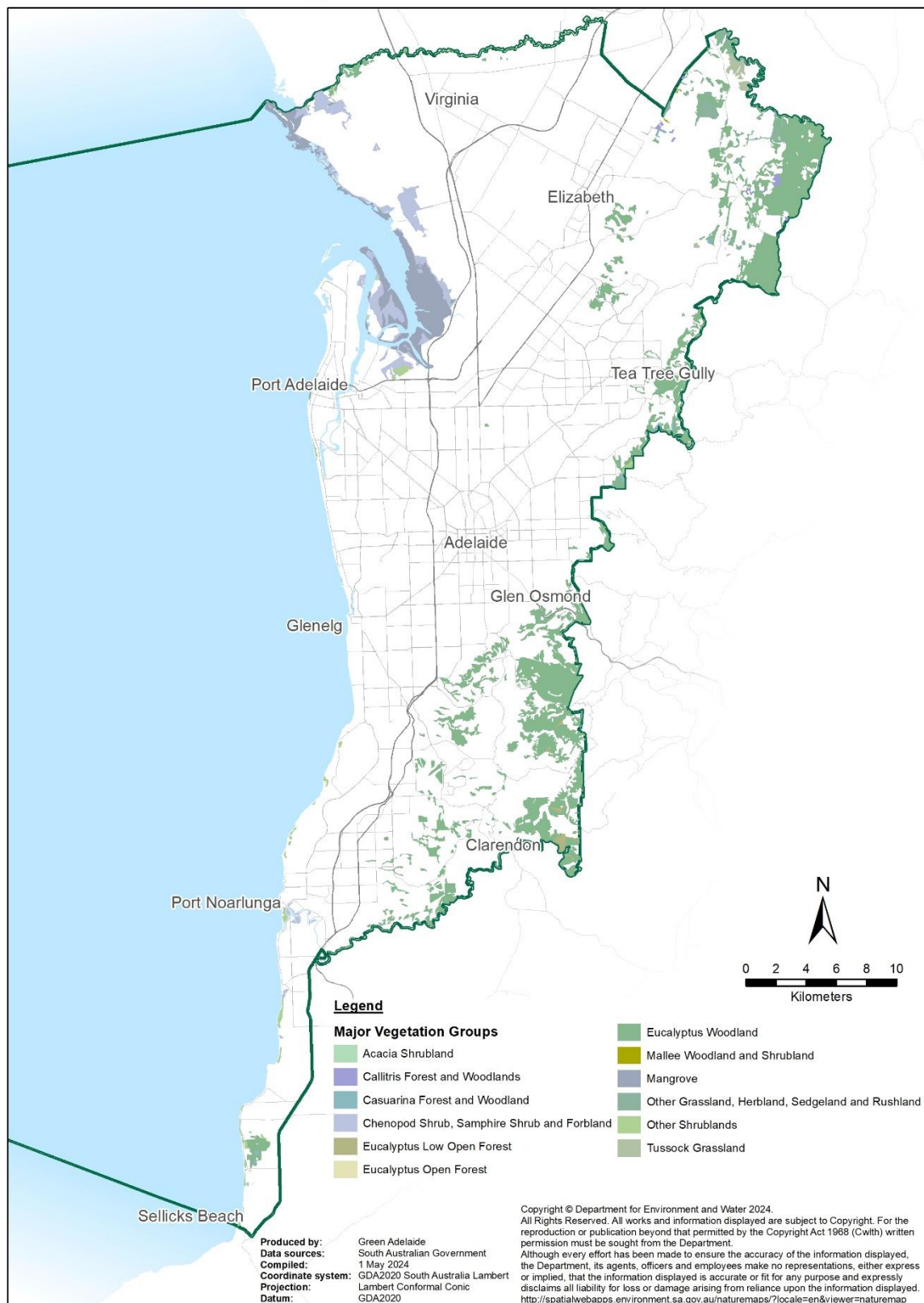


Figure 3. Major Vegetation Groups (ground-truthed) within the Green Adelaide region (Source: DEW, 2023 <http://spatialwebapps.environment.sa.gov.au/naturemaps/?locale=en-us&viewer=naturemaps>)



Figure 4. Possible (satellite inferred) existing native vegetation within the Green Adelaide region (Source: DEW, 2023 <https://data.sa.gov.au/data/dataset/sa-land-cover/resource/c856ebe3-f9bc-4ea8-ac3b-7e2cc877fea3>)

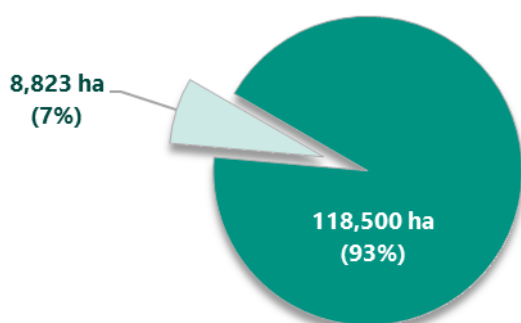
2.3.1 Protected Remnant Native Vegetation

The *National Parks and Wildlife Act 1972* (NPW Act) enables the conservation and protection of native wildlife and the environment in South Australia. In addition to establishing a framework for creating formally protected areas (e.g. national parks, conservation parks, reserves), the NPW Act provides for the protection of native flora and fauna occurring inside and outside reserves. There are currently 26 formally protected areas (NPWS properties) within the Green Adelaide region. The NPW Act also details the conservation status of species throughout South Australia under Schedules 7, 8 & 9.

Currently, less than a third of the known remnant native vegetation (which itself represents only a tiny fraction of the area, thus all being of critical importance for protection) within the Green Adelaide region is conserved within formally protected areas (e.g. national parks, conservation parks, reserves) or through Native Vegetation Heritage Agreements (which establish conservation areas on private land). There is also a large range in the level of protection of the remaining Major Vegetation Groups, disproportionately reflecting less arable areas along the Mount Lofty Ranges (**Figure 5**). Significant remnant native vegetation also occurs outside of protected areas, in areas such as along transport corridors and council managed reserves, and sometimes on private land. For many species and ecological communities within the Green Adelaide region, small roadside fragments or unprotected private land parcels now form their stronghold.

Protection of native vegetation within the Green Adelaide region is also impacted by the limited application of the Native Vegetation Act 1991 to some of the more highly vegetated edges of the region.

a. Green Adelaide region total terrestrial area - protected vs. unprotected



b. Green Adelaide region area of known native vegetation - protected vs. unprotected

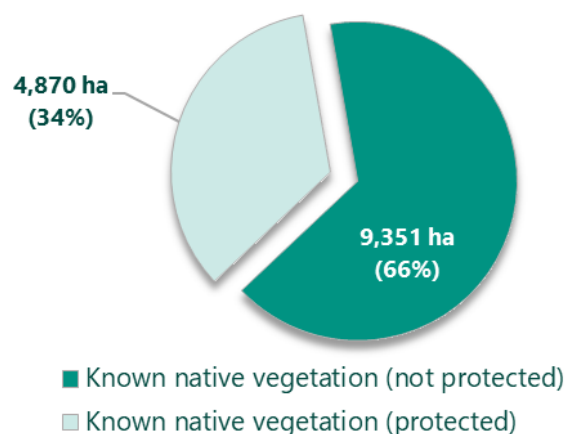


Figure 5. Area (and percentage) of (a) total terrestrial area and (b) area of known native vegetation currently within a formally protected area or Native Vegetation Heritage Agreement within the Green Adelaide region

2.3.2 Threatened Ecological Communities

Despite extensive land clearing in the Green Adelaide region (and the disproportionate way in which some habitats have been cleared compared to others), the level of biodiversity remains high. The Green Adelaide region is part of the broader Mount Lofty Ranges and Adelaide Plains which is recognised nationally as a listed biodiversity hotspot (containing a significant number of threatened ecological communities and species). Within the Green Adelaide region, there are twelve ecological communities which are either listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or provisionally listed as threatened in the *Native Vegetation Council Bushland Assessment Manual* (2020) (see **Table 3**).

Table 3. Listed and provisionally listed threatened ecological communities

Listed threatened ecological communities (under the EPBC Act)	Provisionally listed threatened ecological communities (in the Native Vegetation Council Bushland Assessment Manual 2020)
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	<i>Allocasuarina verticillata</i> Grassy Low Woodland on clay loams of low hills
Iron-grass Natural Temperate Grassland of South Australia	<i>Banksia marginata</i> Grassy Low Woodland on sandy loam plains in higher rainfall areas
Peppermint Box (<i>Eucalyptus odorata</i>) Grassy Woodland of South Australia	<i>Callitris gracilis</i> +/- <i>E. leucoxylon</i> Grassy Low Woodland on quartzite gravels on western footslopes of Adelaide Hills
Subtropical and Temperate Coastal Saltmarsh	<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i> Woodland on seasonally inundated flats
	<i>E. fasciculosa</i> +/- <i>E. leucoxylon</i> Heathy Woodland on sandy loams of flats and slopes
	<i>Eucalyptus viminalis</i> ssp. <i>cygnetensis</i> and/or <i>E. viminalis</i> ssp. <i>viminalis</i> Woodland on alluvial soils in moist areas
	<i>Lomandra effusa</i> Tussock Grassland on shallow loams in low hills
	<i>Themeda triandra</i> +/- <i>Danthonia</i> spp. Tussock Grassland on heavy, fertile soils of plains and hill slopes

2.4 Flora and Fauna of the Green Adelaide Region

2.4.1 Flora of the Green Adelaide region

The Green Adelaide region is recognised for its high floristic biodiversity (as part of the broader Mount Lofty Ranges and Adelaide Plains) and new native plant species continue to be discovered. From records in the Biological Database of South Australia (BDBSA) the total number of native terrestrial plants species in the region is just over 1000 species², with the actual number fluctuating due to taxonomic revisions and new species discoveries.

² There are also in the order of 471 aquatic species of algae, seaweed and seagrasses and in the order of 35 species of moss and 13 lichen species.

There are 19 native terrestrial plant species found in the Green Adelaide region that have been formally listed as threatened at a national level (under the EPBC Act), and 66 species (~6% of the native terrestrial plant species) are listed as threatened at the State level under the NPW Act.

Analysis of regional assessments undertaken by DEW in 2014 determined that more than one third of native terrestrial plant species in the Green Adelaide region are threatened or near threatened (Gillam and Urban, 2014). Seventeen native terrestrial plant species are regionally extinct, primarily due to vegetation clearing and/or habitat degradation.

Table 4. Number of threatened flora species within the Green Adelaide region as assessed under different legislation or regional frameworks (as of 2022³)

Threat Status	EPBC Act	NPW Act	Regional assessment ⁴
Critically Endangered	2		19
Endangered	8	30	51
Vulnerable	9		115
Near Threatened			161
Rare		107	229
Regionally Extinct			17
Data Deficient			19
Least Concern			403
Not Assessed			80

Introduced plant species (including non-endemic native species and exotic species) outnumber endemic native plants, with at least 1,254 introduced plant species recorded in the Adelaide metropolitan area⁵, including many species that are considered native to Australia but which do not occur naturally within either South Australia or the Green Adelaide region. Several new introduced plant species are typically discovered in the Green Adelaide region each year (including 'garden escapees'), with many having significant negative impacts on habitat and biodiversity.

2.4.2 Fauna of the Green Adelaide region

Vertebrate species

According to current records in the BDBSA, there are at least 348 native terrestrial vertebrate species (not including marine mammals or fish, marine birds or freshwater fish) that have been recorded in the Green Adelaide region, including 263 birds, 27 mammals, 50 reptiles, and 8 amphibians. However, the number of native terrestrial vertebrate species found in the region at any one time can be highly variable, as some species only visit the region occasionally or seasonally (i.e. migratory species that move from one geographical region to another) or are vagrant (i.e. appearing outside of normal distribution).

Thirteen native terrestrial vertebrate species have become regionally extinct in Green Adelaide, including 6 mammals and 7 birds (Turner, 2001). Four of these are also listed as threatened or extinct

³ Status assessments of species are constantly taking place therefore these numbers can change. For up-to-date information on national and state species use the following links: National: <https://www.dcccew.gov.au/environment/epbc/our-role/approved-lists> and State: [National Parks and Wildlife Act 1972 | South Australian Legislation](#)

⁴ Reference: Gillam and Urban, 2014 (Note: assessments are regularly being undertaken which may result in updated data.)

⁵ Based on a 2020 data extraction from BDBSA.

under the EPBC Act. Within the Green Adelaide region, 43 native terrestrial vertebrate species are listed as threatened under the EPBC Act, 127 under the NPW Act and 204 based on regional assessments (**Table 5**).

Over 60 introduced terrestrial vertebrate species have been recorded with new species incursions regularly recorded in the Green Adelaide region.

Table 5. Number of threatened vertebrate species under different legislation and regional assessment frameworks (as of 2022)

	Amphibians	Birds	Mammals	Reptiles	Freshwater Fish
EPBC Act	1	26	11	5	-
NPW Act	2	93	24	8	-
Regional Assessments	4	149	20	25	6

Invertebrate species

Relatively little is known of Adelaide's terrestrial insects and other invertebrates. According to the Atlas of Living Australia (ALA), more than 2000 invertebrate species have been recorded in Adelaide. This includes at least 200 species of spider (*Araneae*), 529 beetles (Coleoptera) 100 flies (*Diptera*), and 400 butterflies and moths (*Lepidoptera*). However, recorded species are likely to be a large underestimate of actual species, due to a lack of systematic sampling of terrestrial invertebrates. With a paucity of information on many terrestrial invertebrates, there is also relatively little known about their conservation status.

In addition, work is also required to resolve the taxonomy of many invertebrate species. There is typically more information on larger or more readily identifiable terrestrial invertebrate species, and this includes some of the well-known introduced species such as the European honeybee (*Apis mellifera*), the European Wasp (*Vespula germanica*) and the African Black Beetle (*Heteronychus arator*). In total, records from the ALA suggest at least 90 invertebrate species have been introduced to Adelaide. However, there is significant new information and data being collected on terrestrial invertebrate species, driven largely by citizen science, which will help to fill gaps and be important for decision-making in relation to invertebrate requirements for future biodiversity-sensitive urban design projects.



Currently the formal assessment of butterflies (*Papilionoidea*) in South Australia is underway, building on from an informal assessment made by the Butterfly Conservation South Australia Inc (BCSA). From the initial informal assessment by BCSA, at least half of the 82 butterfly species recorded in the region are believed to be rare or threatened⁶.

Figure 6. yellowish sedge-skipper butterfly (credit: Matt Endacott)

⁶ <https://sabutterflies.org.au/conservation/conservation-status-checklist.html>

3. Benefits of urban biodiversity

Urban biodiversity can deliver a remarkable array of benefits that can be classified under the three dimensions of 'nature for nature', 'nature for society' and 'nature for culture' (Diaz et al. 2015; Oke et al. 2021).

3.1 Nature for nature

Cities around the world host numerous threatened plant and animal species and are important places for conservation in their own right. A recent study found that Australian cities and towns provided/retained habitat for three times as many threatened species per unit area than rural areas (Ives et al. 2016). In part this is because the locations we choose to build cities are often places of high biodiversity (Luck 2007) but also because urbanisation is a significant threat to species and ecosystems (Kondratyeva et al. 2020). Some species are found only in urban environments, while others rely on cities for key food and habitat resources (Soanes and Lentini 2019). Cities are particularly important for some species as, due to plant selection and watering regimes, they can provide stable, year-round resources (Parris & Hazell, 2005).

The future of many threatened species will depend on actions to protect and accommodate their needs within urban boundaries. Furthermore, research is identifying important links between people's everyday experiences of nature, their connectedness with nature and their commitment to pro-biodiversity practices (Prévot et al. 2019).

3.2 Nature for society

'Nature for society' represents the goods and services that nature can provide. Nature-based solutions, including green roofs, wetlands, day-lighted water bodies, sustainable urban drainage systems and more, all work to improve climate resilience, air, water and soil quality and can reduce flood risk (Frantzeskaki et al. 2019).

3.2.1 Helping cities adapt to climate change

Urban environments are warmer than adjacent suburban and rural environments due to the 'urban heat island effect' (Rizwan et al. 2008). This pervasive global phenomenon exacerbates the major threat that heat stress poses to human health and well-being in many cities.

Vegetation in and around cities can deliver a range of ecosystem services critical for climate change adaptation and mitigation. Through evapotranspiration, shading and reflectance, the vegetation present in green spaces can cool these environments substantially, at least partly ameliorating the heat island effect (Bowler et al. 2010). For example, a study based in Adelaide's western suburbs has shown that trees and soft landscaping in gardens can have significant cooling benefits and reduce surface temperature in the garden by 5 to 6 degrees (Ossola et al. 2020).

Vegetation in cities and towns can provide other important climate change adaptation services including alleviating the impacts of flooding by reducing peaks in storm-water runoff (Xiao & McPherson 2002) and providing shelter from extreme weather events (Abdollahi & Ning 2000). Vegetated areas, as compared to impermeable surfaces such as concrete, allow infiltration of water to replenish aquifers while also stabilising slopes and preventing erosion (Styczen et al. 1994).

Finally, vegetation can play a significant role in mitigating climate change impacts by sequestering greenhouse gases – cities can store as much carbon per unit area as tropical forests (Churkina et al. 2010) – and reducing energy consumption for cooling and heating (Coutts et al. 2007).

3.2.2 Community health and wellbeing

Urban nature delivers a remarkable range of human health and well-being benefits. In 1984, Roger Ulrich published the first study to suggest these benefits, when he chanced upon a link between

improved surgical healing times and a room with a view of nature. Since then, numerous studies have revealed a multitude of benefits to interacting with nature in our daily lives.

Children living in streets with trees will have lower incidence of asthma (Lovasi et al. 2008) and allergies (Hanski et al. 2012), and those with nature in their schoolyards will have improved cognitive development (Dadvand et al. 2015) and lower incidence of ADHD (Faber Kuo et al. 2015).

If you are lucky enough to have regular contact with nature, you are more likely to sleep better, have reduced stress levels, reduced risk of poor mental health, a better social life and improved self-esteem and empowerment (Kuo et al. 2015). Indeed, you are more likely to live longer and have better general health and well-being in a city with more biodiversity.

However, the quality as well as the quantity of nature and greening is of critical importance. Increased biodiversity within green spaces leads to greater health (Aerts et al. 2018, Houlden et al. 2021) and restorative benefits to people (Fuller et al. 2007). Recent research in Adelaide has demonstrated that higher levels of biodiversity – as measured by increasing naturalness and vegetation structure – enhanced the psychological benefits of the city's parks (Schebella et al. 2019). This work demonstrates that even small parks can deliver wellbeing benefits if designed to enhance biodiversity.

It should be noted that, while generally positive, in some instances interactions between wildlife and people may need careful planning and/or management to avoid unintended, negative impacts.

3.2.3 Economic benefits

Emerging research demonstrates the economic case for enhancing nature in cities, with numerous studies highlighting the many financial benefits of urban forests. For instance, improved property values; reduced maintenance costs; protection of drainage systems; reduced energy consumption; increased community pride and positive perceptions of the area; and customers drawn to businesses and increasing retail activity, while at the same time increasing workplace productivity. For example, a Brisbane-based study revealed a 5% increase in the median house price in streets with 50% canopy cover (Astell-Burt et al. 2019); and a Perth-based study showed that a broad-leafed tree in front of a home can add more than \$23,000 in value (Ennos 2015).

3.3 Nature for culture

'Nature for culture' acknowledges the importance of people's connections with nature, and the benefits of social cohesion, community connection, educational, and spiritual benefits. Nature can provide the space in which urban communities reconnect with 'place', to establish a sense of belonging that enables social cohesion, health and well-being.

3.3.1 Promoting traditional knowledge and culture

Traditional knowledge of landscape pattern and processes, hydrological cycles and species and ecosystem management are highly relevant to town planning. The potential benefits of engaging Aboriginal people in the planning, design, implementation and governance of urban nature are substantial.

In practice, this could mean:

- highlighting culturally significant species, such as traditional foods and medicines
- reflecting the understanding of landscape and seasons of Aboriginal people in urban design
- developing programs such as 'caring for country' or Aboriginal ranger programs to engage Aboriginal people in the management of urban parks (City of Melbourne 2016)
- prioritising Aboriginal people in urban governance – for example, the City Council of Auckland, New Zealand has an independent Maori Statutory Board and Pacific People Advisory Council to ensure the consideration of Maori and Pacific Islander interests, priorities and values within urban planning (Mercer et al. 2015).

Engagement of this kind may present a way of improving lives and retaining traditional knowledge for urban Aboriginal people (Mercer et al. 2015).

Furthermore, traditional knowledge has proven to contribute to higher quality of urban life, and could improve the success of urban forestry initiatives. Connecting urban residents to the history and culture of Aboriginal people through urban renaturing programs has the potential to create respectful attitudes and pride in local traditional knowledge.

4. Biodiversity Sensitive Urban Design (BSUD)

4.1 What is BSUD?

Biodiversity Sensitive Urban Design (BSUD) is a protocol and process for urban design that aims to create urban environments that are a net benefit to native species and ecosystems through the provision of essential habitat and food resources (Garrard et al. 2018).

BSUD represents an approach to urban biodiversity conservation that seeks to achieve biodiversity benefits on site, within the urban matrix. This is in contrast to the standard offsetting approach, which reduces the opportunity for urban residents to engage with nature and, at the same time, delivers questionable ecological outcomes (Ives & Bekessy 2015).

To deliver biodiversity benefits onsite, within the built environment, BSUD asks urban planning and design professionals to blur the boundaries between what is considered 'built' and 'natural' environments in cities. To achieve this, BSUD must mitigate the detrimental impacts of urbanisation and create and enhance habitat within novel, often highly-modified environments, whilst also encouraging community stewardship of biodiversity and facilitating positive human–nature interactions.

BSUD is underpinned by five principles that assist urban planning and design professionals (as well as those involved in green space management and education programs) to incorporate this knowledge and thinking into urban design (Garrard et al. 2018):

4.1.1 Five BSUD principles

(1) Maintain or create habitat for target species:

New developments can be planned to avoid habitat loss by prioritising development in areas of low ecological value (Bekessy et al. 2012). Retaining and protecting existing vegetation during the development process can also be beneficial for biodiversity (Hostetler 2012; Ikin et al. 2015). Habitat can be enhanced or created in existing urban areas by using native plant species and increasing vegetation complexity (Ikin et al. 2015; Threlfall et al. 2016), adding green infrastructure (Williams et al. 2010) or incorporating critical resources and habitat analogues, such as habitat walls (Lundholm & Richardson 2010). Residential gardens can provide significant habitat, so residential wildlife gardening programs can make a valuable contribution to biodiversity (Goddard et al. 2010).

(2) Facilitate dispersal:

Dispersal can be facilitated by adding animal movement infrastructure (Taylor & Goldingay 2012), or establishing habitat connectivity corridors through private and public land (Goddard et al. 2010). Care should be taken to avoid inadvertently facilitating the spread of invasive weeds and pests.

(3) Minimise disturbances and other threats:

The impact of weeds and exotic predators can be reduced by landscaping with indigenous plants and establishing pet containment programs (Ikin et al. 2015). Increased runoff and nutrient loads can be mitigated by vegetated swales and rain gardens, which also deliver

biodiversity benefits. The impact of noise and light pollution can be mitigated by sound barriers (although take care that this does not affect dispersal), temporary road closures and dimming or reconfiguring street lights (Gaston et al. 2012).

(4) Facilitate natural processes:

The disruptive effects of urbanisation on natural cycles, ecological processes and disturbance regimes (Grimm et al. 2008) can be mitigated by providing adequate resources for target species, protecting and enhancing pollinator habitat, and planning to safely enable natural disturbance events such as fire and flooding.

(5) Facilitate positive human–nature interactions:

Cities are human environments and public engagement is key to successful conservation. Urban design can help facilitate local stewardship of biodiversity by providing “cues to care” (Nassauer 1995), creating opportunities for positive interactions with nature, and addressing conflicts between biodiversity and safety objectives (Ikin et al. 2015) or potential ecosystem disservices.

4.2 How does BSUD work?

BSUD links urban design to measurable biodiversity outcomes; this might occur at any scale, from an individual building or renovation site to a suburb or precinct. It aims to provide a flexible framework for urban designers, planners and developers to consider biodiversity alongside socio-economic considerations, early in the development process. It includes a decision process that involves documenting biodiversity values, identifying biodiversity and development objectives, identifying potential BSUD actions, assessing those actions and reaching a final decision regarding a design for the site that best meets biodiversity and socio-economic objectives. Biodiversity sensitive urban design describes a decision-making process in which biodiversity objectives are considered alongside other socio-economic development objectives, early in the planning process (**Figure 7**, from Garrard et al., 2018).



Document Biodiversity Values

Native plants & animals, incl threatened.
Landscape context, including geological & hydrological features, spatial arrangement, and connectivity.
Potential threats to biodiversity.



Identify Biodiversity Objectives

Maintain or improve viability of threatened species & ecosystems.
Opportunities for rewilding.



Identify Development Objectives

Building & infrastructure requirements.
Population & dwelling targets.
Liveability targets.



Identify BSUD Actions

Considering 5 principles for BSUD.
Seek solutions that address biodiversity & development objectives.
Address key threats to biodiversity



Assess BSUD

Assess the contribution of BSUD using appropriate metrics: Population viability, occupancy, abundance.
Use tools such as PVA & expert elicitation.



Decide

Determine BSUD that best meets biodiversity & development objectives.
Manage trade-offs between objectives using tools such as: Project Prioritisation Protocol and participatory approaches



Figure 7. Biodiversity sensitive urban design describes a decision-making process. From Garrard et al. (2018)

4.2.1 Documenting biodiversity values

The first step in the process is to document the existing biodiversity or ecological values at the site or area in question and is a critical step in aiming to do no harm. This includes documenting any remnant vegetation, ecosystems and native species, including those that are threatened or otherwise protected. It may also include documenting any culturally significant species and communities, novel ecosystems and non-native species that are present. Accurate documentation at this stage is vital and relevant experts should be engaged.

In addition to documenting existing biodiversity, it is also worthwhile documenting any threats, challenges and opportunities that are present, as these may influence biodiversity objectives in the next step. Examples of threats and challenges include the presence of invasive predators or altered soil or water conditions. Conversely, opportunities include things such as historical species and community composition or favourable spatial contexts such as sites that are located close to or between existing remnants.

4.2.2 Identifying biodiversity objectives

Key to successful BSUD is the identification of explicit biodiversity objectives; it is these that form the basis of subsequent designs and decisions in the process. Objectives are likely to be contextual, and will depend on the characteristics of the site and the ambitions and priorities of the decision maker(s) and key stakeholders.

The key aim of BSUD is to enhance on-site biodiversity. This may be reflected in more specific objectives, including:

- improving the persistence of ecologically or culturally-significant species and ecosystems, including improving connection to surrounding areas or corridors;

- bringing back or enhancing populations of target native species, including those that may have historically existed at the site, or those that represent a particular role or value; and
- enhancing or creating opportunities for nature connection and stewardship amongst the local community.

Because they form the basis for designs and outcomes of BSUD, articulating clear objectives is important but it can be challenging. One way to identify and articulate relevant biodiversity objectives is through stakeholder workshops (See Melbourne BSUD Case Study 1, Fishermans Bend, **Appendix D**). When setting objectives for Fishermans Bend in Melbourne, biodiversity objectives were identified during workshops that were attended by the governing body, local councils and community groups, ecologists and planning professionals, and local Traditional Owners. Bringing stakeholders together in this way ensured that biodiversity objectives reflected a diverse range of experiences, preferences and values and helped to ensure they were deliverable through the establishment of buy-in from key decision-makers as well as early identification of potential barriers and enablers.

Although they are not a holistic representation of biodiversity, enhancing or bringing back focal or target species can be important biodiversity objectives. They are intuitively understood by decision-makers and community stakeholders and provide tangible touchpoints for considering key requirements and design solutions. A range of characteristics may be considered when selecting target species, including (Mata et al. 2020):

- **Ecological or conservation value of the species** – will providing habitat and resources for this species benefit the species' conservation status, or deliver benefits to other species?
- **Cultural value of the species** – is the species indigenous to the area? Is it of particular significance to Traditional Owners or the culture of Aboriginal people?
- **Ecological feasibility** – is it reasonable to expect that the requirements of the species can be provided within the urban environment?
- **Economic feasibility** – what are the costs and benefits of bringing this species into the area?
- **Social acceptability** – Does the species represent a specific threat or a potential opportunity for engagement?

For example, in a BSUD assessment for a new development in Melbourne's western suburbs, native blue-banded bees (*Amegilla* sp.) were selected as a target species. The following characteristics make this species a particularly suitable target for BSUD (Bekessy, Garrard et al. 2018):

- **Conservation value** – *Blue-banded bees provide an important ecosystem service.* They utilise a specific pollination method – buzz pollination – which is more effective for pollinating many native flowers. This includes flowers of the native flax-lillies in the genus *Dianella*, which are commonly found in native grasslands and woodlands, and whose berries are an important food source for birds and lizards.
- **Social acceptability** – *Blue-banded bees can bridge the gap between domestic and public open space.* In addition to their role in pollinating native species, blue-banded bees are effective pollinators of many domestically planted species, including amenity species such as lavender, and urban crops such as tomatoes and sweet basil. In addition, they are highly visible and easily recognisable, making them ideal for public engagement. Indeed, the significant capacity for these species to generate public enthusiasm is illustrated in the success of a recent crowdfunding campaign hosted by the Friends of the Merri Creek, which rapidly raised more than \$25,000 to support the planting of 'Bee Cafes' – plantings of nectar-rich wildflowers in public and private spaces – to better connect populations of the endangered Matted flax-lily, *Dianella amoena*, in northern Melbourne.

- **Ecological feasibility** – *Blue-banded bees will utilise novel habitats and resources.* Because they will collect nectar and pollen from a wide range of native and introduced flowering plants, private gardens and ornamental public plantings can provide important habitat and resources. They are solitary nesting bees, and as such, analogue nesting habitats (e.g. mudbrick features with specially drilled holes) can be easily and successfully incorporated into urban areas.



Figure 8. Blue-banded bees, *Amegilla* species.

Source: Flickr, [ron n beths pics](#). Reproduced freely under Creative Commons Licence CC BY-NC 2.0.

4.2.3 Design to achieve biodiversity objectives

Once biodiversity objectives have been established, it is time to design to meet those objectives. Although the exact designs will depend on specific objectives, they are informed by the five key socio-ecological principles of BSUD (see Figure 9):

1. **Maintain or create habitat for target species** – design to meet the food, water and habitat needs of target species and ecosystems
2. **Facilitate dispersal** – design to facilitate the movement of target species through the landscape
3. **Minimise disturbances and other threats and disturbances** – design to mitigate the threats presented by an urban environment, such as noise and light pollution, vehicle-strike and feral predators
4. **Facilitate natural processes** – design to maximise ecosystem services and facilitate, where possible, natural processes
5. **Facilitate positive human-nature interactions** – design to enhance human connection to and experiences in nature, and minimise any potential disservices.

Because biodiversity objectives are identified early in the planning and design process, alongside other socio-economic objectives for the site or area, designs can be developed and evaluated for synergistic benefits to biodiversity and other socio-economic (e.g. recreation) and environmental (e.g. integrated water management) needs.

Design solutions can include tools and interventions from traditional conservation and ecosystem management handbooks; however, because BSUD seeks to provide habitat and resources for native species *within* the built environment, novel solutions will typically also be required. For example:

- Street trees can provide important food and habitat resources, regardless of nativeness and provenance. In some circumstances, particularly where there are multiple values and expectations assigned to street trees, non-native trees or trees from other parts of Australia may offer a more suitable alternative than locally indigenous trees;
- Nesting boxes can provide important habitat in urban environments where old, hollow-bearing trees are not present;
- Introduced species may provide an important conservation function or ecosystem service, such as providing habitat for a target species, stabilising fragile slopes, or reducing surface run-off;
- Artificial structures such as road underpasses and animal ladders play an important role in enhancing connectivity through urban landscapes;
- Private gardens provide food and habitat resources for native species and enhance connectivity in urban landscapes; and
- Novel ecosystems - novel assemblages of species - can play an important role in engaging urban communities with biodiversity and connecting urban residents to nature.

Having said this, nativeness is also key to enhancing biodiversity in urban environments. Key to BSUD is selecting those design solutions that best meet the biodiversity objectives that have been identified. Selecting between novel and 'natural' solutions will depend to a large extent on the context of the site in question, and the specific biodiversity and other objectives identified for the site. However, some general rules of thumb can guide this consideration:

- **Where they exist, remnant vegetation and native ecosystems should be protected.**
Intact, largely intact or semi-intact native ecosystems are functionally irreplaceable. Where they remain, remnant native ecosystems should be protected or restored, even in small patches, which can still be important for conservation (Wintle et al. 2018).
- **Maintain representation of indigenous plants, animals and vegetation communities in the landscape.**
Maintaining representation of locally native plants and animals, even in ecologically novel and cultivated situations, can still provide immense biodiversity benefits for conserving regional biodiversity (Threlfall et al. 2017; Berthon et al. 2021). Where possible and appropriate, prioritise locally native species to enhance biodiversity outcomes.
- **Embrace novelty but use it strategically.**
Where native or locally native species are not suitable due to changed environmental conditions, future climatic conditions, or specific ecosystem service requirements, consider non-local or exotic species that address these specific objectives: for example, native species from distant (but climatically suitable) provenances; or exotic tree species that best deliver biodiversity and other ecosystem services.
- **Enhance vegetation structure and diversity.**
Regardless of novelty and provenance, enhancing species and structural diversity of vegetation is likely to deliver greater biodiversity benefits and increase resilience. Complex under- and mid-storey vegetation is typically depauperate⁷ in cities.

⁷ Depauperate = impoverished; falling short of natural development or size - <https://www.merriam-webster.com/dictionary/depauperate>.

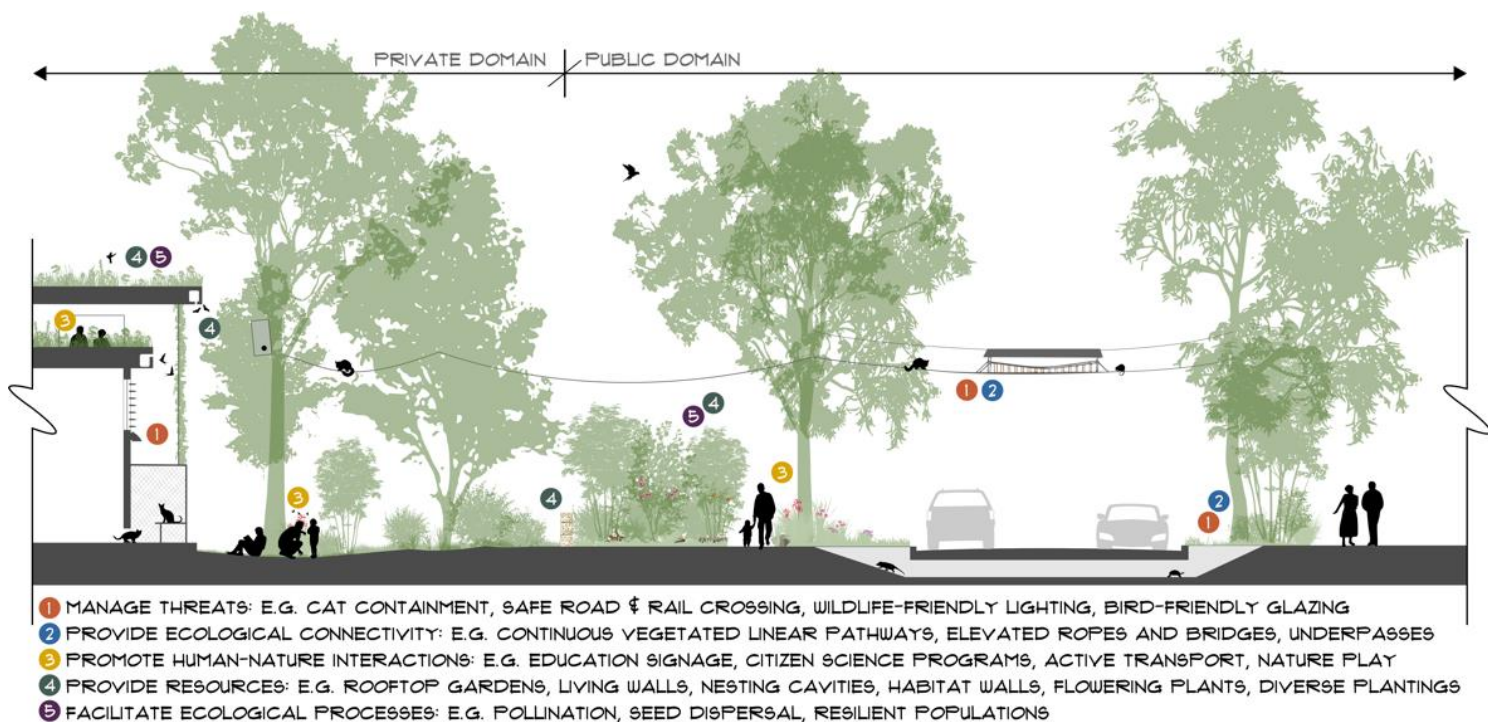


Figure 9. Biodiversity sensitive urban design strategies to deliver benefits to biodiversity and people. Image by Casey Visintin.

4.2.4 Evaluate BSUD

Evaluating BSUD is important for identifying and distinguishing those design solutions that are critical for achieving objectives, monitoring progress and demonstrating success (Garrard et al. 2018). This process also provides a mechanism for users, including developers and planners, to resolve trade-offs between competing objectives.

To evaluate BSUD against biodiversity objectives, those objectives must be measurable. Numerous metrics have been used to assess the impact of urban form on biodiversity, including vegetation cover and proportions of native and non-native species. These simple measures are proxies for the amount of “nature” in an area and don’t directly measure biodiversity outcomes. Alternative metrics, such as the persistence or viability of species and ecosystems, ecological connectivity, and resilience, are more natural measures, in that they directly measure the attributes of the environment that BSUD aims to address.

Species persistence: a measure of the probability that a species will persist in an area. It uses key parameters or attributes of the species and its environment to assess the likelihood that the species will remain for a defined duration. Species persistence can be assessed using formal population viability analyses (PVA) or expert elicitation (Garrard et al. 2018). For example, Garrard et al. (2018) used PVA to demonstrate that policies for cat containment would significantly decrease the likelihood of extinction of striped legless lizards (*Delma impar*) in local urban conservation reserves.

Ecological connectivity: the ability of a species to move through a landscape. Connectivity modelling utilises understanding of a species’ ability to move around a landscape and the arrangement of landscape elements that impede or facilitate that movement to assess ecological connectivity (see **Box 1** overleaf). Kirk et al. (2021) used ecological connectivity modelling to evaluate BSUD for Superb fairy wrens and Growling grass frog at Fishermans Bend (see Melbourne BSUD Case Study 1, **Appendix D**).

Ecological resilience: a measure of a system’s capacity to absorb or adapt to a disturbance or perturbation within changing state. Although intuitive, resilience has proved challenging to measure.

However, it has been shown to be higher in systems that have higher species diversity. Therefore, in the absence of more sophisticated natural measures, species diversity may be a useful proxy metric for biodiversity.

Box 1. Ecological connectivity and urban biodiversity planning

Read more at:

Kirk, H., et al. (2022). *Ecological connectivity as a planning tool for the conservation of wildlife in cities.*

What is ecological connectivity, and why should it be considered when planning urban biodiversity actions?

Ecological connectivity describes the ability of species to move through a landscape, and the arrangement of landscape elements that facilitate or impede such movement. Improving ecological connectivity is particularly important in urban environments where species often face increased levels of habitat fragmentation and novel habitat types that need to be negotiated while moving.

Ecological connectivity analysis can be used to identify key habitat areas that enable species to move across the highly fragmented urban landscape and thus places that should be protected. Formalised connectivity analysis can also allow land managers to target biodiversity-oriented actions, such as revegetation or green-space designation, in areas where connectivity is currently poor (see **Figure 11**).

Planning for connectivity can be as simple as identifying key elements within the landscape:

- habitat patches or corridors
- barriers to movement, such as major roads or densely packed buildings
- large gaps between habitat patches that may be hard to cross

Different species have different habitat requirements and will also have different movement abilities within a landscape. It is therefore important to be aware of your focal species or species group when using ecological connectivity theory for planning.

There are many methods for more formally measuring ecological connectivity such as 'effective mesh size' and including free tools such as Circuitscape or Linkage Mapper.

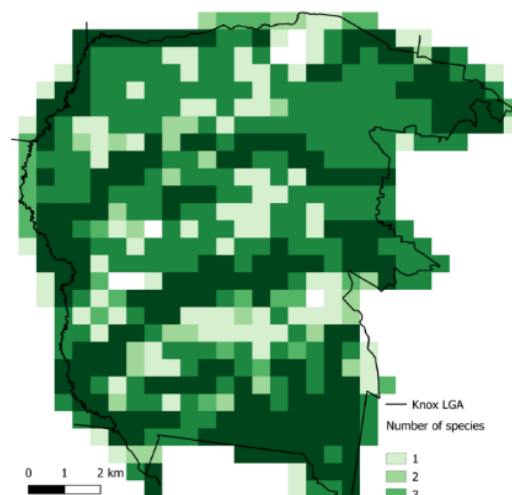


Figure 11. Map showing relative contribution towards landscape connectivity of different areas in the City of Knox

4.2.5 Applying BSUD across scales

BSUD has been designed to apply at multiple scales, from an individual site or street all the way up to a precinct or metropolitan region, and across public and private realms. It can also be applied to new greenfield and urban renewal developments or used to retrofit existing environments (<https://icon-science.org/bsud-home/case-studies/>).

Figure 10 illustrates how the BSUD process relates to the South Australian Planning system and project delivery.

GENERALISED PROJECT DELIVERY PROCESS

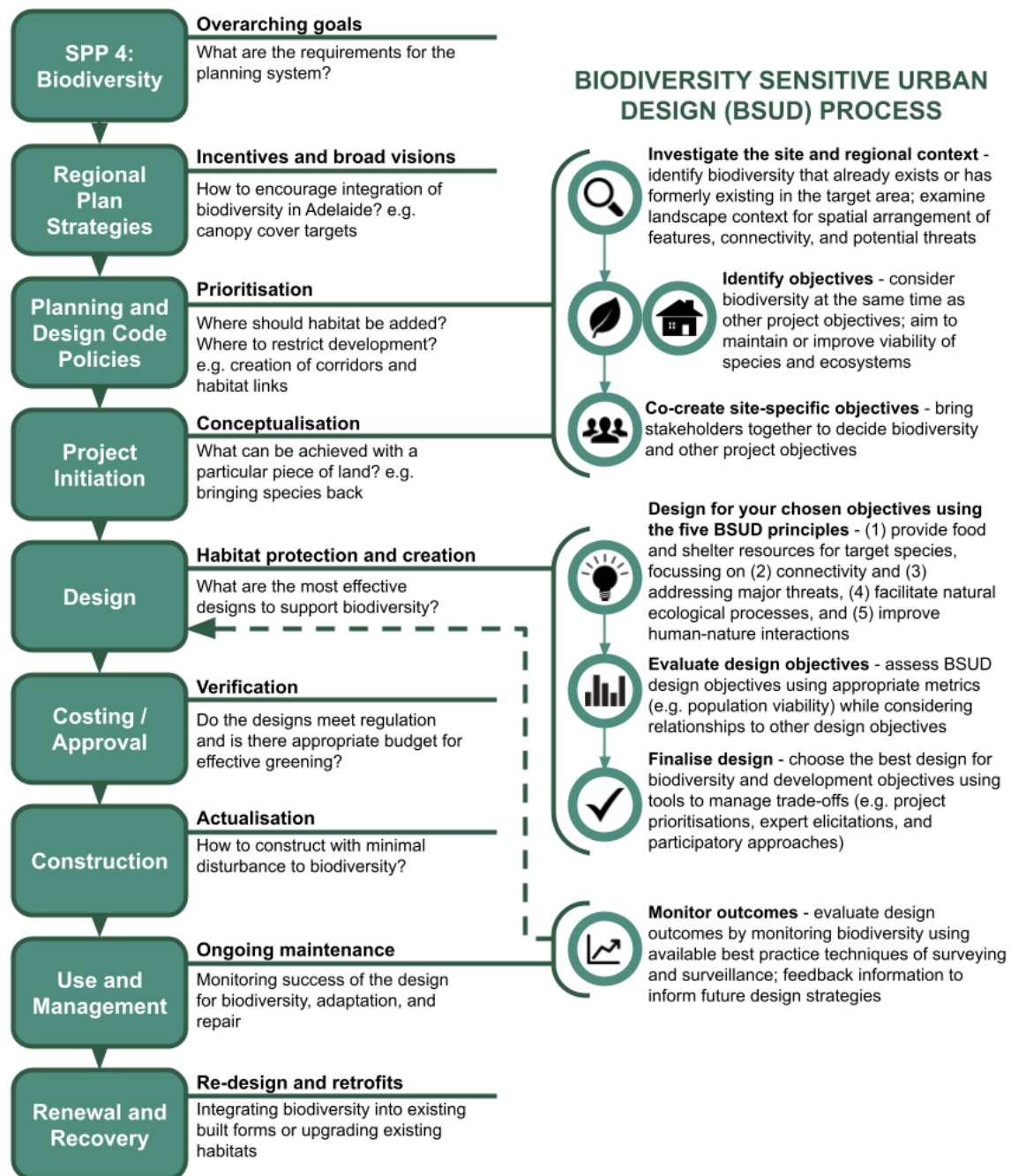


Figure 10. How the BSUD process relates to SA Planning system and project delivery

Modified from [Felson et al. \(2013\)](#), [Garrard et al. \(2018\)](#), and [Bekessy et al. \(2020\)](#)

4.3 BSUD, urban greening and biodiversity conservation

BSUD is a legislated priority for Green Adelaide as it seeks to achieve its biodiversity and greening objectives. Green infrastructure and nature-based solutions are a key mechanism for mitigating warming and extreme weather in cities. While these can also provide biodiversity benefits, biodiversity may not be a priority for green infrastructure, and without careful consideration and clearly articulated objectives, biodiversity outcomes are likely to be opportunistic and poorly co-ordinated.

However, many BSUD designs and interventions will involve adding or enhancing vegetation in urban areas, and BSUD therefore delivers ecosystem services beyond biodiversity conservation. In this way, BSUD both sits alongside and can contribute to urban greening objectives for the city.

Similarly, BSUD is distinct from, but may be complementary to, more traditional conservation efforts and activities that occur in cities. BSUD may help to enhance conservation reserves by addressing key threats that emanate from the surrounding built environment, or improve outcomes for threatened species through the creation of novel habitats or enhancing connectivity between remnant patches.

However, the primary focus of BSUD is on actions that can be taken to improve biodiversity within the built environment; in so doing, BSUD may focus on a broader range of objectives (see [Section 4.2.2: Identifying biodiversity objectives](#)) and embrace additional, often novel, solutions than targeted threatened species and ecosystem conservation programs (see [Section 4.2.3: Design to achieve biodiversity objectives](#)).



Windsor Street linear corridor.

Source: Flickr [COP - local-native landscaping field trip - windsor street... | Flickr](#) Credit: Bill Doyle, City of Playford

5. BSUD case studies

5.1 Melbourne case studies

BSUD has been applied successfully at a number of sites in Melbourne, Victoria. An overview of these is provided in **Table 6** (overleaf), and two of these case studies (Fishermans Bend and Averley) are examined in detail in **Appendix D**. Further case studies and information on the implementation of BSUD can be found on the [ICON Science website](#).

5.2 Adelaide case studies

There are numerous sites across metropolitan Adelaide that have already incorporated, or are incorporating, the principles of BSUD.

To provide decision makers and implementers with examples of how BSUD principles may be applied, RMIT worked with Green Adelaide and members of the Urban Biodiversity Technical Working Group to prepare case study examples that illustrate what successful BSUD solutions can look like in Adelaide. The case studies review a variety of urban biodiversity focused projects across metropolitan Adelaide using the lens of the BSUD principles and process. They offer considerations for future projects, particularly when using the BSUD process from the outset, and illustrate how BSUD can be undertaken at different:

- scales
- stages of the development process
- contexts (i.e., on private and public lands, new developments, and retrofits) – particularly across a diversity of ecosystems.

Case studies include the protection and enhancement of remnant vegetation in linear reserves and riparian sites, restoration of endangered species, biodiversity enhancements in local parks and novel plantings on private and publicly owned lands. A map showing the location of the different Adelaide case studies is provided in **Appendix E**.

Collectively, these case studies demonstrate the application of each of the five BSUD principles (see **section 4.1.1**), and also highlight the numerous co-benefits (such as education and ecosystem services) that can be delivered through BSUD. Key features and benefits of these case studies are presented in **Table 7** and the details of these case studies are provided in **Appendix E (attached)**.

Table 6. Metropolitan Melbourne BSUD case studies and BSUD principles

Context	Case Study Project, location and lead agency	Description	BSUD Principle					Other benefits
			1. Enhance habitat and resources	2. Encourage dispersal	3. Reduce threats	4. Enable ecological processes	5. Human-nature interactions	
Brownfield Urban Renewal 	Fishermans Bend redevelopment, City of Melbourne and City of Port Phillip Fishermans Bend Authority	Scale: precinct A large-scale urban renewal project. Biodiversity objectives and target species were identified during stakeholder workshops, and actions to support these species were assessed using connectivity modelling. Final designs for the precinct development were informed by the effectiveness of different interventions to meet the requirements of four target species: blue-tongued lizards, growling grass frogs, superb fairy wrens and blue banded bees. Co-design of biodiversity objectives and approaches was undertaken with Traditional Owners, ecologists, planners and local environment groups along with the Fishermans Bend Authority and other key State agencies (see further details in Appendix D).	✓	✓	✓	✓	✓	Decision support
Greenfield Development 	Biodiverse greenfield development at Averley Lendlease	Scale: precinct/green street A greenfield development on Melbourne's fringes Lendlease are planning a neighbourhood connected with nature through both landscape design and the provision of sustainable built form options. The plan includes approximately 20 Ha of parks, including areas of natural bushland and recreational spaces. Exemplar 'biodiversity streets' are being designed and implemented. Biodiversity objectives were co-designed with key stakeholders. See further details in Appendix D	✓	✓	✓	✓	✓	Ecosystem services to residents
Linear Corridor 	Melbourne Pollinator Corridor, Birrarung / Yarra River, Westgate Park and the Royal Botanic Gardens Melbourne The Heart Gardening Project	Scale: neighbourhood A community-led street gardening project that is crowd funded and operated within local government guidelines. The goal is to create a continuous corridor of street gardens to connect two large public parks and enhance the dispersal opportunities and habitat availability for native pollinators. The Heart Gardens have now produced a comprehensive street gardening guide with input from ecologists as a template to allow expansion of the initial gardens along the pollinator corridor including design layouts and plant species recommendations. Monitoring of the use of these gardens by pollinators is also underway.	✓	✓			✓	Education, Community cohesion
Streetscape 	Streetscape Biodiversity Project City of Melbourne	Scale: site A collaboration between local government and researchers to create and test a palette of native plant species that could be used to create more biodiverse streetscape plantings. Plantings were maintained using best-practice maintenance techniques and monitored to assess their ability to support native pollinators. A notable increase in native pollinators was observed soon after installation, and monitoring is ongoing.	✓	✓			✓	Water Sensitive Urban Design (WSUD), Decision support

Table 7. Summary of Adelaide urban biodiversity case studies and BSUD principles

Case Study Project, location and lead(s)	Description	BSUD Principle					Other benefits
		1. Enhance habitat and resources	2. Encourage dispersal	3. Reduce threats	4. Ecological processes	5. Human- nature interactions	
BSUD Plans							
 1. Dry Creek Corridor Biodiversity Plan (and implementation Oratanga Reserve to Kingfisher Reserve) City of Tea Tree Gully	Scale: neighbourhood The Dry Creek Corridor Biodiversity Plan 2021 was developed to better protect and enhance biodiversity, including threatened flora and fauna habitat along the Dry Creek Corridor. The plan covers nine reserves along the Dry Creek Corridor, covering nearly 6 kilometres and approximately 47 hectares of linear park. As part of the biodiversity plan, several target species were identified, their habitat requirements assessed, and specific actions for their recovery were outlined. These included the Superb Fairy Wren (<i>Malurus cyaneus</i>). The dense understory habitat plantings have seen the fairy wren disperse between habitats and reaching areas of the creek that it was previously not present.	✓	✓	✓	✓	✓	Decision support
 2. Sturt River 'Warriparri' BSUD Plan City of Marion	Scale: neighbourhood Enabled by the first round of BSUD grant funding provided by Green Adelaide, the Sturt River BSUD Plan encompasses the entire section of Sturt River Corridor that lies within the City of Marion council, including its natural catchment area. The BSUD framework and principles are embedded within the Plan and its key priorities, with target species chosen to represent indicators for each of 7 key themes: Safeguard, Connect, Restore, Survive, Innovate, Engage and Support. The Plan includes detailed spatial mapping to plan for priority restoration sites, with some projects under the plan already successfully funded.	✓	✓	✓	✓	✓	Decision support
Park context							
 3. Biodiversity Planting – Alan E Cousin Reserve, Burnside City of Burnside	Scale: local A local park restoration project supported by local volunteers with funding from the local council. The project has created dense understory vegetation surrounding large remnant Greybox (<i>Eucalyptus macrocarpa</i>) trees, by removal of woody and herbaceous weeds, and extension into underperforming grass areas. Understory vegetation has been allowed to regenerate using the existing seedbank, with very little planting required. This has led to proliferation of unique and rare understory species that would not have otherwise been commercially available.	✓		✓	✓	✓	Placemaking
 4. Grasslands – Victoria Park / Pakapakanthi (Park 16) City of Adelaide	Scale: neighbourhood A project to restore remnant patches of native grasslands in the Adelaide Parklands. There are several active sites for restoration that are maintained by council maintenance teams and local volunteers. After the discovery of the Chequered Copper Butterfly (<i>Lucia limbaria</i>) by a conservation volunteer, a volunteer led outreach program called 'Herding Caterpillars' was established to help monitor the local population. Several restoration approaches have been used, with different and complementary outcomes. In 2021, Victoria Park hosted the first urban cultural burn for grassland maintenance in collaboration with the local Kaurna community.	✓	✓	✓	✓	✓	Education
 5. Thatching Grass and Yellowish Sedge-Skipper butterfly re-establishment Green Adelaide	Scale: regional A collaboration between Green Adelaide and local council to reintroduce the locally extinct Yellowish Sedge-skipper butterfly (<i>Hesperilla flavescens</i>), as part of the broader landscape management plan for Adelaide and Mount Lofty Ranges. After 20 years planning, the first individuals were released in 2019 within the Playford Council area, following extensive habitat restoration works. Applying an adaptive management approach has enabled key learnings and prompted further investigations and field trials.	✓	✓	✓	✓	✓	Integrated pest management

Case Study Project, location and lead(s)	Description	BSUD Principle					Other benefits	
		1. Enhance habitat and resources	2. Encourage dispersal	3. Reduce threats	4. Ecological processes	5. Human- nature interactions		
Linear corridor context								
	6. Breakout Creek redevelopment (Stage 3) City of Charles Sturt and City of West Torrens	Scale: regional Concluding the 30-year transformation of Breakout Creek, the third stage of redevelopment supports urban biodiversity with the addition of 215,000 native plants, and enhancement of the reedbed systems by creating wetland niches. The project offers enhanced habitat value while also contributing to improved water quality of the River Torrens. One of the greatest challenges was to address conflicting stakeholder desires to deliver a project that met all design principles – including a designated area for horse agistment, and protection of the reedbed ecosystem and habitat value of the site for native wildlife.	✓		✓	✓	✓	Placemaking, Traditional Owner engagement
	7. Holdfast Bay Warriparri biodiversity corridor City of Holdfast Bay	Scale: neighbourhood After assessing biodiversity values of local parks in the City of Holdfast Bay, council sought to establish a biodiversity corridor along a section of the Sturt River. While the river channel is managed by SA Water, the goal of the project was to create a biodiverse buffer in the adjoining parklands to expand available habitat across property boundaries. Included in these plantings were non-regionally native plants; but these still provide important structure and resources for local animals.	✓	✓	✓	✓	✓	Education
	8. Biodiversity 'pods' – Smith Creek linear trail City of Playford	Scale: neighbourhood This is a biodiversity enhancement project undertaken by the City of Playford along the popular Smith Creek Linear Trail. Understory patches ('pods') have been established under stands of planted or remnant trees, primarily River Red Gum (<i>Eucalyptus camaldulensis</i>) and Mallee-box (<i>Eucalyptus porosa</i>), using mulch to supress weeds. Establishment success has relied on a co-design process and collaboration in reserve management between the maintenance and biodiversity teams, along with a thoughtful design layout that enhances the community's experience of the reserve and increases shade along the linear pathway network.	✓	✓		✓	✓	Increased tree health
	9. Virginia Grove linear corridor City of Playford	Scale: neighbourhood A council-led initiative to improve the quality of the greenspace provided by new developments while overcoming concerns about maintenance costs. This project is challenging the dichotomy of low maintenance "trees and grass" vs high maintenance irrigated garden beds and argues that there can be increased biodiversity without grossly inflating the cost of maintenance.	✓	✓		✓	✓	Placemaking Low maintenance
Streetscape context								
	10. Windsor Street linear reserve City of Unley	Scale: local Windsor Street Linear Reserve has been created as part of the City of Unley's vision to develop a native vegetation lined cycling and walking corridor from Urrbrae to the Adelaide Parklands, providing unhindered corridors for native bird movement. The plant selection was inspired by Greybox (<i>Eucalyptus macrocarpa</i>) grassy woodland, including a high diversity of understory flowering species. This project serves as a demonstration for the integration of native ecosystems into urban streetscapes.	✓	✓		✓	✓	Cooling, WSUD, Placemaking
	11. The Meadow – Port Road, Woodville City of Charles Sturt	Scale: local A newly renovated street scape, that aims to provide an example of the landscape which once covered the City of Charles Sturt. Instigated due to the Port Road Drainage engineering upgrade, which addressed issues of underground storm water and major flooding, landscaping was considered in the latter stages of the project. However, consideration of BSUD allowed for increased biodiversity value, and awareness and appreciation of local ecosystems.	✓		✓		✓	WSUD

Case Study Project, location and lead(s)	Description	BSUD Principle					Other benefits	
		1. Enhance habitat and resources	2. Encourage dispersal	3. Reduce threats	4. Ecological processes	5. Human- nature interactions		
Small infrastructure context								
	12. Dover Square raingarden – South Brighton Dover Square Tennis Club	Scale: site A community-driven raingarden project on tennis club land that also demonstrates the utility of native species in a low-maintenance context. Increased diversity and suppression of weeds was achieved through dense planting of local native species. Maintenance requirements decreased over time, with very minimal effort required to control plant biomass. However, limited maintenance did lead to a dominance of <i>Carex sp.</i> in the raingarden; limiting this species through regular trimming would open opportunities for flowering plants to flourish as well.	✓			✓	✓	WSUD, Low maintenance
	13. Northern Expressway – Gawler River offset area Department for Infrastructure and Transport	Scale: local To offset the removal of native vegetation required to deliver the Northern Expressway, over 10 hectares of agricultural land adjacent to the Gawler River has been revegetated creating a road reserve offering compensatory habitat. In addition to offsetting losses, areas along the expressway (primarily at entry-exit ramps) were vegetated with native flora. Infrastructure design has allowed for greater water resource availability for Eucalyptus species, supporting the establishment of the open woodland ecosystem, and thus providing food and habitat for local fauna.	✓			✓	✓	WSUD, Low maintenance
	14. Biodiversity planting, Glenelg wastewater treatment plant – Glenelg North SA Water	Scale: site A demonstration site for use of locally native coastal plant species in routine plantings for SA Water. Initially a screening project for SA Water around their Glenelg Wastewater Treatment Plant, shifting the property perimeter fence increased the available planting area. This created an opportunity to host a biodiverse garden bed, which increased the proportion of locally native coastal species in the area. A management technique of utilising “living mulch” protects the soil from erosion while minimising the need for pesticides in management.	✓			✓	✓	Screening, Low maintenance
	15. Adelaide Zoo Sanctuary green wall and green roofs Adelaide Zoo	Scale: site Funded as part of an upgrade to the fencing for Adelaide Zoo. They are a pioneer of green infrastructure in Adelaide, hosting the largest area of green roofs and walls in the state. These novel habitats have been designed to showcase the flora of the Adelaide Plains and aim to offer connective habitat for native fauna in the city. This example of a novel urban habitat enhances biodiversity while creating opportunities for further research through partnerships with The University of South Australia.	✓		✓	✓	✓	Education
	16. Cooling the Schools – Playford Council Area Greening Australia	Scale: local A local scale project designed to combat the dual pressures of the ‘extinction of experience’ from loss of local nature and urban heat, while providing education opportunities for children. A plant palette inspired by Eucalyptus open woodland and grassland species was created and installed in eight schools across Adelaide, with a minimum of 200 plants included in designs for each site. Plant species were selected to provide shade, support biodiversity, or represent culturally significant plant species for the Kaurana community. Integrating information about the ecology and cultural significance of the plantings into the school curriculum has enabled increased awareness and appreciation of local ecosystems.	✓	✓			✓	Education

6. Key insights and learnings from Adelaide urban biodiversity case studies

The following section provides an overview of the key lessons learned from the Adelaide urban biodiversity case studies (detailed in **Appendix E**). The objective is to help stakeholders understand the key challenges, the approaches and methodologies that worked best, outcomes from the different projects (both positive and negative) and provide recommendations for future projects.

Each of these biodiversity projects aligned with at least three BSUD principles.

Eight key insights were drawn from the short and long answer responses in the case study survey, as well as the site visit workshop. Barriers to implementation of BSUD in Adelaide were assessed using multiple choice responses developed from the workshop discussions, with the ability of participants to add 'other' barriers (summarised in **Figure 11** below). Most projects involved multiple stakeholders and multiple funding sources.

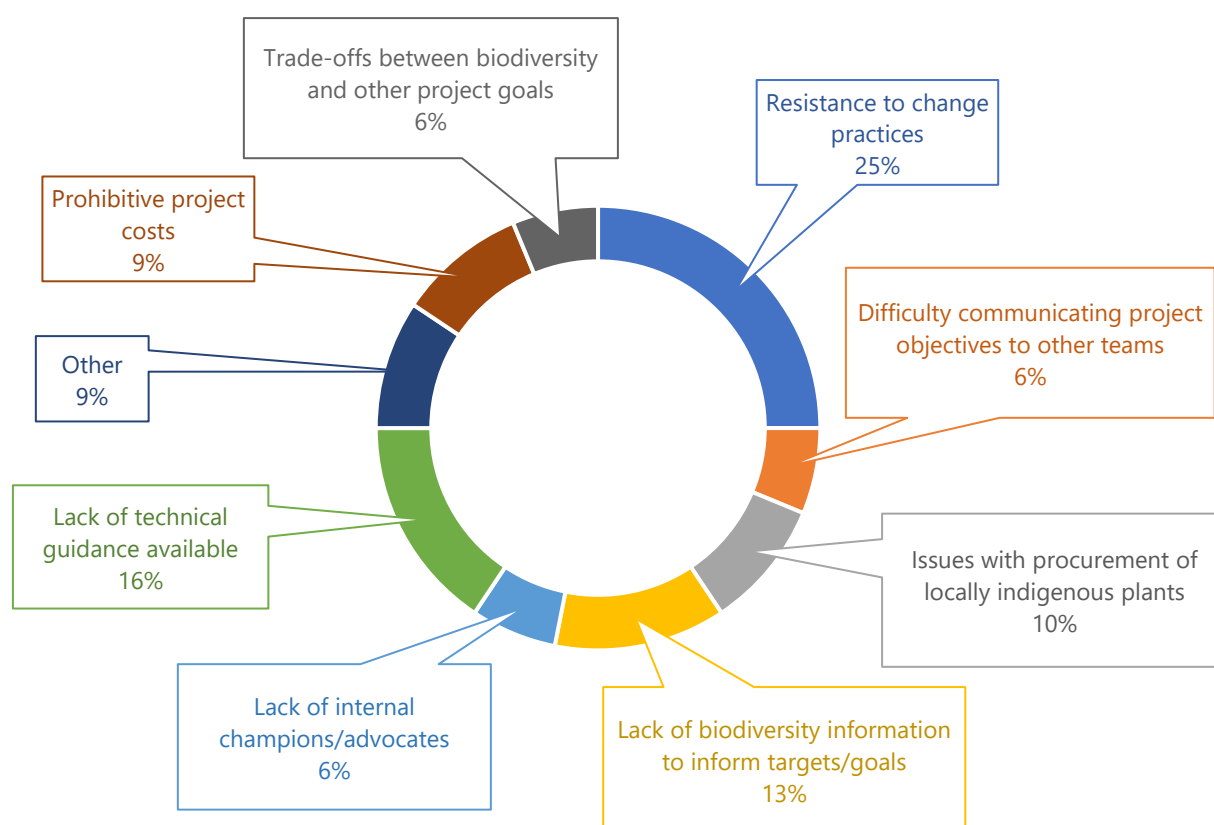


Figure 11. Barriers encountered within the Adelaide case studies.

6.1 Engagement potential of specific target species is being underutilised

Most (69%) case studies in Adelaide contained ecosystem-level targets e.g. restoring Grey-Box Woodland species), and two (12.5%) targeted 'native' vegetation at a local or national scale.

Only five case studies (31%) contained species-specific targets (plants or animals) in their projects. Individual species targets can be a great way of engaging people, by harnessing the power of species stories. For example, the Victoria Park / Pakapakanthi project did this well, successfully using the complex life-history of the Chequered Copper Butterfly by creating an outreach program called 'Herding Caterpillars' that includes a virtual reality rendition of a play about the butterfly and its life cycle.

Melbourne has used the charismatic Superb Fairy Wren to inspire a citizen science project for understanding the prevalence of this iconic species in urban areas - the [Superb City Wrens](#) project. This could have relevant lessons for the Adelaide context. In metropolitan Adelaide case study 1: Dry Creek Corridor Biodiversity Plan implementation (see Appendix E), the City of Tea Tree Gully has also shown success at planting habitat for Superb Fairy Wrens along the creek, resulting in the species being able to migrate to new habitats further downstream.

Species-specific targets can be hindered by lack of information on life history or habitat requirements of local faunal species. This can be an even greater problem for rare or inconspicuous plant species that are endemic to Adelaide. In some situations, focusing work on a limited array of iconic species can homogenise BSUD works across a region, for example, use of a highly recognised species such as a fairy wren or an echidna across large regions can negate a focus on other, less visible or known species. A key challenge is to include a diversity of species as BSUD targets, including those that are locally unique, those that act as 'umbrella' species, and groups such as invertebrates that are sometimes otherwise overlooked.

Biodiversity focused projects can become stronger through thorough use of BSUD principles. Even with best intentions, it can be challenging to determine adequate ecological targets to be specific enough to inform project design. Generalised targets, such as "insectivorous birds" can be too generic to specifically guide designs. This highlights the challenge of determining appropriate target species and therefore, the links to design and monitoring elements of projects.

Recommendations:

- Raise awareness and appreciation of local species through their use as BSUD targets.
- Green Adelaide could take the lead by developing region-wide biodiversity objectives, designing planting palettes for different ecological regions, and articulating design actions that could benefit target species (e.g. planting dense understory vegetation, or floral diversity). Such a list should be sensitive to the variety of habitats present within Adelaide, and ideally developed to reflect this diversity.

6.2 The private realm could be better engaged

While the case studies presented here show excellent progress towards integration of biodiversity into Adelaide, they are often small in scale, and provide site-specific gains without consideration of the surrounding landscape. For example, in metropolitan Adelaide case study 3: Biodiversity Planting – Alan E Cousin Reserve (see Appendix E), the community enthusiasm for maintenance of the remnant habitat in AE Cousins reserve is not reflected in many of the gardens of the residential properties abutting the reserve. There is often a missed opportunity for engagement and integration of BSUD principles into the private realm. To achieve this, there is an opportunity for government organisations such as Renewal SA to integrate BSUD into their practices, and increase biodiversity in residential developments.

[Gardens for Wildlife](#) is a program in Victoria that encourages residents to provide habitat to support biodiversity in their gardens. Volunteer garden guides undertake a site visit to assess potential for

habitat in a resident's garden and provide advice on plants that could be planted to support biodiversity. The council then offers a voucher to purchase native plants.

During the workshops it was recommended that the success of a BSUD demonstration site could be reflected in the uptake of native plantings into residential gardens. Procurement of native plants was identified as an issue in several of the case study surveys (**Figure 11**). However, several councils in Adelaide have already begun programs that have successfully raised the profile of native plants for residential gardening. For example, City of Playford's [Buffers to Bushland](#) program provides native plants to interested landholders that are willing to restore large areas of remnant habitat on their land. Many inner-city councils also have vouchers for residents to obtain cheap local plants.

Recommendations:

- Better support the Native Plant industry in Adelaide to allow for greater uptake of native plant species in the private realm e.g. local gardens, corporate plantings
- Use demonstration sites in iconic areas such as the Adelaide Zoo, and the Botanic Gardens to engage the residents and complement existing Garden Guides
- Establish a Gardens for Wildlife (or equivalent) program for Adelaide.

6.3 Volunteers are an important asset, but can also make projects vulnerable

Many of the case study projects are supported or driven by volunteers. Volunteers enable projects that extend the work of council biodiversity teams and achieve biodiversity outcomes that may not have otherwise been realised. Our survey revealed that prohibitive project costs were often encountered as a barrier to successful implementation (**Figure 11**), and local councils (the other main stakeholder in these projects) have limited budgets for maintenance.

However, there can be challenges associated with managing volunteers, and a reliance on volunteers can also make projects vulnerable (discussed in depth in [section 7.6](#)). For example, the City of Tea Tree Gully noted that at its current size, the council biodiversity team are limited in their ability to manage the administrative protocols of a volunteer program and consequently are not able to provide ongoing support to volunteers. This has contributed to deteriorating habitat values in a previously well-maintained site (metropolitan Adelaide case study 1, Appendix E).

There can be an over-reliance on using volunteers for site maintenance, with the assumption that volunteer maintenance is "free". This is not the case as high quality work with volunteers requires significant time investment by agencies. It can also devalue the maintenance that is required to adequately manage biodiversity sites, and does not necessarily reflect the actual maintenance cost of contemporary land management practices such as irrigated lawns and gardens as compared to management of biodiverse sites.

Recommendations

- Ensure sufficient funding and support is available in order to maximise the benefit that can be provided by volunteers (e.g. a BSUD officer within Green Adelaide or support for volunteer officers within local government).
- Determine the maintenance costs of various biodiverse plantings in order to better compare these with contemporary land management practices (including irrigated, mown lawns and gardens).

6.4 BSUD is often opportunistic

There is a need for overarching species and biodiversity goals for Adelaide to drive targeted, intentional delivery of BSUD. Biodiversity interventions in Adelaide are often opportunistic, in that many BSUD projects have been initiated by integrating biodiversity into existing capital works projects, or as the

result of finding win-win scenarios for WSUD and BSUD outcomes. The survey indicated that a key barrier to implementing BSUD is that it is often seen as an 'add-on' to core business.

Much of the funding for BSUD projects comes from local council capital works budgets or community grants from Green Adelaide or other similar bodies. For example, the creation of the linear park corridor in Windsor Street (case study 10, Appendix E) was driven by a need to upgrade the stormwater infrastructure, which created an opportunity for enhanced biodiversity to be designed into the streetscape. In other cases, projects have made use of unconventional spaces for biodiversity, or are the result of a goal to provide for multifunctional land uses (Virginia Grove corridor, case study 8, Appendix E), rather than specific biodiversity goals. For example, the many roadside biodiversity projects implemented by the Department of Infrastructure and Transport utilise 'leftover' or awkward land parcels that cannot otherwise be developed. The Breakout Creek project (metropolitan Adelaide case study 6) was the result of a large capital works project that attempted to harmonise the multiple objectives of flood management, while providing for biodiversity and community and cultural values (e.g. horse agistment).

This kind of opportunistic implementation of BSUD is positive and demonstrates how consideration of biodiversity can be integrated into many aspects of planning and development. However, more strategic planning for BSUD would enable actions to be prioritised, leading to more optimal outcomes for biodiversity, and would enable projects across property boundaries to complement each other, enhancing landscape connectivity,

An overarching strategy for Adelaide would also enable synergy between fragmented projects, as has been demonstrated by the BSUD plan for the Dry Creek and Sturt River corridors (metropolitan Adelaide case studies 1 and 2, Appendix E). Creating a continuous biodiversity corridor along the Sturt River (metropolitan Adelaide case study 7, Appendix E) relies on collaboration between SA Water and City of Holdfast Bay, as well as the City of Marion and residents with river-facing properties.

An example of coordinated effort can be seen in the City of Melbourne, where greening actions are being prioritised at locations in the city to optimise ecological connectivity for target species (Kirk et al. 2018).

Recommendations

- Develop metropolitan-wide and locally specific targets for biodiversity conservation and restoration as a collaboration between Green Adelaide, local governments, and the Kaurna Community as well as other relevant stakeholders (See [headline initiative 1](#)).
- Encourage development of BSUD plans for implementing locally-specific targets.

6.5 Unique environments and novel trade-offs – using novelty to improve outcomes

Urban areas often require an acceptance of ecological novelty that is a deviation from 'pristine' or 'original' ecosystem paradigms. Many BSUD projects require trade-offs between actions that provide optimal conservation outcomes and the requirement for continued human activities.

Several case studies have used novelty in different ways to enhance the biodiversity outcomes of projects. For example, while use of locally native plant species is ideal, many native animals are capable of utilising plants that are native to larger geographic areas (i.e., nationally) and incorporation of these species into projects can also have enhanced biodiversity benefits.

Novel approaches to maintenance are also required, especially given the ongoing propagule pressure⁸ from weeds, and perceived high ongoing maintenance costs. For example, use of heavy mulching and dense planting techniques can suppress weeds, but do not allow for the restoration of the existing

⁸ "Propagule pressure is a term used to describe introduction effort and is represented by the number, frequency, and quality of organisms being introduced to a new (uninvaded) area" – [Smithsonian Environmental Research Center](#)

native seed bank. Weeds have been used to provide functions such as bank stabilisation, shelter or other resources for fauna – an example of this is shown in the use of maintenance plants in the City of Tea Tree Gully (metropolitan Adelaide case study 1, Appendix E).

When considering novel plantings, it is important to recognise that there can be risk associated with some species performing too well and having unexpected environmental and/or management impact. As a result, the prudent evaluation of species can be a very beneficial process to begin with.

Recommendations:

- Embrace novelty where appropriate but use it strategically. Where native or locally native species are not suitable due to changed environmental conditions, future climatic conditions, or specific ecosystem service requirements, consider non-local or exotic species that address these specific objectives: for example, native species from distant (but climatically suitable) provenances; or exotic tree species that best deliver biodiversity and other ecosystem services. (For further details, refer to section **4.2.3**).
- Adopt a hierarchy of actions for biodiversity as appropriate to the project goals, as described in section **4.2.3**: '[Design to achieve biodiversity objectives](#)'.

6.6 Demonstration sites can ameliorate resistance to change

Resistance to change was the most common barrier to the successful implementation of BSUD projects identified in the surveys (**Figure 11**). However, many of the case studies serve as useful demonstrations of what is possible with BSUD in Adelaide, and can help increase engagement with and acceptance of the approach.

For example, the City of Unley experienced some initial resistance from homeowners when planning their Windsor Street development (metropolitan Adelaide case study 10, Appendix E). However, after the initial section was complete, the residents could see the potential of the native landscaping to enhance the amenity value of their street and were eager to have the design replicated for their footpaths.

Similarly, a lack of experience in horticultural cultivation with native plants is limiting their wider use in urban plantings. Sites like the Glenelg Wastewater Treatment Plant (metropolitan Adelaide case study 14) show the successful implementation of native plants in an urban setting and can inspire residents to consider using locally native species in their own gardens.

The Victoria Park / Pakapakanthi (Park 16) restoration grasslands site can be used as a great engagement tool, as it highlights the beauty and complexity of this ecosystem and the challenges of managing weeds. However, this intensity of management is perhaps not possible at a larger scale.

Recommendation:

- Use the case studies in this report and others gathered through SA Water and Renewal SA to inspire further BSUD projects in Adelaide.

6.7 Monitoring and measurement need to be integrated from the beginning

To be able to understand the impact of biodiversity initiatives, monitoring and measurement of success needs to be integrated into the project design from the beginning. However, most (81%) survey respondents indicated that monitoring was not included in project budgets, and access to maintenance funds was seen as a barrier to project success.

While almost all case study surveys reported successfully increasing biodiversity with their project, few (4 of 16) formally measured faunal use of the site after the project ended. Most measures of success

were based on plant installation or plant survival. Further, most monitoring of project outcomes was informal or opportunistic, through university or volunteer projects rather than formal monitoring schemes.

Only two case studies had appropriate baseline information from which to measure success, but pre-project biodiversity was generally assumed to be low.

There is an opportunity for broader metrics for social benefits e.g. how many people traverse Windsor Street (see metropolitan Adelaide case study 10: Windsor Street Linear Reserve, Appendix E).

Recommendations:

- BSUD projects should include monitoring in their project budgets.
- Monitoring and measurement of projects needs to be better linked to existing government data services – a city-wide monitoring platform could be developed.

6.8 Maintenance is an obstacle for continuing to achieve biodiversity goals

Retaining biodiversity within urban environments requires ongoing maintenance due to the presence of high levels of disturbance, persistent encroachment of weeds, and other threatening processes. However, maintenance is costly, and Adelaide-specific knowledge of the appropriate methods to achieve continued biodiversity in highly urban contexts is still limited.

In some case studies, maintenance was seen as negatively impacting the outcomes of the project success either due to miscommunication between teams, or the perception of biodiversity as an ‘add on’ rather than a core value. For example, establishment of understory vegetation at Smith Creek (metropolitan Adelaide case study 8, Appendix E) had to consider mowing regimes at the design stages to avoid damage to seedlings in the early stages of the project.

Current management practices are often not suitable for maintaining biodiverse native grasslands, and maintenance practices that benefit biodiversity can clash with other regulation. For instance, maintaining dense understory vegetation can be at odds with current Crime Prevention Guidelines on maintaining sight lines. Some grassland patches established by roadsides along the Northern Expressway – Gawler River Offset Area (metropolitan Adelaide case study 13, Appendix E) have seen the loss of native grasses due to mowing being conducted at frequency that does not allow the plants to complete their full life cycle and set seed.

Appropriate maintenance of local biodiversity within the urban context is a new and emerging field. This knowledge is generally present within local council biodiversity teams, but is often not applied outside traditional conservation areas. Maintenance teams, on the other hand, are often time limited and would benefit from strategic guidance or training to identify native plants, and enable them to better distinguish between ‘desired’ and ‘undesired’ plants when maintaining gardens.

Novel approaches to limiting weed abundance and improving the ease of maintenance were utilised in several projects (e.g. use of mulch or dense plantings to suppress weed growth), could be embraced by others (e.g. a hedge barrier to prevent wind dispersal of seeds into the grassland restoration site). It is important to note that the use of mulch can pose a risk to ecosystem function and biodiversity e.g. spider and ant communities as well as the Flinders Ranges worm-lizard (EPBC Act listed).

Recommendations:

- Develop guidelines and associated training programs for maintenance of biodiverse plantings, using plant palettes adapted from local ecosystems for urban areas where a high level of novelty is required. These can be developed using learnings from existing restoration works of remnant ecosystems in highly urban contexts in Adelaide.

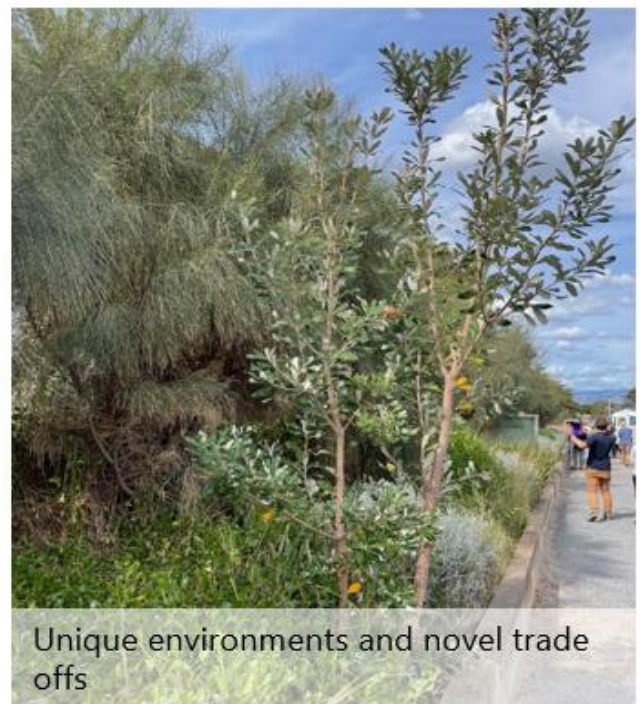


Figure 12. Some barriers and opportunities when undertaking biodiverse greening projects.

7. Challenges and opportunities for biodiverse urban greening in Adelaide

7.1 Habitat clearing and degradation

One of the primary causes of biodiversity loss in Adelaide is clearing or degradation of habitat. It is estimated that almost 90% of the original extent of native vegetation in the Green Adelaide Region has been cleared, some of which is found nowhere else in the region, making it even more critical to conserve (Bradshaw et al. 2012). Without comprehensive mapping and protection, remnant habitat patches may face ongoing risks.

Remaining patches of vegetation are highly fragmented and vulnerable to other modifications of the urban environment (including urban heat, pollution and changes to hydrology) which further degrade habitat conditions. Examples of the most at risk communities in the Green Adelaide region include those that are poorly recognised (such as grasslands and grassy woodland ecosystems) or poorly valued (such as shrublands and salt marshes communities). Well-meaning actions like planting trees in grasslands can degrade these communities and impact on unique biodiversity assets that they contain (e.g. case study 6 - conversion of a saltmarsh into a picturesque wetland).

Reference points for restoration are not readily available for many areas in Adelaide, necessitating high reliance on local expertise and opinion in the absence of knowledge of the ecological history of an area. The Virginia Grove Corridor (case study 8, Appendix E) is an example of a site where the planting program was heavily determined by council staff who have worked on biodiversity sites across the council area for decades.

Furthermore, extinction debts in habitat remnants – which occur when a species is on a trajectory towards extinction but may still be present in low numbers – mean that failure to reverse ongoing threats will lead to continued loss of species (Kuussaari et al. 2009). Similarly, marine and freshwater environments suffer from sedimentation, plastic pollution and nutrient influxes as a result of increased impervious surfaces and fertiliser inputs into urban plantings (Schmarr et al. 2022).

Balancing maintenance needs and biodiversity challenges, such as retaining or re-establishing open grassy woodland habitats while reducing weedy grasses can be difficult. In some instances, retaining weedy though difficult to access areas can protect habitat for animals such as the critically endangered Flinders worm lizard. This means project design must avoid the temptation to heavily mulch and plant difficult to reach areas if biodiversity services are provided in weedy areas. The use of easy maintenance landscaping such as heavy mulch, dense planting and regular mowing can reduce grass cover in areas where native fauna are reliant on access to more open ground such as the spaces between grassy tussocks in grassed areas.

To address habitat loss and biodiversity decline, climate change, and maintain a liveable city for all, it is crucial that the native vegetation that remains in Adelaide is protected and opportunities to restore and regenerate are prioritised.

The *Native Vegetation Act 1991* (Native Vegetation Act) currently applies to a limited number of areas within metropolitan Adelaide, such as the River Torrens / Karrawirra Pari and areas of the Adelaide Foothills and Mount Lofty Ranges. Further, it covers the Hills Face Zone, areas that were previously zoned for the Metropolitan Open Space System, and all or parts of some Hills and fringe councils. To better protect the small percentage of remaining remnant native vegetation in metropolitan Adelaide (including scattered trees) there may be benefit in expanding the application of the Native Vegetation Act to cover, for example, all known areas of native vegetation or strategic biodiversity corridors in metropolitan Adelaide.

There has been much discussion recently – in the community and by stakeholders – about whether South Australia's tree protection laws are strong enough, including the fees associated with tree

removal. Fees for removal of significant and regulated trees are considered insufficient to deter removal and do not adequately capture the ecosystem service and habitat value of urban trees. In response, the following reviews are underway:

- [Open Space and Tree Review Project](#) (State Planning Commission)
- [Planning System Implementation Review](#) (Expert Panel)
- [Inquiry into the Urban Forest](#) (Environment, Resources and Development Committee, ERDC).

Green Adelaide, along with many other government and non-government stakeholders have made submissions outlining the opportunities and challenges of this legislation with regard to supporting biodiverse urban greening outcomes within urban areas – in particular small scale residential infill. For copies of these submissions, visit the above 'Inquiry into the Urban Forest' and 'Planning System Implementation Review' websites.

7.2 Monitoring and data management

Monitoring is vital for understanding the state of urban biodiversity and for determining the impact of investments, such as planting programs, maintenance work, and stewardship programs. It is also necessary to build an evidence base for what interventions or initiatives are effective and what can be done better, particularly in the emerging field of BSUD.

There are many organisations involved in the measurement and monitoring of biodiversity in metropolitan Adelaide, including Green Adelaide and the Department for Environment and Water, local government, research institutes, non-government organisations, and citizen scientists, and there is a need for a more unified system for collating information which is collected. The Biological Database of South Australia (BDBSA), which is the closest to a centralised biodiversity repository for South Australia, could be further enhanced as a resource through improved integration with other biodiversity data management systems and greater resourcing for the processing of existing information which requires verification and analysis prior to upload to BDBSA. Overall, the lack of comprehensive data and a centralised system for storing biodiversity information is likely to hamper efforts to prioritise conservation activities.

Improvements in data management will also provide opportunities for the development of tools that allow quick access to biodiversity information to help create baselines and support decision-making for the implementation of BSUD projects. As an example, once collated, data on biodiversity can be analysed to properly understand trends, gaps, and opportunities for conservation in Metropolitan Adelaide and would support the creation of a Critical Habitat Overlay for inclusion in the State's Planning and Design Code.

7.3 Setting targets and measuring success

A key theme that emerged from the Adelaide BSUD case studies was that monitoring and measurement of success was not usually integrated within initial project budgets (81% of survey respondents). This is due to a number of reasons such as:

- BSUD was often opportunistic rather than the priority resulting in it being an 'add-on' for an existing project therefore not included within proposed monitoring and measurement processes; and
- There is limited funding and resourcing available to include BSUD in the initial scoping phase of projects.

Targets and/or metrics for measuring and monitoring of species to understand the state of urban biodiversity across metropolitan Adelaide and enhance outcomes have not yet been investigated or established at a regional level, and this in-turn limits the setting of targets at a local government area,

suburb, precinct, or project-scale, as there are challenges in defining success due to the lack of baseline.

While there are challenges to identifying and setting targets, the trade-off is that there may be missed opportunities to protect lesser-known habitats and creatures. An example is the missed opportunity to conserve *Maireana aphylla* shrublands along the Gawler River offset site. A BSUD lens to identify the extant communities at the site may have adjusted the scope of the project to include protection of this ecosystem type.

There are opportunities to measure progress for biodiversity conservation in Adelaide, including the goal of becoming nature-positive, through either outcome or process-based targets. Outcome-based targets reflect a measurable outcome (e.g. increases in canopy cover, or abundance/persistence of species). Process-based targets reflect the steps that are required to achieve outcome-based targets (e.g. dedicated annual spending on biodiversity of 5% per year).

Currently, tree canopy cover is the only widely adopted biodiversity related target for metropolitan Adelaide. There is an opportunity to capture other components of urban biodiversity such as habitat condition, percentage of understory vegetation cover, and abundance or diversity of plant and animal species. Resolving gaps will require an iterative conversation regarding what we want to measure, what is possible, and what is cost effective to measure.

7.4 Maintaining biodiverse plantings

A common theme that emerged from the BSUD case studies is the difficulty of maintaining biodiverse plantings. Due to limited budgets, maintenance practices are often geared towards low cost and high efficiency maintenance techniques such as mowing and slashing of open grasses, and limited maintenance of large individual trees. Maintenance is typically undertaken by labourers who have not been trained in appropriate techniques for managing biodiverse plantings. Maintenance techniques are sometimes incompatible with maintaining high biodiversity plantings. For example, mowing regimes may not match the natural regeneration cycle for native annual plants, leading to poor ongoing recruitment and persistence within native sown meadows. Similarly, shrub plantings are often avoided to prevent difficult maintenance situations such as rubbish removal from within bushes, and pruning requirements. The design of green spaces has come to reflect these maintenance styles, but this may create habitat that preferences introduced fauna, and aggressive native species like the noisy miner, *Manorina melanoccephala*.

There are challenges in working with grassy woodland habitats where many of the plants are small and low growing, and particularly susceptible to damage from landscape management practices. Standard mowing regimes and weed management techniques can be destructive, and may need to be more nuanced to preserve habitats. New and novel reserve maintenance practices may need to be identified and considered, such as the use of Kaurna cultural land management practices, timed mowing, and alternative weed suppression techniques.

While cost effectiveness is an important consideration for creating nature-positive cities, two questions are important to ask:

- Firstly, how can the costs associated with enhancing and maintaining biodiversity in cities be reduced? Recent projects, such as Melbourne's Woody Meadows, create biodiverse habitat through dense plantings of novel vegetation communities that are specifically designed to be low input and easy to maintain. A similar approach has been used at SA Water's Glenelg wastewater treatment facility (metropolitan Adelaide case study 14).
- Secondly, what is the value of urban biodiversity; that is, how much are we willing to pay for enhanced biodiversity in the city? Urban biodiversity delivers a range of important benefits over and above those provided by greening, from conservation of biodiversity and improvements to soil through to enhanced resilience and human health and wellbeing (see [Section 3: Benefits of urban biodiversity](#)). Additional costs of maintaining biodiversity in cities should not be

considered in isolation of the range of benefits delivered, nor should they necessarily be born only by budgets reserved for conservation or green space management.

7.5 Access to indigenous plant species

Use of locally native plant species in urban greening projects can be limited by the availability of, or access to suitable plant material. This often results in 'native' plants being sourced from Western or Eastern Australia, representing species that did not historically occur in Adelaide.

A handful of local councils have well established nursery programs that promote local native species through giveaways and other distribution programs to local residents. Many councils do not have sufficient funding to maintain their own nurseries, and native nurseries are often small enterprises that struggle to make profit. However, there may be opportunity to leverage small scale and independent seed banks and nurseries such as Trees-for-Life for access to rarer and lesser known species.

These are also crucial repositories of material for local council revegetation projects. Other councils, and state government bodies such as SA Water have partnered with indigenous plant nurseries to collect and grow local plants for large scale revegetation projects. The Gawler River offset project created a nursery specifically to provide plants and seed stock for the project. Not all projects will have resources to do this type of work, and there can be challenges in finding adequately knowledgeable staff to germinate and grow specialised and rare plant species.

In many cases, substitutions are required for similar but not locally native species due to low stock availability. Increased demand for native species has driven an increase in 'native' plants, but those that are stocked at popular nurseries often don't include plants that are local to South Australia. Therefore, initiatives that support a more consistent supply of local native plants, such as support for indigenous/community nurseries, will be valuable.

7.6 Role of communities acting for nature

A key theme that emerged from Adelaide's BSUD case studies was the critical role of volunteers for championing and maintaining biodiversity in the city; successful biodiverse greening often relied on the activities of volunteers and the persistence of individual people. This is both an opportunity and a risk. Volunteers can be strong advocates and motivators and important for the success of tasks that require hands-on action. However, without systems in place to adequately support volunteers, this can be a tenuous resource.

Critical risks include:

- **An aging volunteer base** - Succession planning is required to encourage and recruit new volunteers.
- **Declining motivation and burn-out** - A concerning consequence of declining contact with nature is that people become more apathetic towards nature and its conservation. To address this, the Victorian Government has implemented the Victorians Value Nature program, which aims to increase motivation to act for nature through a range of nature connection strategies. There is an opportunity to implement a similar program in South Australia.
- **Unsupportive policies/processes** - Some policies and processes designed to protect volunteers and those who manage them can inadvertently act as barriers to volunteer engagement, for example public liability insurance. Support for organisations to overcome these barriers may be necessary.

An overarching strategy for co-ordinating and funding volunteers is provided by the [Volunteering Strategy for South Australia 2021-2027](#), but in order for volunteer programs to be successful this needs

to be supported by ongoing dedication of council budgets to the preservation of biodiversity in urban areas. This Strategy aims to:

- build the capacity of volunteer-involving organisations to engage, train, support and retain volunteers, including young volunteers
- support organisations to develop effective practices, structure, governance and training opportunities for volunteers
- promote the benefits of volunteering to encourage greater participation
- improve the experience of volunteers
- foster continuous improvement through partnerships and collaboration between sectors to sustain volunteering.

7.7 Finding space for urban nature

Finding space for additional urban greening initiatives and biodiverse plantings across metropolitan Adelaide is particularly challenging as it directly impacts land development. Opportunities to set aside dedicated areas for conservation are scarce and increased urban density not only reduces backyard size and opportunities for conservation, but can also reduce the ability for people to connect with nature at home.

Allocating space for nature in public spaces such as streetscapes is also challenging, as this land is often contested (e.g. utilities requirements) and has multiple existing uses. There have been recent positive moves to reduce these conflicts, including efforts by SA Power Networks (SAPN) to involve arborists and council staff in decision-making, but challenges remain with balancing competing needs for public space.

Line of site issues and perceived safety risk can exclude consideration of mid-story vegetation in some situations. However, careful design can potentially mitigate these concerns, including gradually increasing the height of mid-story vegetation from the edges of roads to maintain traffic visibility and planting dense, prickly vegetation in areas where safety is a concern.

Anecdotally, councils are now butting up against space limits, with space traditionally available for greening (such as on road verges and in public parks) already planted to capacity. Increasing biodiverse plantings therefore require substantial measures to reclaim or increase public space for biodiverse greening purposes for example, 'de-paving' road space (e.g. protuberances and offset verges).

Finding redundant or underutilised space is therefore a strong avenue for realising change, particularly when the space is managed by government agencies (Croeser et al. 2022). Infrastructure corridors, creek banks, government properties, sporting facilities and redundant road and parking space all can be valuably retrofitted or repurposed to create biodiverse green space. Identifying these opportunities at scale is now possible with advanced digital mapping techniques, as well as through systematic surveys by experts in partnership with local communities.

In 2021, Green Adelaide undertook a *Greening Prioritisation Pilot Study* to help spatially prioritise greening investment across metropolitan Adelaide (not yet publicly available). This pilot study and any future refinements (e.g. inclusion of additional biodiversity datasets) can be used as a tool to prioritise on-ground works and maximise biodiverse planting investment.

Private property can also be leveraged to enhance local biodiversity. Programs such as 'Gardens for Wildlife' can encourage residents to retrofit their gardens to support native species, while building neighbourhood social capital. When development occurs, the Planning and Design Code requires infill housing to plant a tree, and a portion of the site's plot area is retained for soft landscaping – which could be specified as biodiverse gardens, with suitable planning controls. Rooftop and vertical greening can also be encouraged with innovative planning rules or incentives, both as retrofits and

during development. Currently these are both encouraged in higher density zones in the CBD and along transport corridors.

8. Funding and financing mechanisms

This section highlights some of the funding approaches taken in Adelaide to date to increase and improve urban greening and biodiversity, and outlines other innovative financing mechanisms that could be implemented.

8.1 Existing funding mechanisms

The whole-scale funding of urban greening and biodiversity projects on public land largely falls within the jurisdiction of State and local government. Additionally, there are several State Government offset schemes and grant programs which are available to help councils fund urban greening and biodiversity initiatives in the public realm.

Every council across metropolitan Adelaide funds the protection, creation, and maintenance of vegetation on public open space and streetscapes and may leverage grant funding from State or Federal Government to deliver large-scale greening projects. Many state governments also fund biodiversity conservation works on land that they own and/manage e.g. Department for Environment and Water, Department for Infrastructure and Transport, SA Water.

There are two key existing offset schemes (Urban Tree Canopy Offset Scheme and Open Space Contribution Scheme) which collect money in lieu of providing tree canopy or public open space. The monies raised by these offset schemes is allocated into separate statutory funds established for the purpose of the relevant scheme.

While it is considered that any offsetting scheme should be used as a last resort (the default should be tree planting or provision of public open space due to the significant ecosystem services, health and wellbeing, amenity benefits provided), the monies raised by such schemes could be more strategically allocated towards the protection and creation of urban greening and biodiversity across metropolitan Adelaide.

8.1.1 Open Space Contribution Scheme and Planning and Development Fund

The Open Space Contribution Scheme (section 198 of the *Planning, Development and Infrastructure Act 2016* (PDI Act)) is one of the primary mechanisms for ensuring there is space and funding for open space development and enhancement across South Australia with payments made in lieu of public open space paid into the Planning and Development Fund (the Fund).

The Fund operates under the PDI Act and provides the means for open space and public realm investment across South Australia. It not only supports the Ministerial acquisition, management, and development of land for open space; it also provides grant funding opportunities for local government through the Open Space Grant Program.

Given the significant amount of money available in the Fund, it is recommended that a regional open space strategy be developed to help identify gaps in the open space system, and priority areas for funding.

It is understood that a regional open space strategy will be considered as part of the preparation of the new Greater Adelaide Regional Plan (including review of waterway locations for the potential creation of urban habitats and wildlife corridors) to improve accessibility and space for greening and biodiversity.

8.1.2 Urban Tree Canopy Offset Scheme and Urban Tree Canopy Offset Fund

The Urban Tree Canopy Offset Scheme was established in 2021. Therefore, it is too early to evaluate the effectiveness of this Scheme (and supporting Urban Tree Canopy Offset Fund) and its ability to provide adequate funding to councils to plant trees in parks, reserves and nature strips, or to create new parks.

Further, Part 3 of the State Planning Commission's (SPC) Open Space and Trees project (currently on hold pending the outcome of the Planning System Implementation Review) will involve review of the impact of infill development and the operation of the SPC's 'infill tree policy' within the Planning and Design Code. Part of this review will look at the fees set under the Urban Tree Canopy Offset Scheme, and its spatial application.

8.1.3 Green Adelaide grant programs

Through the landscape levy, Green Adelaide supports two grant programs (Cooler, Greener, Wilder and Grassroots Grants) that provide funding to partners and stakeholders for projects which align with its vision and priorities to deliver a cooler, greener, wilder, and climate-resilient region.

The Cooler, Greener, Wilder Grants Program is a new program (an amalgamation of the former Greener Neighbourhoods, Water Sustainability and BSUD grant programs) specifically for local governments in the Green Adelaide Region to undertake on-ground works that deliver greening and cooling outcomes, which will improve our city's liveability, biodiversity and climate resilience. Projects need to include integrated implementation of greening, WSUD and BSUD design outcomes, in highly modified urban settings with high community usage.

Conversely, Grassroots Grants are for individuals, schools and groups to help them transform their local environments. These grants can be used to support activities such as plantings, nature education, citizen science, weed and pest control, erosion management and community engagement.

8.2 Potential funding mechanisms

Despite the significant expenditure on the urban forest by State and local government, only about 30-40% of metropolitan Adelaide's existing green space and potential forest vegetation is in the public realm. This further underlines the importance of creating mechanisms that either demand private contributions or incentivise it through both existing and potential new mechanisms (discussed below).

8.2.1 Tree bonds

Tree bonds can be used as a type of security bond to protect street trees assets and regulated and significant trees from development works; interstate these bonds apply mostly to public trees. Bonds are usually held by council until work is complete and, if necessary (i.e., where the tree is damaged), fees are kept and held in a fund to plant public trees.

A bond arrangement is recommended to protect regulated or significant trees on a development site, in order to give developers a stronger financial incentive to protect the tree from deliberate or inadvertent construction impacts.

8.2.2 New specialised grant program for biodiversity

This is an established approach to support community groups carrying out maintenance and restoration activities. Leveraging this approach for biodiverse greening in Adelaide may be a matter of establishing a new grant program or partnering with existing state or federal systems.

8.2.3 Crowdfunding

A crowdfunding platform maps out a set of actions and takes donations to support enhanced delivery of greening. This has precedents in Scotland and Santiago (Chile), and often centres on funding individual park proposals. Another example is the crowdfunding of 'bee cafes' hosted by the Friends of the Merri Creek (Melbourne).

8.2.4 Philanthropy

Some impressive outcomes can be achieved through philanthropic donation programs, such as the New York City 'One Million Trees' program. Council may opt to target individuals, or corporates seeking to demonstrate commitment to Sustainable Development Goals.

8.2.5 Direct annual contributions from stakeholders

Alliances of organisations can cooperate to establish centralised funds for urban biodiversity. This would require the development of an agreement between state and local agencies to contribute set funds to a trust on an annual basis. This could allow 'topping up' of capital works funds in infrastructure agencies to support biodiversity delivery in public works projects that otherwise would not necessarily see biodiversity as an objective (for example, new sports facilities, schools, hospitals, water infrastructure, transport corridors, public housing etc). There is an additional opportunity here for consolidated, coordinated stakeholder management, for example by hosting joint working groups.

8.2.6 Public-private Partnership (PPP)

Local councils and other relevant authorities may seek to enter agreements with developers carrying out major redevelopment of a strategic site to ensure biodiverse elements are included. The terms of the PPP can vary widely. For instance, smaller co-funding council grants can match funding for private-realm greening projects, following a similar model to the Melbourne Urban Forest Fund. Care must be taken to ensure additionality in the use of this tool.

8.2.7 Tax Increment Financing (TIF)

The local council takes out a loan to deliver a greening project. Repayments are covered by the increase in rates revenue associated with higher property values around the improved project. This could be calibrated by studying property value uplifts associated with existing greening projects in Adelaide to determine appropriate locations where TIF produces cost-neutral or low-cost urban greening.

8.2.8 Improvement Districts

A community or business group in a set area decides to pay additional levy (e.g. on top of rates, or into a self-administered trust) which is then used to make public-realm improvements in the 'improvement district'. The residents' group or business group largely self-administers and directs their investments – only liaising with council for capital works delivery. This type of arrangement has produced impressive greening outcomes in some areas of central London.

9. Potential initiatives towards the goal of a Nature-Positive Adelaide

9.1 Overview

Through the formation of Green Adelaide, the inclusion of Biodiversity Sensitive Urban Design as a legislated priority and the development of an Urban Green Strategy, Adelaide has an opportunity unique amongst Australian cities to work with partners to achieve ambitious biodiverse greening goals.

To become Australia's first nature-positive city, a combination of initiatives will be required, including enhancements to existing policy, introduction of new guidelines and regulation, and deep engagement with key stakeholders (refer to **Figure 13** for some examples). Different initiatives are grouped into two main sections: strategic and statutory planning, which are split into a further six sub-groups that categorise the initiatives by different objectives.

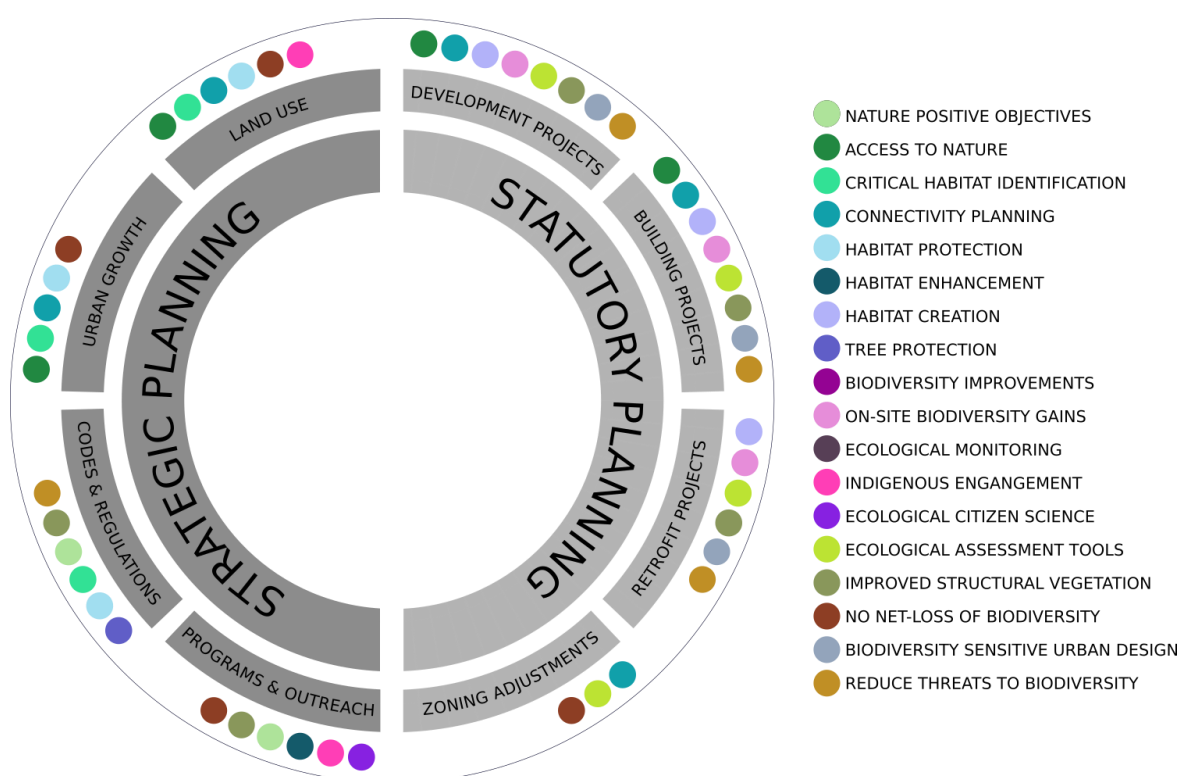


Figure 13. Potential key initiatives to support biodiverse greening and nature-positive objectives.

9.2 Headline Initiatives

Six 'headline initiatives', which would be particularly visible and impactful intervention points, are suggested below along with some supporting actions that could be used to improve biodiverse greening and nature-positive outcomes across metropolitan Adelaide.

Undertaking these headline initiatives would involve working with the following types of key stakeholders:

- State government e.g. Department for Infrastructure and Transport, Department of Environment and Water, Renewal SA, SA Health, and the Department for Trade and

Investment (Planning and Land Use Services; Housing Infrastructure Planning and Development Unit; and Office for Design and Architecture SA)

- local government e.g. urban biodiversity officers, open space and recreation planners, arborists, engineers, maintenance officers, planners and policy officers, spatial and data analysis experts
- non-government organisations e.g. landscape architects, designers, arborists and their professional bodies.
- utility providers e.g. SAPN, SA Water
- research institutions.

Under each initiative there are several actions that could be undertaken to improve biodiverse greening in metropolitan Adelaide, across four themes:

- **Plan** for maximum impact, with biodiversity objective setting, spatial planning, monitoring, engagement, and funding
- **Protect** Adelaide's existing biodiversity
- **Create** new biodiverse spaces in precincts, buildings, streets and parks
- **Enhance** biodiversity in existing green spaces, through a program of retrofits.

Headline initiative 1: Develop nature-positive targets

Develop metropolitan-wide and locally-specific targets for biodiversity conservation and restoration with the overarching goal of becoming nature-positive.

Achieving the goal of becoming nature-positive will require significant planning and development of well-articulated, time bound targets. This could involve:

- identifying target species and ecosystems
- developing regional, metropolitan and local scale targets for species and ecosystems, proportion of canopy cover with species and structural diversity
- establishing a baseline target against which progress can be measured and developing a monitoring plan that can be applied at regional, metropolitan and local scales
- undertaking mapping of critical habitat for target species/ecosystems as well as key locations for improving ecosystem connectivity (e.g. utility corridors, major transport corridor etc.).

Consideration should also be given to identifying ways to prioritise investment, protection, enhancement, and creation of habitat. This could be through the development of a biodiversity layer for inclusion in Green Adelaide's Greening Prioritisation Pilot Study, which could identify:

- areas that should be targeted for creation of new public open space.
- compatible park uses (e.g. ovals and sport fields) that could accommodate biodiversity.
- potential redundant asphalted areas (e.g. wide roads, excessive parking) or wide verges with no planting that could accommodate trees/understorey.
- key transport corridors where vegetation with diversity and structural complexity can be included.

Headline initiative 2: Caring for Country

Engage with Kurna to guide urban Caring for Country

Adelaide's unique species and ecosystems are an integral part of Kurna Country – part of the identity, stories and history of the land and its people. The potential for engaging Kurna in the planning, design, implementation, maintenance and governance of biodiverse greening is substantial.

In practice, this could mean identifying culturally significant target species, reflecting Kurna understanding of landscape and seasons in urban design, developing an urban 'Caring for Country' plan and Ranger Program to engage Kurna in the management of urban parks and prioritizing Kurna community in urban governance.

Headline initiative 3: Establish a new BSUD program

Establish a BSUD program for new public open space and retrofits for parks and streetscapes, starting with a 'showpiece' biodiverse park and set of biodiverse streets

BSUD can guide the restoration of the diversity and structural complexity that best supports the return of native flora and fauna to existing green spaces. Partners should work together to identify priority public open spaces and streetscapes for urban biodiversity improvements. This could involve:

- developing a biodiverse planting program for existing parks.
- revising 'service levels' in parks to integrate biodiversity metrics: species diversity, local suitability, structural diversity.
- identifying ways to overcome barriers to greening spaces constrained by infrastructure (underground and overhead) and developing a set of design solutions.
- aligning infrastructure and streetscape upgrades with biodiversity/tree planting and climate adaption programs (urban heat) to ensure specific biodiversity outcomes (high diversity of native species, structural diversity, location-appropriate species) are integrated.
- developing verge planting guidelines that focus on tree planting, biodiverse understorey and mid-storey creation, infiltration, and soil enhancement.
- investigating opportunities to improve biodiversity outcomes in organised recreation areas (e.g. ovals and sports fields) through the inclusion of functional habitat (e.g. additional tree species, understorey species and structural complexity).
- restoring vegetation along creek and river banks.

Demonstration sites can be powerful to show what is possible and motivate action and participation by other stakeholders. Development of a 'showpiece' park and streetscape will help to demonstrate that biodiversity in green spaces can be visually compelling while delivering impressive ecosystem services.

Headline initiative 4: Collaborate with partners

Collaborate with partners to ensure developments are nature-positive through the implementation of Biodiversity Sensitive Urban Design

Any form of development represents an opportunity for BSUD, whether it be master planned communities, single allotments, backyard renovations or commercial buildings and car parks. Ensuring that new developments and retrofits are nature-positive will require new planning policy and regulation, including regulating for on-site biodiversity gains, integrating biodiversity targets into public and private open space requirements, protecting trees and minimising threats to biodiversity.

Some opportunities to create new biodiverse spaces in development include:

- encouraging biodiverse rooftops and walls
- developing an incentive scheme to encourage commercial car parks to include habitat trees and WSUD
- integrating BSUD landscaping as part of new capital works for government facilities
- identifying appropriate mechanisms for measuring the quality of onsite delivery of habitats
- investigating regulation and policy options to facilitate on-site biodiversity outcomes (consider learnings from the recent UK biodiversity net gain example)
- investigating how the Planning and Design Code could support the creation of biodiverse habitat (e.g. through the soft landscaping and tree planting policies)
- developing design guidelines to encourage appropriate BSUD outcomes (e.g. appropriate lighting, bird-friendly glass).

Headline initiative 5: Build capacity for the delivery of nature-positive objectives

Build capacity for the delivery of nature-positive objectives through the appointment of a Chief Nature Officer, appropriate funding mechanisms and delivery of education programs

Biodiversity Sensitive Urban Design requires new ways of working: what we plan, what we plant, and how we maintain it. A Chief Nature Officer for Adelaide could build capacity and guide councils and other stakeholders to deliver BSUD and achieve nature-positive objectives. This could also involve improving community understanding and uptake of urban biodiversity in their own back yards and neighbourhoods.

Further, volunteers are crucial to the success of urban greening/biodiversity projects, particularly ongoing maintenance requirements. However, central coordination would be beneficial, with the objective of removing barriers and better supporting volunteers to enhance biodiverse greening outcomes.

Delivering new biodiverse green infrastructure, and upgrading existing green space, will also require significant investment. This could involve:

- realigning existing funding opportunities (such as offset schemes) to integrate biodiversity outcomes
- investigating new funding opportunities and mechanisms.
- Developing a spatial resource documenting existing BSUD and WSUD projects and identifying priority future locations.

Carrying out mapping, monitoring, engagement and industry capacity building should also be supported through appropriate funding mechanisms. Together with co-contributions, as well as careful and selective use of other financial tools such as Green Bonds, these mechanisms could deliver substantial liveability improvements across the city.

Headline initiative 6: Strengthen policies and legislation

Strengthen policies and legislation for the protection of Adelaide's trees and remnant vegetation

To achieve a goal of becoming nature-positive, trees and remnant vegetation that make an ecological contribution to Adelaide's urban biodiversity need to be better protected. This could involve:

- investigating whether the *Native Vegetation Act 1991* could apply to additional areas of metropolitan Adelaide⁹
- reviewing planning policy to encourage retention of remnant vegetation on master planned and greenfield development sites.
- ensure implementation of the DIT Green Infrastructure Commitment, and explore similar commitments for other State agencies with large scale landholdings (e.g. DfE)

⁹ Green Adelaide has made this recommendation to the Expert Panel as part of the Planning System Implementation Review

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Appendix A: Key stakeholders

Below is a list of the stakeholders who influence and determine the presence and form of biodiversity in metropolitan Adelaide, their current biodiversity commitments, and their role in implementing Biodiversity Sensitive Urban Design are outlined below:

Green Adelaide

BSUD and conservation of urban biodiversity are embedded within several of Green Adelaide's priorities in its *Regional Landscape Plan 2021-26*. Through implementation of their Regional Landscape Plan, Green Adelaide has set a strategic direction for the protection and enhancement of biodiversity across Adelaide through promotion, coordination and partnerships with other entities, agencies and authorities.

Green Adelaide also plays a role in funding local council projects which deliver greening, biodiversity and water sensitive outcomes through the new Cooler, Greener Wilder Grants program (a merger of the former Greener Neighbourhoods, Water Sustainability and BSUD Grant Programs).

Green Adelaide houses significant expertise on the distribution and conservation of biodiversity in metropolitan Adelaide, with a dedicated urban biodiversity team that administer several monitoring and recovery programs for threatened species, including fish and aquatic invertebrates, bats, butterflies, and plants. Given this wealth of expertise, Green Adelaide is well positioned to provide biodiversity information and advice to local councils and developers, including the creation of advisory documents, e.g. *Adelaide Garden Guide for New Homes*.

Department for Infrastructure and Transport

In response to the targets in the 30-year plan for Greater Adelaide, the Department of Infrastructure and Transport (DIT) made a green infrastructure commitment to four key focus areas for the Department to contribute to urban greening in Adelaide:

- A 20% **increase in canopy cover** on DIT managed land by 2045
- At least 50% canopy cover over footpaths and bikeways to improve **liveability**
- Implementation of **Water Sensitive Urban Design** to achieve performance targets for water quality, flow and flood risk
- Implementation of **Biodiversity Sensitive Urban Design**, including minimising impacts, increasing fauna habitat and connectivity and increasing representation (minimum 50%) of local native species in plantings

Preliminary mapping has shown huge potential for integration of canopy trees on DIT land, but it is crucial that the right kind of trees are used to provide the best outcomes for urban biodiversity. Locally native plant species provide greater biodiversity benefits, and, if selected with appropriate provenance in mind, can also be more suitable for local conditions or future climates. In addition, there is an opportunity to integrate understory plantings in medians and along roads and railways, particularly in places that are prohibitive to increased canopy cover due to safety (e.g. from traffic collisions) or construction feasibility or weight limitations (e.g. on bridges or under powerlines). Understory vegetation structure is important for improving biodiversity, particularly of small birds and invertebrates (Threlfall et al. 2015) and is often lacking within urban environments. Tall shrubs are particularly difficult to integrate in open parklands due to safety concerns (e.g. obstruction of sightlines) but are suitable for along roadsides to provide noise reduction or visual screening barriers. To be effective, noise barriers may need to be planted densely, and have substantial height and width.

SA Water

Multiple activities by SA Water can impact on urban greening, including placement of utilities, conflicts with existing utilities and tree root systems, and accidental discharges from sewerage systems or chlorinated water into natural water courses. However, SA Water contains considerable technical expertise in harmonising conflicts and creating synergies between water utilities and green infrastructure to maximise

space for urban greening in Adelaide. This includes providing advice on placement of utilities but also plant species selections that are compatible with water sensitive urban design and provide habitat benefits (particularly locally native species). SA Water have compiled several plant selection guides and established several demonstration sites using locally native plant species on SA Water land to provide examples of how to use locally native species in urban greening projects. SA Water often collaborate with Renewal SA and other developers to increase the success of urban greening in new developments, and infrastructure upgrades through use of best practice retention and reuse of water, as well as well-designed placement of new utilities. Formalising this collaboration as part of the planning and design process would be highly beneficial.

Renewal SA

Renewal SA is the South Australian Government's urban development agency is a government funded urban development agency that provides land, funding and direction for urban renewal projects as part of delivering the 30- Year Plan for Greater Adelaide. Through contractual agreements with developers, designers and architects, Renewal SA is in a unique position to implement BSUD that goes beyond what is written in the Planning and Design Code. This includes providing for greater than 12.5% greenspace open space or specifying key performance indicators around integration of nature onto or surrounding new buildings. There needs to be strong collaboration links built between Renewal SA (who have the buying power) and Green Adelaide (who have the urban biodiversity knowledge) to enable designs that go beyond traditional planting palettes and urban forms to promote habitat for local biodiversity. Tools such as the Botanic Gardens' [plant selector tool](#), [NatureMaps](#) and the [Green Factor Tool](#) could be used by Renewal SA to define design parameters. Since water and irrigation are often limiting factors for maintaining biodiverse urban greening, collaborations between Renewal SA, SA Water and Water Sensitive SA will also profit from designs that make the best use of water in dry Adelaide environments.

Office for Design and Architecture SA (ODASA)

The Office for Design and Architecture SA (ODASA), led by the Government Architect, provides expert Design Review for landscape and architectural designs in large scale developments, or government projects. ODASA also administers the Open Space Grant Program, which in 2022 is focussed on supporting local councils to acquire land for small pocket parks in their council areas. This program directly funds projects that influence the quality of habitat in urban greenspaces, public open spaces, and biodiversity has been integrated into the key [design principles for greenspace design](#) (Department for Health and Wellbeing and Department for Environment and Water, 2019).

ODASA's review services are available to all developments as specified under the Planning and Design Code, but are not mandatory and could be better utilised, particularly for projects initiated by DIT and Renewal SA. Under the Principles of Good Design used in the Design Review scheme, 'good' design should be:

- 1) context specific;
- 2) inclusive;
- 3) durable, adaptable and long-lasting;
- 4) add value by providing social and cultural benefits;
- 5) maximising opportunities potential benefits (i.e., high performance); and
- 6) sustainable.

Integration of biodiversity design principles into ODASA's Design Review recommendations would enable consideration of biodiversity early in the design process and before design applications have been approved. While ODASA has included biodiversity considerations in its principles for greenspace design, there is an opportunity for BSUD to be more explicitly included in architectural reviews, given the development of new tools like the Green Factor Tool by the City of Melbourne.

Local government

Local councils are primarily responsible for the maintenance of public open space and streetscapes where most of Adelaide's biodiversity is located. They often better understand the context, layout and status of their local biodiversity and are better placed to strategically manage for greater biodiversity outcomes. However, local government is often limited by funding, and support for local projects that enhance local urban biodiversity is often leveraged from state government funding.

While the Planning and Design Code is centralised and local councils have limited influence on the rules surrounding development, they can work collaboratively with developers and other government bodies to improve the biodiversity outcomes of their local areas. Existing partnerships focussed on responses to climate change (i.e., Resilient East, Resilient South and Adapt West) can be leveraged to provide greater biodiversity outcomes when implementing urban greening for cooling. Local councils can also influence the quality of public open space through development of Open Space Guidelines that include considerations for biodiversity such as:

- Using local plant palettes to increase resources for local wildlife
- Encouraging understory planting and vegetation structure which is important for small birds and insects
- Generating connectivity mapping and prioritisation to inform land purchases for new parks or outreach programs for private gardens
- Considering compatible land-uses (sports fields vs riparian areas) and the kind of biodiversity that can be achieved e.g. lower shrubs under powerlines

Other councils (including City of Tea Tree Gully) have developed specific policies and plans for conserving biodiversity in their council areas. Biodiversity officers from Tea Tree Gully who developed the BSUD plan have spoken of the benefits of the plan; in particular, the strategic directions outlined in the BSUD plan mean that biodiversity has a seat at the table in key decisions.

Some councils also have open space policies that provides a framework to guide the provision, development and management of public open spaces within the council area. Open space policies may also include an open space hierarchy and classification which describes the intended catchment area for each open space, level of use and potential types of facilities that may be included. that determine the quality of greenspaces that they are willing to accept from new developments that provide the 12.5% or to strategically direct funding priorities when upgrading existing greenspaces.

Industry Peak Bodies and Professional Networks

The private industry peak bodies and professional networks also have a large role to play in providing advice and determining solution on how their sector can provide a conduit for information, showcase new examples, determining the quality and quantity of habitat available in the urban environment. While BSUD is often implemented in public spaces such as parks and streetscapes, it is through the integration of BSUD across the public and private realm that biodiversity benefits are maximised. Sustainable building rating schemes are beginning to introduce biodiversity targets (e.g. the Green Star rating from the Green Building Council of Australia), and corporate responsibility is beginning to include nature-positive commitments. Knowledge sharing through professional networks will be an important method for disseminating BSUD information. These networks include:

- The World Green Building <https://worldgbc.org/>
- [The Global Convent of Mayors for Climate Change Resilience](#)
- Local Government Association of South Australia
- Local Government Biodiversity Network (LGBN)
- Australian Institute of Landscape Architects

Department for Trade and Investment (Planning and Land Use Services)

The Department for Trade and Investment (Planning and Land Use Services) looks after the land-use planning system in South Australia. Many instruments in the land-use planning system can influence or impact on biodiverse urban greening outcomes. Refer to Appendix B for a list of these.

Appendix B: Legislation and planning system instruments

Legislation	Description
Federal	
<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as matters of national environmental significance
State	
<i>National Parks and Wildlife Act 1972</i>	Provides for the establishment and management of reserves for public benefit and enjoyment; to provide for the conservation of wildlife in a natural environment; and for other purposes
<i>Native Vegetation Act 1991</i>	Provides incentives and assistance to landowners in relation to the preservation and enhancement of native vegetation; to control the clearance of native vegetation; and for other purposes
<i>Landscape South Australia Act 2019</i>	Promotes sustainable and integrated management of the State's landscapes, to make provision for the protection of the State's natural resources, and for other purposes. This legislation is the key framework for managing the State's land, water, pest plants and animals, and biodiversity across the State and is administered by Green Adelaide along with eight regional Landscape South Australia boards. Notably, Green Adelaide (which is established under the <i>Landscape South Australia Act 2019</i>) has a vision to create a cooler, greener, wilder and more climate-resilient Adelaide. A major focus across two of Green Adelaide's legislated priorities (Biodiversity Sensitive and Water Sensitive Urban Design and Green Streets and Flourishing Parklands) is to encourage biodiversity in the urban environment by: • accelerating urban greening to increase habitat for native wildlife and connect people with nature, and • building industry and community capacity to design cooler, greener and biodiverse urban infrastructure to transform green spaces into thriving ecosystems.
<i>Coast Protection Act 1972</i>	To make provision for the conservation and protection of the beaches and coast of this State; and for other purposes
<i>Adelaide Park Lands Act 2005</i>	To establish a legislative framework that promotes the special status, attributes and character of the Adelaide Park Lands; to provide for the protection of those park lands and for their management as a world-class asset to be preserved as an urban park for the benefit of present and future generations; and for other purposes
<i>Planning, Development and Infrastructure Act 2016</i>	To provide for matters that are relevant to the use, development and management of land and buildings, including by providing a planning system to regulate development within the State, rules with respect to the design, construction and use of buildings, and other initiatives to facilitate the development of infrastructure, facilities and environments that will benefit the community. Sets out the overarching framework for planning and development throughout South Australia.

	Consideration for biodiversity is enshrined within the PDI Act (Section 62A) through the mandate for creation of a specific biodiversity policy (SPP 4).
<i>Environment Protection Act 1993</i>	Provides the regulatory framework to protect South Australia's environment, including land, air and water. This Act also provides oversight of the Environmental Impact Assessment.
<i>Local Government Act 1999</i>	Includes environmental considerations in the functions of local councils by a provision for councils: to manage, develop, protect, restore, enhance and conserve the environment in an ecologically sustainable manner, and to improve amenity (Section 7e). Each council must also generate Strategic Management Plans that include financial and asset management plans. This includes creation of Community Management Plans for all land that the council owns.

Planning system instruments that enable and influence urban greening and biodiversity

State Planning Policies

The State Planning Policies (SPPs) set out the overarching goals for the State through a suite of policy directions including one on biodiversity.

The objective of **SPP 4: Biodiversity** is to 'maintain and improve our state's biodiversity and life supporting functions'. There are eight associated recommendations including:

- minimising the impacts of development (4.1,4.2, 4.5), and tourism (4.6),
- managing the risk of biosecurity threats (4.7),
- enhancing habitat through inclusion of diverse and connected green infrastructure in development (4.3,4.4).

Under this SPP there are no requirements for Regional Plans to contain targets related to biodiversity, but rather the emphasis is on mapping and protection of areas of environmental significance.

Other relevant SPPs related to biodiversity include:

- SPP1: Integrated planning – requires regional plans to map existing patterns of growth as well as areas requiring careful management or protection
- SPP2: Design quality – requires regional plans to include accessible and high-quality public greenspaces and development of a series of design standards to set desired outcomes for public (and private) realm infrastructure
- SPP5: Climate change – includes policies for protecting and enhancing biodiversity and ecosystem services, as well as performance targets in regional plans for urban greening and tree canopy
- SPP 6: Housing Supply and Diversity – has policies that influence the form and layout of new developments and the provision of open space
- SPP 8: Primary Industry – relates to managing the impacts of primary industry on biodiversity
- SPP 13: Coastal Environment – specific policies related to protecting coastal biodiversity, particularly safeguarding the carbon storage capacity of mangroves, saltmarshes and wetlands.
- SPP 15: Natural Hazards – contains policies related to use of green infrastructure to avoid natural hazards including coastal protection and mitigation of urban heat.

Regional Plans – new Greater Adelaide Regional Plan

The 30-Year Plan has transitioned to a Regional Plan in the new planning system and includes six high level strategic targets, each with quantifiable progress measures:

- Contain the urban footprint – via increasing the percentage of housing that is built in established urban areas, or townships
- More ways to get around – via increasing the percentage of housing within proximity to public transport
- Getting active – via increasing the share of work trips made via active transport modes (includes bike, walking and public transport)
- Walkable neighbourhoods – via increasing the percentage of residents in ‘walkable neighbourhoods’ as defined by residential proximity to open space, schools and other services.
- A green liveable city – via increases in urban canopy cover to 20% by 2045
- Greater housing choice – via the ratio of detached and non-detached dwellings.

A new Regional Plan for Greater Adelaide has commenced development and will need to be consistent with the State Planning Policies, provide a long-term vision for the region, provide recommendations about the application of the Planning and Design Code and provide a framework for the public realm and infrastructure within the region.

Planning and Design Code

Unlike other states, South Australia’s planning system is highly centralised with the Planning and Design Code (the Code) replacing all 72 hard copy Development Plans that have been in use across the state with a single set of online planning ‘rules’ for assessing development applications. The planning and design code is a system of zones, subzones and overlays that help guide decision making in reference to new development. These zones set out the rules for what kind of development can occur and where,

The Code divides land into zones to provide guidance on what can happen in an area by setting out the policies and rules for certain classes of development. The policies in a zone apply consistently wherever a zone applies and are only able to be varied through a subzone, overlay or technical and numerical variation. It also includes several provisions for the exclusion of land from development where there are significant trees or other values of conservation significance under the *Environment Protection Act 1993* or the *Native Vegetation Act 1991*, as well as requirements and exemptions from impact assessed development.

Some local areas have additional rules (known as subzones), which apply to protect local or unique variations in the character of a particular zone. These rules are in addition to the zone and cannot apply in more than one zone.

In addition to zones and subzones, other requirements apply in the form of overlays. Overlays are the primary mechanism to spatially express the SPPs, can span multiple zones and subzones and more than one can apply to the same area. In the event of a policy conflict, it is important to note that overlay policies take precedence over other policies in the Code.

Several overlays apply to areas of metropolitan Adelaide, which influence the protection and enhancement of biodiversity in Adelaide (as summarised below).

Below is a summary of the key sections of the Planning and Design Code that influence protection and enhancement of biodiversity in Adelaide:

Regulated and Significant Tree Overlay

The Regulated and Significant Tree Overlay provides protection for trees that are declared as having significant environmental, biodiversity or amenity value i.e., ‘regulated’ and ‘significant’ trees.

'Regulated' trees are those that are above 2m in circumference (at 1 m above ground level), or that are comprised of multiple stems of at least 2 m circumference.

'Significant Trees' are those that are above 3m circumference or individual trees with significant environmental, habitat or amenity value (as listed under the PDI Act Section 68).

Species-based protections apply for *Agonis flexuosa* and members of the Eucalyptus genus. Regulated and significant trees require approval or special exemption to be removed or for potentially damaging development works to be carried out. If removed, significant or regulated trees must be replaced at the rate set out in the PDI Act, or an offset paid into the 'Urban Trees Fund' (if one has been established by the council where the relevant tree is situated).

Urban Tree Canopy Overlay

The Urban Tree Canopy Overlay includes requirements for the number of trees that are required to be planted for most residential developments. The Urban Tree Canopy Overlay applies to several residential zones across metropolitan Adelaide and requires either one small, medium or large is planted per new dwelling (depending on allotment size). All new dwellings must have at least one small, medium or large tree depending on lot size, and minimum soft landscaping area of 10-25%. Where existing tree(s) are retained on the subject land a discount to the number of trees required to be planted is applied (the retained tree must meet certain criteria as set out in the Urban Tree Canopy Overlay). Retention of trees existing on site before development are rewarded by application of discounts against the per dwelling requirements.

Guidance advice ([Adelaide Garden Guide for New Homes](#)) has been prepared relating to application of these requirements with suggested planting lists including designs using native plant species in formal and informal garden styles. An online species list is available as a supplement to these guidelines with some information on their biodiversity and habitat value.

Offset Schemes

Open Space Contribution Scheme and the Planning and Development Fund

In all cases where new subdivisions (whether new residential suburbs or infill developments) result in the creation of allotments <1 ha in size, 12.5% of the development area is to be designated as open space. Where this is not possible, due to the site or nature of the infill development, a contribution is to be paid into the Planning and Development Fund to offset the loss of open space. This is one of the primary mechanisms for ensuring there is space and funding for open space development and enhancement in Adelaide.

The Urban Tree Canopy Offset Scheme

The Urban Tree Canopy Offset Scheme (the Scheme) is an offset contribution scheme established under Section 197 of the PDI Act, which has been established to support the Urban Tree Canopy Overlay in the Code. Current contribution amounts to be paid in lieu of planting a tree (or trees) are:

- \$300 for a small tree (max 4m height and 2m canopy spread);
- \$600 for a medium tree (max 6m height and 4 m canopy spread); and
- \$1200 for a large tree (up to 12m height and 8 m canopy spread).

Advisory Material and Design Standards

Green Adelaide has published advisory material to support implementation of the mandatory tree planting and soft landscaping requirements within the Planning and Design Code. The *Adelaide Garden Guide for New Homes* provides advice on how infill developments can meet these requirements and also suggests ways to maximise the benefits from such plantings. The accompanying planting lists includes Australian native plant species and those that provide food resources for native birds and butterflies, but there is scope to expand this to include more locally native plant species. More information on Biodiversity Sensitive Urban Design (BSUD) design principles and guidelines for artificial habitats and habitat structure (e.g. leaf litter and rocks for reptiles and invertebrates), could also be integrated into this guide.

Appendix C: Descriptions of pre-European broad vegetation groups in Green Adelaide

Coastal	Coastal vegetation is vegetation that is subject to the influences of coastal environment. Coastal vegetation faces different environmental conditions that of terrestrial vegetation, and in particular it must be able to tolerate exposure, high salt content and unstable substrates such as sandy soils and eroded cliff tops.
Freshwater	Freshwater includes riparian and wetland vegetation. Riparian vegetation is vegetation found along watercourses and on floodplains. Riparian zones represent transition areas between land and water. The indigenous vegetation of these areas usually reflects the better soils and moist conditions found in the lower parts of the landscape. Riparian zones support typically dense vegetation, with dense understorey, shrub layer and overstorey. Red Gum drainage lines support more open vegetation, with some open grassy patches in the understorey. Wetland vegetation is associated with freshwater swamps, seasonal wetlands of the Adelaide Plains, estuarine creeks (considered under coastal) and Red Gum wetlands along creeks (considered under riparian). Freshwater swamp vegetation is shrub dominated and typically very dense. This vegetation has high structural and floristic diversity, and contain many endemic and rare plants. Seasonal wetlands on the Adelaide plains we flat areas with open water and fringing vegetation such as macrophytes, lignum and samphire.
Grassland	A native grassland is vegetation with few or no trees, and an understorey dominated by native grasses and herbs. Grasslands may have patches of shrubs in the midstorey, particularly on shallow and rocky soils. All grasslands in Green Adelaide are tussock grasslands, having discrete clumps or tussocks of grasses, herbs or sedges. Inter-tussock spaces consist of bare ground with a diverse range of herbs and annual plants emerging in Spring.
Grassy Woodland	Grassy woodlands are woodlands with an understorey dominated by grasses, herbaceous species (e.g. e.g. daisies, lilies) and sedges, scattered shrub layer and a discontinuous tree layer. Grassy woodlands have an overstorey typically dominated by eucalyptus, including smooth-barked gums and/or box. Tree density is variable, but a typical grassy woodland may have a tree density of approx. 30 trees per hectare, which results in some open areas without canopy. In high rainfall areas, tree density may be higher resulting in woodlands that resemble forests. The midstorey of grassy woodlands may contain scattered woody shrubs. Scrub density is highly variable between communities and individual patches of vegetation, probably reflecting soil quality and fire history. Grassy woodlands contain a very high diversity of native plant species. This diversity is particularly apparent during Spring, when many species of wildflower emerge from spaces between grass tussocks.
Heathy Forest	Heathy forest is an open forest with a canopy dominated by eucalyptus, and a dense understorey comprising many species of low shrubs, generally with small, hard leaves (sclerophyllous). The understorey also contains abundant lilies and orchids, and sparse but diverse native grasses
Heathy Woodland	Similar to heathy forest, heathy (open) woodland has a dense understorey and midstorey of a variety of low small-leaved (sclerophyllous) shrubs. These layers have high structural diversity, but contain fewer species than that of grassy woodlands. Most of the midstorey and understorey species listed under heathy forest would also be found in heathy woodland. The overstorey is more spaced and usually lower than in a heathy forest. Most heathy woodland is dominated by eucalypts (often stringybarks), although some is dominated by native pines.

* Source: DEH (2009)

Appendix D: Metropolitan Melbourne BSUD case studies

Melbourne case study 1: Fishermans Bend redevelopment

Background

At 480 Ha, Fishermans Bend is the largest urban renewal project in Australia. With five precincts being converted from low-scale industry and warehousing to mixed-use residential and commercial neighbourhoods, this development spans two local government areas (City of Melbourne and City of Port Phillip), revitalizing both private and public land by 2050.

A “biodiverse community” is one of the sustainability goals identified for Fishermans Bend, leading to the implementation of BSUD in synergy with planning for urban heat, water, and wind management strategies.

Read more:

Kirk, H., et al. (2021). *Building biodiversity into the urban fabric: A case study in applying Biodiversity Sensitive Urban Design (BSUD)*. Urban Forestry & Urban Greening, 62, 127176. <https://doi.org/10.1016/j.ufug.2021.127176>

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

The BSUD framework was used to identify relevant biodiversity objectives and focal species for the site and develop a set of detailed recommendations for the precinct masterplan design. Recommendations were created to address all five of the BSUD principles, as they related to each of the focal species chosen. These recommendations are now being used during the development of the five precinct implementation plans.

Overall, six biodiversity objectives for the site were co-created with local stakeholders in a design workshop – these link the ecological requirements of the focal species to more traditional development objectives and inspired support and uptake of the BSUD recommendations when trade-offs were discussed.

Figure 15 shows the location of recommended BSUD actions, including creation of a biodiverse active transport link through the northern precincts, human and nature

About the site

Context:	Brownfield urban renewal
Location:	City of Melbourne and City of Port Phillip
Scale:	Precinct
Organisation:	Fishermans Bend Authority



Figure 14. Fishermans Bend. Understorey vegetation, rain gardens and tree canopy added to the “Green Link” pedestrian and cycle way. https://www.fishermansbend.vic.gov.au/_data/assets/pdf_file/0038/185996/FB_BiodiversityReport_ICONScience_FINAL.pdf

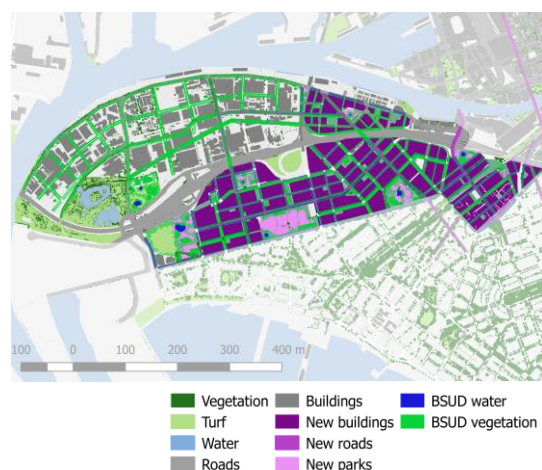


Figure 1. BSUD at Fishermans Bend, Melbourne

linkages across the major road barrier and location of new waterbodies.

Seven focal species with varied resource and threat mitigation requirements were agreed as potential targets – their return to and persistence in Fishermans Bend will serve as an indicator that the overall biodiversity objectives have been achieved (see example in **Figure 16** below).

Four fundamental BSUD requirements for Fishermans Bend were generated:

- 1) retain existing vegetation,
- 2) create biodiverse active transport link,
- 3) enhance green spaces for biodiversity, and
- 4) facilitate dispersal across major road barriers (see map below).

We also provided 21 detailed design recommendations linked to the focal species and biodiversity objectives.

An example of how BSUD principles were followed for the growling grass frog focal species at Fishermans Bend, Melbourne is provided below. The ecology of the species helps to determine specific design actions on-ground.

Challenges and lessons learned

Successful implementation of BSUD needs all stakeholders for a development to be involved in the biodiversity planning and design process – this facilitates better understanding of how the recommendations and objectives are linked, enabling a clearer decision-making process when it comes to identifying trade-offs and synergies.

BSUD guidance needs to be systemised to ensure uptake in the private realm. This means explicit wording and provisions should be made in planning policy and land use plans to hold private land developers accountable.

Recognising compatible and incompatible land uses helps to identify where critical biodiversity enhancements should be placed.



Figure 16. Example of a focal species, outlining habitat requirements and design implications.

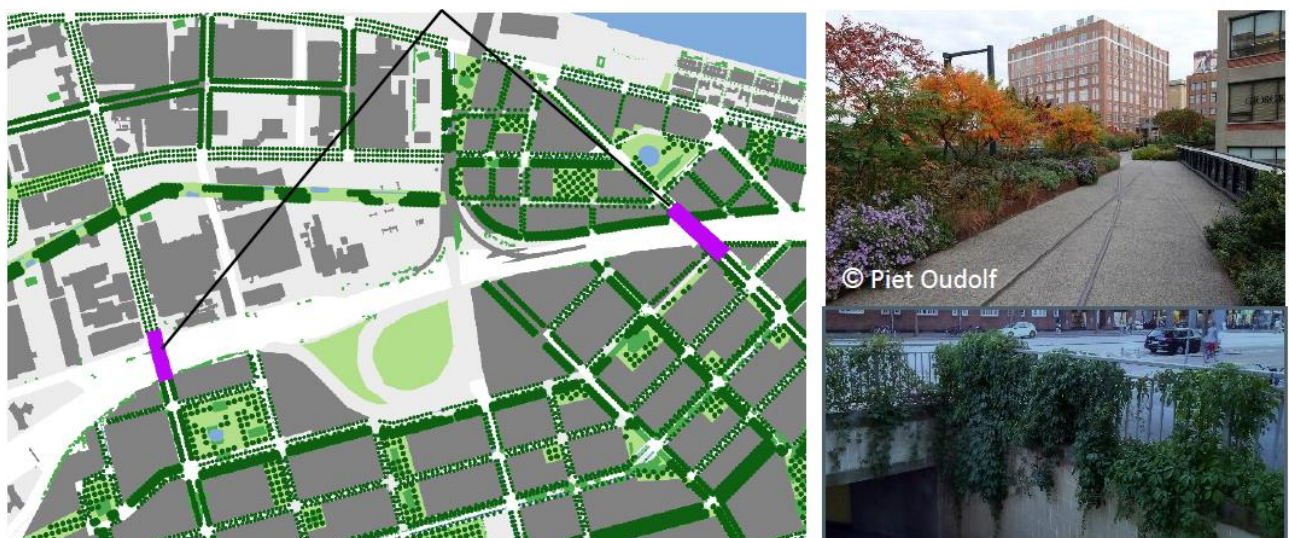


Figure 17. Fishermans Bend. Two "Green Bridges" added where cycle ways cross the Westgate Freeway.

Melbourne Case Study 2: Averley

Background

The Averley Development Project is a new, 113 Ha greenfield development planned for Pakenham East (Cardinia, Melbourne, Australia). Lendlease have created a vision for the community at Averley that will have approximately 20 ha of parks, including areas of natural bushland and recreational spaces. Lendlease are planning a neighbourhood connected with nature through both landscape design and the provision of sustainable built form options.

Application of BSUD principles

ICON Science are working with Lendlease to improve the delivery of biodiversity resources at Averley. The development is still in its early permit stages, allowing us to review plans and suggest novel designs that will provide biodiversity benefits while also meeting the guidelines set out by both the state planning authority and local government. Using Averley as a pilot site, we can measure how different BSUD actions increase on-site biodiversity, deliver environmental benefits and improve human-nature connections. We have used BSUD principles to:

- Hold a stakeholder engagement workshop where biodiversity objectives were identified for Averley.
- Design a biodiversity enhanced “green street” (see Figure 21) that will provide key resources for native pollinators and birds, connect the two planned native green spaces while also promoting walkability for residents.
- Develop a planting palette for landscaping at Averley that supports biodiversity year-round by balancing the flowering phenology of native and exotic species.
- Begin creation of an Averley-specific citizen science monitoring program to engage and educate new homeowners

Recommendations for Averley include typical methods to enhance biodiversity along residential streets: introducing tiered midstorey planting to maintain visibility, planting flowering ground covers and using wildlife-friendly street lighting (**Figure 21**).

About the site

Context:	Greenfield development
Location:	Pakenham East, Melbourne
Scale:	Precinct/green street
Organisation:	Lendlease



Figure 2. Three focal species for Averley development (growling grass frog, eastern yellow robin, native bees)

Challenges and lessons learned

Implementation of BSUD during early land use planning creates a precedent for the local councils and developers. It is possible to introduce BSUD after the precinct planning stage, but it becomes harder as there is no overarching mandate to work from.

Space is at a premium in urban developments – biodiversity design actions may compete with the delivery of utilities to residential houses. Work with the contracted engineers and landscape architects to help find solutions.

Planning and designing needs to take place in tandem with local councils and developers, as the council will be responsible for management of the public land post-development.



Figure 19. Satellite image of Averley site and surrounding farmland (also under development)



Figure 20. The Averley master plan

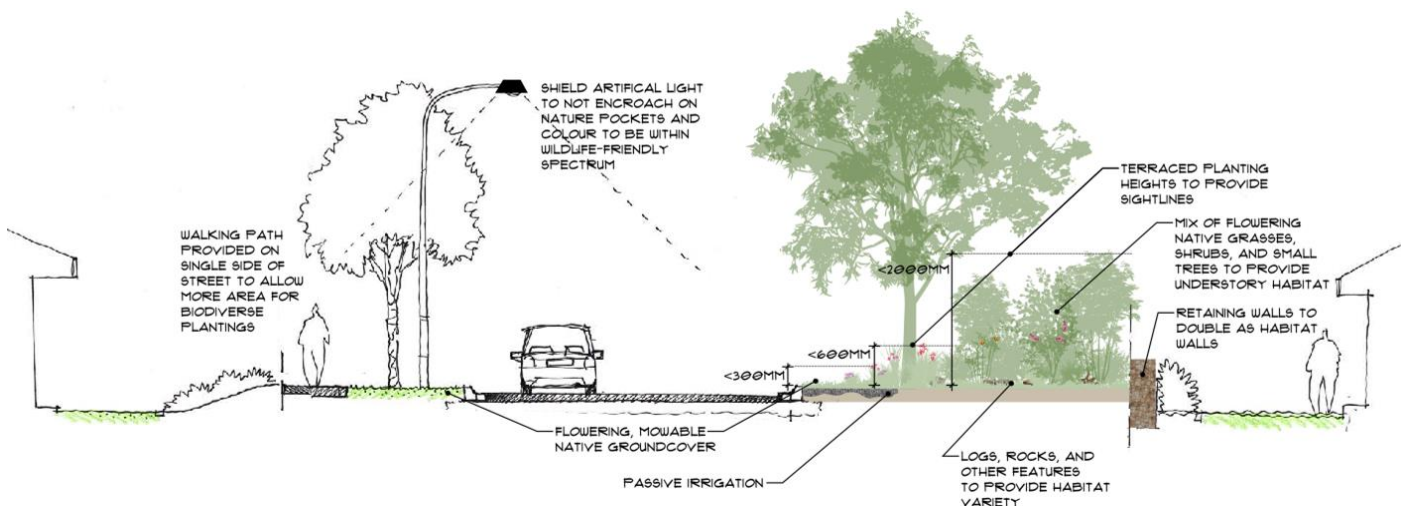


Figure 1. Example visual prompt for workshoping BSUD actions planning teams

Appendix E: Metropolitan Adelaide urban biodiversity project case studies

[several case studies are in development so are not included]



Metropolitan Adelaide BSUD case studies

BSUD Plans

Case study 1: Dry Creek Corridor Biodiversity Plan (and implementation Oratanga Reserve to Kingfisher Reserve)

Background

Dry Creek is an ephemeral stream, which flows from the Adelaide Hills into Gulf St Vincent, forming a catchment area of over 100 km². Within the City of Tea Tree Gully, this linear corridor and adjoining reserves have historically been managed by Council, undergoing restoration over several years. This focused on the removal of woody weeds and revegetation but was lacking a formal plan to coordinate efforts across otherwise disparate projects.

To better protect and enhance biodiversity, including threatened flora and fauna habitat along the Dry Creek Corridor, Council engaged EBS Ecology to develop the [Dry Creek Corridor Biodiversity Plan 2021](#) (Biodiversity Plan). The Biodiversity Plan project area comprises nine reserves along the Dry Creek Corridor, covering nearly 6 kilometres and approximately 47 hectares of linear park.

Seven broad management themes form the guiding principles behind individual management plans for each reserve.

Situated on Kaurna land, the site is also subject to the Kaurna Peoples Native Title Claim and the ILUA Kaurna People Native Title Settlement. Senior Kaurna Traditional Owners conducted a site inspection to identify Aboriginal Cultural and Heritage values and, where possible, recommendations from Traditional Owners have been incorporated into the biodiversity plan.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

The Biodiversity Plan has provided a strategic direction for the coordinated enhancement of the Dry Creek Corridor, including:

- Identification of biodiversity assets to target through habitat restoration/creation.
- Identification of actions that support the restoration of target species; including those that benefit multiple related species.
- Identification and reduction of threats, including weed control.

About the site

Context:	BSUD Plan
Location:	Dry Creek Corridor, Modbury North, Modbury Heights
Scale:	Neighbourhood
Organisation:	City of Tea Tree Gully



Dry creek corridor. Photo: Green Adelaide



Map showing the Dry Creek Corridor BSUD Plan full project area. Source: City of Tea Tree Gully

- Improved habitat connectivity to encourage dispersal of species thorough the landscape.

Produced by professional ecologists, the Biodiversity Plan has significantly contributed to the successful outcomes of current projects, as a useful reference for engaging with developers and for strategic decision making within Council. Already, several habitat restoration projects have been successfully implemented, with anecdotal evidence suggesting an increase in target species.

There are many opportunities to action future habitat enhancement projects proposed by the Biodiversity Plan.

Development of the Biodiversity Plan was informed by identification of the existing biodiversity values of the Dry Creek Corridor. Existing values were identified through desktop research and expert consultation through semi-structured interviews. Field assessment was undertaken to identify areas of interest and biodiversity opportunities.

The completion of detailed flora and fauna surveys was beyond the scope of the Biodiversity Plan. However, this is included in the Plan's recommendations regarding the implementation of ongoing monitoring of species.

Identifying Biodiversity Objectives and Actions

Based on this background information, the Plan then identifies seven broad themes to guide management actions that are not dissimilar to the five principles of BSUD. These are:

- **Habitat for wildlife:** enhancing the availability of habitat resources. *This is comparable to BSUD principle 1.*
- **Dedicated projects:** targeting particular species, or other actions that support the plan themes. *This is comparable to BSUD principle 1.*
- **Plantings for the future:** allows for both enhancing habitat and continuity of ecological processes under a changing climate. *This broadly maps to BSUD principles 1 and 4.*
- **Linking landscapes:** encourages connectivity and dispersal. *This is comparable to BSUD principle 2.*
- **Threat management:** to reduce threats and disturbances to biodiversity. *This is comparable to BSUD principle 3.*
- **Living streams:** focuses on promoting ecosystem functions. *This broadly maps to BSUD principle 4.*
- **Community/cultural engagement:** to facilitate positive human-nature interactions. *This is comparable to BSUD principle 5.*

Target species

The Biodiversity Plan includes targeted actions for particular species (e.g. the Superb Fairy Wren, *Malurus cyaneus*, and the Short-Nosed Echidna, *Tachyglossus aculeatus*), and groups of taxa that have been tied to seven broad management themes.

Each of the main values of biodiversity were broken down into related taxonomic groups (i.e. native plants, birds, mammals, reptiles, invertebrates), and their main threats and requirements outlined. Targets and management actions that either related to single species or groups of related species were then created using the seven themes and background information.

Two example target species relevant to the locations visited are highlighted in the breakout boxes overleaf. Management of the site will encourage recruitment of native grasses and attract insects, which will benefit these target species.

An example of how this BSUD Plan considers target species, refer to pages 45–62 of the [Dry Creek Biodiversity Plan](#).

Revegetation, maintenance, and monitoring

Implementation of the Plan from Oratanga Reserve to Kingfisher Reserve saw revegetation works undertaken with a successional approach:

1. Protection of remnant vegetation where possible.
2. Introduction of trees and fast-growing dense shrubs to compete with weed invasions.
3. Removal of some dense shrubs and the introduction of a lower shrub layer to increase structural diversity.
4. Further removal of dense shrubs to prepare for the introduction of grasses and ground cover.
5. Finally, additional infill planting to increase plant species diversity.

Implementing revegetation works in stages mirrors the process of succession that occurs in nature and has minimised the establishment of weeds within the site, reducing the potential

maintenance costs. In this way, the Council are using ecological processes to enhance the effectiveness of their greening projects.

Creation of habitat and revegetation works were undertaken by the Council Biodiversity Team, Council contractors, and volunteers from the community, including members of the Friends of Dry Creek Trail. This work was able to be implemented swiftly and with short notice, due to the high support within Council for the Biodiversity Plan and the presence of skilled bushland restoration contractors. Different planting styles have allowed for more revegetation to be carried out within available resources.

Understorey plantings of dense shrubs along creeklines provided connectors to biodiverse areas. Weeds are acceptable within these connectors where they maintain ecosystem functions such as bank stability. However, due to the loss of bushland volunteers, limited maintenance was undertaken of a previously well-restored site. This site required more intensive management than could be resourced by the Biodiversity Team.

Other unconventional approaches addressed weed suppression, through dense shrub plantings followed by a successional approach to revegetation.

Current monitoring of fauna is opportunistic, although the Biodiversity Plan suggests developing monitoring for birds using the existing Australian Backyard Bird Count platform. Several other monitoring targets are set, but as yet no detail is provided on how these will be assessed or who will undertake these surveys. This is a challenge that has not been readily addressed for on-ground works that aim to improve biodiversity.

Outcomes

Prior to habitat restoration, the Superb Fairy Wren was only known to inhabit one location (Kingfisher Reserve) within the Dry Creek Corridor. Since enhancing the site with habitat features including dense shrubs and patches of long grasses and opportunities for food resources, Superb Fairy Wren individuals have been spotted downstream (in both Druminor Reserve and Fairleigh Reserve) for the first time.

Dense vegetation has provided semi-protected movement through the corridor; however, other factors are likely to have also influenced the successful dispersal of the species, as an unusually wet spring season invigorated the growth of grasses along the Dry Creek corridor, creating additional protection and feeding opportunities.

Establishment of echidna habitat has been troublesome, due to vandalism and the removal of installed habitat logs. As echidnas are shy and less readily observed compared to



Target species: Superb Fairy Wren
(*Malurus cyaneus*)

- Provides ecosystem services: feeds on insects that damage native vegetation and trees.
- Degradation of native grasslands and a reduction of native mid-story vegetation structure has limited their habitat (Parsons et al. 2019).
- Known to be present in Kingfisher Reserve
- The Dry Creek Corridor seeks to enable dispersal of the Superb Fairy Wren to other areas of Dry Creek by offering suitable habitat downstream.



Target species: Short-Nosed Echidna
(*Tachyglossus aculeatus*)

- Provides ecosystem services: digging behaviour helps create microhabitats, supporting seed germination.
- Grassland areas are known to be important habitats for the Short-Nosed Echidna, and particularly access to ants as a food source
- Seen in grassland areas of the Dry Creek Corridor.
- Addition of large logs within Druminor Reserve offers hollows for echidnas to shelter in, as well as protection for the newly established grassland.

Superb Fairy Wrens, progress tracking will be challenging without formal monitoring.

Challenges and lessons learned

One benefit of monitoring ongoing success is the definition of distinct measures of success that allow for assessment of project outcomes against an appropriate baseline. For example, the presence of Superb Fairy Wrens in the Dry Creek Corridor outside Kingfisher Reserve was a key indicator of the success of new understory plantings.

However, funding of monitoring programs and recruitment of volunteers is an ongoing issue for Council. Key challenges of the implementation of the Biodiversity Plan include:

- **Funding for monitoring** of biodiversity outcomes was not included in the original budget; however, this step is vital to assess the outcomes of such habitat enhancement projects. Additional monitoring challenges include the aligning of targets that are relevant to the icon species, e.g. relationship between echidnas and ants, which may mean that ants are a better indicator of success than plant survival rates.
- **Funding for both on-ground works and maintenance** is limited and may require once-off external funding (through grants or partnerships) or additional ongoing internal funding.
- **Retention of community volunteers:** due to the restriction of annual budgets for maintenance of biodiversity, and the extent of maintenance and restoration work required, Council would benefit from an ongoing Council-led community volunteer program. However, due to the current size of the biodiversity team limiting the ability to manage the administrative protocols of a volunteer program, it has not been possible for Council to provide ongoing volunteer support. As an alternative, partnerships with conservation organisations specialising in volunteer coordination are being trialled.
- **Ongoing urban pressures:** the Biodiversity Plan has connected a series of isolated reserves surrounding Dry Creek to make a continuous linear corridor. While this has benefits, it still sits within the wider urban landscape – and as such is not immune to issues such as run-off pollution, weed dispersal, and feral animal movement. Increases in private housing and other developments continue to put pressure on the uses and maintenance of this waterway. Therefore, engaging the private realm and local residents will become an increasing factor in the success of restoration projects. This extends to the conservation of icon species where significant resources

may sit outside the project footprint, for example, on private properties near the project site.

As a response to urban pressures, Council have developed a hierarchy of planting with varying levels of ecological novelty:

- In areas with good quality remnant patches, seed of local provenance is prioritised to preserve these values.
- In other areas, mixed provenance (with non-local natives) has been trialled at larger scales to increase resilience of vegetation, particularly against climate extremes.
- Useful non-local natives have been embraced for tree screens, with an acceptance of their functional value in some specific circumstances where restoration with locally native species is not possible.

Incorporating citizen science projects could be a useful strategy to manage the financial limitations faced by council and to create opportunities for further community engagement. For example, there are at least 17 butterfly species associated with vegetation within the Dry Creek Corridor, including rare and endemic species. There is an opportunity to create a butterfly garden within Oratanga Reserve, which would offer larval host plants for the suite of invertebrates that are currently unavailable/limited within the landscape. Integrating the needs of the various fauna icons will be an important consideration.



Extract from Biodiversity Plan for Kingfisher Reserve.

Source: <https://www.teatreegully.sa.gov.au/>

A nature play area could be included, to strengthen a connection to biodiversity in the community from childhood. This could also be paired with a program for local residents to take home larval host plants to attract key invertebrates to their own gardens. There is opportunity to highlight the unique relationships between insects, plants and larger fauna such as echidnas.

Funding and partners

Preparation of the BSUD Plan was enabled by the first round of BSUD grant funding provided by Green Adelaide.

Case Study 2: Sturt River 'Warripari' BSUD Plan

Background

Sturt River 'Warripari', flows from the Adelaide Hills in the east of Adelaide, through the council areas of Onkaparinga, Mitcham, Marion and Holdfast Bay, before joining the Patawolonga River in Glenelg North. Once a meandering river, Sturt River 'Warripari' was traditionally used by Kaurna as a meeting place and seasonal migratory route to follow from the hills to the sea.

Post-colonial Adelaide made use of the rich alluvial soils to produce highly productive agricultural land, but the conversion of much of that agricultural land to residential housing in the 1950s and 60s led to widespread concerns about flooding. Under the South Western Drainage Scheme of the 60s and 70s, much of Sturt River 'Warripari' was converted into concrete culverts.

In the 1980s increasing awareness about biodiversity loss and the importance of nature saw the introduction of eucalyptus from WA to revegetate along the river corridor to celebrate biodiversity. By the 1990s and into the 2010s, local provenance and 'water catchment management' approaches led to the construction of Warriparinga and Oaklands wetlands, utilising more locally sourced species and an attempt to restore the former natural environment.

Prepared in 2022, the Sturt River BSUD Plan (the Plan) now seeks to revitalise the natural catchment area, targeting local species and ecosystems, and utilising detailed spatial mapping to identify priority sites and connectivity opportunities. The plan acknowledges the need for stormwater infrastructure while also seeking to maximise biodiversity outcomes.

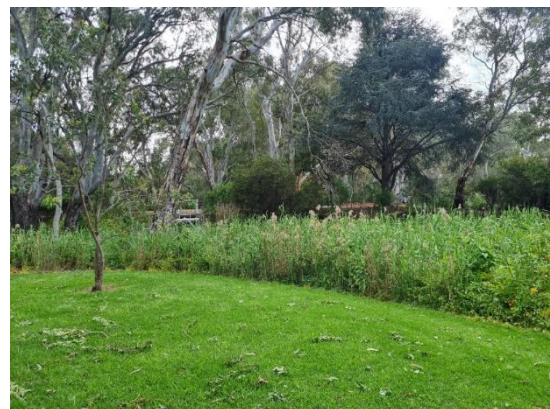
The Plan encompasses the entire section of Sturt River 'Warripari' Corridor that lies within the City of Marion, including its natural catchment area.

About the site

Context:	BSUD Plan
Location:	Sturt River 'Warripari'
Scale:	Neighbourhood
Organisation:	City of Marion



Sturt River / Warripari, where the concrete drain becomes a natural watercourse. Photo: K Berthon



Vegetation along Sturt River 'Warripari'.
Photo: Green Adelaide

While several revegetation projects have been undertaken across the project area, the overarching BSUD Plan was created to allow for better coordination through an overarching framework that prioritised action across the Sturt River Corridor.

A coordinated approach for biodiversity across a larger spatial area enables better prioritisation of revegetation projects; and restoration of local plant species, even in a constructed wetland context, can be successful at attracting biodiversity.

Application of BSUD principles

BSUD principles addressed	
Enhance habitat and resources	✓
Improve connectivity to encourage dispersal	✓
Reduce threats and disturbances	✓
Enable natural ecological processes	✓
Facilitate positive human-nature interactions	✓

The BSUD framework and principles are embedded within the creation of the Plan and its key priorities, with target species chosen to represent indicators for each of 7 key themes: Safeguard, Connect, Restore, Survive, Innovate, Engage and Support.

The Plan includes detailed spatial mapping to identify priority restoration sites, with some of these projects already successfully funded. The land tenure across the site is varied, and there needs to be a focus on cross-collaboration across and within organisations, leading to the establishment of a stakeholder taskforce to help direct action for biodiversity.

A key aim of the Plan is to link up the pockets of space across different land tenures, improving the local population viability of

species present and providing greater connectivity for those species requiring particularly connected habitat. The Plan also aims to reduce future threats and disturbance by proposing revegetation behind fenced areas.

Challenges and lessons learned

Implementation of this Plan will require more specific and measurable targets to be developed related to the target species or principles (above and beyond existing canopy targets).

As in other case studies, a strong volunteer support base (in the form of the Friends of Sturt River Landcare and Friends of Warriparinga) will continue to be crucial to delivering and maintaining biodiversity habitat under this Plan.

Sightings of the endangered Australasian Bittern (*Botaurus poiciloptilus*) were an indicator of the success of the restoration of local wetland vegetation at Oaklands (and its subsequent maintenance), demonstrating the potential for targeted restoration to bring species back.

One of the biggest challenges for Marion Council has been working at the interface between different landholders, including private and public land management bodies. For example, SA Water manages the concrete structure, but Council maintains the vegetation in adjacent parks and public gardens, and many private properties also directly back onto the river. There has been consideration of utilising innovative approaches to increased greening in the concrete watercourse (such as use of trailing plants), but these require co-operation between land managers across property boundaries.

Funding and partners

Green Adelaide provided funding through the first round of their BSUD grant funding program.



Metropolitan Adelaide BSUD case studies

Park context

Case Study 3: Biodiversity Planting – Alan E Cousin Reserve

Background

Alan E (AE) Cousin Reserve is an urban reserve, approximately one hectare in size, which primarily consisted of mown and irrigated turf interspersed with isolated Grey Box (*Eucalyptus microcarpa*). Two patches of essentially unmanaged vegetation also remained, where pasture grasses, herbaceous weeds, and dense woody weeds competed with remnant species such as *Eucalyptus microcarpa* and *Eucalyptus leucoxylon ssp leucoxylon*.

In 2010, a motivated local resident prompted the Urban Biodiversity team at the City of Burnside to undertake targeted weed control around the remnant patches of Grey Box Woodland (an EPBC listed threatened ecological plant community) within the reserve, leading to an ongoing collaboration.

By 2014, a 2,000 m² section of the reserve became formally recognised as an urban biodiversity volunteer site, and ongoing weed control, facilitation of natural regeneration, and strategic replanting were undertaken by the motivated resident and another conservation volunteer, in collaboration with the Council Urban Biodiversity team.

Following community concern about the aesthetics of the remainder of the reserve in 2016, new 'biodiversity areas' were established in a mosaic pattern (under Grey Box trees) – guided by the success of the prior regeneration.

Through replacing exotic grassy areas with understory vegetation, the project has achieved enhanced aesthetic and biodiversity values, while maintaining the passive recreational uses for the reserve.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

Using the threatened Grey Box (*Eucalyptus microcarpa*) Woodland as the target ecosystem, this project focussed on planting locally native species and allowing natural regeneration of the native seed bank, to encourage natural ecosystem processes and increase the native plant diversity of the park.

About the site

Context:	Park
Location:	Sitters Memorial Drive, Burnside
Scale:	Local
Organisation:	City of Burnside and motivated local residents



Understory restoration under remnant Grey-box (*Eucalyptus microcarpa*). Photo: City of Burnside



AE Cousin Reserve is an urban reserve, bounded by residential land in Burnside, Adelaide. Source:

By using the native seed bank, several native understory species have returned that are otherwise difficult to cultivate – for example *Daviesia ulicifolia* which has spontaneously regenerated from the soil seed bank. The site now hosts some of the most intact understory for this ecosystem type within Adelaide.

Some existing areas of the reserve had lost aesthetic value over time, as irrigated turf was struggling under remnant Grey Box (*Eucalyptus microcarpa*) trees. As prior regeneration undertaken by the motivated resident had been successful, this allowed for a proposal to create new biodiversity areas, converting underperforming lawns to a mosaic of local native communities throughout the reserve, and preserving remnant trees. This approach allows for dual use of the parkland, as some lawn areas remain for passive recreation.

A key driver of this project has been a knowledgeable and committed community member, exemplifying the importance of a strong connection of people within communities to local biodiversity outcomes. This community member has become an advocate, motivating neighbours to become involved in protecting and promoting biodiversity in their local area.

Challenges and lessons learned

The involvement of the motivated resident has been a driving factor in the success of this project. The regeneration of AE Cousin Reserve shows that engaged and enthusiastic volunteers from the community can be invaluable assets for achieving BSUD outcomes.

Where possible, councils should continue to support leaders in the community to deliver BSUD projects in their local area, as this has the potential to deliver significant change and encourage other members of the community to come together to deliver positive outcomes for nature.

This project had active community advocates that kept their neighbours engaged and informed, where similar projects in neighbouring reserves have encountered community opposition, possibly due to poor communication about project objectives.

Communication is especially important where there are multiple different aims for the land (e.g. aesthetics, biodiversity and recreation), as there are often opposing views on how land can or should be used.

Finally, while natural regeneration allowed for increased diversity of plantings, the bulk of the regeneration project was supported by the council's native plant nursery. Sourcing of local provenance plant material is often difficult but is crucial to the success of restoration projects, and the indigenous plant nursery at Burnside council is a fantastic asset for BSUD in this area.

Funding and partners

The project was funded by the City of Burnside, with allocation of operational budgets diverted towards regenerating AE Cousin Reserve, and the supply of a variety of locally native plants provided by the council's biodiversity nursery.



Alan E Cousin Reserve. Photo Green Adelaide



Remnant vegetation. Photo: City of Burnside

Case Study 4: Grasslands – Victoria Park / Pakapakanthi (Park 16)

Background

The City of Adelaide is surrounded by 760 hectares of park lands, made up of 29 parks and 6 city squares. One of these spaces is Victoria Park / Pakapakanthi, located in the southeast Park Lands and bounded Wakefield, Fullarton, Greenhill, and Beaumont Roads. Covering an area of 72 hectares, Victoria Park / Pakapakanthi is the largest single park and constitutes about 10% of the total parkland coverage. It also hosts one of the largest and most intact remnants of native grassland communities in Adelaide.

Historically, this public open space has hosted horse and motor racing events and features historical buildings and sporting fields. Horseracing in the park ceased in 2007, and the space has since undergone gradual restoration to protect, enhance, and expand the threatened ecological communities of Grey Box (*Eucalyptus macrocarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia.

Despite over 185 years of European settlement, patches of native grassland communities have remained, hosting species such as Spear Grass (*Austrostipa* spp.), Early Nancy (*Wurmbea dioica*), Tiny Star (*Pauridia glabella*), and Garland Lily (*Calostemma purpureum*). This site is one of the last locations in the Adelaide Plains where such remnant native grassland species has survived.

In 2012, the biodiversity significance of the remnant native grassland species was recognised as Grey Box (*Eucalyptus macrocarpa*) Woodlands and Derived native grasslands of South-eastern Australia, listed as an Endangered ecological community under the EPBC Act. The area was fenced off, securing the site from disturbance yet ensuring it was open to visitation – offering an opportunity to protect and showcase an important part of Adelaide's natural heritage.

The restoration of Victoria Park / Pakapakanthi has targeted the recognised ecological community (Grey Box (*Eucalyptus macrocarpa*) Woodlands and Derived native grasslands of South-eastern Australia,) to protect and enhance these communities. Further, after the rediscovery of the Chequered Copper Butterfly (*Lucia limbaria*) within the site, volunteers have created a 'Herding Caterpillars' program to monitor local populations and carry out restoration works that specifically benefit the butterfly.

About the site

Context:	Park
Location:	Victoria Park / Pakapakanthi (Park 16) South-eastern Adelaide Park Lands
Scale:	Neighbourhood
Organisation:	City of Adelaide



Victoria Park / Pakapakanthi (Park 16). Photo Adelaide Park Lands Association - <https://www.adelaide-parklands.asn.au/park-16-south-tour>



Flowering locally native plants at the grassland restoration site in Victoria Park / Pakapakanthi (Park 16). (Credit: City of Adelaide)

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

Victoria Park / Pakapakanthi uses a combination of traditional restoration techniques to achieve the best outcomes for biodiversity in this grassland. The overarching goal is restoration at an ecosystem level, but specific plants are targeted as they appear with a 'core and buffer' approach, where the growth of regenerating native plants is encouraged by targeted clearing of buffer zones around rare individuals. This technique allows for natural regeneration and increases the representation of native plants that may be otherwise difficult to cultivate using traditional horticultural techniques.

In addition, an area at the edge of the park has had the top layer of soil and the underlying seed bank removed. This removes both weeds and native plant seeds alike but allows for a blank slate for planting and serves as an excellent demonstration of the best-case scenario for grassland diversity.



Kangaroo grass (*Themeda triandra*) at the grassland restoration site in Victoria Park / Pakapakanthi (Park16) with the city in the background.
(Credit: City of Adelaide)

In 2021 adjacent Park 16, the City of Adelaide partnered with the Kaurna community to carry out the first cultural burn in an Australian capital city. The significance of this is three-fold:

- 1) Recognition of the traditional management of the Adelaide Plains by the Kaurna people, and respect of their cultural traditions.
- 2) Bringing the Adelaide community together to celebrate the connection between human and nature through appreciation of the human-involvement required in managing this unique ecosystem.
- 3) Improving the biodiversity outcomes of an ecosystem that has evolved to benefit from fire disturbance.

The City of Adelaide continues to work with the Kaurna community to better manage these precious and rare landscapes.

Removal of fire from these ecosystems is a threat to their survival, and previous techniques to simulate disturbance such as mowing and sheep grazing have not been as effective at promoting growth of native plant species.

In addition to the ecosystem level focus, the Victoria Park / Pakapakanthi restoration project has also targeted supporting the rare Chequered Copper Butterfly through providing vegetation important for its life cycle. Prior to its rediscovery in 2011, the Chequered Copper Butterfly had not been sighted in the Adelaide Plains since 1967.

As well as relying upon the conservation of grassland habitat, this butterfly species is dependent on complex inter-species relationships for survival, with caterpillars hatching from and feeding on Native Sorrel (*Oxalis perennans*). The caterpillars also have an obligatory relationship with common black ants (*Iridomyrmex rufoniger*), who attend to the larvae and provide refuge in their nest chamber below the foodplant.

The ongoing grassland restoration has already increased human-nature connection and raised the profile of grassland species in several ways, for example:

- A volunteer led outreach program called 'Herding Caterpillars' was established to help monitor the local population, and to raise awareness about this unique species through storytelling.
- Public access to the grassland and the installation of appropriate educational signage have been important for fostering connections to the park and increasing appreciation of the site.
- Increasing appreciation of Kaurna cultural practices will be a key feature in ongoing management, with future planned cultural burns undertaken based on site conditions.

The City of Adelaide has implemented a Biodiversity Monitoring Program that measures the success of grassland restoration and the recovery of the butterfly and other faunal species. The program uses transect-based methods (ecological monitoring tool) to measure restoration success, with the goal of increasing the percent coverage of native plant species.

The City of Adelaide has also implemented a biodiversity survey utilising drone-based remote sensing to monitor native vegetation, connecting BSUD to expanding industry applications. The survey will help to develop an ongoing monitoring program in line with international standards to guide future outcomes to be delivered under the City of Adelaide's Integrated Climate Strategy, which outlines a goal for a "city where nature thrives".

Challenges and lessons learned

As in other projects, volunteers and local community have been key drivers in identifying and protecting Adelaide's biodiversity heritage. Both the identification and maintenance of the large and significant remnants of grassland and the rare butterfly that inhabits the site have been helped by enthusiastic local conservation volunteers. City of Adelaide values partnerships with the local community to achieve biodiversity outcomes. Local residents often have time, knowledge and passion to help realise projects that would have otherwise not been possible.

A strength of this project is its well implemented monitoring program, supported by a large community of conservation volunteers. Continual monitoring allows for continual improvement of grassland management and provides a benchmark from which to measure success. In 2018, this monitoring led to the discovery of several new and conservation significant species (eg *Austrostipa gibbosa*) in other areas of the Adelaide Park Lands. Future monitoring will establish the results of the Victoria Park / Pakapakanthi remnant vegetation site. It is hoped that this will show its success protecting pre-colonial ecosystems and rare species in the heart of the Adelaide metropolitan area.

Ongoing weed encroachment poses a problem for the grassland restoration. Once removed, the soil is an essentially blank slate, but is still vulnerable to dispersal of seeds from nearby weedy patches. This kind of technique is highly disruptive and can only be performed a few times before no more viable soil remains beneath the active seed bank.

To counter this, it is important that active removal of weeds is undertaken at this site. To aid this, the site would benefit from an acceptance of novel design techniques, such as the planting of a shrub line to protect the site from weed intrusion. While this breaks from the traditional structure of grasslands, it may enable better preservation of the existing plant community.



Remnant grassland site in Victoria Park / Pakapakanthi (Park16) during a community event in 2018 (Credit: City of Adelaide)

Funding and partners

The project involves ongoing partnerships with multiple stakeholders:

- Site maintenance is managed by both the City of Adelaide and the Department for Environment and Water, while Green Adelaide have also provided in-kind and financial support.
- The Biodiversity Monitoring Program is a collaboration between the City of Adelaide, Flinders University and the University of Adelaide.
- Fauna data is collected in collaboration with consultancy groups, such as Butterfly Conservation SA, and citizen science initiatives including Birdlife Australia's Birds in Backyards.

Case Study 5: Sedge-Skipper Butterfly Reintroductions – Greenfields Wetlands

Background

The Yellowish Sedge-skipper (*Hesperilla flavescens*) is endemic to South Australia but had become regionally extinct in Adelaide in the 1980s due to habitat loss and widespread use of insecticides. The butterfly relies on thatching grass (*Gahnia filum*) to complete its life cycle, with larvae forming shelters using adjoining leaves. To prevent extinction at the state-scale, new populations need to be established and maintained. In 2000, the former Adelaide and Mount Lofty Ranges Natural Resource Management Board (now Green Adelaide) began planning for reintroduction of the sedge-skipper, and the first individuals were released in 2020 after extensive habitat restoration works.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

This project has a clear species target and has applied four of the principles of BSUD to facilitate the re-establishment of species populations, in conjunction with the planned reintroductions.

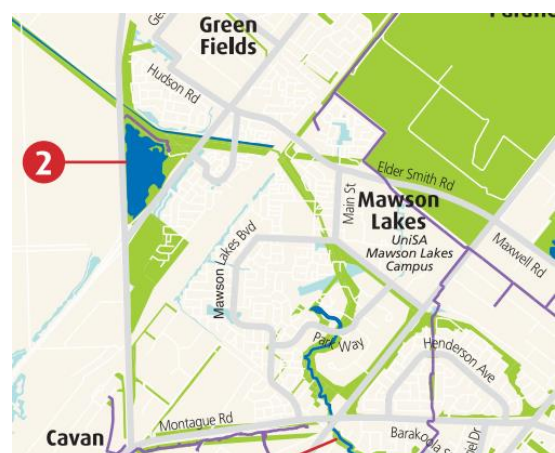
After a period of extensive habitat restoration works, approximately 10,000 Thatching Grass plants were established in existing open space sites, including those with the Salisbury Wetlands: the Greenfields, Kaurna Park, and Springbank Boulevard Wetlands.

About the site

Context:	Park
Location:	665 Salisbury Highway, Mawson Lakes
Scale:	Neighbourhood
Organisation:	Green Adelaide



Salisbury wetlands, showing thatching grass (*Gahnia filum*), the host plant for the Yellowish Sedge-skipper butterfly. Photo Green Adelaide



The City of Salisbury has more than 50 wetlands. Greenfields Wetlands are marked by the number 2 on the map. Source:

<https://www.salisbury.sa.gov.au/services/environment-and-sustainability/wetlands-and-water/wetlands>

Following the habitat establishment stage, the release of Sedge-skipper specimens began in 2021. Three types of re-introductions were trialled: introduction of adult butterflies, pupae, or larvae (caterpillars) inside artificial shelters.

To determine if successful reintroduction has taken place, a goal has been set of greater than 100 individuals present per year in each location. However, this has only been achieved at one of the three restoration sites, as the adults did not seem to reproduce, caterpillars were heavily predated, and only 85 of 140 pupae (approximately 82%) emerged.

Following these low success rates, ongoing monitoring is helping to identify other threats to the butterfly, including the presence of many natural enemies (e.g. parasitic wasps), and issues related to habitat suitability. For example, ongoing maintenance of thatching grass is required to ensure that the plants have sufficient leaf density to allow the caterpillars to form 'shelters' by gluing together two adjacent leaves. Similarly, habitat density may be a future issue, with released individuals being unable to find nesting resources in otherwise densely vegetated environments.

As the health of the *Gahnia filum* through the hotter summer months may have been the contributing factor for the relatively poor success of the sedge-skipper colony, in 2023 the project team trialled planting *Gahnia trifida*, which do not mind having their root systems submerged in water for longer periods. There is hope that having this in aquatic/semi-aquatic areas will give the sedge-skipper a more suitable foliage option over the summer.

In September 2023, pupae collected from numerous sites from the Eyre Peninsula (where *Hesperilla flavescens* is still in high abundance) were released. The adult butterfly was released rather than pupa, to prevent a boost in the number of parasitic wasps on site – the two main wasp species that parasitise the sedge-skipper during the larval period are already widespread through the state. While at the time of writing it is too early to establish the success of these measures, it is hoped that they, in combination with more favourable conditions (weather and parasitic interference), will result in better success.

Challenges and lessons learned

The results of this decades long project have been mixed, but persistence and longevity of funding have been key factors in its success. Long-term projects like these require collaboration across different levels of government, and successful partnerships formed between Council and Green Adelaide, State Government, private industry, Trees for Life, Conservation Volunteers Australia, and Friends Groups, have been integral parts to the project delivery.

Given that habitat loss is the largest contributor to the local extinction of the species, the focus of this project was on re-establishing habitat. While this was successful, the subsequent re-establishment of Sedge-skipper populations has been less successful than anticipated.

Without addressing other threats to the population, establishing habitat alone has been insufficient in allowing for the restoration of Sedge-skipper populations. For example, vegetation structure was a limiting factor in the success of new Thatching Grass plantings, as some butterflies had difficulty locating it within the vegetation matrix and shade from surrounding plants. Future reintroduction projects could increase success by ensuring that all threats are considered.

Several other factors also influenced the success of establishing new sedge-skipper populations, for instance abiotic factors such as pesticide application and dust from nearby construction, as well as the threat of predation.

While measures (i.e. artificial shelters) were taken to prevent bird predation, parasitic wasps limited the success of larval introductions. Release of specimens in their pupae form is likely the most successful mechanism for building Sedge-skipper populations, as larvae are particularly vulnerable to predation and parasitism.

Plantings of native Thatching Grass throughout raingardens and residential yards in the north of Adelaide would further expand Yellowish Sedge-skipper habitat while building the human-nature connection outcomes of this project. Further, by extending this to include other locally appropriate *Gahnia* species, it

would also increase the breadth and availability of habitat for other *Gahnia* dependent butterfly species.

Note: this project is being delivered across a site that was once a samphire plant community that has since been converted to a wetland area. From a BSUD perspective, it would be preferable that the samphire community (now listed as a threatened ecological community) had been protected above all other actions (refer section 7.1).

Funding and partners

The Yellowish Sedge-Skipper project was started in 2000 by the South Australian Urban Forest Biodiversity Program, and a recovery plan developed. Efforts were reinvigorated from 2012 with additional Australian Government and AMLR NRM Board (now Green Adelaide) funding to restore coastal butterfly habitats in the region.



Yellowish Sedge Skipper (Hesperilla flavescens) release (with Salisbury Council biodiversity staff), Greenfields Wetlands 2023. Photos: Danny Millbanks





Metropolitan Adelaide BSUD case studies

Linear corridor context

Case Study 7: Holdfast Bay Warriparri Biodiversity Corridor

Background

An assessment of biodiversity values in the City of Holdfast Bay conducted in 2018 discovered that the suburb of Glenelg North hosted very little floristic biodiversity. Once this was recognised, council sought to develop a biodiversity corridor, utilising several parks (including Fordham Reserve) that adjoin the Sturt River / Warriparri (managed by SA Water).

Public open space sites that shared a boundary with the river channel were selected for native plantings, with a view to upgrading them into stepping-stones of biodiversity along the river corridor, to enhance connectivity and improve human/nature interactions in the suburb.

This project is an example of how collaboration between stakeholders across property boundaries is important for supporting biodiversity and providing a continuous corridor.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

This project began with an assessment of the current biodiversity values within the local council area. This is the first step in the BSUD process and is crucial for being able to monitor the impact of potential interventions.

Following this assessment, the project aimed to add habitat to areas that were directly adjacent to the property boundary with SA Water. This maximised the total impact of the plantings for biodiversity by allowing for a continuous vegetated corridor along the river. This kind of thinking across public and private property is at the heart of BSUD approaches.

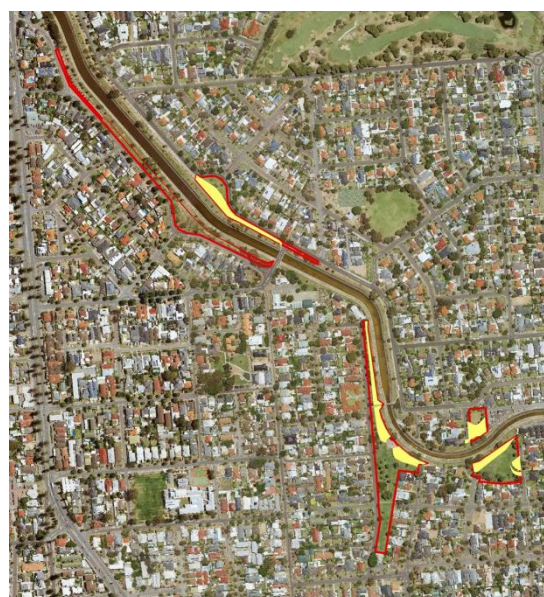
All of the plant species selected for this project were those present in the open woodlands of the Adelaide Plains prior to European colonisation and were recommended by a renowned ecologist. Native plant species were selected that were anticipated to attract additional nectar feeding and insectivorous birds, lizards, and a range of insects. In addition to vegetation, habitat analogues such as nesting boxes and logs have been installed to support local fauna.

About the site

Context:	Linear corridor
Location:	Fordham Reserve, Bob Lewis Reserve, and Steward Avenue Reserve
Scale:	Neighbourhood
Organisation:	City of Holdfast Bay



Native plantings along the Sturt River Channel on the edge of Fordham Reserve. Photo: Green Adelaide



Project revegetation areas along the Warriparri Channel in the City of Holdfast Bay.

Source: City of Holdfast Bay

Layers of habitat structure were utilised to attempt to reduce the threat of noisy miners. Similarly, dense prickly plants in which small birds can take refuge were utilised to reduce disturbance by cats.

Challenges and lessons learned

Stakeholder collaboration has been a major theme of this project. The Friends of Sturt River Landcare Group have been integral to the establishment and success of this project, securing additional funds for the project and offering long term maintenance and community engagement on a voluntary basis. This has alleviated financial and logistical pressures on Council, and empowered residents to contribute to local biodiversity and connect with nature. The Friends Group has also been integral to the open and continuous engagement with the broader community, which has contributed to high community acceptance of the project – including for otherwise controversial actions such as weed tree removal and replacement with more appropriate species.

A council-wide monitoring plan was also used to assess habitat value of local parks and create a baseline biodiversity score, enabling the quantitative evaluation of habitat interventions. Benchmarking approaches such as this can help direct funding and BSUD efforts to the areas that require it most.

As in other Adelaide projects, there were issues with the procurement of seed for local native plants, which meant that some species recommended by ecologists had to be excluded from the project. Increasing support for the local plant horticultural industry within Adelaide would alleviate some of these seed sourcing issues.

A further challenge that has emerged from this project is balancing the needs of native animals and the safety needs of the public. With a focus on maintaining the recreational potential for local residents, only small areas of each park have had additional plantings. For example, for some small birds, spiky plants are suitable habitat, providing refuge from predators; but these plants could pose a risk to people sharing this space. In order to maximise biodiversity potential while minimising risk to the community, it is important to carefully consider placement of such plants.

Funding and partners

Currently, three spaces have been developed (Fordham Reserve, Bob Lewis Reserve and Stewart Reserve). The first two spaces were fully funded by council, while the third has received additional funding from a Green Adelaide Grassroots Grant.

While initially the project was driven by council, the Friends of Sturt River Landcare Group have been invaluable for site maintenance and community engagement at all three sites. After the success of the first plantings, the Friends Group expanded their work to assist with the development of two further sites, with weeding, seed collection, and propagating seedlings.



Bob Lewis Reserve a) before works, and b) with works nearing completion. Source: <https://www.yourholdfast.com/sturtrivergreeningproject>

Case Study 8: Biodiversity 'pods' – Smith Creek Linear Trail

Background

The Smith Creek Trail is a popular shared path that follows Smith Creek from Craigmore to Stebonheath Park at Andrews Farm in the Northern Suburbs of Adelaide. A 54-hectare section of this key recreation corridor has been identified for its potential for biodiversity management. This trail has been subject to a number of upgrades, such as a recently completed wheelchair accessible shared use pathway, and is now undergoing a greening project to enhance the pathway network, increase canopy and create a biodiverse corridor.

This project created a series of understory 'pods', comprising mulched and planted garden beds planted and positioned mainly under remnant mature trees such as River Red Gum (*Eucalyptus camaldulensis*) and Mallee Box (*Eucalyptus porosa*) trees. Pods were planted with hardy indigenous understory plants that mimic the natural understory of woodlands in the area. As part of this project, 15,075 seedlings including 302 trees have been planted within a 26 hectare section of the Smith Creek Linear trail.

This contributes to a model for enhancement of green/grey assets, as a means of increasing community engagement in open space and preparing for climate change in key public spaces.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

The Smith Creek Trail upgrade has been informed by an understanding of the threats to local trees, as well as identifying zones along the trail with the highest vegetation-based biodiversity value and heat footprint to address the areas requiring cooling and ecosystem services the most.

Mature River Red Gum (*Eucalyptus camaldulensis*) and Mallee Box (*Eucalyptus porosa*) are protected as the target species, while their ecosystem value is enhanced by the addition of hardy indigenous plants in mulched pods underneath established trees. Locally native tree

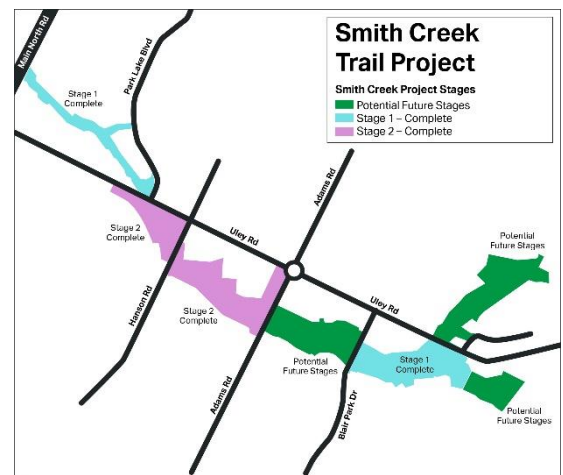
About the site

Context:	Linear corridor
Location:	Smith Creek Linear Trail
Scale:	Neighbourhood
Organisation:	City of Playford



An example of a biodiversity 'pod' at Brian Coward Reserve along Smith Creek Linear Trail.

Photo: City of Playford



Source: City of Playford

species were also planted to increase shade along the pathway network. A combination of tubestock along with more advanced 1.5L aerated pots were used for tree plantings.

The pod design inserts an understory into a landscape dominated by lawn and exotic dryland weed grasses. Collectively, the pods cover a space of over 2.1 hectares (of the 26ha trail area), building on the

existing ecological community to create “micro-environments”. The establishment of shrubs and ground cover will increase bird and beneficial insect habitat, reducing the pressures of pests on trees, with the goal of improved canopy cover and density.

As well as biodiversity outcomes, the pod design is anticipated to improve soil quality and reduce the prevalence of weeds in the understory. Larger areas of open grass were retained in recognition of the open grassy woodland habitat of the area, rather than heavily planting out the parkland. Use of pods can be useful if planted with appropriate low storey species that accurately reflect the suite of native species found in native grasslands.

Challenges and lessons learned

Good communication and collaboration between biodiversity and maintenance teams has been necessary to ensure project success. One of the greatest challenges to the success of this and similar projects is the integration of biodiversity outcomes into core service delivery and landscape design.

Whole of Council support including at senior management levels, along with a willingness to invest operational funding, have been critical to the success of the Smith Creek Trail. Strong communication channels between biodiversity and maintenance teams have been essential for the success of projects such as this, including to establish timing of complementary mowing programs. Close collaboration with maintenance staff during the design phase helped to create a joint vision that considers maintenance needs and creates efficiencies. For example, the shape of the pods considered the ease of movement for mowers and slashers working alongside them.

With an extensive open space network to manage, establishing agreed service levels across teams may assist with cohesive on-going operational resourcing. Continuing to engage with maintenance staff to increase knowledge of local biodiversity and biodiversity sensitive maintenance techniques will also embed these values and secure the long-term success of this and other urban biodiversity projects.

Using trees planted from 1.5 L aerated pots was an innovation trial within this project. The 1.5L aerated pots have performed strongly within the Smith Creek Trail project. They have allowed for faster establishment and lower cost due to lower watering needs in comparison to advanced tree stock. These trees grown in 1.5L aerated pots have now been integrated into the Council’s canopy strategy for delivery across the broader reserve system.

Funding and partners

This project has been enabled by support and funding from several sources. Most of the funding was through Green Adelaide’s Greener Neighbourhood Grants Program and the City of Playford.

The Playford Greening and Landcare group were another significant contributor, providing consultation support, seedling production and planting assistance toward the project as well as \$2000 of funding.

As partners of the project, Trees For Life, and Greening Australia SA also contributed to the Smith Creek Trail with an extended network of volunteer planters and additional financial resources



Biodiversity pods along Smith Creek Linear Trail. Photos: City of Playford

Case Study 9: Virginia Grove Linear Corridor

Background

The Virginia Grove Linear Corridor pilot project focuses on a 600 linear metre pocket of unirrigated, dryland reserve which will trial balancing the goals of enhancing amenity of the reserve, improving biodiversity, while also aiming for cost effective maintenance.

The original impetus for the project was the clearance of remnant vegetation for development in an area largely not protected by the *Native Vegetation Act 1991*. Many local species involved had conservation ratings and were already poorly preserved on roadsides. Some conservation-rated bird species had been seen using roadside remnant vegetation sites, and providing new and safer habitat for them as the sites dwindle has become urgent. In this sense the project aims to reduce the threat of the clearance of roadside native vegetation.

The changed landscape from agriculture to new residential developments has created a unique opportunity to construct native vegetation habitats in urbanised settings, including use of ephemeral stormwater flows and wetlands.

The council has planted 1800 tube stock of locally native plant species along the Virginia Grove corridor, as well as 68 semi-advanced native trees.

Local native species re-colonised after landscaping, including grasses and *Atriplex semibaccata*. Instead of spraying out the beds before planting, the contractor spot sprayed with pine oil. This minimised damage to remnant plants, as well as preventing killing ants, which were actively spreading *Atriplex* seeds at the site.

By vegetating the reserve with locally native species that are resilient to dry conditions, City of Playford hopes to enhance biodiversity and offer a successful example that may serve as a demonstration for extensive similar developments that are anticipated in the area.

Linear pockets of greenspace are expected to be an emerging style of land use within new developments, often handed to council as unirrigated grass reserves with sparse trees. Increasing demand for housing has sparked a proliferation of developments like this (conversion of agricultural to residential land) in the outer suburbs of Adelaide.

About the site

Context:	Linear corridor
Location:	Virginia Grove Linear Corridor Juniper Blvd, Virginia
Scale:	Neighbourhood
Organisation:	City of Playford



Virginia Grove Linear Trail. Photo: City of Playford

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

The City of Playford are working to increase biodiversity to enhance the visual amenity and the quality of experience for residents, in addition to increasing canopy cover, shade and the conservation of local flora, within new developments. This aims to re-introduce a more natural habitat in a substantially degraded area with low access to original habitat reference sites.

Much of the flora of the Adelaide Plains has been the subject of extensive clearing, and by planting rare locally native species, the council is increasing the biodiversity of the reserve and preserving their ecological heritage.

Linear corridors have a high potential to meet a number of the BSUD principles. While this project enhances human-nature interaction as a product of enhanced amenity, it also contributes to the creation of new habitat, and its shape and extent across the landscape make it likely to form part of broader movement corridors to assist local fauna to navigate across developed areas.

Challenges and lessons learned

As the fastest growing council in South Australia, there are potentially kilometres of similar dryland reserves that will be created as new suburbs are built. These offer significant potential for increased local flora and fauna habitat, while also providing a connection for residents with nature. The Virginia Grove Corridor project may offer a blueprint for biodiverse spaces with improved amenity and enhanced community wellbeing.

In outer suburbs like Playford where residential land supply is predominantly in the form of greenfield land, it is more likely that developers will opt for providing the 12.5% public open space required under the *Planning, Development and Infrastructure Act 2016*, rather than paying an offset. However, maintenance cost is often an influential factor in what type of green public open space is provided.

There is an opportunity for councils' Open Space Guidelines to incorporate the principles of BSUD to advocate for better quality greenspace, while acknowledging the costs associated with this. Traditionally there has been a dichotomy of management approaches – unirrigated lawn and trees, with low maintenance requirements, versus high maintenance, irrigated garden beds. The City of Playford is developing a model in-between these two extremes, where the value of linear reserves is increased without extensive added maintenance cost. The comparative cost of maintaining a biodiversity site once it becomes established is anticipated to be comparable or lower than maintaining irrigated lawns and garden beds. These



Virginia Grove Linear Trail. The whitish material on the ground is weedmats (used in some sections) and the remains of weeds treated with pine oil. Photos: City of Playford

sites will have additional benefits to environmental and human health, anticipated to make these a cost-effective landscape management technique.

It is hoped this “bubble of biodiversity” in Virginia Grove will provide evidence that successful delivery and maintenance of habitat is possible, and can thus inform future negotiations with developers.

While this development focuses on providing floral biodiversity, future developments could improve on this example by designing plant palettes that target and address needs and threats to local fauna e.g. white-winged fairy wrens (*Malurus leucopterus*).

Pine oil and spot spraying were more expensive than conventional methods of weed control, and the value of this approach will need to be compared through further trials with other herbicides.

Additional anticipated challenges are gaining recognition of the value of the sites with local residents, including appreciating the grassland and shrubland habitat types of the area.

Weed plant incursions from nearby homes may cause an ongoing management challenge which will need to be monitored. However it also allows a chance for engagement programs with local residents, to encourage use of locally native plants.



Metropolitan Adelaide BSUD case studies
Streetscape context

Case Study 10: Windsor Street Linear Reserve

Background

Windsor Street Linear Reserve has been created as part of the City of Unley's vision to develop a native plant corridor for people to walk or cycle from Urrbrae to the Adelaide Park Lands, and also provides unhindered corridors for native bird movement. Council has taken advantage of an innovative opportunity by repurposing an open concrete stormwater drain to create this scenic corridor featuring locally indigenous vegetation.

The open drain has been replaced with box culverts to manage storm water, and now hosts an 11,000 m² linear reserve featuring 15,000 locally indigenous plants (84 unique species). The plant selection has included threatened species, Grey box (*Eucalyptus microcarpa*), and other plants that constitute the original woodland ecosystems of the area.

For further information about this project refer to:

<https://cdn.environment.sa.gov.au/landscape/docs/hf/green-infrastructure-windsor-st-case-study.pdf>.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	✓
3	Reduce threats and disturbances	
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

This project is an example of the substantial potential that exists in utilising road verges for enhancing biodiversity in the urban environment.

While utilising BSUD principles to maximise biodiversity outcomes was not the initial objective of the project, the Linear Reserve at Windsor Street has managed to implement almost all of the BSUD principles to enhance local wildlife, improve human connection to and experiences in nature, and to maximise provision of ecosystem services. A specific focus on a target species and a pre-implementation survey of fauna and flora may have strengthened a BSUD approach to this biodiversity renewal project.

Principle 1. Enhance habitat and resources

The establishment of Winsor Street Linear Reserve has created habitat using traditional vegetation-based approaches of building ecosystem structure, as well the inclusion of habitat analogues such as water dishes and nesting boxes for birds throughout the space.

About the site

Context:	Streetscape
Location:	Windsor Street (Fisher Street, Fullarton to Henry Codd Reserve, Parkside)
Scale:	Local
Organisation:	City of Unley



Biodiverse and structurally diverse plantings at the Windsor Street Linear Reserve, Unley.

Photo: G Garrard



Windsor Street Linear Reserve. Photo: Planning and Land Use Services (PLUS)

The project uses Grey-box (*Eucalyptus acrocarpa*) woodland as a habitat template for plant species selection, with a view to representing the unique flora that used to reside within the region.

Principle 2. Improve connectivity to encourage dispersal

The establishment of the linear reserve facilitates the dispersal of birds in the urban environment by providing an attractive corridor for movement. It also provides an active transport corridor for people as a place of respite for those traversing the urban environment.

Principle 4. Enable natural ecological processes

The linear reserve was created as part of an upgrade to a stormwater culvert for flood mitigation and has implemented biodiversity best practice. The reserve achieves stormwater management by harnessing natural ecosystem processes of soil-based water infiltration, where vegetation slows the water flow and decreases the strain on artificial management of water flows.

Principle 5. Facilitate positive human-nature interactions

Signage has been included throughout the reserve to inform and educate the public on the historic ecological character of the area, and on biodiversity in the urban environment. The signs present information on creating and preserving habitats, biodiversity and indigenous vegetation, and biodiversity in your garden. These all seek to engage the community and create opportunities for positive interactions with nature. Before the development of the reserve, solid fences obscured the unattractive drain from view. However, these have since been replaced with open fences at many homes so that residents can look into the reserve, strengthening a sense of connection to nature among local residents.

Maintenance

Maintenance is provided by council's Open Space Team who conduct general inspections of the site condition, removal of rubbish and weeds succession plantings undertaken over winter. The team spend approximately one full day per week on maintenance of this reserve (~8 hours).

Irrigation systems are also managed by the Open Space Team, however the space has little irrigation requirements as the selection of native plants fulfil most of their water needs through seasonal rainfall, while plants with higher water needs are irrigated with recycled stormwater.

Challenges and lessons learned

Since the establishment of Windsor Street Linear Reserve, members of the community have reported an increase in the number and diversity of native birds, as the reserve offers habitat, refuge from disturbance, and spaces to forage for food and water. Future opportunities exist to extend the reserve to create a significant wildlife corridor from the hills to the plains of Adelaide through a highly urbanised landscape.

While initially the wildflower diversity in the reserve was high, increasing canopy cover has led to decreased light infiltration,

and lower understory diversity. Since one of the main services of the reserve is shading for pedestrians using the pathway, there remains a trade-off between biodiversity and shading functions.

Several factors have contributed to the success of the project, including:

- a good working relationship among the maintenance team, landscape architect, and native nurseries
- a strong sense of project ownership within Unley Council, fostered by staff inclusion throughout the conceptual, design, and implementation stages of the project.

A staged approach to project delivery also contributed to the success and acceptance of the reserve within the community. The opportunity to showcase the completed first stage of development enabled residents to become accustomed to the new type of vegetation in their neighbourhood and created public interest in covering the remaining uncovered stormwater culverts with native vegetation.

There is opportunity in the future to extend the linear reserve, increasing the prevalence of wildlife corridors dominated by locally native plant species in the City of Unley. If this occurs, biodiversity outcomes of this development could be maximised by utilising the BSUD framework to generate an overarching reserve design aimed to establish habitat for target species or ecosystems.

While ecosystem-level design approaches such as those used in this project are effective for providing habitat generally, they may miss the particular requirements of certain target species. For example, the loss of wildflowers from the reserve could be countered with specific measures such as canopy thinning. Therefore, BSUD targets that include provision of food and shelter for target species could enhance the reserve design.

To further address the principles of BSUD, disturbances and risks could be better managed in this space. Light pollution can disrupt critical behaviours in many animal species and is a driver of insect decline with long reaching effects through the food chain; however, lighting is a feature which is critical

for human safety. Wildlife sensitive lighting design offers a solution to the needs of humans and animals. This can be achieved through installing lighting close to the ground, including shields to manage light direction, prioritising amber to red toned directional LED lighting to ambiently illuminate the area, and utilising motion sensor triggered lighting where necessary.

Finally, the habitat value of this small linear corridor could be enhanced by encouraging complementary actions in the private realm through wildlife gardening programs and engagement through citizen science. This could be achieved through signage providing details on the species, care, and management of native plants within the reserve; and making these plants available for public purchase through local nurseries.

Funding and partners

This project was a pilot with council securing part funding from the Planning and Development Fund which aimed to “enable a unique development in an inner urban area” (c. \$190,000).

Case Study 11: The Meadow – Port Road

Background

Located in the median of Port Road between Findon Road and the Grange train line, sits The Meadow – a newly renovated vegetated street scape which aims to provide an example of the landscape which once covered the City of Charles Sturt before colonial development. Its inception was an outcome of the Port Road Drainage engineering upgrade, which addressed issues of underground storm water and major flooding. Landscaping was an afterthought to this project. However, a Charles Sturt Council landscape architect saw the opportunity to remediate a large roadside plot with minimal public access into a space offering biodiversity value in the urban landscape.

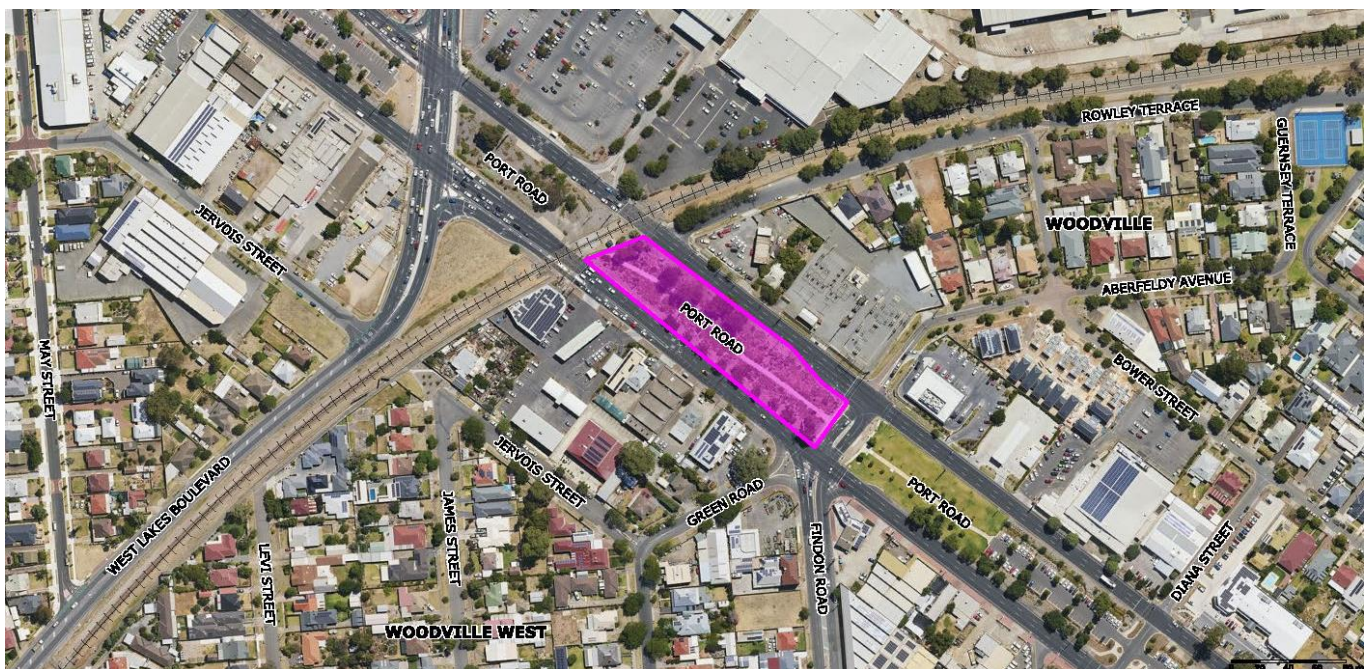
Road verges make up a huge proportion of city landscapes, and present unparalleled opportunities for increasing urban greening. This project is one of the first demonstrations of recreating a local grassland community on a road verge in Charles Sturt Council area.

About the site

Context:	Streetscape
Location:	Port Rd (between Grange train line and Findon Rd), Woodville
Scale:	Local
Organisation:	City of Charles Sturt



*The Meadow project showcases a road verge converted into an active walkway with local grassland plants.
Photo: Bianca Murfit*



Planting area for the Port Road 'the Meadow'. Source: City of Charles Sturt

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	
5	Facilitate positive human-nature interactions	✓

The goal of this project was to recreate a small patch of local grassland, a critically threatened ecosystem within the Adelaide region. Grasslands have been heavily cleared, with less than 1% of the original extent remaining in Adelaide post-settlement. Grasslands are also severely underrepresented in protected areas, making them vulnerable to extinction within Adelaide.

Large existing trees were retained, and an additional 14,000 shrubs, grasses and ground cover specimens were planted within the 3700m² streetscape. Species were chosen that are hardy and are typically found within local grassland systems.

A pathway was installed through the centre of the space, which encourages people to interact with the space, thus improving their connection with biodiversity fostering an understanding of local indigenous landscapes. The pathway also facilitates easier maintenance of the space.

Challenges and lessons learned

While initial planting was a success, this project has highlighted a need within council to increase knowledge of how to manage streetscapes to achieve good ecosystem health and biodiversity outcomes. This planting is unique within the region and has posed a challenge to maintenance staff who are not familiar with locally indigenous landscapes. To address this, the landscape architect has been in ongoing discussion with council staff regarding how to best maintain the space for biodiversity outcomes.

The key strength of this project was the ability to experiment, with successful establishment of native grassland species, including reduced irrigation requirements.

As the first of its kind, the project encountered several challenges related to its novelty, perception, and community appreciation of native, biodiverse landscapes. Due to the seasonal fluctuations in local ecosystems, Charles Sturt Council has received some negative feedback from residents during dry summer periods. To address these shortcomings, signage and other means of community outreach could be used to promote the understanding of the significance of grassland ecosystems and increase community appreciation for this project.

This project aimed to create a completely novel ecosystem which has resulted in associated design and maintenance challenges, for example use of heavy mulching to suppress weeds and for aesthetic reasons, which may not directly align to the functions of grassland ecosystems. Typically, these require bare ground for seed regeneration, the inter-tussock plant spaces for broadleaf grassland species, and habitat for grassland invertebrates.

Despite the mixed response, the grassland remains and is some of the best native vegetation outside of areas maintained by Biodiversity maintenance staff within the City of Charles Sturt. Charles Sturt council maintains many biodiverse landscapes including the River Torrens, various wetlands and remnant dunes ecosystems at Tennyson Dunes.

With the help and support of volunteers, residents and council staff, Charles Sturt continues to maintain and expand its biodiverse landscapes. Some projects moving forward include reducing road widths to create larger verges.



The grasslands were planted in 2 stages (October 2018 and April 2019). This photo was taken in March 2019 between the two stages. Photo: Bianca Murfit, City of Charles Sturt



Metropolitan Adelaide BSUD case studies

Small infrastructure context

Case Study 12: Dover Square Raingarden

Background

The Dover Square Raingarden was installed on the boundary of Dover Square Tennis Club in 2017. Taking the opportunity presented by tree root damage necessitating carpark repairs, this project sought to direct stormwater runoff to the root zone of the existing mature Kurrajong (*Brachychiton spp*) trees. It maintains ecosystem processes through filtering stormwater runoff from the surrounding impervious surfaces, and provides passive irrigation of nearby large amenity trees.

Raingardens are purpose-built garden beds which treat stormwater through physical and biological processes. The plants in the raingarden – in this case, locally native plant species – act as a biofilter, taking up excess nutrients in the stormwater, while the soil media filters litter and sediment.

This WSUD (water sensitive urban design) project trialled the use of rhizomatous species to reduce maintenance demand and increase infiltration. It also sought to improve biodiversity by showcasing local native plants, improving the visual amenity of the space.

Water stress in urban trees can result in the proliferation of surface roots that can cause buckling and rippling of the surrounding bitumen footpaths. Raingardens allow for deeper infiltration of water, providing deeper water sources and encouraging deeper root growth of trees, in turn avoiding disturbance to the footpath.

Often raingardens are lined with an HDPE liner (a bit like a pot plant) with the submerged zone typically holding enough water for an 8 week dry spell. This site is an exception to this as it was not fully lined, with the aim of hydrating the root zone of nearby existing large *Brachychiton* trees.

The establishment of this raingarden also offered a solution to the amenity damage to the tennis court carpark and surrounding footpaths caused by the adjacent mature street trees (under water stress) seeking accessible water.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	
3	Reduce threats and disturbances	
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

About the site

Context:	Small infrastructure
Location:	Dover Square Tennis Club, Broadway, South Brighton (City of Holdfast Bay)
Scale:	Local
Organisation:	Dover Square Tennis Club



Dover Square Raingarden finalised and under construction.



While not a BSUD directed project, it has included some elements of this process. The project targeted locally native plant species; notched sedge (*Carex bichenoviana*), Tom thumb (*Dichondra repens*), slender mint (*Mentha diemenica*), and garland lily (*Calostemma purpureum*). These were selected to emulate the ecological function of intact systems in the raingarden to generate a functional outcome. Of these species, notched sedge dominates the raingarden and will require management to restrict its biomass.

As purely WSUD infrastructure, high biomass of one sedge species will not significantly reduce the efficacy of the raingarden. However, to maintain biodiversity habitat value, biomass must be managed to allow for light in the system for other native plants, particularly pollinator attracting wildflowers, to flourish. Further understanding of the species that are suitable for planting in these types of projects will help bring a stronger BSUD focus in the future.

Despite this requirement, maintenance demand has been reduced by the inclusion of rhizomatous species, which occupy gaps in the garden bed, excluding annual weeds and enhancing the ecosystem processes of the raingarden through maximising the surface area for water filtration.

Challenges and lessons learned

The success of this project from a WSUD perspective is evident in the observation of plant vigour within the raingarden, and the drop off in required maintenance to negligible. This has been achieved by emulating the ability of native vegetation to resist weed invasion by filling overlapping niches with complementary plants of different life forms. While not directly designed from the project commencement, a BSUD outcome is the sightings of native insects such as the blue-banded bee.



Blue banded bees on *Carex bichenoviana* at Dover Square rainwater garden (photo: S Kennedy)

By planting densely, weed growth is reduced, keeping maintenance requirements low. However, for optimal biodiversity outcomes, ongoing management requires cutting back the dominant *Carex* sedges. Taking a stronger BSUD approach by expanding the species selection and the focus, for example, attracting specific pollinators, would help other native plants, particularly wildflowers, to flourish.

Understanding the basic ecology and habit preferences of targeted species is an important part of species selection, as this informs the suitable traits and applicability of various species to different environmental settings.

This raingarden offers an example which could be recreated throughout Adelaide of combined WSUD/BSUD infrastructure, provided that maintenance regimes prioritise biodiversity values. Not only do raingardens offer stormwater filtration as an ecosystem service, they support biodiversity by diverting high nutrient loads from waterways and can offer a provision of water for fauna in the urban landscape. While this garden bed provides an easy, low maintenance design for WSUD, providing better outcomes for biodiversity may require additional plant biomass maintenance.

Inclusion of locally native species is a great step towards enhanced biodiversity of WSUD designs, by representing native biodiversity. Future raingarden projects could be enhanced by targeting flora with relationships to specific fauna as larval hosts or food sources. For example, some *Gahnia* species have relationships as larval hosts for native butterflies.

Funding and partners

This project was funded by the City of Holdfast Bay at a cost of \$48,200 for the planting. The maintenance is undertaken by a Dover Square Tennis Club member who is a professional ecologist. This individual also selected and planted the raingarden vegetation.

Additional resources

Water Sensitive SA has resources available on raingarden plant selection via the following: [A guide to raingarden plant species selection and placement](#), and [Raingarden planting palettes - fact sheet](#).

Case Study 13: Northern Expressway – Gawler River Offset Area

Background

The Northern Expressway is part of Adelaide's North-South Corridor. Completed in 2010, the 23km, four-lane, two-way expressway traverses the Northern Adelaide Plains and provides a link between the Gawler Bypass and the Northern Connector.

The conservation of existing native vegetation was identified as a key objective of the project, enacted primarily through avoiding impacts where possible. However, to ensure the road remains operational during a 1 in 100-year flood event, a diversion channel and two large borrow pits were excavated directly to the north of the Gawler River. This necessitated the removal of a number of mature River Red Gums from the river corridor, in addition to other minor vegetation removals at various sites along the project corridor.

Due to the removal of remnant native vegetation for the construction of the Northern Expressway, the project was obligated under the *Native Vegetation Act 1991* to offset this impact by contributing like-for-like vegetation associations to achieve a 'Significant Environmental Benefit'. This involved revegetating over 10 hectares of agricultural land to the north of the Gawler River, creating a road reserve and wetland environment offering compensatory habitat.

In addition to revegetation, site remediation extends to rehabilitating borrow pits¹ and river diversion channels by creating ephemeral pools.

About the site

Context:	Large infrastructure
Location:	Northern Adelaide Plains
Scale:	Local
Organisation:	Department for Infrastructure and Transport



Northern Expressway – Gawler River Offset Area diversion channel batters looking towards the Gawler River. Photo: Mark Adams



Aerial photograph of site: Northern Expressway – Gawler River Offset Area



Northern Expressway - Gawler River Offset Area Offset Area riparian planting looking north across borrow pit wetland. Photo: Mark Adams

¹ Borrow pit: A deposit of natural gravel, loam or earth that is excavated for use as a road making material (DIT SA)

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	
3	Reduce threats and disturbances	
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

The planting design approach for this revegetation project was informed by selecting two target ecosystems: *Eucalyptus camaldulensis* var. *camaldulensis* Open Woodland and *Eucalyptus porosa* Open Woodland.

In conjunction with meeting legal obligations, the project goals were also developed by the Department for Infrastructure and Transport and endorsed by the City of Playford and Light Regional Council.

To meet the requirements for this 10 hectare offset revegetation project, over 198,000 tubestock and virocell plants were propagated and 5.16 ha of direct seeding was carried out.

As the project area hosted very little remnant vegetation, native seed from the Northern Adelaide Plains area was collected several years in advance of revegetation works. A seed production area and native grass seed orchard were then established at Penfield to generate the large volumes of seed required for landscaping within the road corridor and offset area.

Fauna surveys were conducted along the Gawler River corridor prior to construction activities commenced to determine baseline data and develop a better understanding of the biodiversity values to be protected and enhanced in the area.

Infrastructure for this project (including bridges, diversion channel, low flow pipes, and borrow pits) were designed specifically to support ecological outcomes, including grading the diversion channel to provide deeper ephemeral pools. This design aspect seeks to retain river

water for longer, making water resources accessible for *Eucalyptus camaldulensis*, supporting the establishment of the open woodland ecosystem, and thus providing food and habitat for local fauna.

Challenges and lessons learned

As the landscaping and revegetation work for this project was tied to road construction sequencing, planting and seeding was not always carried out at an optimal time of year for successful plant establishment. Some tube stock plants had to be regrown several times and species substitutions were also required. This challenge is likely to recur when construction works precede the implementation of plantings.

Tubestock planting areas had mixed success. Some areas established extremely well with all species represented in the species mix, while others failed due to erosion, weed competition, lack of water during the establishment phase or riparian species being planted too high on the diversion channel batters.

Although significant effort was invested in the chenopod direct seeding component of the project, it was not successful due to drought conditions, competition from weeds, vehicle damage and poor long-term maintenance techniques. Some areas required re-seeding several times and have ultimately failed to establish.

Many self-sown River Red Gums and aquatic species including Phragmites and Typha have naturally regenerated around the edge of the diversion channel due to its connection with remnant vegetation along the Gawler River. This demonstrates the importance of connecting new biodiversity areas to existing areas of remnant native vegetation.

The major challenge for this project was that landscape planting needed to perform multiple roles including site rehabilitation, batter stabilisation within a highly disturbed and modified road corridor and borrow pit environment, and delivery of the biodiversity benefits required under the *Native Vegetation Act 1991* using the seed resources that were available.

The moderate success of the Gawler River Offset Area can be attributed to a number of factors:

- 3-4 years of advanced seed collection from remnant native vegetation on the Northern Adelaide Plains
- establishment of a 0.5ha seed production area and native grass orchard to produce the seed volumes required
- tube stock plants propagated by the landscape contractor at a purpose-built nursery (with a recycled water allocation) on horticultural land that had been acquired for the project giving more control over species and plant quality.

Maintenance has been an ongoing issue at this site. Due to a 'slash and mow' approach being the primary management style, local grassland species have been lost as they were not given opportunity to set seed. Mowing regimes need to match the ecology of the system and allow grassland species opportunities for seeding and natural recruitment.

Adequate funding for long term maintenance must be provided, along with investing in the skills of the maintenance teams by providing training in minimal disturbance along with selective control of herbaceous and woody weeds.

Serious concerns have been raised over the success of the conservation outcomes delivered under offsetting schemes (Victorian Auditor-General's Office, 2020), and the benefits of such schemes has been questioned (Maron et al. 2016). Avoiding impact and instead developing sites with little current biodiversity value should remain a strong preference. While delivered under an offsetting scheme, this case study at least focused on delivering native vegetation close to where losses occurred, with specific ecosystem and species targets.

Funding and partners

The overall project received a total of \$568 million of funding, with an 80% contribution from the Australian Government, and 20% contribution from the Government of South Australia.

As the native vegetation offset works were delivered in association with the broader civil infrastructure project, total funding for the native vegetation offset component is unknown.



Northern Expressway - Gawler River Offset Area looking east towards Wingate Road

Photo: Mark Adams

Case Study 14: Biodiversity Planting – Glenelg Wastewater Treatment Plant

Background

Located within the City of West Torrens, the Glenelg Wastewater Treatment Plant supports urban greening by returning treated wastewater to the central Adelaide area. This water is mostly used for irrigating public open spaces such as parks, gardens, and sports grounds.

The water treatment facility is situated between two bodies of water: 100 meters from Sturt River to the East, and 200 meters from the ocean to the west. This is a difficult zone in which to find appropriate planting designs.

This SA Water site's contribution to biodiversity in the City of West Torrens has been amplified as the facility now also hosts a 4 metre, biodiverse garden bed along its perimeter.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	
3	Reduce threats and disturbances	
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

Originally planned to offer an aesthetically pleasing screening of the facility, the creation of this garden bed was triggered by a minor infrastructure change (shifting of the boundary fence). SA Water took this opportunity to install plantings that could also offer biodiverse habitat and demonstrate the use of local coastal vegetation in urban plantings.

The selection of hardy and robust local plants which are adapted to highly windy and saline environments, increased the success of plantings while also minimising maintenance requirements. The design sought to minimise weed intrusion by creating a densely planted area with high diversity of vegetation species and high vegetation structure. This created under-, mid-, and overstory in the one garden bed, and left limited space for weeds to penetrate.

A companion planting technique of living mulch has been utilised, in which a low growing ground cover offers the services of traditional mulch. There are several benefits of living mulch, including:

- prevention of soil erosion (which is of particular concern in coastal environments)
- enhancement of soil nutrients and porosity

About the site

Context:	Small infrastructure
Location:	Anderson Ave, Glenelg North
Scale:	Site
Organisation:	SA Water



Local species planted in high densities to produce a novel and structurally diverse ecosystem, which fulfils multiple services at SA Water's Glenelg Wastewater Treatment Plant. Photo: G Garrard

- reduction of weeds, helping to reduce the need for herbicides (which can be detrimental to biodiversity).

The garden bed installation is an example of a project that initially had intentions to use plants to provide screening and privacy but has taken the opportunity to integrate themes of BSUD, extending the scope of the services this garden bed provides. There is potential to expand this project with a stronger focus on BSUD, by selecting target flora or fauna species to cater the space for.

Challenges and lessons learned

The project uses a novel approach to weed control, using dense plantings and living mulch, and implementing elements of BSUD into the design. However, miscommunication between maintenance and biodiversity teams led to loss of living mulch where weeds had been sprayed, as the native plants are sensitive

to herbicides. Accidentally killing the native plants with weed control is a common problem in biodiversity projects, which can be countered with increased training for maintenance teams to identify local native plants.

Most of the initial plantings were successful, with a few tree species needing to be replaced as a result of damage from wind and salt spray. This may be an indication of the difficulty of this location for trees which are not a component of coastal shrubland habitats. This allows the site to demonstrate the growth habit of the plantings, as well as providing a good reference guide for the use of local coastal plants. Further, few weeds have infiltrated due to the use of dense plantings.

No formal monitoring has been undertaken to determine faunal use of the site.

This site provides a demonstration of an under-represented plant community (coastal heath vegetation) in an urban context. SA Water has been proactive in creating demonstration sites like these for several vegetation communities within Adelaide, including plains and hills vegetation areas.

While this opportunistic approach to BSUD has been successful at creating small pockets of biodiversity, a more co-ordinated approach across SA Water properties would have a larger impact on improving habitats within Adelaide. This is particularly the case given that the water bodies / infrastructure that SA Water manages are often connected across council borders, and the private realm. SA Water recognises this and already has significant work underway.



Biodiversity Planting – Glenelg Wastewater Treatment Plant.

Case Study 15: Adelaide Zoo Sanctuary green wall and green roofs

Background

The Adelaide Zoo is a pioneer of green infrastructure in Adelaide, hosting the largest area of green roofs and walls in the state.

In 2009, funding for a new front entrance and office spaces created an opportunity to incorporate green infrastructure into its design. The green roofs and walls provide habitat for native species and a platform for research and knowledge. Rainwater is harvested from the roof and runoff from the forecourt entrance, then filtered through raingardens and used for irrigation. This also has a cooling effect, reducing energy consumption required in the office spaces.

These novel habitats have been designed to incorporate the flora of the Adelaide Plains and aim to offer connective habitat for native fauna in the city. This example of a novel urban habitat enhances biodiversity while creating opportunities for further research through partnerships with The University of South Australia.

Through incorporating BSUD, Adelaide Zoo is taking an additional avenue towards its goal of protecting endangered species, as well as providing a platform to showcase indigenous plant species of the Adelaide Plains along with other plant species.

Application of BSUD principles

BSUD principles addressed		
1	Enhance habitat and resources	✓
2	Improve connectivity to encourage dispersal	
3	Reduce threats and disturbances	✓
4	Enable natural ecological processes	✓
5	Facilitate positive human-nature interactions	✓

During the design process, reptile and native animal keepers were engaged through workshops to gather specialist knowledge on how to replicate a natural habitat to encourage invertebrate and microbat species to take up residence in the green roofs and walls.

Due to constraints of green roof design, the plant selection was not limited to locally indigenous plant species. However species were selected to represent a mallee ecosystem, and incorporated medium sized, multi-stemmed trees.

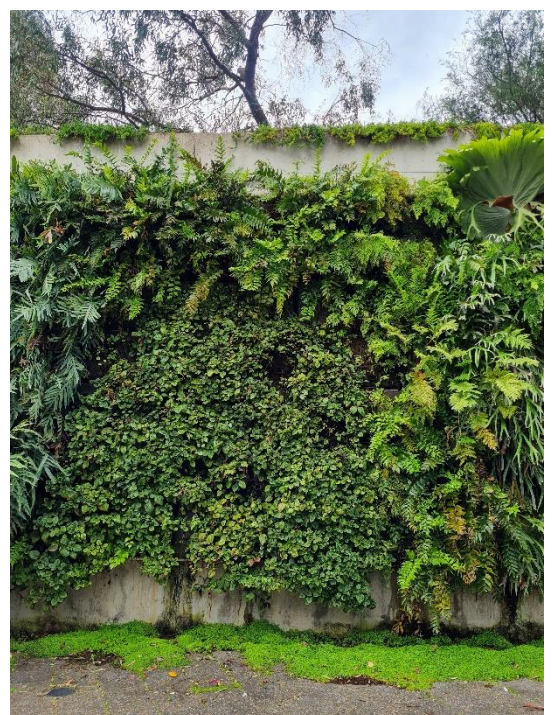
One biodiverse design feature of this green roof that differs from most is the addition of contours, included to provide

About the site

Context:	Small infrastructure
Location:	Adelaide Zoo Frome Rd, Adelaide
Scale:	Site
Organisation:	Adelaide Zoo



Green roof (above) and green wall (below) at Adelaide Zoo. Photo: Green Adelaide



better habitat for soil-dwelling invertebrates and increased rooting depth to allow for greater plant diversity.

Green roofs historically have been flat and offer very little shelter for biodiversity. As this roof was constructed with the intention of attracting biodiversity, many features that are found in a natural landscape have been incorporated into the design.

Advanced Eucalyptus trees form the main planting theme with lots of understorey plantings to create a natural multi-layered ecosystem supportive of a greater range of biodiversity.

For further information see [Adelaide Zoo Plant List](#).

Challenges and lessons learned

Novel ecosystems allow flexibility in plant choices and the Zoo opted for plants that were native to Australia rather than being restricted to locally native species.

High wind loads and shallow rooting depth were limiting factors that influenced plant species selection, and while many Australian plant species are known to tolerate harsh conditions well, there is still little known about the suitability of many local indigenous plants to green roof habitats. Future designs utilising these types of plants will help develop plant palettes that are suited to green roofs and walls.

The project has however successfully attracted bats, birds, and insects to the roof, indicating that these novel habitats are also important for encouraging biodiversity.

Since pioneering the green roof industry in South Australia, Adelaide Zoo has now completed five green roofs within the Zoo grounds and entered a partnership with The University of South Australia. Since its inception, the green roof has been monitored by students and researchers at the University, gathering baseline data preceding construction, measuring the increase in flora and fauna utilising the green roof, including research monitoring microbat movement throughout the space. Partnering with research organisations when creating novel ecosystems such as this provides valuable opportunities for furthering the body of knowledge on biodiversity in the urban environment.



The green roof and green wall at the entrance to Adelaide Zoo. Photo: K Berthon

Case study 16: Cooling the Schools

Background

The Cooling the Schools program was developed by Greening Australia to enhance urban biodiversity and mitigate the urban heat island effect by implementing urban greening projects on school grounds.

A loss of green space and canopy coverage in urban areas contributes to the urban heat island effect, where temperatures in cities are higher than surrounding areas. Loss of nature in cities also leads to a disconnection between humans and nature and is detrimental to local biodiversity.

This Greening Australia program seeks to capitalise on the high greening potential of schoolgrounds in the urban environment. In a schoolground setting, a curriculum that increases "green time" and reduces "screen time" is a strategy to enhance students' mental health, cognitive functioning, and academic achievement, while also fostering ownership of nature-based solutions to urban issues in future generations.

Presently, eight schools have signed up to participate in this program, with Greening Australia endeavouring to expand this to 400 schools across Adelaide by 2030.

Application of BSUD principles

BSUD principles addressed	
Enhance habitat and resources	✓
Enable natural ecological processes	
Reduce threats and disturbances	
Facilitate positive human-nature interactions	✓
Improve connectivity to encourage dispersal	✓

This project identifies target ecosystems to enhance and facilitating natural processes such as pollination and cooling the local environment. It has dual benefits, integrating biodiversity and social outcomes through expanding habitat potential and creating outdoor spaces for learning and exploration, while engaging the community in restoring habitat.

Following the BSUD framework, this project identified Eucalyptus open woodland and grassland as the target ecosystems.

About the site

Context:	Small infrastructure
Location:	Playford Council Area
Scale:	Local
Organisation:	Greening Australia



Cooling the Schools Adelaide. Source:

<https://www.greeningaustralia.org.au/projects/cooling-the-schools-adelaide/>

Once the target ecosystems were selected, the next stage of the project sought to identify planting palettes suitable for schools. These comprised of a minimum of 200 plants at each site, including both shade providing trees and understory plants to provide habitat for native pollinators. Selection criteria for the planting palette included shade provision, enhancing biodiversity, cultural significance, climate resilience, safety, amenity, and management costs. Site visits were conducted at each school to select an area for planting, followed by the development of a list of local provenance species that would suit the space and offer cooling properties.

This project has potential to deliver a suite of benefits for biodiversity, climate, and community. In fulfilling many of the BSUD principles, Cooling the Schools supports biodiversity by expanding potential habitat, filling gaps in the urban mosaic and facilitating dispersal. Increasing green cover and canopy shading also reduces the risk of heat stress,

creating a more comfortable environment for humans and birds on school grounds.

The project also facilitates positive interactions between humans and nature in numerous ways:

- Integration of the ecological knowledge of Traditional Owners in plant species selections
- Creation of outdoor spaces for learning and exploration
- Inclusion of further nature education into the curriculum
- Opportunities for schools to participate in community planting days.

All of these empower the community with a sense of ownership and an ability to enact positive change in their environment.

Challenges and lessons learned

This project demonstrates how BSUD can allow for the integration of better outcomes for biodiversity and people in cities. Integration of biodiversity into the school curriculum will hopefully have lasting effects for students, by raising awareness about their local biodiversity and empowering them to be nature stewards of the future.

With the Cooling the Schools initiative already implemented at eight sites across the City of Playford, this forms the beginning of a connected network of nature refuges in the urban landscape. When expanded, this project has potential to create native habitat at up to 400 schools in South Australia.

Balancing the desire for canopy cover, and associated cooling, with a BSUD-based intent to support regeneration of an open woodland is challenging. This potential could be maximised by ongoing monitoring of vegetation with particular focus on target animal species which utilise the vegetation, and gathering heat data to assess the success of the project. Located in an educational setting, there is potential to engage students and citizen scientists in gathering and analysing this data.

Funding and partners

A number of stakeholders came together to deliver this project.

Financial support through grant funding was provided by Green Adelaide, along with assistance in planning and curriculum design.

RedCentre, an organisation which seeks to share the knowledge and resources of First Nations Australians for Mutual Benefits supported the project delivery in providing plant stock and First Nation planning.

The City of Playford facilitated engagement with local schools, and Greening Australia provided project management, delivery and curriculum design.

After installation, maintenance will become the school's responsibility, with advice from other stakeholders.



Cooling the Schools project. Source: <https://www.greeningaustralia.org.au/projects/cooling-the-schools-adelaide/>



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