

Australian Capital Territory

Planning (Biodiversity Sensitive Urban) Design Guide 2026

Notifiable instrument NI2026–316

made under the

Planning Act 2023, s 50 (Design guides)

1 Name of instrument

This instrument is the *Planning (Biodiversity Sensitive Urban) Design Guide 2026*.

2 Commencement

This instrument commences on 1 July 2026.

3 Design guide

I make the design guide at schedule 1.

4 Revocation

This instrument revokes the *Planning (Biodiversity Sensitive Urban) Design Guide 2024* (NI2024-514).

Chris Steel MLA
Minister for Planning and Sustainable Development
29 June 2026



ACT **Biodiversity Sensitive Urban Design Guide**





Acknowledgement of Country

Yuma

Dhawura Nguna Dhawura Ngunnawal

*Yanggu ngalwiri dhunimanyin Ngunnawalwari
dhawurawari*

Nginggada Dindi yindumaralidjinyin

Dhawura Ngunnawal yindumaralidjinyin

Hello

This is Ngunnawal Country

Today we are meeting on Ngunnawal country

We always respect Elders, male and female

We always respect Ngunnawal Country

The ACT Government acknowledges the Ngunnawal people as traditional custodians of the ACT and recognises any other people or families with connection to the lands of the ACT and region. We acknowledge and respect their continuing culture and the contribution they make to the life of this city and this region.

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Vision for Canberra

*To be a sustainable,
competitive and equitable
city that respects Canberra's
unique legacy as a city
in the landscape and the
National Capital, while being
responsive to the future and
resilient to change.*

Location: Mulligans Flat Woodland
Sanctuary, Throsby ACT.

Photo: Mark Jekabsons



Part One: Introduction

INTRODUCTION AND PURPOSE

Canberra is growing. With more people living and working in Canberra, a clear and easy to use planning system is required that can accommodate future growth without compromising the valued characteristics of the city. Our planning system has been developed to promote better outcomes for development, the environment and, most importantly, Canberrans.

A modern planning system is fundamental to the city's vision of a liveable and sustainable city. The new system focuses on delivering high-quality built outcomes for the residents of Canberra, with embedded flexibility to encourage innovation.

The long-term goals for Canberra have changed in the 15 years since the last significant review of the Territory Plan. These changes reflect the significance of coping with climate change, providing critical infrastructure for our expanding population, and increasing housing choice and accessibility. The Planning Act, a Territory Plan and the ACT planning and district strategies establish the basis of our contemporary planning system.

The planning system also incorporates design guides to help the interpretation and application of the Territory Plan's assessment outcomes. The assessment outcomes specify ways that the desired policy outcomes can be met, particularly through the use of simple and clear diagrams and images.

Please refer to the separate practice note which provides explanatory information on the workflow and interaction of the design guides with other design guides, specifications and the like set by other Directorates in ACT Government.

WHY THE NEED FOR DESIGN GUIDES

Though the Territory Plan contains assessment outcomes that will deliver the desired planning outcomes for the ACT, there is a need for these to be supported by clear methods and examples for how they can be met. This guidance can identify matters that must be addressed and where flexibility in design can be considered.

The design guides and design evaluation processes will support the development application and assessment processes by identifying design possibilities and encouraging innovation.

They will also support the Territory Planning Authority in assessing and determining development proposals that contribute to high-quality development outcomes.

The purpose of the design guides is to elevate design understanding and literacy and elevate good design outcomes by not providing prescriptive quantitative measurements, but by providing clear and easy to understand qualitative guidance that will improve built outcomes for the city. Design guidance has been developed in consideration of a number of ACT Government policies and strategies. Please refer to the list of Government instruments relevant to urban biodiversity in this guide.

DESIGNING FOR BIODIVERSITY

Canberra has a unique position of being a designed City sitting within, and taking design cues from, its landscape context – it deservedly retains the moniker of the Bush Capital. The ACT's unique wildlife and rich natural assets and habitats however are increasingly at risk of further degradation, fragmentation, and loss in the face of climate change and urban development to meet the needs of a growing city with both urban consolidation and sustainability targets.

The ACT has a strong tradition in environmental protection, as evidenced by the comprehensive policy and regulatory frameworks (such as ACT Nature Conservation Act and Strategy, threatened species and ecosystems conservation strategies and associated conservation advice etc) that map the aspirations, goals and strategies to make the Territory into a nation leading jurisdiction in nature conservation. To ensure that Canberra can meet its densification and sustainability targets, new decision-making frameworks and guidance are needed with a dedicated focus on maintaining and enhancing natural values and ecosystem function in the urban landscape.

AIM OF THE DESIGN GUIDELINES

The design guides assist proponents in interpreting and applying the Territory Plan's assessment outcomes. The design guides and design evaluation processes are also critical in supporting the design and assessment processes, particularly those planning provisions that are less prescriptive and leave more room for interpretation and innovation.

The purpose of each design guide is outlined below.

- **Missing Middle Housing Design Guide** (MMHDG) addresses missing middle residential dwellings such as dual and tri-occupancy, townhouse, terrace housing and low-rise apartments.
- **Apartment Design Guide** (ADG) addresses housing and built form outcomes at a range of densities, excluding single residential dwelling.
- **City Centre Urban Design Guide** (CCUDG) is a place specific design guide that communicates the intent to deliver high quality best-practice design outcomes for the City Centre.
- **Urban Design Guide** (UDG) addresses public space, streetscape and built form interface outcomes at a range of scales.
- **Biodiversity Sensitive Urban Design Guide** (BSUDG) provides guidance on biodiversity and ecological design matters.

Other guides as notified by the Minister pursuant to Section 50 of the Planning Act may also be included. The reasoning for the design guides which support the Territory Plan are outlined below.

Community benefit and value

Guiding best practice design can lead to social, environmental and economic benefits to the community, government and private business. Social benefits include supporting people's quality of life and overall health and wellbeing. Environmental benefits encompass the protection and enhancement of environmental assets and the inclusion of sustainable design features and travel. Economic benefits include reduced infrastructure and delivery costs as a result of efficient land use patterns through greater density near activity centres, employment areas and active travel.

Greater clarity and flexibility in process

These guides can provide greater clarity, flexibility and consistency for the community, authority officers and industry. In supporting the Territory Plan, they help people interpret statutory policy, and guide proponents and statutory officers (including development assessment staff, courts and tribunals) within an outcomes based planning system paradigm; clear writing is supported by images and graphics. These guides will give all stakeholders the confidence to fully participate in the planning and development process.

Responsive to contemporary challenges

Our urban environments need to be responsive and adaptable to societal challenges such as natural hazards and pandemics. These guides can help public space and housing designs consider and be responsive to these challenges. By encouraging development to be designed in a responsive manner and of a high-quality, the guides will contribute to improvements in community health and wellbeing.

High-quality and place-based outcomes

An outcomes focused system puts the focus on achieving high quality design outcomes. These design guides support the Territory Plan to ensure the planning system adequately considers design quality and development appropriateness, leading to improved design quality and overall planning and design outcomes. These outcomes can enable more distinctive places that have strong community identities.

PLACE-BASED DESIGN THINKING

Canberra is made up of many different places and districts, each with its own combination of people, culture, built form, landscaping and natural features. The distinct character of each district helps to define it, and helps planners and developers create places that are memorable, with distinct identities and functions. Good design focuses on these aspects, noting that the way a place makes people feel is significantly more important than merely how it looks.

WHAT IS PLACE-BASED DESIGN?

A place-based approach to design builds upon a place's character to create places that are responsive to their context and create a desirable sense of place. Designing for place requires a deep understanding of the physical, environmental, social and cultural attributes that make a place desirable, recognising that solutions that work in one place, may not work in another.

Place-based design recognises current values and patterns while enabling change, to create a compact, sustainable, affordable, vibrant and equitable city.

WHY IS PUBLIC SPACE IMPORTANT?

The importance of public space and amenity as part of successful urban outcomes cannot be diminished. The design guides specifically call out public realm as a key element to be addressed. When public space is designed well, it provides places for human interaction and activity, including culture, entertainment, sport, recreation and commercial activity.

NATIONAL CAPITAL DESIGN REVIEW PANEL

Providing high-quality and sustainable design outcomes is key to the future success of our cities and urban environments. A city must respond to the ever-changing demands and needs of those who use it.

Design review is an effective way to improve the quality of built outcomes within our major cities. Design review allows for key development projects and public spaces to be assessed by suitable peers and design professionals to achieve high-quality design outcomes. Design review is an efficient and cost-effective way to improve the design quality of development proposals

The National Capital Design Review Panel (NCDRP) is an independent and expert panel that provides design advice to the ACT Government, developers and designers for major developments such as buildings, public spaces and public infrastructure projects.

The NCDRP supports decision makers in delivering high-quality, inspiring developments and public spaces to meet the needs of the broader community and to ensure integration with the surrounding environment. Through the process of peer-review by a panel of highly experienced design professionals, design review aims to achieve the best possible design outcome for each development proposal that is presented to the NCDRP.

Referencing these design guides and the Design Principles for the ACT, the NCDRP provides a structured process of design review for the provision of independent design advice for the benefit of the proponent, community and city at large.



ACT PLANNING PROCESS

The Territory Plan is a statutory planning document that guides the development and management of land use in the ACT. It sets out the policies and rules for how land can be used and developed including zoning, building height limits, environmental protection and infrastructure requirements.

The Territory Plan has been written through the lens of providing a more outcomes focused planning system. It is accompanied by supporting material such as design guides and technical planning specifications to deliver a more efficient development assessment process that focuses on developing high-quality built outcomes for Canberra.

ACT Government has several strategies and frameworks that highlight the direction and vision for the city. Although not statutory in weight, these have been considered and referenced throughout these design guides to direct proponents to further information regarding the key ideas and initiatives where necessary. A list of these documents is provided in the appendices.

HOW THE DESIGN GUIDES RELATE TO THE TERRITORY PLAN

The design guides are a key element in the planning system that will help improve the planning and design of streets, public spaces and residential development in the ACT. The design guides do not form part of the Territory Plan, but must be considered if the Territory Plan's assessment outcomes are to be achieved.

The guides support the development and interpretation of statutory policy by providing clear written and visual guidance to help proponents interpret the expected outcomes, while supporting an outcomes-based approach for development assessment.



Coombs and Wright pathway, ACT.

District Strategies

District Policies

Zone and other policies

Design Guides

District Planning specifications

Zone Planning specifications

DEVELOPMENT APPLICATION PROCESS

Proponents should consistently consider the Territory Plan (including the relevant design guides) when preparing plans and DA documentation, including for pre-DA matters such as presentation to the NCDRP.

To help the development assessment process, proponents should consider and respond to the design guides at the beginning of the design process. This will allow flexibility in addressing key recommendations from the guide.

When preparing any plans and documentation, proponents must demonstrate their approach and how they have addressed the relevant elements of the applicable design guides where required. This must be done before going to the NCDRP and after NCDRP advice if relevant, and be part of their DA submission.

Reference and use of the guidelines would be made at design review as part of the proponent presentation to the NCDRP. The panel would reference the design guides at design review as a tool to achieve optimum design outcomes for each design proposition, however would not be seeking a demonstration of methodology to address elements in the guides.

Applicable development thresholds for the NCDRP would, by default, the apply to the use of the design guides.

To help the development assessment process, proponents should consider and respond to the design guides and relevant agency design guides and the like that might be required through the development assessment and evaluation process. This includes the Municipal Infrastructure Standards.

GOVERNMENT INSTRUMENTS RELEVANT TO URBAN BIODIVERSITY

[ACT Nature Conservation Strategy 2013-2023](#)

[ACT Aquatic and Riparian Conservation Strategy](#)

[ACT Native Grassland Conservation Strategy](#)

[ACT Native Woodland Conservation Strategy](#)

[ACT Pest Animal Management Strategy](#)

[Invasive Plants Implementation Plan 2020-25](#)

[Conservation Strategies and Action Plans for Threatened Species and Communities](#)

[Canberra Nature Park Reserve Management Plan 2021](#)

[Urban Forest Act 2023](#)

[Urban Forest Strategy 2020](#)

[ACT Climate Change Strategy](#)

[Living Infrastructure Plan 2019](#)

[ACT Practice Guidelines for Water Sensitive Urban Design](#)

[Municipal Infrastructure Standards \(MIS\) particularly 15 \(Urban edge management zones\), 16 \(Urban open space\), 24 \(Soft landscape design\) and 25 \(Plant species for urban landscape projects\)](#)

[ACT Water Strategy 2014-2044: Striking the Balance](#)

[ACT and Region Catchment Strategy](#)

[Urban Open Space Management Plan](#)

[Loss of Mature Native Trees Action Plan](#)

HOW TO USE THIS GUIDE

This design guide communicates the ACT Government’s intent to deliver high-quality best-practice biodiversity sensitive, ecologically sustainable design outcomes across new developments within Canberra.

WHO IS THIS DESIGN GUIDE FOR?

This design guide is intended for developers, design industry professionals, government officials, institutions, community advocates and generally anyone involved or interested in the planning, design and delivery of built environment projects in Canberra.

This design guide is a key tool for developers when briefing design and ecological consultants, assessing proposals, making decisions, advocating for change and targeting investment.

The guide is also relevant to assessment officers to determine whether development applications are consistent with the themes and outcomes of biodiversity sensitive urban design and the relevant best practice advice.

HOW IS THIS DESIGN GUIDE STRUCTURED

The Biodiversity Sensitive Urban Design Guide focuses on how the development is designed to work in harmony with natural environment and its diverse plant and wildlife. The Guide is structured around four key themes that align with the Territory Plan’s assessment outcomes.

- Theme 1: Maintain and enhance nature.
Loss of native habitat and biodiversity is avoided and/or minimised.
- Theme 2: Connect and extend nature.
Biodiversity connectivity is maintained across the landscape.
- Theme 3: Minimise threats to protect nature.
Threats to biodiversity such as noise, light pollution, invasive

species incursions or establishment, chemical pollution, or site disturbance are avoided or minimised through good design/planning.

- Theme 4: Connect people to nature.
Multiple assessment outcomes in the Urban Design Guide relating to urban trees, landscaping, active travel, recreation, public amenity and natural features as well as creating positive engagement with nature.

The guide presents high level advice on achieving the relevant assessment outcomes. Additional advice, details on possible solutions and best-practice examples that support the intent of the Guide are listed in the Appendix.

WHAT DOES THE DESIGN GUIDE APPLY TO?

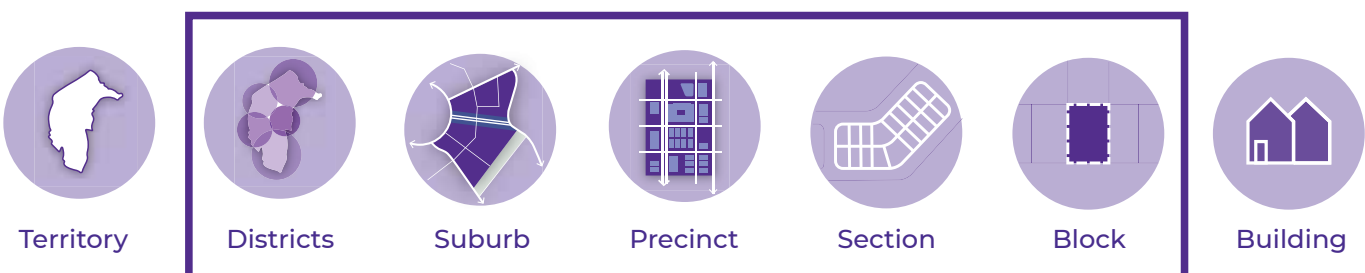
The Urban Design Guide contains design guidance for six themes, which relate to the scale from suburbs, precinct, section and block. The Apartment Design Guide contains detailed design guidance for three themes that relate to residential developments at a block and building scale

The Biodiversity Sensitive Urban Design Guide contains design guidance for its four natural environment themes, which relate to the scale from the district to blocks.

BIODIVERSITY SENSITIVE URBAN DESIGN IN THE ACT PLANNING SYSTEM

This Biodiversity Sensitive Urban Design Guide (BSUDG) complements the ACT Planning System Review and Reform Project by bringing environmental considerations and a focus on urban biodiversity conservation as a priority in the development process. It will help the development proponents to shift their focus from project-

Realm of the Biodiversity Sensitive Urban Design Guide



based, retrospective environmental considerations to a systemic, prospective process.

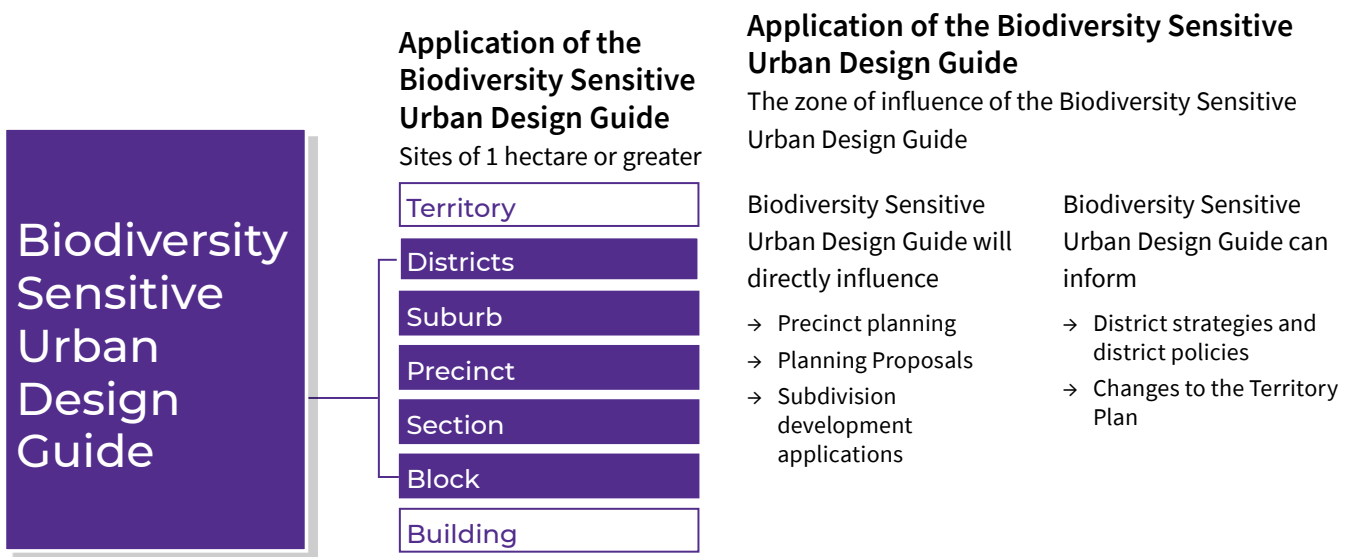
District Strategies are a recent introduction to planning in Canberra. They are living documents that set the high-level direction and intended future planning outcomes for the nine districts of the ACT.

In the District Strategies, the Blue-Green Network identifies two major targets to enable biodiversity, nature reserves, open space, water elements and cultural heritage elements be protected and provide the setting for a city ‘in the landscape’:

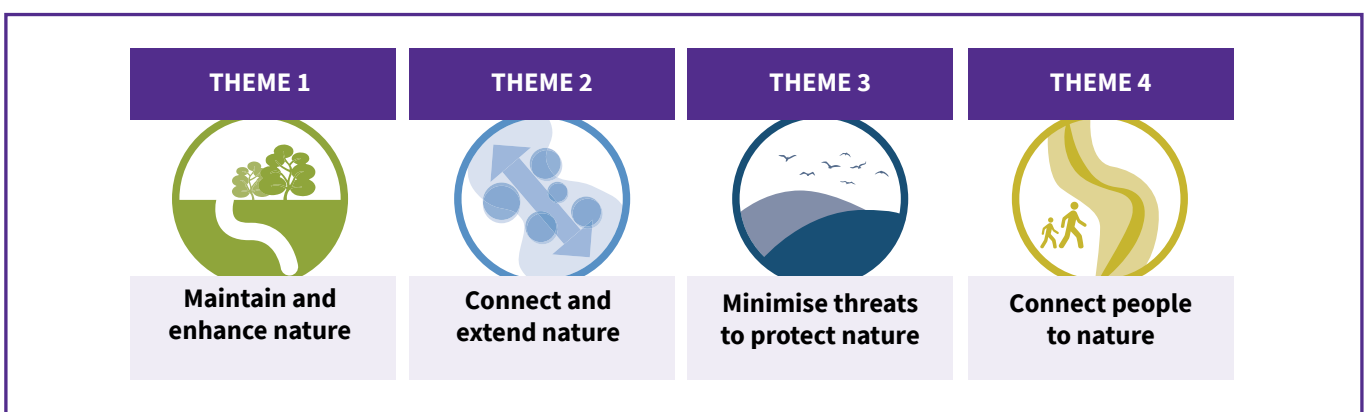
- More nature and retaining water in the city
- Expand liveable blue-green network connections

This guide will also assist in achieving these targets.

The implementation of this guide will place Canberra in the forefront of sustainable development and city planning and enable the delivery of other priorities such as the Living Infrastructure Plan, Climate Change Strategy, the Nature Conservation Strategy and Conservation Strategies for the native grasslands, native woodlands, and aquatic and riparian ecosystems that are such a valuable part of our urban matrix.



Biodiversity Sensitive Urban Design Guide Themes



TERRITORY PLAN ASSESSMENT OUTCOMES

The Territory Plan outlines assessment outcomes for proposed development that align to each of the key themes. Proponents must address these assessment outcomes and provide clear plans and documentation to support how these have been achieved through the development application. The design guides provide clear guidance to support the proponent in delivering great design that achieves the assessment outcomes.

Application of this design guide:

- Development must consider and provide a design response to design guides as notified by the Minister pursuant to section 50 in the Planning Act which includes but is not limited to the Missing Middle Housing Design Guide, Apartment Design Guide, City Centre Urban Design Guide, Urban Design Guide and Biodiversity Sensitive Urban Design Guide.
- The Biodiversity Sensitive Urban Design Guide applies to the planning, design, and approval processes for the development and/or redevelopment of:
 - a) all sites in future urban areas;
 - b) all sites in non-urban zones (NUZ1-5);
 - c) all sites in PRZ1 Urban Open Space;
 - d) sites with an area greater than one hectare in any other zone.
- The Biodiversity Sensitive Urban Design Guide does not apply to single dwelling housing or secondary residences, or development where the increase in impermeable surfaces is 500m² or less.

Assessment outcomes and design theme:

- Development must be consistent with the Territory Plan assessment outcomes.
- In demonstrating consistency with the assessment outcomes, the proposed development must demonstrate consideration of the design guidance provided in the guide for the following themes:
 - Theme 1: Maintain and enhance nature - addressing outcome (1)
 - Theme 2: Connect and extend nature - addressing outcome (2)
 - Theme 3: Minimise threats to protect nature - addressing outcome (3)
- To assist with achieving ACT Urban Design Guide's aspirations relating to urban trees, landscaping and natural features as well as creating positive engagement with nature, consideration of the following design theme is optional but encouraged:
 - Theme 4: Connect people to nature

Links to existing regulations:

This Guide does not alter or modify commitments, obligations and requirements under environmental statutory approvals under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and associated legislation; ACT Nature Conservation Act 2014 and its regulations and Urban Forest Act 2024.

Similarly, although this Guide provides advice on issues such as designing developments to minimise light and noise pollution on surrounding natural areas, ACT's Environment Protection Authority continues to be fully responsible for the administration of the Environment Protection Act 1997.

This Guide draws from and provides specific advice on implementation in the urban design context of existing ACT environmental strategies and policies, such as the ACT Nature Conservation Strategy, ACT Native Woodlands Conservation Strategy, the ACT Native Grasslands Conservation Strategy and the ACT Riparian and Aquatic Conservation Strategy.

This Guide does not include detailed Water Sensitive Urban Design aspects, these are covered in the relevant Territory Plan Policies. Further guidance may also be available in the applicable [Technical Specifications](#).

The application of the Biodiversity Sensitive Urban Design Guide spans a range of typologies and scales - including both public and private developments. This includes and extends beyond the design and delivery of municipal infrastructure projects and assets that might be handed over to Government. As such, the design guides and the Municipal Infrastructure Standards (MIS) should be considered alongside each other. Note for municipal infrastructure projects, the design guides are not intended to replace the MIS and these should be used where required through the course of planning and delivery processes including with referral agencies.

Design guides may provide guidance that goes beyond the requirements set in the Municipal Infrastructure Standards (MIS) for the design of municipal infrastructure. Proponents will still be required to provide a design response to the design guide.

The design guides provide general best practice design guidance. Reference guides, frameworks, strategies and the like in this design guide are not exhaustive and the user should take care to consider what other documents may be required to support the design and delivery of a development for specific design matters.



Location: Gilmore Hill, Canberra
ACT.
Photo: Mark Jekabsons



Part Two: Biodiversity Sensitive Urban Design Guide

BIODIVERSITY SENSITIVE URBAN DESIGN GUIDE

BIODIVERSITY

Biodiversity refers to the variability and variety among and between living organisms and ecosystems (excluding weed and pest species). Biodiverse landscapes support a wide range of species, create a stable environment, and provide essential ecosystem services and economic benefits. Preserving and protecting biodiverse landscapes is critical for maintaining the health and well-being of both humans and the environment. Urban development is one of the biggest threats to biodiversity worldwide.

The ACT Government's Nature Conservation Strategy has a vision for 'biodiversity rich, resilient landscapes stretching from the inner city to the mountains, where well-functioning ecosystems can meet the needs of people and the environment'. This objective necessitates a process where biodiversity values are considered early in any land planning process, and that urban development occurs in parts of the landscape that allow biodiversity outcomes to be achieved.

Urban biodiversity is an undervalued aspect of strategic planning and development and the attempts to protect these values are often retrospective and inadequate to achieve the results people and the environment need. To effectively achieve biodiversity and nature outcomes in urban Canberra, biodiversity-focused outcomes need to be integrated into the initial planning and development thinking.

BIODIVERSITY SENSITIVE URBAN DESIGN GUIDE

Biodiversity Sensitive Urban Design (BSUD) is an approach to planning and development that recognises biodiversity as an opportunity rather than a constraint. The application of BSUD mitigates the detrimental impacts of urbanisation, such as habitat loss and fragmentation, while facilitating necessary and positive human-nature interactions.

BSUD also supports the long term sustainability and ecological function of urban nature reserves and other open spaces, by ensuring ecological connectivity across the landscape, preventing our reserves and green spaces from becoming isolated islands that are less resilient to threats such as invasive species, increased human visitation, and stochastic events such as floods, disease or fire.

BSUD can be seen as a flexible framework for planners and development proponents to consider and address biodiversity alongside socio-economic considerations early in the planning and design process.

In this guide, the Biodiversity Sensitive Urban Design framework initially developed by Garrard et al (Biodiversity Sensitive Urban Design. Conservation Letters 11(2), 2017) has been adapted and distilled into four key design themes:

- maintain and enhance nature
 - Focus is on avoiding and/or minimising loss of native habitat; and retaining and protecting valuable natural areas, existing native vegetation and landscape features, and ecosystem services such as pollination, during and after the development process, and re-creating lost habitats.
- connect and extend nature
 - Maintaining and enhancing biodiversity connectivity across the landscape, i.e., effective links between habitat patches, is a critical element in conserving biodiversity and increasing long-term resilience to climate change and other threats.
- minimise threats to protect nature
 - It is also important to minimise threats and disturbances from urban proximity including invasive species and unnatural pollutants (including light and noise), and to protect the environment from unnatural fire and flood.

→ connect people to nature

- It is important to build in various opportunities for positive people-nature interactions and community engagement that encourages conservation mindset.

This BSUD framework can be applied across a range of urban development types, sizes and planning stages as well as habitat types.

The basic process recommended by this BSUD guide comprises three main steps taken during planning and design phases of the development process:

1. Identify the biodiversity and other natural values, including current or potential future connectivity corridors, that exist on and surrounding the potential development site.
2. Identify the relevant biodiversity objectives you are required to achieve on the site (from legislation, statutory environmental approvals and strategies including this guide).
3. Design the development to achieve site and context objectives, i.e., considering the four key design themes, the relevant assessment outcomes and the planning stage being undertaken.

This process will in most cases be best achieved by engaging a local experienced ecologist to advise on the biodiversity values and outcomes and how the design can meet the requirements, although this is not a mandatory requirement for



implementing the BSUDG. This process may require iterative review and modification to ensure that the design meets best-practice guidance on achieving the biodiversity outcomes. Note that iterative advice should be sought from independent ecological experts. CED does not have capacity to provide iterative advice to proponents.

The level of biodiversity outcomes may also vary depending on the planning phase. For example, the biodiversity outcomes identified at a district level may be at a higher level compared to a new subdivision development application that will include more detailed / on-ground measures.

All development processes which are anticipated to eventually require a Development Application will need to demonstrate consistency with the relevant Territory Plan Assessment Outcomes in principle, at all scales.

This Guide contains Themes, Design Elements and Design Guidance for achieving positive ecological and biodiversity outcomes in the urban parts of the ACT.

Technical advice and further guidance on how to implement BSUD and to achieve the assessment outcomes are provided in the Appendix . The Appendix is an integral part of this Design Guide.

STEP 1: IDENTIFY SITE AND SURROUNDING SPECIFIC BIODIVERSITY VALUES

STEP 1A: IDENTIFY SITE AND SURROUNDING SPECIFIC BIODIVERSITY VALUES

To accurately document the biodiversity values of a particular site and its surrounds, the first step is to identify the local native species and habitat types and their condition. Such an assessment should consider the historical ecological context, current species diversity, and potential future habitat value as species and ecosystems shift in response to climate change. In most cases this step should be undertaken by a local ecologist. In ACT, most large-scale developments (suburb/estate) already employ a professional ecology consultant, and it is a statutory requirement for projects on sites with previously identified biodiversity values that require an EPBC Act and/or Environmental Impact Statement approvals.

Habitats vary structurally and functionally depending on the ecosystem they represent. The most common native ecosystem types in and around the urban center of the ACT are grasslands (0-10% woody canopy cover), woodlands (10-50% canopy cover), forests (>50% canopy cover), riparian zones (land that affects, and is affected by, flowing water of the adjacent waterbody), and aquatic habitats (waterbodies).

Proponents should initially investigate commonly available spatial information such as those available on ACTmapi, before undertaking on-ground surveys to validate desktop assessments and assess ecosystem condition and then determine if further ecological investigation is needed.

Spatial data layers which should be considered include:

- Map of the Blue-Green Network, shown in the District Strategies. A static snapshot is provided in this Guide, for illustration purposes only (pg. 18). This map includes the Urban ACT Ecological Network, protected areas, waterbodies, and creek lines. An interactive version of this map is also available via the [Ecological Network Dashboard](#).
- Predicted habitat and existing fragmentation mapping layers for seven representative fauna groups, also available via the [Ecological Network Dashboard](#).

- Maps of significant plants and animals including declining, rare, and threatened species and endangered ecological communities, vegetation communities, ecological connectivity, and details of trees on the ACT Tree Register are found on the ACT Government's online mapping application [ACTmapi](#).
- Recorded observations of other native species are available on various other platforms, including the Atlas of Living Australia, Canberra Nature Map, and eBird. Note these datasets generally only contain presence only data and cannot be relied on to indicate species absence.

Given the complexity of ecosystems, assistance from a suitably experienced ecologist should be sought in identifying relevant habitat types and biodiversity values within the development site and its surrounding context. Existing spatial data available through online platforms will, in most instances, need to be supported by detailed site-based field survey.

For the vast majority of sites, Plant Community Type mapping and detailed tree mapping will be required as a minimum. In addition, listed plant surveys and listed fauna surveys may be required.

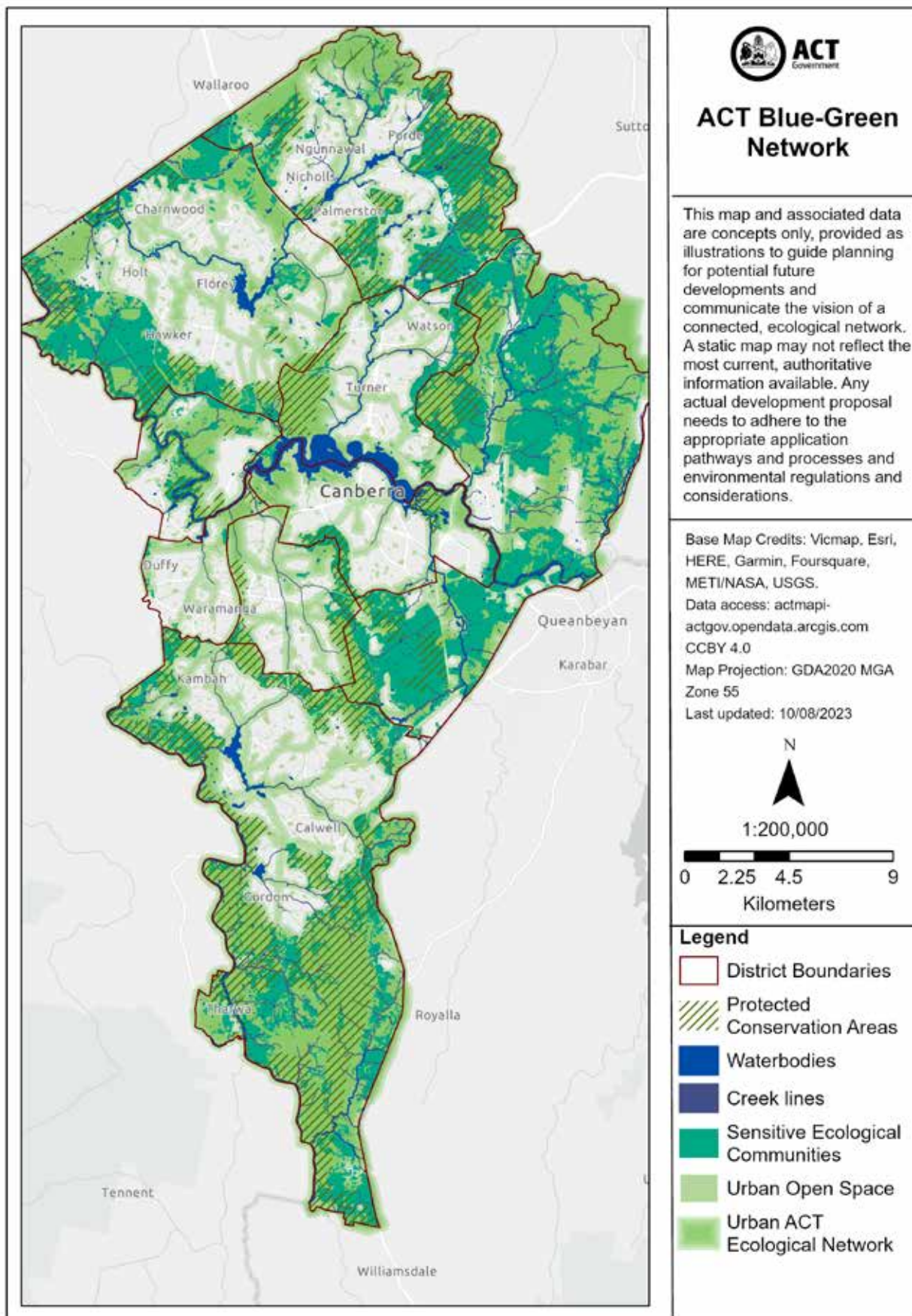
The landscape context of the site should also be considered in this initial assessment. This may include consideration of factors such as the position of the site within a water catchment, the role of the site in providing climate refugia, and the contribution to broader ecological processes such as nutrient cycling or ground water recharge. Not considering landscape function and ecological processes can have direct and indirect impacts on biodiversity conservation. For example, erosion resulting from poor development planning or design can result in a loss of habitat for grassland species, a loss of functionality in woodland ecosystems, and negatively impact on habitat suitability for aquatic organisms in the immediate area or further downstream in the catchment.



Location: Mulligans Flat Woodland Sanctuary, Throsby ACT.
Photo: Mark Jeksabsons

ACT Blue-Green Network

The Blue-Green Network identifies Canberra's major potential habitat areas and the ecological corridors which connect and support them. It incorporates major waterways as well as areas of urban open space and formally protected conservation areas. This map can be used to help identify priority urban areas to protect, enhance and restore habitat and ecological connectivity and deliver best-practice outcomes to support biodiversity.



The Blue-Green Network map on page 18 consists of the following layers:

- Protected Conservation Areas: These areas are current public land areas including ACT's nature reserves and environmental offset sites, which provide protection for natural values and are managed for conservation outcomes under the Nature Conservation Act. As a rule, these areas cannot be used for developments, and any projects within are required to adhere to strict environmental guidelines.
- Waterbodies and Creek Lines include ACT's natural and artificial water sources, both persistent and ephemeral. Waterbodies include standing water bodies like wetlands, lakes, swamps, flood retention basins etc, and creek lines refer to running water (natural and artificial) including rivers, creeks, urban floodways and channels, including some which remain only as underground pipes. Aquatic and riparian ecosystems provide habitat for a diversity of plant and animal species, including threatened and vulnerable species, as well as water and amenity for residents. Development in the surrounding areas should adhere to Biodiversity Sensitive Urban Design, and Water Sensitive Urban Design should be implemented across the associated catchment.
- Sensitive Ecological Communities: There is a high likelihood that these areas are threatened woodlands and/or native grasslands which could include endangered and critically endangered ecological communities under the Nature Conservation Act 2014 and Environment Protection and Biodiversity Conservation Act 1999. Further surveys should be conducted, and an alternative development location may need to be identified in order to be consistent with the ACT Grassland Conservation Strategy and Action Plans, and the ACT Woodland Conservation Strategy and Action Plans.
- Urban ACT Ecological Network is a forward-looking aspiration of what a connected network of wildlife habitat across Canberra could look like. The Ecological Network incorporates the values identified above, as well as core wildlife habitat and existing and potential future ecological corridors identified through connectivity modelling. It includes natural

and semi-natural areas. Developments on sites within the Ecological Network should focus on creating or maintaining native species habitat and ecological connectivity and implement all BSUD elements as applicable. Areas in the Ecological Network are also highly suitable for biodiversity restoration projects, because as an added benefit, ecological connectivity is also enhanced.

- Urban Open Space: Urban Open Space areas are typical public land that is used as district parks, playing fields, pedestrian/cycle pathways, equestrian trails and landscape buffers (vegetated areas surrounding a development), managed according to principles described in the draft Urban Open Space Management Plan. Urban open spaces outside the Ecological Network have relatively low ecological connectivity value due to their isolation, but can still act as 'stepping stones' for mobile species such as birds and pollinators, and provide additional biodiversity, urban cooling, wellbeing and amenity benefits that support a healthy city.



Short Beaked Echidna, Canberra. Photo: Johannes Botha

STEP 1B: ASSESS ECOLOGICAL CONNECTIVITY

One of the key aims of nature conservation within the ACT is to maintain and enhance ecological connectivity. In this context, ecological connectivity means retaining and protecting linkages and movement corridors between patches of core habitat that allow the movement of species. Ecological connectivity facilitates better access to additional habitat and resources, enables populations to retain genetic diversity, and enhances the resilience of species and populations to climate change.

Establishing the role of a potential development site in maintaining or improving broader ecological connectivity is an important step in achieving Biodiversity Sensitive Urban Design. Even sites which are in poor ecological condition can retain high ecological value in terms of their contribution to ecological connectivity at the district or regional scale.

Determining the connectivity value of a given site in the landscape however can be a complex undertaking, particularly in an urban or peri-urban environment where unnatural fragmentation of habitats is extremely commonplace (due to roads, artificial lighting, traffic, habitat loss, etc.).

A valid assessment of ecological connectivity for an area should consider the species present (or potentially present), their movement capabilities and needs, and the relative arrangement of core habitats, potential movement corridors, and movement barriers (e.g. roads, habitat gaps) at a scale relevant to the home range and dispersal distances of the species in question. Predictions for common fauna are available via the Ecological Network Dashboard. Very rarely will an assessment confined to the boundary of a proposed development site be sufficient for considering ecological connectivity at a relevant scale.

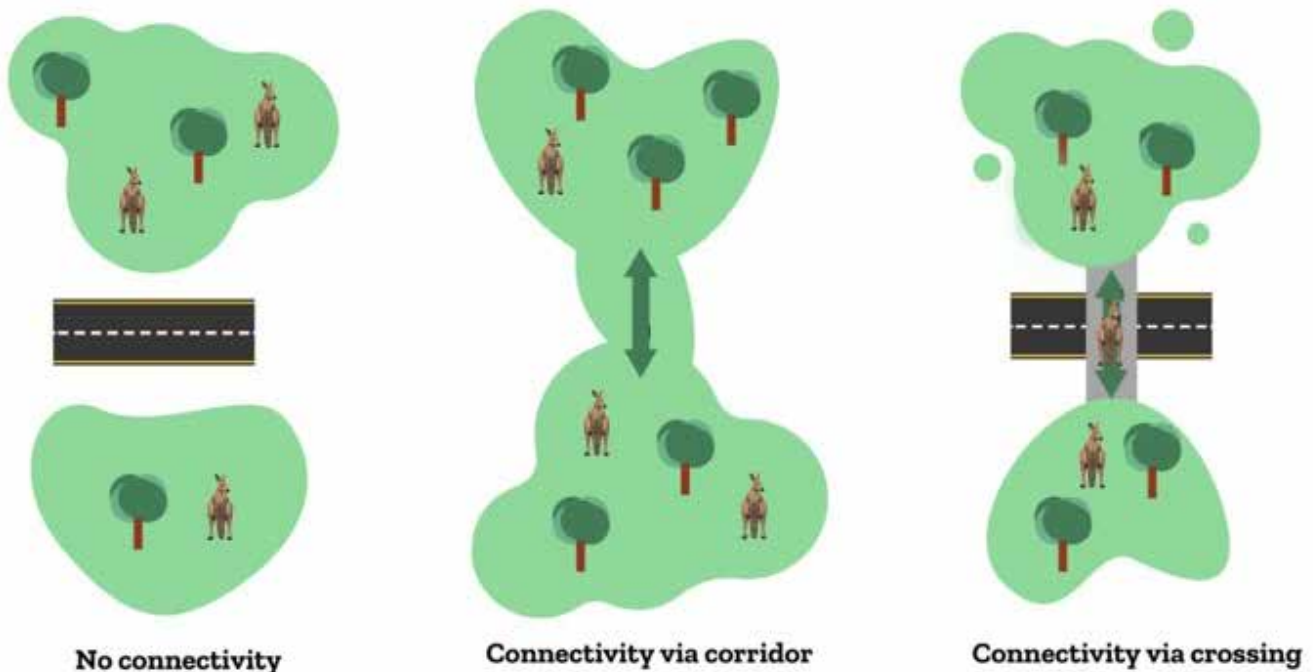
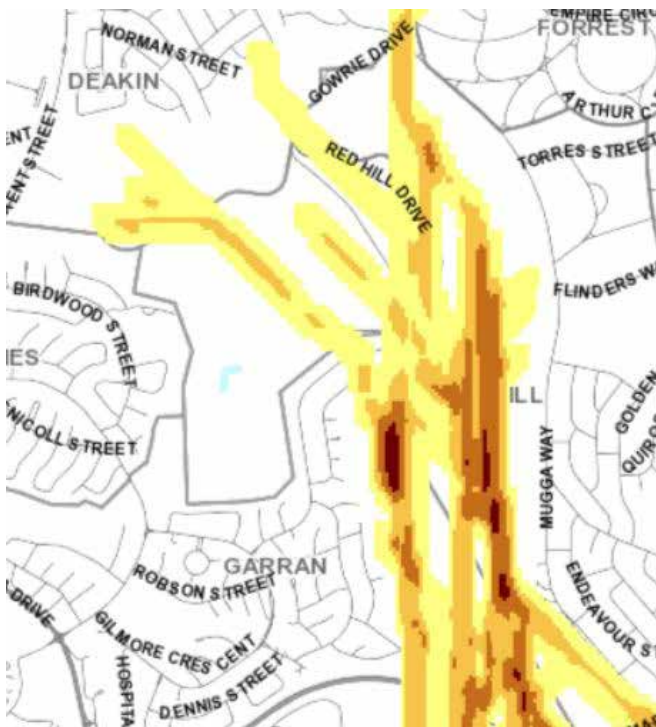


Image adapted from Rachel Caldwell / Center for Large Landscape Conservation

Multiple tools have been developed to assist proponents in considering ecological connectivity. These include:

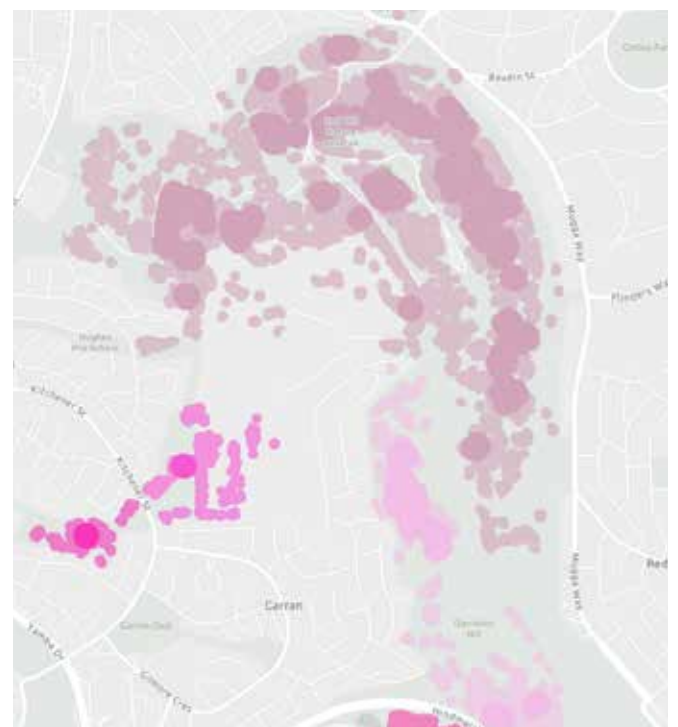
1. Urban Habitat Connectivity Project Core habitat and Corridor Fragmentation mapping (available via ACT Ecological Network Dashboard). This is the most up to date and explicit connectivity mapping available for the urban and peri-urban ACT. These maps indicate areas of predicted core and corridor habitat for species groups across grassland, woodland, aquatic and riparian ecosystems.
2. Ecosystem metrics summary tables in the BSUD Implementation Advice. These metrics provide best practice recommendations for dimensions and general properties for core habitat areas within grassland, woodland and riparian and aquatic ecosystems. Guidance on designing for connectivity and how to avoid introducing movement barriers is also included.



Habitat connectivity value maps are available on ACTmapi. This example shows regional links based on canopy and vegetation mapping with the darker areas indicating areas of highest value.

3. Other tools to assist with connectivity assessments on ACTmapi. These maps indicate areas of likely core habitat and priority movement corridors for woodland and generalist species.

As for the assessment of biodiversity values, an assessment of ecological connectivity values within a proposed development site will also likely require additional field assessment by a suitability qualified ecologist. Such an assessment will enable the identification and documenting of existing structures (e.g., roads, walls), processes (e.g., exposure to predators, or high traffic volumes), or landscape features (e.g., steep terrain, waterways) which may impact on functional ecological connectivity for some species but not be reflected in existing connectivity assessment tools. Further information to support on-ground assessment of ecological connectivity and existing barriers to movement is available in the BSUD Implementation Advice.



Habitat and fragmentation mapping is available on the ACT Ecological Network Dashboard. This example shows core and corridor habitat and fragmentation for small mammals.

STEP 1C: ASSESS THREATS TO BIODIVERSITY

Urbanisation and associated construction and building works can threaten biodiversity through introducing disturbance regimes and pollution sources. For example, risk of soil erosion and nutrient runoff to nearby waterways increases if vegetation cover is removed on a sloping site. This can have flow-on effects on soils, as healthy soils provide ecosystem services like nutrient recycling and breakdown of organic matter, capture and storage of water, therefore supporting biodiversity. Decreased permeability as a result of buildings can change also water flow within catchments and can effect wetlands. Nutrient and sediment runoff can impact stream water quality and aquatic / riparian biodiversity on or around the development site.

If a new development is located next to a protected natural area, risk of weed or pest animal incursions to pristine areas may increase. The design should incorporate mitigating aspects such as buffer zones and pet containment zones.

Light and noise pollution should be addressed through good design too. The aim should be to have as little artificial light and light spill as possible to the surrounding natural areas to minimise impacts upon wildlife.

Finally, an assessment of threats caused directly by humans should be conducted. This can include the likely level of visitor/human use, and associated sources of mortality like traffic and urban heat island effects.

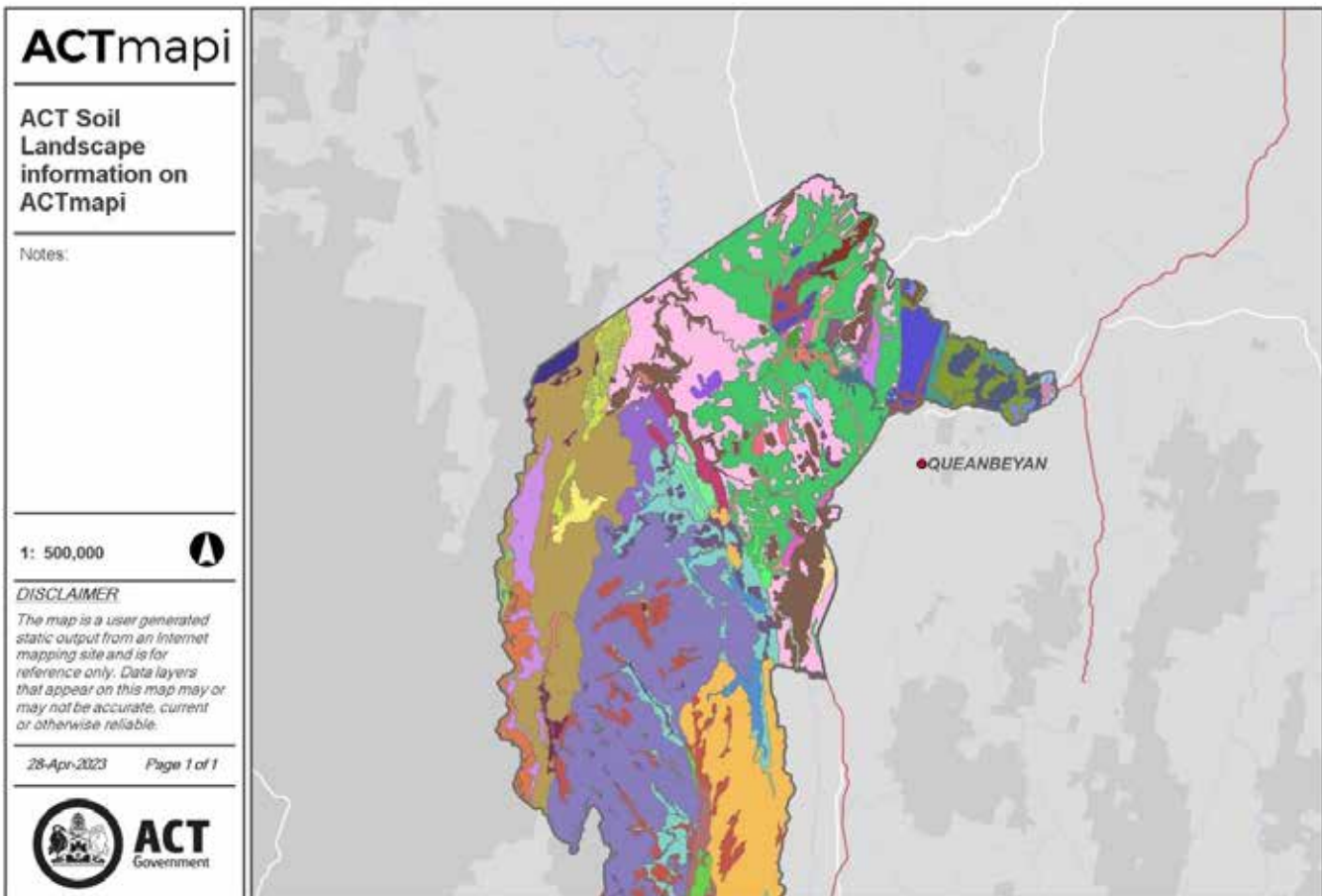


Image: ACTmapi



Location: Mulanggari Grassland, ACT.

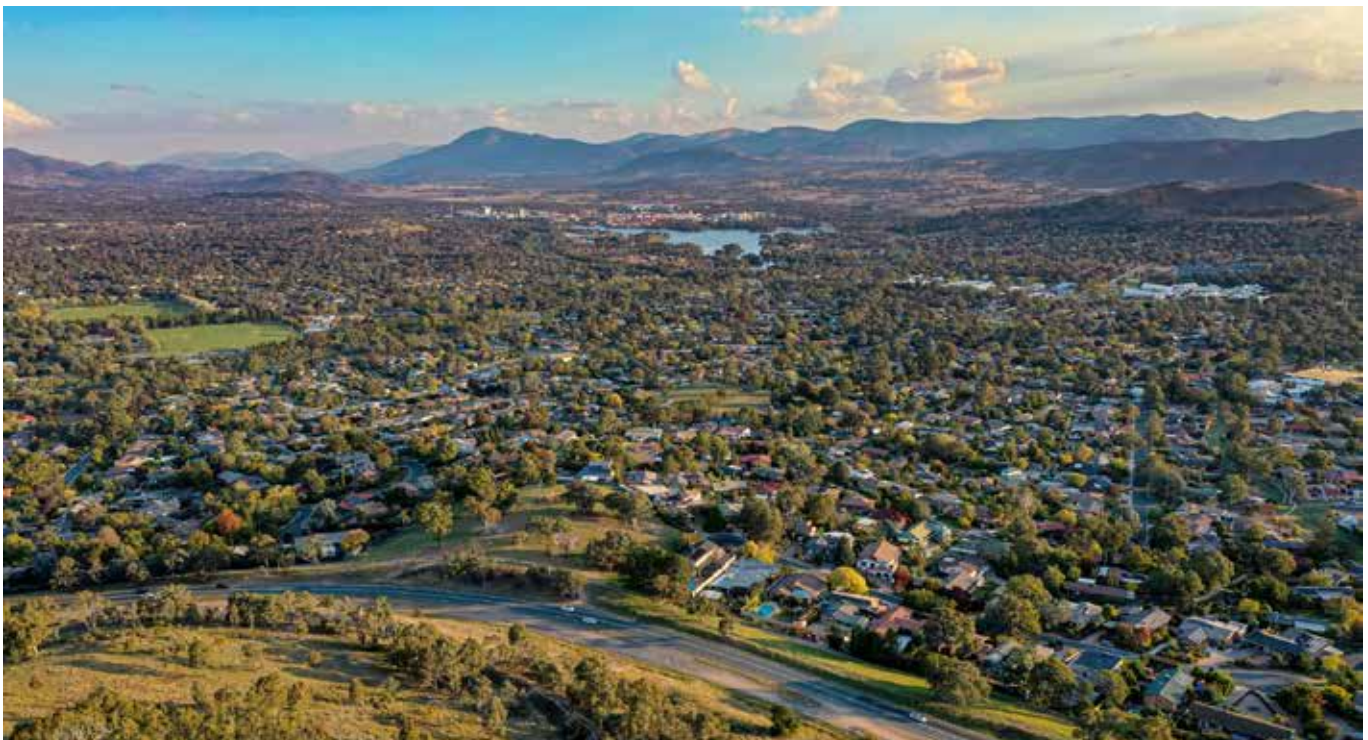
STEP 2: IDENTIFY SITE SPECIFIC BIODIVERSITY OBJECTIVES THAT CONSERVE BIODIVERSITY VALUES

The design elements set out below reflect key ACT Government commitments on biodiversity, the Territory Plan's assessment outcomes, objectives in the ACT Nature Conservation Strategy and ecosystem strategies, and statutory plans and conservation advice for threatened species and ecological communities.

At each site, depending on scale, context, and the results of Step 1, the following themes and design elements should each be explicitly considered, and site-specific objectives based on each should be developed as relevant. For example:

→ For a site with no waterways, functional ecosystems, or high conservation value features, few of the following design elements may be relevant. In such instances, the effect of development on values surrounding the site (such as connectivity between core habitat areas, or water quality outcomes in the broader catchment) must be considered.

→ For a site with native grasslands, woodlands or riparian/aquatic ecosystems, high conservation value natural features or for one in an area significant for ecological connectivity, most or all design elements will be relevant.



Tuggeranong from Mount Taylor, ACT.



MAINTAIN AND ENHANCE NATURE

In order to achieve the Territory Plan assessment outcome of “Loss of native habitat and biodiversity is avoided and/or minimised”, site-specific objectives reflecting the following design elements should be developed:

- Design element 1.1: Urban waterways and catchments
 - **1.1A** Natural context
 - **1.1B** Water sensitive urban design
 - **1.1C** Topography and hydrology
- Design element 1.2: Grasslands and woodlands
 - **1.2A** Natural features
 - **1.2B** Design enhancements
- Design element 1.3: Natural values and features
 - **1.3A** Existing natural values
 - **1.3B** Natural processes



CONNECT AND EXTEND NATURE

In order to achieve the Territory Plan assessment outcome of “Biodiversity connectivity is maintained across the landscape”, site-specific objectives reflecting the following design element should be developed:

- Design element 2.1: Ecological connectivity
 - **2.1A** Habitats and corridors
 - **2.1B** Corridor features
 - **2.1C** Habitat features
 - **2.1D** Connectivity barriers

This includes areas that act as:

- Core habitats and buffers,
- Ecological corridors between habitat areas within an individual site,
- Ecological corridors between habitat areas on adjacent sites (the broader landscape context), and
- Ecological corridors that can link into other corridors thereby connecting into the broader ecological network.



MINIMISE THREATS TO PROTECT NATURE

In order to achieve the Territory Plan assessment outcome of “Threats to biodiversity such as noise, light pollution, invasive species incursion or establishment, chemical pollution, or site disturbance are avoided or minimised through good design”, site-specific objectives reflecting the following design elements should be developed:

- Design Element 3.1: Natural resilience
 - **3.1A** Weeds and pests
 - **3.1B** Natural threats
- Design Element 3.2: Protecting the ecological network
 - **3.2A** Human induced threats
 - **3.2B** Restored nature



CONNECT PEOPLE TO NATURE

To achieve broader aspirations around connections between people and nature the following design elements are optional but encouraged. These elements align with, and assist with achieving the ACT Urban Design Guide’s aspirations relating to urban trees, landscaping and natural features as well as creating positive engagement with nature:

- Design Element 4.1: Community stewardship
 - **4.1A** Co-design
 - **4.1B** Stewardship
- Design Element 4.2: Interacting with nature
 - **4.2A** Respectful connections
 - **4.2B** Interactive infrastructure
- Design Element 4.3: Environmental education
 - **4.3A** Engagement and learning
 - **4.3B** Instilling natural values

STEP 3: DESIGN TO ACHIEVE SITE SPECIFIC BIODIVERSITY OBJECTIVES

Applying the principles and the process of biodiversity sensitive urban design to planning and development thinking will result in ecologically sustainable development that addresses this driving principle of the ACT Planning Act.

The Biodiversity Sensitive Urban Design recommendations will also deliver on the District Strategies' Blue-Green Network driver, and additional Territory Plan outcomes relating to:

- Urban Structure and Natural Systems
- Sustainability and Environment



Urban nature and play, Eddison Park. Photo: Johanna Wallner



Location: Yerrabi Pond, Canberra ACT.

THEME 1:



MAINTAIN AND ENHANCE NATURE

This theme addresses the Territory Plan assessment outcome: loss of native habitat and biodiversity is avoided and/or minimised.

It seeks to protect existing environmental and landscape features that provide healthy, functional habitat from the negative impacts of development and urbanisation. Healthy ecosystems are complex, evolved over millennia and involve thousands of interactions between organisms and their environment. The protection of remaining areas of high-quality habitat is hence a core principle of ecologically sustainable development.

Further, this theme seeks to identify opportunities to reintroduce lost habitat features back into urban areas, where possible, to enhance the existing landscape and create urban environments where people and nature are supported and thrive.

DESIGN ELEMENTS

1.1 URBAN WATERWAYS AND CATCHMENTS

- 1.1A Natural context
- 1.1B Water sensitive urban design
- 1.1C Topography and hydrology

1.2 GRASSLANDS AND WOODLANDS

- 1.2A Natural features
- 1.2B Design enhancements

1.3 NATURAL VALUES AND FEATURES

- 1.3A Existing natural values
- 1.3B Natural processes

Why this is important.

Existing habitat is critical to the continued survival of the animals, plants and ecosystem services associated with that type of natural landscape and therefore for conserving biodiversity. An emphasis should be placed on protecting remaining areas of habitat in good condition from impacts of urban development, as attempting restoration of functional ecosystems requires costly human intervention and long (decadal to centennial) timeframes.

Declining biodiversity and habitat loss can be slowed to some extent by creating additional habitats in urban environments that are compatible with existing natural features, improving connectivity between fragmented habitat patches to support natural recolonisation, and supporting a diverse range of plant and animal species.



T

This theme supports the interpretation, application and assessment of the following assessment outcome as outlined in the

Territory Plan:

→ Loss of native habitat and biodiversity is avoided and/or minimised.

Location: Curtin Ridge, ACT.

DESIGN ELEMENT:

1.1 URBAN WATERWAYS AND CATCHMENTS

ACT's aquatic and riparian ecosystems provide habitat for a diversity of plant and animal species, including threatened and vulnerable species, as well as water and amenity for residents. Catchments i.e. the areas of land from where a river or lake capture water from rain, are crucial in regulating the quality of water in the receiving waterbodies. Urban expansion can lead to negative impacts on both ecosystem health and water quality but good design can alleviate risks.

DESIGN GUIDANCE

1.1A NATURAL CONTEXT

- Retain natural waterways (running water such as rivers, creeks) and wetlands (standing water like lakes, swamps and ephemeral wetlands). Include appropriately sized and vegetated buffer zones to protect water quality, biodiversity and wildlife habitats of the waterbody and its surrounding landscape.
- Protect the functions and values of urban riparian corridors, including their contribution to water quality, biodiversity, ecological connectivity, urban cooling and recreation, by avoiding infringement or disturbance of the stream banks and their broader context.



Ephemeral wetland in Jacka, ACT. Photo: Dr Melissa Snape

1.1B WATER SENSITIVE URBAN DESIGN

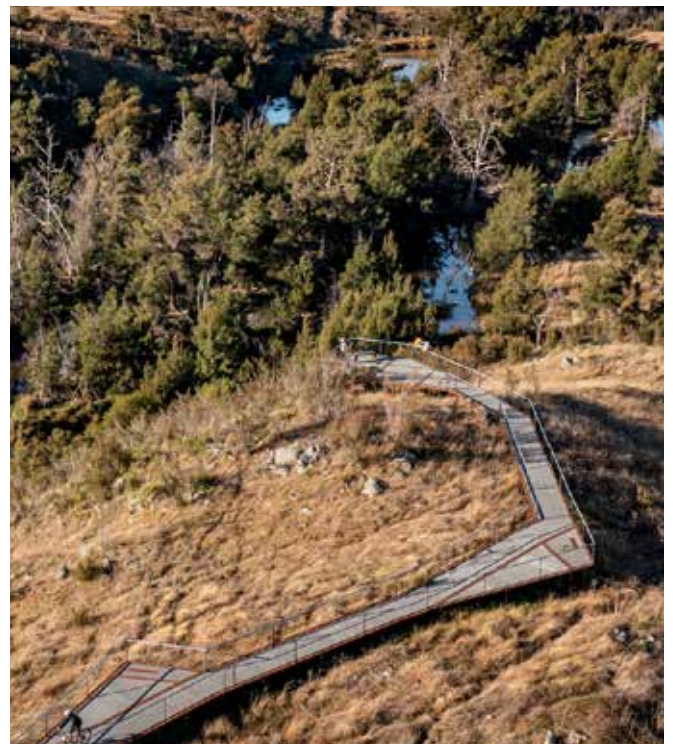
- Use best practice water sensitive urban design, such as rain gardens, permeable pavements, sediment ponds and construction phase sediment and erosion controls to protect catchments from pollution associated with sediment inputs (nutrients, turbidity).
- Design to protect and restore natural water cycle by promoting rainwater harvesting, permeable pavements and other measures that allow rainwater to infiltrate the soil and recharge groundwater, in line with [Canberra's Living Infrastructure Plan](#) and the [ACT Practice Guidelines for Water Sensitive Urban Design](#).
- Improve urban areas' drainage through design interventions that also contribute to biodiversity, such as vegetated swales and biofiltration basins in appropriate locations, allowing the natural filtration of water run-off from the urban environment.



Rain garden at Amaroo Group Centre ACT. Credit: Tait Network

1.1C TOPOGRAPHY AND HYDROLOGY

- Design to minimise landform changes including cut and fill during the development to protect natural hydrological function and limit soil erosion and site disturbance. Consider in the design, where soil compaction may take place (such as in parking areas, paths) and take action to minimise impacts to sensitive habitats and areas, such as tree roots.
- Sensitive integrate development with the natural topography to minimise the visual impact on the landscape and enhance coexistence with ecological systems.



Molonglo Valley raised boardwalk.

1.2: GRASSLANDS AND WOODLANDS

Woodlands provide much loved amenity and recreational opportunities for ACT residents as well as ecosystem services and wildlife habitat. Grasslands are important for ground water recharge, carbon sequestration, and as habitat for rare or threatened species. Semi natural areas such as urban parks and other open spaces can significantly contribute to urban biodiversity. Urban design should protect and enhance the occurrence and function of all these ecosystems.

DESIGN GUIDANCE

1.2A NATURAL FEATURES

- Protect and enhance habitat features specific to the site, including but not limited to, threatened or endangered species and ecosystems with reference to the relevant Action Plans and Conservation Advice (available from [Conservation and Ecological Communities - Environment, Planning and Sustainable Development Directorate - Environment \(act.gov.au\)](#)). Habitats should provide food, water, shelter, and nesting places for native species within the local ecosystem.
- Design landscapes which meet the structural and functional habitat requirements for the ecosystem type(s) appropriate to the landscape context. For example:
 - Functional woodlands need suitable mid- and understory plants, no-mow zones, large rocks, logs, standing dead trees with hollows etc. to provide a variety of habitats for native species.
 - Food resources, such as pollen and nectar producing plants, palatable vegetative and tuberous plants, invertebrates, and other suitable prey items should be available to support a variety of wildlife species.
 - Sunlight and access to water and soil nutrients are important to support vegetation communities, which along with healthy soils, underpin functional ecosystems.
 - Trees and other woody vegetation are structurally inappropriate in a grassland.
 - Aquatic and riparian ecosystems rely on the protection of natural landscape hydrology.
- Celebrate the site's topographic and natural features to highlight visually identifiable elements and establish a distinct character for the place.

1.2B DESIGN ENHANCEMENTS

- Embed man-made habitats for wildlife where appropriate and desirable such as artificial wetlands or rocky shelters for small lizards. These should include habitat for natural predators of invertebrate pests such as birds and beneficial insects to reduce the need for pesticides and chemical controls.
- Design to exclude impermeable surfaces, infrastructure and ground disturbance within the tree protection zone of any retained tree. Consider appropriate underplanting to discourage public access into tree protection zones.
- Tree Protection Zones are defined in the Urban Forest Act 2024 to be: (a) the area under the canopy of the tree; and (b) the 2m wide area surrounding the vertical projection of the canopy; and (c) the 4m wide area surrounding the trunk as measured at 1m above natural ground level.
- Note that native trees should be protected within a suitable ecological context (as per the Mature Native Tree Action Plan), and that regenerating and non-mature trees should also be protected to ensure a steady supply of mature trees as keystone habitat features into the future.



Cockatoo in mature tree hollow. Photo: Mark Jekabsons



Natural Temperate Grassland
Photo: Mark Jekabsons

1.3: NATURAL VALUES AND FEATURES

Many natural features of the landscape have high biodiversity values, as they provide a variety of habitats. Urban trees, including dead mature trees improve animal and bird biodiversity locally as well as more broadly. Designs should work around such features as well as minimise impacts on areas of high ecological value, such as patches with native vegetation.

DESIGN GUIDANCE

1.3A EXISTING NATURAL VALUES

- Focus development on areas of low ecological value (as identified through Plant Community Type zone mapping or other means) and protect high condition ecosystems, habitats and important ecological corridors from construction activities.
- Avoid or reduce the destruction of existing native vegetation, including mature and regenerating trees (including dead trees), native geophytes (plants with underground storage organs), and any areas dominated by native perennial grasses.
- Retain other valuable landscape features such as rocky outcrops, coarse woody debris (fallen logs, branches), swampy meadows and grassland soaks (wetlands that appear and disappear according to rainfall), including their ecological context (surroundings) and connection to the broader landscape. Such features have high biodiversity values, as they provide a variety of habitats and refugia from climate extremes.



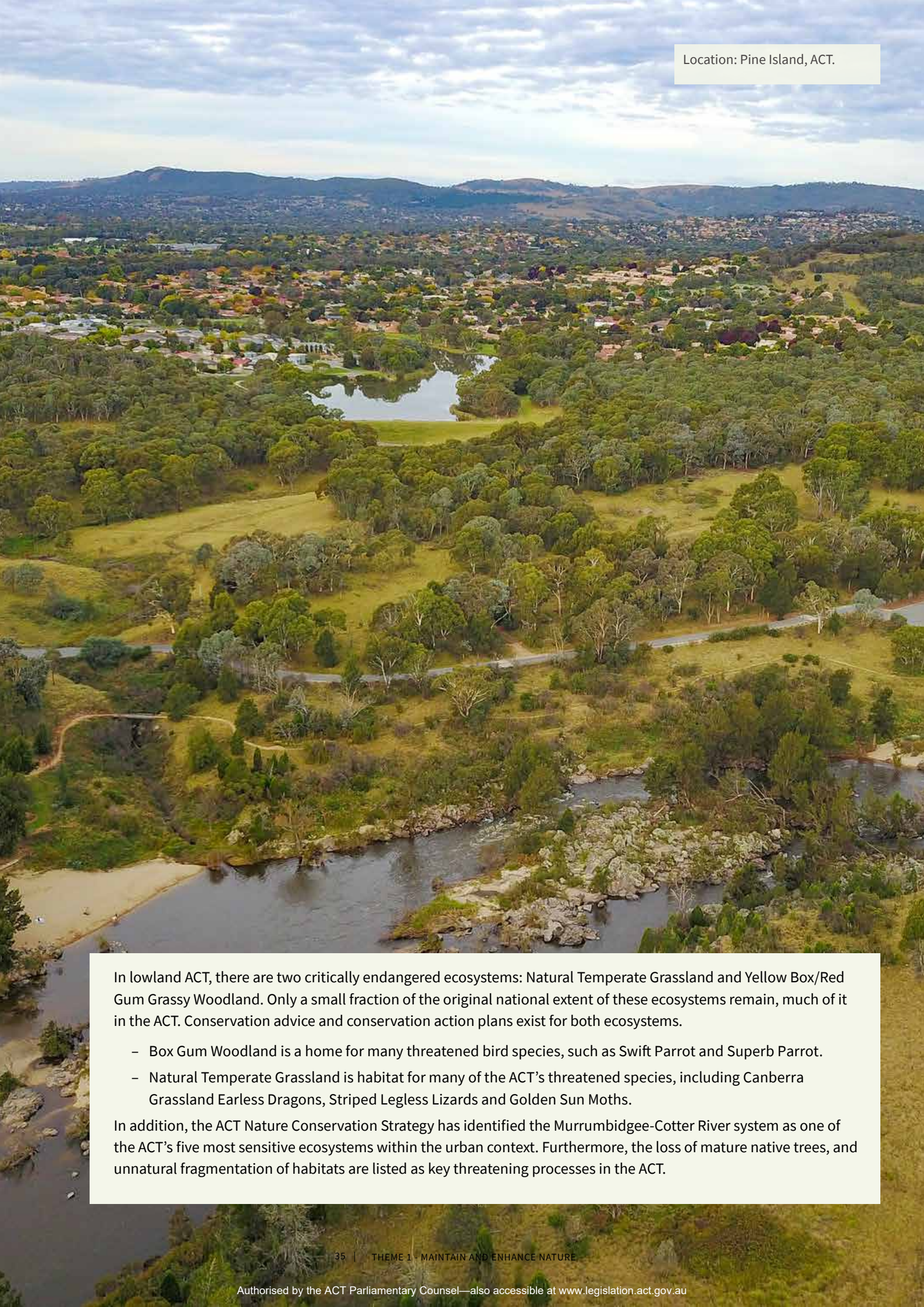
Mature hollow tree. Photo: Mark Jekabsons

1.3B NATURAL PROCESSES

- Design to allow for natural native tree maturation and regeneration in woodlands and wooded riparian ecosystems. Retain a range of native tree age classes on site (saplings through to mature and dead hollow bearing trees) and design to allow for processes such as safe limb fall, natural accumulation of coarse woody debris and natural regeneration through seed drop.
- Design playground, bike and footpath placement to limit pedestrian access to mature native tree locations and thus reduce safety concerns around limb drop.
- Further build habitat complexity through diverse, layered and 'clumped' vegetation arrangements where appropriate. Vegetation layers provide more food, variety of shelters and screening for protection from predators and urban pollutants such as light and noise.



Pollination process. Photo: Mark Jekabsons



In lowland ACT, there are two critically endangered ecosystems: Natural Temperate Grassland and Yellow Box/Red Gum Grassy Woodland. Only a small fraction of the original national extent of these ecosystems remain, much of it in the ACT. Conservation advice and conservation action plans exist for both ecosystems.

- Box Gum Woodland is a home for many threatened bird species, such as Swift Parrot and Superb Parrot.
- Natural Temperate Grassland is habitat for many of the ACT's threatened species, including Canberra Grassland Earless Dragons, Striped Legless Lizards and Golden Sun Moths.

In addition, the ACT Nature Conservation Strategy has identified the Murrumbidgee-Cotter River system as one of the ACT's five most sensitive ecosystems within the urban context. Furthermore, the loss of mature native trees, and unnatural fragmentation of habitats are listed as key threatening processes in the ACT.

ACT's PRIORITY ECOSYSTEMS

Grassland habitat

Native grasslands are highly diverse and contain many small plant and animal species which are specially adapted to this highly sensitive ecosystem. Indicators of high quality grasslands include:

- Up to 25% cover of scattered rocky outcrops and/or bare patches of ground.
- Up to 75% cover of native perennial tussock grasses and diverse ground layer vegetation of other grasses and wildflower species including Kangaroo Grass, Hoary Sunray and Button Wrinklewort.
- Less than 2% tree canopy cover.
- Core habitat patches of 240m minimum dimension.
- Associated specialised native wildlife species including Grassland Earless Dragon, Striped Legless Lizard and Golden Sun Moth.

For further details refer to the ACT Native Grassland Conservation Strategy and Action Plans.

Grasslands, occurring on low lying open land, were considered prime development sites in the past and now less than 5% of remain in moderate condition in south-eastern Australia. As such, a key objective of the ACT Native Grassland Conservation Strategy is to Conserve all remaining areas of native grassland in the ACT that are in moderate to high ecological condition. Protection from further fragmentation from development is required along with planning and design considerations that:

- Avoid linear infrastructure and vertical barriers such as kerbs for the sensitive grassland species that are small and not very mobile
- Avoid the introduction of exotic grasses, woody weeds and trees
- Avoid light spill and chemical pollutants from run-off



Typical Grasslands at Mulligans Flat Woodland Sanctuary, Throssby ACT. Photo: Mark Jekabsons

Woodland Ecosystems

High quality woodlands are characterised by:

- Open canopy with 2 – 50% canopy cover.
- Dominant tree species include Yellow Box, Blakely's Red Gum, Apple Box and Candlebark, with supporting midstorey species appropriate for the vegetation community.
- Understorey structure with up to 45% groundcover of diverse, predominantly native grasses and forbs, interspersed with bare ground and areas covered by leaf litter.
- Additional habitat elements such as hollows, mistletoe, fallen timber, leaf litter and surface rocks
- Core habitat patches of 330m minimum dimension
- Associated diverse native species including birds, wallabies, gliders, bats, reptiles, frogs and bees

Local woodland ecosystems have been extensively cleared for agriculture and development and have declined by at least 66% since 1750. At least 18 threatened species of flora and fauna rely on woodland ecosystems. Protection from further fragmentation from development is required along with planning and design considerations that:

- Retain all hollow bearing mature native trees as critical habitat
- Avoid linear infrastructure and vertical barriers such as kerbs for certain species like turtles which overwinter in woodlands
- Avoid incursion of pest species such as cats and foxes through disturbance such as inappropriate maintenance tracks and habitat lacking appropriate mid and understorey which facilitate pest bird species like noisy miners.



Mount Majura, ACT. Photo: Mark Jekabsons

Riparian and Aquatic Ecosystems

High quality riparian and aquatic ecosystems are characterised by:

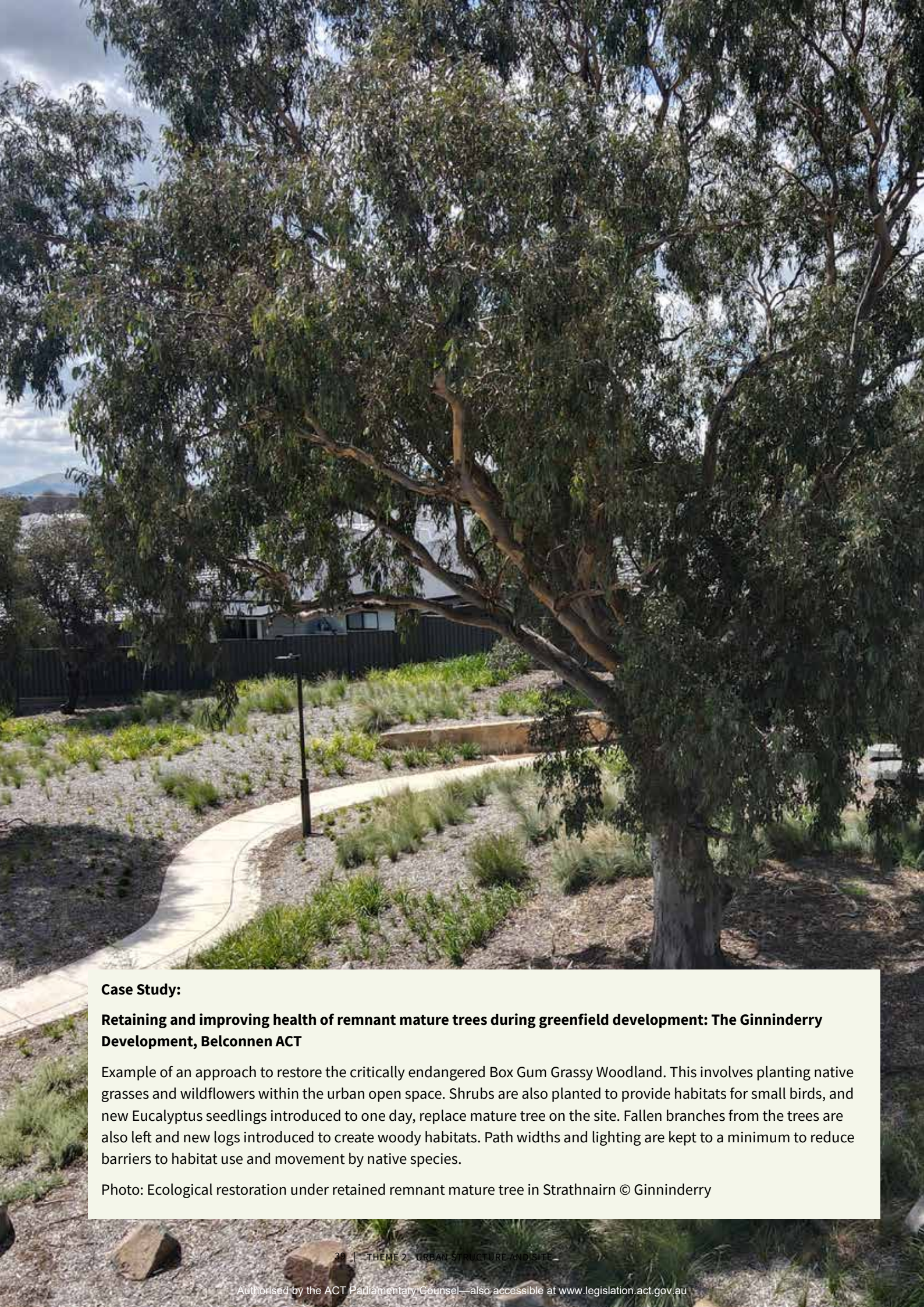
- Wide undeveloped buffers with diverse, predominately native, vegetation in structured layers in riparian areas.
- Permanent ponds with a minimum dimension of 5m for aquatic habitats.
- Up to 50% ground layer vegetation cover focused on the water's edge/bank for stability, with trees every 20-30m where appropriate.
- Habitat patches are connected by corridors minimum 10m and with no vertical barriers to enable connectivity into adjacent grassland or woodland for dependent species such as frogs and turtles.
- Water quality parameters such as dissolved nutrient levels and turbidity are classified as “good” as per ACT Waterwatch adopted classification. In addition, healthy riparian condition is indicated by the presence of macroinvertebrates (“water bugs”).
- Additional features such as rock and woody debris to provide suitable habitat for diverse native fauna, such as freshwater fish.

Local riparian and aquatic ecosystems have been heavily impacted by urban development including by transitioning natural waterways into built structures such as concrete lined channels and through impacts to hydrological processes and water quality. Protection from further fragmentation and impacts from development is required along with planning and design considerations that:

- Maintain natural watercourses as natural or semi-natural ecosystems
- Avoid impacts on hydrological function through implementing Water Sensitive Urban Design practices
- Avoid adjacent waterways from impacts such as erosion and sedimentation during and after construction
- Eliminate vertical barriers such as weirs and kerbs, and other infrastructure such as culverts and pipes which fragment habitat for species species like turtles and fish
- Protect sufficient buffer/riparian corridor areas where human disturbance is minimised and vegetation cover is maximised



Urban waterway in the ACT. Photo: Mark Jekabsons



Case Study:

Retaining and improving health of remnant mature trees during greenfield development: The Ginninderry Development, Belconnen ACT

Example of an approach to restore the critically endangered Box Gum Grassy Woodland. This involves planting native grasses and wildflowers within the urban open space. Shrubs are also planted to provide habitats for small birds, and new Eucalyptus seedlings introduced to one day, replace mature tree on the site. Fallen branches from the trees are also left and new logs introduced to create woody habitats. Path widths and lighting are kept to a minimum to reduce barriers to habitat use and movement by native species.

Photo: Ecological restoration under retained remnant mature tree in Strathnairn © Ginninderry

THEME 2:



CONNECT AND EXTEND NATURE

This theme addresses the Territory Plan assessment outcome: biodiversity connectivity is maintained across the landscape.

It seeks to maintain and enhance ecological connectivity between native habitat patches to allow movement of species through the urban landscape. This enables them to access further resources and increase their resilience to climate change and other environmental stressors.

DESIGN ELEMENTS

2.1 ECOLOGICAL CONNECTIVITY

2.1A Habitats and corridors

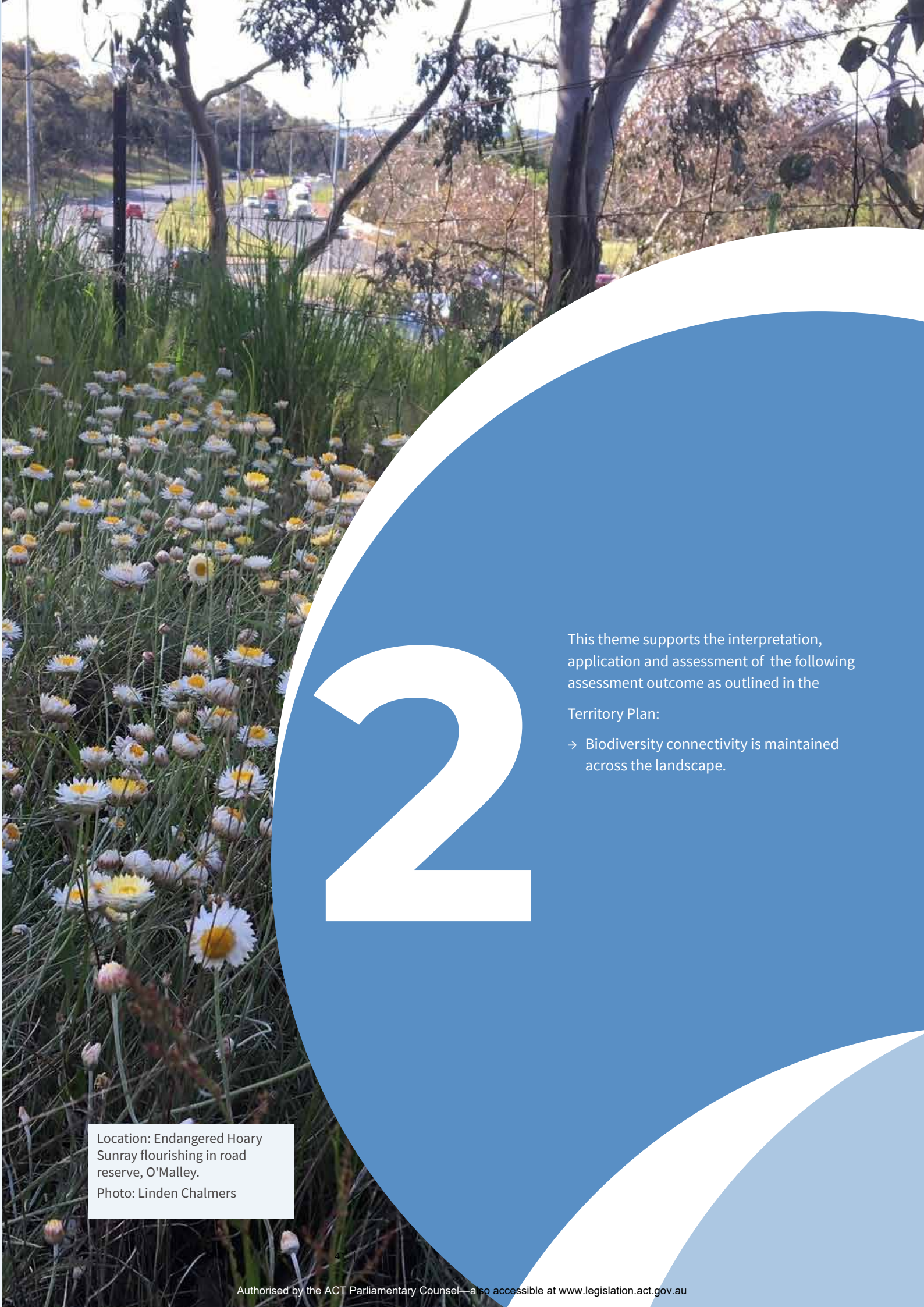
2.1B Corridor features

2.1C Habitat features

2.1D Connectivity barriers

Why this is important.

Fragmented habitats lead to a decline in biodiversity as populations become genetically isolated and vulnerable. This is because they are unable to repopulate after local extinctions or move to areas with more suitable environmental conditions. Connected habitats allow for natural migration, species adaptation and evolution while also supporting sustained ecosystem processes and providing ecosystem services critical to wildlife and human wellbeing.



2

This theme supports the interpretation, application and assessment of the following assessment outcome as outlined in the

Territory Plan:

- Biodiversity connectivity is maintained across the landscape.

Location: Endangered Hoary Sunray flourishing in road reserve, O'Malley.
Photo: Linden Chalmers

2.1: ECOLOGICAL CONNECTIVITY

ACT's natural ecosystems include native grasslands, woodlands, forests and aquatic/riparian ecosystems. Examples of semi-natural ecosystems include ACT's man-made wetlands and lakes, district parks, agistment lots (grazing paddocks) and many recreation reserves. All ecosystem types can have high biodiversity value, and should be included in connectivity design and planning.

DESIGN GUIDANCE

Urban design should be mindful of maintaining the connectivity of the above ecosystems, including areas that act as:

- Core habitats and buffers between core habitats and surrounding areas,
- Ecological corridors between habitat areas within an individual development site,
- Ecological corridors between habitat areas on adjacent sites (the broader landscape context), and
- Ecological corridors that can link into other corridors thereby connecting into the broader ecological network.

Ecological connectivity

Maintaining and enhancing ecological connectivity is widely regarded as a critical element in maintaining biodiversity. This guide will provide guidance on maintaining and enhancing connectivity between native habitat patches to allow movement of species across the landscape, facilitating better access for them to additional habitat and resources. Connectivity can be developed at different scales.

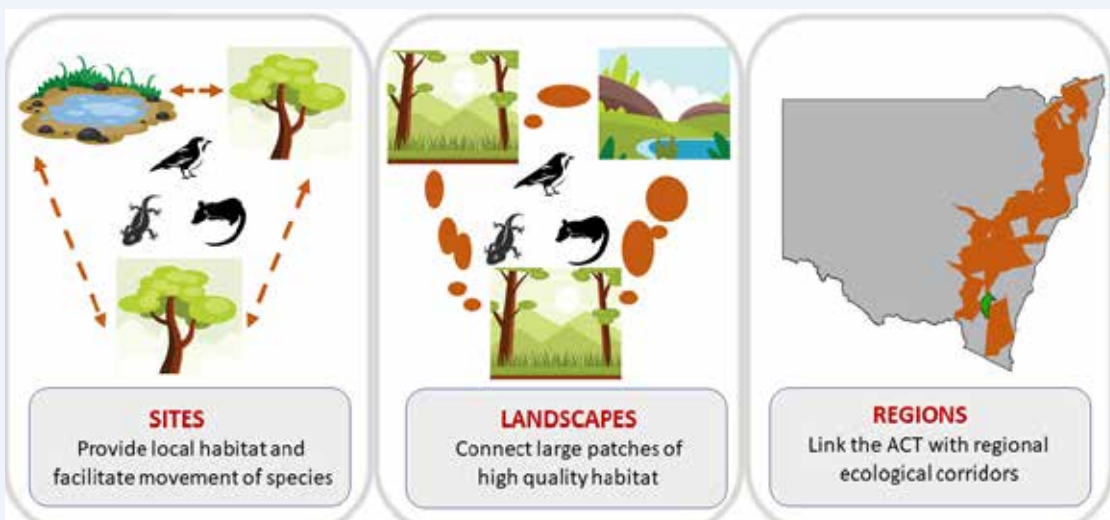


Image redrawn from the ACT Nature Conservation Strategy using public images from NSW Government Spatial Services and publicdomainvectors.org



Green corridor through Crace, ACT.

2.1A HABITATS AND CORRIDORS

- Identify and retain existing core habitats and functional ecological corridors identified through on-ground site field surveys, including Plant Community Type zone mapping. While focus on ecological corridors which retain high ecological and biodiversity value is critical, it is also important to consider corridors that have lower direct biodiversity value but high connectivity significance to core habitat beyond the development site boundary.
 - Use connectivity mapping tools or consult the available connectivity maps to identify existing corridors or fragmented habitat, and potential / possible ecological corridor areas between the identified habitats which contribute to the Urban ACT Ecological Network.
 - The [Ecological Network Dashboard](#) describes the Urban ACT Ecological Network vision (as shown in the District Strategy Blue Green Map), and also provides species-group specific habitat and fragmentation models for the urban ACT.
- Design to establish new, or improve existing connectivity corridors, for example through revegetating areas with native vegetation or removing barriers preventing animal movement.
 - While focus on ecological corridors of high ecological and biodiversity value is critical, it is also important to consider corridors that may have lower direct biodiversity value but high connectivity significance to habitat beyond the development site boundary.
 - The [Ecological Network Dashboard](#) describes the Urban ACT Ecological Network vision (as shown in the District Strategy Blue Green Map), and also provides species-group specific habitat and fragmentation models for the urban ACT.

2.1B CORRIDOR FEATURES

- Design landscapes and ecological corridors to ensure suitability for the intended species or ecosystems, as relevant to the scale of the development.
 - Different ecosystems have their own requirements for ideal and ecologically connected habitats which must be considered (see Tables 2 - 5 in the Implementation Advice Appendix). On some sites, habitat and connectivity requirements for individual or groups of species (like grassland reptiles, woodland birds, amphibians) should also be considered.



Swamp Creek and associated riparian corridor, ACT.
Photo: Mark Jekabsons

Exemplar :

Residential native garden with layered vegetation and the addition of nesting box in the tree. This type of garden provides food, shelter and habitat for many local animals and is easily achievable in the urban context.

Location: Lyons, ACT.

Photo: Johanna Wallner



2.1C HABITAT FEATURES

- Provide suitable sources of food and habitats for pollinators such as bees, butterflies, bats and birds, to facilitate natural pollination and seed dispersal. A diversity of local, native plants, including species that flower year-round, growing in public and private gardens and landscaped areas are key assets.
 - Advice on how to create pollinator-friendly spaces is available from [ACT for Bees](#) website.
 - More information on how to design biodiverse gardens can be found from ACT Suburban Land Agency's booklets on garden design, and from the Municipal Infrastructure Standards Part 25 Plant Species for Urban Landscape Projects.
 - The disadvantages of using plants which produce high nectar yields (e.g. Callistemon species) should be considered to encourage insect pollinators and smaller birds, without providing competitive advantage to large aggressive honeyeaters such as Noisy Miners.
- Particularly in larger developments, the overall design should consider the open spaces as an opportunity to create semi-natural, biodiversity sensitive ecosystems.
 - By including BSUD features such as native garden beds and water bodies, areas of dense shrubs in parks, layered vegetation along transport corridors and playgrounds etc, newly built areas can provide significant biodiversity benefits to both wildlife and residents.

2.1D CONNECTIVITY BARRIERS

- Design linear infrastructure such as new roads or waterbody crossings to enable safe passage of wildlife relevant to the site context (examples include road over and under passes, clear span bridges, vegetated culverts, and rope bridges). Incorporate smooth or slipped pavement and footpath edges that allow species migrating during flood and heavy rainfall events to move into the broader landscape where appropriate.
- Quantitative design guidelines to avoid fragmentation, and guide minimum design requirements for effective corridor design or retention, are provided in the Appendix
- Reduce the effects of traffic and direct human impacts, through appropriate design and preferencing areas for recreational impacts that have lower biodiversity value or which do not provide a movement corridor for native species. These include for example non-erodible, or clearly defined walking paths to enable high intensity recreation while protecting the environment.



Example of path design to discourage access to sensitive areas. The elevated platform also allows for the movement of species beneath the walkway
Location: Molonglo Valley river corridor, ACT.

THEME 3:



MINIMISE THREATS TO PROTECT NATURE

This theme addresses the Territory Plan assessment outcome: threats to biodiversity such as noise, light, pollution, invasive species incursions or establishment, chemical pollution, or site disturbance are avoided or minimised.

It seeks to identify and minimise potential threats to biodiversity which can result from urban encroachment and human impacts. Key threats include biosecurity, i.e., weeds, pests and diseases of plants and animals, and uncontrolled fires and floods.

DESIGN ELEMENTS

3.1 NATURAL RESILIENCE

3.1A Weeds and pests

3.1B Natural threats

3.2 PROTECTING THE ECOLOGICAL NETWORK

3.2A Human induced threats

3.2B Restored nature

Why this is important.

By minimising threats and human induced disturbances, biodiversity sensitive urban design can help to create urban environments that are more resilient, sustainable, and hospitable to a wide range of species. This can have several benefits, including improving the quality of life for humans, enhancing ecosystem services such as pollination and carbon sequestration, and contributing to global efforts to protect biodiversity and combat climate change.

3

This theme supports the interpretation, application and assessment of the following assessment outcome as outlined in the

Territory Plan:

- Threats to biodiversity such as noise, light pollution, invasive species incursions or establishment, chemical pollution, or site disturbance are avoided or minimised through good design/planning.

Location: Mulligans Flat Woodland Sanctuary, Throsby ACT.

3.1 NATURAL RESILIENCE

The commendable efforts to green our cities can sometimes introduce risks, through more community gardens, suburban trees, or urban forests that can attract pests and weeds. Suitable plant selection for urban landscaping is an important factor in protecting the local biodiversity and surrounding natural areas. Design should also incorporate suitable bushfire and flood risk mitigation factors.

DESIGN GUIDANCE

3.1A WEEDS AND PESTS

- Prevent invasive plant or animal incursion and population establishment. One option is to introduce buffer zones to protect the surrounding natural area, particularly from weeds, including escaped garden plants or inappropriate potentially 'weedy' species used in landscaping. Buffer zones can be simple physical buffers (walls, fences) or vegetation and other landscaping features can be included where physical barriers risk impacting on ecological connectivity.
- Further introduction of weedy and exotic plants can be minimised by landscaping with locally native plants, as advised by the [Municipal Infrastructure Standards Part 25 Plant Species for Urban Landscape Projects](#) which lists suitable and pest plants in the ACT as well as species that have restricted use due to their invasive potential.
 - Planting local, native or drought tolerant plant species can also reduce water consumption and increase vegetation survival rates in landscaped areas and gardens.
- Landscape design should also plan for the predicted, more extreme climate in the future. The ACT Government has published [Gawari Ngilanmanyin Remembering the Bush: A Climate-wise Landscape Guide for the ACT](#) to assist in the planning and design of healthy, climate resilient and biodiverse gardens and public spaces.
- Linear pathways through the environment increase the impact of invasive predators (e.g. cats and foxes) on small native species. Small mammals, such as Antechinus and Dunnarts, in particular are now very rare within the urban environment.

3.1B NATURAL THREATS

- Bushfire-resilient plant species in high bushfire risk areas can reduce the movement of embers and mitigate the potential spread of fire.
- Ensure that any bushfire Asset Protection Zones (APZ) are incorporated entirely within the development site boundary to minimise impacts upon surrounding natural values. When these zones extend to the surrounding natural areas, and are subject to management actions, negative environmental impacts such as removal of native vegetation or soil disturbance are likely. When the development is next to protected areas, the APZs should be increased to further prevent impacts.
- Ensure development is located outside of flood prone areas. Where development is located near flood prone areas optimise them to provide habitat and climate refugia for biodiversity and locate more permeable land uses such as parks in these areas to reduce stormwater runoff and mitigate flood risk.



Superb Parrot, threatened due to loss of mature trees. Photo: Mark Jekabsons

3.2 PROTECTING THE ECOLOGICAL NETWORK

Urbanisation and associated construction and building works can threaten biodiversity through disturbance regimes. New developments can minimise impacts on adjacent areas, both during the active building phase by instilling good environmental management, and through design that considers how to avoid or mitigate factors like noise, artificial light and pollution carried by water entering natural areas.

DESIGN GUIDANCE

3.2A HUMAN INDUCED THREATS

- Design to minimise development's threats to environment and human-induced disturbances.
 - ACT Environment Protection Authority has extensive guidance on environment protection during land development and construction ([here](#)).
 - Development should aim to retain natural darkness in all areas which seek to provide effective wildlife habitat in the urban area. This may be achieved by screening artificial light using built or living infrastructure - refer to best practice lighting design [guidance](#).
- Aim to maintain overland flow and infiltration levels equivalent to pre-development standards across all development sites, to avoid impacts to hydrological function and downstream water quality.

3.2B RESTORED NATURE

- Re-naturalise existing urban infrastructure such as stormwater channels and constructed water bodies to create natural assets and improve local amenity, water quality, urban cooling and biodiversity outcomes.



Naturalised urban wetland, Lyneham ACT.

Implementing BSUD to preserve urban green space, vegetation coverage and biodiversity will contribute to other ACT key policies and strategies.

For example, increased green coverage can reduce the long-term impacts of climate change, including changes to soil moisture content, vegetation transpiration rates and productivity, and ambient air and water temperatures, and contribute to the Living Infrastructure Target to provide Canberra's urban footprint with:

- 30% tree canopy cover or equivalent (for example, green roofs, shrub beds, wetlands and rain gardens)
- 30% permeable surfaces (for example, grass, gravel and permeable paving)

In addition, BSUD works alongside the ACT's Urban Forest Strategy that seeks to protect our urban trees, ensure tree canopy is equitably distributed across the urban ACT and increase the tree species diversity.



Woden from Mount Taylor, ACT. Photo: ACT Urban Forest Strategy

THEME 4:



CONNECT PEOPLE TO NATURE

This principle seeks to address multiple Territory Plan assessment outcomes by creating opportunities for positive human-nature interactions by integrating biodiversity into urban environments in a way that increases people's immersion in and understanding, acceptance and appreciation of nature.

DESIGN ELEMENTS

4.1 COMMUNITY STEWARDSHIP

4.1A Co-design

4.1B Stewardship

4.2 INTERACTING WITH NATURE

4.2A Respectful connections

4.2B Interactive infrastructure

4.3 ENVIRONMENTAL EDUCATION

4.3A Engagement and learning

4.3B Instilling natural values

Why this is important.

Exposure to nature has numerous positive impacts upon human health and wellbeing with research showing vast improvements in mental and physical health when natural green spaces are available for people to enjoy. ACT Government's Wellbeing Framework recognises that Canberra residents' health and wellbeing are enhanced by access to the natural environment, and has established Environment and Climate as one of its domains.

Positive human-nature interactions with urban biodiversity increases awareness and appreciation of nature which can lead to greater public support for conservation efforts and environmental stewardship while also reducing human-wildlife conflicts which supports the coexistence of human and wildlife in urban areas.



4

This theme outlines broader aspirations around connections between people and nature, and the associated design elements are optional but encouraged.

These elements align with, and assist with achieving the ACT Urban Design Guide's aspirations relating to urban trees, landscaping, active travel, recreation, public amenity and natural features as well as creating positive engagement with nature.

Location: Yerrabi Pond,
Canberra ACT.

4.1 COMMUNITY STEWARDSHIP

Urban design should encourage people to care for their surrounding natural shared spaces. The sense of community, and shared responsibility of natural areas should be recognised and respected, and built in at the start of the development. Joint ownership can also help with achieving more in terms of conservation and recreation goals.

DESIGN GUIDANCE

4.1A CO-DESIGN

- Provide opportunities for community input and feedback on environmental aspects of planning and design.

4.1B STEWARDSHIP

- Enhance local stewardship with ‘cues to care’ that communicate to people that natural landscapes are intentional, functional and valuable.
- Design for stewardship to ensure the community can take ownership of the biodiversity assets into the future for example with local bush, landcare or ‘friends of’ group activities.



Location: Forde Wetlands, Forde ACT

Exemplar:

Community garden at Dairy Road Precinct
Location: Dairy Road, Canberra ACT.



4.2 INTERACTING WITH NATURE

Urban design should enable appropriate access and interaction between humans and the environment and cultural heritage. Places and objects within the development or in surroundings areas that have cultural or natural significance should be respected and protected. Residents should be provided active transport and accessibility to nature and green space for wellbeing, which includes a diversity of native plant and animal species. Design should also build welcoming and safe spaces where people can interact with each other and experience a sense of escape and connection to nature.

DESIGN GUIDANCE

4.2A RESPECTFUL CONNECTIONS

- Acknowledge and facilitate existing valued features and connections between the community and the natural environmental elements of a site.
- Showcase native species, including endemic ones, to celebrate the local ecologies and strengthen the sense of place.

4.2B INTERACTIVE INFRASTRUCTURE

- Use green infrastructure to create opportunities for interaction and positive engaging experiences with natural environment through community gardens, wildlife observation and nature and water play.
- Facilitate formal and informal use of natural areas with visitor/user infrastructure such as social and gathering spaces, play equipment, fitness equipment, street furniture etc
- Provide high-quality green and walkable connections between open spaces to facilitate active travel and environmental connections.
- Design should also build welcoming and safe spaces where people can interact with each other and experience a sense of escape and connection to nature



Walkable green connection. Location: Greenway ACT.



Exemplar:

Kambah Adventure Playground offers multiple play experiences for all ages and abilities at a range of sites throughout the park, including nature play. There are also toilets, barbeques, seating, tables and other amenities that enable community to spend quality time in the park.

Location: Kambah Adventure Playground, Canberra ACT.
Photograph: Better places to play: ACT Play Space Strategy

4.3 ENVIRONMENTAL EDUCATION

To embed the appreciation of nature, design should offer opportunities for the residents to learn about natural environment and cultural heritage and put those learnings in place. Multi-use areas where people can interact with culture and ecology can also provide education opportunities for local school groups and spaces for active cultural interpretation and place-making.

DESIGN GUIDANCE

4.3A ENGAGEMENT AND LEARNING

- Incorporate opportunities for community engagement and education with explanatory/interpretive signage, sensory gardens, nature-based play and informal learning elements.
- Incorporate space for art, structures, planting, installations etc to create both formal and informal opportunities for learning.

4.3B INSTILLING NATURAL VALUES

- Reflect environmental values through creative interventions and responses in built form and public spaces to incorporate the environmental landscape into the urban environment.
- Foster activities that showcase environmental values and encourage community connection through nature. For example, design should consider providing spaces and opportunities for individual and community gardens, in addition to biodiversity sensitive public, landscaped spaces.



Explanatory signage, Location: Lyneham Wetland, Canberra ACT.



Gubur Dhaura heritage park, Gungahlin ACT. Photo: Mark Jakobsons



Exemplar: Protecting cultural heritage in the Murrumbidgee River Corridor

- The Murrumbidgee River corridor consists of several cultural heritage sites including Aboriginal sites and European ruins. The Murrumbidgee River Corridor Management Plan sets in place several key factors for consideration in designing works and infrastructure through the corridor, which may also be relevant when planning interface zones. These considerations include:
- Walking paths and routes designed to avoid archeologically sensitive areas.
- Restrictions on access to cultural sites to safeguard their security.
- Precinct plans developed for sites of significant cultural heritage to ensure their management and use retain cultural significance.
- Protection of valuable cultural sites must be considered when designing hazard reduction approaches.

Location: Murrumbidgee River Corridor, Photo: Mark Jekabsons



Urban Interface, Gungahlin
Photo: Mark Jekabsons



Appendix

BIODIVERSITY SENSITIVE URBAN DESIGN CHECKLIST

This design criteria checklist is an evaluation tool for those involved in the planning, design and delivery of built environment projects to demonstrate that a given project achieves good design outcomes in the ACT context. It could be used at several stages throughout a project, from early design concepts, to detailed proposals and completed works.

THEME 1 – MAINTAIN AND ENHANCE NATURE	NOTES
This chapter supports the interpretation, application and assessment of the assessment outcomes specified in the Territory Plan.	
1.1 URBAN WATERWAYS AND CATCHMENTS	
1.1a Natural context	<input type="checkbox"/>
1.1b Water sensitive urban design	
1.1c Topography and hydrology	
1.2 GRASSLANDS AND WOODLANDS	
1.2a Natural features	<input type="checkbox"/>
1.2b Design enhancements	<input type="checkbox"/>
1.3 NATURAL VALUES AND FEATURES	
1.3a Existing natural values	<input type="checkbox"/>
1.3b Natural processes	<input type="checkbox"/>

THEME 2 – CONNECT AND EXTEND NATURE	NOTES
This chapter supports the interpretation, application and assessment of the assessment outcomes specified in the Territory Plan.	
2.1 ECOLOGICAL CONNECTIVITY	
2.1a Habitats and corridors	<input type="checkbox"/>
2.1b Corridor features	<input type="checkbox"/>
2.1c Habitat features	<input type="checkbox"/>
2.1d Connectivity barriers	<input type="checkbox"/>

THEME 3 - MINIMISE THREATS TO PROTECT NATURE	NOTES
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This chapter supports the interpretation, application and assessment of the assessment outcomes specified in the Territory Plan.

3.1 NATURAL RESILIENCE	
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3.1a Weeds and pests	<input type="checkbox"/>
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3.1b Natural threats	<input type="checkbox"/>
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3.2 PROTECTING THE ECOLOGICAL NETWORK	
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3.2a Human induced threats	<input type="checkbox"/>
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3.2b Restored nature	<input type="checkbox"/>
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THEME 4 – CONNECT PEOPLE TO NATURE	NOTES
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This chapter supports the interpretation, application and assessment of the assessment outcomes specified in the Territory Plan.

4.1 COMMUNITY STEWARDSHIP	
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4.1a Co-design	<input type="checkbox"/>
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4.1b Stewardship	<input type="checkbox"/>
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4.2 INTERACTING WITH NATURE	
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4.2a Respectful connections	<input type="checkbox"/>
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4.2b Interactive infrastructure	<input type="checkbox"/>
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4.3 ENVIRONMENTAL EDUCATION	
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4.3a Engagement and learning	
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4.3b Instilling natural values	
---------------------------------------	--

GLOSSARY

This glossary identifies the words and acronyms that appear frequently throughout the Biodiversity Sensitive Urban Design Guide, to help the reader identify unfamiliar words and industry specific terminology.

ACT – Australian Capital Territory.

Accessibility – The ease of reaching destinations. In a highly accessible location, a person, regardless of age, ability or income, can reach many activities or destinations quickly, whereas people in places with low accessibility can reach fewer places in the same amount of time.

Biodiversity – The variability among living organisms from all sources including terrestrial, aquatic, marine and other ecosystems and the ecological complexes of which they are part), at all levels of organisation, including genetic diversity, species diversity and ecosystem diversity.

Biodiversity values – The properties or features of a land or a site that make it important for biodiversity. Examples include:

- Land containing important species or ecological communities – such as native grasslands which are habitat for earless dragons,
- Land which is in a riparian zone because this land is important for maintaining good water quality and providing habitat.
- Old growth forests and mature native trees as they are important habitats and provide important features for many plant and animal species.
- Other natural habitat features like rocky outcrops, coarse woody debris (fallen logs, branches), swampy meadows and grassland soaks (wetlands that appear and disappear according to rainfall), that provide native animals with food and shelter and sites for nesting, migration and social interaction.
- Land that acts as an ecological corridor, connecting separate habitat patches.

Buffer – The buffer zones are areas created to enhance the protection of a conservation area, often peripheral to it, inside or outside. Within buffer zones, resource use is managed to reduce the negative impacts of restrictions on the neighbouring communities.

Bushfire Asset Protection Zones (APZ) – an area in and/or beside urban development that is designed and managed to reduce the risk of adverse impacts from bushfires on assets (public or privately owned).

CED - City and Environment Directorate.

Conservation – The protection, preservation, management or restoration of biodiversity.

Core Habitat – An area which contains necessary structural and compositional elements of habitat (e.g. trees, water, grass) and which is of a sufficient size to effectively support an individuals' survival and reproduction.

Corridor Habitat – An area which meets the structural and compositional requirements of core habitat, but on a smaller scale such that movement through the area can be achieved (if not permanent occupancy).

Ecological Connectivity – The degree that organisms or natural processes can move unimpeded across habitats – both terrestrial and aquatic. Natural and semi-natural components of the landscape must be large enough and connected enough to meet the needs of all species that use them.

Ecosystem – A dynamic combination of plant, animal and microorganism communities and their non-living environment (e.g. soil, water and the climatic regime) interacting as a functional unit. Examples of types of ecosystems include forests, wetlands, and grasslands.

Ecosystem services – The services provided by the functioning of natural ecosystems which are essential to human survival and wellbeing. Natural ecosystems maintain the atmosphere; provide clean water; control soil erosion, pollution and pests; pollinate plants; and provide many other essential processes. The language of ecosystem services has emerged in recent decades as a way of representing the significance of the benefits humans derive from natural systems.

Endemic species – In the context of this guide, species which are only found within the ACT and region.

Ephemeral wetlands – The wetlands that appear and disappear according to rainfall and ground water levels.

Fragmentation – The process whereby areas of habitat become inaccessible due to physical or behavioural barriers to species movement. This may result from habitat clearing or removal, excessive noise or light levels creating inhospitable habitat, or built infrastructure which physically impedes the movement of native species (e.g. a fence).

Good Design – Architectural and urban design outcomes is expected to comply with good practice design principles as a minimum ambition.

Habitat – The locality or natural home in which a plant, animal or a group of closely associated organisms live.

- Functional habitat –habitat that can sustain species, populations and biodiversity, in other words, a habitat that can provide food, shelter, and sites for nesting, migration and social interaction etc for a number of species, and is well connected to other habitats.
- Habitat features (structural habitat) - parts of the environment (living or non-living) that provide native animals with structural habitat elements such as shelter and sites for nesting, basking, and foraging, and which also support migration and social interaction.

Hydrological function – The capacity of an area to capture, store and safely release water when that water comes from rainfall or run-on. Optimal hydrological function occurs when soil and the vegetation community is in a condition that they can hold water, and slow its runoff velocity so that soil erosion does not happen.

Impermeable surfaces – The hard surfaces (including compacted soils) introduced by urban infrastructure which restrict or limit the permeability of surface layers of the landscape.

Infrastructure – The basic systems, facilities or framework that support the human community’s population, e.g. roads, transport, utilities, water, sewage.

Invasive plant / animal – The introduced plants/animals that can establish on many sites, multiply quickly and spread to the point of disrupting native plant and animal communities or ecosystems.

Living infrastructure – The vegetation, soils and water systems that are sometimes referred to as blue or green infrastructure.

Native species – In the context of this guide, a native species is one whose natural distribution is considered to include ACT and the surrounding area.

Open space – Areas defined as Urban Open Space in the Territory Plan. This includes areas such as sports grounds, pedestrian ways and urban parks.

Permeable pavements – An alternative to impermeable surfaces, and can include brick paving where water infiltrates between the cracks or paving material designed so water can move through the blocks.

Pest – An exotic species that causes serious social, environmental or economic damage to a valued resource.

Precinct – Is defined as: development on land that forms part of a centre – group centre, town centre, local centre development that forms part of a corridor.

Public Realm – The general term for an open area or place for public use, e.g. streets, parks, plazas, squares.

Remnant vegetation / remnant bushland – Areas of natural ecosystems which are retained within the urban context, and which have suffered relatively little disturbance relative to surrounding areas. These are often maintained as fragmented habitat islands.

Re-naturalise – Restore an area using restoration techniques, to re-establish natural species composition, vegetation and habitat structure, and/or ecological functions.

GLOSSARY

Continued from previous page

Reserve – A reserve is an area defined as a Nature Reserve under the Territory Plan. The primary purpose of these areas is for Nature Conservation value, as well as recreation value.

Resilience – The capacity of a system to absorb disturbances and reorganise while undergoing change so as to retain essentially the same function, structure, identity and feedbacks.

Restore – Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed.

Riparian – An area of terrestrial land adjacent to a water body that is affected by periodic inundation and hydraulic disturbance. As such it contains a suite of landforms and groups of associated vegetation communities that are different to the broader adjacent terrestrial lands.

Sustainability – An approach that considers the environmental, social and economic aspects (such as of a building) so it can meet the needs of the present, without compromising the ability of future generations to meet their needs.

Taxon group – In this document's context, a taxon group is a group of species with similar habitat requirements, ie woodland birds, grassland lizards, freshwater fish etc..

Terrestrial – Species and environments which predominantly live on land, i.e. those other than aquatic or marine environments, and includes subterranean environments.

Threatened – The threatened species or ecological communities are those threatened with extinction or destruction as described in the Nature Conservation Act 2014.

Threatening process – As described in the NC Act. In relation to a species or ecological community, this refers to a process that threatens, or may threaten, the survival, abundance or evolution of the species or community.

Territory Plan – Provides statutory planning guidance for development in the ACT.

Urban encroachment (urban sprawl) – The spreading of urban developments into undeveloped land near a city.

Urban Open Space – Unleased Territory Land within the urban area set aside for public use, zoned as PRZ1 in the Territory Plan.

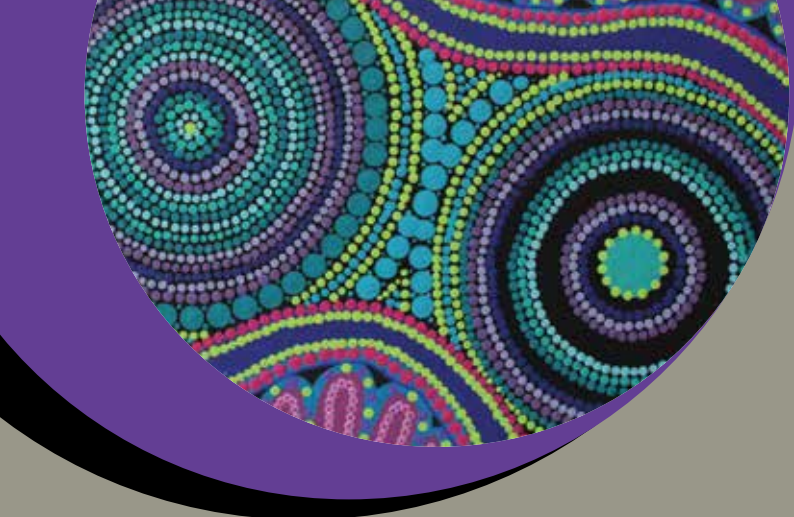
Water sensitive urban design (WSUD) – Is the planning, design or construction of the built environment to minimise water runoff and ensure any runoff causes the least amount of damage. It is also about wise use of that water to improve our urban environment.

Weed – Environmental weeds or invasive weeds are exotic plant species that invade native vegetation and represent a threat to the conservation values of natural ecosystems.



ACT
Government

ACT **BSUD** **Implementation** **Advice**



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Further guidance on implementing BSUD

1 FURTHER GUIDANCE

This Appendix is intended to be read in conjunction with the Biodiversity Sensitive Urban Design Guide. It provides additional detailed information on how to achieve the themes and design elements of the BSUD Guide and includes references to existing requirements and current research from the local context. This includes best practice metrics for achieving protection, function and connection of Canberra's main ecosystem types.

Proponents should note that the quantitative design advice provided in this Appendix is not absolutely required to be used to inform design (consistent with the philosophy of an outcomes based planning system). However, where an alternative or contrary approach is proposed, it is expected that the approach is supported with appropriate evidence-based rationale, to explain how the design is expected to achieve the stated outcome.



Tuggeranong from Mount Taylor, ACT.

2 GENERAL ENVIRONMENTAL PROTECTION SPECIFICATIONS

2.1 ENVIRONMENT PROTECTION CONTROLS

The ACT's Environment Protection Authority has developed [Environment Protection Guidelines for Construction and Land Development in the ACT](#) to provide advice on environmental issues applicable to all land development and construction sites.

2.2 EROSION AND SEDIMENT CONTROL

Erosion and Sediment Control (ESC) Plans are fundamental to the environment protection process. They detail the controls to be used during land development and construction to manage the environmental impacts of activities. ESC Plans are a requirement under the Environment Protection Regulations 2005 and must be submitted to and approved by the EPA as part of the development application process.

ACT's requirements for managing erosion and sediment runoff are documented in [EPA Guidelines for Construction & Land Development](#). This guide is aimed to land developers, builders and anyone carrying out or supervising civil construction and building works in the ACT and is focusing on waterway protection. Further advice on how to implement measures to control erosion and sedimentation is outlined in Municipal Infrastructure Technical Specification (MITS) 00C Control of Erosion and Sedimentation.

NSW Department of Planning and Environment has developed guidelines for effective soil and water

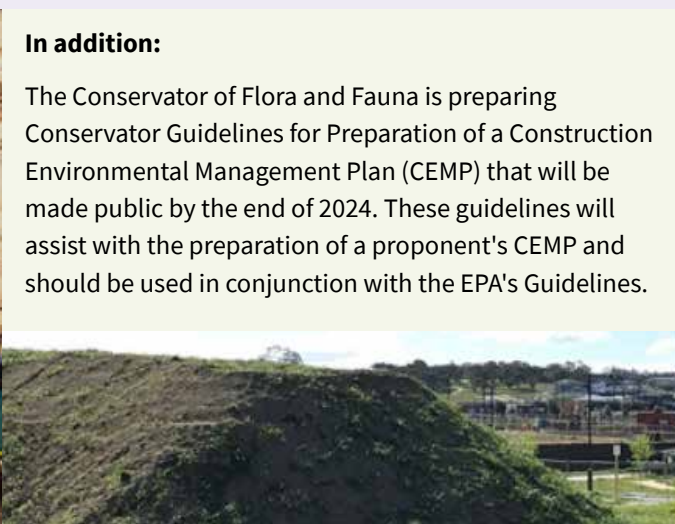
management during construction or other land disturbance activities, including advice on rehabilitation. A report is available for download from [Managing Urban Stormwater soils and construction Volume 1 4th ed | NSW Environment and Heritage](#).

These guidelines, commonly known as the 'Blue Book', need to be adhered to to reduce the impacts of land disturbance activities on waterways through better management of soil erosion and sediment control. The guidelines are built around seven principles:

- assess the soil and water implications of development at the subdivision or site planning stage. Investigate the salinity or acid sulphate potentials of the soils where their disturbance is likely to expose and/or exacerbate this problem;
- plan for erosion and sediment control concurrently with engineering design and before earthworks begin, ensuring proper assessment of site constraints and integration of the various components;
- minimise the area of soil disturbed and exposed to erosion;
- conserve topsoil for later site rehabilitation/ revegetation;
- control water flow from the top of, and through the development area;
- rehabilitate disturbed lands quickly; and
- maintain soil and water management measures appropriately during the construction phase.

In addition:

The Conservator of Flora and Fauna is preparing Conservator Guidelines for Preparation of a Construction Environmental Management Plan (CEMP) that will be made public by the end of 2024. These guidelines will assist with the preparation of a proponent's CEMP and should be used in conjunction with the EPA's Guidelines.



Images of exposed soil and stockpile control measures. Source: [Environment Protection Guidelines for Construction and Land Development in the ACT](#)

2.3 LIGHT POLLUTION

Light pollution is best described as artificial light that is allowed to illuminate areas not intending to be lit. Outdoor lighting must comply with AS4282 – Control of the obtrusive effects of outdoor lighting, however, this is a standard focusing on lighting installations and does not apply to road lighting.

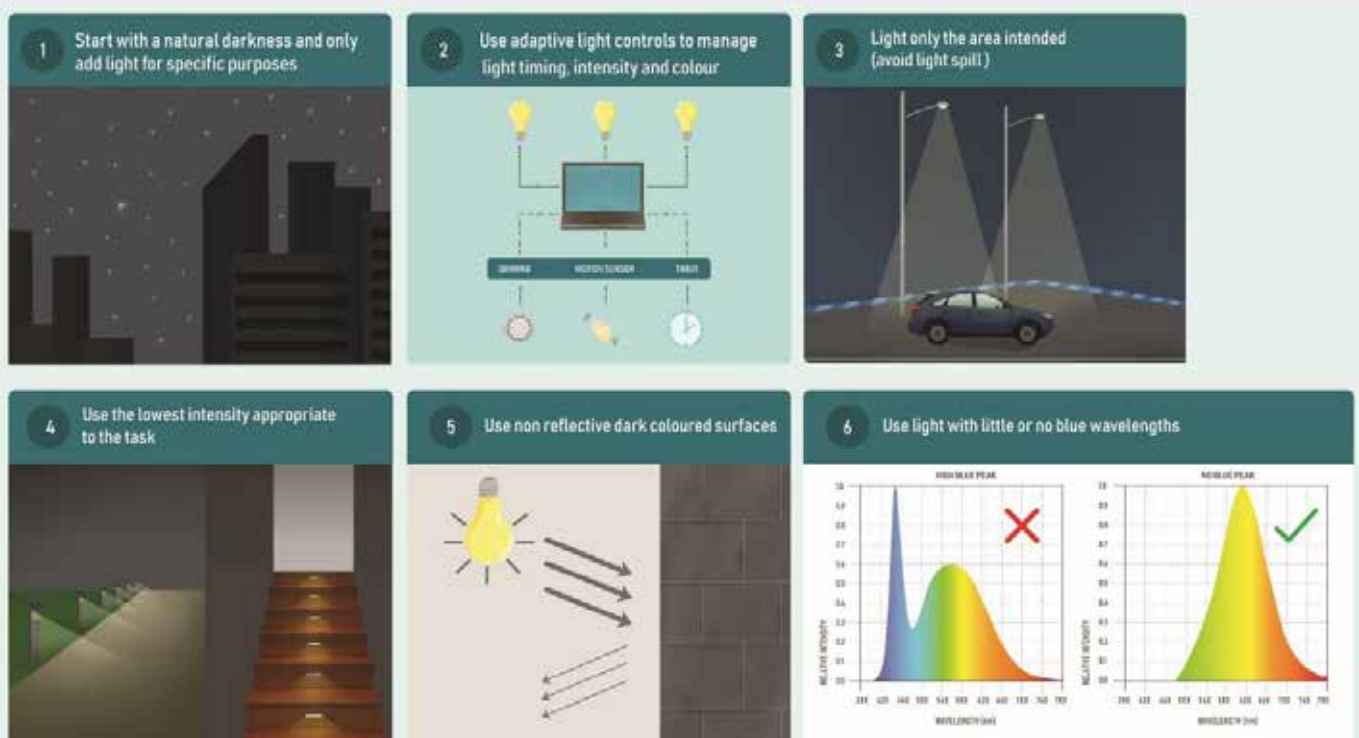
The Environment Protection Act 1997 legislates that there is an environmental duty to take all practical and reasonable steps to minimise environmental harm or nuisance caused by lighting activities. However there are no fixed lighting levels specified to avoid impacts on vulnerable animals or habitats.

Many species and communities are sensitive to artificial light pollution, which can affect how they utilise habitats to find food, avoid predation and travel through the landscape. Artificial lighting can therefore elicit behavioural changes, including functional fragmentation, and reduced survivorship in many species. Development adjacent to natural areas and in spaces intended to

encourage wildlife habitation and movement should aim to have as little artificial light and light spill as possible.

National Light Pollution Guidelines for Wildlife (dceew.gov.au) provides guidance on best practice lighting design and principles:

- Start with natural darkness and only add light for specific purposes avoiding spill into adjacent natural areas
- Use adaptive light controls to manage light timing, intensity and colour
- Light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill
- Use the lowest intensity lighting appropriate for the task
- Use non-reflective, dark coloured surfaces
- Use lights with reduced or filtered blue, violet and ultra-violet wavelengths.



Best practice lighting principles. Source: National Light Pollution Guidelines for Wildlife, DECEW

2.4 UNNATURAL FRAGMENTATION OF HABITAT (LOSS OF ECOLOGICAL CONNECTIVITY)

Habitat fragmentation refers to a process by which habitat loss or artificial barriers result in the division of large habitat patches into smaller isolated patches that disrupt biological processes and significantly increases the likelihood of extinction of flora and fauna, including those listed under the Nature Conservation Act 2014. Unnatural Fragmentation of Habitats is recognised as a Key Threatening Process under the Nature Conservation Act 2014.

In the ACT habitat loss and fragmentation are considered to negatively impact almost every species and ecological community currently listed as threatened including species in woodland (e.g. Swift Parrot), grassland (e.g. Grassland earless dragon) and riparian zones and aquatic habitats (e.g. Macquarie Perch). Urban development, clearing and physical barriers to movement, e.g. vegetation removal, roads, weirs, and poorly placed urban parks, are some of the key causes of fragmentation in the urban context.

Supporting documents and tools

- [Threatened Species and Ecological Communities - Environment, Planning and Sustainable Development Directorate - Environment \(act.gov.au\)](#)
- [Loss of Mature Native Trees Action Plan \(act.gov.au\)](#)
- [Nature Conservation \(Unnatural Fragmentation of Habitats\) Conservation Advice 2019 | Notifiable instruments \(act.gov.au\)](#)
- [ACT Ecological Network Dashboard](#)

Three scales of connectivity:

- **Site level connectivity** refers to the connections between patches of habitat that suit a specific species. Some species have small territorial ranges, so protecting and planting individual trees and patches of native vegetation at the 'site' scale will provide additional cover for these dispersal-limited species to forage and find resources. For example some bird species can move across a landscape via paddock trees while others require continuous cover.
- **Landscape level connectivity** refers to the physical connections between habitat patches across a landscape. More wide-ranging species require movements between large habitat patches across a landscape to access a variety of locally rare resources. For example: linear strips of native vegetation along roadsides or scattered paddock trees through agricultural lands can link larger patches of remnant habitat thereby allowing the movement of animals and seed transfer of plants.
- **Regional connectivity** refers to how ACT links with regional biodiversity/ecological corridors. The ACT is a key 'crossover' location of nationally important wildlife corridors that link the mountainous corridors of the great divide and the coastal ranges of eastern Australia known as the Great Eastern Ranges. Facilitating regional level connectivity is particularly important for migratory species so that they can move long distances between seasonal breeding grounds.

Design Guidance for avoiding unnatural fragmentation of habitats (maintaining ecological connectivity)

- **1. Avoidance** – It is preferable to avoid fragmentation, rather than to attempt to ameliorate it or recreate connectivity. Where possible fragmentation should be avoided by considering re-locating or re-positioning any activity. If that cannot be done, then original habitat should be retained within the development footprint to the greatest extent possible, adhering to the principles listed below.
- **2. Shape and edge effects** – Many species exhibit avoidance of the edges of a habitat. This might be related to a wide range of factors, such as exposure to higher temperatures, more light or noise or the risk of predation. It is best to minimize the amount of edge habitat relative to interior habitat. Ensure that terrestrial habitat patches are approximately circular in shape, while avoiding the creation of patches that are narrow and linear or have a convoluted outline.
- **3. Scale** – Bigger is better. Avoid creating patches that are small. These will support fewer individuals of the species of interest and thus the population of that patch will be less resilient to other impacts.
- **4. Proximity** – Minimise the distance between patches created. This may allow mobile individuals to move between patches, such that individuals lost to impacts on one patch may be replaced by immigration from a neighbouring patch. This increases resilience across all patches that are linked.
- **5. Restoration** - Habitat loss need not be permanent. In areas that will be disturbed during the activity but not permanently destroyed, avoid disturbing soil and long lived features (e.g. large mature trees) and plan to reinstate functional habitats
- **6. Reconnection** - Ideally any patches created by the activity should be reconnected via the restoration of habitats (above) but where this is not feasible, patches can occasionally be reconnected via design features tailored to the species of concern. There are a multitude of methods available to ameliorate barriers and improve connectivity (faunal overpasses/underpasses, rope bridges, fishways, habitat rehabilitation etc). It is important that the method is appropriate to the species of concern. This may require multiple methods to be used. For example, connectivity for some birds may be re-established by the planting of trees tens of metres apart, while ground dwelling mammals may require continuous, low vegetation or road underpasses to bridge the same gap.
- **7. Plants are affected by fragmentation too** - Plants can be susceptible to edge effects and may also need to "move" via the dispersal of seeds and pollen. For example, dams may prevent downstream dispersal of water borne seeds (hydrochory) and this is reflected in different riparian plant communities downstream of dams in comparison to free flowing rivers.
- **8. Barriers may be subtle** - The factors that prevent movement may not be readily apparent to the human eye. The nature of a barrier depends on a range of factors such as the method of dispersal and the size and physiology of the organism. Refer to Table 4 of this document for details.

2.5 FAUNA-FRIENDLY ROAD DESIGN

Appropriately designed fauna crossing structures should be provided where linear infrastructure features (such as roads) fragment native habitats. These fauna-friendly inclusions need to be sufficient to maintain animal movement in the landscape. Such structures should represent continuous stretches of structurally suitable habitat (e.g. consistent with grassland, woodland or aquatic/riparian habitat features as appropriate), be of suitable dimensions, and represent a corridor with an absence of any known or suspected barriers to animal movement.

Fauna crossing structures should facilitate the safe movement by known and potential current or future native wildlife species.

Examples of suitable design considerations can be found at:

- <https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Fauna-Sensitive-Road-Design-Volume-2>
- https://www.vicroads.vic.gov.au/-/media/files/documents/planning-and-projects/environment/vicroads_n1571864_vicroads_fauna_sensitive_road_deisgn_guidelines_final.ashx



Fauna underpass on the Calder Freeway. Source: VicRoads Fauna sensitive road design guidelines.

2.6 WATERWAY CROSSING DESIGN

Creation of waterway crossing structures (such as bridges, culverts and walkways) can result in fragmentation of aquatic habitats for native fauna, including threatened species, fish, turtles, frogs, platypus and rakali. Construction can also result in damage to key aquatic and riparian habitats, and ongoing disturbance to hydrological function, such as changes to bed and bank erosion and sedimentation.

Retaining aquatic connectivity and avoiding ongoing habitat impacts should be a key consideration of designing and constructing waterway crossings and near waterway structures.

It should be noted that permits and approvals may be required under relevant ACT Acts and regulations for construction of waterway crossings. Crossing structure design in the ACT should adhere to the design guidance found within the [NSW Why do fish need to cross the road?](#) document. Additional direction can also be found in the [New South Wales Department of Primary Industry Policy and Guidelines for Fish Friendly Waterway Crossings](#), which contains relevant advice on minimising impact of waterway crossing construction.

- The above guidance is considered to be best practice when considering fish passage. However, additional consideration should be given to potential connectivity for other aquatic biota, including invertebrates and plants.
- In the majority of circumstances, where appropriate, the best design solution to retain aquatic and riparian values is to create a span bridge. This avoids the majority of impacts on aquatic and riparian values, allowing aquatic biota to continue disperse through the landscape.
- Incorporating fish friendly elements into crossing design, such as low water channels, roughness and shelves can enable and encourage passage by a wider variety of biota over a broader range of flow conditions.



Before & after photos of the same road crossing rehabilitated to allow safe fish passage



Fauna underpass on the Calder Freeway. Source: VicRoads Fauna sensitive road design guidelines.



Location: Mulligans Flat Woodland Sanctuary, Throsby ACT.

2.7 THREATENED SPECIES

The ACT is home to many vulnerable, threatened and endangered species and ecological communities as listed below. Unfortunately this list keeps growing and revisions are made regularly. Up to date listings can be found on the Nature Conservation Threatened Native Species List.

Current 2024 threatened species are:

→ Insects and reptiles:

- Canberra Grassland Earless Dragon
- Golden Sun Moth
- Key's Matchstick Grasshopper
- Mountain Skink
- Perunga Grasshopper
- Pink-tailed Worm-lizard
- Striped Legless Lizard

→ Mammals

- Broad-toothed Rat
- Brush-tailed Rock-wallaby
- Eastern Bettong
- Eastern Quoll
- Grey-headed Flying-fox
- Koala
- New Holland Mouse
- Smoky Mouse

- Southern Brown Bandicoot (Eastern)
- Southern Greater Glider
- Spotted-tail Quoll
- Yellow-bellied Glider

→ Birds

- Australian Painted Snipe
- Australasian Bittern
- Brown Treecreeper
- Diamond Firetail
- Gang-gang Cockatoo
- Glossy Black-cockatoo
- Hooded Robin
- Little Eagle
- Painted Honeyeater
- Pilotbird
- Regent Honeyeater
- Scarlet Robin
- Southern Whiteface
- Superb Parrot

- Swift Parrot
- Varied Sittella
- White-throated Needle-tail
- White-winged Triller

→ Amphibians and Aquatic Animals

- Alpine Tree Frog
- Green and Golden Bell Frog
- Northern Corroboree Frog
- Southern Bell Frog
- Yellow-spotted Bell Frog
- Macquarie Perch
- Murray River Crayfish
- Riek's Crayfish
- Silver Perch
- Trout Cod
- Two-spined Blackfish

→ Plants

- Austral Toadflax
- Baeuerlen's Gentian

- Black Gum
- Brindabella Midge Orchid
- Button Wrinklewort
- Canberra Spider Orchid
- Dwarf Violet
- Ginninderra Peppercross
- Hoary Sunray
- Kiandra Greenhood
- Murrumbidgee Bossiaea
- Pale Pomaderris
- Small Purple Pea
- Tarengo Leek Orchid
- Tuggeranong Lignum

→ Communities

- Natural Temperate Grassland
- Yellow Box-Blakely's Red Gum Grassy Woodland
- High Country Bogs and Fens

The conservation advice for species can be found [here](#) and action plans for individual species and communities can be found [here](#).

The conservation of these species and communities are the focus of action plans developed under the Nature Conservation Act 2014. The action plans detail individual requirements for these species and communities, however it is also critical to consider steps that can be taken during land development processes that will facilitate improvements in habitat condition and connectivity.

Related resource: Action plan for listed migratory species, ACT Gov



2.8 URBAN INTERFACE DESIGN

The land between a residential area and non-residential areas, which may include nature reserves or unleased public open space, plays a critical role in protecting and enhancing the ecological values and function.

A key aim is to buffer the impacts of development on surrounding non-urban environments. When designing these areas it is essential to understand the ecological communities and individual species within and surrounding the interface zone. This includes animals that may use the area seasonally or for occasional movement but are not always present. Existing mapping and consultation with experts or EPSDD can illicit this information.

The design recommendations below aim to reduce the impacts of development on the surrounding natural areas. In implementing the recommendations, it is necessary to adhere to ACT's Nature Strip Guidelines that outline requirements for aspects such as the height of groundcover vegetation, and management of street trees.

- Buffer areas between the urban development and the adjacent conservation area should be considered to reduce impacts. Buffer areas could co-locate features such as catch drains, utility easements, bushfire protection zones etc.
- Designing an edge road, maintenance or recreational pathway along the interface can help with weed incursion.
- Retain existing native flora wherever possible and provide additional habitat opportunities, such as clumped understory plantings.
- Consider connectivity needs of wildlife by allowing safe movement through the urban matrix.
- Physical barriers to prohibit illegal vehicles entering the area.
- Additional planting of endemic plant species can provide habitat and further act as a barrier
- Weed and pest management plans should be developed

Threats to ecological communities' species and ecosystem processes need to be identified. Examples include:

- Habitat loss and degradation
- Fragmentation of habitat and loss of connectivity
- Establishment of invasive plants and pest animals
- Ecologically inappropriate disturbance regimes (mowing, fire)
- Construction impacts such as changes to hydrologic regime or soil properties / function
- Noise, light and chemical pollution
- Urban heat

Where the planned development is below a natural asset (Figure 2), the development zone perimeter should consist of an edge street with parallel parking where appropriate. Access and egress should be provided for emergency purposes and the maintenance of fire protection infrastructure.

Where the planned development is above a natural asset (figure 3), the urban interface zone should provide a buffer between urban development and downslope nature reserves or rural landscapes that allows sufficient space to treat stormwater and manage its flow into the nature reserve in a way that avoids erosion as well as any requirement for engineered stormwater treatment structures within the reserve. The development zone perimeter should consist of an edge street with parallel parking where appropriate. The urban interface zone can therefore play an important role in providing sufficient screening to ensure that views of urban elements (houses, cars, roads etc) are limited once within the nature reserve. Access and egress should be provided for emergency purposes and the maintenance of fire protection infrastructure. Trail standards should be designed in consultation with local emergency services.

Where the planned development surrounds a drainage line (Figure 4) the development zone perimeter should consist of an edge street with parallel parking where appropriate. The urban interface zone can therefore play an important role in providing sufficient screening to ensure that views of urban elements (houses, cars, roads etc) are limited once within the drainage line. Access and egress should be provided for emergency purposes and the maintenance of fire protection infrastructure. Trail standards should be designed in consultation with local emergency services.

Stormwater discharge that occurs at the interface of urban developments and drainage lines or creeks can result in flow transmission issues that typically include erosion and sedimentation. Water quality and weed infestation issues may also arise over time. These discharge points require appropriate treatment, potentially including options such as level-spreaders, rock-lined waterways, engineering drainage structures and the use of appropriate vegetation to stabilise discharge areas and manage flows. There should also be sufficient space to treat stormwater quality using WSUD elements such as bio-retention systems and wetlands and manage flows to receiving waters in a way that avoids erosion.



Figure 1 Typical cross-section for an urban interface zone where the adjoining natural asset is above the suburb. Source: Suburban Land Agency.



Figure 2 Typical cross-section for an urban interface zone where the adjoining natural asset is below the suburb. Source: Suburban Land Agency.

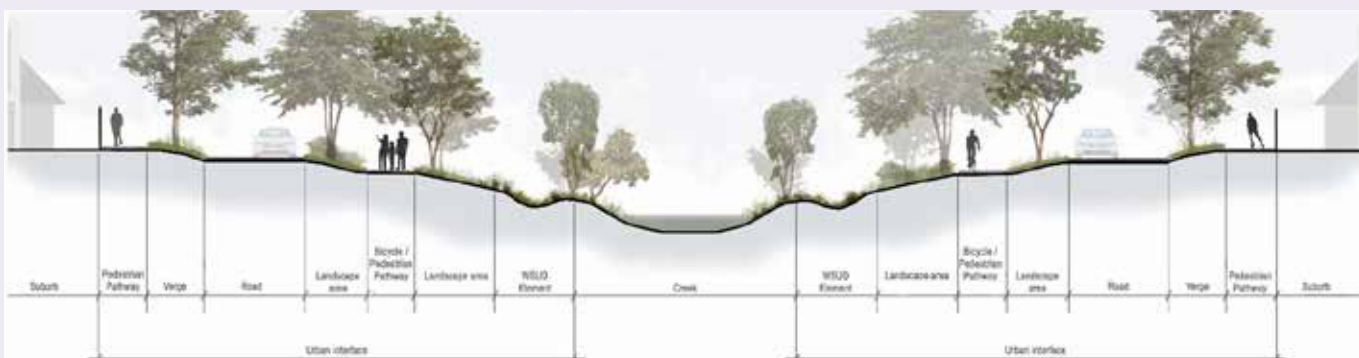


Figure 3 Typical cross-section for an urban interface zone where the adjoining natural asset traverses the suburb. Source: Suburban Land Agency.

2.9 CLIMATE-WISE LANDSCAPING

The ACT has published **Gwawari Ngilanmanyin Remembering the Bush: A Climate-wise Landscape Guide for the ACT** that focuses on six outcomes:



Thermal comfort and urban heat island mitigation



Protected and enhanced biodiversity and urban canopy



Landscapes that are resilient to the challenges of climate change



Cost, efficiency and value optimisation



Improved health and well-being of people, plants and animals



Reduced carbon footprint

Source: *Gawari Ngilanmanyin Remembering the Bush: A Climate-wise Landscape Guide for the ACT*

Key elements of Gwawari Ngilanmanyin guidance that relate to biodiversity sensitive urban design include:

→ Healthy soil is the foundation for healthy ecosystems and its type and quality will determine what can be grown and survive. Understanding soil properties of your site, protecting soil from erosion and compaction and ensuring adequate areas of deep soil are critically important when planning and designing suitable developments.

Watch out!

Compaction

Soil compaction can happen over time and result of foot traffic, heavy water and/or machinery, especially over turfed areas. Ensure soils are loose and aerated to allow for oxygen and water to filter through.

Waterlogging

Waterlogging may be a result of multiple factors such as compaction issues, site design or water management.

Exposed subsoil

Exposed subsoil on the surface is a common result of construction. Be sure to check you have adequate topsoil, which is usually darker in colour. Often plant failure is attributed to plants being planted directly into subsoil which does not have the organic content to support plant growth.



Waterlogged lawn and garden



Unhealthy vs. healthy soil

→ Water is the basis of all life. With future predictions for lower and more inconsistent rainfall for the ACT designing to minimise water runoff, treating water on site, reusing water onsite and providing habitat and improved amenity through retaining water on site is increasingly important.



Source: Gwawari Ngilanmanyin Remembering the Bush: A Climate-wise landscape guide for the ACT

→ Vegetation provides many ecosystem services to urban developments and has great ecological importance. Maximising canopy cover and providing diversity of vegetated areas will increase the resilience of landscapes and provide many social, environmental and economic advantages.

The importance of biodiversity

The plants you include on your site directly influence broader ecological diversity. The best ways to support increased biodiversity are:

- Avoid mono-culture planting (just using one or two types of plants)
- Use plants that attract birds and insects that aid the pollination process and help the health of ecological communities outside your site.
- Use trees and plants that provide safe habitat for animals

A lack of biodiversity in your garden will leave it more susceptible to climate changes over time, particularly if the mono-culture you have used fails in the new climate.

- Existing vegetation should be retained for its immediate shade, cooling, biodiversity and amenity.
- New developments are required to contribute towards ACT’s 30% tree canopy cover by utilising appropriate new plantings.
- Material selection is important in reducing the heat island effect and preserving natural processes in urban areas. Consideration to the colour, composition and permeability of materials and surfaces as well as manufacturing processes, transport costs and the life cycle of materials will improve the environmental and social impacts of poor material choices.

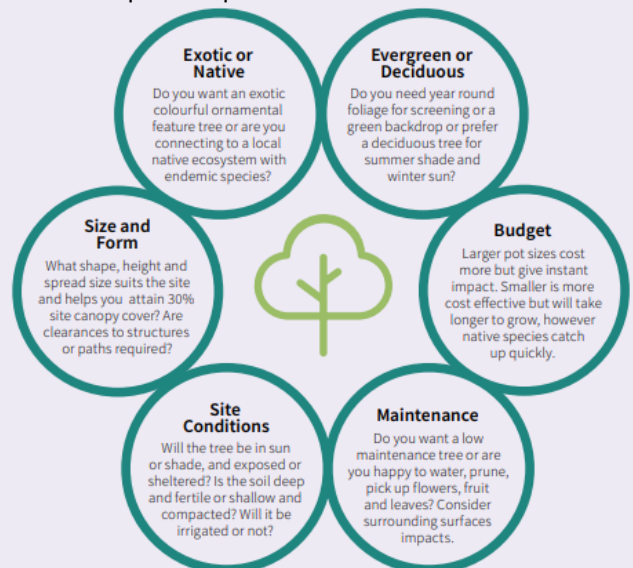


Figure 4 Choosing a tree species involves making important decisions. Source: Gwawari Ngilanmanyin Remembering the Bush: A Climate-wise Landscape Guide for the ACT

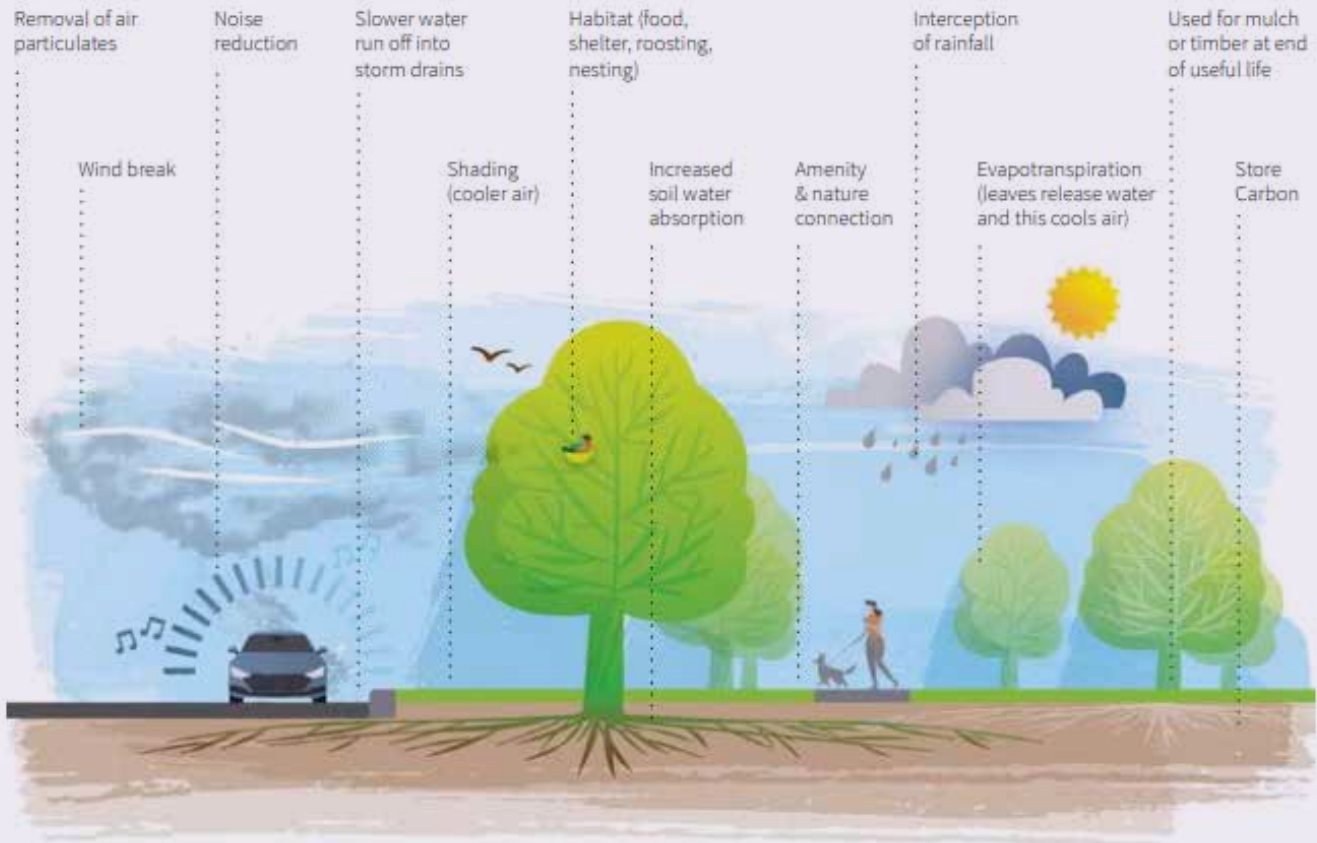


Figure 5 Functions of healthy urban trees. Source: TCCS Values of Street Trees in the Urban Environment.



Reinforced grass



Gravel seating area



Permeable pathway



Site sourced materials



Recycled tumbled glass mulch



Recycled timber sleepers

Examples of permeable and sustainable material selections. Source: Gawari Ngilanmanyin Remembering the Bush: A Climate-wise Landscape Guide for the ACT

3 WOODLAND ECOSYSTEMS

3.1 BACKGROUND

Woodland and forest ecosystems are probably the most familiar natural areas to the ACT community, as they represent the most popular urban nature reserves in and around Canberra. Often positioned on hill tops, woodland and forest ecosystems often offer the best views and recreational opportunities for Canberrans and our visitors, in addition to their role in providing clear benefits in terms of urban cooling as well as critical habitat for a wide range of native plant and animal species. Tree cover in woodland ecosystems can range from as little as 2-20% in open woodlands to over 50% canopy cover for forests. In addition to trees, a mid-storey vegetation layer comprised of shrubs and young trees and a ground layer comprised of grasses, forbs, rushes, rocks, logs and other debris all contribute to the complex structural diversity required to provide functional diverse native habitat for the species which call woodlands home.

As a result of urban development and historic land clearing for agricultural production, many of the former woodland ecosystems of the ACT have been lost. In particular, the Yellow-Box Red-Gum Grassy Woodland community has been heavily impacted since European settlement and is now listed as critically endangered under the Commonwealth EPBC Act.

Woodlands and forests in the ACT also support a diverse range of wildlife species, many of which are threatened or in decline. These include the Canberra Spider Orchid,

Scarlet Robin, Small Purple Pea, Little Eagle, Superb Parrot and Tarengo Leek Orchid; as well as various species of gliders, possums, bats, native bees, wallabies and the Short-beaked Echidna. The familiar Eastern Long-necked Turtle and a wide variety of frog species are known to “overwinter” in the complex understorey of healthy woodland ecosystems. Smaller native carnivores, such as Antechinus, Quolls, and Dunnarts, are now largely absent from our peri-urban ecosystems having fallen prey to cats and foxes or as a result of habitat loss and fragmentation.

Protection of the remaining areas of Yellow-Box Red-Gum Grassy Woodland community ecosystems in the ACT is legislated under the Commonwealth EPBC Act and the ACT Nature Conservation Act. Protecting woodlands and their component species requires careful conservation of key habitat areas, underlying ecological processes such as tree regeneration, hollow formation, limb shedding, nutrient cycling and appropriate hydrology, as well as functional connectivity between patches of woodland across the ACT. Connectivity between patches is particularly important in fragmented and highly disturbed landscapes (such as those in the peri-urban space) to enable the conservation of genetic diversity and species and community adaptive capacity in the face of climate change.

The protection of woodlands in the ACT is guided by the ACT Native Woodland Conservation Strategy and Action Plans.



Mulligans Flat Woodland Sanctuary (M. Jekabsons)

3.2 LOSS OF MATURE NATIVE TREES

Mature Native Trees (MNT) with hollows within the trunk and branches are an important habitat for many native species, however, urbanisation and land clearing have resulted in a dramatic decline. This loss is recognised as a key threatening process under the Commonwealth EPBC Act 1999 and the ACT Nature Conservation Act 2014.

Many trees have been removed in the creation and maintenance of the urban area, and those that remain may be isolated individuals in yards, street verges, or groups in urban greenspace such as parklands. While new trees can be planted to replace them, multiple small trees cannot provide the same biodiversity value as a single large tree.

Each of the new trees would also likely take multiple decades or more to mature. Even dead trees, particularly those with hollows, retain significant habitat value in the urban context.

In the ACT, MNTs are defined as those above 50 cm diameter at breast height (DBH), and most common native species in ACT are Eucalyptus. Other species such as Allocasuarina (she oaks) and Callitris (cypress pines) are much smaller at maturity.

Benefit of a mature tree

Large mature trees are of great importance in our urban environments for both the environment and climate. Older trees store more carbon, have greater photosynthesis processes, usually provide greater canopy cover and essential hollows for animals and birds. They also provide soil stability and can act as significant wind breaks.

Mature Yellow Box at Mulligans Flat Woodland Sanctuary and Superb Parrot using hollow in Blakely's Red Gum



Mature Yellow Box at Mulligans Flat Woodland Sanctuary and Superb Parrot using hollow in Blakely's Red Gum

Design Guidance for preventing the loss of mature native trees:

- Where new urban development is taking place, the design should prioritise the identification and retention of MNT with sufficient space around them to ensure biodiversity value protection, ongoing regeneration and public safety.
- This includes restricting the clearing of:
 - mature eucalypts over 50 cm diameter at breast height
 - mature native trees that contain nest hollows
 - native trees (other than eucalypts) that have reached approximately 67% of their maximum diameter.
- Design should also retain non-mature native trees across urban landscape, so that recruitment / replacement of native trees continues.
- For all trees retained protection measures should be undertaken including:
 - Identification and protection of a tree protection zone as defined in the Tree Protection Act 2005
 - Exclusion of impermeable surfaces, infrastructure, ground disturbance, parking or public amenity asset within the tree protection zone during and post construction
 - Maintenance of suitable natural soil, vegetation and hydrological processes within the tree protection zone and broader ecological context

- Retain standing dead trees wherever possible as habitat trees. Felled mature native trees from within the ecological network area could be reinstated intact as vertical habitat structures.
- Replace removed trees with same species to preserve the broader habitat.
- Design should also provide ecological connectivity through the development area to nearby nature reserves or other adjacent patches of woodland vegetation to avoid isolation and fragmentation.
- Planting of understorey shrubs and clumping grasses nearby adds biodiversity value to mature trees, maintains or improves visual amenity, deters pedestrian access, allows for successful seedling recruitment, safe limb fall and natural accumulation of coarse woody debris.

Design aspects in regard to dead trees and woody debris need to be considered in the context of bushfire fuel management, and attracting animals that may become pests such as termites. Moreover, as such features are preferred by reptiles including snakes, they should be located a safe distance from areas where residents spend time.



Fallen timber, Mulligans Flat Woodland Sanctuary (M. Jakobsons)

3.3 WOODLAND CONSERVATION AND ENHANCEMENT METRICS

In order to maintain optimal ecological function, the following metrics are suggested for ACT woodlands. These were derived from an expert elicitation process, and are provided in more detail in section 6.

- Woodland patches need to have a minimum width of 250m to be considered suitable core habitat for most woodland species.
- Movement corridors between core habitat areas should have a minimum width of 40m, and not exceed 400 m in length when connecting two core habitat patches.
- Woodlands should have at least 35-45% grass cover in total, 75% of which should be native species. Native forbs, leaf litter, rocks and other natural elements should also contribute to ground layer habitat complexity. Habitat areas should be maintained as no-mow areas, but be subject to natural disturbance (e.g., fire, grazing).
- Tree canopies should generally be 10 – 35m apart. Trees should be at least 80% native where possible, and a diversity of tree species and age classes should be maintained which provide different resources for fauna throughout the year.

- Mature native trees, associated with habitat elements such as flaky bark, fallen limbs, and tree hollows should be available at spacings around 20– 65m.
- Shrubs and other mid-storey vegetation should be available at 10 – 35m spacings and be at least 65% native where possible.
- Avoid areas of pavement exceeding 9 m wide (including roads) and waterbodies wider than 15 m. These will act as barriers causing habitat fragmentation for some wildlife in woodland ecosystems.
- Linear vertical barriers (e.g. road curbs, retaining walls) greater than 10cm high will inhibit movement by some species in this habitat type (including turtles) and should be avoided.
- Traffic levels exceeding 6 cars per hour or 10 pedestrians per hour should be avoided in habitat areas. These are considered likely to cause fragmentation through disturbance or direct mortality for woodland fauna.
- In addition:
 - Mature native trees (>50cm DBH) proposed for removal should be reinstated intact as vertical habitat structures wherever practicable. This could be within restoration areas, reserves or offset areas.
 - Semi-mature native trees (21-50cm DBH) proposed for removal should be reinstated intact as coarse woody debris within restoration areas, open space, reserves or offset areas.
 - Removed native immature trees, shrubs and saplings should be utilised on site for soil stabilisation, habitat value, or mulch.

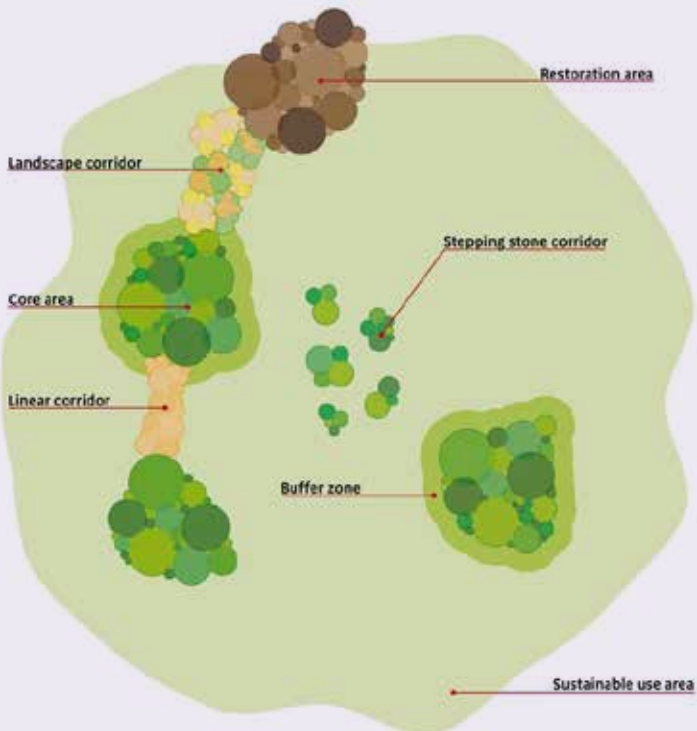


Figure 6 Spatial configuration of core habitat patches and connections between them that will provide for the majority of species movement in fragmented landscapes. Source: Landscape Institute: Connectivity and Ecological Networks Technical Information Note 2016.

4 GRASSLAND ECOSYSTEMS

4.1 BACKGROUND

Grasslands, by definition, are areas comprised predominantly of an intact grassy layer with less than 2% tree canopy cover. They provide a critical role in landscape function with regard to ground water recharge, carbon sequestration, protection of grassland dependent flora and fauna, and promoting highly productive landscapes to support grazing animals. A healthy grassland has a mixed ground layer vegetation layer comprising native grasses, forbs and wildflowers, sedges, rushes and occasional small ferns or shrubs, interspersed with scattered surface rocks, bare ground, grass thatch and patches of moss or lichen. Careful management of disturbance regimes (e.g. grazing, fire, slashing or mowing) is important in grasslands as the critical habitat provided by the grasses is highly variable in response to prevailing climatic conditions (e.g. temperature and rainfall).

Grasslands in the ACT support a broad range of specialised native wildlife species, some which are found nowhere else in the world. These include threatened reptiles (Grassland Earless Dragon, Striped Legless Lizard), invertebrates (Golden Sun Moth, Perunga Grasshopper), plants (Ginninderra Peppergrass, Button Wrinklewort) and a host of rare, native wildflowers and orchids (such as the Greenhood, Tiger, and Golden Moth orchid species). Native bees are also known to use grasslands assuming appropriate floral resources are available. Many species of birds, frogs, and small-medium marsupial mammals will also readily inhabit natural grassland areas, as will the wombats and kangaroos.

Grassland fauna and flora are very susceptible to habitat fragmentation, as many species are small, not very mobile, and have highly specialised habitat and movement corridor requirements. For this reason, maintaining connectivity between core areas of grassland habitat relies on the continuous availability of a diverse and healthy grassy understorey. Fragmentation of this continuous grassy layer, particularly through the construction of linear features such as roads, drains, pipelines, or similar

infrastructure, will permanently isolate some grassland species from other areas of the landscape - increasing the risk of localised extinction. Vertical infrastructure barriers such as curbs, retaining walls, or solid fencing will also fragment habitat for species such as lizards, snakes, frogs, turtles, and some small mammals – with the level of impact proportionate to the species' ability to climb.

Protection of the remaining areas of grassland ecosystems in the ACT, particularly those which remain in higher condition, is legislated under the Commonwealth EPBC Act and the ACT Nature Conservation Act.

The specific grassland conservation objectives set by the ACT Native Grassland Conservation Strategy and Action Plans include taking action to:

- Conserve all remaining areas of native grassland in the ACT that are in moderate to high ecological condition, and
- Retain areas of native grassland in lower ecological condition that serve as ecological buffers or landscape linkages, or contribute significantly to threatened species conservation, or are a priority for rehabilitation

Protecting grasslands and their component species requires careful conservation of key habitat areas, underlying ecological processes such as soil creation, nutrient cycling and appropriate hydrology, appropriate disturbance regimes (fire, grazing) as well as functional connectivity between patches of grassland across the ACT. Connectivity between patches is particularly important in fragmented and highly disturbed landscapes (such as those in the peri-urban space) to enable the conservation of genetic diversity and species and community adaptive capacity in the face of climate change.

The installation of large, grassy underpasses beneath roads is a key design feature which will support the conservation of grassland connectivity at the landscape scale. These, or an equivalent overpass design, are most likely to be effective where sufficient water and light is available to ensure continuous native grass cover, and where the design of the habitat corridor meets the minimum width requirements for the target species. Where pedestrian access is required through grassland habitat, narrow mineral recreation or active travel paths will have less impact compared to wider, paved pathways. Elevated platforms can be installed as an alternative where accessibility requirements or soil stability issues dictate but may have greater ongoing maintenance requirements. Where fragmentation is a risk of vertical barriers, netting fences rather than solid walls may better retain ecological connectivity where gap sizes are adequate to enable movement by the species of interest. Maintaining appropriate density of native flowering plants will also help to maintain genetic diversity in both wind and insect pollinated species.

Many of the threatening processes which impact biodiversity values in native grasslands are associated with, or exacerbated by, the increase in the disturbance associated with urban encroachment. For example, exotic grasses can quickly outcompete native plants causing depleted native plant richness and a reduction in the availability of floristic or habitat resources on which native animals rely. Introduced animals, including foxes, cats and rabbits, also have significant impacts on native grassland species through predation or direct herbivory. Invasive plant and animal species are known to be most commonly associated with areas of high disturbance – and so the physical separation of such impacts from ecologically sensitive areas during the design phase of any development can substantially reduce the need for costly management intervention in the long-term. For example, the appropriate allocation of land to ecological buffers (separating high value ecosystems from the urban edge), and the avoidance of infrastructure in ecologically sensitive areas (such as pipelines, utility assets, or management tracks and trails), will greatly decrease the impacts of invasive species on biodiversity values in the peri-urban area.

Pollutants, including chemical pollutants from paved surfaces such as roads, high nutrient run-off from irrigated ovals, light pollutant from streetlights, vehicles and residential buildings, or anthropogenic noise, can also all impact significantly on biodiversity in urban areas. Addressing these risks requires an understanding of the source of the pollutants, as well as the identification of suitable mechanisms to reduce their spill into ecologically sensitive areas. Planning which avoids the approval of noisy developments (e.g. town centres, industrial areas) in close proximity to core grassland habitats will likely reduce the impacts of noise pollution. Swales and other topographic features similarly may prevent the incursion of chemical pollutants and high-nutrient run-off into grassland ecosystems where they may disadvantage or directly impact on native biodiversity.



Button Wrinklewort and natural temperate grasslands at Majura training area and Striped Legless Lizard in Kangaroo Grass (M. Evans) Source: Native grassland Conservation Strategy and Actions Plans.

4.2 GRASSLAND CONSERVATION AND ENHANCEMENT METRICS

In order to maintain optimal ecological function, the following metrics are suggested for ACT grasslands. These were derived from an expert elicitation process, and are provided in more detail in section 6.

- Grassland habitat patches need to have a minimum dimension of 200m (in any direction) to be considered suitable core habitat for most grassland species.
- Movement corridors between core habitat areas should have a minimum width of 30m, and not exceed 60m in length when connecting two core habitat patches.
- Grasslands should have at least 70% grass cover in total, 75% of which should be native species. Native forbs, grass thatch, rocks and other natural elements should also contribute to ground layer habitat complexity. Grass height should be 10-20cm tall in spring, measured based on the bulk of leaf matter and excluding seed stems, and so grassland habitats should be designated as 'no-mow' areas.
- Trees and shrubs should be excluded for grassland habitats. Woody plants which do remain should contribute to no more than 2% total canopy cover when mature.

- Disturbance such as mowing, grazing, or fire is important for healthy grasslands and should be managed according to best practice conservation guidelines. Any requirements for ground layer vegetation management (e.g. mowing in response to fire risk, urban amenity, or aesthetics) should be considered when assessing the suitability of grassland areas to support biodiversity conservation alongside other land uses in an urban area.
- Areas of bare ground, short grass (<5cm tall), or paved surfaces exceeding 4m wide (including roads) will cause habitat fragmentation in grassland ecosystems. Linear vertical barriers (e.g. road curbs, retaining walls) greater than 10 cm high will inhibit movement by some species in this habitat type (including frogs and turtles) and should be avoided.
- Traffic levels exceeding 6 cars per hour or 10 pedestrians per hour should be avoided in grassland habitat as they will present a further barrier to movement and habitat suitability for species in this ecosystem.
- In addition:
 - Rock (habitat rock and crushed bedrock) removed during the development works should be used for restoration work on site, and in surrounding areas. Remaining rock should be transported and stockpiled in a suitable location for future use. This could include a nearby reserve or offsets site.

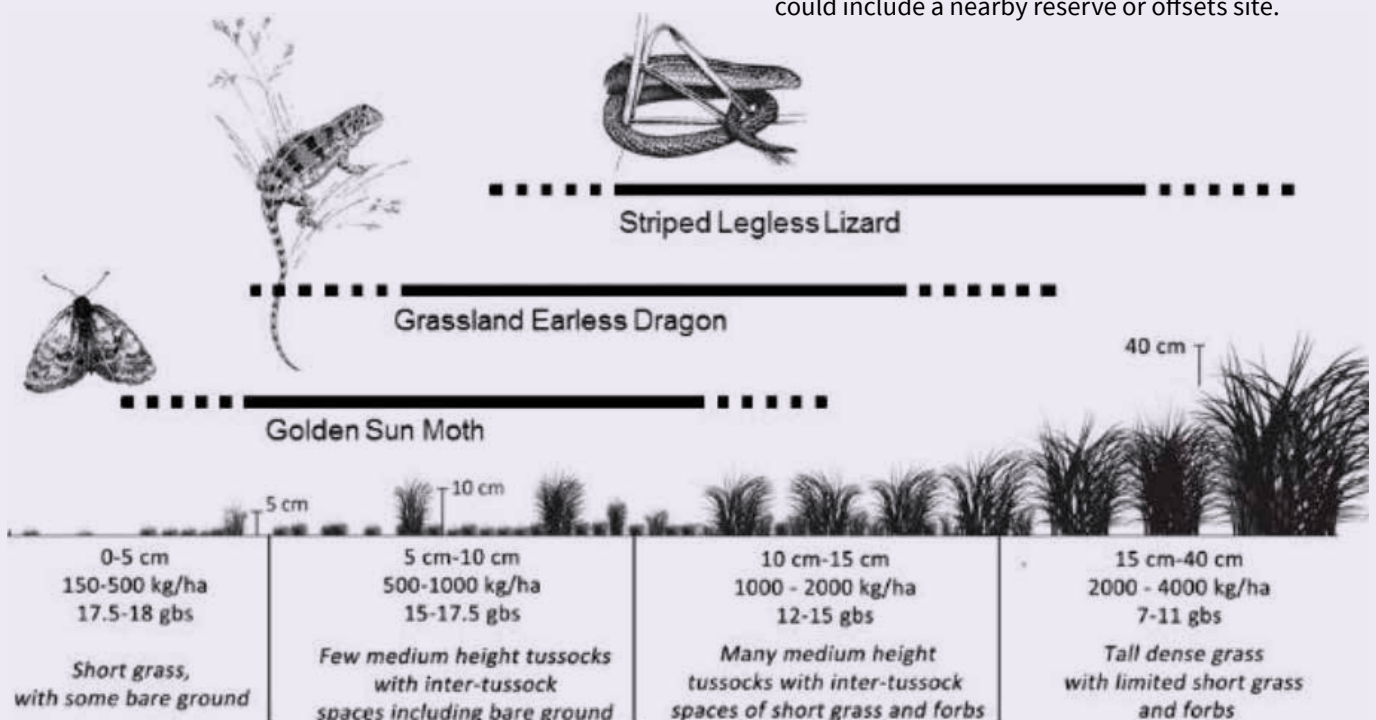


Figure 7 Grass structure and habitat suitability for some threatened grassland fauna. Solid lines are preferred habitat, dashed lines are less suitable habitat. Source: Native Grassland Conservation Strategy and Action Plans.

5 AQUATIC AND RIPARIAN ECOSYSTEMS

5.1 BACKGROUND

The conservation of aquatic and riparian ecosystems is often overlooked in the urban landscape where the focus of water flows tends to be more around the prevention of flood risk to life and property rather than on the conservation of natural hydrology and native species habitat. Nevertheless, where they do persist in a natural form urban aquatic and riparian environments often provide the highest quality urban amenity benefits in terms of aesthetics and recreation opportunities, as well as co-benefits aligned with urban cooling and improved water quality outcomes in the urban environment.

Aquatic and riparian ecosystems, by definition, are based around waterways – including those which are natural or artificial, and reflecting waterways which may be permanent or non-permanent (ephemeral). Riparian ecosystems support a transition zone between the aquatic and terrestrial environments, characterised by variable vegetative and non-vegetative habitat structures such as rushes, sedges, grasses, shrubs and trees alongside snags, rocks, bare ground, sand bars and a variety of leaf litter types. Macrophytes (water plants), representing a variety of submerged and surface vegetation within the water, are also a critical part of structural complexity in the aquatic environment, playing an important role both in terms of habitat suitability and the maintenance of water quality.

Aquatic and riparian environments in the peri-urban areas of the ACT also support a range of iconic native species such as the Platypus, Eastern Water Dragon, Rakali (native water rat), and Eastern Long-necked Turtle, in addition to a variety of species of native frogs, fish, dragonflies, damselflies and waterbirds. The absence of any EPBC listed native species or communities in these ecosystems often prevents their thorough consideration

during planning and development processes, however their environmental, cultural and social values, in addition to their critical role in providing ecosystems services, suggests their conservation should be a focus for urban green and blue spaces within the ACT.

Urban aquatic and riparian zones can be heavily impacted by urban development, both through the transition of natural waterways towards more artificial ‘built’ structures (such as concrete drainage channels) but also by the creation of new urban wetlands and storm water treatment ponds which may offer an opportunity for new areas to support and conserve aquatic and riparian biodiversity. A number of aquatic and riparian species are particularly sensitive to habitat fragmentation. Culverts, changes in water levels over features such as low-level crossings, and the use of pipes to transfer water beneath roads and other built infrastructure all pose permanent barriers to movement by aquatic species within the reach of a catchment.

The conservation of aquatic and riparian ecosystems in the ACT is legislated under the Nature Conservation Act. Due to the restricted nature of these ecosystems within the landscape, conservation of these habitats and species requires careful consideration of broader hydrological processes, water quality and sustainable use, connectivity along aquatic and riparian corridors (including considerate design of built infrastructure) and providing a suitable diversity of instream habitat and flow.

The protection of non-urban aquatic and riparian environments is guided by the [ACT Aquatic and Riparian Conservation Strategy and Action Plans](#). Advice for rivers should be sought from the ACT Conservator of Flora and Fauna.

5.2 AQUATIC AND RIPARIAN CONSERVATION AND ENHANCEMENT METRICS

In order to maintain optimal ecological function, the following metrics are suggested for ACT aquatic and riparian habitats. These were derived from an expert elicitation process, and are provided in more detail in section 6.

- Aquatic ecosystems (waterways) need to have a minimum width of 5 m, and a minimum depth of 2.5 m, in order to represent core habitat for most aquatic organisms.
- Riparian zones should have a minimum width of 40-50m (measured from the edge of the water) to provide core habitat for species such as platypus, Rakali and turtles. This can include areas which transition into woodland or grassland habitats, which are also used as habitat by turtles and frogs.
- Ecological corridors to connect areas of core aquatic and riparian habitat should be at least 10 m wide, 1m deep (aquatic only), and not exceed 400m in length when connecting two core habitat patches. Aquatic wildlife, such as small native fish, will only move 100m within a waterway corridor away from areas of suitable habitat.
- Tree plantings in a riparian ecosystem should be done so that at any one time there is 20 – 25m of open space between canopies, and also maintain mature trees (which contribute snags, logs, and abundant food sources into aquatic and riparian environments) spaced at least every 30m on average. Trees should ideally all be native in riparian environments. An abundance of exotic deciduous trees along creek lines may be associated with poor water quality during periods of excessive leaf fall.
- The ground layer vegetation in riparian environments should be comprised of > 60% native species and include a diversity of different plants. Grass heights should be maintained at 20 – 50cm and be interspersed with gravel or sand bars and north facing rocky outcrops to facilitate successful nesting and basking by native turtles and other species. Emergent vegetation, critical for habitat structure within the waterway, should be maintained with clumps every 10 – 15m.
- Vertical barriers (e.g. steps in built infrastructure, including curbs) must be less than 10cm in height to facilitate movement of wildlife in the aquatic and riparian environments. Sections of concrete drain which do not hold permanent water must also be avoided to prevent fragmentation of fish habitat. Exceptions may be where aquatic barriers are installed with the purpose of maintaining habitats free of invasive species.
- Paved surfaces in the terrestrial environment, including roads, must not exceed 20m diameter. Expanses of concrete lined waterbody sections must also not exceed 5m in length.
- Habitat features (plants, breeding habitat, snags) should be embedded in new aquatic ecosystems (e.g. storm water retention ponds, other WSUD assets) during the design and construction phase. These new elements will be used as habitat and should be designed as such.
- Traffic levels exceeding 6 cars per hour or 10 pedestrian per hour must be avoided in aquatic and riparian habitats to prevent fragmentation through disturbance or direct mortality for species in these ecosystems.

5.3 WATER SENSITIVE URBAN DESIGN

Water Sensitive Urban Design (WSUD) is a way of planning cities to minimise water runoff and ensure any runoff causes the least amount of damage. It is also about wise use of that water to improve our urban environment, including by allowing hydration of urban open spaces and their vegetation using stormwater.

The key principles of WSUD are:

- to reduce the demand for potable (fit for drinking) water by using alternative sources of water such as rainwater and treated wastewater and encouraging water efficient appliances
- to minimise the generation of wastewater and to treat wastewater to a suitable standard for re-use and/or release to receiving waters
- to treat urban stormwater to a quality where it can be reused and/or discharged to surface waters
- to use stormwater in the urban landscape to improve the visual and recreational amenity of developments.

ACT WSUD Guidelines are available for download on: [Water Sensitive Urban Design - Environment, Planning and Sustainable Development Directorate - Planning \(act.gov.au\)](#)

[Municipal Infrastructure Standard \(MIS\) 08](#) contains extensive design guidance and requirements for implementing WSUD, including on artificial wetlands, ponds and other bioretention systems. Development proponents need also adhere to the floodplain planning and design guidance, available in Appendix F of the MIS 08.



Fishway at Vanitys Crossing, Cotter River (M. Jekabsons)

5.4 WSUD AND URBAN BIODIVERSITY

WSUD measures and assets can create many environmental benefits including biodiversity, environmentally sustainable urban development, positive landscape changes, improved management of natural resources and improved environmental quality and water.

For example, the following WSUD assets are usually vegetated or landscaped and as such have the potential to provide important habitats for urban wildlife:

- Buffer strips move runoff from a hard surface to a downstream drainage system and are commonly used along the edge of roads. They are often planted with grasses.
- Tree pit bioretention/biofilter systems are set into the kerb and intercept and clean the rainwater before it goes into the drain. Often includes grasses in addition to trees.
- Bioretention swales (bioswales) are street-scale linear, depressed channels that collect and treat stormwater. Swale element removes sediments and the bioretention system (vegetation) removes finer particulates and dissolved contaminants.
- Artificial ponds retard storm flows and provide some stormwater treatment,
- Stormwater treatment wetlands accept and treat stormwater, with dense vegetation as a key feature.

In addition, the rainwater harvested and stored by WSUD assets is important in supporting landscaping and other vegetation, including trees, in the city. This in turn provides for urban cooling and other environmental benefits, and contributes to ACT's canopy cover and permeable surfaces target. WSUD is also essential in preparing ACT for the climate change future, when more extreme weather events are expected. Whereas WSUD is initially focused on flood flow and water pollution mitigation, it also can also improve water security in times of drought, and help maintaining urban vegetation including trees.

In addition to WSUD, porous paving has an important function, as it allows rainwater to infiltrate the soil and recharge groundwater, improving soil moisture and biodiversity.

Relevant guidance for best practice on the above WSUD aspects is [found here](#). This includes recommendations for the planning, design, establishment, operation, maintenance and decommissioning of WSUD assets.

5.5 PROTECTING RIPARIAN ZONES

The key for protecting riparian corridors is to leave an undeveloped and undisturbed buffer zone along the creek lines. However, the definitions and recommended exclusion widths of the buffer zones / corridors around wetlands or streams vary between jurisdictions.

In terms of waterways (running water), for ACT purposes, the recommendations from the [NSW Department of Planning and Environment](#) could be adopted (Table D1 below). This recommends 10 – 60 m wide core protection areas that should be left undeveloped.

The development application should:

- identify whether or not there is a watercourse present and determine its stream order in accordance with the Strahler System;
- define the core protection area / total corridor width on a map in accordance with Table 1 if a watercourse is present and adopt that as a un-developed buffer, and;
- maintain or rehabilitate the areas with structured native vegetation in accordance with Table 1 below.

Table 1. Riparian Corridors and Dimensions (see also Figure 9 below) Source: Office of Water, ACT Government

STREAM ORDER*	CORE PROTECTION AREA TOTAL WIDTH**	RIPARIAN CORRIDOR TOTAL WIDTH	MAXIMUM OFFSET TO WATERWAY CENTRELINE***
1	20m	20m	5m
2	30m	40m	5m
3	40m	60m	5m
4	50m	80m	10m
5	60m	80m	10m

* Using NSW Government method following the Strahler System of ordering watercourses and using Hydroline Spatial Data

** This is the greater of either the core protection total width as presented in table X, or the 1% AEP flood extent. The Core Protection Area is a sub-set of the Riparian Corridor.

*** Applies to Core Protection Area and Riparian Corridor

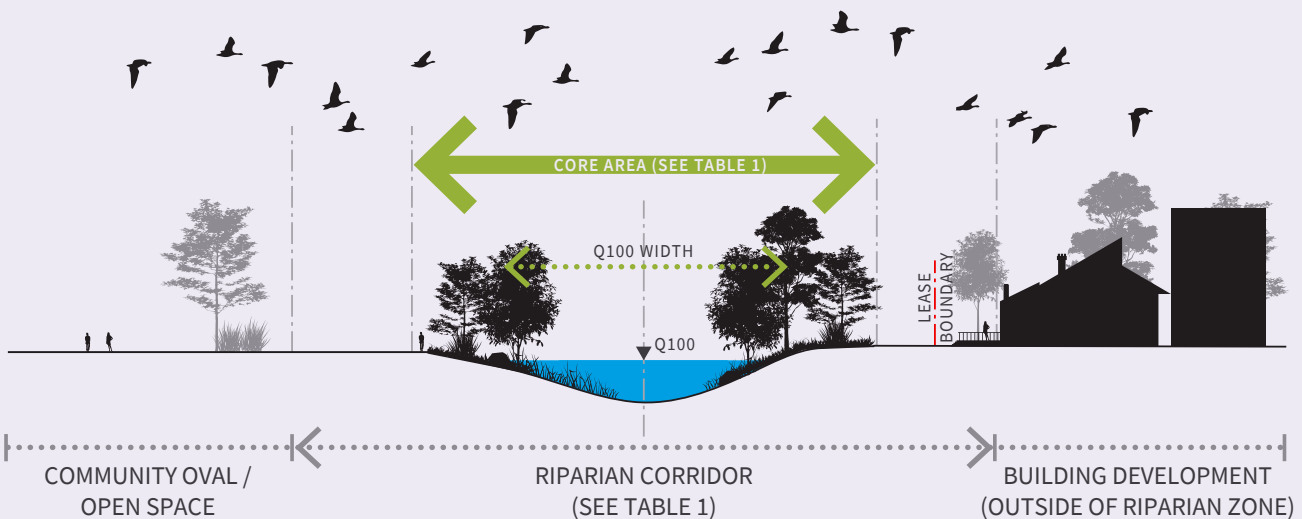


Figure 8. The general layout for a typical riparian corridor in an urban setting. Source: Office of Water, ACT Government

See <https://www.dccew.gov.au/water/wetlands/publications/wetlands-australia/national-wetlands-update-february-2019/buffers-sponges-moderators> for a brief description and their importance.

Planned development within a waterway or associated buffer zone must address issues covered by Section 42 of the Water Resources Act 2007 and the Environment Protection Regulation 2005.

Development applications are required to include an EPA endorsed Waterway Works Management Plan. The Plan would be assessed against the criteria provided in:

- Section 44 of that Act, so that criteria are applied through development assessment processes for those large developments which are exempted from the requirement for a waterway works licence under Sections 42 (2, b and c) of the Water Resources Act 2007, and
- Schedule 3 of the Environment Protection Regulation 2005 to prevent prescribed pollutants from entering waterways, and
- Schedule 4 of the Environment Protection Regulation 2005 so that the environmental values of waterways are protected.

6 COMBINED ECOSYSTEM METRICS SUMMARY TABLES

6.1 HABITAT REQUIREMENTS OF COMMON ACT ECOSYSTEMS

Table 2. Maintain and Introduce Habitat

DESIGN REQUIREMENT	GRASSLAND	WOODLAND	RIPARIAN	AQUATIC
Size and layout				
Minimum width of core habitat patch	200m	250m	30m	5m
(Minimum water depth of core habitat patch)	-	-		2.5m
Vegetation structure and composition				
Preferred distance between mature trees (hollow bearing or habitat rich)	200m	20 – 65m	40 – 50m	-
Preferred distance between tree canopies	100m	10 – 35m	20 – 25m	-
Preferred distance between shrub canopies	75m	10 – 35m	-	-
Preferred height of ground layer vegetation	0.1 - 0.2m	0.1 - 0.5m	0.1 - 0.5m	-
Preferred percentage cover of ground layer vegetation	70%	35 – 45%	15 – 50%	-
Preferred distance between emergent plant groups	-	-		10 – 15m
Preferred percentage cover of sub-surface vegetation	-	-		45%
Preferred percentage of native trees	-	80%		100%
Preferred percentage of native mid-storey	-	65-70%		100%
Preferred percentage of native ground layer	75%	75%	60%	-
Preferred percentage of native aquatic plants	-	-		100%
Availability of other habitat elements				
Preferred total length of coarse woody debris	-	45m/ha	30m/ha	170m/ha
Preferred number of hollow bearing trees	-	20 /ha	9 /ha	-
Preferred number of flowering plant species	55 /ha	45 /ha	-	-
Preferred percentage of surface rock	10%	15%	15 – 25%	45%
Preferred percentage cover of grass thatch or leaf litter	15%	15 – 35%	15 – 30%	-
Preferred percentage cover of bare ground	10 – 15%	10 – 15%	10 – 25%	-
Preferred bank slope	-	-	25 – 30o	-
Preferred bank rugosity	-	-	0.0 – 0.1	-

Table 2 provides general high-level design guidance for core habitat areas for biodiversity within grassland, woodland, riparian and aquatic ecosystems. These metrics reflect the minimum requirements for core habitat based on the preferences of species selected to be characteristic of these ecosystems. Habitat areas which exceed these minimum standards are likely to provide higher quality habitat for a greater diversity of species and accommodate more sensitive species (including many declining or threatened species whose habitat requirements are better described in relevant action plans and conservation advice documents). Metrics can be used as a guide to (a) identify existing areas of the landscape which are likely to be providing core habitat values, and (b) inform the re-introduction of habitat elements to expand or restore core habitat and improve biodiversity outcomes (where habitat requirements are not currently being met). Information in this table can be used to inform BSUD outcomes in conjunction vegetation mapping, species and ecological community distribution layers on ACTmap*i*, core and corridor habitat models in the ACT Ecological Network Dashboard, and other supporting documents and policies. *Note guidance for riparian areas is focused on small urban streams, drainage lines and wetlands. Guidance for riparian areas associated with river corridors should reflect advice within the ACT Aquatic and Riparian Conservation Strategy or be sought directly from the Conservator of Flora and Fauna.

6.2 CONNECTIVITY REQUIREMENTS OF COMMON ACT ECOSYSTEMS

Table 3. Designing Ecological Corridors

DESIGN REQUIREMENT	GRASSLAND	WOODLAND	RIPARIAN	AQUATIC
Minimum width of an ecological corridor	30m	40m	10m	1.0m
Minimum water depth of an ecological corridor	-	-	-	1.0m
Maximum length of an ecological corridor	60m	400m	400m	100m

Table 3 provides guidance on the design of ecological corridors. An ecological corridor, by definition, is a corridor which connects two or more areas of core habitat and in doing so facilitates the safe movement of species between otherwise isolated habitat areas. Ecological corridors need to contain structurally suitable habitat (as described in Table 1 for core habitat) but can be smaller or narrower than core habitat areas. Ecological corridors must be wide enough to avoid edge effects (e.g. the impacts of pest plants or animals whose impacts are greater on the edges of habitat remnants). The length of a functional ecological corridor can also not exceed the distance species can move from of core habitat, and so maximum length dimensions are provided for each ecosystem type. Effective corridor design should involve a corridor which meets the minimum width and maximum length advice below and connect two or more areas of core habitat. Aquatic corridors also have a minimum water depth requirement. Information in this table can be used to inform BSUD outcomes in conjunction with vegetation mapping, species and ecological community distribution layers on ACTmapi, core and corridor habitat models in the ACT Ecological Network Dashboard, and other supporting documents and policies. *Note guidance for riparian areas is focused on small urban streams, drainage lines and wetlands. Guidance for riparian areas associated with river corridors should reflect advice within the ACT Aquatic and Riparian Conservation Strategy or be sought directly from the Conservator of Flora and Fauna.

Table 4. Avoid Barriers to Movement

DESIGN REQUIREMENT	GRASSLAND	WOODLAND	RIPARIAN	AQUATIC
Maximum spacing between preferred habitat patches	10m	25m	25m	20m
Maximum hourly vehicle use	<6/hr	<6/hr	<6/hr	-
Maximum hourly pedestrian use	<10/hr	<10/hr	<10/hr	-
Maximum height of a vertical step/barrier	0.1m	0.1m	0.1m	0.1m
Maximum width of pavement (road/drain/path)	4m	9m	20m	5m
Maximum width of a waterbody	< 1m	15m	30m	-

Table 4 provides guidance on landscape features which will act as movement barriers within grassland, woodland, riparian and aquatic habitats. These include physical barriers (such as a retaining wall which is too high for an animal to climb over) and behavioural barriers (such as traffic on a road, or gaps between habitat which may increase predation risk). The presence of these barriers within core or corridor habitat must be avoided to maintain ecological connectivity and avoid habitat fragmentation. The table below describes the threshold at which habitat features are anticipated to become a barrier to many species in the ecosystem. Information in this table can be used to inform BSUD outcomes in conjunction with vegetation mapping, species and ecological community distribution layers on ACTmapi, core and corridor habitat models in the ACT Ecological Network Dashboard, and other supporting documents and policies. *Note guidance for riparian areas is focused on small urban streams, drainage lines and wetlands. Guidance for riparian areas associated with river corridors should reflect advice within the ACT Aquatic and Riparian Conservation Strategy or be sought directly from the Conservator of Flora and Fauna.

6.3 THREAT MITIGATIONS FOR COMMON ACT ECOSYSTEMS.

Table 5. Avoid Threats.

DESIGN REQUIREMENT	GRASSLAND	WOODLAND	RIPARIAN	AQUATIC
Minimum buffer width from a protected area	70m	200m	200m	200m
Minimum buffer width from a protected matter	20m	20m	20m	20m
Maximum level of artificial noise	24 dB	12 dB	19 dB	25 dB
Maximum hourly vehicle use	<6/hr	<6/hr	<6/hr	-
Maximum hourly pedestrian use	<10 /hr	<10 /hr	<10 /hr	-

*Table 5 provides guidance on thresholds which may guide the protection of biodiversity values in an area. These include buffer widths from urban infrastructure, as well as an indication as to the tolerable level of noise, traffic and pedestrian use of an area. Information in this table can be used to inform BSUD outcomes in conjunction with vegetation mapping, species and ecological community distribution layers on ACTmapi, core and corridor habitat models in the ACT Ecological Network Dashboard, and other supporting documents and policies. *Note guidance for riparian areas is focused on small urban streams, drainage lines and wetlands. Guidance for riparian areas associated with river corridors should reflect advice within the ACT Aquatic and Riparian Conservation Strategy or be sought directly from the Conservator of Flora and Fauna.*

