



Local Biodiversity Strategy 2023-2043

Part 2: Technical Report

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Acknowledgement of Country

We respectfully acknowledge the Traditional Owners, the Whadjuk Noongar People, as the Custodians of this land. We also pay respect to all Aboriginal community Elders, past and present, who have resided in the area and have been and continue to be an integral part of the history of this region.

Message From the Mayor

The Local Biodiversity Strategy provides the framework for the consideration of biodiversity in local land use planning, it provides for biodiversity conservation and management of biodiversity values across our City.

Residents and visitors alike highly value the natural environment of the City of Kalamunda, and nowhere is this displayed more clearly than through the tireless work of our City's many volunteers and friends groups. These values are reflected in the Strategic Community Plan, Kalamunda Advancing 2027, and the City's Environmental Land Use Planning Strategy and Local Environment Strategy, which includes the review and update of the City's 2008 Local Biodiversity Strategy as a priority action.

This strong local desire for environmental protection is well supported by scientific research into the benefits of investment into environmental protection and management, including benefits to human health and community wellbeing, economic activity, moderation of climate and may provide future research opportunities. Benefits of protecting biodiversity go beyond protecting a 'clean and green' environment.

Replacing the plants, animals and the natural systems they maintain with highly modified and simplified landscapes leads to significant degradation of quality of the environment and its capacity to offer the services such as clean air, clean water, renewable resources, pollination of crops, natural pest control and other provisioning or regulating services. There is also a clear link between the diversity of natural areas and their values to improving human wellbeing with natural areas retaining high biodiversity providing greater benefits to human health.

Many cultural practices have developed around specific features of natural areas and to be able to maintain these cultural practices or cultural identities, it is critical to retain the natural landscapes.

Natural areas with high biodiversity provide greater opportunities for future research, diversity in economic opportunities and in artistic expressions.

Cr Margaret Thomas
Mayor



Vision

The biodiversity vision statement for the City of Kalamunda (the City) was developed in 2008 by the Kalamunda Local Biodiversity Planning Project Steering Group. The Steering Group included representatives from the City of Kalamunda’s Council and the local community. The vision statement represents the long-term City direction steering biodiversity conservation and captures the opinion of the local community.

Vision for the City's *Local Biodiversity Strategy 2023-2043*:

The City of Kalamunda and its community will protect, manage, and value the local biodiversity to ensure a lasting legacy for future generations.

Executive Summary

The City of Kalamunda is home to diverse and precious natural ecosystems supporting a wide range of plant and animal species. As the community grows and changes, and the City succeeds in attracting employment drivers complementing its natural assets to deliver locally sustainable jobs and businesses, there is a need to balance development with the protection of the natural environment. Community engagement research has revealed the community shares the City’s strong desire to conserve and protect our environment.

The vision for the City’s Local Biodiversity Strategy (LBS) is that the City of Kalamunda and its community will protect, manage, and value the local biodiversity to ensure a lasting legacy for future generations.

The LBS provides a roadmap for the City to design, manage and improve local biodiversity on land managed by the City or on private land, for the wellbeing of our residents, enterprise, and ecosystems. It sets out a framework to maintain a balance between protecting biodiversity values and meeting the projected social and economic development needed in the City over the next 20 years.

Investing in the protection of biodiversity brings numerous benefits to our community. It improves community health and well-being, supports cultural identity, stimulates economic activity, moderates climate and diseases, enhances resilience, and creates future research opportunities. Protecting our natural resources also generates job opportunities for local communities. Scientific research also supports engaging with diverse green spaces, with access to such spaces proven to have greater positive impact on community wellbeing than simplified parks with limited plant species.

The LBS builds upon the City’s existing conservation efforts and aligns with the State government-endorsed methodology for biodiversity planning. By adopting a holistic and strategic approach, the City aims to increase the conservation protection status of 500 hectares (ha) of land, containing approximately 270 ha of native vegetation.

The LBS considers local challenges and opportunities, and offers a framework for assessing areas of biodiversity, setting conservation priorities, and implementing methods to enhance biodiversity. The LBS sets out specific goals, measurable actions, as well as a plan to monitor and report on the progress of implementation to ensure continual improvement.

Broadly, the goals of the LBS are based on the pillars of Retain and Protect, Investigate, Manage and Enhance, Link and Engage. This provides a holistic and strategic approach to achieving our target.

Protecting biodiversity is a shared responsibility among government agencies, the City, and the community. The City will collaborate with stakeholders to conserve biodiversity values and influence policies and initiatives at the state and federal levels. Through the implementation of the LBS and the dedication of all involved, we can safeguard our natural heritage for future generations.



1 Introduction

1.1 Background

The City is challenged to balance its future growth with retaining, protecting and managing natural areas with biodiversity value, enabling residents to be surrounded by nature, while responding to needs for increased urban density, land use objectives, development priorities and pressures of climate change.

Biodiversity is defined as the variety of life forms, including plants, animals, fungi, and microorganisms, as well as the genes they contain and the ecosystems they form (Commonwealth of Australia 1996).

As such, biodiversity is typically explored at three levels:

- 1. Genetic diversity
- 2. Species diversity
- 3. Ecosystem diversity.

Together, these three levels of biodiversity create the complexity of all life on Earth.

Some aspects of biodiversity conservation are regulated through legislation, including the protection of rare or threatened plants, animals, and ecological communities at the State and Federal government levels. However, the latest State of the Environment (SOE) report (2021) shows that biodiversity is continuing to decline, and the number of threatened species is increasing. The SOE report identified that key threats to biodiversity include climate change, habitat loss and degradation, and invasive species.

The City is an important influence on protecting, retaining, and enhancing biodiversity (as defined in Section 1.2) through implementing planning controls, overseeing on-ground management, supporting residents for voluntary protection, delivering education programs, and managing revegetation and restoration initiatives.

This Local Biodiversity Strategy (LBS) aims to ensure the City's biodiversity will be protected, managed and enhanced to conserve flora and fauna and ecological communities, retain natural ecological processes, and ensure local natural areas (LNAs) continue to provide a resilient place for people, enterprise, and ecosystems to flourish into the future.

1.2 History

Before European settlement, the area now known as the City of Kalamunda (the City) was densely covered in native forest, woodlands and shrublands. The region was home to natural ecosystems supporting a variety of plant and animal species and provided a range of environmental, economic, health and wellbeing benefits to local people, enterprise, and ecosystems.

The Whadjuk people have occupied the land in its natural state for thousands of years, moving through the local area, living off the bush and using native vegetation in a sustainable manner (Kalamunda and Districts Historical Society 2018).

The Kalamunda Townsite was gazetted in 1902 and quickly became a tourism destination. Advertised as a 'health resort', people living in more urban Perth suburbs travelled to Kalamunda to enjoy nature, fresh air, and a change of climate.

In 1918 most people living in the district worked in the timber and orchard industries, on the railway or quarrying (Kalamunda and Districts Historical Society 2018). There are no longer any working timber mills within the City, however many private and commercial orchards operate.

Over time, the City's natural environment has changed considerably, with native vegetation cleared predominantly for rural practices and urban development.

1.3 Local Natural Areas

Biodiversity is present within all natural areas. The term natural area refers to any physical area that contains native species or ecological communities in a relatively natural state, and therefore contains biodiversity.

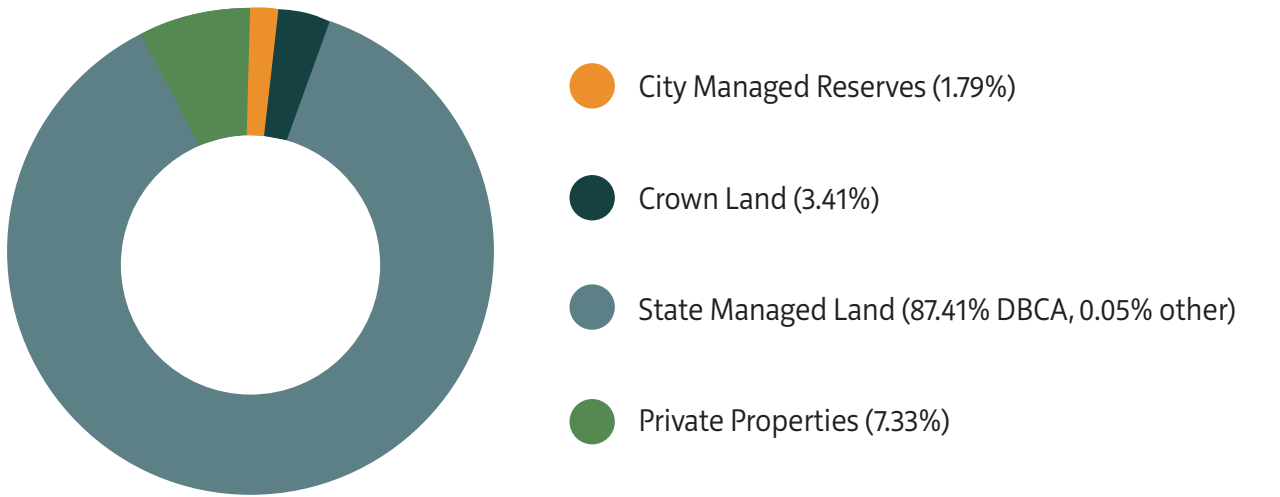
This LBS recognises LNAs as native vegetation, vegetated or open wetlands (lakes and swamps) and waterways (rivers, streams, creeks, and estuaries). The objectives and actions of the LBS seek to conserve, protect, and enhance areas where living organisms indigenous to the area have naturally colonised and persist.

The term LNA is used throughout this LBS. LNAs refer to areas containing endemic species or ecological communities in a relatively natural state, with an inference of potentially high biodiversity values. Further detail on how LNAs were identified is provided in Section 3.

This LBS describes LNAs as native vegetation situated on land managed by the City or on private land, outside of areas managed by the State government. The percentage of the native vegetation extent within City of Kalamunda held within each land management category is shown in Plate 1. LNAs covered by this LBS are shown on Figure 1, where black outlines indicate reserves managed by the City.

It is noted that areas of native vegetation may exist which are not recognised in the mapping of LNAs (due to limitations with the State dataset used to derive LNAs). This LBS focuses on retaining, conserving and managing LNAs and other areas of native vegetation/ biodiversity value which may not be reflected by the mapped LNAs, on land managed by local government and seeks to encourage and support retaining and managing LNAs on private land.

Plate 1. Tenure of Remnant Native Vegetation within the City of Kalamunda



1.4 Purpose of the Local Biodiversity Strategy

The LBS sets out a framework to maintain a balance between protecting biodiversity values and meeting the projected social and economic development needed in the City over the next 20 years.

The purpose of the LBS is to:

- identify and determine the protection status of all priority LNAs within the City;
- formalise policies and processes to ensure biodiversity considerations are integrated into the assessment of development proposals and other construction activities;
- develop and provide support and incentives to encourage the conservation of biodiversity on private land; and,
- plan for the effective management of local reserves and other local government lands to conserve biodiversity.

The LBS is a non-statutory document that seeks to inform and guide the City’s local planning framework as well as continued engagement with the local community and other stakeholders.

This framework identifies specific Focus Areas and associated goals, which are described in Table 1. These are accompanied by strategic objectives and actions, outlined in Section 6. The action plan articulates the implementation of the actions, and describes how actions will be monitored, reviewed, and reported periodically, as outlined in Section 7.

The City’s target is to increase the conservation protection status of 500ha land, containing approximately 270ha of native vegetation.

Retain and Protect	Retain and protect LNAs and other biodiversity values on City-managed land and private land.
Investigate	Investigate and actively pursue new resourcing (human, funding, and data) and research opportunities to enable further investment and improvement in on-ground actions on public and private land to manage and protect local biodiversity.
Manage and Enhance	Manage, enhance, and rehabilitate LNAs and other biodiversity values on City-managed land to improve the quality and quantity of biodiversity values.
Link	Maintain and improve local and regional ecological linkages that allow flora and fauna species movement and the flow of genetics throughout the landscape.
Engage	Actively engage with Aboriginal representatives to understand and integrate cultural knowledge into local biodiversity management. Engage with the community to strengthen the appreciation of biodiversity values, and encourage them to retain, protect and enhance biodiversity values on private land.

1.5 Strategic Context

The City’s strategic framework and relevant State and Commonwealth guidance, policy, and legislation guided this LBS development.

The update of the City’s 2008 LBS was initiated through actions included in the City’s Local Environment Strategy (LES) and Environmental Land Use Planning Strategy (ELUPS). The specific actions are identified below:

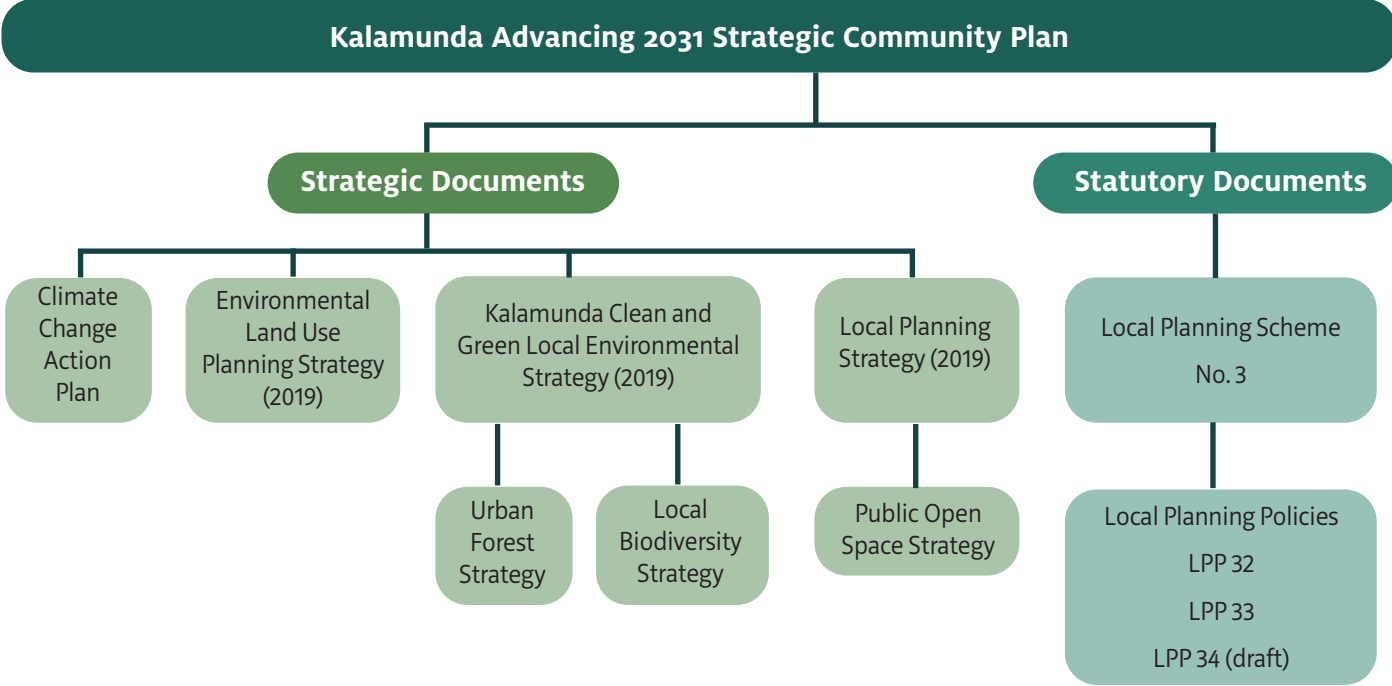
- LES - Prepare an updated LBS that identifies priority natural areas and ways to protect them; and,
- ELUPS - prepare an updated LBS to assess risk to biodiversity through implementation of the bushfire regulations and determine appropriate planning mechanisms for balancing biodiversity protection and protection of life and property.

1.5.1 City of Kalamunda Strategic Direction

This LBS will guide and shape future natural area management decisions to align with the City’s overall strategic framework. Plate 2 shows the strategic and statutory documents which interact with local biodiversity protection, retention, and management, which are delivered under the City’s Kalamunda Advancing Strategic Community Plan 2021-2031.

The City’s Kalamunda Advancing Strategic Community Plan 2021-2031 demonstrates a continued commitment to building the City’s future while preserving its heritage. This is reflected in one of the four priority areas: “Delivering environmental sustainability and maintaining the integrity of the natural environment”.

The City has several strategic documents which consider local biodiversity, including the *Environmental Land Use Planning Strategy 2019*, *Kalamunda Clean and Green Local Environment Strategy 2019*, *Climate Change Action Plan 2023*, and *Urban Forest Strategy 2023-2043*.



1.5.2 Local Planning Framework

Local Planning Strategy

The Local Planning Strategy sets out the long-term planning directions for the City, applies State and regional planning policies, and provides the rationale for the zoning and other provisions of the scheme.

Local Planning Scheme

The City's Local Planning Scheme provides a statutory mechanism to consider LNAs and other biodiversity values through the planning framework. The City's current Local Planning Scheme No. 3 (LPS3) zones land within the City, specifies permitted land uses, and sets the assessment considerations and minimum standards for development.

Local Planning Policies

The provisions (existing and proposed) of the Local Planning Scheme are supported by local planning policies, such as Local Planning Policy 32 – Public Open Space (LPP 32), Local Planning Policy 33- Tree Retention (LPP 33), and Draft Local Planning Policy 34 – Wetlands and Waterways (LPP 34).

1.5.3 State and Commonwealth Legislation

Commonwealth and State legislation governs retaining, conserving, and managing biodiversity. This legislation is supported by regulations, statutory planning policies, and strategic plans which guide local government authorities and private entities.

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides protection of the environment and biodiversity at the Commonwealth level. Environmental Protection and Biodiversity Conservation Regulations 2000 support the EPBC Act and outline implementation procedures.

WA Environmental Protection Act 1986

The *Environment Protection Act 1986* (EP Act) provides protection of the environment at a State level and outlines development and strategic documents which require referral to the Environmental Protection Authority for assessment. Environmental Protection (Clearing of Native Vegetation) Regulations 2004 support the EP Act and address several matters relating to clearing native vegetation, such as defining native vegetation, fees, data requirements, and circumstances where clearing is exempt from requiring a permit.

WA Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) governs managing threatened flora, fauna, and ecological communities. The Biodiversity Conservation Regulations 2018 support the BC Act and provide greater protection for biodiversity, particularly threatened species and threatened ecological communities.

WA Planning and Development Act 2005

The *Planning and Development Act 2005* (PD Act) is the primary piece of legislation governing developing and subdividing land in Western Australia. Schedule 7 of the PD Act, which covers "Matters which may be dealt with by a planning scheme", establishes biodiversity as a valid planning consideration. Planning and Development (Local Planning Schemes) Regulations 2015 supports the PD Act and prescribes the preparation and adoption procedures for local planning strategies, local planning schemes and amendments to local planning schemes.

WA Conservation and Land Management Act 1984

The *Conservation and Land Management Act 1984* (CALM Act) applies to the public conservation system and includes provisions for establishing and managing national parks, nature reserves, conservation parks, regional parks, and Marine Parks in Western Australia. Land protected in the City under this Act has been considered in preparing this Strategy.

1.5.4 State Policies

This LBS is supported by the following State Planning Policies prepared under the *Planning and Development Act 2005*. These include (but are not limited to):

- State Planning Policy 2 – Environment and Natural Resources Policy;
- State Planning Policy 2.5 – Land Use Planning in Rural Areas;
- State Planning Policy 2.7 – Public Drinking Water Source;
- State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Area;
- State Planning Policy 2.9 – Water Resources;
- State Planning Policy 3.7 – Planning in Bushfire Prone Areas;
- State Planning Policy 7.0 – Design of the Built; and,
- Native Vegetation Policy for Western Australia (May 2022).

This LBS has been prepared according to State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Area (SPP 2.8) developed by the Western Australian Planning Commission (WAPC). SPP 2.8 supports implementing Bush Forever, a State government framework which provides for protecting regionally significant bushland on the Swan Coastal Plain. The framework, which is designated under the Metropolitan Region Scheme, includes a target of a minimum of 10% representation of each ecological community type.



1.6 What has the City done so far?

The City is an active conservator of the environment, and already works to protect and enhance local biodiversity assets. The LBS builds on the City's current activities, including those adopted in the Kalamunda Clean and Green Local Environment Strategy.

The City was one of three local governments that piloted a local biodiversity conservation planning process developed in partnership with the Western Australian Local Government Association (WALGA) in 2004. The City published its first LBS in 2008, becoming the first Western Australian local government to adopt an LBS aligning with the State Government-endorsed methodology for biodiversity planning.

The 2008 LBS sought to retain, protect, and enhance the viability of natural areas containing threatened ecological communities; declared rare flora, threatened, and specially protected fauna including their significant habitat, priority species, wetlands, and waterways; and aimed to improve connectivity between those natural areas.

Since 2008, the City has created three new reserves via the provisions of the *Land Administration Act 1997* (LA Act) with 'conservation' as their vesting purpose. This resulted in the protection of an additional 2.2 ha of natural areas and raised the number of reserves being managed by the City for conservation purposes to eight. The City recognises that there is an opportunity to significantly improve the protection of natural areas and commits to striving to protect an additional 500ha of land, containing approximately 270ha of vegetation, as outlined in Section 1.4.

Since 2008, the City has recorded a number of key achievements, including:

- preparing and adopting the City's Public Open Space Strategy in 2018 and continuing its successful implementation;
- creating a new full-time role of Environmental Planner;
- employing structure planning to retain natural areas containing threatened ecological communities and threatened flora and buffer a watercourse;
- retaining areas with high biodiversity value within areas of Public Open Space through the approval conditions for proposed subdivisions;
- proactively monitoring compliance with permit conditions relating to environmental outcomes;
- adopting Local Planning Policy 33 – Tree Retention to minimise removing trees of a certain size and maturity to maintain and increase canopy cover;
- drafting and publicly advertising Local Planning Policy 34 – Wetlands and Waterways to guide managing wetlands to protect them from the impacts of development, improve water quality, and manage potential risks of property damage;
- commencing drafting Local Planning Scheme No. 4, adding provisions for biodiversity protection and consideration;
- employing a full time Bushcare Officer;
- implementing several restoration projects within reserves recognised as having significant conservation value, including some funded by offset requirements for native vegetation clearing within the City;
- implementing a weed disposal program offering residents unlimited green waste disposal at Walliston Transfer Station;
- creating wetland areas and vegetated swales in new developments according to Water Sensitive Urban Design;
- gazetting a Cat Local Law with declared cat-free zones and educating the community on responsible pet ownership;

- receiving the first draft of the Bushfire and Biodiversity Management Guidelines as an outcome of the Local Environment Strategy;
- publishing the Private Landholder Bushland Information Package in 2013;
- increasing the number of Friends Groups implementing numerous restoration projects within the City;
- continuing the 'Plants for Residents' program and encouraging residents to use native species; and,
- engaging with local Aboriginal leaders to prepare the City's Draft Reconciliation Action Plan, currently published for public consultation.



Plants for Residents program

2 Benefits of Local Biodiversity

Biodiversity is important in maintaining natural systems and processes, as well as for supporting our community's health and wellbeing. Species and ecosystems are interconnected and interdependent, and we are all are reliant on the food, water, health, and recreation opportunities produced by the natural environment. Direct impacts on one species may have a flow-on effect on other species, highlighting the need for a whole system approach to biodiversity conservation.

The benefits of biodiversity are substantial, and include:

- creating soils;
- maintaining air, water, and soil quality;
- naturally controlling pest populations;

Dianella revoluta

- decomposing and recycling nutrients from organic waste material;
- pollinating and facilitating natural regeneration and crop production;
- stabilising climate and moderating extreme weather patterns;
- sequestering carbon;
- enhancing the resilience of natural areas to acute and chronic stressors, including climate change;
- ensuring food security for human survival;
- providing natural resources for human health care;
- ensuring income generation and economic growth; and, retaining spiritual and cultural values.

In 2021 the City surveyed its community with the Local Environment Strategy Vision and Values Survey. Survey results revealed locals value the natural environment highly, with 93% of respondents agreeing the City's bushland, trees and natural vegetation are important.

This result was also supported in the 2020 Strategic Community Plan consultation survey. A total of 70% of respondents rated biodiversity conservation as important or very important.

Scientific research also supports the benefits of investing in environmental protection, which include community health and wellbeing, cultural identity, economic activity, moderating climate or diseases, greater resilience, and future research opportunities.

Similarly, environmentally sourced products are highly valued by the community. The ability to deliver these via agriculture, forestry, tourism, or product development depends on the continuation of ecosystem services supporting the natural landscape where such clean and green products can be produced (Commonwealth of Australia, 2019).

Managing natural resources creates a range of local job opportunities, including important opportunities for employing Aboriginal people in both knowledge sharing and direct on-ground management roles. Noongar knowledge of traditional land management practices contributing to conserving biodiversity in the Southwest of Western Australia is increasingly valued, and is recognised in programs such as the Department of Biodiversity, Conservation and Attractions' (DBCA) Aboriginal Ranger Program and the City of Swan Indigenous Trainee Program.

Growing evidence shows accessible and diverse green spaces offer higher restorative benefits to human health and wellbeing over those which can be realised in simplified natural environments, such as landscaped parks with limited numbers of plant species (Wood et al 2018 and Marselle et al 2019).

Having a clear plan for local biodiversity conservation helps the City meet local community expectations, and provides opportunities to use the varied ecosystem services supporting community wellbeing, economic prosperity, and sustainability. The plan also guides the City in ensuring its actions complement its role in supporting Noongar people's continuing connection to country and sense of place.



Plate 3. Diagram Describing the Benefits of Local Biodiversity



3 Measuring Local Biodiversity

Accessing, collecting, and analysing data and information across the wide breadth and depth of local biodiversity levels is a challenge to measuring local biodiversity. To address this challenge, inferences are often made from available data, such as the extent, variation, and condition of native vegetation and wetlands waterways, and the presence of conservation-significant species and ecological communities. The City's surveillance of priority LNAs will improve this data over time and provide increasingly comprehensive knowledge of local biodiversity.

Several publicly available datasets are used to inform understanding of local biodiversity values. The City then uses a variety of scientifically accepted methodologies and site assessments to confirm and provide details on the values being assessed.

The Department of Primary Industries and Regional Development (DPIRD) currently provides the best available data on broadscale native vegetation extent. This data is based on interpreting satellite imagery supplemented by aerial photographs. The data is continually improved, with the latest update in 2020, and provides a snapshot in time of native vegetation extent. While it forms a sound basis for monitoring clearing, it is imperfect and may over or underestimate the actual extent of native vegetation over time.

This methodology challenged the City in measuring progress against targets set out in the 2008 LBS, with some results attributed to changes in mapping methodology, rather than real losses of vegetation. For example, some areas previously mapped as native vegetation that were already devoid of native vegetation, such as access tracks, buildings, fire breaks and plantations, were removed from the dataset to represent the extent of native vegetation more accurately. This reclassification was not a real reflection of physical native vegetation loss.

One significant example of this was in data showing a large and unexpected loss of native vegetation extent of 633ha. On investigation, this was attributed to the change in the mapping methodology, rather than actual native vegetation loss.

It is anticipated that as this technology advances, data collection and processing methods will also continue to evolve, which may influence long-term monitoring of native vegetation extent.

The implementation roadmap for the WA Native Vegetation Policy (GoWA 2022) identifies an action to develop a new dataset and monitoring system to improve clearing tracking. Dataset monitoring will be semi-automated and regularly updated to leverage remote sensing and machine learning for improved tracking capability.

4 The City's Local Biodiversity

4.1 Environmental Context

The City of Kalamunda is located on the Swan Coastal Plain and the Darling Ranges of the Southwest Ecoregion of Western Australia, which is recognised globally as one of the world's top 36 international biodiversity hotspots. Biodiversity hotspots are described as 'the richest and most threatened reservoirs of plant and animal life on Earth'.

To qualify as a biodiversity hotspot, an area must meet two strict criteria:

1. Contain at least 1,500 species of vascular plants found nowhere else on Earth (known as "endemic" species).
2. Have lost at least 70 percent of its primary native vegetation.

4.1.1 Bioregions

The City is split across two bioregions under the Interim Biogeographic Regionalisation for Australia (IBRA). IBRA was developed in 1993-1994 and is endorsed by all levels of government as a key tool for identifying land for conservation under Australia's Strategy for the National Reserve System 2009-2030. The western side of the City is in the Swan Coastal Plain Bioregion and the eastern portion is in the Jarrah Forest Bioregion (Plate 4).

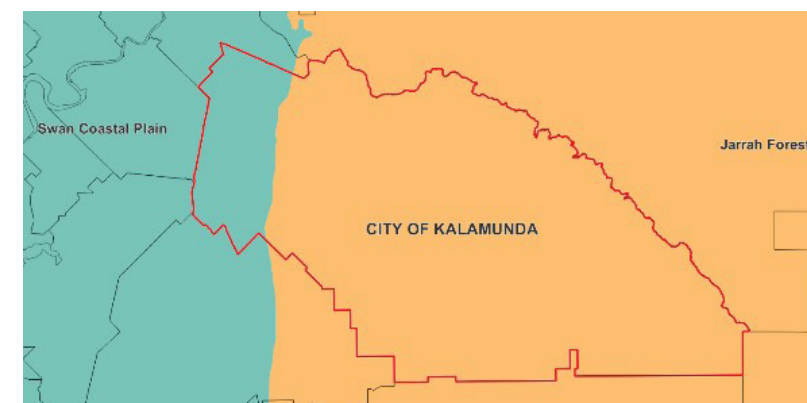


Plate 4. City of Kalamunda Bioregions

4.1.2 Landforms

The City can be divided into three geographic regions based on landform differences. These are the Swan Coastal Plain, Escarpment, and Darling Plateau (Plate 5). The majority of City’s land area is situated within the Darling Plateau (76%), followed by the Swan Coastal Plain (14%) and the Escarpment (10%).

The physical and biological characteristics of each region vary, with different topographies, soils, vegetation, ecological communities, and fauna habitat types. Similarly, land use varies across each region with highest population densities on the Swan Coastal Plain, and decreasing density eastward to the Escarpment and Darling Plateau.

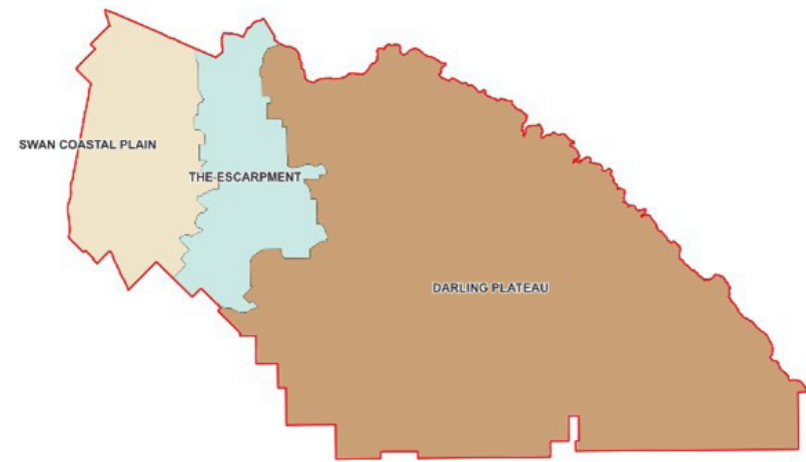


Plate 5. City of Kalamunda Landform Regions

4.1.3 Land Uses

Historical impacts on biodiversity are greatest in the Swan Coastal Plain due to substantial urban development. Urban development is expected to continue to support projected population growth according to State strategies and planning frameworks. Urban development in the Escarpment has been limited due to the physical nature of the landscape, however urban, commercial, industrial, State forest, and national park land uses are present. Land uses within the Darling Plateau include drinking water protection areas, State forest, national parks, agriculture, horticulture, and rural and semi-rural development.

4.2 Natural Areas in the City of Kalamunda

The City contains some of the largest and best preserved remaining woodland within the Perth region. Table 2 shows approximately 72.13% of the City remains covered by native vegetation, meaning there is 23,353.20 ha of native vegetation supporting a variety of flora, fauna, and ecological communities (DPIRD, 2020).

Table 2. Breakdown of vegetated and non-vegetated land within the City.

Category	Area (ha)	% of City area
City of Kalamunda	32,375	100
Areas without remnant native vegetation	9,021	28
Extent of remnant native vegetation (DPIRD, 2020)	23,353	72

LNAs, as defined in Section 1.2, are natural areas held outside of the Western Australian conservation estate and form the primary focus of this strategy, in addition to other biodiversity values which may not be reflected by the mapping of LNAs. Table 3 provides a breakdown of the remaining native vegetation within the City by administrative category. The extent of native vegetation within the City, as mapped by DPIRD (2020), is illustrated in Figure 2. Most remaining native vegetation within the City is managed by DBCA, most notably within State forest (46.26%) and national park (39.21%). The City manages around 4.16% of total native vegetation, and around 8.18% is held within private lands¹.

As identified in Section 1.2, this LBS applies to LNAs and other biodiversity values within City-managed reserves and seeks to support and encourage protecting and enhancing those on private land.

¹Note: 2.19 ha of native vegetation unaccounted for under an Administrative Category due to mapping inaccuracies resulting from the mapped vegetation polygons of DPIRD-005 not aligning completely with reserve or lot boundaries leaving numerous, very narrow slivers of mapped vegetation unaccounted for.

Table 3. Area of Native Vegetation held within different Administrative Categories within the City

Category	Area (ha)	% of native vegetation	% of City area
Vested with DBCA	20,414.4	87.41%	63.06%
• State forest	10,803.4	46.26%	33.37%
• National Park	9,157.08	39.21%	28.28%
• Crown Freehold Department Managed	387.60	1.66%	1.20%
• Nature Reserve	46.80	0.20%	0.14%
• Conservation Park	11.61	0.05%	0.04%
• Section 5(1)(h)	6.95	0.03%	0.02%
• <i>Swan Canning River Management Act - River Reserve</i>	0.95	0.004%	0.003%
Bush Forever - managed for conservation	56.0	0.24	0.17
City conservation reserves and Conservation Covenants	35.6	0.15%	0.11%
Bush Forever without formal protection	232.3	.099%	0.72%
Regional parks (includes land managed by the State and the City).	700.43	3.0%	2.16%
Other Local Natural Areas	2,286.41	9.79%	7.06%



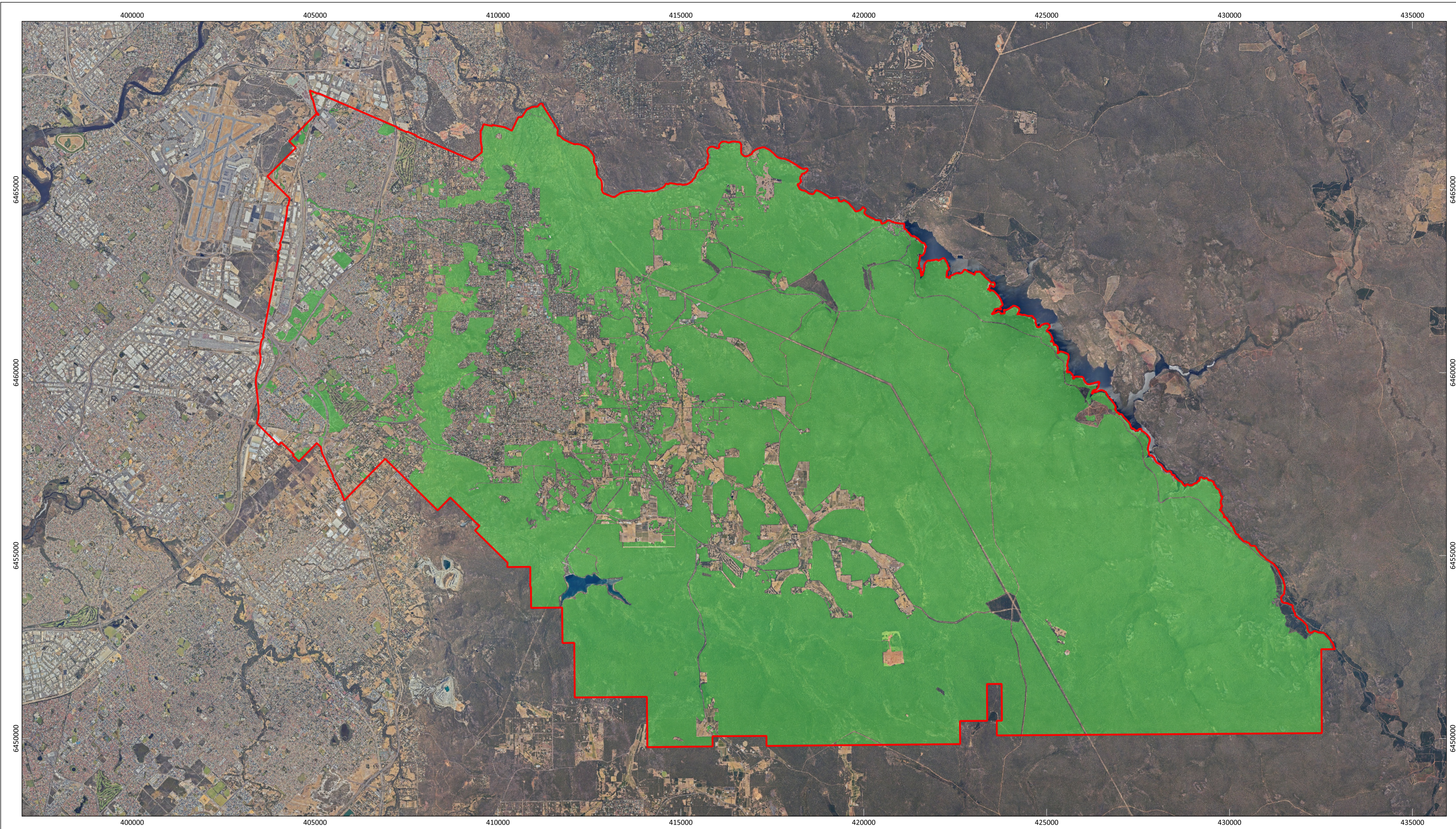


Figure 2: Native Vegetation Extent within the City of Kalamunda

0 2 4 6 km

SCALE
1:100,000

SHEET SIZE
A3 COLOUR

PROJECT/REPORT NAME
Local Biodiversity Strategy
City of Kalamunda

CLIENT
City of Kalamunda

COORDINATE REFERENCE SYSTEM
GDA2020 / MGA zone 50

DATA SOURCE
LANDGATE AERIAL IMAGERY Summer 2023

PROJECT NUMBER
A23.017

VERSION
0

DRAWN BY / REVIEWED BY
MD/HS

DATE
7/7/2023

Legend

City of Kalamunda

Extent of Native Vegetation within the City of Kalamunda (DPIRD-005)

No	Description	Drawn	Approved	Date
A	Original Issue	MD	HS	7/7/2023

NOTES:
Cadastral boundary from LANDGATE 2022. Label corresponds to the vegetation association number.

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Figure 2. Native Vegetation Extent (DPIRD-005) within the City of Kalamunda

4.3 Significant Biodiversity Assets in the City of Kalamunda

The *State Biodiversity Conservation Act 2016* (BC Act) and *Commonwealth Environment Protection Biodiversity Conservation Act 1999* provide for the listing of threatened native plants, animals, and ecological communities requiring protection, as they are under identifiable threat of extinction (species) or collapse (ecological communities). For this LBS, such biodiversity values are considered 'significant', and are summarised within this section.

Detailed lists of conservation significant species and communities are provided in Appendix 1.

It is acknowledged that although this section of the LBS focusses on conservation significant plants, animals, and ecological communities, other native species and communities are also important and play a vital role and function in local biodiversity.

4.3.1 Representation of Vegetation Complexes

Vegetation complex mapping is based on the landform, soil, and climate patterning of vegetation at a regional scale. These vegetation complexes are then used to assess and compare representation of various vegetation units against pre-European settlement levels (Heddl et al. 1980; Mattiske & Havel 1990).

In Western Australia, regulatory processes require retaining at least 30% of the original extent of each ecological community in a Bioregion (e.g. Swan Coastal Plain or Jarrah Forest Bioregions). This threshold is widely recognised as the minimal level needed to prevent exponential loss of species and maintain natural process. Where less than 10% of the original ecological community remains, that community is considered threatened.

The Regional Forest Agreement process sets a minimum of 1,500 ha or 15% as a criterion to protect forest ecosystems in the Jarrah Forest bioregion (ANZECC/MCFFA 1997). This has since been adopted by the EPA and in the Forest Management Plan 2014-2023 that informs establishing new formal and informal conservation reserves in the forest ecosystems.

These thresholds inform conservation priorities at both bioregion and local levels.

A total of 14 vegetation complexes are mapped within the City. Four of these represent complexes on the Swan Coastal Plain, one on the Escarpment, and nine on the Darling Plateau. The pre-European settlement and remaining extent of each vegetation complex mapped within the City are presented in Table 4 and shown on Figure 3.

Three of the vegetation complexes, Swan, Guildford, and Swamp, are represented with less than 100ha. It is important to note three complexes were below 100ha in their pre-European settlement extent. Three vegetation complexes, Cooke, Swamp and Yarragil 2, predominantly maintain their pre-European extent of vegetation.

Of the vegetation complexes present within the City, three have relatively low representation in the bioregion, below or near the 10% threshold. These are Guildford (5.0% remaining), Forrestfield (12.30% remaining), and Swan (13.53% remaining).

Three complexes are not currently protected locally, which are:

- Guildford Complex (0% protected locally),
- Yarragil 2 Complex (0% protected locally), and
- Swamp Complex (0% protected locally)

An additional three complexes have very low protection across the Swan Coastal Plain bioregion. These are:

- Forrestfield (1.37% protected)
- Southern River (1.18% protected)
- Swan (0.37% protected).

In the Jarrah Forest Bioregion (The Escarpment and Darling Plateau) there are three vegetation complexes with less than 15% of the pre-European extent (in the Bioregion) protected. These are:

- Darling Scarp (D1 and D2; 8.14 % protected)
- Yarragil 1 (9.87% protected)
- Yarragil 2 (10.58% protected).

Of these the Darling Scarp vegetation complex also has less than 30% of the pre-European extent remaining in the Bioregion.

Increasing the protection status of these vegetation complexes on lands where the City has influence is one of the Local Biodiversity Strategy's objectives.

A description for each of the vegetation complexes is provided in Appendix 2.



Table 4. Native Vegetation Complexes within the City of Kalamunda by Region

Vegetation complex/ retention and protection status at the regional level	Pre-European extent (ha) within City	2020 extent (ha) ² within the City	% Of pre-European extent retained in City	Extent protected in the City (ha) (proportion of pre-European extent) ³
Swan Coastal Plain IBRA bioregion				
<10% remaining in the bioregion				
Guildford	77.51	8.47	10.93	0 ha
<10% remains and <10% protected in the bioregion				
Forrestfield	1,924.36	209.26	10.87	43.27 ha (2.25%)
Southern River	2,318.00	225.66	9.74	30.54 ha (1.32%)
Swan	1.97	1.67	84.77	1.32 ha (67.01%)
Jarrah Forest IBRA bioregion				
At risk of being reduced <30% retention and <15% protected in the bioregion				
Darling Scarp (D1 and D2)	1,462.33	996.60	68.15	506.48 ha
>60% retained and <15% protected in the bioregion				
Yarragil 1	4,478.80	3,226.47	72.04	1,160.58 ha (25.91%)
Yarragil 2	489.03	486.27	99.44	0 ha
>60% retained and >15% protected int he bioregion				
Cooke	247.28	274.19	99.97	177.14 ha (64.58%)
Dwellingup 2	13,410.17	10,951.54	81.67	3,989.19 ha (29.75%)
Murray 2	3,591.14	3,345.51	93.16	1,113.09 ha (31.00%)
Helena 1	407.33	382.95	94.01	103.53 ha (25.42%)
Helena 2	1,887.53	1,551.21	82.18	1,069.76 ha (56.68%)
Murray 1	1,997.18	1,637.45	81.99	1,052.50 (52.70%)
Swamp	55.96	55.95	99.98	0 ha

²Extent of native vegetation by complex and associated proportion of pre-European extent remaining represents a static moment in time and given data constraints, cannot be used to interpret changes over time. Refer to section 3.1 for further detail.

³Extent of native vegetation protected within the City calculated based on extent within DBCA lands managed for Conservation, including National Park, Nature Reserve, and Conservation Park.

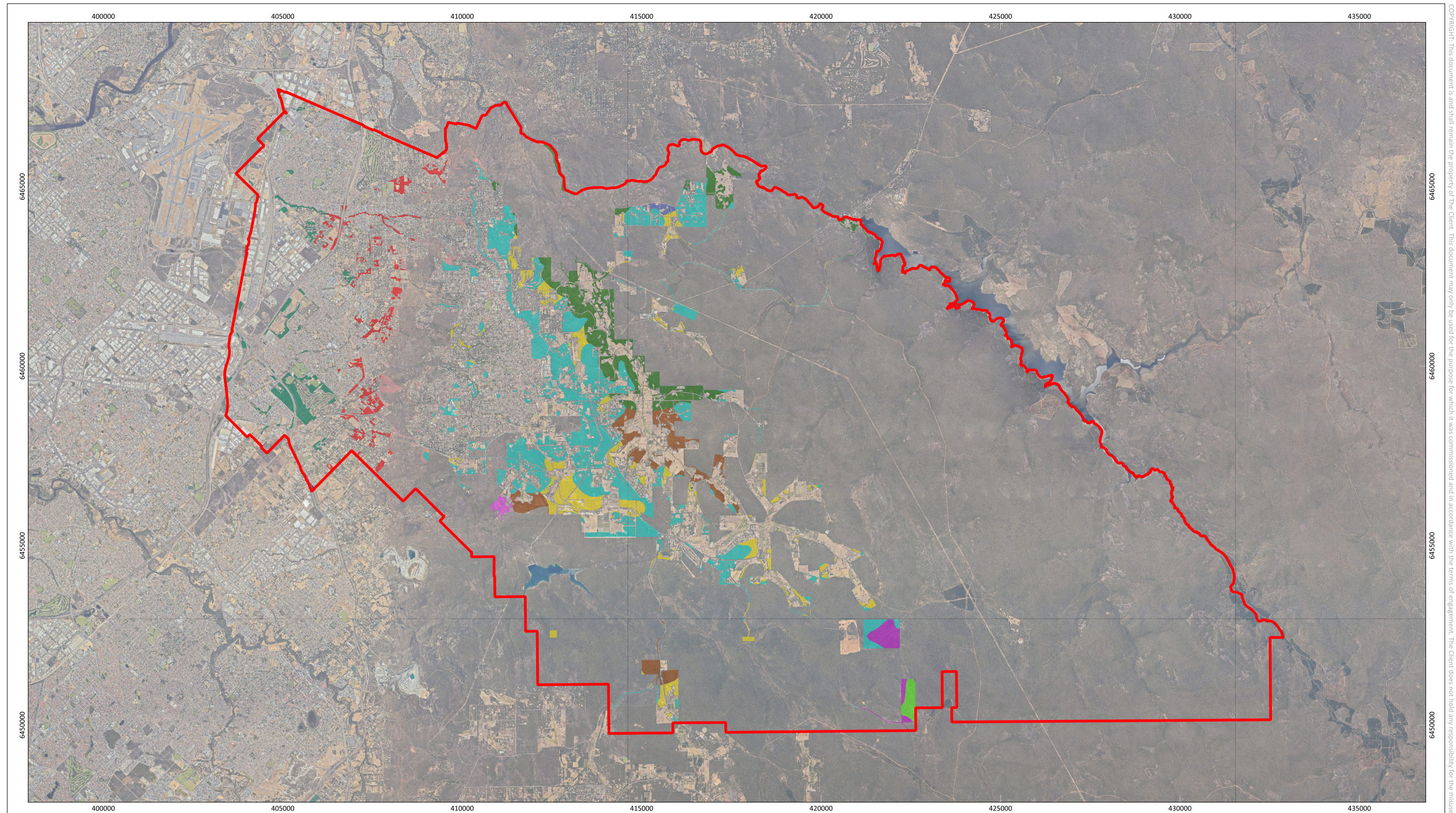

















Figure 3: Vegetation Complexes within the City of Kalamunda

 		PROJECT/REPORT NAME Local Biodiversity Strategy City of Kalamunda		Legend <div> <div> City of Kalamunda</div> <div> <div> Forrestfield Complex</div> <div> Helena 1, He1</div> <div> Swamp, S</div> </div> <div> Vegetation Complexes (DBCA-046) <div> Southern River Complex</div> <div> Darling Scarp, DS2</div> <div> Murray 1, My1</div> <div> Yarragil 1, Yg1</div> </div> <div> <div> Guildford Complex</div> <div> Dwellingup, D2</div> <div> Murray 2, My2</div> <div> Yarragil 2, Yg2</div> </div> </div>	CLIENT City of Kalamunda
SCALE 1:100,000	SHEET SIZE A3 COLOUR	PROJECT NUMBER A23.017	VERSION 0		
COORDINATE REFERENCE SYSTEM GDA2020 / MGA zone 50		DRAWN BY / REVIEWED BY MD/HS	DATE 11/7/2023		
DATA SOURCE LANDGATE AERIAL IMAGERY Summer 2023					

NOTES:

Cadastral boundary from LANDGATE 2022. Label corresponds to the vegetation association number.



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Figure 3. Pre-European Vegetation Complexes within the City of Kalamunda

4.3.2 Threatened and Priority Ecological Communities

Ecological communities are a group of native plants, animals, and other organisms that naturally occur together, interacting and depending on each other in a unique habitat. The structure, composition, and distribution of ecological communities are determined by environmental factors such as soil type, position within the landscape, climate, water availability, chemistry, and movement.

The complexity and inter-connectedness of the components of ecological communities means they can become threatened or at risk of collapse or extinction when the natural composition and function of the ecological community has been significantly depleted. Ecological communities may be listed as Threatened under the EPBC Act and BC Act.

Priority Ecological Communities (PEC) are possible threatened ecological communities that do not meet survey criteria or are not adequately defined. There are five priority ratings that apply to ecological communities, with two ratings represented within the City. These are:

- Priority 3: poorly known ecological community where further survey and definition of the community is required to evaluate conservation status and consider their declaration as a threatened ecological community, if applicable.
- Priority 4: ecological communities that are adequately known and are either rare but not threatened, meet criteria as near threatened, or have been recently removed from the threatened list. These communities require regular monitoring.

The mapping of threatened and priority ecological communities provided by DBCA (2023) identifies most of the native, intact vegetation on the Swan Coastal Plain portion of the City as a threatened ecological community. It is important to note this information is indicative only, as it is based on broad scale mapping. Detailed ecological surveys are required to confirm the presence, absence or type of threatened or priority ecological communities.

The City supports several Threatened and Priority Ecological Communities which are protected under both Commonwealth and State legislation (Table 5).

Table 5. Threatened and Priority Ecological Communities Recorded within the City of Kalamunda (DBCA 2023)

Ecological Community	Conservation Status	
	EPBC Act	BC Act
Swan Coastal Plain		
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Priority 3
<i>Banksia attenuata</i> woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson et al. (1994))	Endangered	Critically Endangered
<i>Corymbia calophylla</i> - <i>Kingia australis</i> woodlands on heavy soils, Swan Coastal Plain (floristic community type 3a as originally described in Gibson et al. (1994))	Endangered	Critically Endangered
<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain (floristic community type 20b as originally described in Gibson et al. (1994))	Endangered	Critically Endangered
Shrublands and woodlands of the eastern side of the Swan Coastal Plain (floristic community type 20c as originally described in in Gibson et al. (1994))	Endangered	Critically Endangered
<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain (floristic community type 3c as originally described in in Gibson et al. (1994))	Endangered	Endangered
Central Northern Darling Scarp Granite Shrubland Community	N/A	Priority 4
Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	Endangered
Southern wet shrublands, Swan Coastal Plain (floristic community type 2 as originally described in Gibson et al. (1994))	N/A	Critically Endangered
Herb rich saline shrublands in clay pans (floristic community type 7 as originally described in Gibson et al. (1994))	Critically Endangered	Endangered
Herb rich shrublands in clay pans (floristic community type 8 as originally described in Gibson et al. (1994))	Critically Endangered	Endangered
Shrublands on dry clay flats (floristic community type 10a as originally described in Gibson et al. (1994))	Critically Endangered	Endangered
<i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i> woodlands on sandy clay soils of the southern Swan Coastal Plain (floristic community type 3b as originally described in Gibson et al. (1994))	N/A	Endangered



Table 5. Threatened and Priority Ecological Communities Recorded within the City of Kalamunda (DBCA 2023)

Ecological Community	Conservation Status	
	EPBC Act	BC Act
The Escarpment		
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Priority 3
<i>Banksia attenuata</i> woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson et al. (1994))	Endangered	Critically Endangered
<i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands of the eastern side of the Swan Coastal Plain (floristic community type 20b as originally described in Gibson et al. (1994))	Endangered	Critically Endangered
Shrublands and woodlands of the eastern side of the Swan Coastal Plain (floristic community type 20c as originally described in in Gibson et al. (1994))	Endangered	Critically Endangered
<i>Corymbia calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain (floristic community type 3c as originally described in in Gibson et al. (1994))	Endangered	Endangered
The Darling Plateau		
Central Northern Darling Scarp Granite Shrubland Community	N/A	Priority 4

4.3.3 Threatened and Priority Flora

Since the adoption of the City’s previous LBS in 2008, several new species of threatened and priority plants have been recorded within the City. DBCA’s threatened and priority flora records identify 14 threatened flora species listed under the EPBC Act and BC Act, and 42 DBCA listed priority flora species occurring within the City. A detailed list of threatened and priority flora is provided in Appendix 1.

Nearly a quarter of natural areas managed by the City contain threatened and priority flora.

Some of the most recognisable Threatened flora species recorded within the City are:

- Purdie’s donkey orchid (*Diuris purdiei*; Endangered);
- Star Sun Orchid (*Thelymitra stellata*; Endangered); and,
- Wavy-leaved Smokebush (*Conospermum undulatum*; Vulnerable).



Star Sun Orchid
Source: Florabase



Purdie’s donkey orchid
Source: WA Native Orchd Study and Conservation Group



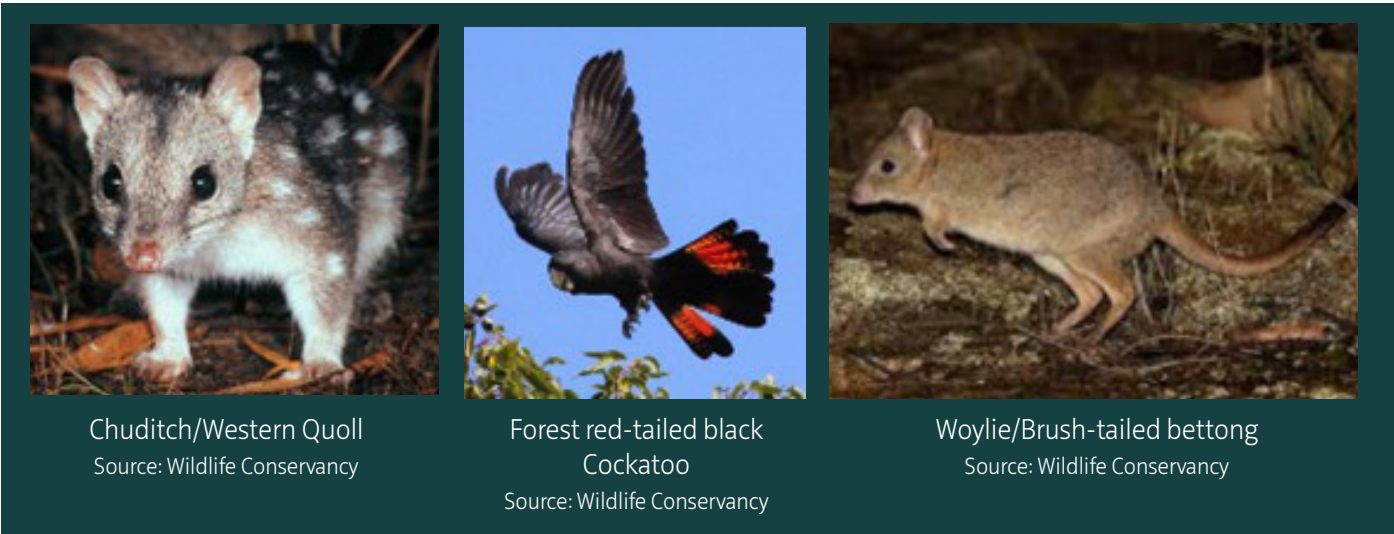
Wavy-leaved Smokebush
Source: Atlas of Living Australia

4.3.4 Conservation Significant Fauna

DBCA's NatureMap (2020) identified 407 native species and 13 introduced species of fauna occurring within the City⁴. DBCA's records of conservation significant fauna occurring within the City include 12 fauna species listed as Threatened under the BC Act and EPBC Act, 14 specially protected species and 15 priority species. These conservation significant species are listed in Appendix 1.

Threatened fauna species recorded within the City include:

- Western Swamp Tortoise (*Pseudemydura umbrina*; Critically Endangered);
- Woylie, Brush-tailed bettong (*Bettongia penicillata ogilbyi*; Critically Endangered);
- Numbat, Walpurti (*Myrmecobius fasciatus*; Endangered)⁵;
- Short-tongued bee (*Leioproctus douglasiellus*; Endangered);
- Baudin's cockatoo (*Zanda baudinii*; Endangered);
- Carnaby's cockatoo (*Zanda latirostris*; Endangered);
- Forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*; Vulnerable);
- Carter's Freshwater Mussel (*Westralunio carteri*; Vulnerable)
- Chuditch, / Western Quoll (*Dasyurus geoffroii*; Vulnerable);
- Malleefowl (*Leipoa ocellata*; Vulnerable);
- Quokka (*Setonix brachyurus*; Vulnerable).



⁴Additional species may occur within the City that have not been recorded by DBCA.

⁵Last recorded in 1996 (translocation)

The City has recently recorded Forest red-tailed black cockatoo breeding within artificial nesting hollows on the Escarpment. This shows how important it is to create extra places for breeding to help the species survive.

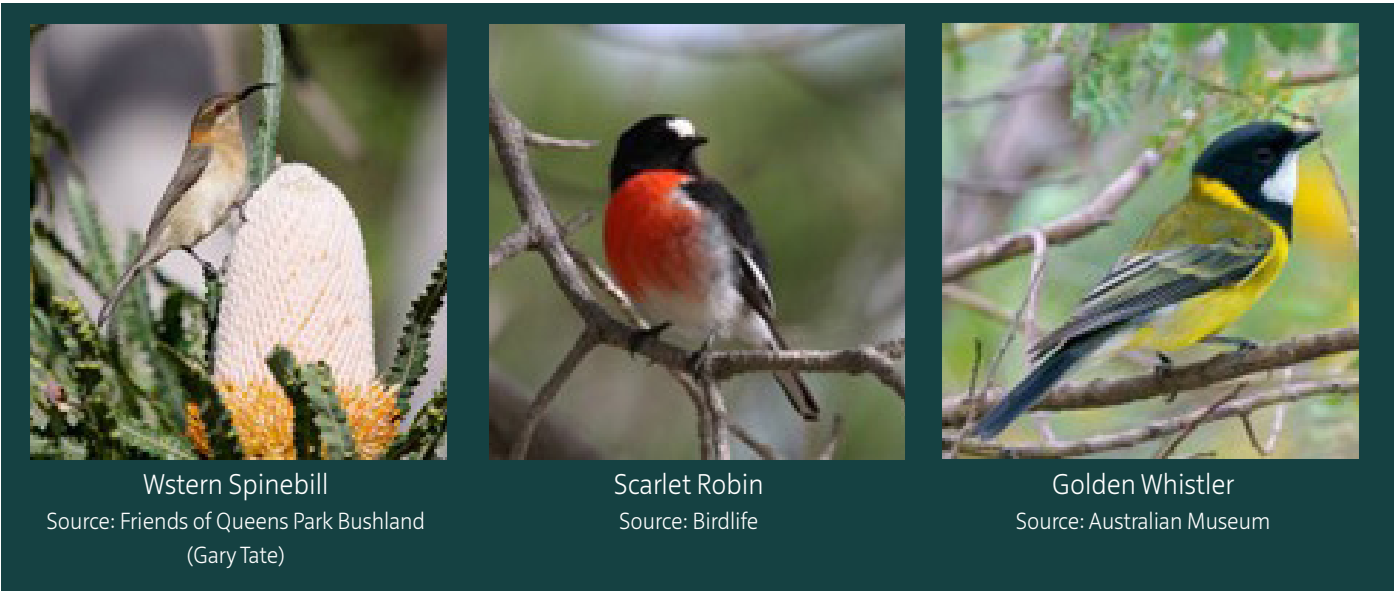
The diversity of the landscape in the City is reflected in the diversity of reptiles found in the area. Several reptile species are restricted to granite outcrops, like the Stone gecko (*Diplodactylus granariensis*), Stimson's Python (*Antaresia stimsoni*) and the Ornate dragon (*Ctenophorus ornatus*). There are also several species of reptiles associated with the lateritic soils of the forest with nearly identical species on the coastal plain, like *Lerista distinguenda* which lives on the escarpment and the nearly identical *Lerista elegans* found on the Swan Coastal Plain.

Similar dynamics between forest and coastal plan regions are observed in the diversity of frog species. One of the largest species in Southwest Western Australia, the Hooting frog (*Heleioporus barycradus*) occupies the forested part of the City. However, on the Swan Coastal Plain it is replaced with the Moaning frog (*Heleioporus eyerei*) and Sandplain frog (*Heleioporus psammophilus*). Maintaining the patterns of flooding and drying of wetlands is critical to retaining the diversity of frogs, reptiles, and other animals which depend on water.

Changes in natural flooding patterns can mean losing species like the Moaning Frog or Gunther's Toadlet, as they rely on specific water levels during



In the Perth region, large vegetated natural areas in the City are also important for a number of bird species. The City is home for some species which have declined or been lost from more urbanised parts of the metropolitan area, such as Western Spinebill (*Acanthorhynchus superciliosus*), Scarlet Robin (*Petroica boodang*), Golden Whistler (*Pachycephala occidentalis*) and Western Yellow Robin (Davis et al, 2013, Davis, R.A. & Douglas, T.K., 2019).



4.3.5 Fungi

There are many more fungi in Australia than plants. It is estimated only about 10% of Australia's fungi have been discovered and named. Yet, fungi play significant roles in bushland ecosystems as they transport, store, release and recycle nutrients.

Many plants such as eucalypts, wattles and orchids depend on the beneficial partnerships with fungi called mycorrhizal associations. Due to the very small size of their seeds, germinating orchids, especially leafless orchids, depend on fungi for nutrients. Different types of mycorrhizal associations have been documented for common plants in the Yule Brook area.

The fruiting bodies of fungi provide food and habitat for many animals, including invertebrates and mammals.

Several species of truffle and fungus-eating marsupials contribute to dispersing fungi and play important role in maintaining ecosystem functions. These include the locally recorded woylies (*Bettongia penicillata*) and quenda (*Isodon fusciventer*) which seek out fungi seasonally (Davison et al 2019).

DBCA's records (January 2020) show 52 records of fungi within the City, including two Priority 3 species of fungi⁶. One species of local fungi carries the City's name; *Amanita kalamundae* or Kalamunda Lepidella.

Building the knowledge base on local fungi will improve the understanding of ecosystem health and inform future management.

The strategy does not include any actions that specifically relate to fungi, however maintaining natural ecological function, ecological community representation, and enhancing ecological linkages facilitating movement between natural areas will consequently maintain and improve the habitat for fungi.



Lacrymaria asperosora - fungi painting by Kevin Griffiths

⁶ Additional species may occur within the City that have not been recorded by DBCA.

4.3.6 Wetlands and Waterways

Maintaining healthy waterways and sensitively managing drainage through the landscape are critical to maintaining the diversity of aquatic ecosystems and water-dependent terrestrial ecosystems. In some parts of the City, waterways or drains are the only opportunity to improve connectivity between natural areas including Poison Gully, Woodlupine Brook, Crumpet Creek, and Yule Brook.

The importance of Yule Brook as a connector of highly diverse plant communities was recognised by the Beeliar Group – Professors for Environmental Responsibility who, in 2018, proposed to the State government that the area become a new regional park. This area consists of bushland along Yule Brook and Crystal Brook from Lesmurdie Falls to Canning River, including bushland and wetlands of Hartfield Park and Greater Brixton Street wetlands.

The City's waterways contribute to catchments of two major rivers of the Swan Coastal Plain, the Swan and Canning Rivers. The Piesse Brook catchment covers the largest part of the City area and contributes to the Swan River catchment. The Yule Brook catchment is the second largest in the City and contributes to the Canning River.

The City's Environmental Land Use Planning Strategy (2019) sets out specific approaches and actions to protect and enhance waterways, wetlands, and groundwater to ensure the sustainable use and management of water resources within the City.

4.3.7 Ecological Linkages

Ecological linkages facilitate the movement of flora and fauna, and connect significant vegetation, habitat, and landscape features.

The local and ecological linkages within the City generally run from north to south and east to west, linking continuous corridors of vegetation, the national park and State forest.

In fragmented landscapes, ecological linkages are particularly important for maintaining biodiversity. The linkages allow wildlife to move out of sites that become unsuitable, allow recolonisation of sites and prevent wildlife from becoming isolated in one bushland area.

Regional ecological linkages were mapped by WALGA in 2009. The designated regional ecological linkages serve to link protected patches of regional significance by identifying the best condition patches available as stepping-stones for flora and fauna between regionally significant areas within the study area.

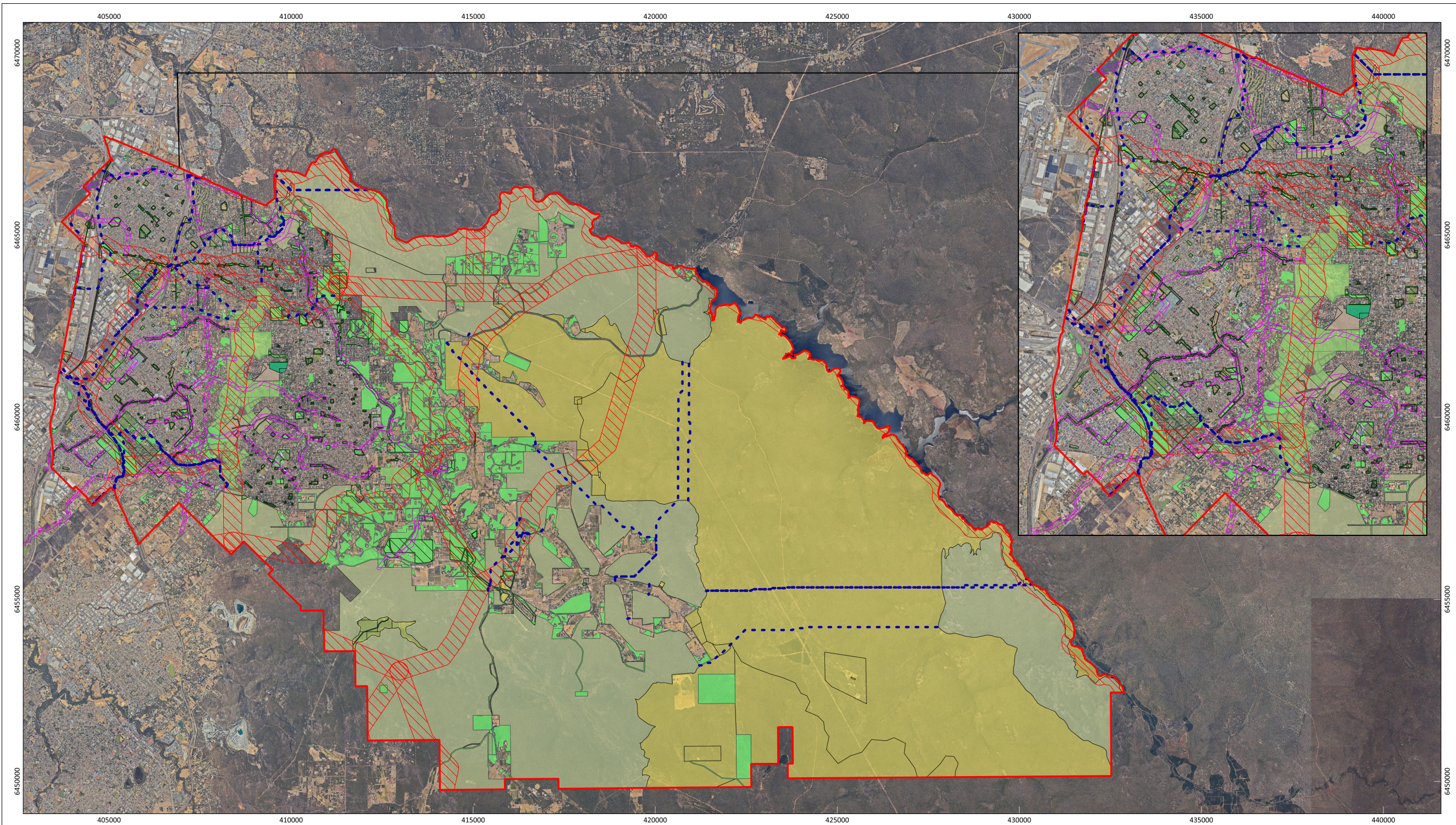
In 2022 Murdoch University published a NatureLinks dataset identifying nature-friendly pathways joining two or more protected natural areas providing the least risk to species moving across the urban landscape. The NatureLinks dataset updates and builds upon the regional ecological linkages identified by WALGA in 2009, reflecting the land use changes that have occurred since the linkages were first identified.

NamNaturra mapped local ecological links in 2020 which show the connections between different natural areas in Perth. These connections help link protected areas, reserves managed by the City, and important conservation areas. The map also identifies areas that provide the most efficient and effective stepping-stones, linking habitats within these connections.

Ecological linkages ideally comprise of native vegetation and flora species (given the City's local wildlife are adapted to natives), however when considering how vegetation lands, such as rural land, contributes to connectivity, the importance of some non-indigenous plants like pecans or macadamias to native animals can be considered. It is important though to provide guidance to landowners on how these crops can be managed sustainably to meet the potentially conflicting needs (DBCA 2017).

It is noted that the City's Urban Forest Strategy will also assist in enhancing ecological connectivity in liveable areas through increasing tree cover.

The City seeks to consider all three datasets in actions to retain, protect, and enhance ecological linkages in accordance with Focus Area 4: Link (Section 6). Mapped ecological linkages within the City of Kalamunda are shown in Figure 4.



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Figure 4: Ecological Linkages Mapped within the City of Kalamunda

Scale
1:100,000

Sheet Size
A3 COLOUR

Coordinate Reference System
GDA2020 / MGA zone 50

Data Source
LANDGATE AERIAL IMAGERY Summer 2023

Project/Report Name
Local Biodiversity Strategy
City of Kalamunda

Client
City of Kalamunda

Project Number
A23.017

Version
0

Drawn By / Reviewed By
MD/HS

Date
7/7/2023

Legend

- City of Kalamunda
- NatureLinks (Haddleton et al., 2022)
- City of Kalamunda Reserves
- Regional Ecological Linkages (WALGA, 2008)
- Local Ecological Linkages (NamNatura, 2020)
- Local open space

- Local Natural Areas
- Managed Land (DBCA-011)
- National Park
- Nature Reserve
- Conservation Park
- Section 5(1)(h) Reserve
- State Forest
- SCRM Act - River Reserve
- Crown Freehold - Dept Managed

No	Description	Drawn	Approved	Date
A	Original issue	MD	HS	7/7/2023

NOTES:
Cadastral boundary from LANDGATE 2022.
Label corresponds to the vegetation association number.

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Figure 4. Ecological Linkages mapped within the City of Kalamunda

4.4 Priority Local Natural Areas

While all natural areas have ecological value, it's necessary to compare them to other areas in the City to prioritise conservation. This helps when deciding where to allocate funds for management proposals and increases our understanding of each area's value. However, it's crucial not to use relative conservation significance as a reason to clear any natural area, as that would result in the loss of the City's biodiversity.

Understanding the ecological values of LNAs is an essential part of biodiversity planning, protection, and management. The City and its stakeholders must also consider economic and social implications of protecting LNAs. This consideration is factored into the Strategy, in part, through revisions to the local planning framework.

Natural area prioritisation is the important first step in identifying priority areas for protection, conservation and management in the City. The prioritisation process aims to find natural areas that have multiple or complementary conservation values to focus on opportunities which will benefit multiple species or ecosystems. By identifying these areas, the City can allocate its resources effectively and achieve significant biodiversity outcomes.

Once natural area prioritisation scores (NAPS) were determined as part of the development of this LBS, priority LNAs were further assessed for their viability and connectivity, which are integral in determining if the LNA may continue to self-sustain. These factors are described in more detail below.

4.4.1 Natural Area Prioritisation Score

Prioritisation considers a range of criteria defined by the Perth Biodiversity Project (2012), including:

- representation;
- rarity;
- diversity;
- wetland, streamline, estuarine and coastal vegetation; and,
- maintaining ecological functions through factors such as patch size and connectivity.

The complete methodology used to assign NAPS to LNAs is available as Appendix 3. This process defined priority LNAs, as LNAs that satisfied at least one prioritisation criteria (i.e. a NAPS of one or greater). The priority scores identified through this process are shown in Figure 5, with higher biodiversity significance shown by higher scores. A low NAPS does not indicate that an area does not contain significant biodiversity values, rather the NAPS is a tool used to prioritise the allocation of resources toward protecting, managing and enhancing the biodiversity of an area.

The priority scores are assigned by a desktop assessment and must be verified through site surveys. Reviewing and updating or confirming these priority scores is an action for this LBS.

The scores identified in Figure 5 indicate the number of criteria met by each LNA, with values ranging between two and 42.5. Where LNAs are situated on land managed by the City, those with highest environmental significance (NAP score of 25 or greater) will be prioritised for conservation and management (Actions 1.1 and 3.1). An assessment of the management priorities for City Reserves, with consideration of priority scores and viability (as described in Section 4.5 below), is provided in Appendix 4.

4.5 Viability

When deciding where to focus conservation management efforts, it's important to assess the viability of LNAs. Viability provides an indication of the ability of a LNA to self-sustain, or the level of management and intervention required for an LNA to persist and thrive into the future (lower viability suggests greater management/ intervention is required). The assessment of viability undertaken as part of the development of this LBS considers the LNAs mapped area, shape, perimeter to area ratio, vegetation condition, and its distance from other protected or unprotected natural areas.

4.6 Connectivity

Habitat fragmentation is a major threat to biodiversity. Improving ecosystem resilience and connectivity, expanding the network of LNAs and protecting important refugia are recommended as priority management approaches to adapting to the impacts of climate change.

As a result, an important part of the Strategy is to improve connections between natural areas in the City. When vegetation patches are isolated, fewer species can survive in those patches over time. The survival of any natural area depends on its closeness to other natural areas and the quality of connections or obstacles in the landscape between them. Connectivity of LNAs were modelled by Nam Natura (2020), considering the fragmentation, regional connectivity, and connectivity reach of LNAs within the City, resulting in the local ecological linkages shown in Figure 4.

While we have some knowledge of how habitat fragmentation affects fauna populations, we don't have a good understanding of how urbanisation impacts the long-term survival of plant communities. A study was conducted on remnant Banksia woodlands in the Perth region to investigate the effects of urbanisation. The results showed that when Banksia communities are isolated for a long time, there are changes in the types of species and the overall structure of the plant community. In small (1-5ha) remnants that were isolated for 45 years or longer, species richness was reduced by nearly 50 percent.

This study also highlighted the impacts of this fragmentation will not be visible for some time and recommended focusing conservation efforts on areas that were recently fragmented and those without significant land-use legacies.

5 Local Biodiversity Challenges and Opportunities

Significant threats to conserving, retaining, and enhancing biodiversity values include:

- land clearing and habitat fragmentation;
- introduced plants (weeds);
- pest animals;
- altered hydrology;
- inappropriate fire regimes;
- diseases;
- inappropriate human use and uncontrolled access; and,
- climate change.

These challenges and their impacts on the City’s biodiversity are discussed below. This section also outlines the City’s current responses and identifies opportunities and proposed measures to conserve and manage biodiversity. The key opportunities identified have informed the development of the LBS focus areas, goals, strategic objectives and action plan.

5.1 Land Clearing, Degradation, and Habitat Fragmentation

The leading cause of native vegetation clearing resulting in habitat fragmentation is urban development, including residential, infrastructure, agricultural, and industrial development. Bushfire risk management, the spread of diseases and pathogens, altered hydrological regimes, and inappropriate land use also contribute to habitat fragmentation. Evidence of habitat fragmentation is seen throughout the City, most significantly on the Swan Coastal Plain, with the Escarpment and Darling Plateau impacted to a lesser degree.

Fragmented landscapes limit the ability of native animals and plants to move across natural areas and severely restricts the dispersal of genetic material for flora species. The inability of populations to recolonise areas after a disturbance may result in the continued loss of species across a landscape long after the initial clearing.

Fragmented natural areas are also more likely to be impacted by edge effects from weed species, wind, and water erosion, or the predation of or over grazing by fauna.

Sustainable land use planning must be considered to stem the City’s largest threat to biodiversity from increasing development in the City. Like many local government areas, the City is facing increasing population projections and State government housing targets, which will necessitate rural or semi-rural zoning changes allowing for urban and industry development.

Sustainable land use planning can contribute significantly to maintaining natural landscapes, biodiversity, and ecological linkages. The City will continue to balance its goals of biodiversity protection and economic and social growth.

Impacts of land clearing and fragmentation, and the City’s current and proposed response are identified in Table 6.

Table 6. Impacts of Land Clearing on Biodiversity and the City’s Current and Proposed Response

Impacts	<ul style="list-style-type: none">• Loss of habitat and plants, many of which cannot be preserved elsewhere.• Loss of ecosystem services provided by the plants and animals such as pollination or control of nutrient run-off.• Loss of dispersal by native species.• Loss of water quality within water catchment.• Land degradation (erosion, soil acidification).• Loss of economic opportunities dependant on high quality natural areas.• Reduced resilience of protected areas to other threatening processes.
Current Response(s)	<ul style="list-style-type: none">• Using the provisions of the regulatory process to manage land use.• The City’s Local Environmental Strategy 2019 includes an action to develop a plan to link green spaces through the landscape.
Additional Response(s)	<ul style="list-style-type: none">• Prioritise LNAs for protection and retention (Action 1.2).• Identify opportunities for facilitating species dispersal and providing alternative habitat (Action 4.2).• Increase provisions of the local regulatory processes to increase natural retention and protection (Action 1.1).• Increase protection of retained natural areas via changes to land tenure (Action 1.3).• Local Planning Policy for Biodiversity• Increase density through provisions in the local planning scheme to facilitate increased housing supply while reducing the demand for urban expansion into rural and semi-rural areas (Action 1.1).

5.2 Weeds

Invasive species threaten biodiversity and can reduce native flora and fauna species populations due to changes to competition, predation, mortality, or habitat degradation.

Weed species respond positively and rapidly to land or habitat disturbance, such as clearing, rubbish dumping, trampling and fire.

Impacts of weeds on local biodiversity, and the City's current and proposed response are identified in Table 7.

Table 7. Impacts of Weeds on Biodiversity and the City's Current and Proposed Response

Impacts	<ul style="list-style-type: none">Competing with native vegetation by inhibiting growth. Without management, weeds can displace native species over time.Riparian native vegetation along wetlands and waterways can become choked with weed species. Seeds from the weed species can be transported downstream.Grassy weeds can increase the risk of bushfire.Fauna habitat can be altered significantly by weed species that take over the native vegetation.Replacing diverse native plant communities with more uniform weed communities.Diminishing economic viability of agriculture, tourism, or bushland restoration programs.
Current Response(s)	<ul style="list-style-type: none">Implementing weed control aligning with the City's priorities.Grab-a-gladdie initiative.Support for community volunteers undertaking weed control in selected reserves.Control of landscaping practices via development approval processes.Community education via publication of Plants Out of Place booklet.The City's Local Environmental Strategy 2019 includes an action to review and update the City's Weed Control Strategy.Understand role of fire mitigation on weed abundance through the development of the Bushfire and Biodiversity Management Guidelines as an outcome of the Local Environment Strategy.
Additional Response(s)	<ul style="list-style-type: none">Update and distribute information for private landholders on best practice natural area management (Action 5.5).

5.3 Feral Animals

Invasive species are a significant pressure on native fauna, and were estimated to affect 82% of threatened taxa in Australia in 2018 (Commonwealth of Australia 2021). Foxes, cats, rabbits, and feral pigs are among the feral animals most destructive to flora and fauna within the City. Feral invertebrates such as the European wasp, European house Borer and polyphagous shot-hole borer are at risk of becoming established within the City and threatening local biodiversity.

Impacts of feral animals on local biodiversity, and the City's current and proposed response are identified in Table 8.

Table 8. Impacts of Feral Animals on Biodiversity and the City's Current and Proposed Response

Impacts	<ul style="list-style-type: none">Predation by foxes and cats is the major contributor to the loss of small mammals, native birds and lizards.Spread of weed species.Loss of nesting hollows to the more aggressive introduced birds and feral bees.Competition for declining food sources.Land degradation through trampling, soil disturbance and erosion.
Current Response(s)	<ul style="list-style-type: none">Pest management via development approval processes.Providing information on pest control via the City's website.Targeted feral animal control.The City's Local Environmental Strategy 2019 includes an action to develop a strategic approach to the control of feral animals in the City.Gazettal of a new Cat Local Law and enforcement of declared cat-free zones.Develop and release educational messaging on responsible cat ownership and property management to discourage feral animals.
Additional Response(s)	<ul style="list-style-type: none">Work with neighbouring local government areas and DBCA on coordinated feral animal control (Action 3.9).Update and distribute information for private landholders on best practice natural area management (Action 5.5).

5.4 Altered Hydrology

Hydrology, or the properties and movement of water on land, is impacted by land clearing, modifying watercourses, and pressures such as land fill and over-use of fertilisers.

Impacts of altered hydrology on local biodiversity, and the City’s current and proposed response are identified in Table 9.

Table 9. Impacts of Altered Hydrology on Biodiversity and the City’s Current and Proposed Response

Impacts	<ul style="list-style-type: none">• Loss of habitat and biodiversity.• Loss of water quality within water catchments.• Land degradation (erosion, soil acidification).• Loss of economic opportunities dependant on high quality natural areas.• Reduced resilience of protected areas to other threatening processes.
Current Response(s)	<ul style="list-style-type: none">• Adopting catchment management strategies to guide land use and development in the City’s public drinking water supply catchments.• Working with relevant State Government agencies to integrate wetlands into developments.• Supporting the managed Aquifer Recharge project (Hartfield Park).• The City’s Local Environmental Strategy 2019 includes an action to develop catchment management plans to inform surface water management and to develop a Local Planning Policy for waterways’ protection.• Finalise draft Local Planning Policy 34 – Wetlands and Waterways for adoption.
Additional Response(s)	<ul style="list-style-type: none">• Guide private landholders on best practice management of waterways and their buffers (Action 5.5).• Restore native vegetation along priority waterways, drains and drainage basins (Action 3.7).

5.5 Plant Diseases

Pathogens are organisms such as fungi, bacteria and viruses that cause plant diseases. While some pathogens occur naturally within soil types, others have been introduced to the environment through the movement of plant materials and soils. Pathogens can exist in the soil for long periods of time without causing an outbreak of disease in plants. Disease outbreaks are either caused by an increase in the population of the pathogen or by an increase in the susceptibility of the host species. The population of the pathogen depends on whether the soil conditions are favourable for its growth and survival.

The City is known to have five key plant pathogens:

- *Phytophthora cinnamomi* (Dieback): an introduced pathogen that is widespread in the southwest and urban areas of Perth. This pathogen has a very wide host range, with more than 2,300 species of Western Australian native plants considered to be susceptible;
- *Phytophthora multivora*: an emerging pathogen that is described from natural ecosystems in Australia. It impacts *Eucalyptus marginata* (Jarrah), *Eucalyptus gomphocephala* (Tuart), *Agonis flexuosa* (WA peppermint) and *Corymbia calophylla* (Marri);
- *Phytophthora nicotianae*: a soil-borne pathogen which was identified as affecting herbaceous and woody plants used within agriculture and horticulture; however, it is now established within natural ecosystems of Western Australia;
- *Quambalaria coyrecup* (Marri Canker): a canker disease that impacts *Corymbia calophylla* (Marri) and amenity planted *Corymbia ficifolia* (Red Flowering Gum). Once impacted by the disease, trees do not appear to recover; and,
- *Fusarium* fungus (associated with Polyphagous shot-hole borer): *Fusarium fungus* (which has a symbiotic relationship with polyphagous shot-hole borer) kills vascular tissue in susceptible trees causing Fusarium dieback and tree death.
- *Armillaria* fungus is an endemic parasitic fungus that can infect the roots of most shrub and tree species, eventually killing them.

Impacts of plant diseases on local biodiversity, and the City’s current and proposed response are identified in Table 10.

Table 10. Impacts of Plant Diseases on Biodiversity and the City’s Current and Proposed Response

Impacts	<ul style="list-style-type: none">• Plant pathogens can cause loss of biodiversity due to changes to plant community structures and loss of habitat (e.g. nectivorous birds are at high risk of significant decline due to spread of dieback).
Current Response(s)	<ul style="list-style-type: none">• Dieback warning signage at selected City managed reserves.• Pest management via development approval processes.• Providing information on dieback on the City’s website.• The City’s Local Environmental Strategy 2019 includes an action to map of City’s LNA’s for <i>Phytophthora</i> species
Additional Response(s)	<ul style="list-style-type: none">• Adopt dieback hygiene procedures for all City operations (e.g. roadworks, infrastructure development and maintenance) (Action 3.6).• Update and distribute information to private landholders and contractors on best practice natural area management (Action 5.5).• Local Planning Policy for Biodiversity to include construction management.



5.6 Altered Fire Regimes

Since European arrival, the fire patterns in Australia have changed, with larger and more frequent fires happening. This increase in bushfire frequency significantly impacted native plants and animals in Western Australia.

Altered fire patterns can cause changes in the structure and composition of vegetation. If fires occur too often, species that are sensitive to fire may not be able to grow and reproduce. If fires are too infrequent, species that rely on fire for reproduction may struggle to set seeds or germinate. These changes not only affect the vegetation itself but also impact the available habitat resources for animals. Intense fires can harm populations of sensitive species, while frequent fires can limit population recovery and promote the growth of invasive weed species.

Managing the risk of bushfires requires a careful balance between protecting lives and infrastructure and preserving biodiversity. Finding this balance can be challenging because strategies to reduce bushfire risk and preserve ecosystem values may sometimes conflict.

Impacts of altered fire regimes on local biodiversity, and the City’s current and proposed response are identified in Table 11.

Table 11. Impacts of Altered Fire Regimes on Biodiversity and the City’s Current and Proposed Response

Impacts	<ul style="list-style-type: none">• Potential reduction in native species and increased weed infestation.• Potential reduction in success of re-sprouting of native plants after each fire.• Significant reduction in above-ground material including leaf litter and logs, which are important habitats for native fauna species.• High mortality of native fauna species.• Opportunities dependent upon high quality natural areas.
Current Response(s)	<ul style="list-style-type: none">• The City provide a fuel load measuring kit and guidelines to landowners on minimising bushfire risk on their properties without affecting the vegetation on adjoining land.• The City’s Local Environmental Strategy 2019 includes an action to determine ecological fire requirements and to develop fire and biodiversity conservation procedures for the management of City reserves.• The City currently maps fuel age and load to inform burning regime.• Consult with technical experts from fire management background, fire ecologists, and local Indigenous representatives to develop an agreed approach for managing fire in areas of high ecological value.• Application of State Planning Policy 3.7 Planning in Bushfire Prone Areas and the Guidelines for Planning in Bushfire Prone Areas through the planning and development process to ensure appropriate separation between new development and vegetated areas.
Additional Response(s)	<ul style="list-style-type: none">• Use the NAPS to inform land use planning, avoiding further subdivisions in high conservation value areas (Action 1.1).• Consulting with technical experts from fire management background, fire ecologists and local Indigenous representatives and determine an agreed way forward for managing fire in areas of high ecological value, in accordance with the Bushfire and Biodiversity Management Guidelines (Action 3.8).

5.7 Uncontrolled Access

Uncontrolled access to natural areas and State Forest for recreational activities such as trail bike riding and four-wheel driving is an issue for the City as these activities can cause significant damage to landscapes.

Table 12. Impacts of Uncontrolled Access on Biodiversity and the City’s Current and Proposed Response

Impacts	<ul style="list-style-type: none">• Loss of biodiversity can occur from uncontrolled vehicle and pedestrian access due to:<ul style="list-style-type: none">» physical removal of vegetation.» introducing weed species and pathogens.» disturbing soil surfaces leading to erosion or compaction.» fauna disturbance, injury, or death.» rubbish dumping.» reducing aesthetic values of the natural landscape.• Loss of economic opportunities dependent upon high quality natural areas.
Current Response(s)	<ul style="list-style-type: none">• Supporting community volunteers involved in management of bushland reserve.• Fencing and signage in selected reserve.• Cleaning up areas when observed or reported.
Additional Response(s)	<ul style="list-style-type: none">• Adopting a plan for adequate fencing and signage for all high conservation value reserves (Action 3.1).• Updating and distribute information for private landholders on best practice natural area management (Action 5.5).• Engaging broader community to become stewards of local bushland and report activities threatening biodiversity values (Action 5.2 and Action 5.5).• Local Planning Policy for Biodiversity to include vegetation protection/ access control.



5.8 Climate Change

The southwest of Western Australia is becoming a hotter and drier climate with more frequent and severe bushfires and extreme weather events.

The number of hot days over 35°C has doubled in the southwest of Australia over the last 50 years. Over the same period, rainfall has declined in southwest WA at a faster rate than elsewhere in the country (GoA 2022). Hotter and drier conditions have also increased the risk of bushfire, which also increases risk of local biodiversity loss.

The 2021 State of the Environment report prepared for Australia identified that climate change and extreme weather events are increasingly driving chronic and acute changes in biodiversity. Chronic impacts include more gradual lifecycle shifts, changing abundances, and range expansions and contractions, while acute impacts include mass mortality and loss of biodiversity caused by extreme events such as fires and unprecedented droughts (Prober et al. 2019).

Table 13. Impacts of Climate Change on Biodiversity and the City’s Current and Proposed Response

Impacts	<p>Climate change has the potential to adversely affect biodiversity in the City through:</p> <ul style="list-style-type: none">• changing to the quality, extent and distribution of native vegetation and habitat.• reducing the range of many species.• changes to hydrology (the natural wetting and drying cycles and frequency and duration of inundation) of wetland and watercourses.• changes in the diversity and abundance of wildlife reliant upon those habitats.
Current Response(s)	<p>The City currently manage the impacts of climate change through the Local Environment Strategy, with strategies including:</p> <ul style="list-style-type: none">• managing bushfire risk without adversely affecting biodiversity in our reserves.• holistically managing surface water resources to improve water quality and natural values.• identifying and using fit for purpose water resources and using technology to attain water use efficiencies. <p>The City recently adopted its first Climate Change Action Plan which includes actions targeted at reducing organisational greenhouse gas emissions and maintaining and improving local biodiversity despite the impacts of climate change. These actions will be ongoing, delivered through the Climate Change Action Plan and supported by the LES and LBS, and include:</p> <ul style="list-style-type: none">• developing thresholds for unacceptable change in the condition of natural areas and appropriate corrective actions.• designing Public Open Spaces to provide increased shade for users (through the Urban Forest Strategy).• landscaping Public Open Spaces to incorporate species suited to projected conditions (drought-tolerant, and resilient to heat).• implementing program of converting areas of irrigated turf that are not essential to amenity or recreation to eco-zoning plantings with reduced water needs.
Additional Response(s)	<ul style="list-style-type: none">• Undertake a climate risk assessment to identify the impact of climate change on keystone species and natural areas within the City, to inform a climate change adaptation strategy (Action 2.3).



6 Action Plan

Protecting and enhancing the City's local biodiversity is a shared responsibility between government agencies, local government, and the community. Local government has varying degrees of influence over how different land uses and tenures impact upon LNAs and other biodiversity values. This is illustrated by Plate 6.

Concern

Relates to issues over which the City has limited influence or control, such as international agreements, broader societal trends, or the introduction of strategies by the State government that seek to support growth while balancing social and economic outcomes. The City can monitor these changes and respond strategically.

Influence

Matters that are outside of the City's direct control, but over which it has a degree of influence. These include the management of biodiversity on private land through education and support, community initiatives, and advocacy to influence state and federal policies and initiatives. The City could influence the retention of biodiversity values by permitting higher density within urban areas and reducing demand for urban sprawl into areas of higher biodiversity.

Control

Matters within the City's direct control such as the protection and management of City parks and reserves and the discharging of statutory responsibilities for which the City has a decision-making role.

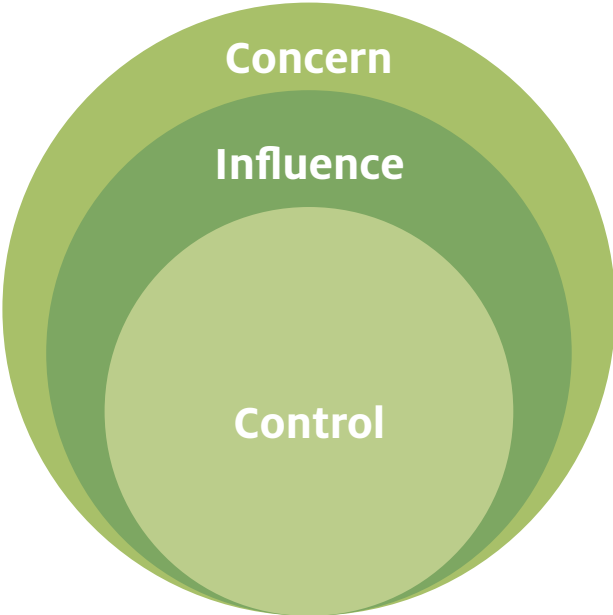


Plate 6. The City's Varying Degrees of Influence over the Management of Biodiversity

Table 14. Local Biodiversity Focus Area Goals, Strategic Objectives and Actions

Focus Area 1:	Retain and protect LNAs and other native vegetation on City-managed land and private land.
Retain and Protect	
Strategic objectives	<div>Strategy</div> <div><div>1. Retain and protect ecological values on City-owned and managed land by formally setting aside land for conservation purpose and improving operational processes.</div><div>2. Maximise retaining and protecting high biodiversity values through strengthening the planning and development framework.</div></div>

Focus Area 1:	Retain and protect LNAs and other native vegetation on City-managed land and private land.
Retain and Protect	
Action 1.1	<div>Introduce provisions for biodiversity retention and protection on private land in the local planning framework, including:</div> <div><div>1. Integrating the Local Biodiversity strategic objectives and LNA mapping into the City's Local Planning Strategy.</div><div>2. Introducing a new Local Open Space category for environmental conservation in Local Planning Scheme 4.</div><div>3. Introducing a requirement in Local Planning Scheme 4 for rehabilitating land where an owner or occupier has caused or allowed land to be intensively cleared or degraded.</div><div>4. Investigate measures and general provisions to retain, protect and manage biodiversity through the Local Planning Scheme 4.</div><div>5. Investigate the inclusion of provisions for rural land uses in Local Planning Scheme 4 that provide for biodiversity retention and management, such as:<div><div>a Extending land use provisions to facilitate business opportunities that are compatible with natural areas (e.g., 'care farms' or conservation cooperatives);</div><div>b Providing flexibility in minimum lot size (where average lot size and/or total lot yield is maintained) to minimise the need for vegetation clearing and maximise vegetation retention.</div></div></div><div>6. Preparing a Local Planning Policy for Biodiversity Conservation to provide for the assessment, retention, protection and management of biodiversity through the planning and development process.</div></div>
Action 1.2	Review and update prioritisation mapping completed in 2020 as shown in Figure 4 to assign or confirm priority ratings for City-managed reserves based on environmental significance.
Action 1.3	<div>Assess the adequacy of current planning protection of existing and proposed City LNAs and identify and implement appropriate planning controls, such as⁷:</div> <div><div>1. changing the purpose (management order) of reserves containing priority LNAs to include "conservation" (Action 1.1).</div><div>2. for Reserves that serve both a conservation and recreation function, consider defining each purpose on separate lots or as separate reserves, particularly where the recreation is more organised (and may involve leasing arrangements) and/or if the conservation areas involve other government agencies or areas with significant environmental value.</div><div>3. changing the classification of local open space containing priority LNAs to a new local reserve category (refer Action 1.1) providing for biodiversity conservation.</div></div>

⁷This action is to be informed by the land tenure category recommendations in Appendix 5 and is to be prioritised based on City managed LNAs with the highest NAPS.

Focus Area 2:	Investigate and actively pursue new resourcing (human, funding, and data) and research opportunities to enable further investment and improvement in on-ground actions on public and private land to manage and protect local biodiversity.
Investigate	
Strategic Objectives	<ol style="list-style-type: none"> 1. Identify and secure adequate resources to implement the Strategy. 2. Improve knowledge of the ecological values within the City's LNAs and understand their threatening processes. 3. Develop, expand, and manage a central ecological database. 4. Collaborate with land management agencies and research institutions to examine best practice management and education relating to biodiversity.
Action 2.1	Undertake on-ground surveys of LNAs situated on land managed by the City to confirm and record environmental values, priority listing and threatening processes. Prioritise survey locations based on environmental significance (highest Natural Area Prioritisation Score), and the risk of degradation and level of investment required to ensure a self-sustaining ecosystem (based on viability score). ⁸
Action 2.2	<p>Develop an internal, central environmental database to inform the City's decision making. The database should capture:</p> <ol style="list-style-type: none"> 1. existing and new records of flora, fauna, and ecological community data from consultant reports, City technical studies, and community group studies; 2. LNA priority mapping; and 3. available ecological spatial data layers (e.g. native vegetation extent, Threatened and Priority species and communities, wetlands and waterways, ecological linkages).
Action 2.3	Undertake a climate risk assessment to identify the impact of climate change on keystone species and natural areas within the City, to inform a climate change adaptation strategy. This will include the development of thresholds for unacceptable change in the condition of LNAs managed by the City, to inform management actions in the Greening Masterplan.
Action 2.4	<p>Through developing the Annual Implementation Action Plan (see Section 7.1), identify human resource needs for implementation of the Strategy. This may include:</p> <ol style="list-style-type: none"> 1. additional part-time or full-time staff. 2. collaborating with land management agencies, research institutions and not-for-profit organisations. 3. utilising volunteers / Friends Groups / professional learning and research opportunities.

Action 2.5	<p>Through developing the Annual Implementation Action Plan (see Section 7.1), identify and secure third-party funding to support the City in implementation of the Strategy. This may include:</p> <ol style="list-style-type: none"> 1. Grant funding opportunities. 2. Third party environmental offsets (e.g. those required under the Environmental Protection Act 1986 and Environment Protection Biodiversity Conservation Act 1999). 3. Exploring funding opportunities with other agencies, such as: <ol style="list-style-type: none"> a. the Water Corporation Waterwise Greening Scheme, as an Endorsed Waterwise Council to facilitate the conversion of resident verges to waterwise, native gardens. b. State and Commonwealth partnerships to deliver on actions within adopted Threatened species and communities recovery plans and manage the City's LNAs containing these values.
Action 2.6	Look for opportunities to partner with other agencies, universities, private sector, NGOs, and community groups to deliver research projects to improve understanding and best-practice management relating to biodiversity, such as studies on rehabilitation, threatened species and communities, ecological linkages, climate change impact on biodiversity, weed, pest and feral fauna management.

¹This action should be informed by Appendix 4, which prioritises City Reserves with a high Natural Area Prioritisation Score and low viability score. This assessment is based on the ratio of Natural Area Prioritisation Score to viability score, however, does not consider pressures such as highly frequented public areas (e.g., Hartfield Park), the purpose of the Reserve or the size of the Reserve. As such, additional characteristics must be considered on a case-by-case basis in determining survey priorities.

Focus Area 3:	Manage, enhance, and rehabilitate LNAs and other native vegetation on City-managed land to improve the quality and quantity of biodiversity values.
Manage and Enhance	
Strategic Objectives	<ol style="list-style-type: none"> 1. Plan and implement managing, enhancing and rehabilitating biodiversity values on City owned and managed land in line with best industry practice. 2. Work collaboratively with other public land managers and knowledge holders for cohesive management of LNAs
Action 3.1	<p>Using on-ground information gathered through Action 2.1, ensure current, best-practice environmental management is determined and implemented for LNAs and native vegetation on City owned or managed land through the development of environmental management plans and/or an appropriate design response.⁹</p> <p>This will include:</p> <ul style="list-style-type: none"> • an appropriate planning and/or design response for Reserves with high environmental values but low viability based on their small size and/or linear shape, or their purpose/ function. For example drainage reserves and waterways; and/or, • the preparation and implementation of environmental management plans for larger LNAs with high environmental values (prioritisation score) and greatest threatening process (e.g. highly frequented by the public, and/or low viability score). For example; Hartfield Park, Maida Vale Reserve. <p>At a minimum, environmental management plans (EMP) will include:</p> <ul style="list-style-type: none"> • a description and spatial mapping of environmental values and threats (e.g. vegetation type and condition, habitat, flora and fauna species list, presence of weeds/ pests/ disease). • identifying mitigation and management measures to protect and enhance biodiversity values (e.g. weed control, access control, feral pest management). • identifying areas for rehabilitation/enhancement of biodiversity values. • a program for implementing the EMP, including identifying completion criteria, roles, responsibilities, and timeframes.
Action 3.2	Using on-ground information gathered through Action 1.1 and other available spatial information, develop a register of sites containing biodiversity values that would benefit from additional management actions and rehabilitation programs. This register can be provided to third parties seeking environmental offset opportunities within the City which will assist with identifying third party funding and resources for the implementation of the LBS. ¹⁰
Action 3.3	<p>Revise the City's Public Open Space Strategy including:</p> <ol style="list-style-type: none"> 1. updating the "Biodiversity Asset" mapping to reflect the presence of priority LNAs. 2. revising Action 1.1.6, or include an additional action, that requires replacing all native vegetation removed within Public Open Space at a minimum ratio of 2:1 either within the same reserve or another City-managed reserve, within 12 months of the vegetation being removed. The current Public Open Space Strategy Action 1.1.6 applies only to 'significant trees'.

Action 3.4	Identify opportunities for fauna management and enhancement of fauna habitat on City-managed land, such as installing black cockatoo nesting hollows, water stations, fauna road crossings and educational signage.
Action 3.5	Investigate opportunities to require protecting and improving habitat value on City owned or managed land that is leased to private entities for recreation or similar through the lease conditions (e.g. Hartfield Park Golf Course).
Action 3.6	Develop and implement best-practice operational procedures (e.g. dieback/ hygiene management procedures) for all City staff and contractors working near and accessing natural areas and managing infrastructure assets.
Action 3.7	Develop and implement a Greening Masterplan guiding a revegetation and landscaping that uses local native species, for City managed land, including public open space, drains and drainage basins, street verges and other suitable City-managed assets.
Action 3.8	<p>Consult with technical experts from fire management background, fire ecologists and local Indigenous representatives to:</p> <ol style="list-style-type: none"> 1. Determine an agreed way forward for managing fire in areas of high ecological value, in accordance with the Bushfire and Biodiversity Management Guidelines; and, 2. Establish one reference Ecological Burn Site in each of the key vegetation Associations across the City.
Action 3.9	Explore multi-tenure land management programs such as targeted pest and weed control, disease and pathogen, fire management and stream and roadside reserve restoration works.

⁹This action should be informed by Appendix 4, which prioritises City Reserves with a high Natural Area Prioritisation Score and low viability score. This assessment is based on the ratio of Natural Area Prioritisation Score to viability score, however, does not consider pressures such as highly frequented public areas (e.g., Hartfield Park), the purpose of the Reserve or the size of the Reserve. As such, additional characteristics must be considered on a case-by-case basis in determining survey priorities. The list requires further assessment by City Officers to determine the management response required (such as a planning or design response, or a Reserve environmental management plan) depending on the physical characteristics of the Reserve (size, connectivity), threats (including anthropogenic) and purpose of the Reserve.

¹⁰This action builds on Action 1.1.5: of the City's Public Open Space Strategy which states: "Utilising this Strategy as an overarching authority, a project specific brief for the development of a framework that identifies all available land areas that can be rehabilitated / revegetated through offset plans for the City to be utilised as environmental offsets. The Environmental Planning Strategy, Local Biodiversity Strategy 2008 and Local Environment Strategy are to assist in informing rehabilitation and revegetation plans and offset areas."



Focus Area 4:	Maintain and improve local and regional ecological linkages that allow flora and fauna species movement and the flow of genetics throughout the landscape.
Link	
Strategic Objectives	<ol style="list-style-type: none"> 1. Maximise retaining, protecting and enhancing ecological linkages through the planning framework. 2. Retain, protect, and enhance ecological linkages within City-managed land. 3. Encourage enhancing ecological linkages on private property.
Action 4.1	Include measures to retain, protect and enhance ecological linkages within the Local Planning Policy for Biodiversity Conservation to be prepared under Action 2.2.
Action 4.2	<p>Retain, protect, and enhance ecological linkages within City owned and managed land as a component of the Greening Masterplan (see Action 3.7), developed through the following steps:</p> <ol style="list-style-type: none"> 1. undertake a desktop mapping exercise to identify City owned and managed land that can potentially be enhanced and/ or managed as local ecological linkages connecting remnant patches of vegetation, for example within public open space and reserves, along suitable local roads, walkways, cycleways, waterways and through converting open drains and restoring riparian vegetation on creek lines. 2. prioritise site selection for potential rehabilitation and management based on connectivity between LNAs with high biodiversity value. 3. validate or augment the desktop mapping to confirm suitability of sites for rehabilitation/ management and prepare a conceptual Green Links Masterplan map. 4. develop and implement a rehabilitation and management program on a site-by-site basis.
Action 4.3	<p>Encourage enhancement of ecological linkages on private property through:</p> <ol style="list-style-type: none"> 1. Targeting educational material for landowners located within a mapped regional or local ecological linkage informing how they can contribute, such as planting of suitable local native species and creating habitat. 2. Investigating incentives for properties within a mapped regional or local ecological linkage to manage and enhance biodiversity values, such as a local plant subsidy scheme. 3. Continuing to deliver the Plants for Residents program, or similar.



Focus Area 5:	Actively engage with Aboriginal representatives to understand and integrate cultural knowledge into local biodiversity management. Engage with the community to strengthen the appreciation of biodiversity values, and encourage the retention, protection and enhancement of biodiversity values on private land.
Engage	
Strategic Objectives	<ol style="list-style-type: none"> 1. Aboriginal representatives are engaged and actively involved in managing biodiversity and promoting the cultural values of natural areas. 2. Members of the community (e.g. residents, education providers and the private sector) are educated, incentivised and engaged on the importance of maintaining and improving local biodiversity, as well as effective land management techniques to manage and enhance LNAs on private land. 3. Members of the community actively participate in events relating local biodiversity management and enhancement. 4. Members of the community engage in education programs to improve knowledge and provide inspiration for private land holders.
Action 5.1	Engaging with local Aboriginal representatives to investigate opportunities for their involvement in managing biodiversity and promoting the cultural values of natural areas in the City, such as guided biodiversity walks by Aboriginal people or an Indigenous Ranger traineeship program.
Action 5.2	Preparing a report/plan analysing the location and conservation or amenity value of priority LNAs on private land to identify opportunities for targeted engagement.
Action 5.3	<p>Identify and implement opportunities to incentivise retaining, protecting, managing, and enhancing LNAs on private land. Incentives may include:</p> <ul style="list-style-type: none"> • fiscal incentives where the City can secure funding, • Local Planning Scheme provisions that allow incentives in a planning context, • educating rural landowners on existing incentives to protect biodiversity on private land (e.g. conservation covenant programs/ tax offsets).

Action 5.4	<p>Build on the City's existing Local Environment Strategy education campaign and coordinate biodiversity planning (ecological communities, local ecological linkages, etc.) and educational efforts across the City , including but not limited to:</p> <ol style="list-style-type: none"> 1. The establishment of a physical and online environmental hub including local biodiversity information, such as: <ol style="list-style-type: none"> a. updated environment module on public Intramaps b. best-practice land management for biodiversity c. natural history of Kalamunda d. lists of indigenous flora and fauna e. guidance on planting in private land f. weed identification and control g. bee keeping h. habitat creation i. sustainable landscaping – linked to ecological linkages j. benefits of biodiversity and the value of bush land to the broader community k. recognising community efforts in managing and enhancing biodiversity l. legislative protection of biodiversity values. 2. Educational programs with schools, early learning centres and community groups to initiate improvements in biodiversity (e.g. revegetation and installing nest boxes) on City reserves or on school grounds, especially those next to existing local natural areas/ areas of native vegetation. 3. Complementary consultation on LNA management for private landholders. 4. Targeted consultation with landowners and land managers regarding retaining, protecting, managing and enhancing priority LNAs on or adjacent to private land.
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7 Monitoring, Reporting and Adaptive Management

7.1 Annual Local Biodiversity Action Plan

This LBS will inform an annual action plan which will detail actions to be implemented during the following year. The action plan will be developed by a working group formed within the City with expertise in arboriculture, environmental management, planning and operations.

The action plan will include quantifiable, time-based, and prioritised actions. The action plan will also outline the resources required to implement the actions for the given year. The list of priority actions will be published on the City's website for each implementation year, along with the proposed measures of success determined by the Monitoring and Evaluation Program (MEP) outlined below.

The internal working group will seek feedback from the Kalamunda Environment and Sustainability Advisory Committee on the annual action plan and MEP, and will provide progress reports through Corporate Business Plan updates.

7.2 Monitoring and Reporting

A MEP will be established by the working group to track the progress and relative success of the LBS actions and assess whether the City is meeting the goals and strategic objectives. The objectives of the LBS are specific, measurable, actionable, realistic, and time-bound to ensure progress toward targets can be effectively measured, reported, and adapted if needed.

Each year the City will monitor and report against:

1. Progress toward the aspirational target to increase the conservation protection status of 500ha land, containing approximately 270ha of native vegetation.
2. Progress toward the focus area goals of Retain and Protect, Investigate, Manage and Enhance, and Engage.
3. Progress toward the strategic objectives (refer Action Plan Table 15).
4. Achieving the actions and their determined, measurable targets under the Annual Local Biodiversity Action Plan for the given year.

Annual reporting will be undertaken each year, with results provided with the following years' annual action plan.

Annual reporting on the progress and measures of success of the LBS actions will be conducted through the City's Corporate Business Plan, and provided with the following years' annual action plan. Additionally, key updates on the LBS will be reported via a Local Biodiversity landing page on the City's website.

The LBS will be reviewed every four years to analyse changes in native vegetation extent and associated ecological values and to determine if the LBS needs to be adjusted to address any new issues or actions that have not been effective.

As identified in Section 3.1, the current native vegetation extent mapping has limited utility in tracking changes in native vegetation over time, due to the different parameters for data collection employed between years. However, the data provided by DPIRD is currently the best available dataset for this purpose. The City will supplement this information with site-specific data captured throughout the year, including through planning outcomes, revegetation and restoration actions, and volunteer activities. These data sources will be used to amend the native vegetation extent data. The City will continue to monitor the availability of improved data sources released by the State government, as is planned through the Native Vegetation Policy Implementation Plan.

7.3 Resourcing

To achieve the target, goals and strategic objectives of the LBS, the City will need to review and enhance existing natural area management and community programs as well as develop new programs, in line with the actions in Section 6. Meeting the City's target involves a substantial increase in the amount of land managed for conservation, and implementing the LBS effectively will require additional funding and resourcing.

As outlined in Section 1.3, the LBS includes an overall target of increasing the conservation protection status of 500ha land, containing over 270ha of native vegetation. This represents a considerable increase on the 28ha of reserves the City currently manages and conserves. Future planning decisions may mean new LNAs are transferred into the City's management.

Funding is a key determinant in the amount of land that can be feasibly managed and conserved by the City, particularly where on-ground management is required.

The community values protecting and managing LNAs, and the City commits to prioritising resources to support this value. This may include investigating the community's perspective on an environmental levy to assist in funding the proposed expansion of the City's conservation estate.

Conservation and management arrangements may also assist the City in achieving the LBS target, goals, and strategic objectives. For example, the LBS proposes, implementing a Local Planning Policy for Biodiversity Conservation to develop a framework to rapidly assess the requirement to accept management of LNAs where biodiversity values require those sites to be retained. This will allow for accurate allocation of resources and expediting proposed management decisions facilitating the transfer of LNAs into the City's conservation estate.

The City is currently preparing draft Local Planning Scheme 4. This new scheme will include more comprehensive provisions to protect and enhance vegetation, including rehabilitation, rather than simply referring to other environmental legislation.

The City will continue to monitor and apply for government or other environmental grants as opportunities present to support its aims of protecting, growing and enhancing local biodiversity.



8 Glossary

Bush Forever Sites: areas identified in the Bush Forever 10-year strategic plan to protect regionally significant bushland, as endorsed by Cabinet (Government of Western Australia 2000).

Bushland: land on which there is vegetation that is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation and provides necessary habitat for fauna.

Clearing: refers to the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems; of the doing of any other substantial damage to some or all the native vegetation in an area. Clearing includes the draining or flooding of land, the burning of vegetation, the grazing of stock, or any other act to activity that causes the killing or substantial damage to some or all the native vegetation in an area.

Condition: refers to vegetation condition as assessed using published methodologies. In the Perth Metropolitan Region, the methodologies of Keighery (1994) are widely used.

Connectivity: refers to the degree of connection between natural areas.

Corridors: contiguous natural areas or revegetated areas that directly connect larger natural areas allowing the movement of organisms between larger areas over time.

Ecological Community: A naturally occurring group of plants, animals, and other organisms interacting in a unique habitat.

Ecological Linkages: non-contiguous natural areas that connect larger natural areas by forming steppingstones that allow the movement of organisms between larger areas over time.

Ecosystem Services: the role played by organisms in creating a healthy environment for human beings, for example the production of oxygen, soil formation, and maintenance of water quality.

Edge Effects: threatening processes acting at the edges of natural areas. Examples of edge effects include weed invasion, grazing and trampling, increased sun and wind exposure, pollutant (fertiliser, pesticide, toxin, excess water) drift or runoff, air pollution from traffic or industry, noise, artificial lighting at night, rubbish accumulation or dumping and exposure to feral animals, pests, and diseases from surrounding land uses.

Endemic: a species having a natural distribution confined to a particular geographical region.

Environmental weeds: plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.

Floristic community type: floristic assemblages as defined by Gibson et al. (unpub. 1994) and Department of Environmental Protection (unpub. 1996). The presence or absence of individual taxa in standard areas (plots, sites, quadrats) is used to define floristic groupings based on shared species.

Freehold: property tenure where an estate of inheritance in fee simple or fee tail or for life is held. It refers to a landholding that is owned by a landholder having certain rights over that land, for example, private land or Council-owned land that can be sold.

Habitat: the natural environment of an organism or community, including all biotic (living) or abiotic (non-living) elements; a suitable place for an organism or community to live.

Habitat fragmentation: the process of isolating (usually by land clearing) a once continuous habitat into smaller isolated natural areas.

Local Natural Areas (LNAs): natural areas that exist outside of Bush Forever Sites (Swan Coastal Plain), the DBCA Managed Estate and Regional Parks.

Monitoring: the regular collection and analysis of information to assist timely decision-making, ensure accountability and provide the basis for evaluation and learning.

Native vegetation: indigenous aquatic or terrestrial vegetation. It does not include vegetation that was intentionally sown, planted or propagated unless that vegetation was sown, planted, or propagated as required under the *Environmental Protection Act 1986* or another written law; or that vegetation is of a class declared by regulation to be included in this definition. Native vegetation does not include dead vegetation unless that dead vegetation is of a class declared by regulation to be included in this definition. Native vegetation does include non-vascular plants (for example, mosses, fungi, algae) and marine plants (seagrass, macro algae [seaweed]). Native vegetation is more than trees and includes understorey and groundcover plants.

Natural area: describes an area that contains native species or communities in a relatively natural state and hence contains biodiversity. Natural areas can be areas of native vegetation, vegetated or open water bodies (lakes, swamps), or waterways (rivers, streams, creeks – often referred to as channel wetlands, estuaries), springs, rock outcrops, bare ground (generally sand or mud), caves, coastal dunes, or cliffs.

Priority Local Natural Areas: LNAs that demonstrate one or more prioritisation criteria defined by the Perth Biodiversity Project (2012).

Protection: refer to natural areas that are secured for conservation either as public lands bested for a biodiversity conservation purpose (e.g., nature conservation) or private lands where the biodiversity values are secured for conservation under zoning or covenanting.

Rehabilitation: the restoration of a natural area that has been temporarily and grossly disturbed and no natural components are present.

Reserves: areas of Crown land reserved for various public purposes, for example, parks, recreation, drainage, or church sites.

Restoration: the return of a community to its pre-disturbance or natural state in terms of abiotic (non-living) conditions, community structure and species composition with the aim to reinstate a long-term self-regenerating natural ecosystem.

Retention: the process of ensuring a natural area is retained but not necessarily afforded protection to ensure its continued existence and viability. For example, a natural area may be retained through Council refusing or conditionally approving a development application.

Revegetation: the planting or direct seeding of native species in areas that have been cleared or highly modified. The mix of species may not be the same as originally occurring in that patch of vegetation. In and around natural areas, local native species of local provenance should be used. Revegetation should only occur in areas within or around natural areas where there is no potential for using regeneration techniques to assist natural regeneration processes.

Tenure: commonly referred to as ownership. However, land differs from goods in that no one person can possess land in absolute ownership. Tenure is the system of holding land for the Crown.

Threatening processes: any occurrence, activity or institutional process or structure, that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.

Viability (as in ecological viability): the likelihood of long-term survival of a particular ecosystem or species.



9 References

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Appendix 1 – Conservation Significant Flora and Fauna

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Conservation Significant Fauna Recorded within City of Kalamunda				
Scientific Name	Common Name	Class	State Status	Commonwealth Status
<i>Bettongia penicillata ogilbyi</i>	woylie, brush-tailed bettong	MAMMAL	Threatened - Critically endangered	Endangered
<i>Pseudemydura umbrina</i>	western swamp tortoise	REPTILE	Threatened - Critically endangered	CR
<i>Pseudocheirus occidentalis</i>	western ringtail possum, ngwayir	MAMMAL	Threatened - Critically endangered	CR
<i>Calyptorhynchus baudinii</i>	Baudin's cockatoo	BIRD	Threatened - Endangered	Endangered
<i>Calyptorhynchus latirostris</i>	Carnaby's cockatoo	BIRD	Threatened - Endangered	Endangered
<i>Leioproctus dougiasiellus</i>	a short-tongued bee	INVERTEBRATE	Threatened - Endangered	CR
<i>Myrmecobius fasciatus</i>	numbat, walpurti	MAMMAL	Threatened - Endangered	Endangered
<i>Calyptorhynchus banksii naso</i>	forest red-tailed black cockatoo	BIRD	Threatened - Vulnerable	VU
<i>Dasyurus geoffroii</i>	chuditch, western quoll	MAMMAL	Threatened - Vulnerable	VU
<i>Leipoa ocellata</i>	malleefowl	BIRD	Threatened - Vulnerable	VU
<i>Setonix brachyurus</i>	Quokka	MAMMAL	Threatened - Vulnerable	VU

Conservation Significant Fauna Recorded within City of Kalamunda				
Scientific Name	Common Name	Class	State Status	Commonwealth Status
<i>Westralunio carteri</i>	Carter's freshwater mussel	INVERTEBRATE	Threatened - Vulnerable	VU
<i>Kawaniphila pachomai</i>	grey vernal katydid (southwest)	INVERTEBRATE	P1	Not listed
<i>Glossurocolletes bilobatus</i>	a short-tongued bee (southwest)	INVERTEBRATE	P2	Not listed
<i>Ixobrychus flavicollis australis</i> (southwest subpop.)	black bittern (southwest subpop.)	BIRD	P2	Not listed
<i>Australotomurus morbidus</i>	cemetery springtail, Guildford springtail	INVERTEBRATE	P3	Not listed
<i>Australotomurus morbidus</i>	cemetery springtail, Guildford springtail	INVERTEBRATE	P3	Not listed
<i>Idiosoma sigillatum</i>	Swan Coastal Plain shield-backed trapdoor spider	INVERTEBRATE	P3	Not listed
<i>Lerista lineata</i>	Perth slider, lined skink	REPTILE	P3	Not listed
<i>Neelaps calonotos</i>	black-striped snake, black-striped burrowing snake	REPTILE	P3	Not listed
<i>Acanthopis antarcticus</i>	southern death adder	REPTILE	P3	Not listed

Conservation Significant Fauna Recorded within City of Kalamunda				
Scientific Name	Common Name	Class	State Status	Commonwealth Status
<i>Ctenotus delli</i>	Dell's skink, Darling Range southwest Ctenotus	REPTILE	P4	Not listed
<i>Hydromys chrysogaster</i>	water-rat, rakali	MAMMAL	P4	Not listed
<i>Isodon fusciventer</i>	quenda, southwestern brown bandicoot	MAMMAL	P4	Not listed
<i>Notamacropus irma</i>	western brush wallaby	MAMMAL	P4	Not listed
<i>Oxyura australis</i>	Blue-billed duck	BIRD	P4	Not listed
<i>Platycercus icterotis xanthogenys</i>	western rosella (inland)	BIRD	P4	Not listed
<i>Cacatua pastinator pastinator</i>	Muir's corella	BIRD	Specially Protected - conservation dependent	Not listed
<i>Phascogale tapoatafa wambenger</i>	south-western brush-tailed phascogale, wambenger	MAMMAL	Specially Protected - conservation dependent	Not listed
<i>Actitis hypoleucos</i>	common sandpiper	BIRD	Specially Protected - migratory	MI

Conservation Significant Fauna Recorded within City of Kalamunda				
Scientific Name	Common Name	Class	State Status	Commonwealth Status
<i>Apus pacificus</i>	Fork-tailed swift	BIRD	Specially Protected - migratory	MI
<i>Arenaria interpres</i>	Ruddy turnstone	BIRD	Specially Protected - migratory	MI
<i>Hydroprogne caspia</i>	Caspian Tern	BIRD	Specially Protected - migratory	MI
<i>Numenius phaeopus</i>	Whimbrel	BIRD	Specially Protected - migratory	MI
<i>Pandion haliaetus</i>	Osprey	BIRD	Specially Protected - migratory	MI
<i>Plegadis falcinellus</i>	Glossy ibis	BIRD	Specially Protected - migratory	MI
<i>Thalasseus bergii</i>	Crested tern	BIRD	Specially Protected - migratory	MI
<i>Tringa glareola</i>	wood sandpiper	BIRD	Specially Protected - migratory	MI

Conservation Significant Fauna Recorded within City of Kalamunda				
Scientific Name	Common Name	Class	State Status	Commonwealth Status
<i>Tringa nebularia</i>	Common greenshank	BIRD	Specially Protected - migratory	MI
<i>Tringa stagnatilis</i>	Marsh sandpiper	BIRD	Specially Protected - migratory	MI
<i>Falco peregrinus</i>	peregrine falcon	BIRD	Specially Protected - other specially protected	

Conservation Significant Flora Recorded within City of Kalamunda		
Species	State Conservation Status	Commonwealth Conservation Status
<i>Scholtzia</i> sp. Bickley (W.H. Loaring s.n. PERTH 06165184)	Extinct	
<i>Acacia anomala</i>	Threatened - Vulnerable	
<i>Acacia aphylla</i>	Threatened - Vulnerable	
<i>Andersonia gracilis</i>	Threatened - Vulnerable	
<i>Anthocercis gracilis</i>	Threatened – Vulnerable	
<i>Austrostipa bronweniae</i>	Threatened - Endangered	
<i>Banksia mimica</i>	Threatened - Vulnerable	
<i>Conospermum undulatum</i>	Threatened - Vulnerable	
<i>Darwinia apiculata</i>	Threatened - Endangered	
<i>Diuris purdiei</i>	Threatened - Endangered	
<i>Grevillea thelemanniana</i>	Threatened - Critically Endangered	
<i>Lepidosperma rostratum</i>	Threatened - Endangered	
<i>Macarthuria keigheryi</i>	Threatened - Endangered	
<i>Thelymitra magnifica</i>	Threatened - Critically Endangered	
<i>Thelymitra stellata</i>	Threatened - Endangered	

Conservation Significant Flora Recorded within City of Kalamunda		
Species	State Conservation Status	Commonwealth Conservation Status
<i>Boronia humifusa</i>	Priority 1	Not listed
<i>Hydrocotyle striata</i>	Priority 1	Not listed
<i>Senecio gilbertii</i>	Priority 1	Not listed
<i>Andersonia</i> sp. <i>Blepharifolia</i> (F. & J. Hort 1919)	Priority 2	Not listed
<i>Bossiaea modesta</i>	Priority 2	Not listed
<i>Johnsonia pubescens</i> subsp. <i>cygnorum</i>	Priority 2	Not listed
<i>Melaleuca viminalis</i>	Priority 2	Not listed
<i>Paracaleana ferricola</i>	Priority 2	Not listed
<i>Thysanotus</i> sp. <i>Badgingarra</i> (E.A. Griffin 2511)	Priority 2	Not listed
<i>Acacia horridula</i>	Priority 3	Not listed
<i>Acacia oncinophylla</i> subsp. <i>oncinophylla</i>	Priority 3	Not listed
<i>Amanita fibrilloses</i>	Priority 3	Not listed
<i>Amanita kalamundae</i>	Priority 3	Not listed
<i>Asteridea gracilis</i>	Priority 3	Not listed

Conservation Significant Flora Recorded within City of Kalamunda		
Species	State Conservation Status	Commonwealth Conservation Status
<i>Banksia pteridifolia</i> subsp. <i>vernalis</i>	Priority 3	Not listed
<i>Beaufortia purpurea</i>	Priority 3	Not listed
<i>Byblis gigantea</i>	Priority 3	Not listed
<i>Grevillea dissectifolia</i>	Priority 3	Not listed
<i>Haemodorum loratum</i>	Priority 3	Not listed
<i>Halgania corymbosa</i>	Priority 3	Not listed
<i>Isopogon autumnalis</i>	Priority 3	Not listed
<i>Lasiopetalum glutinosum</i> subsp. <i>glutinosum</i>	Priority 3	Not listed
<i>Pithocarpa corymbulosa</i>	Priority 3	Not listed
<i>Platysace ramosissima</i>	Priority 3	Not listed
<i>Schoenus pennisetis</i>	Priority 3	Not listed
<i>Schoenus</i> sp. <i>Waroona</i> (G.J. Keighery 12235)	Priority 3	Not listed
<i>Sporobolus blakei</i>	Priority 3	Not listed

Conservation Significant Flora Recorded within City of Kalamunda		
Species	State Conservation Status	Commonwealth Conservation Status
<i>Stackhousia</i> sp. <i>Red-blotchea corolla</i> (A. Markey 911)	Priority 3	Not listed
<i>Styphelia filifolia</i>	Priority 3	Not listed
<i>Thysanotus anceps</i>	Priority 3	Not listed
<i>Thysanotus cymosus</i>	Priority 3	Not listed
<i>Acacia oncinophylla</i> subsp. <i>patulifolia</i>	Priority 4	Not listed
<i>Cyanicula ixioides</i> subsp. <i>ixioides</i>	Priority 4	Not listed
<i>Cyanothamnus tenuis</i>	Priority 4	Not listed
<i>Grevillea pimeleoides</i>	Priority 4	Not listed
<i>Lasiopetalum bracteatum</i>	Priority 4	Not listed
<i>Ornduffia submersa</i>	Priority 4	Not listed
<i>Pimelea rara</i>	Priority 4	Not listed
<i>Senecio leucoglossus</i>	Priority 4	Not listed
<i>Stylidium striatum</i>	Priority 4	Not listed
<i>Thysanotus glaucus</i>	Priority 4	Not listed

Conservation Significant Flora Recorded within City of Kalamunda		
Species	State Conservation Status	Commonwealth Conservation Status
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	Priority 4	Not listed

Appendix 2 – Description of Vegetation Complexes within the City of Kalamunda

Swan Coastal Plain (Heddle, E.M., Loneragan, O.W. and Havel, J.J., 1980)		
Ridge Hill Shelf	Forrestfield	Vegetation ranges from open forest of <i>E. calophylla</i> - <i>E. wandoo</i> - <i>E. marginata</i> to open forest of <i>E. marginata</i> - <i>E. calophylla</i> – <i>A. fraseriana</i> – <i>Banksia spp.</i> Fringing woodland of <i>E. rudis</i> in the gullies that dissect this landform.
Fluviatile deposits	Guildford	A mixture of open forest to tall open forest of <i>E. calophylla</i> – <i>E. wandoo</i> – <i>E. marginata</i> and woodland of <i>E. wandoo</i> (with rare occurrences of <i>E. lane-polei</i>). Minor components include <i>E. rudis</i> – <i>M. rhapsiophylla</i> . Swan Fringing woodland of <i>E. rudis</i> - <i>M. rhapsiophylla</i> with localised occurrence of low open forest of <i>C. obesa</i> and <i>M. cuticularis</i> .
Aeolian deposits	Southern River	Open woodland of <i>C. calophylla</i> – <i>E. marginata</i> – <i>Banksia spp.</i> with fringing woodland of <i>E. rudis</i> – <i>M. rhapsiophylla</i> along creek beds.
Darling Plateau - Uplands	Darling Scarp	Mosaic of open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> , with some admixtures with <i>Eucalyptus laeliae</i> in the north (subhumid zone), with occasional <i>Eucalyptus marginata</i> subsp. <i>elegantella</i> (mainly in subhumid zone) and <i>Corymbia haematoxylon</i> in the south (humid zone) on deeper soils adjacent to outcrops, woodland of <i>Eucalyptus wandoo</i> (subhumid and semiarid zones), low woodland of <i>Allocasuarina huegeliana</i> on shallow soils over granite outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complex on or near granite outcrops in all climate zones.
	Cooke	Mosaic of open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> (subhumid zone) and open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> (semiarid and arid zones) and on deeper soils adjacent to outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complex on granite rocks and associated soils in all climate zones, with some <i>Eucalyptus laeliae</i> (semiarid), and <i>Allocasuarina huegeliana</i> and <i>Eucalyptus wandoo</i> (mainly semiarid to perarid zones).
	Dwellingup 2	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> on lateritic uplands in subhumid and semiarid zones.
Jarrah Forest (Mattiske and Havel, 2000)		
Darling Plateau - Valleys	Helena 1	Mosaic of open forest of <i>Corymbia calophylla</i> - <i>Eucalyptus patens</i> - <i>Eucalyptus marginata</i> subsp. <i>marginata</i> with some <i>Eucalyptus rudis</i> on the deeper soils ranging to closed heath and lithic complex on shallow soils associated with granite on steep slopes of valleys in humid and subhumid zones.
	Helena 2	Mosaic of open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> and woodland of <i>Eucalyptus wandoo</i> with some <i>Eucalyptus accedens</i> and <i>Eucalyptus rudis</i> on the deeper soils ranging to closed heaths and lithic complex
	Murray 1	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> - <i>Eucalyptus patens</i> on valley slopes to woodland of fs24 <i>Eucalyptus rudis</i> - <i>Melaleuca rhapsiophylla</i> on the valley floors in humid and subhumid zones.

	Murray 2	Open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> - <i>Eucalyptus patens</i> and woodland of <i>Eucalyptus wandoo</i> with some <i>Eucalyptus accedens</i> on valley slopes to woodland of <i>Eucalyptus rudis</i> - <i>Melaleuca raphiophylla</i> on the valley floors in semiarid and arid zones.
	Yarragil 1	Open forest of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> - <i>Corymbia calophylla</i> on slopes with mixtures of <i>Eucalyptus patens</i> and <i>Eucalyptus megacarpa</i> on the valley floors in humid and subhumid zones.
	Yarragil 2	Open forest of <i>Eucalyptus marginata</i> subsp. <i>thalassica</i> - <i>Corymbia calophylla</i> on slopes, woodland of <i>Eucalyptus patens</i> - <i>Eucalyptus rudis</i> with <i>Hakea prostrata</i> and <i>Melaleuca viminea</i> on valley floors in subhumid and semiarid zones.
Darling Plateau – Depressions and Swamps on Uplands	Swamp	Mosaic of low open woodland of <i>Melaleuca preissiana</i> - <i>Banksia littoralis</i> , closed scrub of Myrtaceae spp., closed heath of Myrtaceae spp. and sedge lands of <i>Baumea</i> and <i>Leptocarpus</i> spp. on seasonally wet or moist sand, peat and clay soils on valley floors in all climatic zones.

Appendix 3 – Methodology for Identifying Areas of High Conservation Value

Prioritisation of local natural areas

The prioritisation process adopted in this document follows the main principles of the State government endorsed methodology developed via the Perth Biodiversity Project (Del Marco *et al* 2004) and utilises the advances in mapping and prioritisation techniques used effectively by others since the City’s first Local Biodiversity Strategy.

Prioritisation considers two types of criteria:

1. Supported by legislation and policy (*Environmental Protection Act 1986, Biodiversity Conservation Act 2016* and the *EPA Guidance Statement No 33*), that define the regional conservation significance criteria in the following categories:
- Representation

• Rarity

• Diversity

• Wetland, streamline, estuarine, coastal vegetation

• Maintenance of ecological functions (patch size & connectivity).
2. Supported by best practice local biodiversity conservation as outlined in the Local Government Biodiversity Planning Guidelines (Del Marco *et al* 2004), providing for consideration of locally significant vegetation and local ecological linkages.

Each of the prioritisation criteria can be represented with mapping. For the purposes of this analysis, ‘vegetation’ is defined as the combined layer of the 2020 native vegetation extent (DPIRD, 2020) and the City’s LNA11 areas (City of Kalamunda, April 2020). LNA areas mapped by the City as being Completely Degraded were removed from the City’s LNA dataset for this analysis. The list of criteria and datasets used as surrogates to represent each criteria are listed in Table 10.

All vegetated areas are scored in accordance to the number of criteria being represented within that area. Two types of scores were used:

1. A simple presence or absence score, where 1 is added for each criteria being represented within a vegetated area and 0 for an absence;
2. Weighted score – the purpose of the weighting being applied to selected criteria is to highlight vegetation where the representative values are protected by legislation. For example, if two areas meet the same number of criteria, they will be assigned the same score. If one of these areas also includes a record of threatened flora and the other includes a record of Priority flora, the area with the threatened flora will be scored higher because instead of a count of 1, a score of 4 is given to vegetation within a buffer of threatened species record and a score of 3 is given to vegetation within a buffer of a priority species.

The weighting was only applied to criteria that are also used by the City to rank bushland reserves managed by the City and the weighting numbers were determined by the City’s staff.

11 City’s LNAs or City of Kalamunda Local Natural Areas (LNAs) are based on assessment by City staff. It does not include all the natural areas defined as ‘Local Natural Areas’ in the local biodiversity planning process (Del Marco *et al*, 2004). Criteria used by the City to select the City’s LNAs are described in Appendix A.

Prioritisation criteria

Key to a Priority Field in the on-line model	Perth Biodiversity Project Criteria (2012)	Spatial data (relevant to the City of Kalamunda)	Criteria score
P1_1	Recognised International, National, State or Regional Conservation Value but not already protected	Regional Parks	N = 0 Y = 3.5
		Bush Forever Sites	
		Informal Reserves (based on Forest Management Plan 2014-2023)	
		DBCA Conservation Covenants	
		Directory of Important Wetlands	
P1_2a	of an ecological community with only 1500 ha or 30% or less remaining and <10% protected (formal) in the IBRA sub-region (here we use <or=40%)	Vegetation extent by vegetation complexes: Forrestfield, Guildford, Southern River, Swan,	1
P1_2b	of an ecological community with only 1500 ha or 30% or less remaining in the IBRA sub-region (here we use <or=40%)	Vegetation extent by vegetation complexes: Forrestfield, Guildford, Southern River, Swan,	N = 0 Y = 3
P1_2c	of an ecological community with 90-100% of its original proportion of the original extent occurs within the study area	Pre-European extent of vegetation complexes in IBRA sub-region: Forrestfield, Helena 2	1
P1_2d	of an ecological community with 60-89% of its original proportion of the original extent occurs within the study area	Pre-European extent of vegetation complexes in IBRA sub-region: Guildford, Swan, Darling Scarp, Dwellingup D2, Helena 1	1
P1_3	large (greater than 20ha) natural areas	Remnant vegetation in patches greater than 20ha.	N = 0 Y = 2.5
P1_4	of an ecological community with only 1500 ha or 15% or less protected for conservation in the Jarrah Forest sub-region (use 20%)	Vegetation extent by vegetation complexes: Cooke, Darling Scarp, Dwellingup 2, Murray 2, Yarragil 1, Yarragil 2	N = 0 Y = 2.0
P1_5	of an ecological community with only 400 ha or 10% or less protected for conservation on the SCP portion of Perth and Peel	Vegetation extent by vegetation complexes: Forrestfield, Guildford, Southern River, Swan,	N = 0 Y = 2.0
Rarity			
P3_1	of an ecological community with only 1500 ha or 10% remaining in the IBRA sub-region	Vegetation extent by vegetation complexes: Forrestfield, Guildford, Swan,	N = 0 Y = 4.0
P3_2	of an ecological community with only 400 ha or 10% or less remaining in the Bush Forever	Vegetation extent by vegetation complexes: Forrestfield, Guildford, Southern River, Swan,	N = 0 Y = 4.0
P3_3	contains a Threatened Ecological Community (TEC)	TEC boundaries and buffers (DBCA, March 2020)	N = 0 Y = 4.0
P3_4a P3_4b	contains a Priority Ecological Community (PEC) P1-3 or P4	PEC and buffers (DBCA, March 2020)	1
P3_5 P3_5wh	contains Threatened Flora wh – presence of Herbarium data	Threatened Flora locations with 50m buffers (DBCA, March 2020)	N = 0 Y = 4.0

Key to a Priority Field in the on-line model	Perth Biodiversity Project Criteria (2012)	Spatial data (relevant to the City of Kalamunda)	Criteria score
P3_7	Threatened and specially protected fauna	Threatened Fauna (CR, EN, VU, OS - Other Specially Protected) (DBCA, March 2020)	N = 0 Y = 4.0
P3_6 P3_6wh	contains Priority 1,2,3,4 Flora wh – presence of Herbarium data	Priority Flora with buffers (DBCA, March 2020)	N = 0 Y = 3.0
P3_8	Priority fauna	Priority 1,2, 3, 4 Fauna (DBCA, March 2020)	N = 0 Y = 3.0
P3_9a P3_9b P3_9c	significant habitat for significant fauna	Areas requiring investigation for Carnaby's cockatoo feeding habitat (Swan Coastal Plain)	N = 0 Y = 2.0
		Areas requiring investigation for Carnaby's cockatoo feeding habitat (Jarrah Forest)	N = 0 Y = 2.0
		Carnaby's Cockatoo habitat - breeding sites (confirmed & possible) with 12 km buffer	N = 0 Y = 2.0
		Carnaby's Cockatoo habitat - roosting sites (confirmed & unconfirmed) with 6 km buffer	N = 0 Y = 2.0
P3_10	contains other significant flora	Significant flora – Locally significant flora	N = 0 Y = 2.0
P3_11	or other significant fauna	Decliner Bird Species Potential Quenda habitat	N = 0 Y = 2.0
Maintaining ecological processes or natural systems – connectivity			
P4_1	natural areas acting as stepping-stones in a regionally significant ecological link	Connectivity layer - current remnant vegetation that touches the Perth Metropolitan Region Regional Ecological Linkages	N = 0 Y = 1.0
Protection of wetland, streamline and estuarine fringing vegetation and coastal vegetation			
P5_1	Remnant vegetation within Conservation Category Wetlands plus 50m buffer	Geomorphic wetland mapping (DBCA 2019)	N = 0 Y = 2.0
P5_1b	Remnant vegetation within Resource Enhancement Wetlands plus 50m buffer	Geomorphic wetland mapping (DBCA 2019)	N = 0 Y = 2.0
P5_3	riparian vegetation	riparian vegetation surrogate - hydro lines buffered and used to intersect with current remnant vegetation	N = 0 Y = 1.0
P5_4	floodplain area	floodplain areas with floodplain ecosystems	N = 0 Y = 1.0
Representation – Local			
P6_1	of an ecological community with 10% or less remaining within Local Government area	Vegetation extent by vegetation complexes within each the City: Forrestfield, Southern River Complex, Guildford	N = 0 Y = 1.5
P6_2	of an ecological community with 30% or less remaining within a Local Government area	Vegetation extent by vegetation complexes within the City: Forrestfield, Southern River Complex, Guildford	N = 0 Y = 1.0
P6_3	natural areas acting as stepping-stones in a locally significant ecological link	Local linkages – as described in section 5.1.2 of this report	N = 0 Y = 0.5

The final priority score is a simple sum of individual criteria scores, with higher numbers identifying natural areas with higher number of criteria being met (Figure 8).

The first column in Table 10 provides a reference to the mapping data displayed in LGmap, the on-line mapping portal enabling the viewing of mapping layers developed for this Strategy. The key in Table 10 can be used to identify the specific criteria contributing to the final score for any mapped vegetation. Instructions on viewing the Local Biodiversity Strategy mapping layers via LGmap are in Appendix G.

It is important to note that this dataset represents a snapshot in time. The mapping is based on known records of plants, animals or ecological communities as they were at the time of the analysis being undertaken (June 2020). Low prioritisation scores cannot be interpreted as those areas not containing significant biodiversity.

For most areas, specific surveys will be required to determine the biodiversity conservation values. Even in areas where records exist, it does not necessarily mean that those sites were subject to a comprehensive survey or that species not identified in an area in the past do not inhabit that area now. Any final decisions regarding protection or land use change need to be based on field assessments to confirm the indicative biodiversity values. Finally, specialist's advice is required to determine the significance of the known population of threatened plants or animals as the distribution of some threatened species can be very limited.

Despite this, the natural area prioritisation mapping provides an effective tool for strategically identifying areas with existing or potential high conservation values and informing future land use decisions. The methodology provides for assessment of local conservation priorities in the context of regional representation. The mapping can be replicated and updated as new data becomes available.

Natural area prioritisation represents the first step in identifying priority areas for protection and conservation in the City. Figure 8 shows all remaining native vegetation, including already protected areas. The ability to conserve 'Local Natural Areas' depends on further factors such as land tenure, existing land use commitments and opportunities to change current land uses to those that better conserve biodiversity. Section 5.2.1 describes the next steps in mapping the Local Natural Area Prioritisation for protection by assessing the opportunities provided by the current land use provisions.

Ecological linkages and vegetation connectivity

One of the main threats to biodiversity is habitat fragmentation. Improvement of ecosystem resilience and connectivity, expansion of the network of protected areas and protection of important refugia are recommended as priority management approaches to adaptation to the impacts of climate change (CSIRO 2014, Australian Government 2012a, EPA, 2008; Wilkins et al, 2006; Molloy et al, 2009). Therefore, one of the objectives of this Strategy is to provide a framework of increasing connectivity between natural areas in the City.

With isolation of vegetation patches, over time, the number of species being able to persist in those patches decreases. The viability of any natural area depends on its proximity to other natural areas, the quality of linkages or barriers in the landscape between them (Del Marco et al 2004, Davis and Brooker 2008, Molloy et al 2009)

While the impacts of habitat fragmentation on fauna populations were documented to some degree, the effects of urbanisation on long term viability of plant communities is not well understood. A study by Ramalho (2012) into the effects of urbanisation on remnant Banksia woodlands in the Perth region showed that long term isolation of Banksia communities leads to changes in the species composition and plant community structure, recording nearly 50 percent reduction in species richness within small (1-5 ha) remnants that were isolated for 45 years or longer. This study also highlighted that these impacts of fragmentation will not be visible for some time and recommended focusing conservation efforts on areas that were recently fragmented and those without significant land-use legacies.

To increase the capacity of natural areas to retain biodiversity in fragmented urban landscapes and adapt to climate change, the recommended management responses include the following (Molloy et al 2009, Commonwealth of Australia 2010, CSIRO 2014):

- Provision of access to a greater number and diversity of resources
- Conservation of larger and more viable populations
- Ensuring species distribution in many populations to spread extinction risk associated with catastrophic events such as fires or drought
- Enabling species dispersal and migration; facilitating movement along corridors
- Provision of a more representative mosaic of habitat types and structures
- Facilitation of greater genetic variation within species
- Identification and management of refuges that buffer species from rapid change
- Increase the capacity of species and communities to persist through removal of threats and adapting to disturbances.

Establishment and maintenance of effective ecological linkages address many of the above recommendations.

Regional ecological linkages for the Perth region were mapped by the Perth Biodiversity Project in 2004. Since then, land use changes affected the feasibility of some regional linkages in parts of Perth. To test the feasibility of the Perth regional ecological linkages in the City of Kalamunda and to identify feasible local linkages, vegetation connectivity modelling was undertaken.

Vegetation connectivity used the methodology developed by the Local Biodiversity Program (2012). The connectivity model considers the size, shape and the distance between vegetation patches and is described with three connectivity characteristics:

- Fragmentation
- Regional connectivity
- Connectivity Reach.

Connectivity Reach is an indicator of how large is a network of patches that any patch of vegetation is connected to. This measure helps to identify patches of vegetation that might be considered fragmented or unviable because of their shape (high area to perimeter ratio) but are very important due to their proximity to other patches that are interconnected. Narrow strips of vegetation retained along waterways are a good example of such remnants.

However, retaining only vegetation along waterways will not be enough to meet the needs of all species. Ecological linkages should include the major variations in plant communities and fauna habitat typical of the region. In the City of Kalamunda, the Darling Scarp forms a distinct feature and fauna and flora move primarily north-south within the Scarp habitat types. They use the adjoining Darling Plateau or the Swan Coastal Plain much less extent. Habitats typical of the top of the scarp should be linked to others at the top of the scarp and granite outcrops should be linked to other granite outcrops. On the Darling Plateau the habitat types are strongly influenced by topography and this should be reflected in the linkages.

Three vegetation connectivity scenarios were tested to:

- identify which protected areas might be at risk of becoming isolated due to future vegetation loss;
- assess the effectiveness of the proposed network of local ecological linkages;
- test the relevance of the regional ecological linkages mapped in 2004 by the Perth Biodiversity Project (Del Marco et al 2004).

When mapping Local Ecological Linkages, the following criteria were used (Figure 9):

- Support the Perth Regional Ecological Linkages as they remain relevant in the City of Kalamunda;
- Provide for connection between protected natural areas, City managed reserves proposed to be protected in this Local Biodiversity Strategy (see section 5.2), areas mapped as having very high conservation value (WALGA, 2019) and not within the regional linkages;

- Include areas with high Connectivity Reach values and with “least cost”¹² opportunities for retention to act as stepping-stones within linkages. Examples include areas of native vegetation on public lands or freehold lands within land use categories supporting vegetation retention and areas where restoration of public lands will improve connectivity;
- Ensure the widest range of habitats or vegetation types are connected via the ecological linkages; including valleys, high points in the landscape, foothills and the top of the Scarp

Vegetation connectivity modelling scenarios are described in Appendix D.

The regional and local ecological linkages mapping will inform decisions on:

- priority vegetation for retention to maintain connectivity between already protected natural areas
- the identification of priority area for restoration or revegetation to reduce gaps in connectivity.

When considering how vegetation on rural lands contributes to connectivity, the importance of some non-indigenous plants like pecans or macadamias to native animals can be considered. It is important though to provide guidance to landowners on how these crops can be managed sustainably to meet the potentially conflicting needs (DBCA 2017).

¹² The term ‘least cost’ refers to the modelling and method of analysis used to determine ecological linkage pathways that provide the least resistance for fauna movement. This term does not refer to financial cost.

Appendix 4- Prioritisation of City Reserves for Management

To guide the prioritisation of management of the City’s reserves, this table provides a list of City reserves with a Natural Area Prioritisation Score (NAPS) of 25 or greater. The reserves are in descending order of the greatest NAPS to Viability score ratio, that is, areas with the greatest biodiversity (based on the NAPS methodology in Appendix 3) and at the greatest risk of degradation (based on the Viability assessment outlined in Section 4.5). This list requires further assessment by City Officers to determine the management response required (such as a planning or design response, or a Reserve Environmental Management Plan) depending on the physical characteristics of the Reserve (size, connectivity), threats (including anthropogenic) and purpose of the Reserve.

It is noted that reserves which are not listed below may also be determined by the working group to benefit from a management and/or design response and therefore this list is not exhaustive.

LNA/ Reserve name ¹³	Reserve number	2020 Viability estimate	2020 Natural Area Prioritisation Score	Prioritisation ratio	Reserve area (ha)
Yule Brook Drainage Reserve	R 49714	4.0	28.5	7.1	0.3
Crumpet Creek (Holmes Road)	R 37218	5.7	32.0	5.6	2.95
Forrestfield Woodlupine	R 34250, R 38597, R 32912	5.0	27.5	5.5	5.03
Woodlupine Brook - Preece Court	R 42353	6.5	32.0	5.0	0.25
Woodlupine Brook- Cypress Road	R 33912	5.5	27.0	4.9	1.87

¹³ Includes unofficial reserve names.

Poison Gully- Lillian/Hawtin Road	R 27792	8.0	36.5	4.6	0.47
Norwood Reserve	R 40275	6.9	30.5	4.4	1.09
Yongar Reserve	R 37650	9.6	39.5	4.1	7.58
Edinburgh Road Reserve	R 27566	8.0	31.5	4.0	0.86
Poison Gully- Maidavale/Hawtin Roads	R 27792, R 48084	9.9	36.5	3.7	2.00
Quenda Creek- Kadina Brook Bridal Trail Reserve	R 37762	9.9	36.0	3.7	3.90
Quenda Creek Reserve	R 37219	9.1	31.5	3.5	6.24
Poison Gully Pinker Crescent	R 48084	10.8	36.5	3.4	2.50
Poison Gully Booralie	R 32613	10.2	33.0	3.3	2.27
Poison Gully Brae Road	"R 37323, R 36492, R 35209, R 40947"	11.8	37.0	3.1	6.39

Poison Gully Meloway	"R 32230, R 32108, R 33433, R 35209, R 40947, R 29519"	11.6	36.0	3.1	3.72
Poison Gully-Milner Road	R 36492, R 48986	10.7	33.0	3.1	5.04
Kalari Drive/Gillings Parade POS	R 47767, R 48696, R 52090, 345 Hale Road (not reserved).	8.8	26.0	3.0	7.4
Norwood Reserve	R 22502	12.2	35.5	2.9	2.43
Poison Gully-Lillian/Cootamundra Roads	R 32613	11.4	33.0	2.9	2.27
Millson Reserve	R 31954	11.6	33.5	2.9	0.79
Stewart Rd Bridal Trail	R 37323	11.7	33.5	2.9	0.39
Maida Vale Reserve	"R 14088, R 38489, R 33262, R 49122, R38541"	14.0	38.5	2.8	32.45
Smokebush Reserve	Freehold	11.7	32.0	2.7	2.21
Poison Gully West	R 40228	12.1	33.0	2.7	3.55

Lions Lookout	R 49560	10.2	26.5	2.6	10.21
Anderson Reserve	R 34600, R 34364, R 31348	12.0	31.0	2.6	13.80
Lower Lesmurdie Falls	Freehold	16.2	38.5	2.4	18.80
Hartfield Reserve	R 17098	18.6	36.0	1.9	159.41
Pioneer Park	R 41156, R 44545	17.3	31.5	1.8	51.65
Kalamatta Way Reserve Reserve	R 28735	14.7	25.0	1.7	2.69

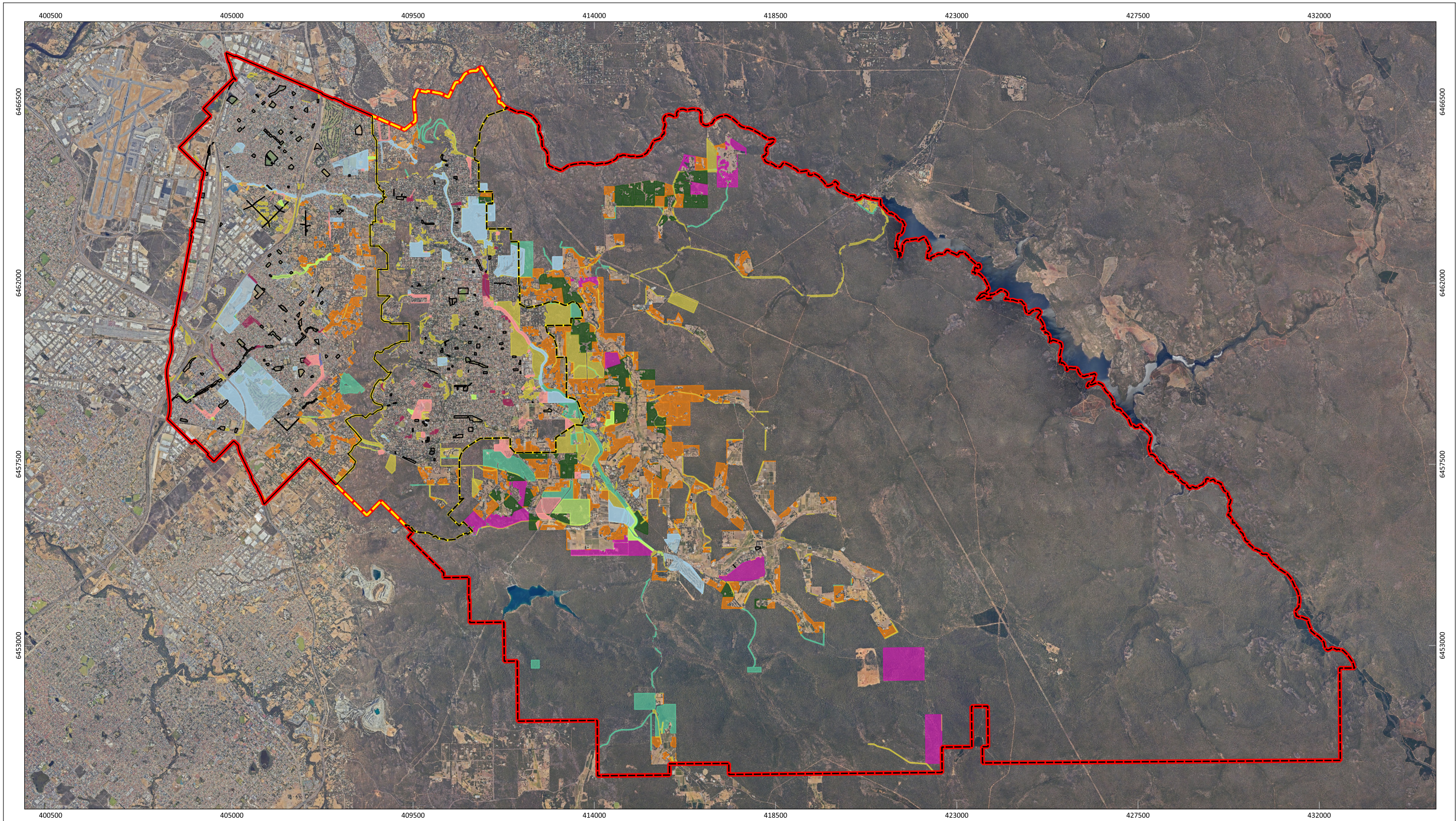
Appendix 5- Recommended Actions for Conservation based on Land Tenure

Table 5.1: Recommended Actions for Conservation based on Land Tenure

Management Category		Recommended Planning Conservation Actions
A	Conservation Reserves managed by the City	<ul style="list-style-type: none"> Those mapped as Local Open Space in the City’s Local Planning Scheme, reclassify to ‘Conservation Local Open Space’, or similar.
B	Proposed conservation reserves managed by the City (refer Table 5.2 below)	<ul style="list-style-type: none"> Consolidate adjoining reserves into a single reserve and seek change of vesting purpose or management order of the listed reserves to include conservation (through an application to Landgate under the <i>Land Administration Act 1997</i>) In the City’s Local Planning Scheme, reclassify to ‘Conservation Local Open Space’.
C	Bush Forever Areas outside State managed lands not reserved as Parks & Recreation in the Metropolitan Region Scheme	<ul style="list-style-type: none"> Seek protection of these natural areas through structure planning, including vegetation in good or better condition into adjoining existing or proposed conservation reserves (under the provisions of the <i>Land Administration Act 1997</i>); Classify these natural areas as ‘Conservation Local Open Space’, or similar in the Local Planning Scheme.
D	LNA reserved in MRS for Parks and Recreation but not on Crown Land (not in reserves designated under the <i>Land Administration Act 1997</i>)	<ul style="list-style-type: none"> For land not currently managed by the City, seek formalisation of land tenure by the State (WAPC).
E	LNA in Local Open Space and on Crown land (except City-managed reserves)	<ul style="list-style-type: none"> Reclassify to ‘Conservation Local Open Space’, or similar
F	LNA in Local Open Space but not on Crown Land (not in reserves designated under the <i>Land Administration Act 1987</i>)	<ul style="list-style-type: none"> For LNAs of with a high Natural Area Prioritisation Score, seek formalisation of protection for these natural areas by ceding land to the Crown under the <i>Land Administration Act 1997</i> with vesting purpose to include “conservation”. In instances where these adjoin reserves in Management Category B, consider consolidating the reserve boundary to form a single reserve with “conservation” purpose. In the Local Planning Scheme, reclassify to “Conservation Local Open Space”.





















		<ul style="list-style-type: none"> For LNAs adjoining existing or proposed conservation reserves, seek formalisation of land tenure for these natural areas by ceding land to the Crown under the Land Administration Act 1997.
G	LNA on Rural Conservation and Rural Landscape Interest zoned land on blocks larger than 12 hectares	<ul style="list-style-type: none"> Seek to retain existing lot sizes. Any future development should be within the provisions of the Scheme and the proposed Local Planning Policy for Biodiversity Conservation. Note this may include increased flexibility of lot sizes and uses consistent with biodiversity retention, protection and management in Local Planning Scheme 4.
H	LNA on Rural Conservation and Rural Landscape Interest zoned land on blocks 6 -12 hectares	<ul style="list-style-type: none"> No further reduction in lot sizes should be supported unless it is demonstrated that it can be achieved without clearing of Local Natural Areas and meeting the bushfire risk management requirements. Any future development should be within the provisions of the Scheme and the proposed Local Planning Policy for Biodiversity Conservation. Note this may include increased flexibility of lot sizes and uses consistent with biodiversity retention, protection and management in Local Planning Scheme 4.
I	LNA on varied rural lots (of any size) and on Rural Conservation and Rural Landscape Interest on blocks less than 6 hectares	<ul style="list-style-type: none"> Any future development/subdivision should be within the provisions of the Scheme and the proposed Local Planning Policy for Biodiversity Conservation (e.g. High Conservation Value LNAs to be retained as Local Open Space for conservation).
J	Areas allocated as future Local Open Space	<ul style="list-style-type: none"> Area to be retained as Local Open Space in a WAPC approved structure plan, as a condition of development. When implemented, classify the land as the proposed Conservation Local Open Space in the Local Planning Scheme.
K	Reserves managed by the City, for purposes other than conservation.	<ul style="list-style-type: none"> Review and amend the Local Planning Scheme zoning over lands not mapped as Parks and Recreation in the MRS.

L	All other LNA	<ul style="list-style-type: none"> On lands subject to structure planning, and no Environmental Conditions determined under environmental regulations, seek protection of High Conservation Value LNAs via Public Open Space allocation (according to the proposed Local Planning Policy for Biodiversity Conservation).
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Figure 1: Biodiversity Management Categories

 		PROJECT/REPORT NAME Local Biodiversity Strategy City of Kalamunda		Legend  City of Kalamunda Landform Districts  Darling Plateau  Swan Coastal Plain  The Escarpment	Biodiversity Management Categories <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;">  A  B  C  D </div> <div style="width: 50%;">  E  F  G  H  I </div> <div style="width: 50%;">  J  K  L  M </div> </div>				<table border="1"> <thead> <tr> <th>No</th> <th>Description</th> <th>Drawn</th> <th>Approved</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Original issue</td> <td>MD</td> <td>HS</td> <td>12/10/2023</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>	No	Description	Drawn	Approved	Date	A	Original issue	MD	HS	12/10/2023																															 WESTERN ENVIRONMENTAL <small>Western Environmental Pty Ltd 08 6244 2310 enquiries@western.com.au Level 5/25 Province St, West Perth WA 6005 western.com.au</small>
No	Description	Drawn	Approved		Date																																													
A	Original issue	MD	HS		12/10/2023																																													
CLIENT City of Kalamunda		VERSION 0		NOTES: Cadastral boundary from LANDGATE 2022. Label corresponds to the vegetation association number.																																														
PROJECT NUMBER A23.017		DATE 12/10/2023																																																
DATA SOURCE LANDGATE AERIAL IMAGERY Summer 2023		DRAWN BY / REVIEWED BY MD/HS																																																

G:\GIS\Project Data\A23.017\A23.017.qgz

Table 5.2 Recommended City Reserves for Conservation Purpose

Reserve No	Reserve Name	Prioritisation score	LNA Viability Score#	DPIRD-005 Native vegetation extent (ha)	Total Reserve land area
R 14088	Maida Vale Reserve	38.5	13.96*	10.30	30.57
R 15470	Marko Travicich Reserve	9	14.48	1.96	2.07
R 16922	Ledger Road	19	17.37*	7.95	8.49
R 17098	Hartfield Reserve	36	9.98-18.61	67.93	159.41
R 17343	Schipp Road	14.5	17.54	7.46	7.60
R 17358	Carmel Reserve	4	14.95	1.72	1.92
R 22502	Norwood Reserve	36	12.21	1.33	2.43
R 23040	Hill Street Resreve	17.5	14.68	3.98	4.05
R 23383	Eversden Reserve	9.5	10.51	2.93	4.30
R 24130	Crocus Road Reserve	14.5	10.15	2.16	2.38
R 24948	Basildon Reserve	18	13.55	0.38	0.67
R 25393		18	13.55	0.15	0.16
R 27154	Ledger Road	18	17.37*	45.45	50.73
R 27566	Edinburgh Rd reserve	32	7.97	0.54	0.86
R 27792	Poison Gully-Maida Vale/Hawtin Roads	36.5	9.84 & 8.00	0.41	0.47
R 27799	Old Railway Reserve-Williams St-Browning Rd	21.5	6.61-19.36, 15.50 & 18.27	7.44	8.34
R 27800	Railway Heritage Trail South ((Schmitt-Stanhope)	8	9.83	4.45	6.99
R 28735	Kalamatta Wy Reserve Reserve	25	14.69 & 18.37	1.99	2.69

Reserve No	Reserve Name	Prioritisation score	LNA Viability Score#	DPIRD-005 Native vegetation extent (ha)	Total Reserve land area
R29013	Crumpet Creek Reserve 1	27	15.28	0.34	0.61
R 30924	Old Railway Reserve-Union Rd-Canning Rd	5.5	17.14	11.48	11.48
R 31954	Millson Reserve	33.5	11.57	0.00	0.79
R 32108	Poison Gully Meloway	36	11.59	0.47	1.08
R 32230		36	11.59	0.234	0.422
R 32613	Poison Gully-Lillian/Cootamundra Roads	33	10.15 & 11.37	1.54	2.27
R 33433	Poison Gully Meloway	36	11.59	0.83	0.96
R 35209		32	11.21	0.79	1.03
R 35412	East Terrace	22	13.32	4.79	5.35
R 36492	Poison Gully Brae Road	40.5	10.68, 10.94 & 11.80	3.69	4.85
R 37218	Crumpet Creek (Holmes Road)	32.5	5.73	0.96	2.95
R 37219	Quenda Creek Reserve	35		3.51	6.24
R 38489	Maida Vale Reserve	35	13.96*	0.28	0.29
R 39218	Fleming Reserve	23	9.78	1.79	5.87
R 40228	Poison Gully West	33	12.11	2.58	3.55
R 40947	Poison Gully Brae Road	32	11.21	0.10	0.11
R 41156	Pioneer Park	29.5	17.27 & 9.87	12.68	51.59
R 45989	Poison Gully Myerson	29.5	11.28	0.81	2.36
R 48084	Poison Gully Pinker Crescent	29.5	10.82 & 9.85	1.31	2.50

Reserve No	Reserve Name	Prioritisation score	LNA Viability Score#	DPIRD-005 Native vegetation extent (ha)	Total Reserve land area
R 48986	Poison Gully-Milner Road	33	10.68	0.09	0.19
R 50554	Jorgenson Park	15.5	17.18	23.54	39.90
R 51230	Bluebell Park	29	10.68	0.01	0.31
R 52678	George Spriggs Reserve/ Pickering Brook Golf Course	8	17.66	7.77	41.23
R 9093	Brine Moran	24	17.10	11.73	13.11
R 9311	Carmel Camping Ground	10.5	23.10	20.00	20.34
TOTAL				279.85	513.51