Town of Gawler
Biodiversity Management Plan

Gawler

Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

Version History

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- Adrian Shackley, Gawler Environment and Heritage Association – Field surveys, flora and fauna records, pre-European vegetation.
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- Belinda Copland – Field surveys
- The Gawler Urban Rivers Biodiversity Working Group – Broad-ranging input throughout the process.
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- And all the community members who attended workshops, or provided written feedback, to the plan.

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Executive Summary

This document is intended as a key tool for understanding, valuing, managing and improving the natural biodiversity of the Town of Gawler.

Biodiversity is the variability among living organisms and the ecological complexes of which they are a part: this includes diversity within species, between species and of ecosystems. Biodiversity is essential for maintaining ecological processes at a range of scales from the imperceptible to the global; and it is these processes which ultimately underpin the quality of life for the world's human population. However, the benefits of biodiversity are often poorly articulated and not well understood by the general population, as a result there is a prevailing attitude that biodiversity happens in reserves, or 'natural' areas and not in the urban environment. The Town of Gawler has a vital part to play in maintaining biodiversity and the ecosystem services it delivers to its residents by providing understanding to the context in which it occurs and leading by example.

Future growth in the Council area is currently focussed in Residential Zones on foothills areas extending from Gawler East to Evanston South, and the plains from Evanston South to Hillier. These zones predominantly comprise areas previously or currently managed for cropping and grazing, but also do contain areas of high biodiversity, particularly along the creek lines which run out of the hills. Decisions now will set the course for biodiversity management in the new and existing urban spaces. By incorporating biodiversity into the forward planning of this urban expansion, the Town of Gawler can set itself up for success. Without proper planning and implementation at an early stage biodiversity is likely to decline significantly and irreversibly.

There are a large number of stakeholders which have an interest in maintaining and improving biodiversity in the Town of Gawler, providing Council with a number of potential partnerships to improve the effectiveness of biodiversity project delivery. These include public, private, community and charitable organisations based within Gawler or servicing the Gawler area.

There are 9 major pre-European vegetation communities present in the Town of Gawler spanning a number of environments including of wet rivers, occasionally inundated floodplains and dry plains and hillsides. In addition to these standard vegetation types, this report identifies a number of anthropogenic 'novel ecosystems' in the Town of Gawler including backyards, roadsides and urban parks. This project has surveyed these areas and identified biodiversity values present within them, and threats which are degrading the biodiversity now or may do so in the future.

Major threats include:

- Habitat destruction
- Habitat fragmentation
- Climate change
- Pest animals
- Weeds
- Changes to hydrology
- Inappropriate herbicide use

This report makes 35 recommendations, including a range of programs, projects and policy changes, to improve biodiversity in the Town of Gawler. Where appropriate, each has been broken into a number of action steps. Each recommendation is approximately costed and prioritised to allow Council to weigh up the cost/benefit of each recommendation.

Purpose of this Document

The Town of Gawler Biodiversity Management Plan is intended as a key tool for understanding, valuing, managing and improving the natural biodiversity of the Gawler district. The Plan serves multiple purposes including:

- Providing legislative, environmental and social context for the management of remnant vegetation, native plants and animals within the Council area and nearby region,
- Identifying and mapping the key remaining biodiversity assets within and adjacent to the Gawler Council area,
- Identifying the key threats to the condition and persistence of biodiversity assets and opportunities for improvement, including the relationship between biodiversity and the future development and expansion of the built environment,
- Providing key guiding principles, strategies and goals for the management of biodiversity assets including priority areas,
- Identifying opportunities for Town of Gawler to cooperate with other bodies to achieve biodiversity goals, and
- Identifying opportunities for landowners, community organisations and individuals to participate in improving biodiversity in Gawler.

What is Biodiversity? And Why is it Important?

What is Biodiversity?

Biodiversity (or biological diversity) can be described most simply as the variety of all life forms**.**

The UN Convention on Biological Diversity (1992) defines it as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part: this includes diversity within species, between species and of ecosystems."

The Australian Biodiversity Strategy (2010) gives a comprehensive definition which describes three levels of biodiversity:

- *genetic diversity* - the variety of genetic information contained in individual plants, animals and micro-organisms
- *species diversity* - the variety of species
- *ecosystem diversity* - the variety of habitats, ecological communities and ecological processes;

And three attributes:

- *components* - the identity and variety of genes, species and ecosystems
- *patterns* - the spatial distribution of genes, species, habitats and other resources at a range of scales from small patches to landscapes.
- *processes* - ecological and evolutionary processes whereby genes, species and ecosystems interact with one another and with their environment.

This Plan describes to biodiversity within the local context of the Town of Gawler Council region. However, as described above there is a wider context from regional to global for the management of biodiversity and an interconnectedness which should be recognised.

Why is Biodiversity Important?

Biodiversity is essential for maintaining ecological processes at a range of scales from the imperceptible to the global; and it is these processes which ultimately underpin the quality of life for the world's human population.

The Australian Biodiversity Strategy 2010 asserts that "Conserving biodiversity is an essential part of safeguarding the biological life support systems on Earth. All living creatures, including humans, depend on these systems for the necessities of life. For example, we need oxygen to breathe, clean water to drink, fertile soil for food production and physical materials for shelter and fuel. These necessities can be described collectively as *ecosystem services*."

According to Australia's Strategy for Nature 2018 – 2030, **b**iodiversity is important because it "plays a critical role in maintaining the natural function of ecological systems. Losing biodiversity can change the way the natural world functions, and can have severe, unpredictable impacts that are sometimes irreversible. High biodiversity can act as insurance against change; the more variety we maintain in nature, the greater the chance that some species will survive and adapt in the future. Encouraging high biodiversity is the best way to build resilience, the ability to bounce back from the impacts of threats, pressures and disasters."

Biodiversity also plays an important role in the community's health. The Regional Public Health and Wellbeing Plan (Healthy Environs, 2014) aims to leverage the region's quality natural environment to improve community health, and specifically refers to the physical and mental health benefits of access to the natural environment and green spaces.

Biodiversity is also a key factor in the 'green economy'. The recycling and renewable energy industries are well known components of this sector, but biodiversity management and planning are also important parts of the sector, providing jobs, training and career pathways for a range of environmental professionals.

While the benefits of retaining and maximising biodiversity are widely recognised in the scientific and environmental community, they are often poorly articulated and not well understood by the general population. There is a prevailing attitude that biodiversity happens in reserves, or 'natural' areas. But this misses the myriad functions that pollinate our backyard tomatoes, keep the Kookaburras laughing and the Red Gums healthy – all the things which an urban population can take for granted. The Town of Gawler has a vital part to play in maintaining these things that society values so much by providing understanding to the context in which it occurs and leading by example.

Methodology

Desktop Studies

Prior to the commencement of any field surveys Greening Australia was provided with a wealth of published material which served as a basis for identifying key local and regional issues and priority areas for field assessment. During the report writing process additional material was provided by Council as it became available and additional resources were collated by the author independent of Council. Reference and Further Reading lists this material.

Significant background material by way of species lists and anecdotes for environmental issues and changes were provided by Adrian Shackley based on his personal knowledge and via information and data held by the Gawler Environment and Heritage Association.

Field Surveys

The initial plan for this report was to base the recommendations mostly on the wealth of available information, however several knowledge gaps and inconsistencies in approaches to these reports were identified in relation to the on-ground situation and it became clear that this plan would achieve the best results if more emphasis was given to field work.

The Town of Gawler conducted a mailout to targeted landholders with potentially significant biodiversity assets on their land. Initial responses, positive or negative, were limited and so were supplemented with phone calls to landholders to seek land access. In most cases the combination of methods was successful, and most priority parcels were accessed, with very few landholders declining. Notably, those that did opt out were predominantly the properties along the proposed East Link corridor, where landholders expressed some exasperation at being asked by numerous agencies for access to their land.

The significant level of field work has had the added benefit of generating a wealth of standardised geospatial data which could form the basis of the Town of Gawler's digital biodiversity management system. A permit for conducting these surveys on DEW and Crown land was obtained (permit number Y26734-1), although most of surveys were conducted on Town of Gawler and private land. Surveys were collected by James McGregor, with field assistance at some sites by Adrian Shackley and Belinda Copland. The author thanks them for their volunteered contributions to this work, as well as Stuart Collard of Greening Australia for his verification of images of birds taken in the field.

Two integrated systems were developed for recording and mapping field data:

1) A portable geospatial mapping tool was developed using the ESRI ArcGIS "Collector" app. This enabled the surveyors to collect point and polygon information. Point information collected included:
    a. Threats
    b. Important habitat features (e.g. permanent pools)
    c. Ecological processes (e.g. mass germination/dieback event)
    d. Flora and fauna observations

    Polygons were used to delineate a 'patch' which became the base unit at which the field datasheet collected information.

Screen shot of the 'Collector' app used for field mapping. Blue lines are the polygons and black dots are the points. Other base layers were available, such as cadastre, but are turned off in this view.

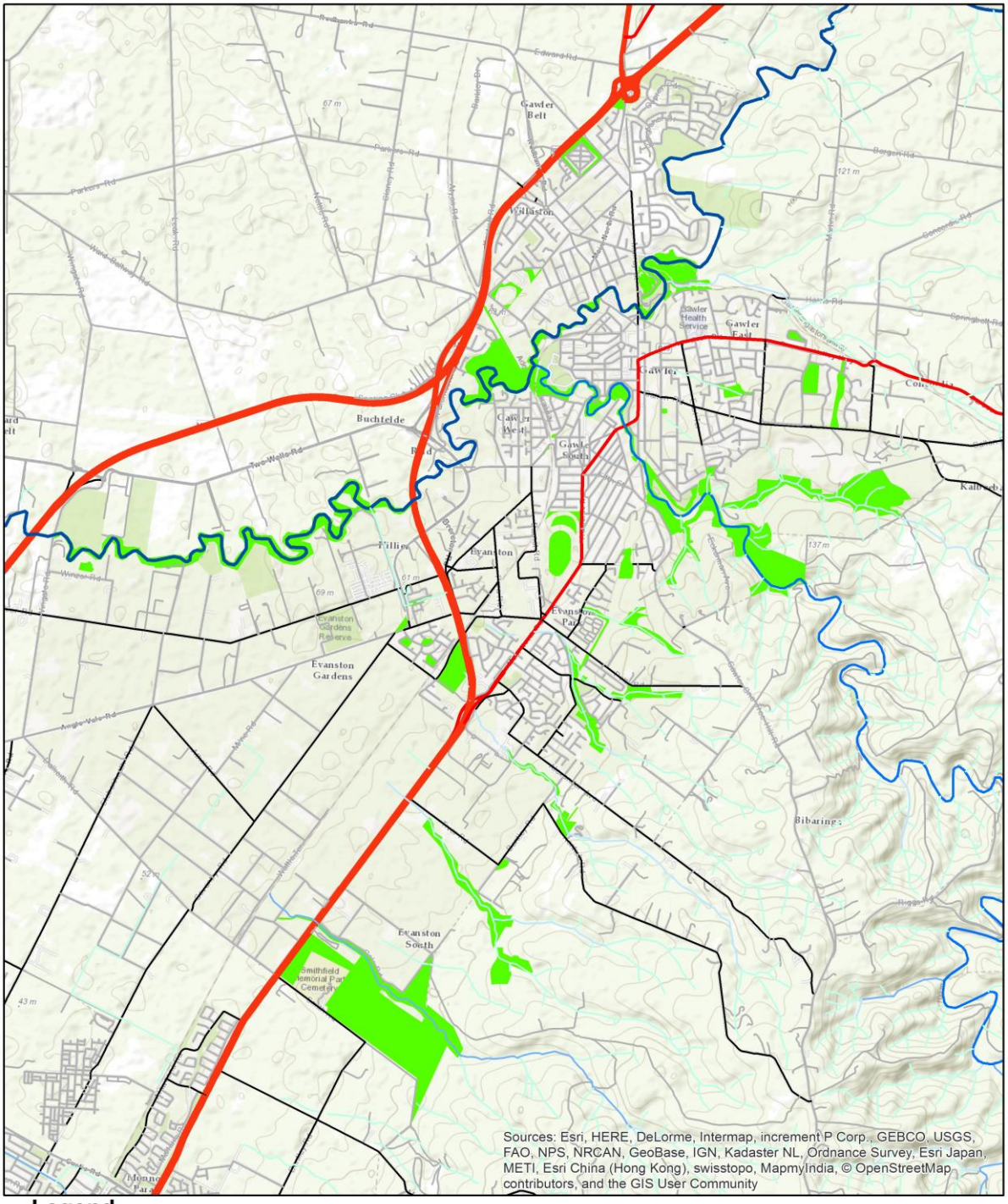
2) A field datasheet (physical paper copy) which collects a range of important patch features was developed. This evolved over time to collect more useful information, but also to allow it to be more swiftly digitised. A copy is provided in Appendix 1.

The mapped polygon and its associated datasheet were linked with a unique patch ID, which was just a sequential number, or sometimes alpha numeric such as "12a". This enables a 'joining' process which permanently linked the field data table with the field mapping. This allows for advanced mapping and analysis of any of the field data to be undertaken with ease.

Town of Gawler State of the Environment

The combined data set; desktop material published by external parties and the ground-truthed information collected through the field surveys, effectively constitutes a state of the environment assessment for the Town of Gawler. It functions as a reference point in time which is the basis for analysis in this report, and may be used for comparison in future years, should the process be replicated, to determine trends in the state of the environment over time.

Map 1: Field Work Survey Areas



Legend

Water Stream Order

- <3
- 3
- 4
- 5
- 6

Inspected Areas

0 0.5 1 2

Kilometers

Greening Australia

Workshops (Community and Council)	
6/9/2017	Gawler Urban Rivers Working Group Presented proposed priority areas and field methodology. Some important additional sites were added to the priority field survey list.
10/1/2018	Gawler Urban Rivers Working Group Demonstrated some of the potential outputs based on the field data collected to date. Presented some preliminary findings relating to vegetation types, their conservation status and issues relating to their conservation. Presented some early recommendations relating to the management of the 'Rivers and Steep Creek Lines'.
5/4/2018	Gawler Urban Rivers Working Group Presented broad content of report's key findings and proposed biodiversity projects.
22/6/2018	Town of Gawler Biodiversity Management Plan Draft Workshop Presentation of complete draft biodiversity management plan to Council employees.
17/7/2018	Town of Gawler Infrastructure and Environmental Services Committee Presentation of complete draft biodiversity management plan to Council.
6/2/209	Community consultation workshop at Gawler Sport and Community Centre. Presentation of desktop and field observations. Question and answer session supplemented with written feedback from community.
20/2/2019	Town of Gawler Biodiversity Management Plan Draft Elected Member Workshop Presentation of information gathered for the draft biodiversity management plan, including community consultation feedback, to Council.
12/6/2019	Community consultation workshop at Gawler Sport and Community Centre. Presentation of recommendations. Question and answer session supplemented with written feedback from community.
30/7/2019	Town of Gawler Biodiversity Management Plan Draft Elected Member Workshop Summary of community consultation and feedback and presentation of recommendations to Council.

Limitations and Knowledge Gaps

This report is based on field surveys and many disparate studies of biodiversity issues in and around the Town of Gawler. This body of evidence, though significant, has focussed on the large open space environment and has omitted one spatially and ecologically significant piece of the Town of Gawler; the urban backyard environment. No extensive survey work has been done on investigating the biodiversity values of the matrix of backyards. Citizen science has a crucial, and efficient, future role to play on gathering this information.

Roadsides were also not significantly surveyed during the production of this plan, and the survey work that was conducted was ad-hoc opportune observations whilst commuting between larger open space surveys. Although some roadside vegetation surveys have previously been conducted using the DEW roadside vegetation survey methodology for South Australia, this is only a small fraction of the roadsides with native vegetation, and these were mostly conducted in 1999 by DPTI and are of limited use to Council.

Much of this study has been conducted over the summer of 2017-2018 which has given a survey bias towards detecting summer active and perennial plant species. It has also reduced the number of fauna able to be observed as they tend to be inactive on hot days and thus harder to detect.

As mentioned in the methodology section above, some landholders did not grant access to survey priority targeted parcels of land. Some information from these has been gleaned from observations made from nearby vantage points or from other studies which did access these sites in previous years. In these instances, the information is not of equal accuracy or is not contemporary with information on adjoining parcels.

The author's (and principle surveyor's) expertise is primarily in the field of botany so information collected is biased in that respect. Whilst effort was made to gather information on fauna, many field records will have been missed, particularly smaller and harder to identify animal species. No fauna captures were conducted during the field work for this report, instead relying on visual recognition or photographic interpretation for fauna records. Furthermore, no effort was made to collect information regarding simpler life forms such as Mosses, Liverworts, Lichen, Fungi, Slime Moulds, etc. There is a paucity of records for these taxa, as well as invertebrates, and generally limited data for reptiles, bats and fish within the Town of Gawler. The fields best surveyed have been birds and vascular plants, although a large number of new flora records were achieved in this study, indicating the value of consistent field observation.

Future Growth of the Council in the context of the 30 Year Plan for Greater Adelaide

The 30 Year Plan for Greater Adelaide, first prepared in 2010 and most recently updated in 2017, describes “how Adelaide should grow to become more liveable, competitive and sustainable”. The plan sets out 14 principles which underpin the policies and actions relating to development within Greater Adelaide:

1. A compact and carbon neutral city
2. Housing diversity and choice
3. Accessibility
4. A transit focused and connected city
5. World-class design and vibrancy
6. Social inclusion and fairness
7. Heritage and character protection
8. Healthy, safe and connected communities
9. Affordable living
10. Economic growth and competitiveness
11. Climate change resilience
12. Environment protection, restoration and enhancement
13. Natural resource management
14. Better community engagement

Principles 12 and 13, those with a strong focus on biodiversity, are supported by 8 policies:

Policy 90. Delineate and maintain areas with significant environmental values to protect landscape health; conserve biodiversity; and improve development certainty and transparency.

Policy 91. Protect coastal features and biodiversity.

Policy 92. Support the enhancement of the urban biodiversity of metropolitan Adelaide through the development of greenways in transit corridors, along major watercourses, linear parks and the coast and in other strategic locations.

Policy 93. Ensure that greenways are landscaped with local indigenous species where possible to contribute to urban biodiversity outcomes.

Policy 94. Protect the natural and rural landscape character of the Hills Face Zone and ensure that land uses in this zone contribute to this landscape backdrop and area of significant biodiversity.

Policy 95. Support the enhancement of the urban biodiversity of metropolitan Adelaide through a connected and diverse network of green infrastructure.

Policy 96. Incorporate information on nature protection areas, complementary developed areas and coastal features within the South Australian Multiple Land Use Framework, to support consideration of benefits and consequences for land users and the wider community in land use decision-making.

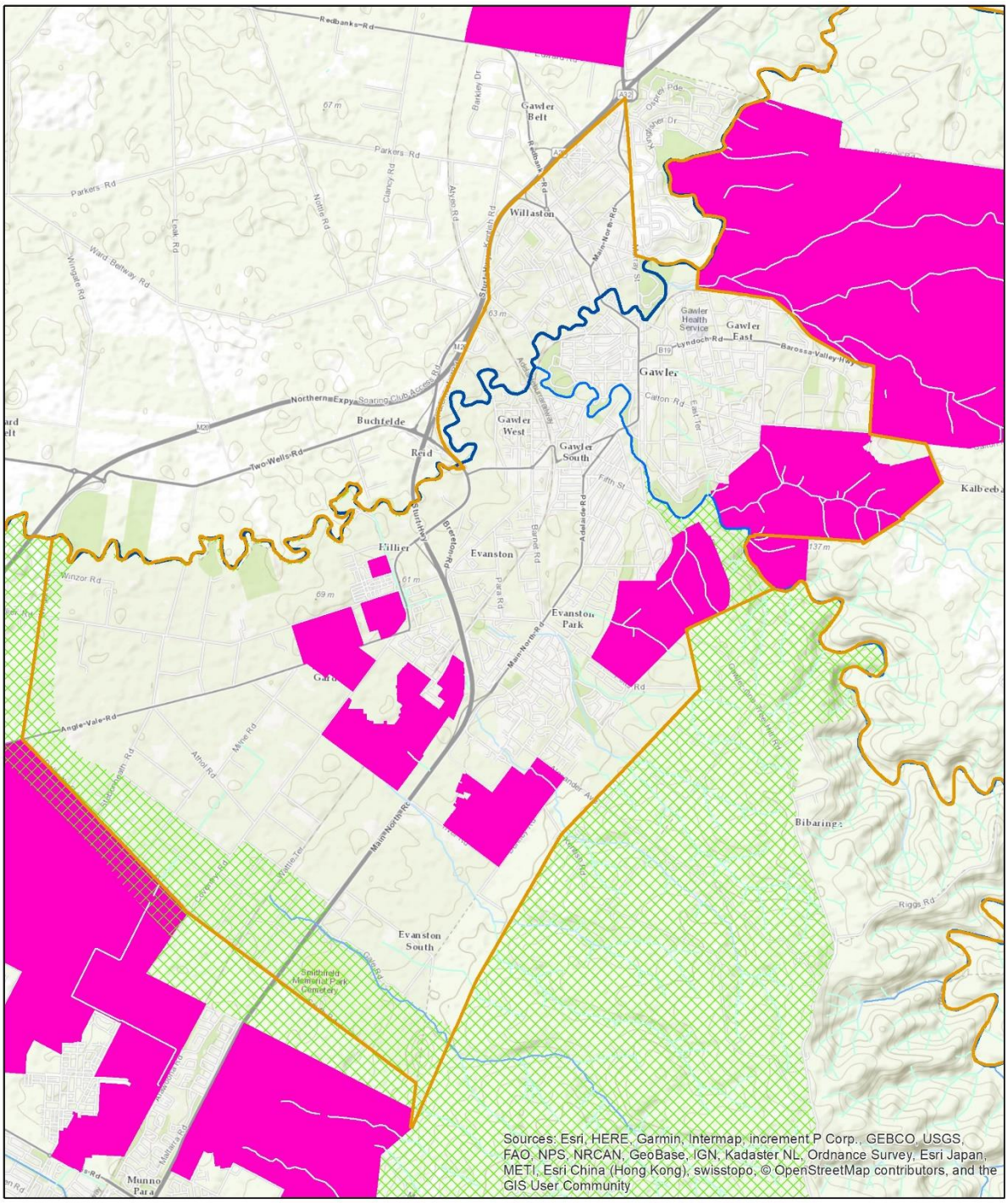
Policy 97. Minimise or offset the loss of biodiversity where this is possible and avoid such impacts where these cannot be mitigated (for areas not covered by the Native Vegetation Act 1991).

Future growth in the Council area is currently focussed in Residential Zones on foothills area extending from Gawler East to Evanston South, and the plains from Evanston South to Hillier. These zones predominantly comprise areas previously or currently managed for cropping and grazing, but also do contain areas of high biodiversity, particularly along the creek lines which run out of the hills.

Supporting these growth areas is an increase in the road network, as set out in the Gawler Growth Areas Transport Framework, the most notable of which is the Gawler East Link Road, currently in the advanced stages of planning.

Decisions now will set the course for biodiversity management in the new and existing urban spaces. By incorporating biodiversity into the forward planning of this urban expansion, the Town of Gawler can set itself up for success. Without proper planning and implementation at an early stage biodiversity is likely to decline significantly and irreversibly. There are also significant potential changes to stormwater management being considered in a Town of Gawler Stormwater Management Plan.

Map 2: Future Urban Growth Areas within and around the Town of Gawler



Legend

- Local Government Boundary
- Metropolitan Open Space System (MOSS) Study Area
- Future Urban Growth Areas

0 0.5 1 2
Kilometers

Greening Australia

Relevant Legislation and Planning

The conservation of biodiversity in the Gawler district is subject to international, national, state and regional plans, agreements and legislation. The most relevant of these are listed in Figure 1 below.

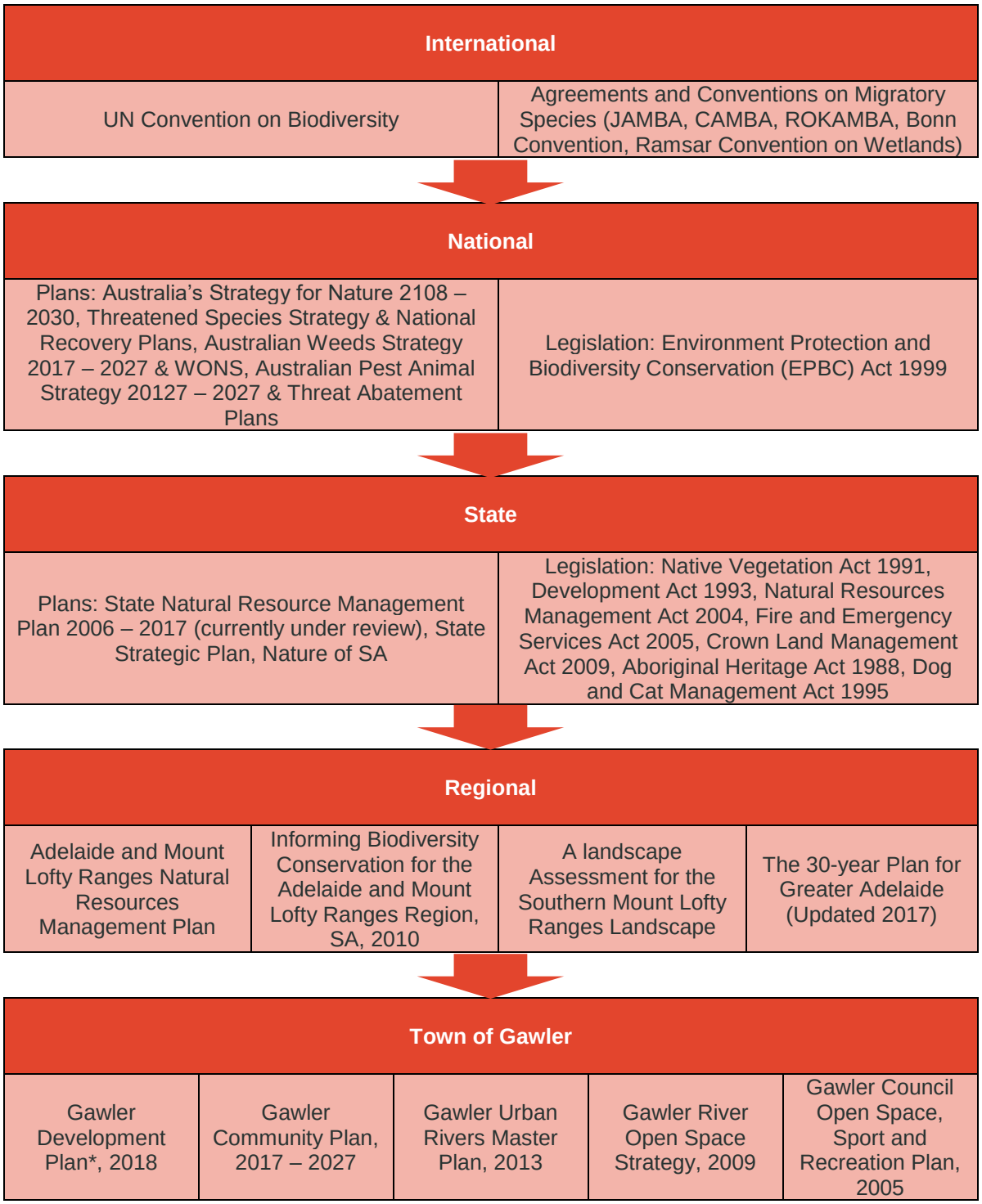


Figure 1: Relevant Legislation and Planning

*Gawler Development Plan to be superseded by the Planning and Design Code under the Planning, Development and Infrastructure Act, 2016.

Links with Existing Local, State and National Government Policies, Programs, Strategies and Grants

National Government

Australia's Strategy for Nature 2018 – 2030: Is the principal guiding document for Australian Government's vision for biodiversity and natural area conservation. The document encourages Australians to connect with nature, care for its diversity and to build and share knowledge. Among the most relevant Objectives for the Town of Gawler are:

- Maximise the number of species secured in nature;
- Reduce threats to nature and build resilience;
- Use and develop natural resources in an ecologically sustainable way;
- Enrich cities and towns with nature.

National Landcare Program: The National Landcare Program is a major component of the Australian Government's funding commitment to the environment and sustainable agriculture. This is a competitive grants program which includes the Smart Farms initiative and a major tender process aligned with NRM organisations. The Town of Gawler can participate in projects directly, or through partnerships with NRM, NGOs and community groups.

Climate Change Policy: The focus of the Australian Government response to climate change is largely focussed in the areas of carbon emissions reduction rather than biodiversity. However, there are potential links to this policy area through carbon biosequestration opportunities and building resilient landscapes.

State Government

The recent State election in South Australia has created some uncertainty in the policy setting regarding biodiversity. However, there are still several key policies and programs that the Town of Gawler will interact with over the coming years. These include:

- ***Adelaide and Mt Lofty Ranges Natural Resources Management Plan***: A principal Plan for guiding environmental activities in the region. Covers pest animals, water, soil, climate change and biodiversity;
- ***Native Vegetation Council Policy:*** The Native Vegetation Act applies to most of the state. The Act provides protection for remnant vegetation within the northern part of the Town of Gawler and may provide opportunities to develop and register Significant Environmental Benefit offset projects which could enhance the Town's biodiversity estate;
- ***Green Cities Policy Area***: The State Government has been a strong supporter of green cities initiatives and this appears likely to continue. There may be future funding opportunities in this space and opportunities to incorporate biodiversity outcomes through habitat restoration, community events and education.
- ***The 30 Year Plan for Greater Adelaide***, (see previous section)

Local Government

Gawler Community Plan (2017-2027): Council has clearly outlined its position in relation to the environment in this document, with Goal 4 – Our Environment being to "Respect and Nurture the Environment" through the following 5 objectives:

4.1 Create and maintain a riverine environment that reflects the social, cultural and landscape values of the river corridor

4.2 Support development that respects the environment and considers, the impacts of climate change

4.3 Protect environmentally significant areas of native vegetation for present and future generations

4.4 Support sustainable use of natural resources and minimise further waste to landfill

4.5 Support provision of useable open space that preserves natural habitat and biodiversity

Gawler Development Plan (T): Consolidated in February 2018 by the Department of Planning, Transport and Infrastructure, this document provides key guidance on issues relating to development, environment and biodiversity. Appendix 2 sets out the Development Objectives and Principles of Development relating to Biodiversity in the Gawler Development Plan.

Gawler River Floodplain Management Authority: Formed in 2002 as a Regional Subsidiary under the Local Government Act 1999, this Authority includes representation from Adelaide Hills Council, The Barossa Council, Town of Gawler, Light Regional Council, Adelaide Plains Council and the City of Playford. The principle function of the Authority is to co-ordinate the construction, operation and maintenance of flood mitigation infrastructure for the Gawler River, and to provide a mechanism for the constituent Councils to work together. There may be decisions or infrastructure projects which impact biodiversity assets within the Town of Gawler.

Stakeholders and Potential Partnerships in Biodiversity Management

Government Agencies

Country Fire Service

The CFS are major stakeholders in fire threat management throughout South Australia. The CFS provide planning support to biodiversity management in fire risk areas, particularly where this management is likely to result in a change to the fire regime, with a view to reducing the fire risk to the community as much as practicable.

The CFS are potential partners in the planning and implementation of prescribed burns for biodiversity and fuel reduction purposes.

The Department for Environment and Water / Natural Resources Adelaide and Mount Lofty Ranges

The Department for Environment and Water (DEW) and Natural Resources Adelaide and Mount Lofty Ranges (NRAMLR) are the principal state government agencies with a mandate for maintaining and improving biodiversity throughout South Australia. Both DEW and NRAMLR are potential partners in the implementation of any biodiversity project which aligns with their existing policies, programs and strategies (see page 16). Within the Town of Gawler DEW actively manages the Gawler Buffer East reserve. They also own and manage a portion of Para Woodlands which is directly adjacent to the Town of Gawler and is part of an important biodiversity corridor along the South Para River. NRAMLR and DEW staff have been involved in the development of this Plan.

NRAMLR is supported in its planning and decision making through a number of committees such as the Water Allocation Plan Advisory Committee (Northern Adelaide Plains) and the Adelaide and Mount Lofty Ranges NRM Board Advisory Committee.

DEW / NRAMLR may be partners in providing knowledge support to improve outcomes or provide funding support for the implementation of these projects. They should be made aware of projects for which the Town of Gawler is seeking funding, and which align with the existing policies, programs or strategies.

The Department of the Environment and Energy

The Department of the Environment and Energy (DoEE) is the principal Commonwealth government agency with a mandate for maintaining and improving biodiversity throughout Australia, including obligations to a number of international conservation treaties (e.g. the Convention on Biological Diversity and the Convention on the Conservation of Migratory Species of Wild Animals). The DoEE's primary role is through partnering with delivery agencies, such as Council or other partners, and providing funding support for the implementation of projects as well as regulating projects which have potential impact on EPBC listed species and threatened plant associations.

Dog and Cat Management Board

The Dog and Cat Management Board (DCMB) is a statutory board established under the Dog and Cat Management Act (1995). The DCMB works with state and local governments to improve dog and cat management through legislation and regulation. The DCMB would be important partners in any significant changes to cat management by-laws in the Town of Gawler.

Adjacent Councils

The City of Playford, The Barossa Council and Light Regional Council share adjacent boundaries and are stakeholders in the health of Town of Gawler's biodiversity, which does not respect lines on maps and relies on mutual population connectedness between council regions for ongoing health. These Councils are also key bodies for partnerships on cooperative management of watercourses and road reserves which run between councils and have expertise and equipment for local biodiversity management which may be shared between councils.

Gawler River Floodplain Management Authority

The Gawler River Floodplain Management Authority (GRFMA) is made up of 6 constituent Councils with the purpose of coordinating the construction, operation and maintenance of flood mitigation infrastructure for the Gawler River. Projects and works along the major watercourses have potential significant impacts on biodiversity but also provide opportunities for biodiversity improvement.

Non-Government Organisations Based in Gawler

Apex Club of Gawler

The Apex club of Gawler is a community organisation with a focus on fundraising through catering. They have previously been involved in volunteer planting in areas of the Gawler parklands.

Gawler Environment and Heritage Association

Gawler Environment and Heritage Association (GEHA) have a long track record in recording and improving the biodiversity of the Town of Gawler and surrounding districts. GEHA has been active in conducting significant plant surveys in the region, planning and assisting with revegetation projects as well as securing and propagating common and rare plant species of local provenance. GEHA may provide expert ecological advice, particularly regarding appropriate plant selection, or supply local provenance seedlings.

Gawler Environment Centre

The Gawler Environment Centre (GEC) is a local community based environmental organisation which aims to support ecologically sustainable natural resource management in the region, build the capacity of the community to undertake natural resource management and to provide a focus for the natural resource management activities of community groups. The GEC currently managed an initiative called the 'Understorey Project' (in conjunction with GEHA) which aims to increase the amount of appropriate local native planting in urban gardens and rural properties. The GEC would be an important partner for communicating some of the objectives of this plan to community members.

Gawler Scout Group and Gawler Girl Guides

The Gawler Scout Group and the Gawler Girl Guides are youth focussed organisations which seek to educate and challenge participants through a wide range of adventurous activities. Both groups have previously been involved in volunteer planting events in the Gawler parklands.

Gawler River Riparian Restoration

The Gawler River Riparian Restoration (GRRR) group work on the revegetation and restoration of a length of the Gawler River immediately downstream from the Gawler Bypass, alongside a section known as the Food Forest, Hillier. Work is conducted by volunteer community members.

Kiwanis Club of Gawler

The Kiwanis Club is a service club which is involved in many projects to raise money for community causes, with a particular focus on children. The Kiwanis have previously been involved in volunteer planting events in the Gawler parklands.

Lions Club of Gawler

The Lions Club of Gawler is a general service club, rather than a specifically nature-oriented organisation as many others in this section are. The Lions Club seeks to support the local community, and to improve cultural and civic amenities of the town. This is done through a number of mechanisms including fundraising and contribution of labour.

Rotary Club of Gawler and Gawler Light

The Rotary Club of Gawler Light is a general service club, rather than a specifically nature-oriented organisation as many others in this section are. The Rotary Club seeks to bringing together local leaders to take action in bettering the world through humanitarian service. This is done through a number of mechanisms including fundraising and contribution of labour.

Whitelaw Creek Catchment Care Group

Whitelaw Creek Catchment Care Group is a community group that has for more than 10 years focussed on the improvement of Whitelaw Creek, a major tributary into the North Para River at Clonlea Park. Projects in Clonlea Park should seek to partner with the Whitelaw Creek Catchment Care Group.

Willaston Cemetery Bush For Life Group

The Willaston Cemetery Bush For Life Group has been active since 1997. The group consists of around 5 community members and a Trees For Life supervisor who undertake predominantly weed control activities for around 20 days per annum in the western, northern and eastern portions of the site. This work is currently supported with funding from the Town of Gawler.

Non-Government Organisations in the Region

Barossa Bushgardens

The Barossa Bushgardens is a native flora centre established with the aim of conserving, promoting and supplying the Barossa region's local native plants. Although Gawler is not in the Barossa region, the plant selection and provenance is very similar. The Barossa Bushgardens may provide expert plant selection advice or supply local provenance seedlings. The Barossa Bushgardens also maintains a large garden of composed of local native plants which provides an excellent demonstration for landholders and landscapers looking to incorporate native plants inti their gardens.

Kaurna

It is well documented that the Gawler, South Para and North Para Rivers near Gawler and the surrounding plains and foothills were important living areas for the Kaurna people (AHCM, 2010). These traditional links to the country continue today and are recognised through the large number of cultural sites and artefacts that have been recorded, and the stories held by the Kaurna descendants. On 21 March 2018, the Kaurna people were formally recognised as native title holders for an area around Adelaide, including the Town of Gawler.

The Town of Gawler has responsibilities to adhere to relevant Aboriginal heritage legislation (e.g. Aboriginal Heritage Act 1988, Native Title Act 1993) and has responsibilities relating to the care and protection of the recorded sites, and any future artefacts, remains or cultural sites that may be found.

Three Kaurna Heritage Groups (Kaurna Aboriginal Community and Heritage Association Incorporated (KACHA), Kaurna Elders and Kaurna Meyunna) have been responsible for interactions with the Kaurna nations (www.ahcsa.org.au), Kaurna Yerta Aboriginal Corporation as the corporate body managing native title in the area is likely to be the body managing Aboriginal heritage at some stage.

The naming of the river junction area "Parridla Taikondi", the rivers path "Tapa Pariara" and associated activities have occurred in consultation with Kaurna representatives. There are many opportunities for the Town of Gawler to partner with the Kaurna community on biodiversity related projects.

Kersbrook Landcare Group

The Kersbrook Landcare Group (KLG) is a community-based organisation established in 1997. The KLG provides information and support to local residents and landholders (in the Kersbook and South Para catchment area) on agricultural and environmental issues, including biodiversity. The KLG operates a small-medium sized nursery which specialises in local native plant species, many of which would be appropriate for use in revegetation or landscaping projects in the Town of Gawler.

Seeding Natives

Seeding Natives is a recent not-for-profit venture which aims to reverse species loss through innovative native grassland restoration for the benefit of humanity and the earth's biological diversity. Seeding Natives specialises in working in native grasslands, providing weed control and revegetation in this vegetation type. There are particularly notable for their grassy groundcover restoration technique, using a specialised sowing machine which can establish broad acre, diverse grasslands.

Non-Government Organisations Operational throughout the State

Conservation Volunteers Australia

Conservation Volunteers Australia (CVA) facilitate nature-based volunteering experiences through a range of community and government programs, for people of all skill levels. CVA is currently advertising opportunities to contribute the restoration of the Gawler River on the banks adjacent the Food Forest, Hillier. They may provide training and management of community volunteers contributing to Town of Gawler projects.

Greening Australia

Greening Australia (GA) is a national organisation with a significant presence in South Australia, with the aim of creating healthy, productive landscapes that work for communities, economies and nature. GA provides a range of biodiversity services including specialist ecological advice, plant and seed supply, on-ground works (weed control and revegetation), monitoring and carbon offsetting.

GA could act as a delivery partner on biodiversity projects but may also be the lead proponent and/or project manager for biodiversity projects as they seek funding from a range of funding sources including state and federal governments and corporate philanthropy. GA should be made aware of projects for which the Town of Gawler is seeking funding, and which align with the GA mission.

Native Grass Resource Group

The Native Grass Resource Group (NGRG) is a community-based organisation which aims to promote the community awareness of the value of native grasses for biodiversity and production and to disseminate information about native grasses. When pursuing native grassland restoration, the NGRG would be able to provide a wealth of information about how to go about it and who to contact for further information and resources.

Nature Foundation SA

The Nature Foundation SA (NFSA) is an environmental organisation that works on their nature reserves and throughout South Australia to connect with and inspire people to Save, Protect, Restore and sustainably manage South Australia's natural heritage. Notably NFSA owns a large portion of the Para Woodlands Reserve which is directly adjacent to the Town of Gawler and is part of an important biodiversity corridor along the South Para River.

Trees For Life

Trees For Life (TFL) is a membership-based community organisation active throughout South Australia, with the aim of revegetating and conserving South Australia’s vegetation. TFL provides a range of biodiversity services including specialist ecological advice, plant and seed supply, on-ground works (weed control and revegetation), training and carbon offsetting. TFL offers two significantly different delivery models for on-ground weed control; The Bush For Life program utilises trained community volunteers to adopt a patch of good condition vegetation to improve the condition of the site through minimal disturbance techniques over extended periods of time (see Willaston Cemetery Bush For Life Group above) whereas their commercial on-ground works team provides fee-for-service weed control using paid professionals.

TFL could act as a delivery partner on biodiversity projects but may also be the lead proponent and/or project manager for biodiversity projects as they actively seek funding from a range of funding sources include state and federal governments, corporates and philanthropy. TFL should be made aware of projects for which the Town of Gawler is seeking funding, and which align with the TFL mission.

The pre-European Landscape

Setting the Scene

Cast yourself back 200 years, standing on the hills face above Gawler and looking around. What would you have seen? In many places on the hills there would have been clear vistas, the hills face was generally grassland, or lightly timbered woodland. Much of the plains below were a mix of grasslands of various types with a few patches of woodland, some of it pines, some sheoak, some mallee box, some mallee. The eye would have been drawn to the tall, linear woodland which snaked its way across these plains along the Gawler River. Perhaps there was also a blackened fire-scar, a reminder of one of the frequent fires which burnt through the landscape, often started by Kaurna people as part of their land management activities.

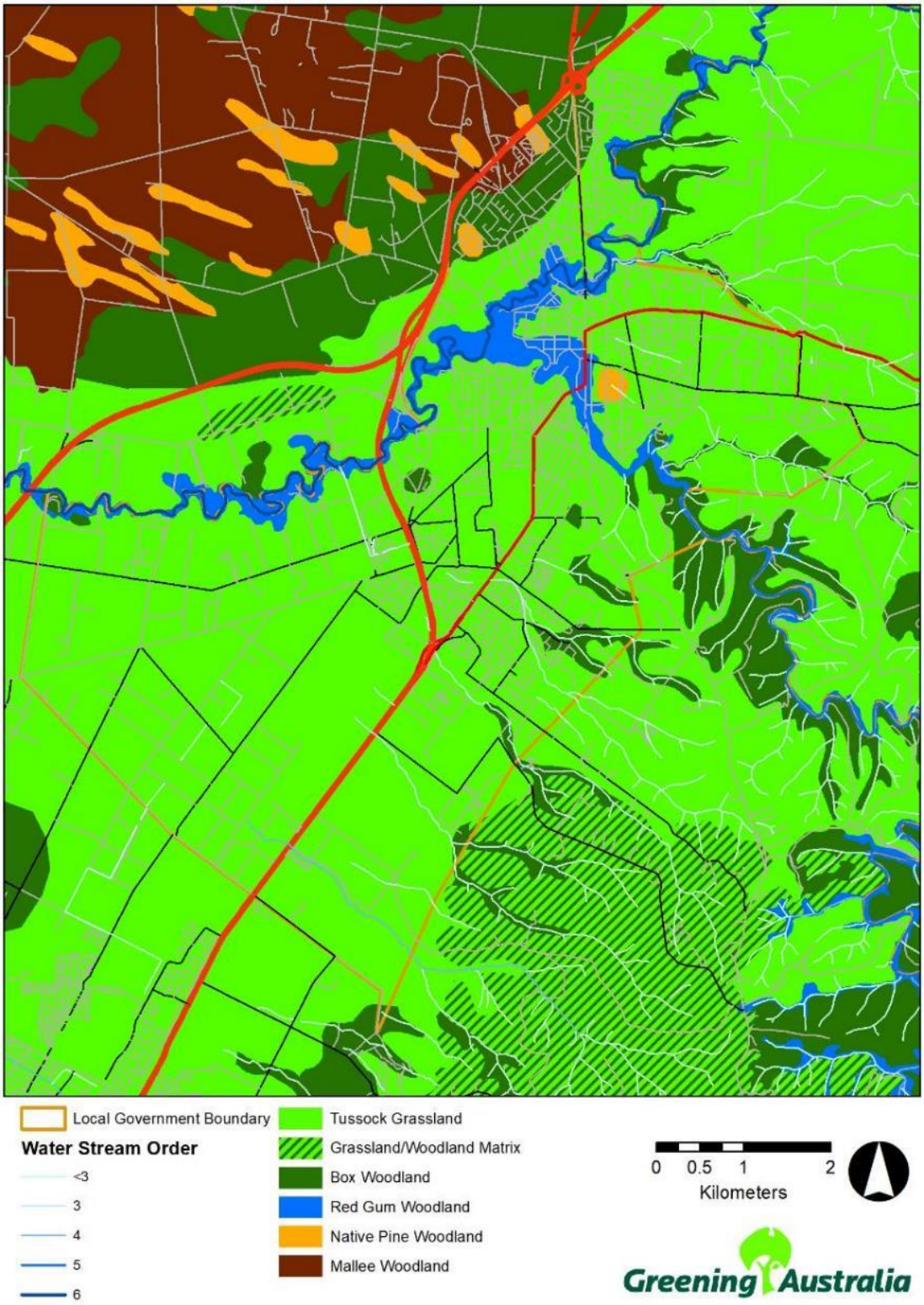
Looking closer the environment would have been filled with animals of all kinds; the still familiar Western Grey Kangaroo (*Macropus fuliginosus*) would have been in minority compared to the many other smaller mammals such as Bilbies (*Macrotis lagotis*), Quolls (*Dasyurus* spp.), Echidnas (*Tachyglossus aculeatus*), Bettongs (*Bettongia lesueur*), Bandicoots (*Isoodon obesulus*), Antechinus (*Antechinus flavipes*) and many species of marsupial mice and rats sharing the environment with numerous bird species along with fish, eels and frogs in the main rivers, parrots, wrens, finches and owls in the open woodland areas and a range of ground dwelling birds such as the Stubble Quail (*Coturnix pectoralis),* Australian Bustard (*Ardeotis australis*), Plains Wanderer (*Pedionomus torquatus*) and Spotted Quail-thrush (*Cinclosoma punctatum*). They would have been wary though, with many Raptors, Dingoes (*Canis lupus dingo*) and Sand Goannas (*Varanus gouldii*) hunting for their next meal. The soil would have been soft under foot, with the animals constantly turning over the soil in search of the rich diversity of invertebrates.

Major Vegetation Groups

The following table described the 9 major vegetation groups of the Town of Gawler and their preferred situation.

Situation	Cover Type	Composition
Dryland	Woodland	Mallee Box (*Eucalyptus porosa*) Grassy Woodland
		Mallee (*Eucalyptus phenax, E. dumosa* and *E. socialis*) Woodland
		Native Pine (*Callitris gracilis*) Woodland
	Grassland	Iron-grass (*Lomandra effusa* and/or *L. multiflora* and / or *L. densiflora*) Tussock Grassland
		Tussock Grasslands (*Austrostipa* spp.*, Aristida behriana, Rytidosperma caespitosum, Enteropogon acicularis, Themeda triandra, Dichanthium sericeum*)
Flood Plain	Woodland	River Box (*Eucalyptus largiflorens*) Grassy Woodland
Wetland	Woodland	Red Gum (*Eucalyptus camaldulensis*) Woodland
	Sedgeland	Bul-rush (*Typha domingensis*) and / or Common Reed (*Phragmites australis*) Reed Beds
		Sea Rush (*Juncus kraussii*) Sedgelands

Map 3: Pre-European Vegetation Types of the Gawler Area



Adapted from DEW pre-European Vegetation Mapping, Shackley (2015 & unpublished) and field surveying undertaken as part of this report. This map varies significantly from previous maps produced including Kraehenbuehl (1996) and the corresponding DEW spatial data sets, with far more grassland cover represented. It is largely based on historical records from newspapers, explorers and other early records. See Appendix 7 for examples. DEW mapping should be updated to align with the above mapped features.

Mallee Box (*Eucalyptus porosa*) Grassy Woodlands

Historically found predominantly on the hills, along the banks of ephemeral creek lines and the steep slopes above South Para with isolated patches on the plains and lower hills. This community has an open to very open woodland canopy over sparse woody shrubs over a very diverse grassy and herbaceous ground layer. In the Willaston Cemetery this association appears to have intergraded with Mallee and Native Pine vegetation types found nearby. It has a shrubby understorey which may be natural, or possibly reflects the removal of fire and grazing from this area, allowing this stratum to flourish.

The large trees form hollows which are important habitat for a range of birds and mammals, whilst the lower lateral branches and overhead canopies provide good perching opportunities for small birds which utilise the grasses and herbs below and nearby for feeding.

Common Species by Strata for Mallee Box Grassy Woodlands

Overstorey	*Eucalyptus porosa* (dominant) *+/- E. odorata +/- Callitris gracilis +/- Allocasuarina verticillata*
Upper Midstorey	*+/- Acacia pycnantha +/- Eremophila longifolia*
Lower Midstorey	*+/- Acacia acinacea +/- Acacia cupularis +/- Acacia ligulata +/- Acacia notabilis +/- Bursaria spinosa +/- Cullen australasicum +/- Maireana* spp*. +/- Rhagodia parabolica +/- Senna artemisioides*
Ground Layer	*Anthosachne scabrus, Aristida behriana, Arthropodium* spp*., Atriplex semibaccata, Austrostipa* spp*., Boerhavia dominii, Calostemma purpureum, Cheilanthes* spp*., Chloris truncata, Chrysocephalum* spp*., Convolvulus* spp*., Crassula* spp*., Dianella* spp*., Dichanthium sericeum, Enteropogon acicularis, Goodenia pinnatifida., Lomandra* spp*.,* Orchid spp., *Oxalis perennans, Pimelea* spp*., Poa labillardieri, Rytidosperma* spp*., Sida corrugata, Stackhousia subterranea, Teucrium racemosum, Themeda triandra, Velleia* spp*., Vittadinia* spp*.*

Native Pine (*Callitris gracilis*) Woodlands

Historically found on the sand dunes about Willaston and on the escarpment immediately east of the Gawler town centre. These two localities had different mid and understorey species composition owing to the different soil types and surrounding ecosystems. The escarpment soil is shallow with limestone near the surface, the dunes to the west of Gawler are deep sand and the areas of Native Pine Woodland at Willaston are intermediate between the two. This community usually had a mid-dense overstorey which would have been frequently refreshed as the dominant *Callitris gracilis* does not tolerate fire and is only moderately long lived (50-100 years). The mid-storey would have been a matrix of different species of shrubs.

This denser vegetation would have provided excellent shelter for small cryptic fauna who avoided the open grassland and grassy woodlands as well as species which specialised in sand burrowing.

Common Species by Strata for Native Pine Woodlands

Overstorey	*Callitris gracilis* (dominant) *+/- Eucalyptus porosa +/- E. phenax +/- E. socialis +/- Allocasuarina verticillata*
Upper Midstorey	*+/- Acacia pycnantha*
Lower Midstorey	*Acacia notabilis, Rhagodia parabolica +/- Acacia acinacea +/- Acacia cupularis +/- Acacia hakeoides +/- Acacia ligulata +/- Acacia spinescens +/- Bursaria spinosa +/- Cassinia arcuata +/- Leucopogon cordifolius +/- Melaleuca* spp*. +/- Dodonaea viscosa +/- Grevillea ilicifolia +/- Maireana* spp*. +/- Senna artemisioides*
Ground Layer	*Arthropodium* spp*., Atriplex semibaccata, Austrostipa* spp*., Boerhavia dominii, Bulbine* spp., *Caesia calliantha, Chrysocephalum* spp*., Convolvulus* spp*., Crassula* spp*., Dianella revoluta, Goodenia* spp*., Helichrysum leucopsideum, Hibbertia* spp*., Kennedia prostrata, Lepidosperma viscidum, Lomandra* spp*., Olearia spp.,* Orchid spp., *Orobanche cernua, Pimelea* spp*., Podolepis spp., Senecio pinnatifolius, Sida corrugata, Stackhousia subterranea, Swainsona* spp*., Vittadinia* spp*., Zygophyllum* spp.

Mallee (*Eucalyptus oleosa, E. phenax, E. socialis*) Woodlands

Historically found on calcareous loamy soil, often over calcrete, to the north west of the Town of Gawler, with perhaps a small footprint in the Town of Gawler in the Willaston cemetery area. The dominant overstorey species tend to fluctuate based on variations in the soil type and depth to calcrete, but usually multiple overstorey species make up the canopy in any one area. The small tree and shrub layer could vary from dense to open.

Common Species by Strata for Mallee Woodlands

Overstorey	*Eucalyptus oleosa* (co-dominant), *E. socialis* (co-dominant) *E. phenax* (co-dominant), *E. dumosa* (co-dominant) +/- *E. porosa +/- Callitris gracilis*
Upper Midstorey	*+/- Acacia pycnantha +/- Pittosporum angustifolium*
Lower Midstorey	*Acacia notabilis, Rhagodia parabolica +/- Acacia hakeoides +/- Acacia ligulata +/- Acacia oswaldii, +/- Acacia spinescens +/- Alyxia buxifolia +/- Dodonaea viscosa +/- Eremophila deserti +/- Grevillea ilicifolia +/- Leucopogon cordifolius +/- Maireana* spp*. +/- Santalum acuminatum +/- Senna artemisioides*
Ground Layer	*Atriplex semibaccata, Austrostipa* spp*., Chrysocephalum* spp*., Clematis microphylla, Crassula* spp*., Dianella revoluta, Einadia nutans, Enchylaena tomentosa, Enneapogon nigricans, Goodenia willisiana., Helichrysum leucopsideum, Hibbertia* spp*., Lomandra* spp*.,* Orchid spp., *Orobanche cernua, Pimelea* spp*., Sclerolaena* spp., *Senecio pinnatifolius, Vittadinia* spp*., Zygophyllum* spp.

Iron-grass (*Lomandra effusa, L. densiflora* and *L. multiflora* ssp*. dura*) Grasslands

Historically found throughout the hills and plains of the Town of Gawler, the dominant structural Lomandra species (properly a lily not a grass) occurred as single dominant species or as mixed dominant species, usually with significant true grass cover. Although these grasslands would have been interrupted by the occasional medium shrub or tree, for the most part the vegetation would have been below knee height.

The dense, rigid, and sometimes sharp tussocks provided protection for a range of reptiles and small mammals. Grassy vegetation was an important feeding resource for many reptile and bird species and the thatch was important for ground nesting birds.

Common Species by Strata for Iron-grass Grasslands

Overstorey	*+/- Eucalyptus porosa +/- Allocasuarina verticillata*
Upper Midstorey	*+/- Acacia pycnantha +/- Eremophila longifolia*
Lower Midstorey	*+/- Acacia acinacea +/- Acacia notabilis +/- Bursaria spinosa +/- Cryptandra* spp*. +/- Cullen australasicum +/- Maireana* spp*.*
Ground Layer	*Acaena echinata, Anthosachne scabrus, Aristida behriana, Arthropodium* spp*., Atriplex semibaccata, Austrostipa* spp*., Boerhavia dominii, Bulbine bulbosa, Calocephalus citreus, Calostemma purpureum, Cheilanthes* spp*., Chloris truncata, Chrysocephalum* spp*., Convolvulus* spp*., Crassula* spp*., Dianella* spp*., Dichanthium sericeum, Drosera* spp*., Dysphania pumilio, Enteropogon acicularis, Eryngium ovinum, Gonocarpus* spp*., Goodenia pinnatifida, Leiocarpa* spp., *Lomandra* spp*.* (dominant)*, Lotus australis, Oxalis perennans, Pimelea* spp*., Podolepis* spp*., Ptilotus spp., Rytidosperma* spp*., Sida corrugata, Stackhousia subterranea, Swainsona* spp*., Teucrium racemosum, Themeda triandra, Velleia* spp*., Vittadinia* spp*., Wahlenbergia* spp*.*.

Tussock Grasslands (*Austrostipa* spp., *Aristida behriana*, *Rytidosperma caespitosum*, *Enteropogon acicularis*, *Themeda triandra* and *Dichanthium sericeum*)

Historically found throughout the hills and plains of the Town of Gawler, the dominant structural grass species occurred as single dominant species or as mixed stands, the composition depending on subtle changes in soil and hydrology. These grasslands would have been interrupted by the occasional shrub or tree, but for the most part the vegetation would have been low, although early European descriptions of Kangaroo Grass (*Themeda triandra*) grasslands suggest these communities grew very tall on the fertile plains. In part, the frequent fires kept the grasslands free of woody vegetation.

Top: Kangaroo Grass (*Themeda triandra*) Grassland. Bottom: Spear-grass (*Austrostipa* spp.) and Brush Wire Grass (*Aristida behriana*) Grassland (note the two Lomandra tussocks in the foreground).

Left: Silky Blue-grass (Dichanthium sericeum) Grassland. Right: Wallaby Grass (Rytidosperma caespitosum) Grassland.

Common Species by Strata for Tussock Grasslands

Overstorey	Absent
Upper Midstorey	*+/- Acacia pycnantha*
Lower Midstorey	*+/- Acacia acinacea +/- Acacia notabilis +/- Bursaria spinosa +/- Cryptandra* spp. *+/- Cullen australasicum +/- Maireana* spp.
Ground Layer	*Acaena echinata, Anthosachne scabrus, Aristida behriana (dominant), Arthropodium* spp.*, Atriplex semibaccata, Austrostipa* spp. *(dominant), Boerhavia dominii, Bulbine bulbosa, Calocephalus citreus, Calostemma purpureum, Cheilanthes* spp.*, Chloris truncata, Chrysocephalum apiculatum, Chrysocephalum semipapposum, Convolvulus* spp.*, Crassula* spp.*, Dianella* spp.*, Dichanthium sericeum (dominant), Drosera* spp.*, Dysphania pumilio, Enteropogon acicularis (dominant), Eryngium ovinum, Gonocarpus* spp.*, Goodenia pinnatifida, Leiocarpa* spp.*, Lomandra* spp.*, Lotus australis, Oxalis perennans, Pimelea* spp.*, Podolepis* spp.*, Ptilotus spp., Rytidosperma* spp. *(dominant), Sida corrugata, Stackhousia subterranea, Swainsona* spp.*, Teucrium racemosum, Themeda triandra (dominant), Velleia* spp.*, Vittadinia* spp.*, Wahlenbergia* spp..

River Box (*Eucalyptus largiflorens*) Woodlands

Historically found on heavy soils in periodically inundated flood plains adjacent to the Gawler River there was probably only small areas of this community in the Town of Gawler. The understorey would have been a combination of flood tolerant species that are common in the Gawler River proper and the grasslands species of the surrounding plains.

The large trees form hollows which are important habitat for a range of birds and mammals, whilst the lower lateral branches and overhead canopies provide good perching opportunities for small birds which utilise the grasses below and nearby for feeding. Shrubs such as Lignum are excellent roosting places for small birds which could feed on insects and grass seeds in the surrounding areas.

Above: Roadside remnant River Box Woodland near Roseworthy. This is likely similar to the structure of the pre-European community around the Gawler River.

Common Species by Strata

Overstorey	*Eucalyptus largiflorens* (dominant) +/- *Eucalyptus camaldulensis*
Upper Midstorey	*+/- Acacia salicina +/- Acacia pycnantha*
Lower Midstorey	*Duma florulenta +/- Bursaria spinosa +/- Cullen australasicum +/- Maireana* spp.*+/- Myoporum montanum +/- Nitraria billardierei*
Ground Layer	*Alternanthera denticulata, Anthosachne scabrus, Aristida behriana, Arthropodium* spp.*, Atriplex semibaccata, Atriplex suberecta, Austrostipa* spp.*, Boerhavia dominii, Calostemma purpureum, Carex bichenoviana, Chloris truncata, Chrysocephalum* spp.*, Convolvulus* spp.*, Crassula* spp.*, Cyperus gymnocaulos, Dianella revoluta, Dichanthium sericeum, Dysphania pumilio, Einadia nutans, Enchylaena tomentosa, Enteropogon acicularis, Oxalis perennans, Rhagodia parabolica, Rytidosperma caespitosum, Setaria jubiflora, Sida corrugata, Sporobolus virginicus, Swainsona* spp.*, Teucrium racemosum, Themeda triandra, Vittadinia* spp.*, Wilsonia* spp.

Red Gum (*Eucalyptus camaldulensis*) Woodlands

Historically found on a relatively well-defined ribbon along the North Para, South Para and Gawler Rivers, some higher order tributaries such as Whitelaw Creek and on the floodplains about the confluence of the North Para and South Para Rivers. These areas of the river include permanent water and ephemeral water, and all areas would have been subject to periodic flooding events. The understorey would have varied in character between areas of perennial and ephemeral water regimes.

The large trees with many large and small hollows and extensive sections of coarse shedding bark Red Gums are a diverse habitat in their own right. Combined with a dense rush and sedge ground layer, easily accessible water and areas of steep banks this vegetation community would have supported a vast array of fauna.

Above: Remnant Red Gum Woodland over dense Common Reed on the North Para River at Clonlea Reserve.

Common Species by Strata for Red Gum Woodlands

Overstorey	*Eucalyptus camaldulensis (*dominant*)*
Upper Midstorey	*+/- Acacia salicina +/- Acacia pycnantha*
Lower Midstorey	*Phragmites australis +/- Bolboschoenus caldwellii +/- Bolboschoenus medianus +/- Callistemon sieberi +/- Cullen australasicum +/- Duma florulenta +/- Myoporum montanum +/- Nitraria billardierei, +/- Rhagodia parabolica, +/- Schoenoplectus* spp*. +/- Typha domingensis*
Ground Layer	*Alternanthera denticulata, Atriplex semibaccata, Atriplex suberecta, Austrostipa* spp*., Baumea juncea, Boerhavia dominii, Calystegia sepium, Carex bichenoviana, Cyperus gymnocaulos, Cyperus vaginatus, Distichlis distichophylla, Dysphania pumilio, Einadia nutans, Enchylaena tomentosa, Enteropogon acicularis, Juncus kraussii, Lobelia anceps, Lythrum hyssopifolia, Malva preissiana, Mimulus repens, Oxalis perennans, Rytidosperma caespitosum., Schoenoplectus pungens, Schoenus apogon, Selliera radicans, Setaria jubiflora, Sida corrugata, Sporobolus virginicus, Triglochin* spp*.*

Bul-rush (*Typha domingensis*) and/or Common Reed (*Phragmites australis*) Reed Beds

Closely aligned with the distribution of the Red Gum (*Eucalyptus camaldulensis*) Woodlands along the North Para, South Para and Gawler Rivers. It is possible that historically this community was almost entirely found in Red Gum woodlands, but clearance of the overstorey has given the rushes and reeds dominant strata status across a larger area. The dominance of one species or the other is dependent on hydrology, Bul-rush dominates deeper water and Common Reed dominates shallower water. Bul-rush does not occur on the Gawler River in the Town of Gawler, as this is mostly an ephemeral river.

The dense reeds are important habitat for a variety of birds including waterfowl, ducks and Reed Warblers (*Acrocephalus australis*). The reeds are also important instream habitat for Water Rats (*Hydromys chrysogaster*), a range of fish, frogs and invertebrates, as well as the Red-bellied Black Snake (*Pseudechis porphyriacus*) which preys on them. Reeds perform a vital role in slowing water movement, filtering sediment and preventing erosion.

Above: A dense Bul-rush Reed Bed on the North Para River at Clonlea Reserve.

Common Species by Strata for Bul-rush and/or Common Reed Reed Beds

Overstorey	Absent
Upper Midstorey	Absent
Lower Midstorey	*Phragmites australis* (dominant), *Typha domingensis* (dominant) +/- *Bolboschoenus caldwellii* +/- *Bolboschoenus medianus* +/- *Callistemon sieberi* +/- *Duma florulenta* +/- *Schoenoplectus* spp.
Ground Layer	*Alternanthera denticulata, Baumea juncea, Calystegia sepium, Carex bichenoviana, Cyperus gymnocaulos, Cyperus vaginatus, Distichlis distichophylla, Eleocharis acuta, Juncus kraussii, Lobelia anceps, Lythrum hyssopifolia, Mimulus repens, Samolus repens, Schoenoplectus pungens, Selliera radicans, Triglochin* spp.

Sea Rush (*Juncus kraussii*) Sedgelands

Sea Rush (*Juncus kraussii*) as a species is found in the South Para, North Para and some tributaries. One such tributary, an ephemeral creek line running through Gawler East has Sea Rush as a dominant species, and it is assumed that this is a remnant vegetation community. It occurs in discrete patches along this creek line and commences abruptly, with a dramatic change in hydrology caused by an in-stream spring. The ground water supporting this sedgeland is quite saline which is a major determinant of the vegetation community, including the dominance of *Juncus kraussii*. This creek line has low base flows, with surface water flows in winter and spring, but little surface water under summer conditions, however the bed appears to be thoroughly saturated.

These sedgelands are a much lower, more open canopy than the reed beds so they do not provide the same level of shelter for birds, they do however retain a rich diversity of invertebrates.

Above: Sea Rush Sedgeland on the creek bed in Springwood.

Common Species by Strata for Sea Rush Sedgelands

Overstorey	*+/- Eucalyptus camaldulensis*
Upper Midstorey	*+/- Bolboschoenus caldwellii*
Lower Midstorey	*Juncus kraussii* (dominant)
Ground Layer	*Baumea juncea, Carex bichenoviana, Cyperus gymnocaulos, Cyperus vaginatus, Distichlis distichophylla, Lythrum hyssopifolia, Mimulus repens, Samolus repens, Schoenoplectus pungens*

The Current Landscape

What do the pre-European habitats look like now?

Immediately after Adelaide was settled farmers were drawn north to the large expanses of grasslands which were palatable to stock and their soils were fertile and initially yielded excellent crops. The Gawler area was particularly attractive due to the permanent water in the North Para and South Para rivers.

Ploughing, sheep and cattle, combined with the pressures of introduced pests, particularly foxes and rabbits, and weeds wrought massive changes to the region's biodiversity. Also, critically, the displacement of many Aboriginal people and the interruption of their traditional fire stick land management practices deprived the environment of an important management intervention which the ecosystem had evolved alongside. In the early and mid-1900's the broad-scale application of fertilisers and new herbicides brought a second wave of impacting activities. Finally, as the population of greater Adelaide and Gawler increased farming land and remnant vegetation has been converted to housing, roads and other development. But importantly, these impacts were not homogenous, and the current landscape strongly reflects this.

The plains grasslands have been preferentially impacted as they were the easiest to work and build upon. Remnant grasslands on the plains are now few and far between and where they do occur, they tend to be very simplified in flora composition and support generalist fauna. Some plains grasslands have returned in paddocks, council reserves and roadsides which are no longer ploughed, particularly if those areas are slashed/mown, but again, their floral diversity is limited. Grasslands have, however, remained in moderate condition and extent in places where the plough did not reach. This includes the gorges and gullies of rivers and ephemeral creeks lines reaching down from the hills and the foothills from Concordia through to Munno Para. Although these tends to be very narrow bands they provide a window into the structure and composition of what these grasslands were once like. They also tend to contain some specialist grassland animals which have used the continuous creek line corridors to move around. These include birds like Richard's Pipit and the Stubble Quail. Despite their conservation value grasslands have tended to be overlooked as worthy of conservation and in places have been subjected to revegetation efforts which have planted trees and shrubs at densities which are detrimental to the grassland association.

The Native Pine (*Callitris gracilis*) Woodlands are very rare in the Town of Gawler. Willaston Cemetery contains a small remnant of high biodiversity but is effectively disconnected from other similar woodlands, which means without active intervention this remnant has been declining and will continue to decline over time. A tiny remnant of moderate biodiversity remains on private land adjacent to Duffield Street. In this vicinity a few pockets of remnant trees and scattered understorey species can be seen with a keen eye and indicate the previous extent of this woodland.

The River Box (*Eucalyptus largiflorens*) Woodlands in the Town of Gawler were never very extensive and their current state is degraded in extent and condition – with two small patches at Hillier and Evanston. The remnant population in Hillier is on private land and appears to be heavily infested by woody weeds including Boxthorn (*Lycium ferocissimum*) and Olives (*Olea europaea*). The surrounding area is managed for high intensity grazing which provides the association little opportunity to re-establish. The remnant population at Evanston is on Department for Transport land and has an almost entirely weedy understorey. Because it is publicly owned land there is reasonable potential for revegetation and regeneration. Both patches are located near the Gawler River which may provide a source for recruitment of flora and fauna.

Mallee (*Eucalyptus phenax*, *E. dumosa* and *E. socialis*) Woodlands only barely extended in the Town of Gawler about Willaston. Where these mallee species still exist in Willaston they are not he dominant species and may not have been historically. Mallee Box is the predominant species today, but there is a wide range of Eucalyptus species present. As seen in the flora list, many of the plants that are

associated with the sandier soils, such as this mallee association, have not been recorded since the mid 1900's or earlier. Areas of this association are still found in fragmented patches west of the Town of Gawler in Gawler Belt, Ward Belt and further west to Lewiston and Reeves Plains.

The current distribution of Mallee Box (*Eucalyptus porosa*) Grassy Woodlands are probably similar to their pre-European extent in the Town of Gawler. Large expanses of this community still exist on the slopes above the South Para River and the ephemeral creeks and hillsides near Potts Road and Kentish Road. These have been subject to a variety of management regimes and as a result retain varying levels of floral diversity, from poor to good with corresponding levels of fauna diversity. Because of their connectivity along the watercourses they are probably subject to improved recruitment and there has been a level of recruitment occurring, particularly where grazing has been less intense. A small patch of Mallee Box Woodland east of Bluestone Quarry Road (Vadoulis Reserve) retains good floral diversity but has become disconnected from other remnant vegetation through agriculture and housing development encompassing the patch. Not many fauna taxa were recorded in this patch at the time of survey (although it included 1 of only 3 sightings of Striated Pardalote (*Pardalotus striatus*). Another notable patch of Mallee Box woodland occurs on the slopes and creek lines of the Springwood development area. This woodland shows typical signs of a long history of set stock grazing, with the large old trees still standing, but the ground layer depleted of much of its diversity. It does contain a few plants of note including Hairy Sundew (*Drosera peltata*) the only known location of this species within the Town of Gawler. These patches in Springwood retain connectivity with other vegetation through the creek line and as the Para Woodland matures, it will be further connected to other woodlands to the east and south.

The only patch of true Sea Rush (*Juncus kraussii*) Sedgeland occurs in the creek line of the Springwood area and immediately downstream on land owned by the State Government. It retains high biodiversity including notable flora and fauna records, and good condition (concurring with KBR, 2010). The community starts abruptly in the creek line where it is linked with a significant hydrological feature and it is probably similar in extent to pre-European times. This area was called Spring Gully during the 1900's and there is at least one other spring not far upstream (A. Shackley, pers. comm.).

The other Sedgeland in the Town of Gawler is the Bul-rush (*Typha domingensis*) and Common Reed (*Phragmites australis*) Sedgeland. It is possible that some of this is derived sedgeland, brought about by the removal of the Red Gum (*Eucalyptus camaldulensis*) overstorey. It is primarily found in perennial water bodies of the North Para and South Para River but also in patches on the creek line in Springwood and Whitelaw Creek. These tend to retain high levels of biodiversity, particularly birds and invertebrates. A peculiar relict of this association occurs in the creek line adjacent to Gale Road in the 'Gawler Buffer East'. Some depauperate stands of Common Reed (*Phragmites australis*) along with Spiny Flat-sedge (*Cyperus gymnocaulos*) occur in bends of the creek line which were once wet but have since dried out. There is a spring a few hundred metres upstream which is currently dammed on the Council boundary, but which flowed much more strongly a few decades ago, reaching the railway line near Kudla Station and flowing south along the rail line (A. Shackley, pers. comm.). No other native species characteristic of this association was found in the creek.

Red Gum (*Eucalyptus camaldulensis*) Woodlands are the other major vegetation community in the Town of Gawler. The community is found along the North Para, South Para and Gawler Rivers in a distribution probably similar to the pre-European distribution, but some of the floodplain areas around the confluence of the North Para and South Para, near where the town centre is sited, are likely to have been lost. Although the association is extant, an inspection of the trees suggests that many trees are young (relatively) and probably represent a generation after an earlier clearance of most of the trees present at the time of European colonisation (related to use for industrial boilers and other uses) (A. Shackley pers. comm.). The most significant effect of this is that there is a lack of large hollows throughout substantial portions of the association. Trees with large hollows do occur in groups in some places such as on the North Para River near the Netball courts and along the Gawler River. The large stumps of some chopped down Red Gums can also be observed in some places. The association supports highly variable levels of biodiversity which is generally correlated with the presence and abundance of surface water, although this is also likely to have been the case prior to pre-European

settlement. The other major influence on biodiversity is the extent of woody weed infestation. Red Gum Woodlands have been severely impacted by a range of woody weeds including Olives (Olea europaea), Ash (*Fraxinus angustifolia*), Peppertree (*Schinus molle*), Boxthorn (*Lycium ferocissimum*), Prickly Pear (*Opuntia* spp.), Castor Oil (*Ricinus communis*) and Giant Reed (*Arundo donax*). These species create very dense canopies along much of the Gawler River, impacting on native species which prefer an open canopy, whilst facilitating pests such as Rabbits (*Oryctolagus cuniculus*) and Blackbirds (*Turdus merula*).

Above: A permanent pool surrounded by Common Reed at Clonlea Park.

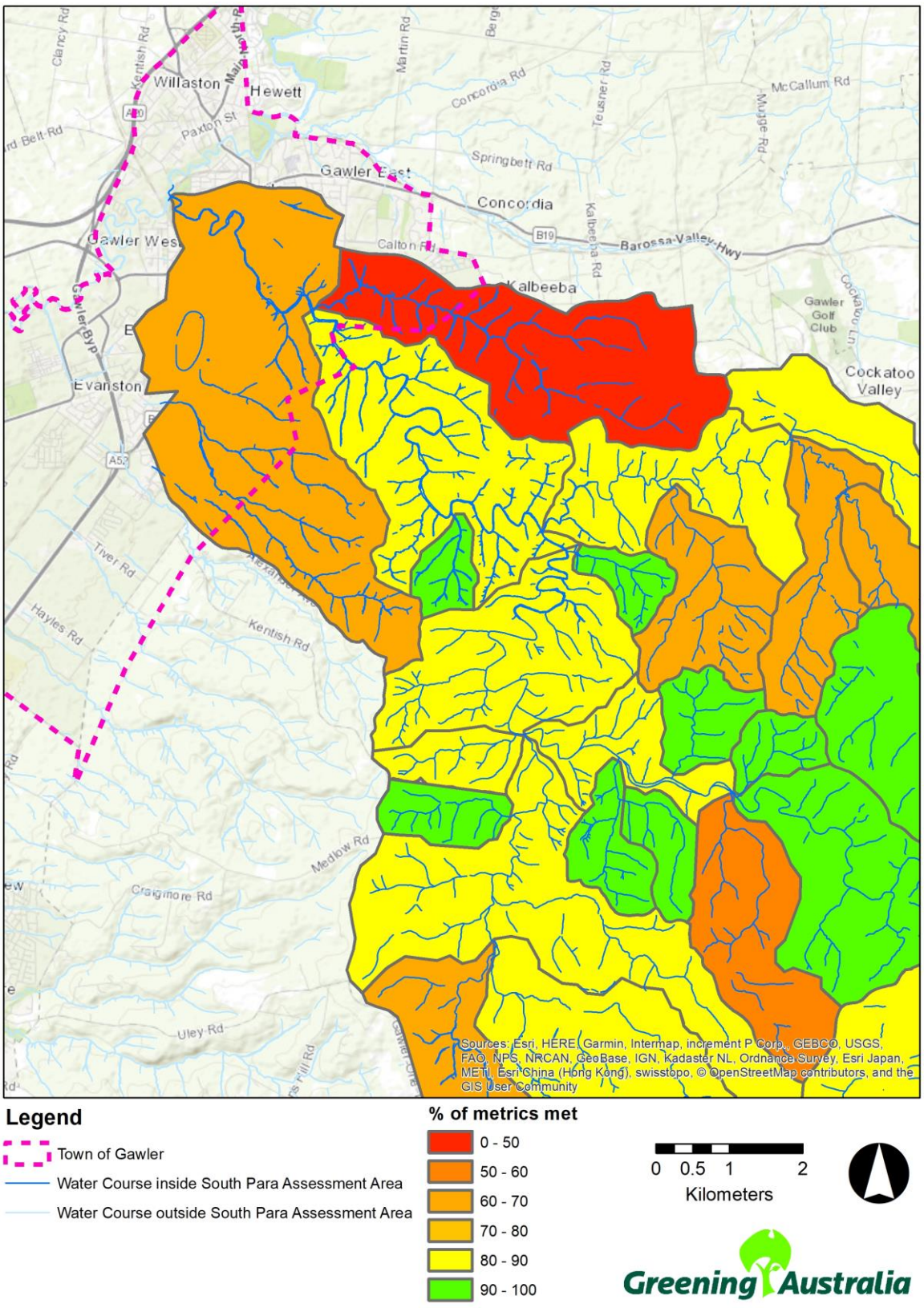
A key feature of the riparian systems described above is the occurrence of permanent pools which are vital refugia for water dependent species, such as Yabbies (*Cherax destructor*), waterbirds and a variety of fish and invertebrates. A long-necked Turtle (*Chelodina longicollis*) was found in South Para River near Para Woodlands, outside the Town of Gawler, but these also occur within the Council boundary too. A number of native fish are known to inhabit the rivers including Big-headed Gudgeon (*Philypnodon grandiceps*), Common Galaxias (*Galaxias maculatus*), Bluespot Goby (*Pseudogobius* sp.) and Congolli (*Pseudaphritis urvillii*), as well as introduced Mosquito Fish (*Gambusia sp.*) and European Carp (*Cyprinus carpio*). No detailed studies were conducted in the aquatic environment in the compilation of this report, however a water quality study conducted as part of the Gawler Urbans River Masterplan (SMEC, 2013) concluded that at that time water quality varied from good (reference condition) to poor (well below reference condition).

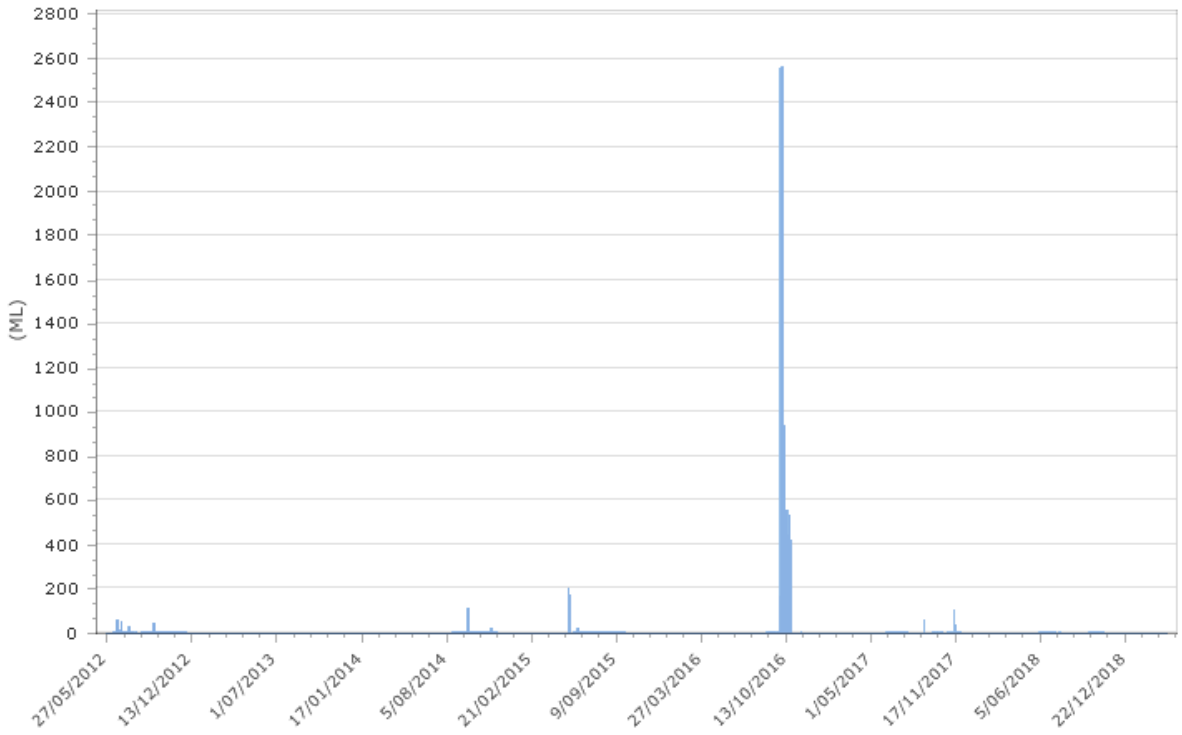
Flows seasonally connect the permanent pools and flooding is still a feature of the rivers which facilitates connectivity from upstream to the sea. This is an important connection for native fish and other species such as Eels and Lampreys which have a life cycle involving both the sea and freshwater rivers. Regular high flow events also clean out water channels and prevent sedimentation or permanent pool refugia.

The catchment of the South Para River is a prescribed water resource (under the NRM Act, 2004) and includes the Barossa Reservoir and the South Para Reservoir, which are critical resources for domestic water supply, but which significantly alter the natural flows in the lower catchment. An assessment of the environmental water requirements in the South Para Catchment (VanLaarhoven and van der Wielen, 2009) suggested that much of the catchment is likely to meet the majority of metrics they developed, which means much of the catchment probably has a suitable hydrological regime or is a low risk (see map 4). The creek flowing through Springwood is a notable exception, suggesting it is higher risk, however the modelling is based on runoff and doesn't consider that for this creek springs are likely to be a significant source of environmental water. This underpins how important proper management of ground water hydrology in this area is as development covers its surface water

catchment. SA Water and NRAMLR oversee an environmental flows program which seeks to provide environmental flows.

Map 4: Percentage of Environmental Water Metrics Met (adapted from VanLaarhoven and van der Wielen, 2009)





Above: Flows in the South Para River as measured at the Barossa Diversion Weir (Water Data Services on behalf of AMLRNRMB, 2019). Note the September 2016 flood event is a significant outlier.

Novel Habitats

Novel habitats are manmade ecosystems. Arguably all extant habitats are novel due to the extent of human modification, but in this report the term refers to habitat types which are heavily modified from the pre-European ones referred to above. They can contain elements of the remnant ecosystem from which they are derived, but this is not necessarily the case. Their biodiversity, functions and processes are often simplified compared to native ecosystems, but they still perform important ecosystem services. Where native systems are predominantly valued for their inherent conservation value, novel ecosystems are predominantly valued for the services they perform for humanity. The three novel ecosystems covered below are Backyards, Suburban Parks and Roadsides.

Backyards

As acknowledged in the 'Limitations and Knowledge Gaps' section below, no field surveys or data were collected from the backyard environment of the Town of Gawler. Some data has been contributed. These areas are likely to support significant biodiversity within the Council area. These novel ecosystems are doubtless significant havens for biodiversity and because of their proximity to residents, have a very direct impact on the liveability of the region. This would be true for backyards which are planted with native or introduced species. Introduced garden species often fulfil many habitat requirements of local native animals but also have the potential to be sources of new environmental weed incursions. Backyards planted with local native species are advantageous as they provide reduced weed potential and are likely to support a greater range of desirable local native animals. Biodiversity in the built-up areas should be managed to maintain or improve biodiversity and the services it provides to humanity and adjacent ecosystems, whilst mitigating the risk of environmental weed introductions. Programs such as the Gawler Environment Centre's "Understorey Project" and information packs such as the NRAMLR's "Creating a Wildlife Friendly Garden", Butterfly Conservation SA's "Attracting Butterflies to your Garden" and the Nursery and Garden Industry of Australia's "Grow Me Instead" provide excellent information resources to improve the biodiversity of the backyard environment.

Above: A private front yard in Gawler planted with local and non-local native species (photo contributed).

Backyard gardens also perform important services such as mitigating heat island effects and facilitating water infiltration into the soil profile (see key Sensitive Areas and Areas of Concern in Relation to Future Development). One critical threat affecting the conservation value of backyards is the trend of larger house footprints on smaller blocks (subdivision or greenfields development) reducing or eliminating the backyard garden and therefore the biodiversity that they support and the services they provide.

RECOMMENDATIONS

1. Improve backyard habitats and planting appropriateness

1. Support the Gawler Environment Centre's "Understorey Project" and other similar measures to promote the planting and retention of local native and biodiverse backyards.
2. Increase the awareness of inappropriate plantings of environmental weeds such as Ash, Gazania, Fountain Grass and Palms in favour of more desirable native, or at least non-invasive, alternatives. Existing resources could be used or adopted as a template for a Town of Gawler specific version. Targeting new residents, new migrants and the horticultural and landscaping industry may have the greatest impact.
    a. Identify key contacts in the landscaping and gardening industry including peak bodies (e.g. Master Landscapers of SA, Nursery and Garden Industry South Australia, Sustinable Gardening Australia) and significant local contractors and nurseries, who can influence plant selection.
    b. Support these entities and their industries to more easily choose or direct their clients towards desirable local natives (as per step 1 above) and avoid undesirable species (as per step 2 above).

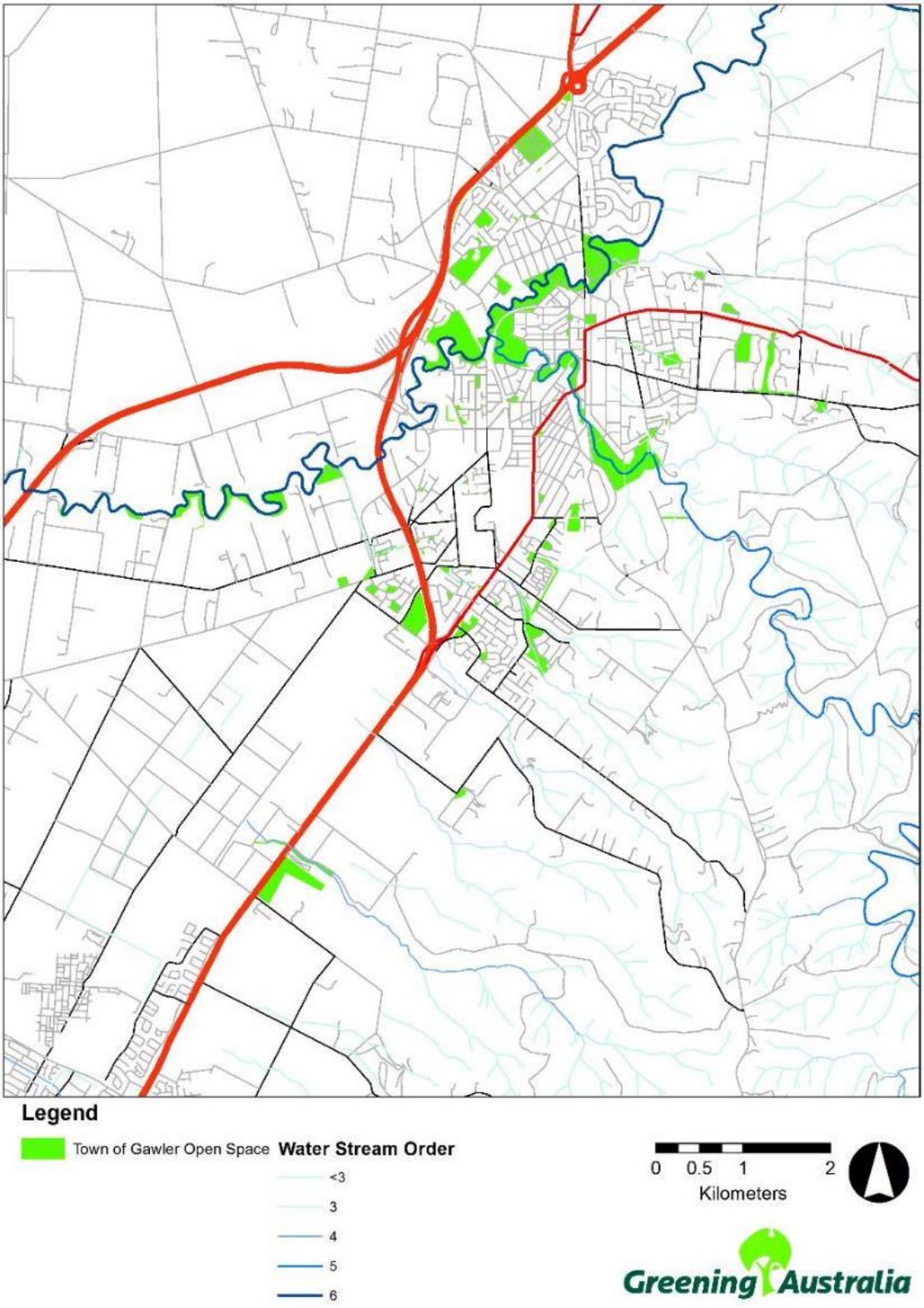
2. Maintain backyard habitats

Encourage the retention of open garden space in new developments and subdivisions through planning policies and decisions.

Suburban Parks and Open Space

The Town of Gawler owns and manages around 282 hectares of open space comprised of 202 land parcels, although many of these are adjoining. The bulk of this land is situated along the major watercourses; the North Para, South Para and Gawler Rivers.

Map 5: Town of Gawler Suburban Parks and Open Space



Some of the open space is occupied by extensive native vegetation and can be managed for traditional conservation outcomes. These include large biodiverse reserves such as the rivers, Gawler Buffer East, Willaston Cemetery, Vadoulis Reserve, the reserve adjacent to Sunnyside Drive and the detention basins on Dawson Road, Evanston Gardens. The powerline reserve in Gawler East has moderate biodiversity, but very important connectivity from Springwood through to Concordia.

However, other areas of open space and suburban parks have been heavily modified and are managed for a broader array of outcomes. They provide local open space for residents to utilise for physical and social recreational activities which contributes to the community's health and wellbeing, mitigate the urban heat island effect and facilitate water infiltration. These tend to be lawned/grassed reserves with sparse introduced tree species, which are maintained predominantly with mowing – the stereotypical park lands. A variety of suburban parks occur in Gawler, Evanston Gardens, Gawler East and Willaston which, although they have no significant focus on biodiversity, do retain some floral diversity, some generalist bird species and an array of invertebrates, including some specialists. There is an opportunity to build on from these existing values to enhance biodiversity and use these areas as demonstration sites for the public to install similar features in their backyards.

The powerline reserve between Calton Road and Barossa Valley Way in Gawler East is a peculiar piece of land, whose development and use has been limited by the overhead high voltage powerlines. The edges have been planted with various non-local and local native species as well as some other species which appear to have been planted by neighbouring landowners. Likewise, the pipeline easement through Springwood needs to be kept open for maintenance. It features in Springwood Masterplan's (2018) open space and is slated for a shared-user path development. The requirement to keep these tracts of land open makes them a perfect location to utilise grassland restoration techniques to develop a native grassland corridor from the creek line, through Springwood through to Concordia.

Above Left: Interpretive sign along the South Para River with information about the Red Gum vegetation community. Above Right: Local native and non-local plantings integrated with recreational use of a park, Clonlea.

Above: Pioneer Park. An excellent example of a suburban park with a strong focus on visual and cultural amenity, but not biodiversity (Courtesy Town of Gawler).

Modified Woodland or Grassland

C, D, F, P

Parkland Woodland

R, W

Shrubby Woodland Mosaic Revegetation

States and Transitions

in Suburban Parks and Open Space

Details of each state (park vegetation type) and each transition driver (C, D, F, P, R and W) can be seen on the next 2 pages

R, W

Revegetated Shrubby Woodland

R, W

D, P

Partially Developed Area

D, R, W

Nature Play Reserve

Restored Grassland

D, R, W

Highly Modified Grassland

C, D, F, P

Lawns and Playing Fields

R, W

Planted Greenfields

States and Transitions in Suburban Parks and Open Space

Transitions

C: Clearance – removal of native vegetation

D: Development – infrastructure and earthworks

F: Fertilising – Fertiliser and other inputs such as irrigation.

P: Planting – planting of non-native species

R: Revegetation – planting of native species

W: Weed control – management of environmental weeds

States

Modified Woodland or Grassland (High Biodiversity)

- Relictual areas which most closely resemble pre-European vegetation types.
- Some important ecological processes absent.
- Biodiversity significantly lower than the pre-European association from which it is derived, but still recognisable.
- Regarded as 'natural' areas. Mostly undeveloped, or have some walking trails (formal and informal)

Parkland Woodland (Moderate Biodiversity)

- Simplified structural complexity. Native understorey almost completely absent. Replaced by lawns of Kikuyu and/or Couch. Large remnant trees retained, sometime supplemented with non-local tree species.
- Irrigated or rely on naturally high soil moisture.
- Infrastructure present includes formal walking trails, seats, benches and other amenity features.
- Maintenance is by mowing.

Shrubby Woodland Mosaic Revegetation (Moderate Biodiversity)

- Large remnant trees retained.
- Patches of structural complexity have been restored. These are usually bound by formal paths, but not dissected by infrastructure.
- Slightly improved biodiversity on the Parkland woodlands. Good for reducing Noisy Miner abundance, which encourages other bird species.
- Maintenance is by mowing grassed areas and by mulching and targeted weeding in shrubby areas.

Highly Modified Grassland (Moderate Biodiversity)

- Usually not irrigated. No infrastructure present.
- Native grasses retained and encouraged through mowing regime.
- Native herbs mostly absent.
- Some non-local overstorey planted.
- Herbaceous weeds common (e.g. *Galenia pubescens*)

Revegetated Shrubby Woodland (Moderate Biodiversity)

- Structural complexity increased through planting of native shrub species. This usually results in a novel vegetation composition.
- Native grasses and related grassland species (when present) decline when over-planted with shrubs.
- Woody weeds controlled.
- Herbaceous and grassy weeds common.
- Maintenance is through the targeted application of herbicides and ongoing infill planting.
- Mostly undeveloped, or have some walking trails (formal and informal)

Partially Developed Area (Low Biodiversity)

- Localised development of irrigated lawns and infrastructure (including play equipment and amenities).
- Includes areas of diverse vegetation, but this is usually composed of introduced species for amenity rather than biodiversity.
- Some native flora found in undeveloped areas without irrigation.

Nature Play (Moderate Biodiversity)

- Infrastructure is extensive, but sensitive to vegetation.
- Users encouraged to actively utilise the planted areas as infrastructure is integrated with remnant and revegetated features.
- Key habitat features such as logs and rocks reintroduced.

Lawns and Playing Fields (Low Biodiversity)

- Irrigated throughout most of footprint.
- Native grassy understorey replaced with lawn or pasture grasses.
- Overstorey almost entirely absent.
- Maintenance is by mowing, fertilising and broad-leaf selective herbicides.

Planted Greenfields (Moderate Biodiversity)

- Structural complexity increased through planting.
- Usually a novel vegetation composition.
- Herbaceous and grassy weeds common.
- Mostly undeveloped, or have some walking trails (formal and informal)

Restored Grassland (Moderate to High Biodiversity)

- Species complexity increased through the establishment of a broad suite of native grasses and herbs.
- Grassy and herbaceous weed abundance reduced.
- Maintenance is by mowing or suitable techniques.

RECOMMENDATIONS

3. Improve native diversity of park vegetation

a) Identify suppressed native shrubs, herbs and grasses in suburban parks and delineate a management zone (i.e. no mowing/spraying) to allow them to grow up.
b) Incorporate planting of patches of local native shrubs, herbs and grasses into suburban parks. These should be integrated into the design of infrastructure features.

4. Habitat enhancement in parks

Install habitat enhancing features in suburban parks such as:

- "Bee hotels"
- Bird boxes
- Possum boxes
- Bat boxes
- Logs
- Bared soil
- Rockeries

Install interpretive material for people to understand the value of these in the suburban landscape and improve adoption of them in private backyards.

5. Grassland restoration along the Gawler East easements

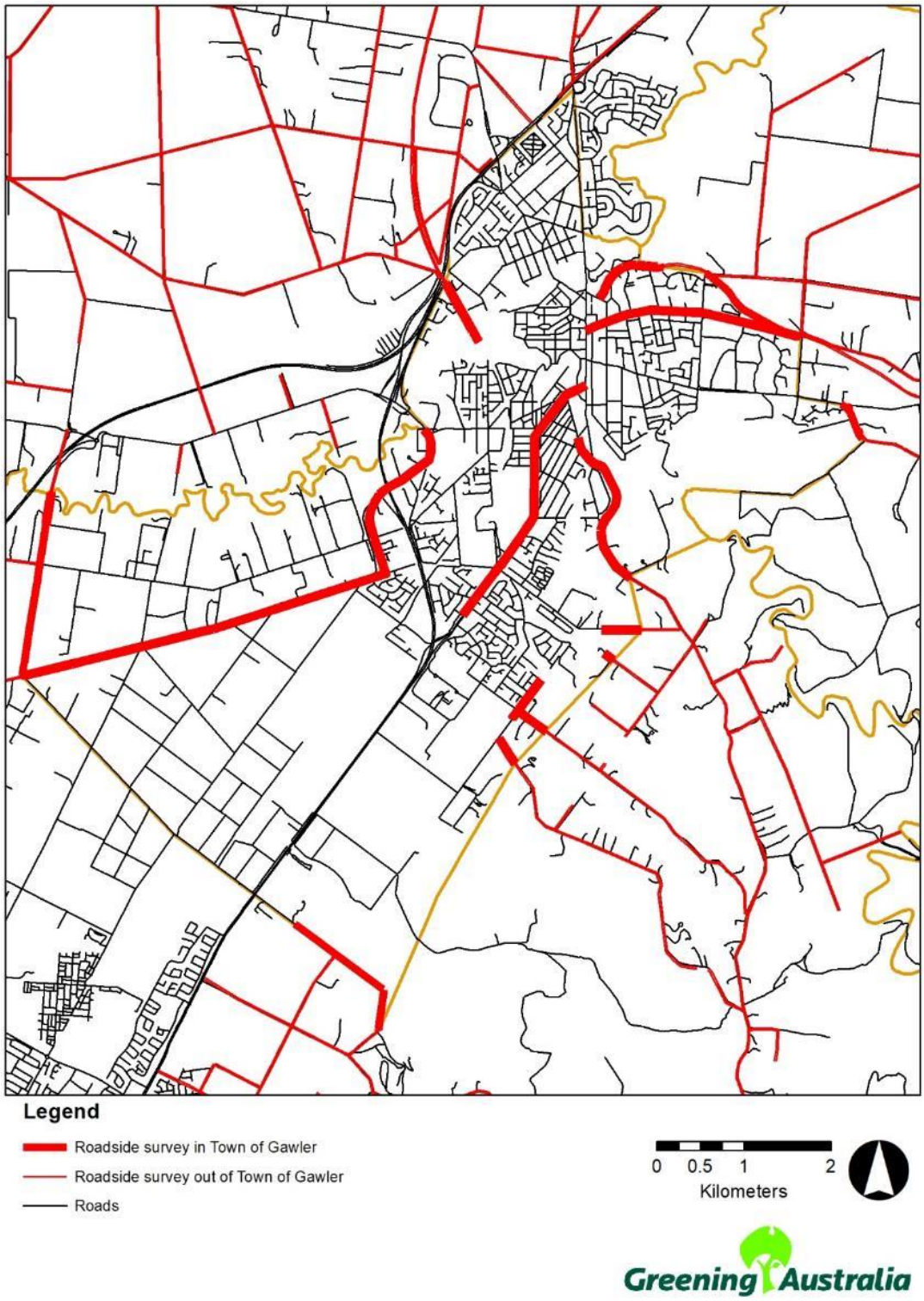
The powerline and pipeline easements in Gawler East are excellent candidates for suburban connectivity grasslands restoration as they are incompatible with other revegetation and other elevated infrastructure and amenity.

1. Discussions with Springwood over the possible development and landscaping in these corridors
2. Scaling up works to implement a viable grassland restoration
    a. Secure seed supply through arrangements with grassland owners or creating a seed production area
    b. Discuss implementation with Seeding Natives or Greening Australia or other suppliers (see "Stakeholders and Potential Partnerships in Biodiversity Management") about methodology and technology limitations
3. Implement grassland restoration projects and maintenance as appropriate
4. Install interpretative signage regarding the value and function of native grasslands in the local environment.

Roadsides

As referred to in the knowledge gaps section above, there has been no previous comprehensive effort to survey the roadsides in the Town of Gawler and the field work for this project surveyed a small portion of the roadsides. Therefore, the condition and biodiversity value of roadsides is largely unquantified and only generalised comments and recommendations can be made.

Map 6: The Coverage of Recorded Roadside (and railway) Surveys

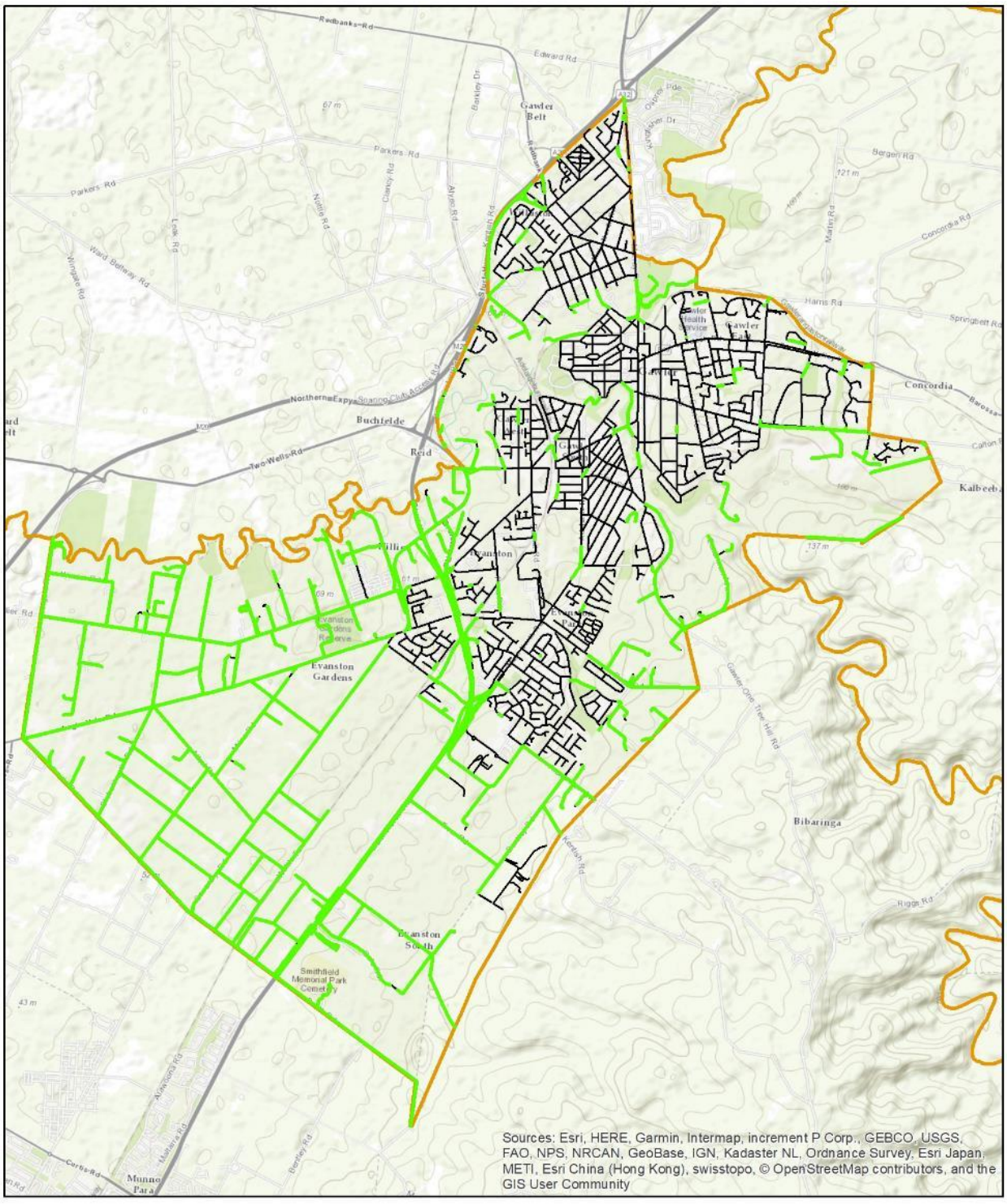


There are approximately 270km of roadsides in the Town of Gawler, the majority of which is maintained by Council, with some managed by the Department of Planning, Transport and Infrastructure and a small portion privately owned and managed. If we assume that on average each roadside supports 10m of open space (5m on each side) then that would equate to 270 hectares of roadside (only slightly less than current other open space). It is estimated that 115km of roadsides are likely to be grassy in nature (peri-urban and rural), with the balance of 155km mostly paved or similar (urban).

The open vistas of roadsides are an important safety feature in maintaining visibility, whilst the green vegetation improves visual amenity, buffers the area from heat effects, allows for water infiltration into the soil profile and supports biodiversity.

Roadsides suffer from a high level of edge effects, which are exacerbated by the fact that roads are constantly traversed by vehicles which can import a broad range of new and potentially invasive weeds, pests and diseases. The linear nature of roadsides tends to facilitate wind and water dispersal of plants and invertebrates along their length. This can be beneficial with respect to desirable plant species, but undesirable for weeds, with Gazania being a prime example.

Map 7: Roadsides with Probable Grassy or Paved Verges



Legend

- Estimated Grassy Roadsides
- Estimated Paved Roadsides

0 0.5 1 2
Kilometers

Greening Australia

Peri-urban and Rural Roadsides

Peri-urban and rural roadsides are broadly defined by the absence of built up areas and the presence of an undeveloped roadside verge. Typical peri-urban and rural roadsides have a buffer from the edge of the seal which is maintained through non-selective herbicide application. Beyond the buffer, verges tend to be grassy in nature, partially because in many places grasslands were the pre-European vegetation community, but also because native grasses, along with Tar-vine (*Boerhavia dominii*), Caustic Spurge (*Euphorbia* sp.) and to a lesser extent Native Sorrell (*Oxalis perennans*) are colonising species which tolerate high exposure and disturbance. Several introduced species are also commonly found in roadsides including Wild Oats (*Avena* spp.), Kikuyu (*Cenchrus clandestinus*), Couch (*Cynodon dactylon*), Gazania (*Gazania linearis*), Rice Millet (*Piptatherum miliaceum*), Scabious (*Scabiosa atropurpurea*), Caltrop (*Tribulus terrestris*) and a variety of mostly non-local tree species. A very small minority of roadsides are currently, or have recently been, cultivated – presumably by adjacent landholders for fire or weed management. Infrastructure in these areas is generally limited to overhead powerlines, buried cables and some unsealed shallow spoon drains at the bottom of the road shoulder. Some of these spoon drains have eroded and have been remediated with rip-rap.

Two significant issues impact on this roadside vegetation; excessive reliance on a herbicide-based maintenance regime and the abundance of woody weeds.

The reliance on foliar applied non-selective herbicide to manage roadsides is having a number of perverse outcomes including:

- Reducing biodiversity

Spray regimes tend to favour herbicide resistant species such as Gazania, short-lived species such as Sow Thistle (*Sonchus oleraceus*) and summer active species such as Caltrop (*Tribulus terrestris*) when spraying is concentrated in winter and spring, which is common Council practice for road verges. Furthermore, once the roadside is disturbed by spraying, the bared soil is often favourable to the establishment of introduced colonising species which can take hold if regular spraying is ceased.

Simplified native assemblages can persist, particularly common broadleaf native species which are winter dormant or semi-dormant species as they can cope with spraying of broadleaf or non-selective herbicides in winter and spring. A notable species is the native Corrugated Sida (*Sida corrugata*) which is rated as Rare in the Adelaide and Mount Lofty Ranges Region, Mount Lofty Ranges Subregion (Gillam and Urban, 2014) and Near Threatened for the St Vincent Subregion (Gillam and Urban, 2008). It is a summer active species which has a deep root system and has survived well along road verges despite not being a recognised colonising species.

- Facilitating herbicide resistance in weeds

The repeated application of herbicides of the same mode of action in the same location is likely to result in an increase in herbicide resistance. Herbicide resistance manifests as the herbicide becoming ineffective, needing to be applied at higher concentrations or needing to be applied more frequently. The result is that control of the weed becomes increasingly expensive to effectively implement.

- Accelerating erosion

Non-selective herbicides remove or significantly reduce all vegetative cover in the location they are applied. The loss of cover results in an increased potential for erosion, particularly water erosion as roadsides tend to be subject to increased water flows as it sheds from the impervious road surface. Several roadsides are seriously affected by gutter erosion which, in many instances, can be attributed to the lack of vegetation cover brought about by the non-selective herbicide regime.

- Increasing the maintenance burden

The use of herbicide is a temporary control method. Once the herbicide application is ceased, then the weed load returns. This necessitates an ongoing maintenance burden ad infinitum to retain the status quo.

Above: A reasonably well managed roadside in the peri-urban and rural areas. Slashed native grasses and a shoulder with minimal sprayed area. This is demonstrative of the impact of herbicide management. The grassy vegetation, which in this instance is connected to a native grassland, would support a moderate level of biodiversity, the sprayed shoulder would support very little.

A more sustainable and cost-effective management solution to the broad scale use of non-selective herbicides is mowing. Mowing generally tends to favour native grasses over the introduced species, but where there is no native seed present to stimulate the native grass establishment the introduced species are dominant.

Many of the roadsides are uneven, either with naturally steep slopes, cuttings or drains, and have obstacles such as signs, stoby poles and other features which are impediments to a simple mowing regime using standard tractor mounted decks. Cost efficiency in mowing is gained when the number of passes is minimised, and the speed of each pass is maximised, as the most significant costs of the maintenance lifetime is the cost of fuel and the cost of labour (setting aside the upfront fixed cost of plant). To this end, machinery which can overcome the complexities of obstacles and terrain and/or reduce the number of passes required and/or the time taken to mow will reduce the operational costs and improve cost efficiency. There are a number of machines which have been developed to overcome these issues and facilitate cost efficient mowing, such as:

- Articulated arms which can alter the angle of the mowing flail, multiple arms can cover variable terrain in a single pass.
- Articulated arms with a pivot which works around posts, reducing the need to swerve around or do a pass on both sides, and enabling forward speed to be maintained.

Above: Flail mower on an articulated arm capable of adjusting deck angle to match terrain (chattanoogatractor.com).

Above: Articulated mower with deck which pivots around roadside posts, improving mowing maintenance efficiency and verge coverage.

Woody weeds are common in many of the rural roadsides. Olives (*Olea europaea*) are particularly common, with occasional Pepper Tree (*Schinus molle*), Boxthorn (*Lycium ferocissimum*), Prickly Pear (*Opuntia* spp.) and Giant Reed (*Arundo donax*). Most of these weeds are declared under the Natural Resources Management Act (2004) and adjoining landholders should be undertaking the control of these. The direct impact of these roadside weeds on biodiversity are relatively minor but they are a source for further spread of the weeds, so control should be undertaken in the context of a broader control strategy to avoid wasting resources. Particularly serious infestations, or deliberate breaches of the NRM Act, where the landholder is unwilling to undertake control efforts, should be managed by NRAMLR with appropriate action, but generally this should be a last resort measure.

Urban Roadsides

Note, where the roadside adjoins a large open space the roadside tends to be more diverse and should be considered as part of that ecosystem (see Suburban Parks and Open Space above).

Suburban roadsides predominantly have a paved verge, on one or both sides. Vegetation, if present, tends to be introduced grass (Couch or Kikuyu) below street trees. In many instances ground layer vegetation is almost completely absent, with the ground either entirely paved, mulched or sprayed out with herbicide (residual or repeated application of foliar applied herbicide) and just street trees present. Street trees are represented by a broad array of species including exotic species, Australian native species and local native species, with a significant proportion being Australian native flowering gums (Eucalyptus spp.). A diversity of tree species in the roadside environment is desirable as it mitigates the risk of catastrophic vegetation loss due to a disease or pest, such as the Elm-leaf Beetle (*Xanthogaleruca luteola*) which has recently decimated street trees in parts of Adelaide. Somewhat surprisingly, native colonising species such as Tar-vine (*Boerhavia dominii*) and Caustic Spurge (*Euphorbia* sp.) persist in most suburban roadsides. In some residential areas, presumably where foot traffic is minimal, front gardens have colonised the public land to the kerb. This usually consists of low shrubs of introduced species or lawns of Kikuyu.

Generally suburban roadsides support very low biodiversity. The trees tend to be medium sized trees which do not bear hollows. Their open structure suits generalist bird species such as Noisy Miners (*Manorina melanocephala*), and the flowering gums favour common parrots and honeyeaters such as Musk Lorikeets (*Glossopsitta concinna*), Rainbow Lorikeets (*Trichoglossus haematodus*), New Holland Honeyeaters (*Phylidonyris novaehollandiae*), Red Wattlebirds (*Anthochaera carunculata*) and Noisy Miners, many of which aggressively compete with other bird species. The trees with loose bark are likely to support Marbled Geckos (*Christinus marmoratus*) and Speckled Wall Skinks (*Cryptoblepharus pannosus*).

Because the ground layer is largely lacking in vegetation the ground dwelling fauna is equally simplified. Birds feeding on the ground tend to be generalists such as Australian Magpies (*Gymnorhina tibicen*) and introduced Feral Pigeons (*Columba livia*), Spotted Doves (*Spilopelia chinensis*) and House Sparrows (*Passer domesticus*). Native reptiles such as Bluetongues (*Tiliqua scincoides*), Shinglebacks (*Tiliqua rugosa*) and Garden Skinks (*Lampropholis guichenoti*) are occasional residents and frequent visitors to roadsides. Invertebrates are likely to be diverse but simplified from more complex ecosystems. Insects that persist in grasses such as Blue Butterflies (*Lycaenidae* spp.), Crickets (*Grylloidea*), Meat Ants (*Iridomyrmex purpureus*) and some moths such as the Crow Moth (*Cruria donowani*) are still common where some vegetation is retained. It is worth noting that the bare soil of roadsides does provide a habitat niche which may not be present in the adjacent parks and gardens. Funnel-web and Trapdoor spiders (*Mygalomorphae*) and native bees such as the Blue-banded Bees (*Amegilla chlorocyanea*) are probably common in bare soils which have not been too severely compacted.

If the trend for subdivision, smaller blocks and urban infill continues, the pressure on open space to provide ecosystem services and mitigation of urban heat island effects will increase. Whilst parks and open space may perform some of these functions, they have limited distribution. Roadsides however are distributed throughout the Council area and the surface is generally underutilised as a biodiversity resource. There is scope to significantly improve the contribution of these roadside areas.

Above: A native Spear-grass grassland along suburban Cheek Avenue, Gawler East. Large areas of native grass on roadsides such as this are uncommon in the suburban area. Note the Gazania in the foreground which dominates the sprayed strip.

Above: A suburban roadside which appears to have been treated with residual herbicide. The only vegetation which is present is Gazania (*Gazania linearis*). Although bare soil can be a useful habitat feature, excessively large areas are undesirable for exacerbating heat and erosion issues.

RECOMMENDATIONS

6. Roadside vegetation survey

Conduct a roadside survey of vegetation types, conservation value and specific management requirements. This need not be as per the standard roadside survey methodology but should be a practical inventory to precede, and better inform, the delivery of the below recommendations.

7. Roadside mowing maintenance regime

Mowing of rural roadsides should replace herbicide management practices wherever practicably possible. Mowing/slashing should retain a good cover of vegetation above ground level and avoid disturbing the soil.

- Investigate / Trial suitable machines capable of variable terrain / angles / obstacles.
- Trial suitable regimes (timing, frequency, target species).
- Supplement with targeted control of persistent weeds and seeding of desirable native species

8. Targeted roadside woody weed control

Targeted woody weed control along rural roadsides (to be considered in context of broader weed control strategy).

9. Diversify street trees

Maintain a diversity of street trees, whilst reducing the emphasis on 'flowering gums' in new or replacement street trees. Explore the feasibility of increasing the number of local and other native tree and large shrub species which meet infrastructure compatibility criteria.

10. Suburban roadside regreening

Increase the structural complexity of vegetation on the verges of suburban roadsides. This should include clearly delineated patches of highly diverse local native grassy and herbaceous species, as well as a broader move away from large areas devoid of vegetation in favour of increasing native grass cover. Other habitat features should also be incorporated where feasible such as logs and rocks.

Mulch as an Alternative to Maintaining Grasses

The broadscale use of mulch (chipped vegetative material; usually coarse twigs and leaf matter or sometimes shredded wood. Commercial landscaping grade mulch can also be made of recycled timber) is used in some situations to suppress vegetation. This is achieved by smothering plants in a layer of at least 10cm of mulch, which prevents extant and emerging plants from accessing light and exhausts their energy stores before they can grow through it. This is very effective, but has a limited lifespan, usually 12 to 24 months, before it requires replenishing. As the mulch breaks down it converts the coarse material into fine material which becomes available nutrients, effectively fertilising the soil, which has a knock-on effect of favouring plants which are high nutrient adapted – mainly weeds, are disadvantaging many native grass species. This cycle of short-term suppression, long-term promotion of weeds is not dissimilar to the cycle associated with the application of herbicides. Other potential downsides include the introduction and spread of pathogens and weeds and the high cost of installation and replenishment. Mulch does have a niche application in supressing weeds around plantings, or in small areas which cannot sustain desirable vegetation cover, it generally is not a cost-effective alternative to maintaining a grassy cover through slashing.

Current Habitat Viability

The inherent viability of ecosystems in their current state can be expressed by considering the main factors which allow them to function; Connectivity, Condition and Size.

Connectivity refers to the current extent and effectiveness of the connections between patches of this ecosystem and other patches.

Condition refers to the diversity of flora and fauna currently present in the ecosystem relative to estimated pre-European diversity.

Size refers to the total area of the ecosystem relative to the estimated total area prior to European settlement.

Scores for each component was made based on assessment of each habitat type during the field work phase, recent records and input from the Gawler Urban Rivers Working Group. These measurements necessitate a level of approximation and averaging across an array of variable patches.

The aim of the table is to highlight, all else being equal, which ecosystem is currently most at risk of decline and what the likely drivers of decline are. This allows targeted action to be undertaken to better address important issues. Inversely, it also highlights the ecosystems which are most robust and likely to be able to better withstand impacting threats such as weeds, pests and climate change.

Habitat Type	Connectivity	Condition	Size	Current Viability
Plains Grasslands	Fair	Poor	Fair	Fair
Hills Grasslands	Good	Fair	Fair	Fair
Native Pine	Poor	Fair	Poor	Poor
River Box	Fair	Poor	Poor	Poor
Mallee	N/A			
Mallee Box	Good	Fair	Very Good	Good
Sea Rush Sedgeland	Very Good	Very Good	Very Good	Very Good
Bul-rush and Common Reed Sedgeland	Very Good	Very Good	Very Good	Very Good
Red Gum Woodland	Very Good	Fair	Very Good	Good
Permanent Pools	Very Good	Fair	Very Good	Good
Roadside Vegetation	Fair	Poor	N/A	Poor

Biodiversity Assets of the Town of Gawler

A photographic tour of some of the important biodiversity and habitat features of the Town of Gawler

The broader habitat types have been defined above but there are a number of important specific habitat features and species contained within those habitat types which are worth highlighting for their importance, rarity or cultural significance.

Habitat Features

Steep riparian cliffs and bare ground are important resources for a range of bird species including Fairy Martins (*Petrochelidon ariel*) (Right), Rainbow Bee-eaters (*Merops ornatus*) (Below) and Peregrine Falcons (*Falco peregrinus*).

These features are most common along the riparian systems.

Rocky cliffs and caves including man-made features are important habitat for birds, reptiles and possibly bats.

Above: Old quarry feature in the creek line in Springwood.

Below: A natural cliff and cave system on the South Para River

Springs, soaks and seeps (all effectively groundwater derived) are important hydrological features which maintain a number of water dependent ecosystems. In the picture below, the moisture seeping from the otherwise dry rocky river bank supports a water dependent Club-rush (*Isolepis cernua*) which would otherwise not survive at this location.

Large trees, including “significant trees” and “regulated trees” but also any other large, hollow bearing trees provide a wide range of niche habitats and support an extensive food web.

Above: A very large old Red Gum with many hollows near the creek line in Springwood. A Brown Treecreeper (barely visible at end of arrow) is ascending this tree.

Below: A very large Red Gum in a reserve beside Sunnyside Drive.

Urban green space can be just as important as remnant areas for maintaining functional ecosystems in a developed area like the Town of Gawler. Compatible landscaping can value add to conservation outcomes in adjacent areas.

Above: A combination of local and introduced plant species used in a playground at Clonlea Park

Below: A shared use track and rest stop with local native revegetation off Potts Road, Evanston Park.

Flora

Several species of riparian specialist flora have a very limited distribution within the Town of Gawler. The four species pictured below are only recorded on the South Para River, and only recorded once each in the Town of Gawler.

Above Left: Water Ribbons (*Triglochin procerum*)

Above Right: Common Spike-rush (*Eleocharis acuta*)

Below Left: Whorled Pennywort (*Hydrocotyle verticillate*)

Below Right: Swamp Pennywort (*Centella cordiflora*)

A number of dryland species of note include Lemon Beauty-heads (*Calocephalus citreus*) (top right) which is only known from a population of about 6 plants in the Gawler Buffer East. Yellow Tails (*Ptilotus nobilis*) (bottom right) is found in only three locations on private land off West Down Road, Evanston Park, Eckerman Avenue, Gawler South and Gawler East rail corridor. Tall Scurf Pea (*Cullen australasicum*) is a moderately common species which tends to only occur in locations with recent soil disturbance near creeks and rivers.

Birds

Birds can be broadly grouped into six categores in the Town of Gawler:

1. Woodland Specialists - prefer taller canopies with varying densities of shrubs and grasses below. E.g. Tree Creepers, Grey Shrike Thrush, Striated Pardalote, Kookaburra
2. Shubland Specialists - prefer low canopies, usually dense to mid dense. E.g. Singing Honeyeater, White Fronted Chat.
3. Grassland Specialists - prefer grassland habitat with little to no over storey and shrubs. E.g. Quails, Australian Pipit, Nankeen Kestrel, Black Shouldered Kite.
4. Weltand Specialists – prefer wetlands and water bodies. E.g. Reed Warbler, Ducks, Herons, Cormorants.
5. Urban Specialists – do well in built up environments. E.g. Feral Pigeons, Sparrows.
6. Generalists – no specific preferences. Equally found in all vegetation types. E.g. Australian Magpie, Raven, Rosella, Crested Pigeon, Corella.

Diversity of birds relies on a diversity of habitats. It is worthwhile keeping this in mind when considering the objectives of restoration projects – i.e. designing the work with a particular outcome for a particular category.

A small group of four Crested Shrike-tits (*Falcunculus frontatus*) (below right) were observed in the Gawler River corridor. This species is a woodland specialist more commonly associated with areas higher up the ranges and was only observed once during the surveys. Rated as Rare in South Australia, but Endangered and declining for the Gawler area (Gillam and Urban, 2014).

Australian Pipit (*Anthus australis*) (below left) is a grassland specialist bird which was commonly observed around Gawler Buffer East, which is not unexpected, but also turned up in the centre of the Gawler Racecourse. Rated as Rare and declining in the Gawler Area (Gillam and Urban, 2014). About 20 Brown Quail (*Coturnix ypsilophora*) (below centre, courtesy Adrian Shackley) also inhabit Gawler Buffer East. Rated as Vulnerable in South Australia, and Rare and declining for the Gawler area (Gillam and Urban, 2014).

A number of other noteworthy birds not captured on carmera include:

- Stubble Quails, another grassland specialist only observed in the grassland of Gawler Buffer
- Peregrine Falcon, only recorded once
- Barn Owl, only recorded once
- Horsefield’s Bronze Cuckoo, only recorded once
- Sacred Kingfisher, recorded several times in urban parts of the Gawler River.

Insects

There is a relative paucity of robust information regarding insects in the Town of Gawler. This was not a major focus for surveying but those records which were collected highlight that there was significant diversity within and between sites including some specialist species. A selection of interesting species has been included below.

Above Left: Grass Blue (*Zizena labradus*) is commonly sighted in the Town of Gawler. One of its caterpillar host foods is Tall Scurf Pea (*Cullen australasicum*) photographed above.

Above Centre: Southern Dart (*Ocybadistes walkeri*) was observed on a few occasions. Its caterpillars feed on native and introduced grasses which are commonly available throughout the Town of Gawler including the urban areas.

Above Right: Caper White (*Belenois java teutonia*) was commonly sighted throughout the Town of Gawler and was particularly abundant in the Willaston Cemetery. This butterfly is a seasonal migrant to southern Australia, its caterpillars feed on Native Oranges (*Capparis mitchellii*) which do not naturally occur in the Town of Gawler.

Above Left: The Crow Moth (*Cruria donowani*) is very common throughout the Town of Gawler. Its caterpillars feed only on the native Tar Vine, which is an often-overlooked low growing herb which is found in almost any location where native vegetation grows.

Above Centre: Paper Wasps (*Polistes* sp.) are social wasps which attach their many celled nests equally in native vegetation or urban infrastructure. The pictured wasp is just starting the nest (attached to a Red Gum) and so is probably the queen.

Above Right: A Braconid Wasp (*Braconidae*) which is a parasite of other invertebrates.


Above Left: A native Bee (possibly a Halictid Bee (*Lasioglossum lanarium*).

Above Right: Native bees are predominantly solitary, but males can aggregate in swarms as pictured.


Above Left: A native termite (probably *Nasutitermes exitiosus*) which build recognisable rounded earthen mounds. A single mound was found during the surveys, in a suburban park on Palamountain Road, Evanston Park.

Above Right: The beautiful Austral Ellipsidion Cockroach (*Ellipsidion australe*) with intricate and vibrant patterning is a striking sight in the bush. Only one was found, but they are probably more common. They do not infest houses like their introduced relatives.


Above Left and Right: An adult Ant Lion (*Myrmeleontida* sp.) and the distinctive conical traps of its larvae. These insects were commonly found in a range of grassy ecosystems across the Town of Gawler including urban parks.

At least three species in three different genera of Ladybird were observed.

Above Left: Common Spotted Ladybird (*Harmonia* conformis) with recognisable orange and yellow markings.

Above Right: A ladybird (*Micraspis furcifera*) distinctive because it is yellow and striped as opposed to the more common orange spotted types.

Above Left: An unidentified Damselfly. These animals rely on water for their early stage but can be found long distances from water once they take to the wing.

Above Centre: An unidentified Ichneumon Wasp. These wasps parasitise other insects.

Above Right: Two Potter Wasps (*Abispa* sp.) resting on Wild Oats.

Reptiles and Allies

Unfortunately, few reptiles were captured well on camera due to their generally cryptic nature. Reptile assemblages are variable depending mainly on vegetation structure and the presence of critical habitat components such as rock ledges and preferred prey species. For example, Red-bellied Black Snakes (*Pseudechis porphyriacus*) tend to be found along watercourses where they can eat their preferred diet of frogs.

Below: As far as urban biodiversity goes few animals, and probably no reptiles, are as well liked as Bluetongues (*Tiliqua scincoides*). They suffer from a range of pressures including predation, road kill and snail baiting, but persist in the urban environment.

Below Left: This Long-necked Tortoise (*Chelodina longicollis*) was found just outside the Town of Gawler, on the South Para River in Para Woodland.

Below Right: A Speckled Wall Skink (*Cryptoblepharus pannosus*) inside the trunk of hollow Mallee Box tree. They also frequent building walls in urban areas.

Fish

Below: No targeted searches for fish were undertaken during the field work, however the chance recovery of a submerged Yabbie net on the North Para River recovered a Congolli (*Pseudaphritis urvillii*), which was persisting in a small pool.

A wide array of native fish has previously been recorded for the North Para, South Para and Gawler Rivers. Their survival requires good water quality, healthy riparian habitat (structure and prey availability), regular flows, and in some cases connectivity of these flows to the coast.

Climate Change Considerations

Climate Change in the Global Context

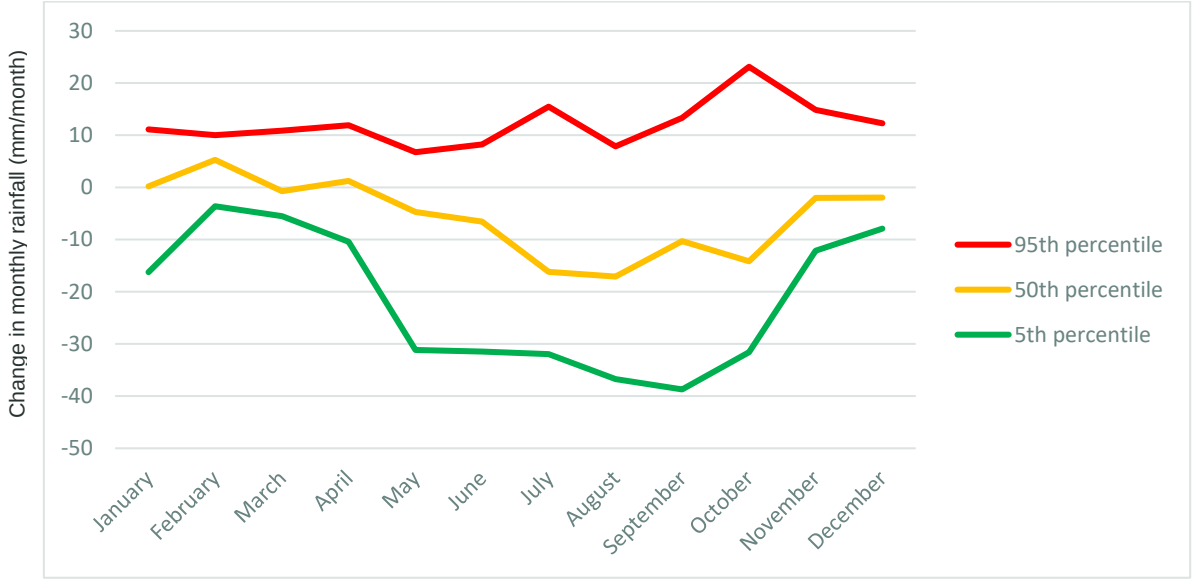
Australia's climate has warmed by just over 1°C since 1910 (CSIRO & BOM, 2018). The latest report from the Intergovernmental Panel on Climate Change (IPCC) states with high confidence that human activities have caused approximately 1.0°C of global warming above pre-industrial levels and is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (IPCC, 2018). Estimates of the global emissions of current international mitigation ambitions under the Paris Agreement will not limit global warming to 1.5°C (IPCC, 2018). It is important to note that the 'global warming' figure of 1.5°C includes warming over water which warms slower than land. On land, extreme hot days in mid-latitudes warm by up to about 3°C at global warming of 1.5°C and about 4°C at 2°C. Future climate-related risks depend on the rate, peak and duration of warming (IPCC, 2018).

As global warming increases, species loss and extinction are likely to increase. Of 105,000 species studied by the IPCC, 6% of insects, 8% of plants and 4% of vertebrates are projected to lose over half of their climatically determined geographic range for global warming of 1.5°C. Impacts from other biodiversity-related risks such as forest fires and the spread of invasive species also increases with global warming (IPCC, 2018). Southern Australia is already experiencing significant decreases in rainfall, increases in extreme heat events and increases in extreme fire weather. This trend is projected to continue, with further increase to temperatures, with more hot days, decreased rainfall and more time in drought, accompanied by an increase in heavy rainfall events (CSIRO & BOM, 2018).

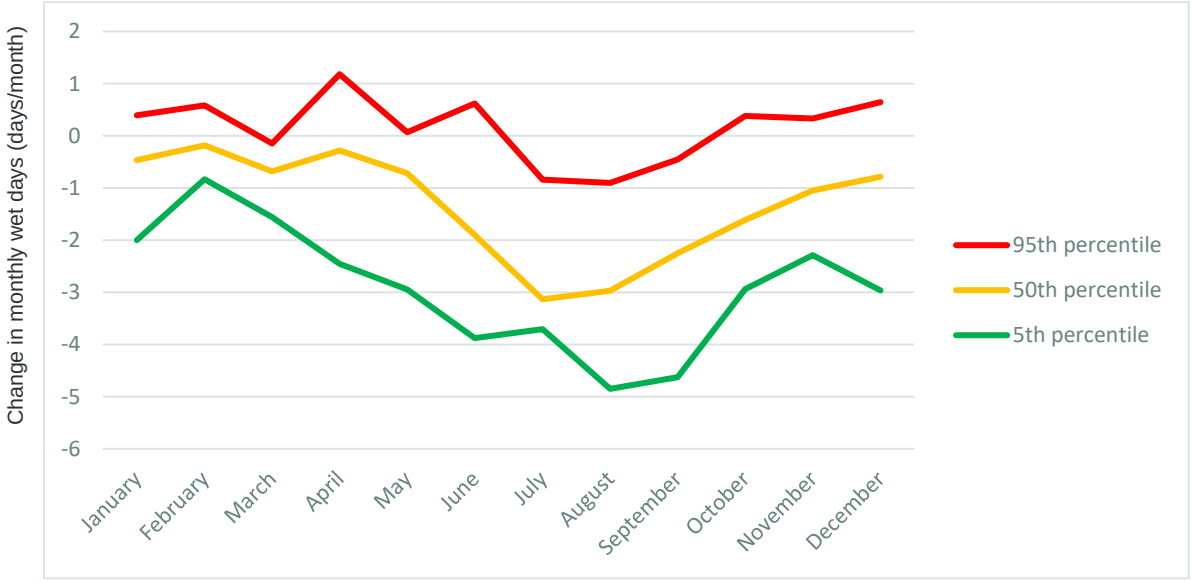
Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth increase with global warming of 1.5°C and increase further with 2°C. Populations at disproportionately higher risk of adverse consequences with global warming of 1.5°C and beyond include disadvantaged and vulnerable populations, some indigenous peoples, and local communities dependent on agricultural or coastal livelihoods. Any increase in global warming will affect human health, with primarily negative consequences. Lower risks are projected at 1.5°C than at 2°C for heat-related morbidity and mortality. Urban heat islands often amplify the impacts of heatwaves in cities (IPCC, 2018).

Changing Climate

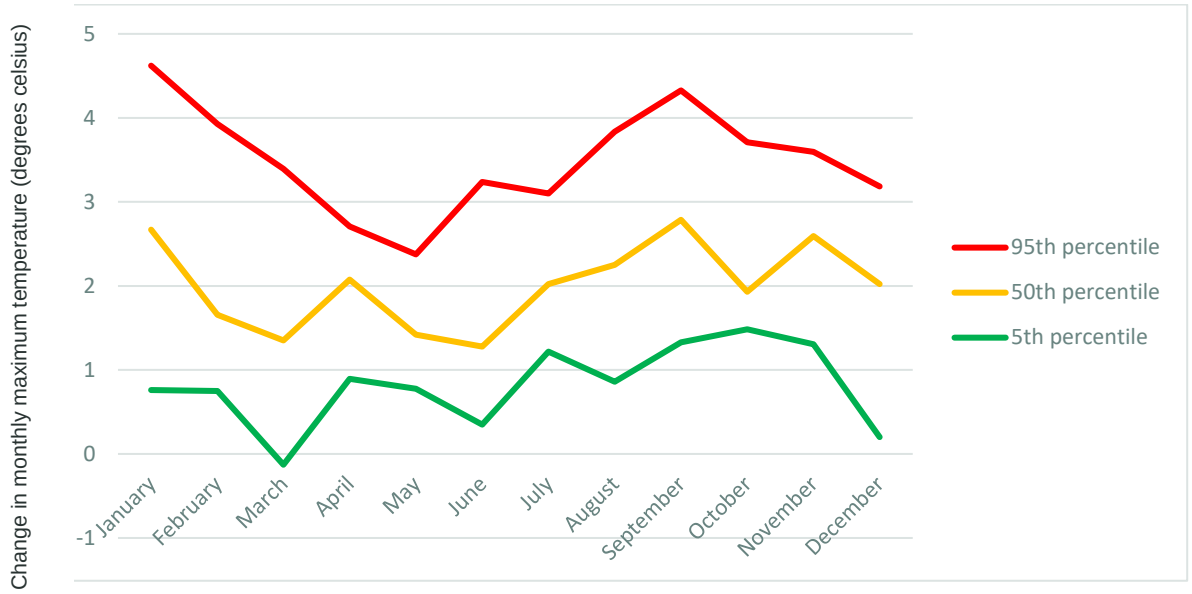
Australia's climate is changing. Modelling is not at a scale fine enough to know what will happen in the Town of Gawler, but some modelling for the surrounding area presents a number of significant changes. See Appendix 6 for the modelling area and modelling details of the following charts. Modelling is derived from General Circulation Model: ©IPCC 2007: WG1-AR4: 1st Runs, A2 (high greenhouse gas concentration - CO_2) and is related to the baseline period 1961-1990.



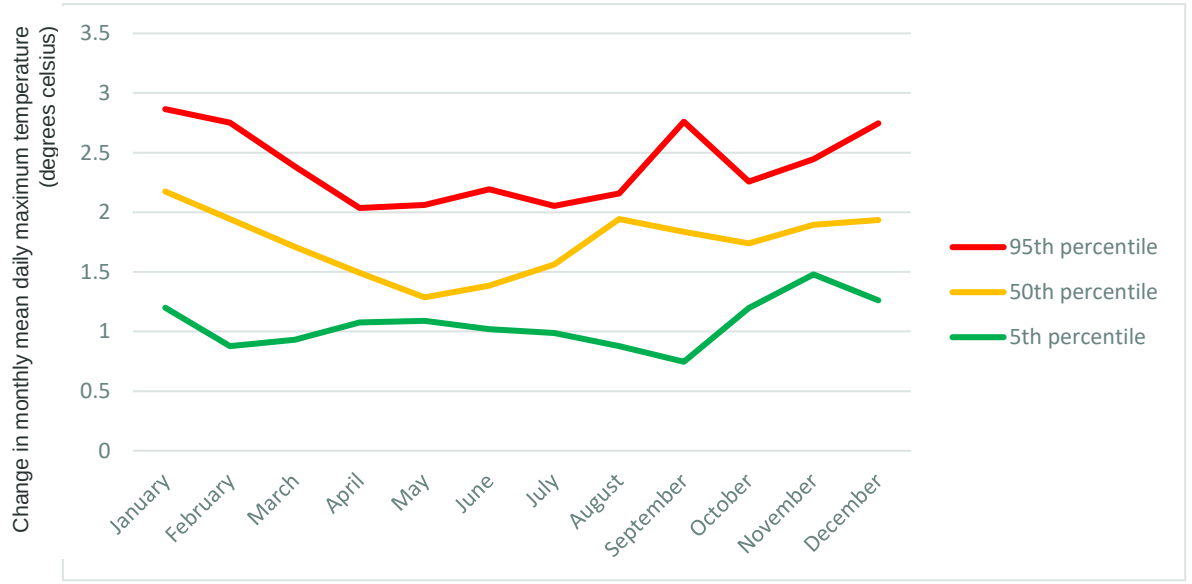
Above: Modelled change in monthly rainfall for the period 2046-2065. Rainfall is likely to decrease for May-October and remain relatively unchanged in other months.



Above: Modelled change in wet days (with precipitation > 0.2mm/day) per month for the period 2046-2065. The number of wet days is likely to reduce significantly for the June – October period.



Above: Modelled change in maximum temperature (ºC) for each month. Hottest days (extreme events) are likely to get hotter.

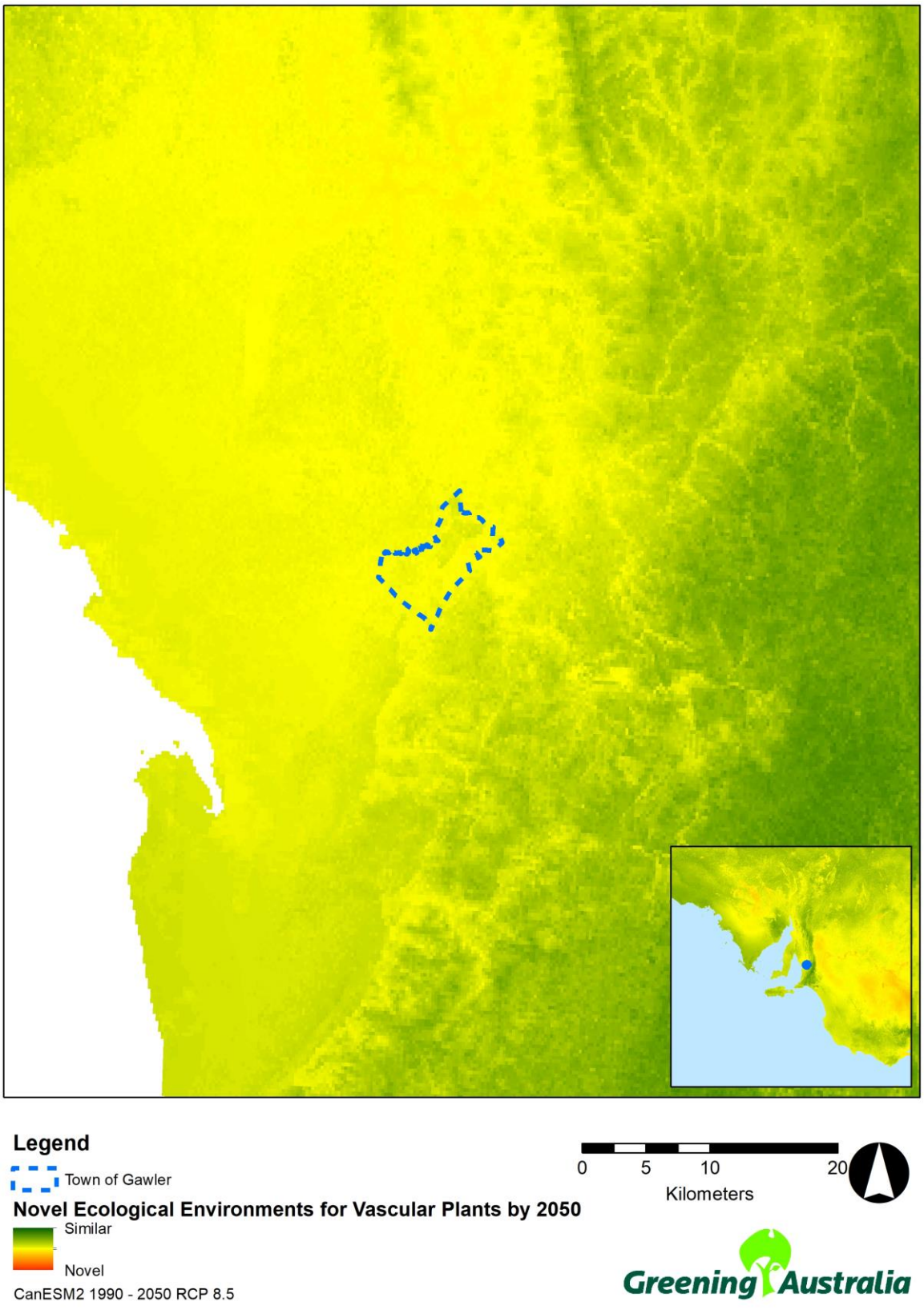


Above: Modelled change in monthly mean of daily maximum temperatures (ºC). Daily maximums are likely to get hotter on average.

It is likely that average temperatures will increase, rainfall in winter and spring will be reduced and evaporation rates increase, drying the environment and increasing fire risk. And extreme events are likely to increase; there is likely to be more heat waves, more droughts and more heavy rain events than previously. All of these factors are crucial factors in habitat preferences for biota and there is increasing evidence that this is already impacting on biodiversity (Rogers and West, 2016). It is therefore imperative that conservation management consider the potential implications of climate change when undertaking long term biodiversity planning.

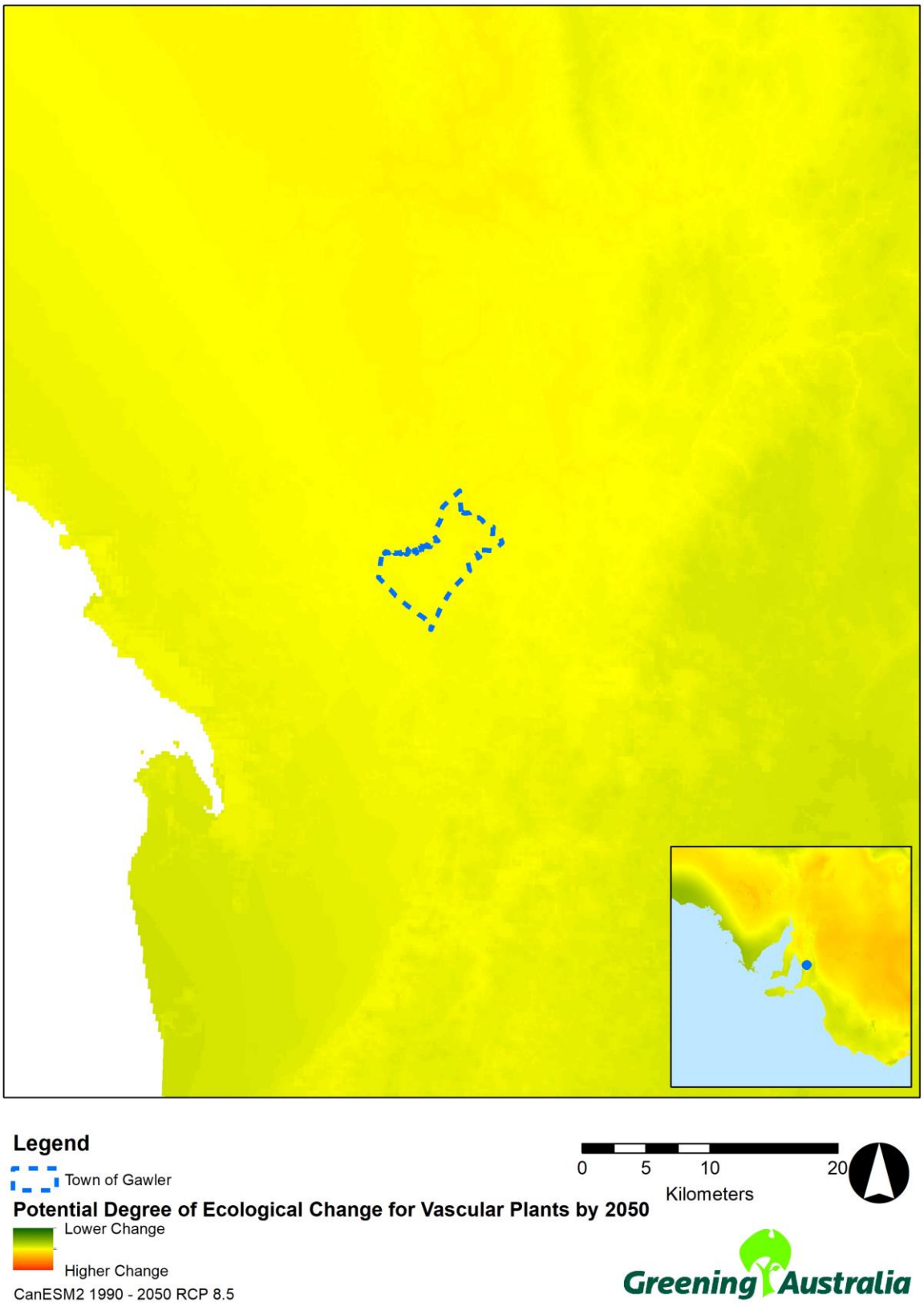
The CSIRO produced some excellent modelling (Harwood, 2014) which visualises what climate change means for vascular plants, mammals, reptiles and amphibians.

Map 8: Novel Ecological Environments for Vascular Plants by 2050



Novel ecological environments (Harwood, 2014) show how unique the future assemblage may be, the more 'novel' the less similar that group may be to anything which exists in Australia today. The Town of Gawler tends towards the similar to intermediate part of the spectrum.

Map 9: Potential Degree of Change of Vascular Plants by 2050



The potential degree of ecological change (Harwood, 2014) shows where future species compositions may be different to present compositions. The Town of Gawler tends towards a moderate level of change relative to today.

Mitigation vs. Adaptation

Climate change can be addressed, broadly, in two main ways;

1. **Mitigation** addresses the root cause of climate change, i.e. greenhouse gas concentrations. It includes strategies such as reducing emissions and increasing sequestration.
2. **Adaptation**, also called resilience, addresses the environment's ability to cope with the impacts of climate change.

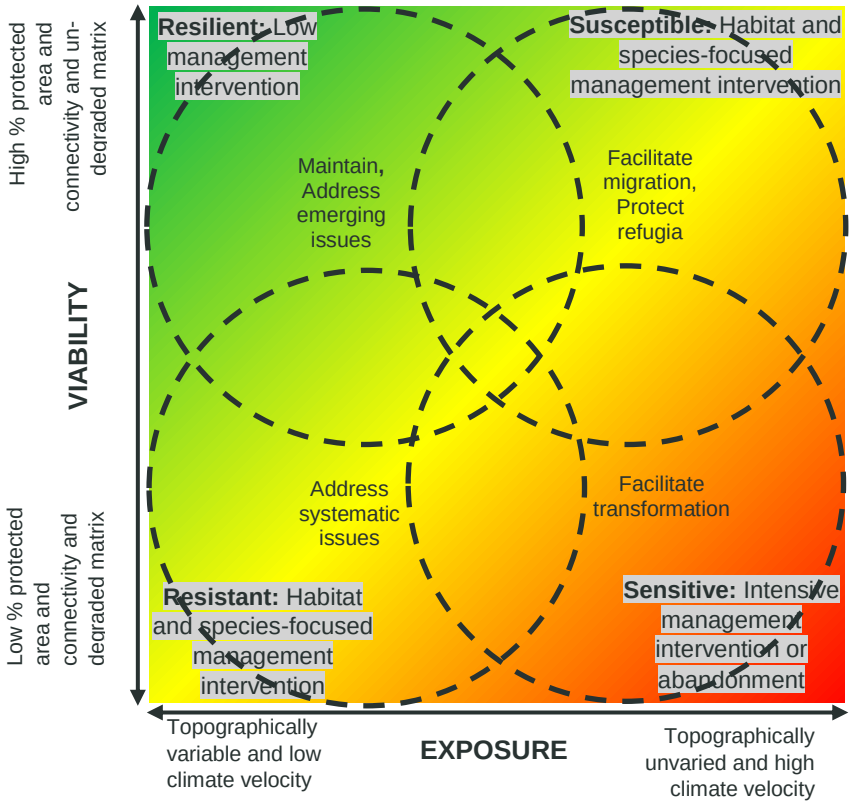
The two strategies are complementary, but only the latter is considered in this plan as it has direct implications for biodiversity management strategies in the Town of Gawler in the short to medium term which this plan covers. The implications of climate adaptation have been factored into the recommendation and prioritisation of all relevant strategies in this report.

The Impacts to Biodiversity Assets and Improving Resilience

Climate change will not impact biodiversity assets homogenously, but is likely to impact them in a different way depending on two key factors:

1) The current viability of the asset – i.e. its condition, size and connectivity.
2) The exposure of the asset to climate change.

The position on each spectrum can be plotted on a chart to provide insight into which management strategies may be best pursued for that asset.



'Resilient' systems have a low exposure to future climate change and are currently in good condition. This makes 'Resilient' systems more robust and less likely significantly decline than other systems. Management of these systems should largely involve passive adaptation, i.e. maintaining areas that

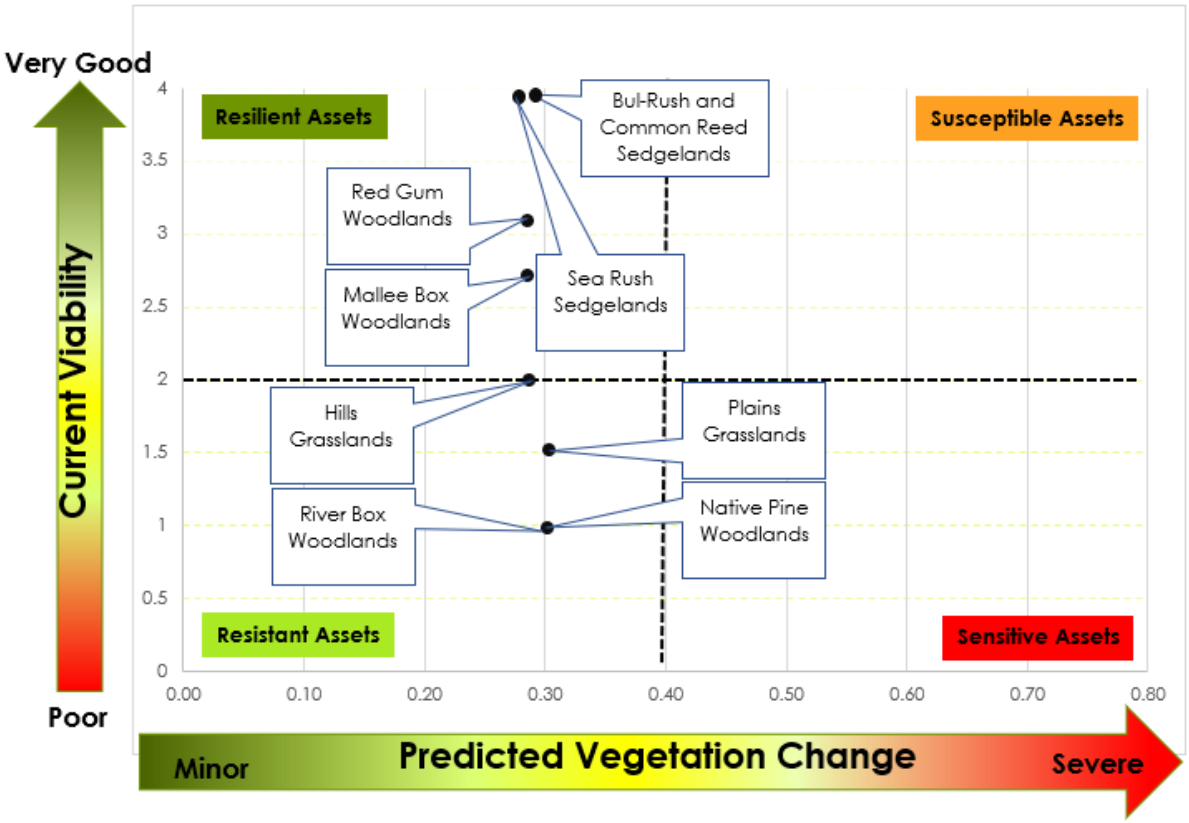
currently support native biodiversity; ensuring that a diversity of functional environments are represented in the landscape; and addressing existing stressors.

'Resistant' systems have a low exposure to future climate change but are currently in poor condition. This makes 'Resistant' systems likely to decline, but not due to climate change issues, but more likely due to traditional threats such as weeds and pests. Management of these systems should largely involve active adaptation, i.e. restoring habitats and ecological processes; identifying and protecting climate refugia; identifying the key drivers that are placing these systems at risk and implement active management to address the impacts of these drivers.

'Susceptible' systems have a high exposure to future climate change but are currently in good condition. This makes 'Susceptible' systems likely to decline due to climate change impacts. Management of these systems should largely involve active adaptation, as above, but with a particular emphasis on protecting climate refugia and facilitating new species to enter the system to maintain function.

'Sensitive' systems have a high exposure to future climate change and are currently in poor condition. This makes 'Sensitive' systems likely to decline due to traditional threats and climate change. Management of these systems should largely involve transformation, i.e. species translocation and habitat intervention to maintain important species in-situ.

Using a synthesis of the work of Harwood (2014) (see maps 8 & 9), Rogers and West (2016), Koch (2017) and the extensive field work undertaken for this report the following chart has been developed to conceptualise the relative positions of the remnant vegetation biodiversity assets.



This would suggest that Bul Rush and Common Reed Sedgelands, Sea Rush Sedgelands, Red Gum Woodlands and Mallee Box Woodlands focus on a strategy of maintaining their viability by addressing existing biodiversity issues, i.e. Passive Adaptation.

The strategy for River Box Woodlands, Native Pine Woodlands and Plains Grasslands would be to actively facilitate climate adaptation through habitat restoration and restoring ecological processes to address key threats which will be exacerbated by climate change.

The Hills Grassland sits right on the margin of the two strategies, reflecting their position in the hills face, with some fragmentation and urbanisation, but with strong links into the intact and elevated hills. The strategy should be tailored to the resilience of the individual patches and therefore broadly include both strategies.

It is important to note that no matter where the community, or vegetation patch, sits on the continuums, basic principles of biodiversity management, i.e. reducing threats, are important to maintain or improve the biodiversity and function of that asset, and this will improve its inherent viability and therefore resilience to a changing climate. Given the assets tend to the minor predicted change (left) side of the climate change species turnover these principles are the core driver for management recommendations.

Matters of National Environmental Significance

The following information has been derived from the EPBC Act Protected Matters Search Tool (http://www.environment.gov.au/epbc/pmst/index.html). This tool uses modelling to determine potential occurrences of species protected under the federal Environmental Protection and Biodiversity Conservation Act (1999). The modelling tends to over generalise, and the comments field is added to provide more accurate information on the likelihood of the taxa occurring in the Town of Gawler council region.

Threatened Ecological Communities

Name	Status (EPBC Act)	Type of Presence	Comments
Iron-grass Natural Temperate Grassland of South Australia	Critically Endangered	Community likely to occur within area	Confirmed in Council area.
Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia	Critically Endangered	Community likely to occur within area	Does not occur in Council area.

Birds

Name	Status (EPBC Act)	Type of Presence	Comments
Common Sandpiper, *Actitis hypoleucos*	Marine	Species or species habitat may occur within area	Migrant. May occur but not resident.
Fork-tailed Swift, *Apus pacificus*	Marine	Species or species habitat likely to occur within area	Migrant. May occur but not resident.
Great Egret, *Ardea alba*	Marine	Species or species habitat known to occur within area	Likely to occur in Council region.
Cattle Egret, *Ardea ibis*	Marine	Species or species habitat may occur within area	Possibly occurs in Council region.
Australasian Bittern, *Botaurus poiciloptilus*	Endangered	Species or species habitat likely to occur within area	Possibly occurs in Council region.
Sharp-tailed Sandpiper, *Calidris acuminata*	Marine	Species or species habitat may occur within area	Migrant. May occur but not resident.
Curlew Sandpiper, *Calidris ferruginea*	Marine, Critically Endangered	Species or species habitat may occur within area	Migrant. May occur but not resident.
Mt Lofty Ranges Spotted Quail-thrush, *Cinclosoma punctatum anachoreta*	Critically Endangered	Species or species habitat may occur within area	Probably locally extinct.
Latham's Snipe, *Gallinago hardwickii*	Marine	Species or species habitat may occur within area	Migrant. Not resident.

Name	Status (EPBC Act)	Type of Presence	Comments
Painted Honeyeater, *Grantiella picta*	Vulnerable	Species or species habitat may occur within area	Very unlikely. Well outside current distribution.
White-bellied Sea-Eagle, *Haliaeetus leucogaster*	Marine	Species or species habitat likely to occur within area	Very unlikely to occur in Council area.
Malleefowl, *Leipoa ocellata*	Vulnerable	Species or species habitat may occur within area	Does not currently occur in Council area.
Rainbow Bee-eater, *Merops ornatus*	Marine	Species or species habitat may occur within area	Confirmed in Council area.
Grey Wagtail, *Motacilla cinerea*	Marine	Species or species habitat may occur within area	Rare vagrant. Very unlikely to occur.
Yellow Wagtail, *Motacilla flava*	Marine	Species or species habitat may occur within area	Rare migrant. Very unlikely to occur.
Satin Flycatcher, *Myiagra cyanoleuca*	Marine	Species or species habitat may occur within area	Very unlikely. Well outside current distribution.
Eastern Curlew, *Numenius madagascariensis*	Marine, Critically Endangered	Species or species habitat may occur within area	Migrant. Unlikely to occur in Council area.
Osprey, *Pandion haliaetus*	Marine, Threatened	Species or species habitat may occur within area	Very unlikely to occur in Council region.
Plains-wanderer, *Pedionomus torquatus*	Critically Endangered	Species or species habitat may occur within area	Unlikely to occur in Council area.
Australian Painted Snipe, *Rostratula australis*	Endangered	Species or species habitat may occur within area	Unlikely to occur in Council area.
Common Greenshank, *Tringa nebularia*	Marine, Threatened	Species or species habitat likely to occur within area	Migrant. May occur but not resident.
Bassian Thrush, *Zoothera lanulata halmaturina*	Vulnerable	Species or species habitat may occur within area	Very unlikely. Occurs in suitable habitat east of Council area.

Mammals

Name	Status (EPBC Act)	Type of Presence	Comments
Southern Brown Bandicoot, *Isoodon obesulus obesulus*	Endangered	Species or species habitat may occur within area	Unlikely to currently occur but is found nearby.
Grey-headed Flying-fox, *Pteropus poliocephalus*	Vulnerable	Foraging, feeding or related behaviour likely	Vagrant. May occur but not resident.

Plants

Name	Status (EPBC Act)	Type of Presence	Comments
White-beauty Spider-orchid, *Caladenia argocalla*	Endangered	Species or species habitat may occur within area	Does not currently occur but is found nearby.
Greencomb Spider-orchid, *Caladenia tensa*	Endangered	Species or species habitat may occur within area	Does not currently occur.
White Rabbits, *Caladenia xantholeuca*	Endangered	Species or species habitat may occur within area	Does not currently occur.
Silver Daisy-bush, *Olearia pannosa* ssp. *pannosa*	Vulnerable	Species or species habitat may occur within area	Does not currently occur but is found nearby.
Pale Leek-orchid, *Prasophyllum pallidum*	Vulnerable	Species or species habitat may occur within area	Does not currently occur but is found nearby.
Plum Leek-orchid, *Prasophyllum pruinosum*	Endangered	Species or species habitat may occur within area	Does not currently occur but is found nearby.
Spiral Sun-orchid, *Thelymitra matthewsii*	Vulnerable	Species or species habitat may occur within area	Does not currently occur.

Reptiles

Name	Status (EPBC Act)	Type of Presence	Comments
Flinders Ranges Worm-lizard, *Aprasia pseudopulchella*	Vulnerable	Species or species habitat may occur within area	Confirmed in Council area.

In addition to this it is speculated that there is the potential for Pygmy Bluetongue Lizards (*Tiliqua adelaidensis*) to occur in remnant native grasslands, although no confirmed sightings have been made in the area. The original record of this species was a specimen taken near Gawler in 1863 by Dr. Richard Schomburgk.

Environmental Pest Animals

Name	Status	Type of Presence	Comments
Indian Myna, *Acridotheres tristis*		Species or species habitat likely to occur within area	Unlikely to occur in Council area.
Skylark, *Alauda arvensis*		Species or species habitat likely to occur within area	Unlikely to occur in Council area, has been previously recorded.
Mallard, *Anas platyrhynchos*		Species or species habitat likely to occur within area	Probably occurs in Council area.
European Goldfinch, *Carduelis carduelis*		Species or species habitat likely to occur within area	Confirmed in Council area.

Name	Status	Type of Presence	Comments
European Greenfinch, *Carduelis chloris*		Species or species habitat likely to occur within area	Confirmed in Council area.
Feral Pigeon, *Columbia livia*		Species or species habitat likely to occur within area	Confirmed in Council area.
House Sparrow, *Passer domesticus*		Species or species habitat likely to occur within area	Confirmed in Council area.
Red-whiskered Bulbul, *Pycnonotus jocosus*		Species or species habitat likely to occur within area	Unlikely to occur in Council area.
Spotted Turtle-Dove, *Streptopelia chinensis*		Species or species habitat likely to occur within area	Confirmed in Council area.
Common Starling, *Sturnus vulgaris*		Species or species habitat likely to occur within area	Confirmed in Council area.
Common Blackbird, *Turdus merula*		Species or species habitat likely to occur within area	Confirmed in Council area.
Domestic Cattle, *Bos taurus*		Species or species habitat likely to occur within area	Confirmed in Council area.
Domestic Dog, *Canis lupus familiaris*		Species or species habitat likely to occur within area	Confirmed in Council area.
Goat, *Capra hircus*		Species or species habitat likely to occur within area	Possibly occurs in Council area.
Cat, *Felis catus*		Species or species habitat likely to occur within area	Confirmed in Council area.
Brown Hare, *Lepus capensis*		Species or species habitat likely to occur within area	Confirmed in Council area.
House Mouse, *Mus musculus*		Species or species habitat likely to occur within area	Confirmed in Council area.
European Rabbit, *Oryctolagus cuniculus*		Species or species habitat likely to occur within area	Confirmed in Council area.
Brown Rat, *Rattus norvegicus*		Species or species habitat likely to occur within area	Confirmed in Council area.
Black Rat, *Rattus rattus*		Species or species habitat likely to occur within area	Confirmed in Council area.

Name	Status	Type of Presence	Comments
Pig (feral), *Sus scrofa*		Species or species habitat likely to occur within area	Recent record.
Red Fox, *Vulpes vulpes*		Species or species habitat likely to occur within area	Confirmed in Council area.

Environmental Weeds

Name	Status	Type of Presence	Comments
Madeira Vine, *Anredera cordifolia*	Weed of National Significance	Species or species habitat likely to occur within area	Possibly occurs in Council area.
Bridal Creeper, *Asparagus asparagoides*	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
Bridal Veil, *Asparagus declinatus*	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
Climbing Asparagus-fern, *Asparagus plumosus*	Weed of National Significance	Species or species habitat likely to occur within area	Possibly occurs in Council area.
Prickly Pears, *Austrocylindropuntia* spp.	Weed of National Significance	Species or species habitat likely to occur within area	Possibly occurs in Council area.
Boneseed, *Chrysanthemoides monilifera* ssp. *monilifera*	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
English Broom, *Cytisus scoparius*	Weed of National Significance	Species or species habitat likely to occur within area	Possibly occurs in Council area.
Montpellier Broom, *Genista monspessulana*	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
Lantana, *Lantana camara*	Weed of National Significance	Species or species habitat may occur within area	Possibly occurs in Council area.
Boxthorn, *Lycium ferocissimum*	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
Chilean Needle Grass, *Nassella neesiana*	Weed of National Significance	Species or species habitat likely to occur within area	May occur in Council area.
Olive, *Olea europaea*		Species or species habitat likely to occur within area	Confirmed in Council area.

Prickly Pears, *Opuntia* spp.	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
Radiata Pine, *Pinus radiata*		Species or species habitat likely to occur within area	Confirmed in Council area.
Blackberry, *Rubus fruticosus* aggregate	Weed of National Significance	Species or species habitat likely to occur within area	Possibly occurs in Council area.
Willows (excluding Weeping Willows), *Salix* spp.	Weed of National Significance	Species or species habitat likely to occur within area	Unlikely to occur in Council area.
Silver-leaf Nightshade, *Solanum elaeagnifolium*	Weed of National Significance	Species or species habitat likely to occur within area	Confirmed in Council area.
Athel Pine, *Tamarix aphylla*	Weed of National Significance	Species or species habitat likely to occur within area	Possibly occurs in Council area.
Gorse, *Ulex europaeus*	Weed of National Significance	Species or species habitat likely to occur within area	May occur in Council area. Occurs nearby.

Flora and Fauna Assets

Flora

A total of 544 plant taxa have been recorded for the Town of Gawler. 283 of these are native species from within the Council area or have been transplanted from nearby populations but which are likely to have naturally occurred previously in the Town of Gawler, i.e. accepted as being local native species. The origin of 1 can not be determined. The remaining 260 taxa are introduced from other areas, including Australian native species which are not believed to have naturally occurred in the Town of Gawler. See Appendix 4 for a complete listing.

These lists would not include a large range of taxa which would occur in backyards and some public open space which is not managed for conservation. These areas are unlikely to include any native species not previously recorded, but would include a significant number of introduced species, some of which would have potential to become environmental weeds if given appropriate conditions.

Fauna

At least 349 vertebrate and invertebrate taxa have been recorded within the Town of Gawler. 331 of these are recorded as being native to the Town of Gawler and 18 of these are introduced. The fauna can be further broken down into 138 birds (131 native, 7 introduced), 135 insects (all native), 25 reptiles and allies (all native), 22 mammals (15 native, 7 introduced), 12 fish and allies (8 native, 4 introduced),1 crustacean (native), 6 frogs (all native), 6 spiders (all native), 2 snails and slugs (both native), 1 molllusc (native) and 1 flat worm (native). See Appendix 5 for a complete listing.

As noted in the knowledge gaps section above, the bird and mammal lists are probably fairly comprehensive, however the other classes are likely to be significantly underrepresented.

Biological Threats

Pest Animals

Feral Honey Bee (*Apis mellifera*)

Feral Honey Bees occur throughout the Town of Gawler. They primarily inhabit hollows in large trees, particularly Sugar Gum (*Eucalyptus cladocalyx*), Red Gum (*E. camaldulensis*) and Mallee Box (*E. porosa*), but occasionally establish hives in built infrastructure. This behaviour displaces other native animals which require hollows to nest (e.g. Parrots, Owls, Pardalotes, Possums and Bats). Bees utilise a wide range of native and introduced flowers, from urban and agricultural settings. This is likely to lead to significant competition for resources with native bees, as well as a broad range of other insects and some nectar feeding birds. Their feeding patterns are also likely to differ from native species which means that native pollination mechanisms may be disrupted, modifying geneflow in remnant vegetation. Their pollination services are invaluable to many commercial crops including agriculture and horticulture. Honey Bees also create a public nuisance in the actual and perceived threat of stings to people using private and public open space. Town of Gawler has a Honey Bee control program which destroys nests on public land once they are located, but there is no active searching as part of this program, instead relying on chance observations or public reporting. Where control occurs, it will result in a short-term reduction in bee populations, but eradication is not feasible. *Inset: The distinctive combs of the Feral Honey Bee of an abandoned nest at the hollow base of a Mallee Box tree.*

Feral Pigeon (*Columba livia*)

Very common in built up areas, especially near suitable nesting infrastructure such as bridges and buildings, but also on large cliffs (such as at Clonlea Reserve). Their public nuisance is a well-known issue with faecal deposits and noise on and around perches and nests. They also cause significant material damage to buildings and fixtures. Where they inhabit cliffs, they cause a multitude of issues including erosion through direct soil movement and undermining of cliff tops. This also displaces other cliff dwelling species including Rainbow Bee-eaters (*Merops ornatus*) and Fairy Martins (*Petrochelidon ariel*). Council has a current program of shooting and designing and retrofitting the built environment to reduce habitable areas for the bird. Although this is unlikely to eradicate the pest, it can reduce the area's population and therefore reduce associated maintenance costs and improve public amenity. The cliff populations require a targeted approach.

Little Corella (*Cacatua sanguinea*)

Little Corellas were sighted throughout the Town of Gawler, although they were only sighted coming to ground or perches in a few places. Little Corellas are an Australian native parrot but did not historically occur in the southern areas of South Australia including the Town of Gawler in significant numbers. It is believed they have increased since the early 1900's due to broader land management changes. Little Corellas have a broad variety of impacts; they can form large flocks which cause significant noise pollution and faecal deposit issues, their powerful beaks wreak apparently senseless damage to large trees and built infrastructure, they tear up turf looking for seeds and tubers and they can leave unsightly faecal deposits near roosts. Council currently uses bird scare tactics to move birds on from high risk areas. This will reduce damage but is not a permanent method to control the problem. DEW is currently developing and coordinating a state-wide approach, which Council has indicated it is involved with. *Inset: A flock of around 50 Little Corellas takes flight from the Gawler Racecourse.*

European Carp (*Cyprinus carpio*)

Found in permanent pool refugia during dry periods and probably throughout much of the North Para, South Para and Gawler Rivers when flowing, and also accessing other tributaries such as Whitelaw Creek. Carp are predatory, feeding on fauna including zooplankton, invertebrates and vertebrates (fish and frogs) or their eggs. They feed in suspension or in the sediment. When feeding in sediment suck sediment into their mouths, filter out the food and eject the remnants. This results in increased levels of water turbidity which can affect other water dwelling flora and fauna. The most feasible form of control is likely to come from the release of the Carp herpesvirus (Cyprinid herpesvirus (CyHV-3). The Federal Government has announced the development of a plan for its national release, but no certain timeframe. *Inset: A large European Carp observed in the South Para River.*

Fallow Deer (*Dama dama*)

Recorded as being of significant abundance in the Buckland Park area which encompasses the lower reaches and mouth of the Gawler River. A number of Fallow Deer have been seen in the Town of Gawler, however none were apparently formally recorded. Whilst a significant control program is being undertaken in Buckland Park, there is potential for the animals to continue to disperse along the Gawler River into the Town of Gawler. Deer can damage vegetation and infrastructure as well as being significant traffic hazards. They may also transmit disease between livestock. Shooting is the preferred control method where it can be safely undertaken, however, this is severely restricted as population density increases.

Monarch Butterfly (*Danus plexippus*)

Common throughout the Town of Gawler. Larval host food is introduced Cotton-bushes (*Gomphocarpus cancellatus* and *G. fruticosus*) which occur in low to moderate numbers about the Council area. This instantly recognisable pest enjoys a place among popular culture for its large size, attractive colouring and ability to be easily pupated in captivity. This can lead to some friction with attempts to control or eradicate the host weed. Their broader ecological impact is not known but is not likely to be significant as they mainly feed on introduced weeds and do not specifically support any other introduced species. However, they potentially displace native Lesser Wanderer (*Danaus petilia*) which also feed on this weed as well as native alternatives. Control currently does not occur and is not warranted.

Mosquito Fish (*Gambusia holbrooki*)

Found in permanent pool refugia during dry periods and probably throughout much of the North Para, South Para and Gawler Rivers when flowing, including accessing other tributaries such as Whitelaw Creek. Gambusia typically feed on zooplankton, invertebrates and the eggs and juveniles of native fish. They compete with other small fish and invertebrates for these feeding resources, but also aggressively chase and attack native fish. Their range and numbers are currently beyond reasonable control.

European Hare (*Lepus europaeus*)

Common to rural areas around the Town of Gawler. Hares are herbivorous, preferring green grass and herbs. They tend to have large ranges with a low population density which means their impact is usually less than rabbits in a saturated environment and are not considered a major agricultural pest or significant biodiversity threat, although they can impact on revegetation projects.

Mouse (*Mus musculus*)

Common throughout the Town of Gawler, they are particularly abundant in soft soils with dense grass vegetation which is commonly the state on the banks of Council managed watercourses, and cropped paddocks and are well adapted to the urban environment. Their ability to rapidly increase their population to ‘plagues’ is well known, causing significant economic and nuisance damage. Mice predominantly feed on grass seeds and bulbs, particularly Thread Iris (*Moraea setifolia*) and Guildford Grass (*Romulea* spp.) bulbs. This feeding behaviour, combined with their extensive burrowing, can create or exacerbate erosion issues. Mice have replaced some of the functions of the now extinct small mammals in their feeding behaviour and are also a substitute food source for a range of predatory birds including raptors, owls and larger reptiles. Mouse control outside urban areas is generally limited to managing peak populations as it is otherwise not financially viable. This baiting carries a risk of off-target damage to other animals eating the baits and secondary poisoning of mice predators. Control generally achieves a moderate level of local control, but eradication is not feasible.

European Rabbit (*Oryctolagus cuniculus*)

Common in rural areas and especially along the rivers and creeks. Rabbits are herbivorous, preferring green grass and herbs. Competition and land degradation by rabbits is listed as a key threatening process for biodiversity conservation under the EPBC Act. Rabbits are well known for their agricultural impacts. Rabbits degrade native vegetation impacting on biodiversity by competing for feeding resources. Their grazing and burrowing also exacerbates erosion issues. In the absence of many small native mammals, rabbits have a role in supporting the resident populations of large raptors. Rabbit

control is left to individual landholders, with oversight by NRAMLR, but no coordinated program is currently in place around the Town of Gawler. Many landholders, including councils, have been relying on Calicivirus for rabbit control over recent years. Control generally achieves a moderate level of local control, but eradication is not feasible. The amount of rabbit activity along the main rivers is sufficient to be a nuisance with revegetation projects depending on the seasonal conditions (A. Shackley, pers. comm.). Removal of Olives, Boxthorn and other shrubby weeds providing cover for rabbits would help to reduce grazing impacts on native vegetation.

House Sparrow (*Passer domesticus*)

Common around dense shrubs, particularly Boxthorn (*Lycium ferocissimum*), and the built-up environment. Sparrows are omnivorous, but predominantly feed on grass seeds (including agricultural varieties), fruit and vegetables causing economic damage and nuisance issues. This extends to their faecal deposits on and around perches and nests. Their main ecological impact is in potentially displacing other native seed eating finches. Their range and numbers are currently beyond reasonable control.

Koala (*Phascolarctos cinereus*)

Although an Australian native animal, Koalas are not naturally occurring in the Town of Gawler or in the nearby Adelaide Hills. At least one animal is known to be resident in the area about Tingara Road and others may occur. They generally prefer Blue Gums (*Eucalyptus leucoxylon*) which are very rare in Gawler, but also feed on Red Gum (*Eucalyptus camaldulensis*) which is abundant along the waterways of Gawler. It is likely that they move down from more suitable habitat in the hills along the waterways and into Gawler. Although Koalas can have devastating impacts on their preferred food sources, their low population means that they have very little environmental impact in Gawler. Koalas are protected under the EPBC Act, but this does not apply to populations in South Australia. Control does not occur and is not warranted.

Cabbage White (*Pieris rapae*)

Very common throughout the Town of Gawler owing to the abundance of their favoured larval food source, Brassicas (*Cruciferae* family), particularly Wild Turnip (*Rapistrum rugosum*). They have a small economic cost to broad acre agriculture growing Canola, but market gardens and home gardens growing Brassicas are more heavily impacted. Their broader ecological impact is not known but is not likely to be significant as they mainly feed on introduced weeds and do not specifically support any other introduced species. Control tends to be highly localised and it is not possible to achieve eradication. *Inset: A Cabbage White found on the Gawler River.*

Brown Rat (*Rattus norvegicus*) and Black Rat (*Rattus rattus*)

Assumed to be common throughout the Town of Gawler (several dead animals were sight during the field work) including urban areas and open space. Rats are omnivorous, predominantly feeding on grains but also on invertebrates, fruit, vegetation and occasionally vertebrates and their eggs. Their impact on the environment has not been quantified, but they will be in direct competition with native Water Rats (*Hydromys chrysogaster*) and Brush-tailed Possums (*Trichosurus vulpecula*) for food resources and represent a threat to eggs and young birds in nests. There is no targeted control beyond highly localised urban trapping and baiting which will reduce numbers but not achieve eradication.

Spotted Dove (*Spilopelia chinensis*)

Common throughout the Town of Gawler. These birds predominantly feed on seeds, but also eat human food scraps in urban areas. They have only a minor impact on native fauna but are more of an aesthetic nuisance with faecal deposits on and around perches. Their range and numbers are currently beyond reasonable control.

Starling (*Sturnus vulgaris*)

Common in woodland and urban environments throughout the Town of Gawler. Starlings feed on fruits and grains, including agricultural and horticultural produce. Starlings nest in hollows including natural tree hollows, but also built infrastructure. This behaviour displaces other native animals which require hollows to nest (e.g. Parrots, Owls, Pardalotes and Martins), this also creates an aesthetic nuisance with faecal deposits on and around perches and nest development in buildings may create other damage. Their range and numbers are currently beyond reasonable control.

Pig (*Sus scrofa*)

A wild pig has been recorded in the Gawler River corridor, where it was reportedly attacking horses. Aside from stock, pigs may also damage native animals, destroy vegetation, create erosion, spread livestock diseases and pose a threat to people. Control of pigs may be done through trapping, baiting or shooting, the latter two options may be severely restricted as population density increases.

Blackbird (*Turdus merula*)

Common in any areas with dense vegetation, especially the dense olive (*Olea europaea*) and Ash (*Fraxinus angustifolia*) in the North Para, South Para and Gawler rivers, but also in dense vegetation in urban settings. Blackbirds are omnivorous, predominantly feeding on the ground by working through leaf litter. Their main ecological impact is in displacing other birds with similar feeding habits (or mammals such as Southern Brown Bandicoots (*Isoodon obesulus obesulus*). They also eat horticultural crops including soft skinned fruit such as grapes and peaches. They may be seasonally aggressively territorial towards other bird species. Control of this pest would best focus on removing the dense habitat along the main rivers which would have multiple ecological benefits.

European Wasp (*Vespula germanica*)

Few European Wasps were sighted during the field work for this report. This may reflect an actual low population or a survey bias for native areas which they may not prefer. They construct their nests in underground cavities, hollows or similar spaces in built infrastructure. This behaviour displaces other native animals which require hollows to nest (e.g. Parrots, Owls, Pardalotes, Possums and Bats).

European Wasps naturally feed on other invertebrates, carrion and flowers, but in an urban setting they often substitute or supplement this with human food and sugary drinks. This feeding habit, combined with their potent and repeatable sting, brings them into direct conflict with people in public and private situations. Town of Gawler has a European Wasp control program which destroys nests on public land once they are located, but there is no active searching as part of this program, instead relying on chance observations or public reporting. Without a clear understanding of the population it is unclear whether the population can be effectively eradicated or whether control only achieves a short-term outcome.

Red Fox (*Vulpes vulpes*)

Commonly sighted in rural areas but expected to live throughout the built-up areas too. Foxes are omnivorous, eating fruit, invertebrates and small to medium sized vertebrates (including carrion). Predation by the Foxes is listed as a key threatening process for biodiversity conservation under the EPBC Act. Their impacts on native biodiversity is significant, primarily impacting on ground dwelling fauna, but also on ground nesting and feeding birds, especially waterbirds. They are a known livestock pest and significantly impact on domestic pets and poultry. Fox control is left to individual landholders, with oversight by NRAMLR, but no coordinated program is currently in place around the Town of Gawler. Coordinated control can achieve a local reduction in fox numbers which provides multiple benefits for landholders and the environment, although eradication is not currently feasible.

Inset: A Fox observed in the Gawler River.

Cat (*Felis catus*)

Cats are likely to be found throughout the Town of Gawler. This includes roaming domestic cats, ownerless cats and possibly a low level of truly feral cats. Cats are predators, killing, but not always eating a range of mainly vertebrate prey including birds, smaller mammals and reptiles. Cats also carry the parasite *Toxoplasma gondii*, which can cause toxoplasmosis in native animals and humans. The average feral cat eats about two birds every five days, and birds that feed or nest on the ground or are medium-sized (60-300g) are most likely to be killed by cats (Woinarski, 2017). This is particularly worrying for Quails, but any animals which fit their prey preferences are vulnerable, in backyards or in natural or other open areas.

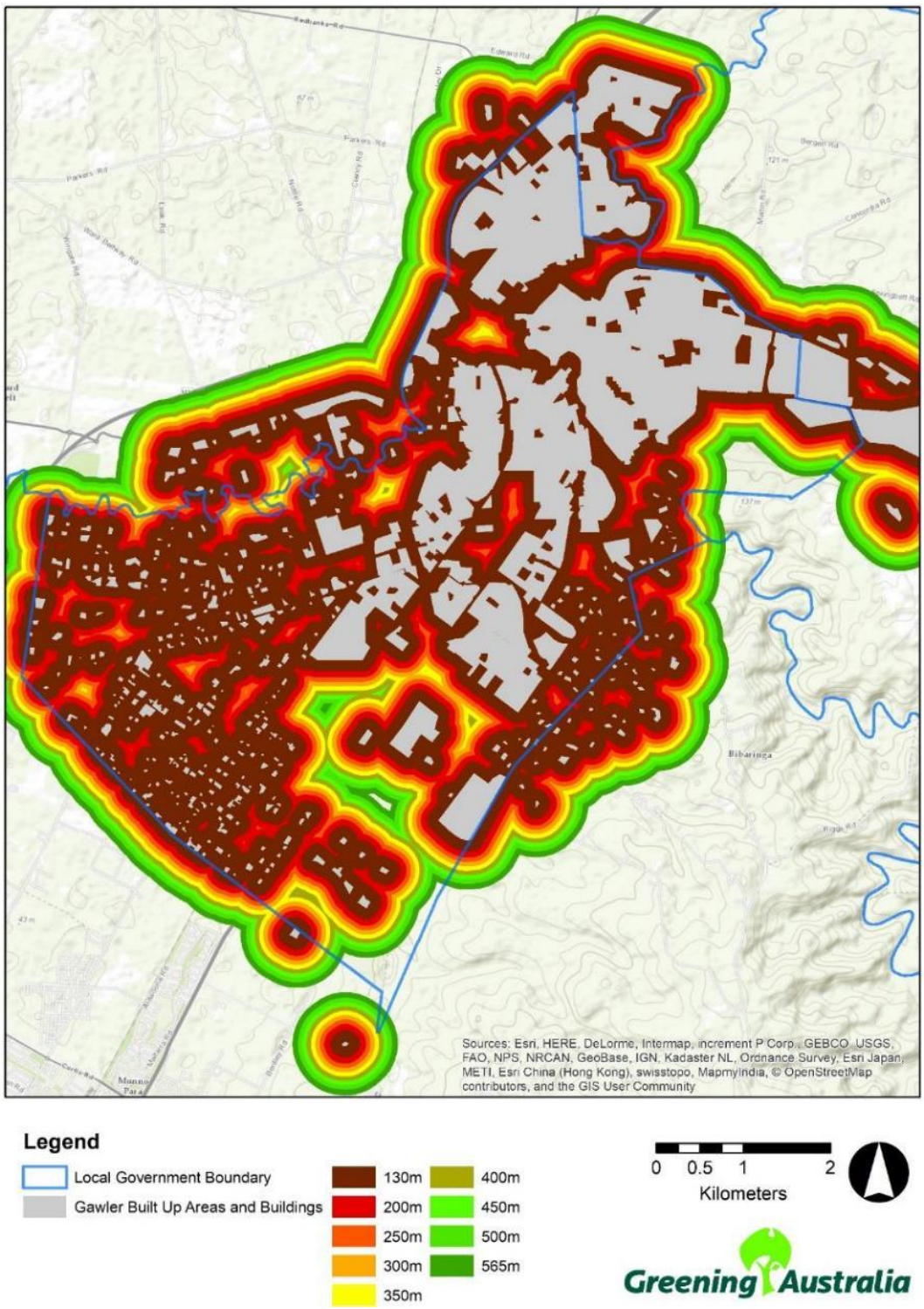
Inset: A cat observed near Dead Man's Pass.

Recent new laws for Cat management are unlikely to change cat impacts in open space in the Town of Gawler, and with increasing urban expansion the impact of cats is likely to increase. Map 10 is a simplified model of potential cat territory, based on an average range of free-roaming domestic cats (Horn et al, 2011) from domestic buildings. This suggests the areas in the Town of Gawler currently least likely to have regular cat incursions are the southern parts of Springwood, and the Gawler Buffer East. With Springwood expected to become developed, presumably with some level of cat occupancy, this leaves the Gawler Buffer as the area most likely to have low levels of cat incursion.

Several South Australian local governments have enacted by-laws in this area. On Kangaroo Island, council by-laws state that "no cat is to be kept outdoors on any premises where… there is no secure

or appropriate area where a cat may be effectively confined." (KI Council, 2017). In the context of Kangaroo Island seeking to be a completely feral cat free, Kangaroo Island Council have further proposed the phasing out of private cat ownership across the whole of the island. This would put them as the most active Council in the management of cats by a long margin. The deeply ingrained culture of cat ownership means that radical change is populated areas is unlikely to be feasible, instead groundwork through education and gradual change is likely to bring about more sustainable and compliant behaviour change in relation to cat ownership and management.

Map 10: Indicative Cat Range in the Town of Gawler



Domestic Dogs (*Canis familiaris*)

Truly wild dogs are not known to occur in the Town of Gawler, but domestic dogs off leash in high biodiversity reserves do pose a potential threat to biodiversity where they harass or attack native animals in these areas and disturb their habitat. This may result in direct fatalities of these animals, destruction of nests or abandonment of territory and habitat. The same principals would also apply to backyards, where dogs may impact upon animals in these areas. Transitory birds, reptiles and mammals are most at risk, where they enter a backyard inhabited by a dog, and owners should be aware of their pet's potential to adversely affect these animals. Such encounters between snakes and dogs are broadly documented in urban areas around Australia. Preventing or reducing negative interactions in backyards would require vigilance and/or training by owners of dogs. Preventing or reducing negative interactions in public areas would require the establishment and enforcement of on-leash or dog exclusion areas.

The recent management of Hooded Plover (*Thinornis rubricollis*) on the Adelaide metropolitan coastline by NRAMLR and several councils provides an example of awareness raising engendering excellent community support for similar pet management for a conservation outcome.

Prioritisation Matrix for Pest Animals in the Town of Gawler

Definitions:

Abundance: Based on field observations of the number and distribution of each pest.

Feasibility: The ability to effectively managing an infestation at any point. This includes access to effective methods, cost of implementing these methods, public licence to conduct the control, etc.

Eradicability: An average of the above two factors. An indicator of the investment required to achieve eradication (or effective control).

Benefits: The benefit control of the pest has on the environment (including human amenity) and an indication of how important it is to control.

Priority: An average of the above two factors. Provides a relative ranking of cost effectiveness.

Very High – pursue eradication of the pest.

High – pursue eradication of the pest.

Medium – control the pest only where high value asset protection warrants.

Low – control is not cost effective.

Very Low – control is not cost effective.

Name	Abundance	Feasibility	Eradicability	Benefits	Priority
Feral Pigeon (*Columba livia*)	Medium	Medium	Medium	High	High
Blackbird (*Turdus merula*)	Medium	Low	Low	High	Medium
European Carp (*Cyprinus carpio*)	Medium	Low*	Low	High	Medium
Mosquito Fish (*Gambusia holbrooki)*	Medium	Low	Low	High	Medium
Cat (*Felis catus*)	High	Low	Low	High	Medium
Red Fox (*Vulpes vulpes*)	High	Medium	Low	High	Medium
European Rabbit (*Oryctolagus cuniculus*)	High	Medium	Low	High	Medium
Mouse (*Mus musculus*)	High	Low	Low	High	Medium
European Wasp (*Vespula germanica*)	Low	Medium	Medium	Medium	Medium
Little Corella (*Cacatua sanguinea*)	Low	Low	Medium	Medium	Medium
House Sparrow (*Passer domesticus*)	Medium	Low	Low	Medium	Low
Spotted Dove (*Spilopelia chinensis*)	Medium	Low	Low	Medium	Low
Starling (*Sturnus vulgaris*)	Medium	Low	Low	Medium	Low
European Hare (*Lepus europaeus*)	High	Low	Low	Medium	Low
Rats (*Rattus* spp.)	High	Low	Low	Medium	Low
Koala (*Phascolarctos cinereus*)	Low	Medium	Medium	Low	Low
Monarch Butterfly (*Danus plexippus*)	High	High	Medium	Low	Low
Feral Honey Bee (*Apis mellifera*)	High	Medium	Low	Medium	Low
Domestic Dog (*Canis familiaris*)	High	Low	Low	Low	Very Low
Cabbage White (*Pieris rapae*)	High	Medium	Low	Low	Very Low

*Carp control feasibility scored as low. This is based on current methodologies and does not consider the Carp Herpes Virus.

The prioritisation matrix suggests that only Feral Pigeon control warrants broad scale investment. No other animal control project scored in this category. This is predominantly owing to the low feasibility of control, mainly because the region will be continually subject to new recruitment of these pests. The only truly eradicable pest is the Monarch Butterfly because its key feeding resource can feasibly be eradicated. That is not to say that control should not be implemented if there is good reason to run a control

program, but it must be acknowledged the costs associated with such a program would be recurring ad infinitum and therefore the benefit must be equally high. European Wasp control is an example of such a program, where public safety warrants the investment and rate payers have demonstrably supported this.

RECOMMENDATIONS

11. Feral Pigeon and European Wasp control programs

Continue Council's Feral Pigeon and European Wasp control programs. Feral Pigeon control should be expanded to include sites which have biodiversity value not just urban areas.

12. Large scale Rabbit and Fox control program

Participate in, and actively promote, large scale Rabbit and Fox control programs coordinated through NRAMLR. Rabbit and Fox control should be integrated.

13. Designate on-leash areas for dogs in locations of high/sensitive biodiversity

Areas of high biodiversity or which support species of conservation significance should be protected from negative impacts of dogs by designating on-leash areas. This should include the Gawler River and Dead Man's Pass (above the lawned areas). Community awareness and support is critical to ensuring a high level of compliance.

14. Change cat ownership and management regulations

Cats have a significant impact on biodiversity and a Council which is seeking to maximise biodiversity and ecological function needs to take the management of cats in the landscape seriously. To reduce the extent of the cat threat Council would need to make changes to the existing management policies. The most beneficial biodiversity outcome would be to aim for the cessation or limitation of cat ownership. A variety of other policies which restrict cats' interaction with open space would be beneficial.

Environmental Weeds

Feathertop (*Cenchrus longisetus*)

Uncommon in Gawler, mainly found in low numbers around Gawler East. Feathertop could establish dense infestations which can exclude ground layer biodiversity. It mainly spreads by wind but may also be spread on mowing or grading machinery. Control is simple and effective in a short timeframe.

Fountain Grass (*Cenchrus setaceus*)

Fountain Grass has established two large infestations centred on the Gawler-One Tree Hill Road, with a possibly related satellite occurrence at Gawler East. Several other occurrences are likely to be garden escapees. These infestations have already created dense swards of Fountain grass to the exclusion of other native herbs and grasses and significantly increased the fire danger in these areas. They appear to be still expanding along the downwind edge of the population, where seeds are easily dispersed long distances. Control is simple but may require follow-up to treat reshooting plants and deplete the soil seed bank.*Inset: A portion of the Fountain Grass infestation south of Gawler-One Tree Hill Road.*

Montpellier Broom (*Genista monspessulana*)

A single mature plant was found along Sunnyside Drive. There are a number of questionable plantings in this location and it is possible that it was planted by a nearby resident. Given its proximity to the nearby creek line it has significant potential to establish and spread. Montpellier Broom can form dense monoculture stands which impacts heavily on biodiversity. Control is simple but may require repeat events over several years if a viable seed bank has been established.

Buckthorn (*Rhamnus alaternus*)

A small number of isolated plants occur in Hillier, Gawler and Gawler East. Buckthorn can establish in dense infestations, particularly along creek lines, where it shades out the ground layer and impact on biodiversity. Seed is usually spread by animal vectors such as birds, possums and foxes. Control is simple with occasional follow up events required.

Watsonia (*Watsonia meriana*)

A few Watsonia plants were found in the South Para River at Dead Man's Pass and immediately downstream of the Main North Road bridge. Watsonia can establish dense stands though vegetative multiplication of its underground bulbs and above ground bulbils. These propagules can also be transported in water, which is significant given the location of the known plants. Control is effective with several follow up events usually required to treat previously dormant bulbs.

Giant Reed (*Arundo donax*)

Giant Reed is abundant along the North Para, South Para and Gawler Rivers, it is also found in some roadside and private drainage lines on the plains around Kudla. In some places it exists as small stands of several square metres, but in others it can be hundreds of square metres, turning some river banks into monocultures. Giant Reed is very flammable and increases fire risk considerably where there are large stands (Bell, 1997). It spreads slowly by outward growth of its rhizomes, but when rhizome fragments are transported by water they readily establish new infestations downstream. Control of Giant Reed is effective where systemic herbicides can deplete the root mass, noting that some herbicides may not be suited to the riparian environment (Bell, 1997). Follow up control is likely to be required for a number or years.

Non-local Sheoaks (*Casuarina glauca, C. cunninghamiana, C. equisetifolia*)

These close relatives of the native Sheoak (*Allocasuarina verticillata*) occur as small scattered populations throughout the Town of Gawler. Their origins are mostly amenity plantings, with some being recruited through natural process. River Sheoak (*C. cunninghamiana*) and Swamp Oak (*C. glauca*) can produce prolific suckers which outcompete native vegetation. Bull-oak (*C. equisetifolia*) does not have this habit. Control of the latter is simple, whilst the former two require repeat treatments over a number of years before the roots are adequately exhausted.

Tagasaste (*Chamaecytisus palmensis*)

A single small stand was found on private property above the South Para River. Tagasaste can form moderately dense stands which outcompetes other plants. It is generally suppressed by grazing, but with increasing urbanisation this may become a sleeper weed. It produces large amounts of long-lived dormant seed which can require many years of follow up to effectively control, although control techniques are simple and effective.

Boneseed (*Chrysanthemoides monilifera* ssp. *Monilifera*)

A single Boneseed plant was found during the field surveys on the road reserve north of the Willaston Cemetery. It was removed, and the population can probably be considered eradicated, but ongoing vigilance is required. A population has previously been recorded in Gawler East. New plants are easily controlled with hand weeding, but once established the weed can produce a prolific and long-lived soil seed bank. Seed is readily dispersed by birds and foxes.

Pampas Grass (*Cortaderia selloana*)

A single plant was located on the outer bend of the South Para River by Glenelg Lane. Its preference for damp situations makes this location a threat to further establishment. Pampas Grass can establish tall, dense infestations with complete canopy cover to the ground making it incompatible with other vegetation. Dispersal is through wind and water vectors. Control is simple and occasionally needs follow up.

Three Corner Jack (*Emex australis*)

Three disparate populations were found at Hillier, Gawler West and Evanston South during the field surveys, but others likely exist outside important biodiversity areas. They are all on private land. Three Corner Jacks produce hard, sharp spined seeds which are a hazard to animals and people.

They are primarily dispersed by rubber tyres, but also in water. Control is simple but requires ongoing vigilance to achieve eradication.

Ash (*Fraxinus angustifolia*)

Common throughout most of the riparian areas of the Town of Gawler and a few dry land areas too. Some ash varieties are planted as ornamental trees. Ash forms a dense canopy though much of the Gawler River where it shades out desirable species. It is a deciduous tree which sheds significant loads of leaves and nutrients interrupting terrestrial and aquatic biodiversity. Seeds are prolific and spread on wind and water. Control is simple but laborious and relatively expensive. Several years of follow-up are required to eliminate soil seed banks.

Morning Glory (*Ipomoea indica*)

Two populations are known; one on the South Para River and one on the Gawler River. Morning Glory is a sprawling and climbing vine which completely smothers groundcovers, shrubs and small trees. Dispersal and reproduction is mainly through stem fragments which break off the parent plant and then spread on water, rooting where they land. Control is likely to require multiple repeat events using systemic herbicide to eliminate the plant's roots and stems.

Boxthorn (*Lycium ferocissimum*)

Common throughout the Town of Gawler on public and private land. Tends to occur as individual plants but can be in large, dense stands, especially under perching trees. Seed is dispersed by birds and foxes. Dense stands of the weed exert considerable water stress on surrounding desirable vegetation, including large trees. The large spines are a threat to stock and people and form sheltered harbours for pest animals including Rabbits and Sparrows. Control is simple, but laborious and occasionally requires follow up.

Horehound (*Marrubium vulgare*)

Sparse populations found throughout the Town of Gawler, predominantly on the hills from Gawler East to Evanston South, where grazing is still occurring. Horehound can form dense stands of low shrubs which outcompete desirable plants and is unpalatable (and occasionally poisonous) to stock. Seed dispersal is by seed attachment to fur, wool or clothing. Control can be difficult to achieve and usually requires repeat events.

Olives (*Olea europaea*)

Olives are common and abundant throughout much of the Town of Gawler, with very few surveyed areas not being impacted by them. Olives form dense stands which shade out the ground layer and some shrubs. Olives are flammable and dense stands significantly increase fire risk. Seeds are dispersed by birds, foxes and water. Control is simple but laborious and often requires repeat events, although recently develop methods of basal bark spraying are promising in reducing the efficiency of control.

Prickly Pear (*Opuntia* spp.)

Opuntia monacantha and *O. ficus-indica* were found in the Town of Gawler. The former is abundant along the banks of the Gawler River, forming impenetrable thickets in some areas. The latter was found in a few disparate locations throughout the Town of Gawler and were not formed into dense infestations. Both species have sharp spines which are a hazard to people, stock and native animals. The plant usually spread by animals or water moving pads or fruit, which readily establish. Several successful biological controls exist for both species including Cochineal bug and Cactoblastis moth. No signs of either were noted in the extant populations. Herbicide methods are very effective but laborious to implement.

Pines (*Pinus halepensis, P. radiata, P. pinea*)

Planted throughout the Town of Gawler, but also naturalised. Pines are generally not found in high numbers as an environmental weed. They have the capacity to form large dense stands which shade out and smother lower growing vegetation. Pine cones are often moved by Cockatoos. Control is generally simple, except where plants are very large.

Myrtle-leaf Milkwort (*Polygala myrtifolia*)

A single plant was found along Sunnyside Drive, which was likely planted. Myrtle-leaf Milkwort has the potential to establish dense stands which outcompete desirable small shrubs and ground layer. The weed is easily controlled.

Roses (*Rosa* spp.)

Found along watercourses in the Town of Gawler, including the ephemeral creek lines along the hills face, but only abundant along the Gawler River, where many large plants occur. Seed from the fruit is spread by birds and foxes. This weed can establish dense infestations which outcompete desirable vegetation, and its sharp thorn are a hazard for people and stock whilst providing a harbour for Sparrows and Rabbits. Control is laborious and often requires retreatment.

Peppertree (*Schinus molle*)

Common throughout the Town of Gawler, particularly along watercourses where it forms dense stands which shade out the understorey. Seed is predominantly dispersed by birds, but also by water. Usually regarded as originating from historic plantings, but new plantings are still being undertaken. Control is simple except where plants are very large.

Creeping Groundsel (*Senecio angulatus*)

One large infestation on the South Para River along Scheibner Terrace (Goose Island) on public and private land. An uncommon environmental weed in South Australia. Forms dense scrambling infestations which smother other vegetation. Spreads with windblown seed of the movement of stem fragments in water or contaminated soil. Control with selective herbicides is effective.

Nasturtium (*Tropaeolum majus*)

Found on the North Para, South Para and Gawler Rivers. Nasturtiums are very abundant on the South Para River in particular, usually forming near monoculture stands from the bank-tops to the water's edge. They smother low growing plants. Control is simple, but requires several years follow up to deplete the soil seed bank which may create soil erosion issues.

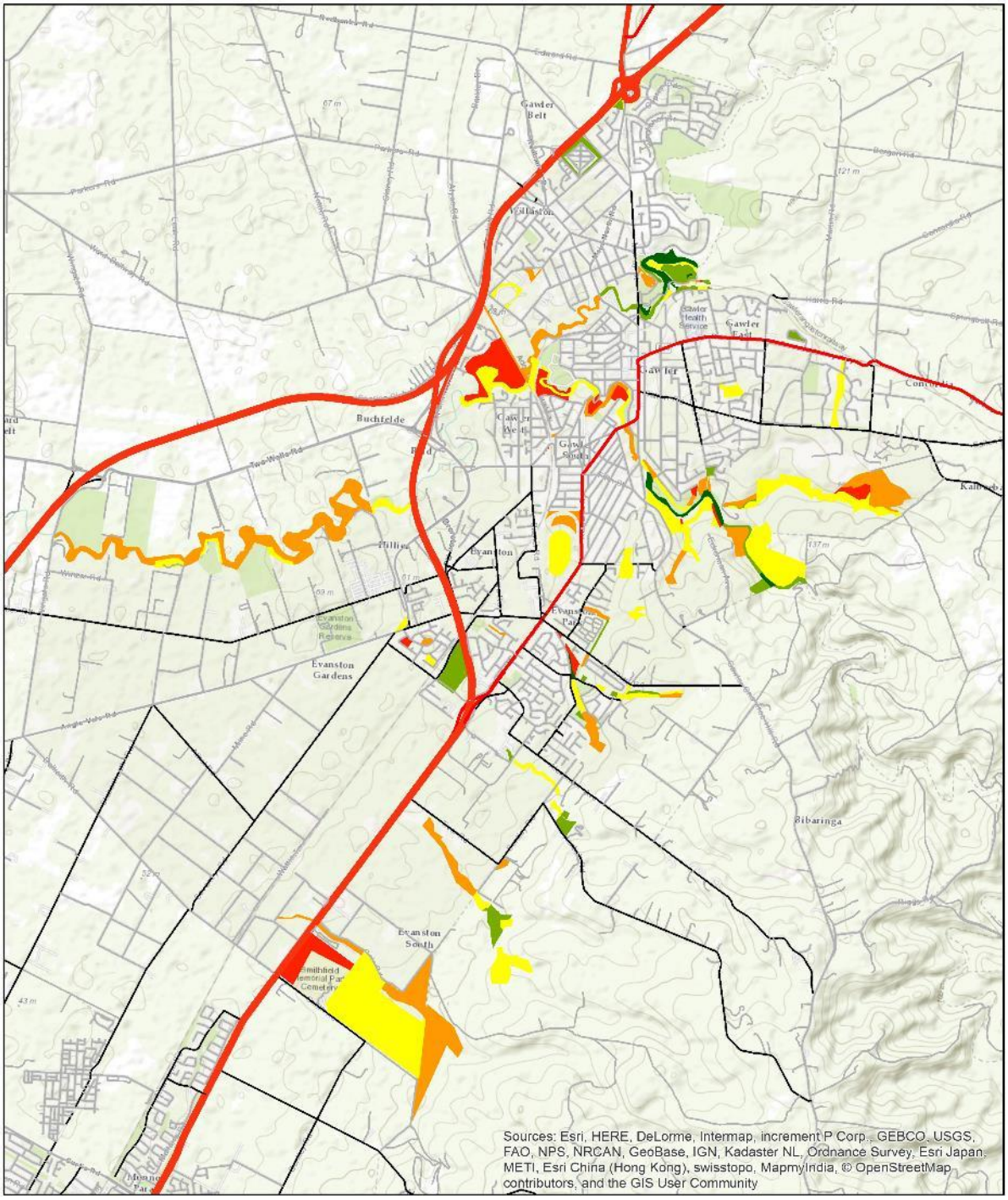
Periwinkle (*Vinca major*)

Only found in two locations in the field surveys, both on private land along ephemeral water courses. The weed has the potential to establish dense sprawling mats which smother low growing plants. However, Periwinkle is only likely to achieve this level of growth in wet areas such as the North Para and South Para Rivers, where it is currently absent. Control is very difficult requiring many follow up control events to eradicate a single population.

Winter Cherry (*Withania somnifera*)

Found in low to moderate abundance in a corridor along the South Para River from the Para Woodlands through to Reid. This distribution supports the assumption that birds are the major vector for this weed. Anecdotally this weed is rapidly increasing in the Town of Gawler. Appears to have a moderate local impact when at low density, but likely to increase in impact to the ground layer as it increases in cover. Control is simple.

Map 11: Introduced Species Coverage by Patch



0 0.5 1 2
Kilometers

Legend

WEED

>50 plants, <5%	5-25%	26-50%	51-75%
			>75%

Greening Australia

Prioritisation Matrix for Environmental Weeds in the Town of Gawler

Name	Abundance	Feasibility	Eradicability	Impacts	Priority
Feathertop (*Cenchrus longisetus*)	Low	High	High	High	Very High
Montpellier Broom (*Genista monspessulana*)	Low	High	High	High	Very High
Watsonia (*Watsonia meriana*)	Low	High	High	High	Very High
Creeping groundsel (*Senecio angulatus*)	Low	High	High	High	Very High
Giant Reed (*Arundo donax*)	Medium	Medium	Medium	High	High
Fountain Grass (*Cenchrus setaceus*)	Medium	Medium	Medium	High	High
Ash (*Fraxinus angustifolia*)	High	High	Medium	High	High
Morning Glory (*Ipomoea indica*)	Low	Medium	Medium	High	High
Boxthorn (*Lycium ferocissimum*)	High	High	Medium	High	High
Horehound (*Marrubium vulgare*)	Medium	Medium	Medium	High	High
Olives (*Olea europaea*)	High	High	Medium	High	High
Prickly Pear (*Opuntia* spp.)	High	High	Medium	High	High
Pines (*Pinus halepensis*, *P. radiata, P. pinea*)	Medium	High	Medium	High	High
Roses (*Rosa* spp.)	Medium	Medium	Medium	High	High
Peppertree (*Schinus molle*)	High	High	Medium	High	High
Nasturtium (*Tropaeolum majus*)	Medium	Medium	Medium	High	High
Periwinkle (*Vinca major*)	Low	Low	Medium	High	High
Buckthorn (*Rhamnus alaternus*)	Low	High	High	Medium	High
Oaks (*Casuarina* spp.)	Low	High	High	Medium	High
Tagasaste (*Chamaecytisus palmensis*)	Low	High	High	Medium	High
Boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*)	Low	High	High	Medium	High

Name	Abundance	Feasibility	Eradicability	Impacts	Priority
Pampas Grass (*Cortaderia selloana*)	Low	High	High	Medium	High
Three Corner Jack (*Emex australis*)	Low	High	High	Medium	High
Myrtle-leaf Milkwort (*Polygala myrtifolia*)	Low	High	High	Medium	High
Winter Cherry (*Withania somnifera*)	Low	High	High	Medium	High
Bridal Creeper (*Asparagus asparagoides*)	Medium	Low	Low	High	Medium
Kikuyu (*Cenchrus clandestinus*)	High	Medium	Low	High	Medium
Field Bindweed (*Convolvulus arvensis*)	Medium	Low	Low	High	Medium
Artichoke Thistle (*Cynara cardunculus*)	High	Medium	Low	High	Medium
Drain Sedge (*Cyperus eragrostis*)	Medium	Low	Low	High	Medium
Coastal Galenia (*Galenia pubescens*)	High	Low	Low	High	Medium
Gazania (*Gazania linearis*)	High	Medium	Low	High	Medium
Wild Turnip (*Rapistrum rugosum*)	High	Medium	Low	High	Medium
Castor Oil (*Ricinus communis*)	High	Medium	Low	High	Medium
Fennel (*Foeniculum vulgare*)	Medium	High	Medium	Medium	Medium
Perennial Veldt Grass (*Ehrharta calycina*)	Low	Medium	Medium	Medium	Medium
False Caper (*Euphorbia terracina*)	Low	Medium	Medium	Medium	Medium
Wild Tobacco (*Nicotiana glauca*)	Medium	Medium	Medium	Medium	Medium
Palms (*Phoenix* spp.)	Low	Medium	Medium	Medium	Medium
Caltrop (*Tribulus terrestris*)	Medium	Medium	Medium	Medium	Medium
Elm (*Ulmus* sp.)	Low	Medium	Medium	Medium	Medium
Bathurst Burr (*Xanthium spinosum*)	Low	Medium	Medium	Medium	Medium
Noogoora Burr (Xanthium strumarium)	Low	Medium	Medium	Medium	Medium

RECOMMENDATIONS

See recommendation 1

15. Fountain Grass eradication

Fountain Grass is ranked as a high priority for control and is rapidly expanding into areas of high biodiversity value. It is also expanding into areas of future development which increases the fire risk of these locations. A highly targeted eradication program for this species could be completed within a few years but would require cooperation from the private landholders who own much of the infested land.

1. Negotiate with NRAMLR and landholders for an eradication program.
2. Commence weed control program from the northern extent of the infestation and progress in a southernly direction.
3. Educate landholders
    a. On native grass management to promote their recolonization of these areas.
    b. On follow up control methods to transfer maintenance onus.
4. Engage with the local nurseries to promote no sale of these plants to reduce local supply.

16. Eradication of small populations of high potential weeds

1. Montpellier Broom
   Known in a single location, the existing plant(s) should be removed, and the site monitored in the future for emergence of seedlings.
2. Watsonia
   Found in 2 locations on the South Para River, the existing plants should be removed, and the site monitored in the future for emergence of seedlings.
3. Creeping Groundsel
   Found in a single location on the South Para River, the existing plants should be removed, and the site monitored in the future for emergence of seedlings.
   NOTE – this area is to be treated in the upcoming 2018 GURWG planting plan.
4. Perennial Veldt
   Found in a single location at Clonlea Park. the existing plants should be removed, and the site monitored in the future for emergence of seedlings.

17. Winter Cherry eradication

This rapidly expanding weed is spreading throughout the Council area, but a concerted control effort on public and private land is still capable of eradicating this weed.

1. Control should work across the known range, with priority given to the outliers to the west, and those plants along the rivers where spread has the most potential.
2. Private landholders will need to participate in the program, by controlling the weed or by allowing access to council/contractors to control. NRAMLR may need to be involved in facilitating this.
3. Control needs to be coordinated with DEW / Nature Foundation who are currently controlling the assumed source in the Para Woodlands.
4. Seek funding support from NRAMLR to support delivery of the program or manage the program.

18. Priority weed control program for the Gawler, North Para and South Para Rivers

Weeds are the most significant threat to the 3 rivers' biodiversity. Priority weeds include *Arundo donax, Fraxinus angustifolia, Lycium ferocissimum, Ipomoea indica, Olea europaea, Opuntia* spp*., Phoenix* spp*., Ricinus communis, Schinus molle and Senecio angulatus* (see Recommendation 16).

a) Implement a monitoring program for key performance indicators relating to function of corridor.
    - Probably woodland birds are the best proxy for connectivity and condition of the corridor.

b) Weed control should start in the upper catchments – The North Para and South Para Rivers. It should not commence in the Gawler River until these areas have significantly reduced weed abundance.
    - Notify landholders along the river of their weed control obligations as per the NRM Act (2004) to increase likelihood of private complementary works.
    - Seek landholder consent to undertake complementary buffering revegetation along riparian strip.
        i. Identify areas where banks are eroding through fence lines and into paddocks as the priority location for these works.
    - Enter into discussions with Playford, Light and Barossa Councils and NRAMLR to seek complementary weed control activities in the catchment areas above the Town of Gawler.

c) Where necessary control should be followed up with appropriate revegetation to ensure bank stability.

d) Seek to acquire land, or an interest in land, along the watercourses to ensure land management security and continuity (also increases feasibility of a linear path along this corridor at some future date).

Key Sensitive Areas and Areas of Concern in Relation to Future Development

In the broader landscape context, the Town of Gawler is a key custodian of one of the most important corridors on the Adelaide plains. The rivers and steep creek lines that extend down the hills face are vital components of the corridors that link the higher Mount Lofty Ranges with the plains remnants and lower waterway reaches of the Town of Gawler. These waterways should also be considered as viable ecosystems in their own right. As development encroaches on these waterways, maintaining them as functional biodiversity corridors becomes a vital element in maintaining or improving biodiversity and population viability on the plains.

Corridors and Connectivity

The North Para, South Para and Gawler Rivers and their tributaries and bank/gully remnants connect the relatively intact and functional habitat in the higher Mount Lofty Ranges with the relatively intact and functional coastal strip, taking in some plains remnants enroute. This is a near continuous corridor which traverses an increasingly urbanised landscape. A variety of plants and animals move along the watercourses and remnants, but barriers to movement such as clearings comprised of unsuitable terrain or physical barriers, can stop the movement of the plants and animals or their genetics (e.g. interruptions to pollinators). As development encroaches on these waterways, pressure on maintaining them as functional biodiversity corridors increases as marginal habitat on the fringes of these corridors, which are currently moderately permeable open space, no longer supports significant movement of wildlife. The ability to move through the landscape is more important when considering the compounding effects of climate change, and the potential need for geneflow for resilience and climate retreat.

With urban development, barriers in these watercourses are likely to come from two main types of infrastructure; roads and smaller pedestrian and shared use paths (formal and informal). The Gawler East Link Road project is a primary example of the former, but smaller suburban roads present a similar barrier. The latter poses a reduced risk as a barrier to fauna movement, but both may equally interrupt surface water flows to the same extent.

A barrier in one location, regardless of the biodiversity value of the local impact, is a threat throughout the entire system. Local impacts associated with the replacement of habitat is covered below.

It is desirable to ensure that some formal pedestrian crossing points are installed in these watercourses to discourage the establishment and proliferation of informal alternative crossing points which are likely to be more impacting on the environment, including biodiversity and erosion impacts, but also increase public risk in traversing this terrain, which is very steep in some places.

Vegetation within these systems are suited to low flow environments. Where modifications to the surface water flows are brought about by infrastructure such as culverts or similar pipe works the velocity of the water movement may be increased. This has the potential to uproot and destroy the vegetation causing direct biodiversity damage and likely secondary erosion damage to beds and/or banks if corresponding measures are not made to slow the velocity at the outfall. The low flow systems are also unlikely to be well suited to interruptions to the flows which create local checks to flows (i.e. dams). Infrastructure should be designed such that low flows are maintained as seasonally appropriate.

Habitat and Condition

As well as being important corridors at the landscape scale, the areas zoned for future development include considerable areas of remnant vegetation and habitat which is valuable in its own right. Any remnant vegetation is important in sustaining a range of specialist and generalist flora and fauna species and should be preserved as open space wherever possible. Several habitat features are critically important in supporting specialist habitat requirements and should be preserved wherever possible. These include:

- Iron-grass (*Lomandra* spp.) temperate grasslands. There are a number of areas where this association exists, including an area subject to an EPBC referral in Springwood, as well as areas on the southern bank of Dead Man's Pass, banks of the creek line along Gale Road, Sunnyside/Tingara Creek and Whitelaw Creek. Some of these areas have been impacted by revegetation with an inappropriately high density of trees and shrubs.
- Remnant tussock grasslands, particularly those that include native broadleaf herbs.
- Remnant Mallee Box (*Eucalyptus porosa*) grassy woodlands
- Habitat for the EPBC listed Flinders Ranges Worm Lizard (*Aprasia pseudopulchella*) which potentially exists in most steep creek lines with stony banks and adjacent remnant grassland and grassy woodland.
- Steep banks with exposed soil as nesting habitat for the EPBC listed Rainbow Bee-eater (*Merops ornatus*) and other birds. This includes man-made features such as the quarry face in the Springwood area (KBR, 2010).
- Large trees, especially Red Gums (*Eucalyptus camaldulensis*) and Mallee Box (*E. porosa*) as important nesting habitat for raptorial birds and their hollows as important habitat for birds and mammals.
- Permanent and near-permanent pools as important resources for aquatic animals and plants.
- Springs as a source of water for plants, animals and simpler lifeforms year-round, whilst providing water inputs to the riparian system.
- Rocky cliff faces, ledges and caves as important habitat for a range of reptiles, birds and possibly bats.

The general condition of open space is a key issue for future development. This comes in several forms;

First, there is a general tendency to plant densely into 'native' open space areas with trees and shrubs for 'restoration'. There are a number of financial and cultural reasons for this, but regardless, the outcome is a closed, or more shaded, habitat that is incompatible with the grassland or grassy open woodland structure which exists, or previously existed, in most of the development zone. The current Town of Gawler Development Plan in some places aids in perpetuating the fallacy that treed landscapes are the desirable state, e.g. "Tree planting should be encouraged," and "Development should…provide sufficient space for the planting of trees to… enhance the landscape character of a neighbourhood deficient in trees". See Appendix 2 for a full list of biodiversity related Development Plan items. It is probably not the intention of the document to undermine the aim of maintaining some grassland remnants and establishing new grasslands, but the wording, if taken literally could have this result.

Secondly, much of the remnant vegetation in the development zone is heavily impacted by weeds which are steadily degrading their function. Developers do not have a clear motivation to improve the condition of this vegetation, particularly where there is no clear business case for making vegetation condition improvements.

The effects of development also include the encroachment on the edges of remnant vegetation, important habitat areas and the corridors covered above. The perimeter to area ratio of a patch of vegetation is an important measure to consider; the smaller the ratio, the better able that vegetation is likely to be able to withstand edge effects. These effects include:

- nocturnal light,
- noise,
- weed incursion,
- pest incursion (including domestic cat and dog forays),
- pollution (runoff and rubbish), and
- changes to the microclimate.

Furthermore, some desirable species moving into and through these corridors use cryptic behaviours and would be deterred from moving into and through a narrow, exposed corridor. As a general guide this corridor should be as wide as is practicably possible, a number of studies have demonstrated a correlation between habitat health and buffer width, but the following table provides a guide for the minimum width corridors need to be to provide some benefits.

Function	**Minimum Width (edge to edge)**
Improved Water Quality	60
Provide Food and Resources	95
Improve in-stream Biodiversity	100
Improve Terrestrial Biodiversity	**200**

Minimum buffer width (m) to initiate a range of functions (Adapted from Hansen, et al., 2010)

As previously noted, Council only has one chance to set the vegetation buffers at the correct width before they become permanently settled in the development footprint.

With the increase in local population around important biodiversity assets comes an increased likelihood of negative interactions such as:

- informal tracks (walking and bicycle),
- inappropriate planting in adjoining reserves by neighbouring residents,
- collection of plants, bird eggs, tadpoles, native fish, yabbies and other fauna,
- pets accessing significant habitat,
- rubbish dumping, and
- arson.

The design of access types and their location needs to consider the potential for these negative interactions and seek to reduce them as far as possible.


Above: Examples of inappropriate gardening where the adoption of Council open space has led to private planting of inappropriate species, including the environmental weed Pepper Tree (*Schinus molle*) *(*right).

For a large urban biodiversity corridor to be effective it will need to be valued by the community. Without the community sensing an inherent value in the site, or Council's objectives, there are likely to be too many degrading pressures inflicted on the corridor for it to be cost effectively managed. Conversely, good planning and community involvement can build understanding of the benefits of biodiversity and induces voluntary input by residents and community groups which can promote and sustain good biodiversity outcomes.

RECOMMENDATIONS

Key threats to the function of biodiversity corridors are fragmentation, encroachment and degradation in condition or, for many of these sites, failing to reduce the prevailing weed abundance. The following actions are designed to mitigate these effects as much as possible.

19. Improving condition of suburban corridors

The forecast expansion in subdivision and development of the land parcels which the steep creek lines and rivers dissect represents an opportunity for Council to manage planning power to ensure that works within these corridors are conducted to maintain and improve the function of these corridors and reduce Council's and resident's liability for significant ongoing maintenance and fire hazards.

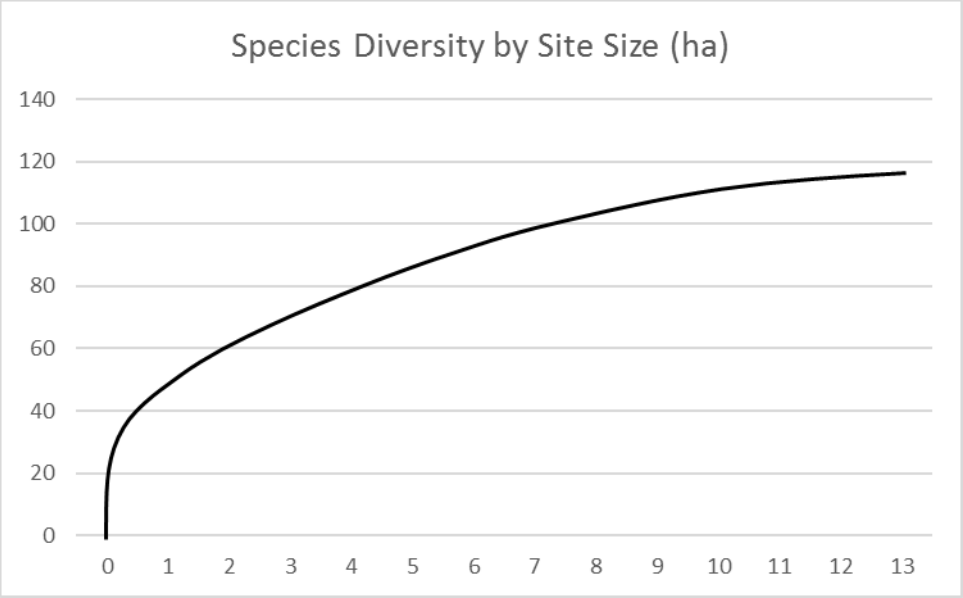
Prior to the vesting of land to Council, Council may request the land be vested to an acceptable standard which meets one objective; the site achieves a desirable level of native biodiversity that is self-sustainable, or sustainable with the least possible human intervention. To measure the site's progress against this objective the following criteria are proposed:

1) Eradicate (none of the following pest species are present on the site):
Non-local *Acacia spp., Arundo donax, Asparagus asparagoides, Asphodelus fistulosus, Casuarina* spp*., Cenchrus longisetus, Cenchrus setaceus, Chamaecytisus palmensis, Chrysanthemoides monilifera, Cirsium vulgare, Convolvulus arvensis, Cortaderia selloana, Cotoneaster* spp*., Cynara cardunculus, Cyperus eragrostis, Echium plantagineum, Ehrharta calycina, Emex australis,* Non-local *Eucalyptus, Foeniculum vulgare, Fraxinus angustifolia, Gazania linearis, Genista monspessulana, Hyparrhenia hirta, Lycium ferocissimum, Marrubium vulgare, Nicotiana glauca, Olea europaea, Opuntia* spp*., Phalaris* spp*., Phoenix* spp*., Prunus* spp*., Rapistrum rugosum, Reseda lutea, Rosa* spp*., Schinus molle, Senecio pterophorus, Sisymbrium* spp*., Solanum elaeagnifolium, Sorghum halepense, Tribulus terrestris, Tropaeolum majus, Vinca major, Withania somnifera, Xanthium* spp*.* and *Zantadeschia aethiopica.*

Oryctolagus cuniculus and *Vulpes vulpes* (not resident – roaming animals cannot be cost effectively excluded at the small scale)

2) Control (tolerate the following weeds to a total of less than 15% cover):
Other grasses not in above (E.g. *Avena* spp*., Briza* spp*., Brachypodium distachyon, Catapodium rigidum, Cenchrus clandestinus, Cynodon dactylon, Dactylis glomeratus, Ehrharta longiflora, Hordeum* spp*., Lolium* spp*., Panicum capillare, Paspalum dilatatum, Piptatherum miliaceum, Rostraria cristata, Vulpia myuros), Arctotheca calendula, Centaurea* spp*., Conyza* spp*., Chondrilla juncea, Dittrichia graveolens, Erodium moschatum, Fumaria capreolata, Galenia pubescens, Galium murale, Gomphocarpus* spp*., Heliotropium europaeum, Helminthotheca echioides, Hypochaeris* spp*., Kickxia* spp*., Lactuca serriola, Lathrys tingitanus, Lepidium africanum, Malva* spp*., Medicago* spp*., Moraea* spp*., Oenothera stricta, Oxalis pes-caprae, Papaver* spp*., Phyla canescens, Plantago* spp*., Polygonum aviculare, Rumex* spp*., Salvia verbenaca, Scabiosa atropurpurea, Sherardia arvensis, Solanum nigrum*, *Sonchus oleraceus, Symphyotrichum subulatum, Trifolium* spp., *Verbascum* spp. and *Vicia sativa.*

3) Restore (establish a representative number of native species proportionate to the size of the site)
E.g. a site of around 1-hectare may support 50 native species, whereas a 10-hectare site may support around 100 species as there is likely to be a more diverse range of habitat niches.



See Appendix 3 for a list of suitable grassland and grassy woodland species for these areas.

To resolve the agreement the onus is on the proponent to develop and fully implement a plan which will meet these criteria. Where land is to be handed over to council this should be achieved prior to hand over, where the land is to be retained in private ownership a fixed period of 10 years should be allowed to achieve this. The emphasis from Council should be to get proponents to commence the planning and implementation as soon as possible. This has the potential to reduce costs and also maximise the benefits to developers in terms of amenity appeal and community involvement for prospective purchasers. The soil seed banks in these areas are considerable and, in most cases, cannot be entirely depleted, therefore a site can only achieve self-sustainability by relying on establishing resilient native cover which can withstand and suppress the emergence of these weeds, thereby depleting this seed bank over time without direct intervention.

No prescribed methodology to achieve this needs to be stipulated. Aside from traditional methodologies of chemical and physical controls, sustainable grazing techniques and fire may also be employed with good effect. Estimates range from $5,000 to $30,000 per hectare to achieve these objectives, with variance relating to the starting condition and the cost of the required interventions.

Although this may seem a disincentive to retain open space by imposing a cost for its retention, these corridors are primarily dominated by native vegetation which is protected protected by the native vegetation act, or at least functions as a financial disincentive to clear or impact on it. Such an approach would also fail to acknowledge the potential marketing benefits which native biodiversity can offer.

Plans for open space in large developments should be communicated to community members from the outset with an emphasis on generating community support for the outcomes of effective implementation of the plan, and involvement where appropriate. Highlighting the improved biodiversity (especially birds and mammals) and improved fire management are major selling points. The objective is to maximise community ownership and adoption of the plan with a potential to support increased sale prices, conservation participation and community cohesion.

20. Minimise encroachment and edge effects

The aim of corridors is to improve terrestrial biodiversity. To achieve this a corridor width of 200m is desirable. Larger buffers are better where this can be achieved. Compromises will obviously need to be made in some areas for narrower buffers, where 200m cannot be achieved. Negotiations to achieve higher quality corridors may help to mitigate the reduced width.

In addition to these buffers of native vegetation, development on the outer edge of these buffers should, where possible, be tapered in order of the development's potential to contribute to the severest edge effects, from least impacting to more impacting features. For example: BUFFER →open space →paths → roads → housing. This step back would also align with CFS bushfire buffer zone management practice (CFS, 2016).

21. Mitigate fragmentation and blockages

a) Ensure that some formal crossing points, with appropriate design, are installed in these watercourses to discourage the establishment and proliferation of informal alternative crossing points.
b) The design of a road barrier should incorporate underpass and overpass features which allow terrestrial animals to easily move from one side to the other without the risk of being exposed to traffic.
    - Underpass features should ensure that the size is large enough allow a kangaroo to move through and ensure that light can penetrate throughout.
    - Ideally an underpass would retain or re-establish vegetation similar to the adjacent remnant, but this is not always feasible from an infrastructure maintenance point of view.
    - Overpasses should install climbing features to cater for highly mobile animals such as Possums and Koalas which may find themselves trapped on or outside a road.
c) Infrastructure should be designed such that low flows are maintained as seasonally appropriate.

22. Foster community value of open space

There are a number of measures which could be employed to increase community support for the outcomes of, and effective management of corridors in suburban areas.

1) Plans for open space in large developments should be communicated to community members from the outset with an emphasis on generating community participation.
2) Select a flagship species to represent the success of project. These should be compelling to the public, be ambitious to foster a sense of drive to achieve it and be realistic so that community can experience some measure of success. E.g. Superb Fairywren, Echidnas, etc.
3) Formally name the many unnamed creeks in the hills face area. This should be in accordance with Geographical Names Act 1991. It will give the community an easy reference to the geographic areas.
4) Foster the development of local 'Friends of' or 'Landcare' type community groups. See "Opportunities for School and Community Involvement" for more in this theme. Ensure Council employees actively work with community groups to engender cooperation and trust.

23. Formal recognition of the value of grasslands

The Town of Gawler Development Plan should be amended to more appropriately recognise the value of grasslands in the Council area and formalise a desire for this to be an acceptable vegetation community in open space areas.

Hydrology

Another potential change with significant secondary impacts to biodiversity is altered surface and groundwater hydrology brought about by increased hard surfaces, stormwater interception and rainwater capture. This changes the area, volume and location of infiltration and surface flows. There are a number of hydrologically sensitive vegetation types and habitat feature which are found in or near to the development zone which may be impacted by such changes.

There are several known and suspected springs and soaks. Some are easily identified on the surface by their differing vegetation or green growth in summer. Others, particularly those entering the South Para River, cannot be distinguished, but may in some instances by inferred by the permanence of pools. These springs and soaks are recharged by groundwater infiltrating the soil surface and entering an aquifer. Determining the type of aquifer and their recharge zones are beyond the scope of this report but given the terrain it is likely that many are localised. Any development which interferes with infiltration has the potential to disturb the hydrology of these springs, altering the duration, volume or ultimate existence of these features, which in turn has knock on effects for biota dependent on them.

The large areas of new hard surfaces associated with development, particularly roads, retain surface stormwater and there is a need to divert and remove this as efficiently as possible. There is a temptation for this to be directly channelled into the various watercourses in the development zone and therefore integrate these natural watercourses into the stormwater system. This is likely to have adverse effects on the vegetation composition which has established to suit the hydrology of their circumstance. Direct inputs also have the potential of creating points of erosion and an increased likelihood of weed and pest recruitment and pollutants entering these systems.

Water detention basins often overcome the issues of directing water directly into natural watercourses, and can provide additional benefits such as visual amenity, but may present their own set of issues such as inappropriate plantings, difficult maintenance requirements and the need to accommodate a large open space into developed or nearby developing areas.

In several places along the South Para and Gawler Rivers there are obvious instances of building overburden being pushed over banks, extending these features into the watercourse. These are water affecting activities in contravention of the Natural Resources Management Act 2004. It is likely to smother and kill desirable vegetation, be highly mobile and add significant sediment to future high flow events, exacerbate or create local erosion issues and possibly introduce new contaminants into the waterways. Future development encroaching on the watercourses runs the risk of similar actions, deliberate or accidental, and underpins why buffers are an important issue for planners.

RECOMMENDATIONS

24. Water sensitive urban design

Development has the potential to alter surface and groundwater hydrology through increased hard surfaces, stormwater interception and rainwater capture. This changes the area, volume and location of infiltration and surface flows which can have secondary impacts on a number of hydrologically sensitive vegetation types and habitat feature which are found in or near to the development zone. Overcoming these issues can use a combination of conventional and progressive water sensitive urban design (WSUD) engineering.

1) As much as possible permeable surfaces or similar should be utilised to minimise the extent of changes to water infiltration patterns.
2) Where detention is required it should be as close as possible to source, with facilities made for infiltration from these points where suitable. This may be on Council reserves or similar open space. These should be planted with appropriate wetland adapted local native species (see Appendix 3).
3) In appropriate locations, smart rainwater tanks should be trialled. These release a measured amount of stored rainwater in advance of a forecast rain event. This can help smooth out the storm water surges, reducing pressure on stormwater management infrastructure and improving ground water infiltration.

Areas and issues of possible Cultural Heritage Significance in the context of Biodiversity Conservation

Areas of Significance

The South Para, North Para and Gawler Rivers are of particular significance for the cultural sites they contain (ACHM, 2010). A number of sites are recorded on the Aboriginal Sites and Objects Register and there are many more sites along the rivers outside of the Town of Gawler.

Cultural Site Disturbance

Aboriginal sites could be disturbed while undertaking a range of biodiversity-related activities including:

- Revegetation – e.g. site preparation (ripping, direct seeding, planting);
- Earthworks and landscaping (e.g. wetland construction, erosion control);
- Weed Control – (e.g. woody weed removal and control in the river channel and banks);
- Construction of water infrastructure (culverts, regulators, fishways).

Opportunity and Inclusion

It is important that Kaurna representative groups are included in biodiversity projects from the development stage in order to benefit from traditional knowledge and perspectives, and to avoid issues arising during the implementation phase of projects.

There are many opportunities for the Town of Gawler to engage with and include the traditional owners in biodiversity conservation including and not limited to:

- Inclusion as partners in grant submissions for environmental projects;
- Consultation and planning input in the early stages of project development;
- Employment opportunities during the implementation of projects;
- Cultural monitors for activities which may disturb significant sites;
- Opportunities to provide input into artwork and signage (ACHM 2010).

Native Title and Land Use

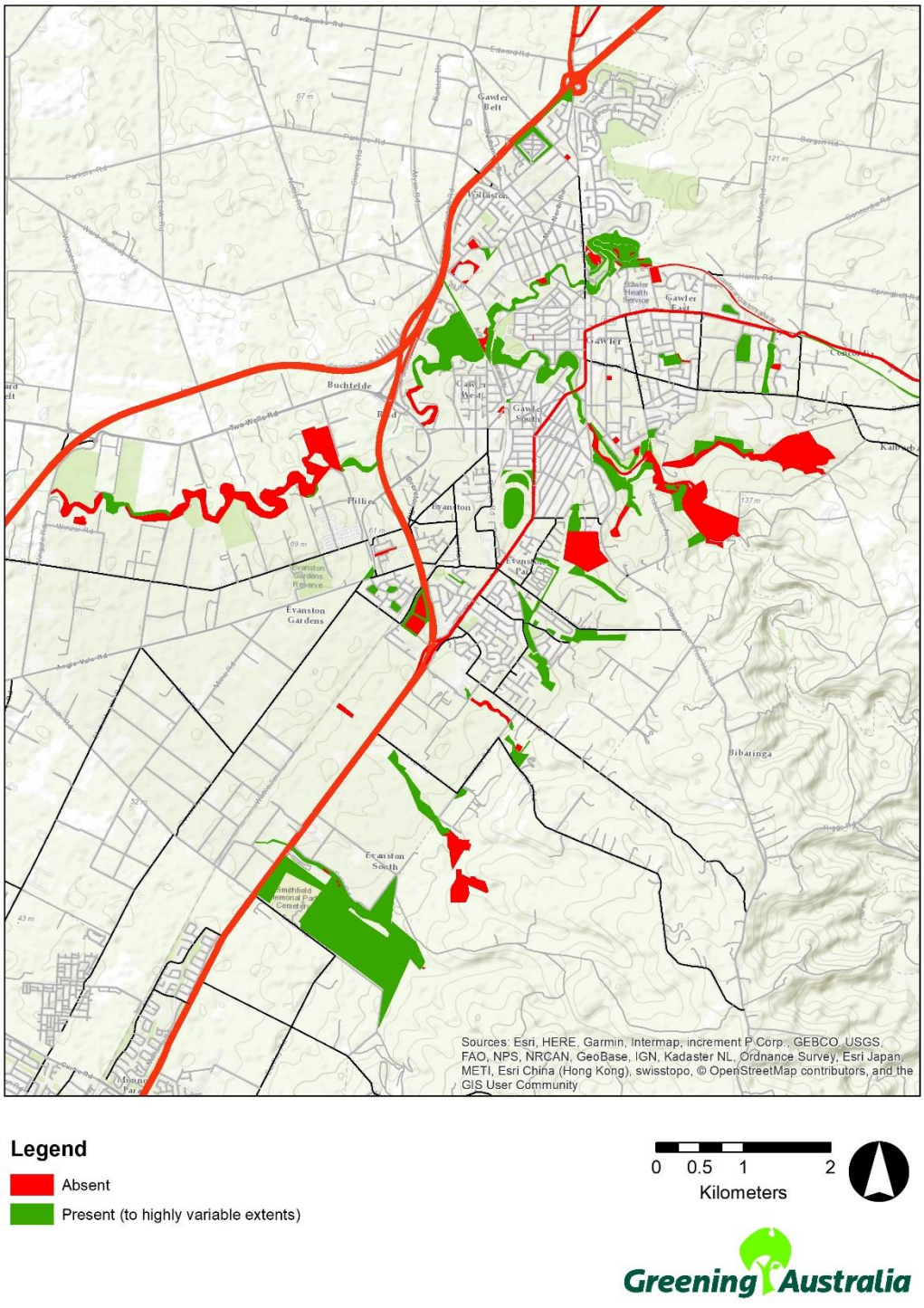
On 21 March 2018, the Kaurna people were formally recognised as native title holders for a significant determination area on the Adelaide plains, including the Town of Gawler. The rights and interests awarded under the Native Title Act 1993 apply to nominated land parcels within the Determination Area, of which none occur in the Town of Gawler (www.judgments.fedcourt.gov.au).

The Town of Gawler can use the understandings in the Kaurna Native Title Determination to assist its interactions with Kaurna people and help build cooperative relationships related to its ongoing biodiversity planning and restoration activities.

Areas of Existing Revegetation / Restoration Projects

The Town of Gawler has large expanses of land which have been subject to revegetation of various scales for various objectives.

Map 12: Presence and Absence of Revegetation within Surveyed Patches.



Legacy Revegetation

Several areas of legacy revegetation projects, conducted before the 'local is best' understanding was established are still extant in the Town of Gawler, including large areas of Clonlea Park, Dead Man's Pass, Gawler Buffer East, Sunnyside Drive, Evanston Gardens Stormwater Detention Basins, the powerline reserve between Calton Road and Barossa Valley Way. One particularly notable planting is the 1889 Arbor Day planting on the North Para River, adjacent Murray Road ford. The revegetation areas of recent decades are mostly planted with a variety of Australian Natives, some of which are local species of unknown provenance. The revegetation at Clonlea Park and Dead Man's Pass undertaken some 30 years ago are notable for their allelopathic effects on understorey, suppressing the establishment of any other vegetation layers. Generally, these old revegetation sites produced very few notable fauna records, although Gawler Buffer East did turn up a Barn Owl (*Tyto delicatula*) and Sunnyside Drive a Southern Boobook (*Ninox boobook*).

Gawler Urban Rivers Project

The Town of Gawler, with support from Natural Resources Adelaide and Mount Lofty Ranges and the Department for Environment and Water, has undertaken significant revegetation works program along the North Para, South Para and Gawler Rivers as part of the Gawler Urban Rivers Project. These works are underpinned by the Gawler Urban Rivers Masterplan (SMEC, 2013) with a steering committee comprised or Council, NRAMLR and community members. The project has a focus on improving bank stability, habitat values, amenity and utility. Revegetation has repotedly had mixed success in terms of survival rates (based on community feedback), with the cause of this variation possibly driven by operational issues, severe drought or other factors. The field work for this report did not detect a significant difference in fauna correlating with this revegetation work. Without good baseline data it is difficult to measure such changes. The revegetation works have been accompanied by a significant investment in weed control in the site preparation and maintenance phase. There were notably less environmental weeds where the revegetation has been undertaken. An important note for this project is that there are no criteria established at the outset against which to evaluate the success or otherwise of the project.

RECOMMENDATIONS

See 18 and 29.

25. Biodiversity Programs are developed around SMART objectives

The planning of a biodiversity project or program should include some clear measures by which the performance of that project or program can be evaluated. The acronym SMART stands for Specific, Measurable, Actionable, Realistic and Timebound (there are variations on this equally valid). These objectives may include outputs (e.g. numbers of trees planted/surviving, km of fencing) but should certainly include outcomes (e.g. Quails recolonise restored grasslands).

Food Forest and Gawler River Restoration

The Food Forest has made a private undertaking to revegetate a large stretch of the Gawler River at Hillier using local native plants predominantly supplied by GEHA. These works have achieved a very high level of success such that much of the banks are now covered in predominantly native plants. Complementary weed control activities supported or undertaken by the Light Regional Council on the other side of the Gawler River can enhance the outcomes of this work. This site did correlate with a very high level of bird diversity, the greatest number of species (18) found for any patch during the field work for this report.

Gawler Buffer East

Gawler Buffer East (and its counterpart Gawler Buffer West in Playford Council) is a strategic exercise in establishing a large corridor of native vegetation in the urban growth corridor between Gawler and Playford Councils as part of the Metropolitan Open Space System (MOSS) to improve habitat connectivity between the hills and plains. It is oriented along a creek line with significant remnant vegetation, with revegetation work including this creek line and the previously cropped paddocks to its south. Some of this land is owned by the Town of Gawler and some by the Minister for the Environment. The restoration goal of the site was the "recovery of the damaged vegetation associations that existed prior to European settlement on the land at Gawler Buffer East" (DEH, 2007). Revegetation included the establishment a locally uncommon vegetation type Short-leaf Bluebush (*Maireana brevifolia*) Low Shrubland, Woodlands including Mallee Box (*Eucalyptus porosa*) and Native Pine (*Callitris gracilis*) and some excellent examples restored native grass cover including Kangaroo Grass (*Themeda triandra*), Wallaby Grass (*Rytidosperma caespitosum*) and Spear grass (*Austrostipa nodosa*), although it lacks herbs. Generally speaking it appears that the emphasis of revegetation was given to a selection of treed reference sites as opposed to grasslands reference sites. Unfortunately, this has resulted in some examples of dense overplanting of remnant native grasslands along the creek lines, to the detriment of those grasslands. Across the site as a whole native plant diversity is high, but weed load is also high. This area supports a number of birds not recorded elsewhere in the Town of Gawler in survey work for this project including Brown Quail (*Coturnix ypsilophora*), Stubble Quail (*Coturnix pectoralis*) and Little Eagle (*Hieraaetus morphnoides*) and had a nesting pair of Black Shouldered Kites (*Elanus axillaris*). There are previous records in other areas of Town of Gawler.

RECOMMENDATIONS

26. Gawler Buffer East grassland restoration

Gawler Buffer East is undoubtedly a successful restoration project which has clearly achieved significant improvements in ecosystem function and biodiversity. However, the focus has been on the establishment of grassy woodland and shrubland vegetation with little emphasis given to grasslands. Given this site retains a number of flora and fauna grassland specialist species it is a lost opportunity if a greater proportion of the work doesn't focus on grasslands restoration. This could be an important site to work with Para Woodlands to improve the efficacy of native grassland establishment methodologies.

1. Discuss with NRAMLR and DEW the possibility of a shift in focal vegetation community.
2. On Council land
    a. Remove inappropriate trees and shrubs.
    b. Promote perennial native grass cover with a mowing regime.

Vadoulis Reserve

A small-scale dryland revegetation program has been undertaken in Vadoulis Reserve to supplement the diverse native vegetation present on the site. This has established well, with signs of natural recruitment of a number of these species, however weed load is significant with little weed control. This reserve also contains a small patch of revegetation around a stormwater detention basin which is a novel riparian ecosystem.

RECOMMENDATIONS

27. Vadoulis Reserve corridor program

This patch of native grassland and grassy woodland on a steep slope is effectively stranded from other large patches of native vegetation. Depending on the land use of the adjacent DPTI land, a biodiversity corridor could be established to reconnect it with the nearby ephemeral creek line to the south and the South Para to the North. This should be undertaken with a general investment in improving the condition of Vadoulis Reserve as it currently stands.

a) Undertake condition improvements in Vadoulis Reserve proper
    a. Weed control of priority weeds. Including a slashing regime to reduce annual grass coverage.
    b. Revegetation with appropriate grassland plant species.
b) Discussions with DPTI around future land use of their parcels of land in this vicinity (dependent on alignment of the Link Road and development choices).
c) Develop a restoration plan for the potential corridors.
d) Implement restoration in line with the plan.
e) Seek to foster a community group to adopt the reserve and undertake management actions. Ensure Council employees actively work with the community group to engender cooperation and trust.

Willaston Cemetery

Willaston Cemetery is a biologically valuable relic of the pre-European Mallee and Native Pine Woodland associations and contains a number of species not found anywhere else in the Town of Gawler. Willaston Cemetery is a Trees For Life Bush For Life site which receives regular weed control works and minor revegetation. The work is conducted with great care with good results, but this work is not at a scale sufficient to cover the whole of this important patch, with the south side being relatively neglected and over-run with weeds (noting that this is not part of the contracted area). The impact of the high biomass of introduced Sugar Gums (*Eucalyptus cladocalyx*) is depleting soil moisture, creating additional shade, attracting birds such as Little Corellas and impacting significantly on the biodiversity value of the area. These Sugar Gums do however also provide hollows for Common Brushtail Possums (*Trichosurus vulpecula*) (M. Lock, Council submission). Despite the best efforts at this site, floral diversity has declined, particularly the small, herbaceous species (A. Shackley, historical data).

The site is stranded in an urban environment with very few opportunities for recruitment or dispersal, weed load is high and natural dispersal opportunities are very limited. Looking through the lens of climate change pressures on this site, in the medium-term focus should shift from managing the site for in-situ conservation, to translocating the valuable genetic material of locally rare species and outlier populations to appropriate locations where they are better serviced by ecological processes and can contribute to their species and vegetation community's survival. Such a site may not necessarily be in the Town of Gawler.

RECOMMENDATIONS

28. Willaston Cemetery management program

This report concurs with the recommendations from the draft Willaston Cemetery Conservation and Management Plan (2016):

1. "*The remnant native vegetation is to be excluded from cemetery activities and will be managed as a remnant vegetation area, no burials or internment is to take place in the defined area. Restrictions on public walking paths through this area should be confined to the present points of access.*
2. *The original CMP policy recommendation to retain and continue the row of sugar gums within the reserve (inner rim, as highlighted in the South-west and South-east quadrants) is not supported..."*

Maintain and improve the resilience of the site.

1. Produce an updated Management Plan for the native vegetation area.
    a. Include an assessment of the options for restoring native species which are known to have died out in the Cemetery or are known to have occurred in the locality but are not present in the Cemetery.
    b. Continue current maintenance activities to improve health and resilience as far as possible.
    c. Weed control should be prioritised over additional planting.
    d. Sugar Gums (*Eucalyptus cladocalyx*) and Aleppo Pines (*Pinus halepensis*) within the native vegetation, and the large Casuarina (*Casuarina* sp.) in the north west corner should be removed. These trees are impacting desirable vegetation through moisture and shade competition.
        i. Hollows should be salvaged and re-installed on site to maintain Possum habitat, but in a manner which will discourage Corella use.

Translocate rare species and genetics.

2. Translocate the genetic material of the Willaston Cemetery to alternative sites with better long-term viability
    a. Identify a suitable translocation site which will meet the habitat needs to the vegetation (e.g. soil, hydrology, aspects, etc), including consideration for future climate change. If no site exists in Town of Gawler, the following points may be implemented by another agency (Council, NRM, NGO).
    b. Collect seed and cuttings from as wide a range of remnant plants as possible to maximise genetic diversity.
    c. Commence revegetation with this material and other suitable provenance material.

Clonlea Park and Whitelaw Creek

Clonlea Park is a well-connected reserve of high biological value, mainly due to the number and diversity of habitats concentrated there. The park is home to a variety of revegetation vintages; some old, well established revegetation is comprised of non-local species planted at high density and is suppressing the establishment of almost all understorey which is detracting from, or at least not adding to, the biodiversity. More recent revegetation has focussed on the North Para River and Whitelaw Creek banks, with appropriate species selection and structural composition.

RECOMMENDATIONS

29. Restoration program of Clonlea Park and Whitelaw Creek

The gradual thinning and removal of the old, inappropriate overstorey, combined with the facilitated recovery of native grasses and herbs could establish a functional grassy woodland which would further boost the biodiversity value of the reserve. This site is an excellent location to demonstrate grassy woodland biodiversity to the community as it has extensive, well used walking trails.

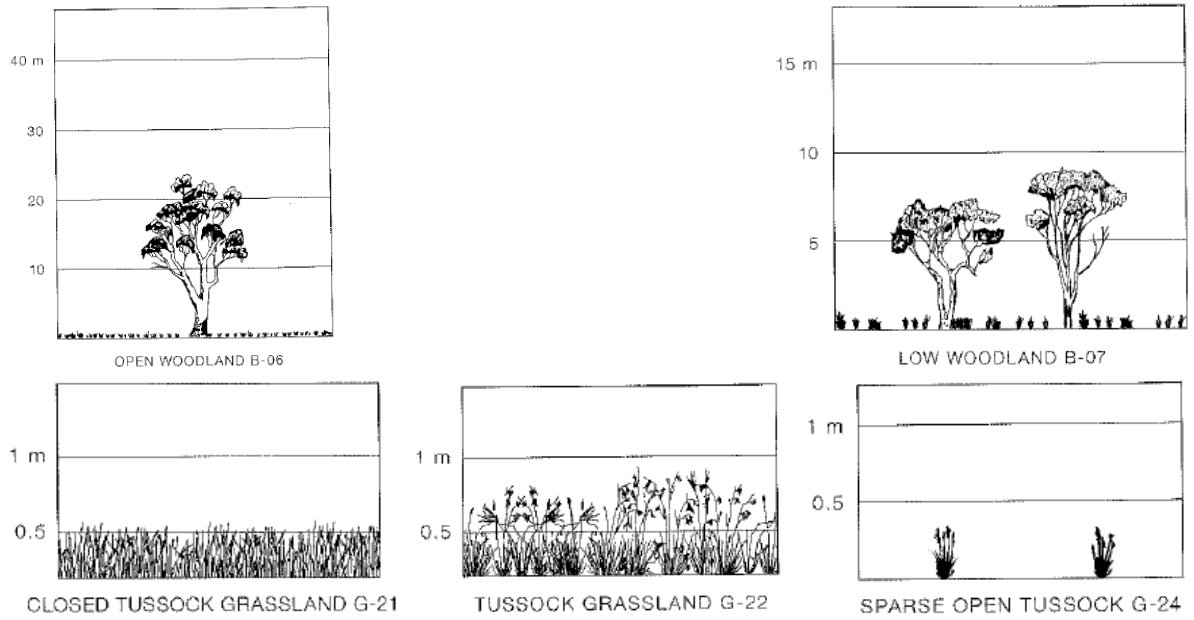
1. Maintain the pre-existing mowing regime in the open areas of the park. Expand to other grassy areas which are not subject to regular mowing.
2. Thin the canopy of non-local species gradually, radiating from the grassland remnants and derived grasslands as these will be most effectively recolonised.
    a. Control the spread of Senna artemisioides in vicinity of Whitelaw Creek.
3. Eradicate priority weed species such as Boxthorn, Olive, Prickly Pear and Perennial Veldt.
4. Control Rabbits and ongoing monitoring for new recruitment.
5. Supplement natural recruitment with plantings of grassland species.
6. Install interpretive signage
    a. Initially explaining the transitional approach to the reserve
    b. Later highlighting the biodiversity value of grassy woodlands and the role they play in local ecology.
7. Foster a community group, possibly the Whitelaw Creek Catchment Care Group, to participate in the works and adopt the area to increase community investment. Ensure Council employees actively work with the community group to engender cooperation and trust.

Fire Considerations

The native vegetation of the Town of Gawler, as with most Australian native vegetation, is by nature flammable and consideration must be given to this fact. But what is often overlooked is that most remnant native vegetation in the landscape is comprised of significant levels of introduced weeds. In many cases the weed biomass would be greater than the native biomass for a given patch. The most widespread and abundant weeds are probably Olives (*Olea europaea*) and Wild Oat (*Avena barbata*) which contribute very significantly to fuel loads.

In many instances it could be expected that a remnant or restored patch of native grasslands, or grassy woodland of suitable composition would be less flammable and less dangerous than the more common prevailing degraded state. These native systems have very low shrubby biomass, if any, and a sparse woodland overstorey. Additionally, the grass layer is composed of a mixture of summer active (C4) and winter active (C3) grasses, supporting green growth year-round, as opposed to the dry thatch that the introduced weedy grasses usually produce during the peak fire danger periods. In this sense, active and appropriate revegetation programs can be complementary to fire risk management planning, particularly where the appropriate revegetation type is a grassland.

The Australian Standard for Construction of buildings in bushfire prone areas (AS3959-Amdt 2-2011-02-15) classifies ‘grasslands’ (including low open shrublands, closed tussock grasslands and tussock grasslands) and ‘open woodlands’ or ‘low open woodland’ over ‘grasslands’ which are managed in a minimal fuel condition as low threat (i.e. low bushfire attack level), consistent with the discussion above.



Above: Diagrams of the desirable vegetation types in the Town of Gawler which would be classified as low threat when managed in minimal fuel condition (extracted from AS3959-2009). Clockwise from top left: Open Woodland, Low Woodland, Sparse Open Tussock Grassland, Tussock Grassland, Closed Tussock Grassland. Note – an open woodland is the Town of Gawler is unlikely to achive 20m tall as indicated in this diagram.

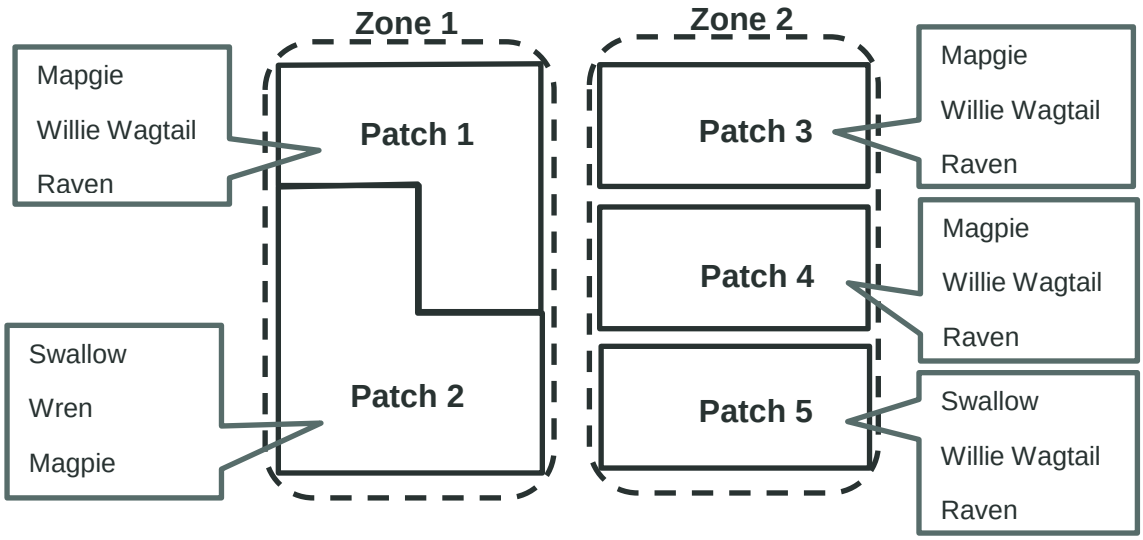
The Town of Gawler Development Plan (2018) page 12 Bushfire Protection Objective 3 states that **“**Development should minimise the threat and impact of bushfires on life and property while protecting the natural and rural character”. By utilising desirable native vegetation types and compositions both objectives are achieved.

Prioritisation of Areas in Relation to Biodiversity Value and Management

A number of indicators from the field work can be used to prioritise the relative biodiversity value of areas of the Town of Gawler. Bird and flora indicators are useful as they are relatively substantial datasets. A third dataset is the 'patch score' which is a qualitative assessment of each patches' value in terms of uniqueness, flora and fauna diversity and remnancy and the presence and abundance of threatened species.

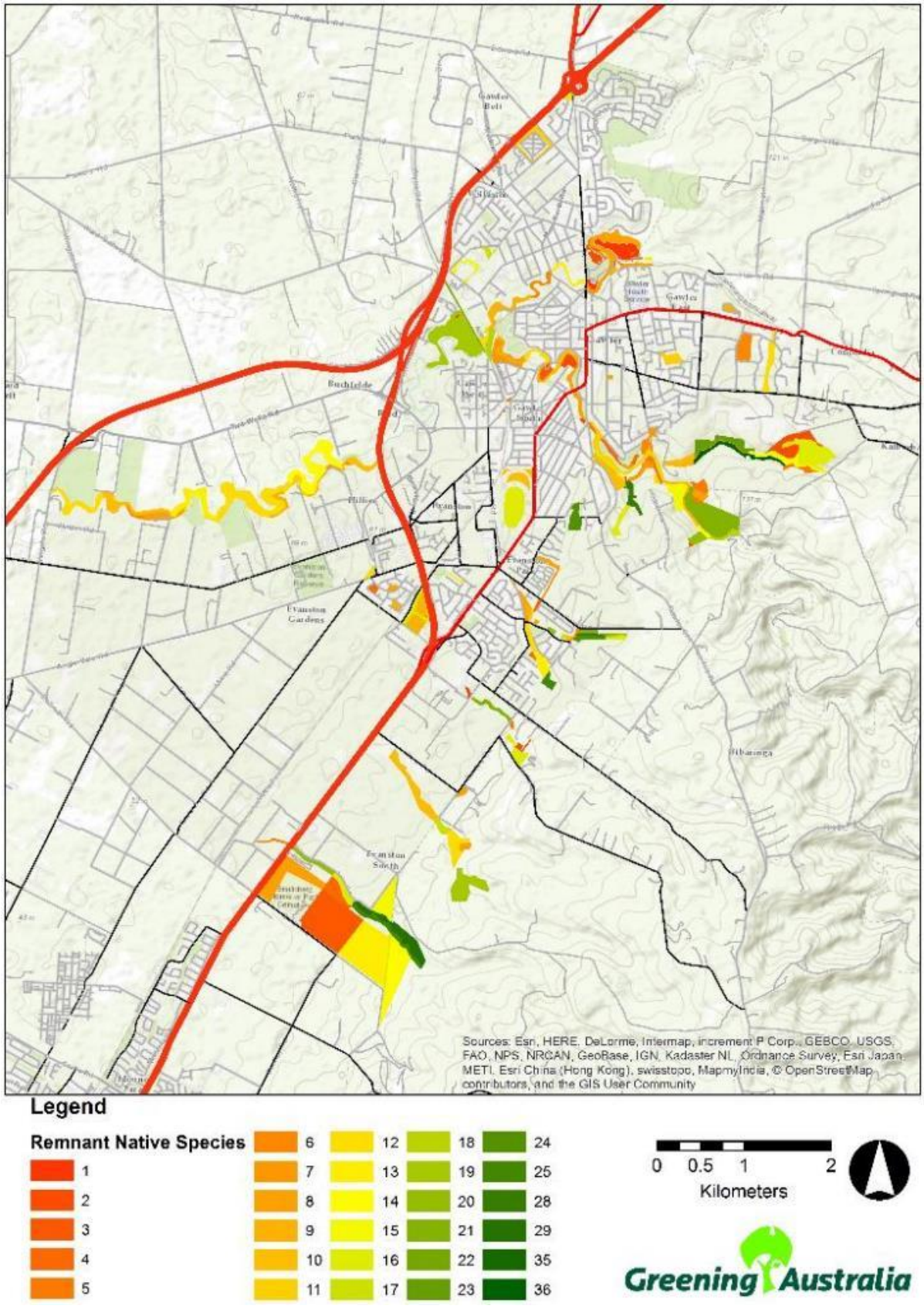
Patches are the base unit for which species abundance has been recorded in the field and is useful for highlighting small areas of very high (or low) diversity or threats. Zones are useful indicators in connected areas as they can demonstrate a more complete (or degraded) ecosystem. They also include some historic records which are not spatially accurate enough to place in a smaller patch.

Data is presented for the small surveyed patches as well as a cumulative data set for larger Zones, which include data from this survey, as well as historic records. Zone values are calculated by adding all unique records from their component patches, as demonstrated in the diagram below:



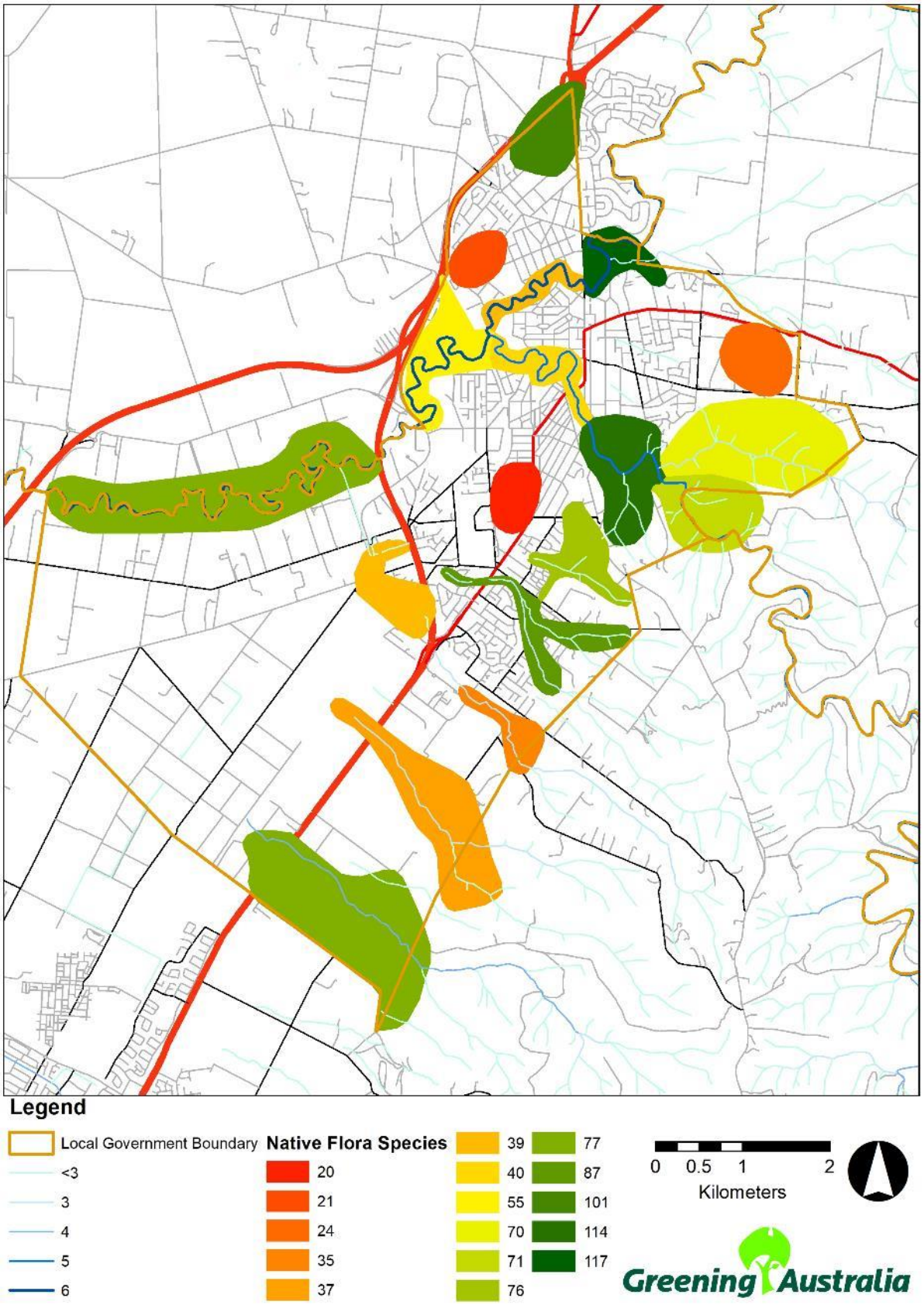
In the diagram above, each Patch scores a 3 for bird diversity as they each have 3 species recorded. A simple sum of these records would suggest Zone 1 has 6 species and Zone 2 has 9 species recorded, which is misleading as some of the species are duplicated in the component Patches. Instead the number of unique species is used for the Zone score, with Zone 1 scoring 5 and Zone 2 scoring 4.

Map 13: Number of Unique Remnant Native Species Recorded for each Patch.



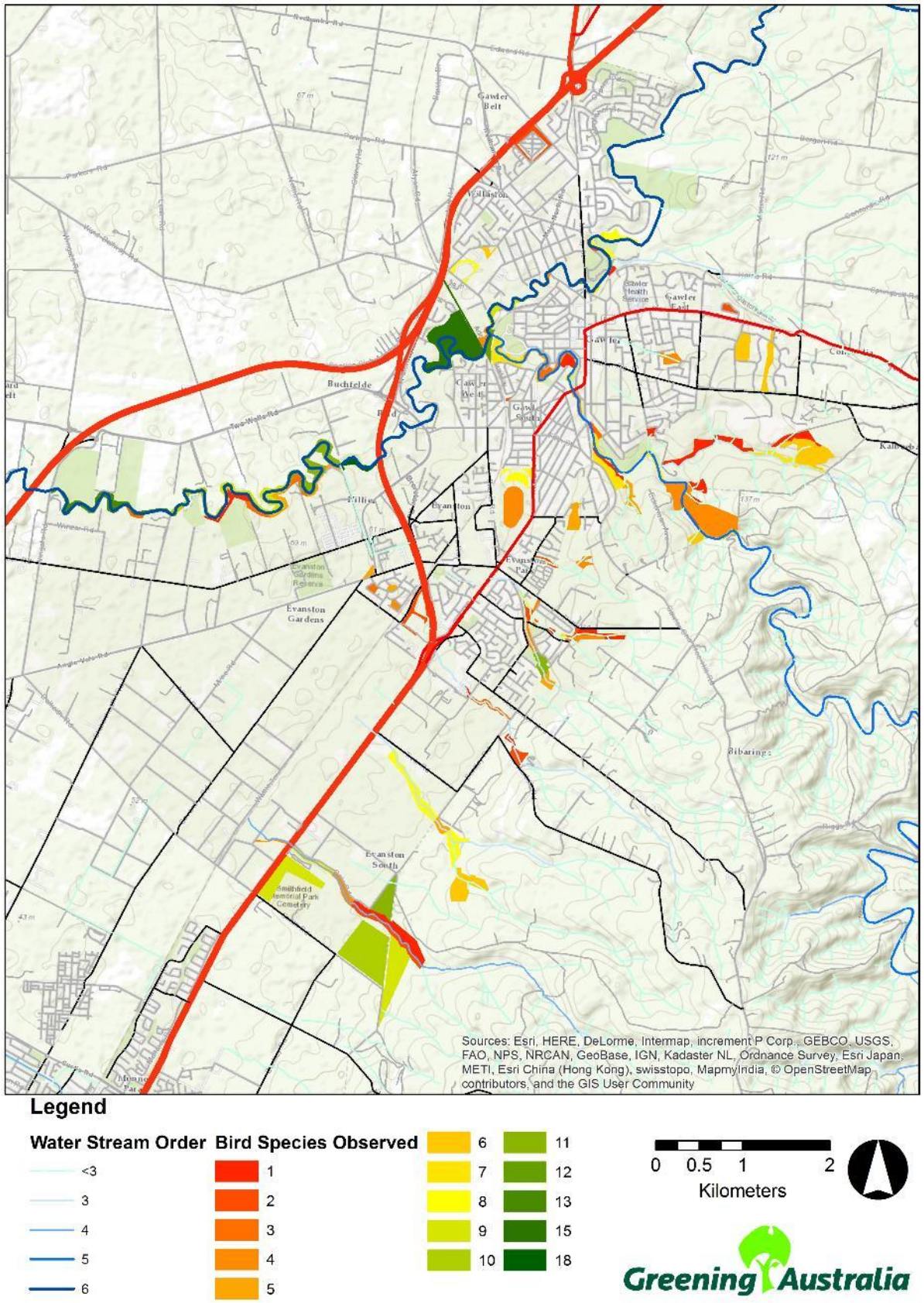
Total Native Plant Species for Zones

Map 14: Total Unique Native Plant Species, including Historic Records, for Zones



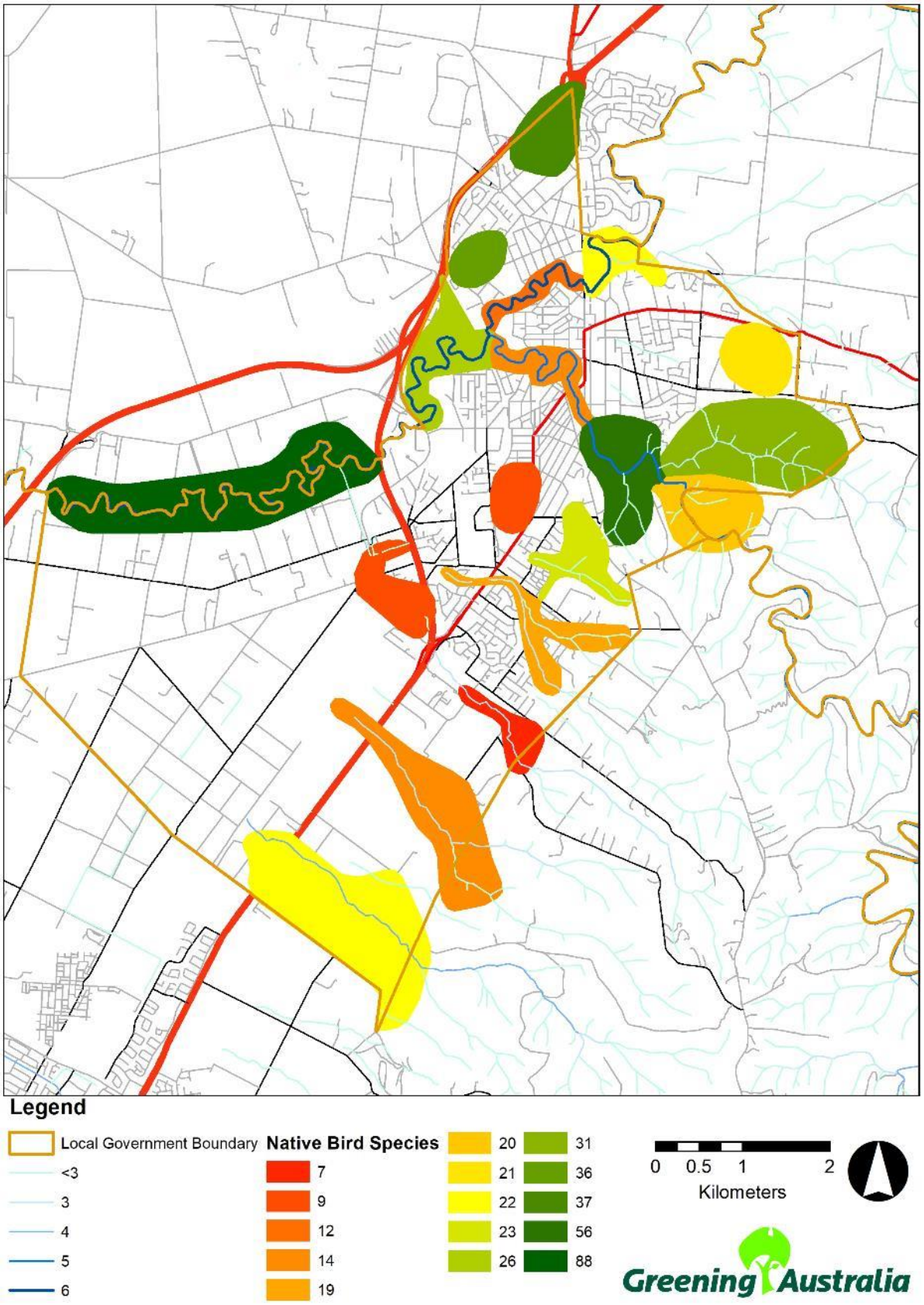
Bird Species Observed

Map 15: Number of Unique Bird Species Recorded for each Surveyed Patch.



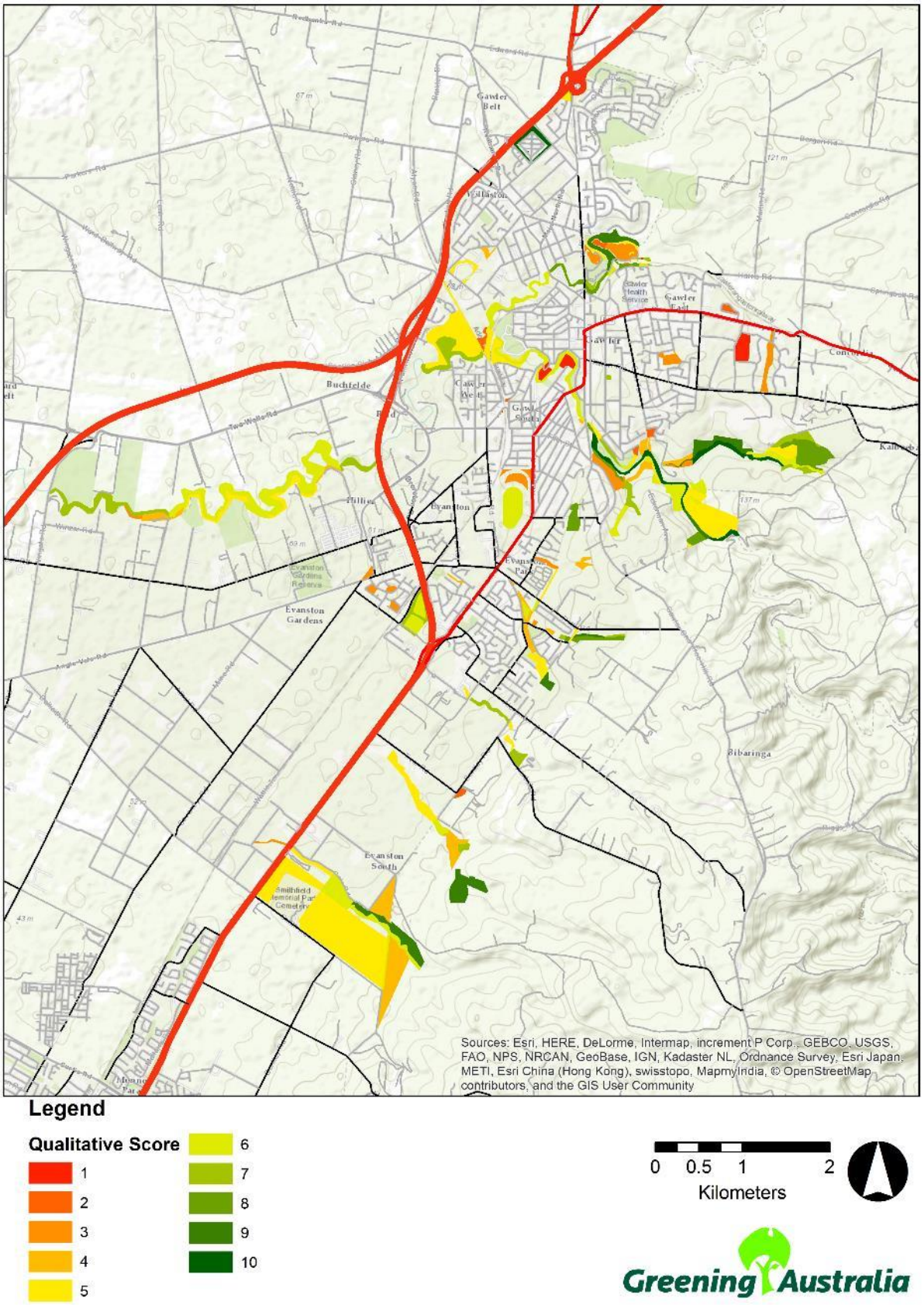
Total Native Bird Species for Zones

Map 16: Total Unique Native Bird Species, including Historic Records, for Zones



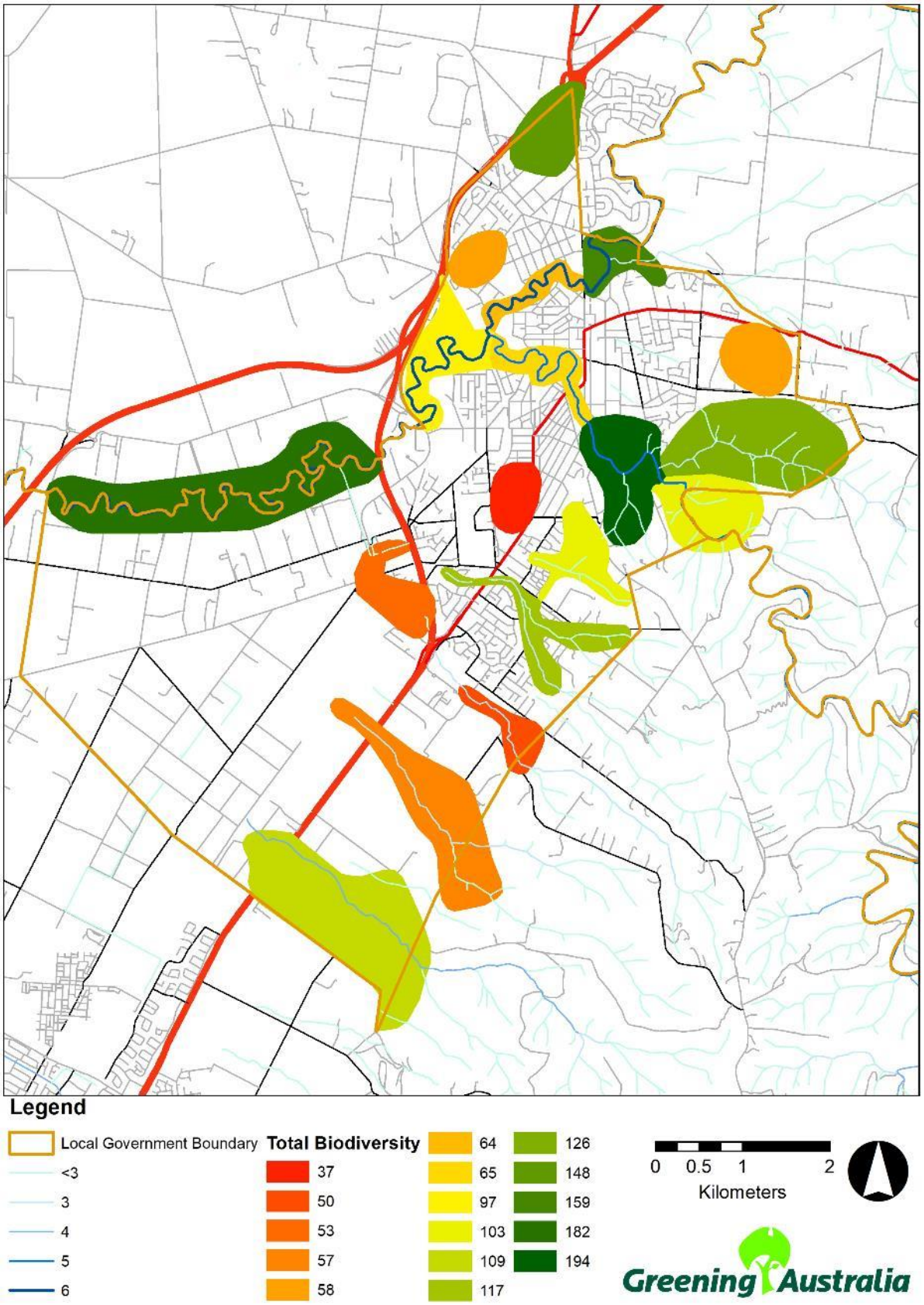
Qualitative Patch Score

Map 17: The Qualitative Patch Score for each Surveyed Patch.



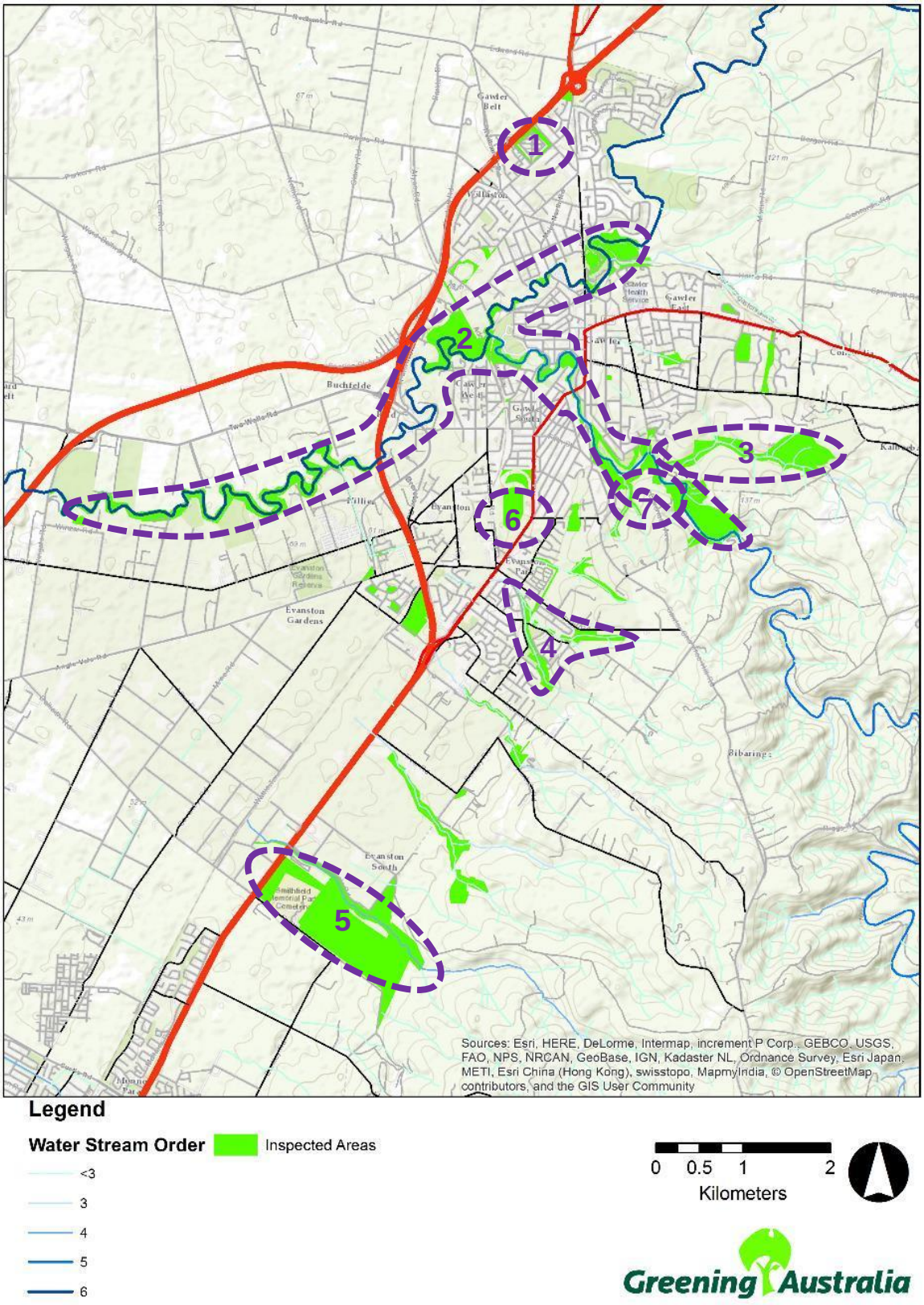
Total Biodiversity for Zones

Map 18: Total Biodiversity, including Historic Records, for Zones



Priority Areas

Map 19: Priority Areas for Biodiversity Conservation



Note: Numbers 1-7 are for labelling purposes only and do not represent a relative priority.

Priority Biodiversity Area 1 – Willaston Cemetery

Willaston Cemetery contains a number of species not found anywhere else in the Town of Gawler. This vegetation is classified as climate change resistant. The site is stranded in an urban environment with very few opportunities for recruitment or dispersal, weed load (including planted trees) is high and natural dispersal opportunities are very limited. Opportunities to use the genetic material on this site to translocate to alternative sites with better long-term viability.

RECOMMENDATIONS

See recommendation 28.

Priority Biodiversity Area 2 – North Para, South Para and Gawler River

Critically important as a regional biodiversity corridor but also includes a patch with the maximum number of birds recorded, including several EPBC listed species, and the maximum qualitative patch score for the Town of Gawler. Remnant floral diversity is at the lower end of the spectrum across most of the corridor, but this is partially skewed by the inherent nature of the vegetation and has been significantly improved with recent revegetation projects.

RECOMMENDATIONS

See recommendations 13, 16, 18 and 29.

30. Revegetation of the North Para, South Para and Gawler River

Revegetation is likely to be required, to varying extensts, to improve species and structural diversity along the much of the 3 Rivers, very much in line with the existing Gawler Urban Rivers Project. This revegetation should be undertaken after appropriate weed control, identified in previous recommendations, to also contribute to bank stabilistation after this vegetation removal.

Refer to species diversity mapping for specific locations where floral diversity, or key structural species are absent.

31. Reconnect and Restore River Box Woodlands

Several small populations of River Box occur along the Gawler River in Hillier and Evanston. These remnants are very degraded and are slightly isolated from the more intact Red Gum woodlands along the main river channel.

Given this work is not on Council land, these steps may be suited to NRAMLR.

1. Approach the landholder(s) to determine feasibility.
2. Implement condition and connectivity improvement activities
    a. fencing
    b. woody weed control
    c. revegetation
3. Explore the potential uptake of sustainable grazing with landholder(s) to facilitate complementary land management practices.

Council should seek to replicate some River Box Woodlands in man-made environments such as stormwater wetlands and similar water detention systems to improve the representation of this community in the area.

Priority Biodiversity Area 3 – Springwood Creek Line and nearby open space

Springwood contains elements of almost every vegetation type in Gawler in a situation which is likely to be resilient to the changes of climate change and therefore function as a local refugia. Most of the patches had a relatively high number of remnant native plants and a very high qualitative patch score. It scored quite poorly for birds observed, but other biodiversity reports confirm higher bird diversity. The patch is well connected and is an important component of the South Para River's biodiversity corridor.

RECOMMENDATIONS

See recommendations 5, 17, 19, 20, 21, 22 and 24.

Priority Biodiversity Area 4 – Evanston Park Creek Lines

Council owns the lower portions of the creek lines, with the upper portions in private land. Current private land management practices are very good. Although the indicators decline markedly as the creek lines enter the higher density built up areas these creek lines bound by Potts Road and Sunnyside Drive contain a large number of uncommon species and some excellent examples of large remnant trees. The upper reaches of the northern branch (private land) are in particularly good condition. High biodiversity values within these creek lines combined with high levels of weed threats makes this site a priority for conservation action.

RECOMMENDATIONS

32. Evanston Park creek line restoration program

The gradual restoration of grassy woodland along the two creeks to improve corridor function into suburban Evanston Park.

1. Engage private landholders to gauge interest in participation.
2. Establish a detailed prioritised management plan for the project.
3. Weed control of priority weeds working from upper catchment to lower (including private land where possible). Transition management of grassland areas to a mowing regime once persistent weeds are controlled.
4. Formalise access paths within the open space.
5. Revegetate with appropriate grassy woodland species.

Priority Biodiversity Area 5 – Gawler Buffer East

Gawler Buffer East, particularly the watercourse running through it, scored very highly for remnancy and qualitative patch score. It did not score well for bird diversity, however the bird assemblage observed there was significantly different to other areas in the Town of Gawler, containing many grassland specialists as opposed to woodland specialists or generalists.

RECOMMENDATIONS

See recommendation 25

Priority Biodiversity Area 6 – Gawler Racecourse

A surprisingly biodiverse piece of land, not least because it contains a significant number of Austral Trefoil (*Lotus australis*), the only known location for the species for a significant distance, but a number of other important biodiversity assets including patches of native grassland, Maireana brevifolia shrubland and the only known suburban Australian Pipits (*Anthus australis*). The current land management has no conservation focus and a single adverse event may cause significant biodiversity losses.

RECOMMENDATIONS

33. Conserve and improve the biodiversity values of the Gawler Racecourse

1. Draft a management plan to reduce the potential for impacting activities.
    a. Brief the groundskeepers on the practical implementation of this.
2. Clearly mark out the Lotus australis plants for specific protection.
3. Obtain permission to collect seed and translocate populations elsewhere in the Town of Gawler to backup genetic resources.
4. Negotiate with Gawler and Barossa Jockey Club the potential of site being a focus for ground-nesting bird conservation by improving grassy habitat.

Priority Biodiversity Area 7 – Dead Man's Pass

The grassland and grassy woodland areas in this reserve are of high biodiversity value, particularly the area along the southern bank. This remnant grassland area contains some 60 native flora species and a large variety of fauna making it one of the most concentrated biodiverse areas in the Council.

RECOMMENDATIONS

34. Biodiversity management of grasslands and grassy woodlands in Dead Man's Pass

1. Prepare a management plan for this area based on previous biological survey work.
2. Weed control of priority weeds
    a. Woody weed control throughout the area.
    b. Herbaceous weed control in areas of sensitive native species to encourage recruitment.
    c. Thinning of overly dense tree plantings to facilitate natural recruitment of grassland species.
3. Supplement natural recruitment with plantings of appropriate grassland species.
4. Formalise tracks and take measures to close informal tracks, particularly along the clifftops which are dangerous and support sensitive biodiversity assets.
5. Install interpretive signage highlighting the biodiversity value of the area.
6. Foster a community group to participate in the work and adopt the area to increase community investment. Ensure Council employees actively work with the community group to engender cooperation and trust.

Areas to be Formally Protected

There were no sites identified which warrant or require formal protection at this time. Council has secure tenure and with proper management under existing legislation and regulation there are sufficient levers available to Council to protect important biodiversity areas.

One scheme to leverage investment into priority conservation projects is to voluntarily enter the Native Vegetation Council's third-party provider Significant Environmental Benefit (SEB) offset scheme. Recent changes to the Native Vegetation Act (1991) allow for someone other than the person carrying out clearance (such as the Town of Gawler) to provide an SEB offset. Council could proactively seek funds from the clearance proponents to implement site improvements in priority locations in exchange for offsetting local biodiversity impacts.

This would require the proposed SEB land to be covenanted with a heritage agreement and have a prescribed management plan developed. This would have the effect of providing a type of formal protection, but with a financial reward to enable the on-ground work to be effectively delivered. The City of Onkaparinga has already gone down a similar route, primarily to offset its own SEB obligations under the Act.

RECOMMENDATIONS

35. Utilise the SEB process for funding biodiversity programs

Council scope a conservation project/program for potential SEB credits and seek market investment into implementing this project/program.

Opportunities for School and Community Involvement

Town of Gawler and community groups have worked together a number of times in the past to plant native species within the reserves of Gawler. These community planting activities have been facilitated with planning and preparation works by Town of Gawler, in consultation with the community groups. Following these activities weed management, watering and monitoring has been undertaken by Council staff.

During Youth Week April 2018, Council undertook engagement sessions with school aged children. Responses captured in a survey on matters concerning the environment included examples of initiatives young people may like to get involved in and barriers that may prevent them from doing so.

According to responses, local environmental initiatives young people would like to be involved with were:

- Local walks (80%)
- Tree planting (60%)
- Nature crafts (58%)
- Upcycling & recycling activities (37%)
- Picking up rubbish (32%)
- Environmental group (27%)
- Revegetation activity (26%)

Provided responses from youth to the question "What would help you get more involved?"

- Knowing what's happening and available
- Doing activities with a group of friends
- Make activities fun and interactive
- Weekends or school based
- Explain why I could make a difference
- Free

With any community planting activity; long term follow-up activities require appropriate planning and management by Council staff to ensure long term success of the progress. To expand on these earlier programs the following opportunities have been identified.

School Grounds

Trinity College has a creek line of moderate biodiversity value, with good connections upstream and potential for restoration. Some biodiversity work has been undertaken in the creek line, but there is scope for more to be done to improve species diversity, structure and habitat components. Other large areas of grounds and open space nearby could all be improved with school participation, although there are no immediate plans for conservation work within these areas.

Gawler East Primary School has a significant patch of revegetated woodland and creek line in an adjacent reserve which could be improved with planting and weeding.

Immanuel Lutheran School has no significant grounds which would suit a significant in-situ biodiversity project. Bee hotels, Bat boxes and similar may be suitable.

Gawler Primary School was recently awarded a 'Fund My Neighbourhood' grant for a nature play area and outdoor classroom. They do not have any significant grounds which would suit a significant in-situ biodiversity project. Bee hotels, Bat boxes and similar may be suitable.

Gawler and District College has a wetland on Barnett Road, providing opportunities for planting, weed control, water monitoring and animal identification.

Opportunities to Contribute to Council Projects and Programs

There are three main areas in which community involvement in Town of Gawler projects could be directed:

1. Joining a community group which adopts a patch of native vegetation or a project to establish native vegetation.

2. Making bee hotels, bird boxes, bat boxes and similar in workshop situations for installation into sites. This would suit school groups learning woodwork skills, or biology students learning about habitat requirements of different animals.

3. Participation citizen science monitoring programs which inform the general biodiversity of the area and/or project performance. Broadly available programs include water watch and frog watch. A more specific monitoring program would include participation in the proposed bird monitoring program on the 3 rivers. This should not be a substitute to professional science but viewed as valuable supplements to it.

Allocation of Council Resources to Deliver Recommendations

Council currently has resources in terms of staffing, equipment and budget for managing its open space, road reserves and other assets which have biodiversity significance. Costings are indicative of the (mostly) time and inputs required. Some of the projects could be supported with input from community groups and other volunteers. The resources suggested below may involve re-allocation of existing resources rather than new resources.

Projects

1. Improve backyard habitats

1. Support the Gawler Environment Centre's "Understorey Project" and other similar measures to promote the planting and retention of native and biodiverse backyards.
2. Increase the awareness of inappropriate plantings of environmental weeds such as Ash, Gazania, Fountain Grass and Palms in favour of more desirable native, or at least non-invasive, alternatives. Existing resources such as the "Grow Me Instead" initiative by the Nursery and Garden Industry Australia and the "Creating a Wildlife Friendly Garden" resource by NRAMLR could be used or adopted as a template for a Town of Gawler specific version. Targeting new residents, new migrants and the horticultural and landscaping industry may have the greatest impact.

Timeframe: Short to long term - ongoing

Resourcing:

Council could support the understorey project by providing promotion through its public communication channels. They could also provide financial support by subsidising the cost of seedlings to Town of Gawler residents. Cost would vary depending on the level of support.

Utilising existing communication resources would not have any significant impost. If a Town of Gawler specific guide for appropriate native plantings was developed it would cost around $10,000 - $15,000 to produce a print ready resource (which could be available as a web resource) and another $5,000 to print hard copies for dissemination. A process would need to be developed whereby it was provided to targeted residents and this would need to be resourced with staff time to administer.

Year 1: TBC **Total Year 10:** TBC

Relative Priority: Medium

3. Improve native diversity of park vegetation

1. Identify suppressed native shrubs, herbs and grasses in suburban parks and delineate a management zone (i.e. no mowing/spraying) to allow them to grow up.
2. Incorporate planting of patches of local native shrubs, herbs and grasses into suburban parks. These should be integrated into the design of infrastructure features.

Timeframe: Medium term – 5 years

Resourcing:

Site preparation, planting and installation of a small section (≈100m²) of a park would cost round $2,000. Ongoing maintenance of around 2 person days would cost around $1,500 per annum for the first 2 years, reducing to less than 1 day per annum thereafter.

Year 1: $2,000 **Total Year 5:** $6,000

Relative Priority: Medium

4. Habitat enhancement in parks

Install habitat enhancing features in suburban parks such as:

- “Bee hotels”
- Bird boxes
- Possum boxes
- Bat boxes
- Logs
- Bared soil
- Rockeries

Install interpretive material for people to understand the value of these in the suburban landscape and improve adoption of them in private backyards.

Timeframe: Short to long term - ongoing

Resourcing:

Bird, Bat and Possum boxes range in price from $40-$60 each. However, these items are ideal project for school children of varying ages to build as part of woodwork or environmental classes, or for mens’ sheds and similar hands-on groups. Council could provide the materials or subsidise the material costs to construct the nest boxes. An allocation of $1,000 per annum would support the production of around 50 boxes. Installation would cost around $1,500 per annum depending on the heights at which they are installed. Material costs for bee hotels are very low to negligible as they can be made from logs, bamboo canes or lumps of clay.

Logs could be sourced from woody weed control projects throughout the council area. They may need to be secured with wire or pins to prevent theft. Cost would be less than $1,000 per park to install a log pile. Assuming there are 30 parks that are suitable for these features = $30,000.

Rockeries can be developed with large landscaping rocks (preferably avoiding ‘moss’ rocks), piled to provide overhangs. Alternatively, a single gabion (≈2m^3) block with large rocks can fulfil the same function. Moss rocks cost $50-$100 per tonne which would be adequate for a park. Any use of moss rocks should only be from a sustainable source. The cage and materials for a single gabion would cost around $200 each. Labour and machinery to install would probably cost around $500 each, regardless of the option. One such feature per park would be adequate. Assuming there are 30 parks which would be suitable for these features = $19,500.

Year 1: $7,500 **Total Year 10:** $75,000

Relative Priority: Medium

5. Grassland restoration along the Gawler East easements

The powerline and pipeline easements in Gawler East are excellent candidates for suburban connectivity grasslands restoration as they are incompatible with other revegetation and other elevated infrastructure and amenity.

5. Discussions with Springwood over the possible development and landscaping in these corridors
6. Scaling up works to implement a viable grassland restoration
    a. Secure seed supply through arrangements with grassland owners or creating a seed production area
    b. Discuss implementation with Seeding Natives or Greening Australia or other suppliers (see “Stakeholders and Potential Partnerships in Biodiversity Management”) about methodology and technology limitations
7. Implement grassland restoration projects and maintenance as appropriate
8. Install interpretative signage regarding the value and function of native grasslands in the local environment.

Timeframe: Medium term – 5 years.

Resourcing:

Grassland restoration using the grassy groundcover methodology costs around $10,000 hectare. The powerline easement is around 2.5 hectares so would cost around $25,000 to install. The pipeline easement on the east side of the South Para River is around 1.5 hectares so would cost around $15,000 to install. Total cost is around $40,000. Establishing less diverse and basic native grass cover can be cheaper. Maintenance is minimal, if installed effectively, approximately $1,500 per annum.

Year 1: $40,000 **Total Year 5:** $47,500

Relative Priority: Low

6. Roadside vegetation survey

Conduct a roadside survey of vegetation types, conservation value and specific management requirements. This need not be as per the standard roadside survey methodology but should be a practical inventory to precede, and better inform, the delivery of recommendations 7, 8, and 10.

Timeframe: Short term < 1 year

Resourcing:

A consultant could produce a survey and report of this information for around $8,000.

Year 1: $8,000

Relative Priority: High

13. Designate on-leash areas for dogs in locations of high/sensitive biodiversity

Designate areas of on-leash only dog areas in Dead Man's Pass and the Gawler River to reduce negative interactions with wildlife and habitat. Community awareness would need to be raised through signage and advertising. Interpretive signage detailing the values of biodiversity in the area and its exposure to threats (as per recommendation 33) would also support this objective.

Timeframe: Short term < 1 year

Resourcing:

Production and installation of a number of standardised signs would cost in the order of $2,000. Public awareness advertising / advertorial in newspapers signs would cost in the order of $5,000.

Year 1: $7,000

Relative Priority: Low

15. Fountain Grass eradication

Fountain Grass is ranked as a high priority for control and is rapidly expanding into areas of high biodiversity value. It is also expanding into areas of future development which increases the fire risk of these locations. A highly targeted eradication program for this species could be completed within a few years but would require cooperation from the private landholders who own much of the infested land.

1. Negotiate with NRAMLR and landholders for an eradication program.
2. Commence weed control program from the northern extent of the infestation and progress in a southernly direction.
3. Educate landholders
    a. On native grass management to promote their recolonization of these areas.
    b. On follow up control methods to transfer maintenance onus.
4. Engage with the local nurseries to promote no sale of these plants to reduce local supply.

Timeframe: Medium term – 5 years practical completion.

Resourcing:

20 person days slashing, followed by 10 person days spraying per annum = $18,000 per annum, reducing to maintenance levels in years 4 and 5. Some contribution should be sought from landholders to reduce this cost, either as financial or in-kind.

Year 1: $18,000 **Total Year 5:** $65,000

Relative Priority: High

16. Eradication of small populations of high potential weeds

1. Montpellier Broom
   Known in a single location, the existing plant(s) should be removed, and the site monitored in the future for emergence of seedlings.
2. Watsonia
   Found in 2 locations on the South Para River, the existing plants should be removed, and the site monitored in the future for emergence of seedlings.
3. Creeping Groundsel
   Found in a single location on the South Para River, the existing plants should be removed, and the site monitored in the future for emergence of seedlings.
   NOTE – this area is to be treated in the upcoming 2018 GURWG planting plan.
4. Perennial Veldt
   Found in a single location at Clonlea Park. The existing plants should be removed, and the site monitored in the future for emergence of seedlings.

Timeframe: Short term – 3 years practical completion.

Resourcing:

Montpellier Broom and Perennial Veldt could be controlled in half a person day = $300. Watsonia control would take about 3 person days = $2,000. Creeping Groundsel may require maintenance after this year's initial control. Allow for 2 person days per annum = $1,500. All other weeds could be managed with a 1 person day per annum maintenance = $600. $6,500 total.

Year 1: $3,800 **Total Year 3:** $6,500

Relative Priority: High

17. Winter Cherry eradication

This rapidly expanding weed is spreading throughout the Council area, but a concerted control effort on public and private land is still capable of eradicating this weed.

1. Control should work across the known range, with priority given to the outliers to the west, and those plants along the rivers where spread has the most potential.
2. Private landholders will need to participate in the program, by controlling the weed or by allowing access to council/contractors to control. NRAMLR may need to be involved in facilitating this.
3. Control needs to be coordinated with DEW / Nature Foundation who are currently controlling the assumed source in the Para Woodlands.
4. Seek funding support from NRAMLR to support delivery of the program or manage the program.

Timeframe: Short term – 3 years practical completion.

Resourcing:

A contractor visiting all the known locations would take around 2 person days to control = $1,500. Further searching, monitoring of previous infestations and control should be undertaken in the following 2 years with the same effort = $1,500 per annum.

Depending on the success of control in the Para Woodlands area, ongoing minor control may be required.

Year 1: $1,500 **Total Year 3:** $4,500

Relative Priority: High

26. Gawler Buffer East grassland restoration

1. Discuss with NRAMLR and DEW the possibility of a shift in focal vegetation community.
2. On Council land along Gale Road, Smith Road and Main North Road.
    a. Remove inappropriate trees and shrubs.
    b. Promote perennial native grass cover with a mowing regime.

Timeframe: Short term – 3 years practical implementation

Resourcing:

Removal of inappropriate trees by contractor would cost around $10,000 per annum over 3 years = $30,000 total.

Mowing would require around half a day for a tractor to complete the flat areas. Creek line areas could be slashed annually with around 6 person days effort, $4,000 per annum over 3 years= $12,000 total. This regime would be ongoing.

Year 1: $14,000 **Total Year 3:** $42,000

Relative Priority: Medium

31. Reconnect and Restore River Box Woodlands

Council should seek to replicate some River Box Woodlands in man-made environments such as stormwater wetlands and similar water detention systems to improve the representation of this community in the area.

Timeframe: Medium term – 5 years

Resourcing: A passive approach would not be an additional cost, but a change to a business-as-usual planting program around a wetland construction.

A proactive approach, to plant into an existing wetland system such as Reid Park would cost around $10,000 for installation plus $5,000 per annum to maintain for 5 years.

Year 1: $15,000 **Total Year 5:** $35,000

Relative Priority: Medium

33. Conserve and improve the biodiversity values of the Gawler Racecourse

1. Draft a management plan to reduce the potential for impacting activities.
    a. Brief the groundskeepers on the practical implementation of this.
2. Clearly mark out the Lotus australis plants for specific protection.
3. Obtain permission to collect seed and translocate populations elsewhere in the Town of Gawler to backup genetic resources.
4. Negotiate with Gawler and Barossa Jockey Club the potential of site being a focus for ground-nesting bird conservation by improving grassy habitat.

Timeframe: Short term – 1 year

Resourcing:

A management plan for this area would cost around $5,000, including a groundskeeper's brief.

Marking out the Lotus plants would cost around $500 for labour and materials.

Year 1: $5,500

Relative Priority: Medium

7. Roadside mowing maintenance regime

Mowing of rural roadsides should replace herbicide management practices wherever practicably possible. Mowing/slashing should retain a good cover of vegetation above ground level and avoid disturbing the soil.

- Investigate / Trial suitable machines capable of variable terrain / angles / obstacles.
- Trial suitable regimes (timing, frequency, target species).
- Supplement with targeted control of persistent weeds and seeding of desirable native species

Timeframe: Long term – ongoing (costed over 10 years)

Resourcing:

Articulated flail mowers cost around $45,000. Shared machinery ownership with adjacent councils should be explored as an option for reducing up-front costs. An operator would probably cover the 115km of roadsides in around 10 person days = $7,000 per pass. Assuming 3 passes per annum that would cost around $21,000 per annum = $210,000 over 10 years.

Targeted herbicide control of persistent weeds would cost around $5,000 per annum over 5 years = $25,000.

Year 1: $57,000 **Total Year 10:** $280,000

Relative Priority: High

8. Targeted roadside woody weed control

Targeted woody weed control along rural roadsides (to be considered in context of broader weed control strategy).

Timeframe: Long term > 10 years.

Resourcing:

Without a detailed survey of the extent of the weed issue, it is difficult to determine what control might cost. A conservative estimate would be $10,000 per annum = $100,000 over 10 years.

Year 1: $10,000 **Total Year 10:** $100,000

Relative Priority: Low

9. Diversify street trees

Maintain a diversity of street trees, whilst reducing the emphasis on 'flowering gums' in new or replacement street trees. Explore the feasibility of increasing the number of local and other native tree and large shrub species which meet infrastructure compatibility criteria (e.g. sections 13-15 of the Water Industry Regulations 2012 under the Water Industry Act 2012 and the Electricity (Principles of Vegetation Clearance) Regulations 2010).

Timeframe: Long term - ongoing

Resourcing:

Replacement of trees should be through natural attrition and therefore additional cost to business as usual is negligible.

Relative Priority: Low

10. Suburban roadside regreening

Increase the structural complexity of vegetation on the verges of suburban roadsides. This should include clearly delineated patches of highly diverse local native grassy and herbaceous species, as well as a broader move away from large areas devoid of vegetation in favour of increasing native grass cover. Other habitat features could also be incorporated where feasible such as logs and rocks.

Timeframe: Long term > 10 years (costed over 10 years)

Resourcing:

Methodology, and therefore expense, will likely vary depending on the findings of recommendation 6 above.

Select a street or two which are particularly amenable to regreening (suitable topography, width, near native vegetation) and do these as trials and demonstration sites, with a view to gradual progression throughout the Town of Gawler. For example, the Dawkins Road reserve adjacent to Willaston Cemetery, the southern verge of Potts Road and the road verges adjacent to Elliott Goodger Reserve. Using grassy groundcover methods at a cost of around $15,000 per hectare, and working with a 4m strip this would cost around $6,000 per km to install, but this would vary depending on the nature of the roadside strip, particularly obstacles. Evaluation of this method versus traditional tubestock planting could be undertaken. Also, the cost: benefit in a presumed reduction in weed control over time should be monitored.

Year 1: $10,000 **Total Year 10:** $100,000

Relative Priority: Medium

11. Feral Pigeon and European Wasp control programs

Continue Council's Feral Pigeon and European Wasp control programs. Feral Pigeon control should be expanded to include sites which have biodiversity value not just urban areas.

Timeframe: Long term - ongoing

Resourcing:

Additional cost to existing program is probably minimal.

Relative Priority: Medium

12. Large scale Rabbit and Fox control program

Participate in, and actively promote, large scale Rabbit and Fox control programs coordinated through NRAMLR. Rabbit and Fox control should be integrated.

Timeframe: Long term – ongoing

Resourcing:

Council expenditure on this recommendation would be limited to land under the care and control of council. No major rabbit populations were identified on Council land, except at Clonlea Reserve. Control here has been costed in recommendation 27.

Relative Priority: High

18. Priority weed control program for the Gawler, North Para and South Para Rivers

Weeds are the most significant threat to the 3 rivers' biodiversity. Priority weeds include *Arundo donax, Fraxinus angustifolia, Lycium ferocissimum, Ipomoea indica, Olea europaea, Opuntia* spp*., Phoenix* spp*., Ricinus communis, Schinus molle and Senecio angulatus* (see Recommendation 13).

1. Implement a monitoring program for key performance indicators relating to function of corridor.
    a. Probably woodland birds are the best proxy for connectivity and condition of the corridor.
2. Weed control should start in the upper catchments – The North Para and South Para Rivers. It should not commence in the Gawler River until these areas have significantly reduced weed abundance.
    a. Notify landholders along the river of their weed control obligations as per the NRM Act (2004) to increase likelihood of private complementary works.
    b. Seek landholder consent to undertake complementary buffering revegetation along riparian strip.
        i. Identify areas where banks are eroding through fence lines and into paddocks as the priority location for these works.
    c. Enter into discussions with Playford, Light and Barossa Councils and NRAMLR to seek complementary weed control activities in the catchment areas above the Town of Gawler.
3. Where necessary control should be followed up with appropriate revegetation to ensure bank stability.
4. Seek to acquire land, or an interest in land, along the watercourses to ensure land management security and continuity (also increases feasibility of a linear path along this corridor at some future date).

Timeframe: Long term >10 years (costed over 10 years)

Resourcing:

The design and implementation of a bird monitoring program along the 3 rivers would cost around $7,000 per annum = $70,000 over 10 years.

The North Para and South Para have had a reasonable level of recent weed control so the expense to work in these areas is far lower per kilometre than weed control in the Gawler River. It is estimated that control of the priority weeds in the North Para River would cost around $60,000, with an ongoing investment of $4,000 per annum for maintenance = $100,000 total. It is estimated that control of the priority weeds in the South Para River would cost around $80,000, with an ongoing investment of $10,000 per annum for maintenance = $180,000. It is estimated that control of the priority weeds in the Gawler River would cost around $400,000, with an ongoing investment of $10,000 per annum for

maintenance = $500,000 total. Adjacent councils may contribute funding or resources where a river is a common boundary and therefore cost impact to Town of Gawler could be reduced.

The requirement for supplementary planting is likely to be highly variable throughout the program area. An arbitrary figure of $10,000 planting per annum could be allowed, with $4,000 per annum maintenance = $140,000 total.

Year 1: $161,000 **Total Year 10:** $1,090,000

Relative Priority: High

22. Foster community value of open space

There are a number of measures which could be employed to increase community support for the outcomes of, and effective management of corridors in suburban areas.

1. Plans for open space in large developments should be communicated to community members from the outset with an emphasis on generating community participation.
2. Select a flagship species to represent the success of project. These should be compelling to the public, be ambitious to foster a sense of drive to achieve it and be realistic so that community can experience some measure of success. E.g. Superb Fairywren, Echidnas, etc.
3. Formally name the many unnamed creeks in the hills face area. This should be in accordance with Geographical Names Act 1991. It will give the community an easy reference to the geographic areas.
4. Foster the development of local 'Friends of' or 'Landcare' type community groups. See "Opportunities for School and Community Involvement" for more in this theme.

Timeframe: Long term – ongoing (costed over 10 years)

Resourcing:

The cost of supporting a community group to participate in site activities is difficult to estimate. To create a new group time would need to be invested by Council in enrolling members, training the team, organising roles, etc. NRAMLR may play a role in facilitating such a group. Costs to provide material support to a community group are usually minor, with a once-off cost to purchase equipment and then support for consumables. Associated material costs would be around $2,000 at start-up and $500 per annum = $7,000 total.

Year 1: $2,500 **Total Year 10:** $7,000

Relative Priority: Medium

27. Vadoulis Reserve corridor program

1. Undertake condition improvements in Vadoulis Reserve proper
    a. Weed control of priority weeds. Including a slashing regime to reduce annual grass coverage.
    b. Revegetation with appropriate grassland plant species.
2. Discussions with DPTI around future land use of their parcels of land in this vicinity (dependent on alignment of the Link Road and development choices).
3. Develop a restoration plan for the potential corridors.
4. Implement restoration in line with the plan.
5. Seek to foster a community group to adopt the reserve and undertake management actions.

Timeframe: Medium term – 5 years to practical completion.

Resourcing:

Initial weed control would require around 30 person days and cost around $20,000 in the first year, including woody weed control and slashing. Subsequent years would require around 3 person days per month = $2,000 per annum.

A restoration plan for the corridors would cost around $10,000.

Implementation of a revegetation program of around 5 hectares would cost around $30,000. Annual maintenance would require around 3 person days per month = $22,000 per annum.

The cost of supporting a community group to participate in site activities is difficult to estimate. To create a new group time would need to be invested by Council in enrolling members, training the team, organising roles, etc. NRAMLR may play a role in facilitating such a group. Costs to provide material support to a community group are usually minor, with a once-off cost to purchase equipment and then support for consumables. Associated material costs would be around $2,000 at start-up and $500 per annum = $4,500 total.

Year 1: $62,000 **Total Year 5:** $160,500

Relative Priority: Low

28. Willaston Cemetery management program

Maintain and improve the resilience of the site.

1. Produce an updated Management Plan for the native vegetation area.
    a. Include an assessment of the options for restoring native species which are known to have died out in the Cemetery or are known to have occurred in the locality but are not present in the Cemetery.
    b. Continue current maintenance activities to improve health and resilience as far as possible.
    c. Weed control should be prioritised over additional planting.
    d. Sugar Gums (*Eucalyptus cladocalyx*) and Aleppo Pines (*Pinus halepensis*) within the native vegetation, and the large Casuarina (*Casuarina* sp.) in the north west corner should be removed. These trees are impacting desirable vegetation through moisture and shade competition.
        i. Hollows should be salvaged and re-installed on site to maintain Possum habitat, but in a manner which will discourage Corella use.

Translocate rare species and genetics.

2. Translocate the genetic material of the Willaston Cemetery to alternative sites with better long-term viability
    a. Identify a suitable translocation site which will meet the habitat needs to the vegetation (e.g. soil, hydrology, aspects, etc), including consideration for future climate change. If no site exists in Town of Gawler, the following points may be implemented by another agency (Council, NRM, NGO).
    b. Collect seed and cuttings from as wide a range of remnant plants as possible to maximise genetic diversity.
    c. Commence revegetation with this material and other suitable provenance material.

Timeframe: Medium term – 5 years practical completion

Resourcing:

Production of a site management plan would cost around $5,000.

A weed control contractor providing 2 person days per month would cost around $15,000 per annum = $75,000 total, in addition to the current support being provided to the Bush For Life team.

Removal of Sugar Gums and Pines within the native vegetation area may cost around $30,000 (net) by a professional arborist. The total cost is likely to be higher, but some wood could be sold to offset the cost – although some should be kept as materials for habitat boxes and log features.

Collecting a representative seed bank would cost around $5,000 to collect and bag samples for those species which produce seeds. This should be repeated at least once = $10,000 total cost. Utilising the Bush For Life team to conduct collection may reduce this cost.

A passive approach to translocating the genetics would not be an additional cost, but a change to a business-as-usual planting program around another planting site. A proactive approach, to plant a new site, would cost around $10,000 for installation plus $5,000 per annum to maintain for at least 3 years. = $25,000 total. A hybrid approach would be an intermediate cost.

Year 1: $65,000 **Total Year 5:** $145,000

Relative Priority: Medium

29. Restoration program of Clonlea Park and Whitelaw Creek

1. Maintain the pre-existing mowing regime in the open areas of the park. Expand to other grassy areas which are not subject to regular mowing.
2. Thin the canopy of non-local species gradually, radiating from the grassland remnants and derived grasslands as these will be most effectively recolonised.
    a. Control the spread of Senna artemisioides in vicinity of Whitelaw Creek.
3. Eradicate priority weed species such as Boxthorn, Olive, Prickly Pear and Perennial Veldt.
4. Control Rabbits and ongoing monitoring for new recruitment.
5. Supplement natural recruitment with plantings of grassland species.
6. Install interpretive signage
    a. Initially explaining the transitional approach to the reserve
    b. Later highlighting the biodiversity value of grassy woodlands and the role they play in local ecology.
7. Foster a community group, possibly the Whitelaw Creek Catchment Care Group, to participate in the works and adopt the area to increase community investment.

Timeframe: Long term – 10 years to practical completion.

Resourcing:

Expanded mowing regime might require an additional 6-8 person days per annum. Contracted cost of around $3,500 - $5,000 per annum = $35,000 - $50,000 total.

Canopy thinning would require around 10 person days plus minor chipping per annum for 4 years. Contracted cost of around $7,000 per annum = $28,000 total.

Senna control would require around 2 person days per annum. Contracted cost of around $1,200 per annum = $12,000 total.

Eradication of woody weeds would require an initial investment of around 15 person days, with 2 person days per annum maintenance. Contracted cost of $10,000 for first year and $1,200 per annum = $21,000 total.

Rabbit control would require a single initial treatment, with 2 subsequent treatments likely over 10 years. Contracted cost of around $3,000.

Annual planting of 1,000 seedlings per annum would cost around $5,000 per annum, plus $5,000 per annum maintenance = $100,000 total.

Interpretive signage would cost around $10,000 to design and install.

The cost of supporting a community group to participate in site activities is difficult to estimate. If WCCCG were to play a role in this, costs would be reduced as they already have an established working group. Whereas if a new one was to be created time would need to be invested by Council in enrolling members, training the team, organising roles, etc. NRAMLR may play a role in facilitating such a group. Costs to provide material support to a community group are usually minor, with a once-off cost to purchase equipment and then support for consumables. Associated material costs would be around $2,000 at start-up and $500 per annum = $7,000 total.

Year 1: $46,000 **Total Year 10:** $231,000.

Relative Priority: Medium

30. Revegetation of the North Para, South Para and Gawler River

Timeframe: Long term > 10 years (costed over 10 years)

Resourcing:

The extent of required revegetation is somewhat unknown until after priority weed control works have been completed (see recommendation 17). An allowance for revegetation to rehabilitate these areas is accounted for in that section. Additional revegetation in areas of low structural and/or species composition may amount to around 2,000 plants per annum = $12,000 per annum = $120,000. Costs could be reduced if community groups or a community planting event is involved in the planting.

Year 1: $12,000 **Total Year 10:** $120,000

Relative Priority: Medium

32. Evanston Park creek line restoration program

1. Engage private landholders to gauge interest in participation.
2. Establish a detailed prioritised management plan for the project.
3. Weed control of priority weeds working from upper catchment to lower (including private land where possible). Transition management of grassland areas to a mowing regime once persistent weeds are controlled.
4. Formalise access paths within the open space.
5. Revegetate with appropriate grassy woodland species.

Timeframe: Long term > 10 years (costed over 10 years)

Resourcing:

Establishing a detailed management plan for this area could cost up to $10,000.

Initial woody weed control would cost around $20,000, with maintenance weed control costing $5,000 per annum for 2 years. Initial herbaceous weed control would cost around $20,000 with maintenance weed control costing $10,000 per annum for 10 years – transitioning from herbicide based control into mowing/slashing maintenance.

Revegetation would cost around $30,000 over 5 years.

Year 1: $60,000 **Total Year 10:** $190,000

Relative Priority: Medium

34. Biodiversity management of grasslands and grassy woodlands in Dead Man's Pass

1. Prepare a management plan for this area based on previous biological survey work.
2. Weed control of priority weeds
    a. Woody weed control throughout the area.
    b. Herbaceous weed control in areas of sensitive native species to encourage recruitment.
    c. Thinning of overly dense tree plantings to facilitate natural recruitment of grassland species.
3. Supplement natural recruitment with plantings of appropriate grassland species.
4. Formalise tracks and take measures to close informal tracks, particularly along the clifftops which are dangerous and support sensitive biodiversity assets.
5. Install interpretive signage highlighting the biodiversity value of the area.
6. Foster a community group to participate in the work and adopt the area to increase community investment.

Timeframe: Long term – 10 years

Resourcing:

A management plan for this area could cost up to $8,000. There are some earlier plans which could be a basis for further planning.

Woody weed control would require an initial investment of around 15 person days, with 2 person days per annum maintenance. Contracted cost of $10,000 for first year and $1,000 per annum = $20,000 total.

Herbaceous weed control in sensitive areas would require an initial investment of around 4 person days per annum. Contracted cost of $2,500 per annum = $25,000 total. A complementary mowing/slashing regime would also need to be instigated to manage grassy/herbaceous weeds in the broader area. This would require around 10 person days per annum = $6,000 per annum = $60,000 total.

Canopy thinning would require around 10 person days plus minor chipping per annum for 2 years. Contracted cost of around $7,000 per annum = $14,000 total. Some wood could be sold to offset the cost – although some should be kept as materials for habitat boxes and log features.

Removal of trees adjacent to priority grassland area would cost around $5,000. Some wood could be sold to offset the cost – although some should be kept as materials for habitat boxes and log features. Planting up of this area with appropriate species would cost around $5,000, with an ongoing maintenance requirement of around $1,000 per annum.

Formalising the tracks would require the installation of barriers/infrastructure. Costs unknown.

Interpretive signage would cost around $10,000 to design and install.

The cost of supporting a community group to participate in site activities is difficult to estimate. To create a new group time would need to be invested by Council in enrolling members, training the team, organising roles, etc. NRAMLR may play a role in facilitating such a group. Costs to provide material support to a community group are usually minor, with a once-off cost to purchase equipment and then support for consumables. Associated material costs would be around $2,000 at start-up and $500 per annum = $6,500 total.

Year 1: $49,500 **Total Year 10:** $102,500

Relative Priority: High

2. Maintain backyard habitats

Encourage the retention of open garden space in new developments and subdivisions through planning policies and decisions.

Relative Priority: Medium

14. Change cat ownership and management regulations

Cats have a significant impact on biodiversity and a Council which is seeking to maximise biodiversity and ecological function needs to take the management of cats in the landscape seriously. To reduce the extent of the cat threat Council would need to make changes to the existing management policies. The most beneficial biodiversity outcome would be to aim for the cessation or limitation of cat ownership. A variety of other policies which restrict cats' interaction with open space would be beneficial.

Relative Priority: High

19. Improving condition of suburban corridors

The forecast expansion in subdivision and development of the land parcels which the steep creek lines and rivers dissect represents an opportunity for Council to manage planning power to ensure that works within these corridors are conducted to maintain and improve the function of these corridors and reduce Council's and resident's liability for significant ongoing maintenance and fire hazards.

Prior to the vesting of land to Council, Council may request the land be vested to an acceptable standard which meets one objective; the site achieves a desirable level of native biodiversity that is self-sustainable, or sustainable with the least possible human intervention.

Relative Priority: High

20. Minimise encroachment and edge effects

The aim of corridors is to improve terrestrial biodiversity. To achieve this a corridor width of 200m is desirable. Larger buffers are better where this can be achieved. Compromises will obviously need to be made in some areas for narrower buffers, where 200m cannot be achieved. Negotiations to achieve higher quality corridors may help to mitigate the reduced width.

In addition to these buffers of native vegetation, development on the outer edge of these buffers should, where possible, be tapered in order of the development's potential to contribute to the severest edge effects, from least impacting to more impacting features. For example: BUFFER →open space → paths → roads → housing. This step back would also align with CFS bushfire buffer zone management practice (CFS, 2016).

Relative Priority: High

21. Mitigate fragmentation and blockages

1. Ensure that some formal crossing points, with appropriate design, are installed in these watercourses to discourage the establishment and proliferation of informal alternative crossing points.
2. The design of a road barrier should incorporate underpass and overpass features which allow terrestrial animals to easily move from one side to the other without the risk of being exposed to traffic.
    a. Underpass features should ensure that the size is large enough allow a kangaroo to move through and ensure that light can penetrate throughout.
    b. Ideally an underpass would retain or re-establish vegetation similar to the adjacent remnant, but this is not always feasible from an infrastructure maintenance point of view.
    c. Overpasses should install climbing features to cater for highly mobile animals such as Possums and Koalas which may find themselves trapped on or outside a road.
3. Infrastructure should be designed such that low flows are maintained as seasonally appropriate.

Relative Priority: High

23. Formal recognition of the value of grasslands

Relative Priority: Medium

24. Water sensitive urban design

Development has the potential to alter surface and groundwater hydrology through increased hard surfaces, stormwater interception and rainwater capture. This changes the area, volume and location of infiltration and surface flows which can have secondary impacts on a number of hydrologically sensitive vegetation types and habitat feature which are found in or near to the development zone. Overcoming these issues can use a combination of conventional and progressive water sensitive urban design (WSUD) engineering.

1. As much as possible permeable surfaces or similar should be utilised to minimise the extent of changes to water infiltration patterns.
2. Where detention is required it should be as close as possible to source, with facilities made for infiltration from these points where suitable. These should be planted with appropriate wetland adapted local native species (see Appendix 3).
3. In appropriate locations, smart rainwater tanks should be trialled. These release a measured amount of stored rainwater in advance of a forecast rain event. This can help smooth out the storm water surges, reducing pressure on stormwater management infrastructure and improving ground water infiltration.

Timeframe: Long term - ongoing

Resourcing: Smart rainwater tanks have not been utilising at scale and cost is unknown. Contact Water Sensitive SA to develop a demonstration site.

Relative Priority: Low

25. Biodiversity Programs are developed around SMART objectives

Biodiversity projects and programs should be developed around SMART objectives which will enable proper performance evaluation.

Timeframe: N/A.

Resourcing: Should be incorporated into standarard planning processes. Additional monitoring requirements or equipment may be need to be resourced, but cannot cost cannot be pre-empted.

Relative Priority: High

35. Utilise the SEB process for funding biodiversity programs

Council scope a conservation project/program for potential SEB credits and seek market investment into implementing this project/program.

Timeframe: N/A.

Resourcing: The preparation of and SEB application by an accredited consultant costs around $10,000 – $15,000 depending on the scale of the proposed offset. This cost can be recouped as part of the payment for delivering the offset.

Relative Priority: High

Prioritised List of Recommendations

Rec. Number	Recommendation Title	Locality	Timeframe* (years)	Total Estimated Cost	Priority	Category
25	Biodiversity Programs are developed around SMART objectives	Entire Council Area	-	-	High	Policy
16	Eradication of small populations of high potential weeds	Gawler, Gawler South	3	$6,500	High	Projects
18	Priority weed control program for the Gawler, North Para and South Para Rivers	3 Rivers	10+	$1,090,000	High	Programs
21	Mitigate fragmentation and blockages	Gawler East, Gawler South, Evanston Park	-	-	High	Policy
20	Minimise encroachment and edge effects	Gawler East, Gawler South, Evanston Park	-	-	High	Policy
19	Improving condition of suburban corridors	Gawler East, Gawler South, Evanston Park	-	-	High	Policy
14	Change cat ownership and management regulations	Entire Council Area	-	-	High	Policy
34	Biodiversity management of grasslands and grassy woodlands in Dead Man's Pass	Gawler South	10	$102,500	High	Programs
15	Fountain Grass eradication	Gawler East, Gawler South, Evanston Park	5	$65,000	High	Projects
17	Winter Cherry eradication	Entire Council Area	3	$4,500	High	Projects
6	Roadside vegetation survey	mainly Evanston Gardens, Hillier, Kudla, Evanston South	1	$8,000	High	Projects
7	Roadside mowing maintenance regime	mainly Evanston Gardens, Hillier, Kudla, Evanston South	10+	$280,000	High	Programs
12	Large scale Rabbit and Fox control program	Entire Council Area	-	-	High	Programs
35	Utilise the SEB process for funding biodiversity programs	Entire Council Area	-	-	High	Policy
28	Willaston Cemetery management program	Willaston	5	$145,000	Medium	Programs

Rec. Number	Recommendation Title	Locality	Timeframe* (years)	Total Estimated Cost	Priority	Category
1	Improve backyard habitats	mainly Willaston, Gawler, Gawler West, Gawler East, Gawler South, Evanston, Evanston Gardens, Evanston Park	-	-	Medium	Projects
22	Foster community value of open space	mainly Gawler, Gawler East, Gawler South, Evanston Park	10+	$7,000	Medium	Programs
31	Reconnect and Restore River Box Woodlands	Reid, Gawler West, Hillier	5	$35,000	Medium	Projects
4	Habitat enhancement in parks	Entire Council Area	10	$75,000	Medium	Projects
3	Improve native diversity of park vegetation	Entire Council Area	5	$6,000	Medium	Projects
30	Revegetation of the North Para, South Para and Gawler River	3 Rivers	10+	$120,000	Medium	Programs
29	Restoration program of Clonlea Park and Whitelaw Creek	Willaston	10	$231,000	Medium	Programs
23	Formal recognition of the value of grasslands	Entire Council Area	-	-	Medium	Policy
33	Conserve and improve the biodiversity values of the Gawler Racecourse	Evanston	1	$5,500	Medium	Projects
10	Suburban roadside regreening	TBC, potential throughout Entire Council Area	10+	$100,000	Medium	Programs
11	Feral Pigeon and European Wasp control programs	Entire Council Area	-	-	Medium	Programs
2	Maintain backyard habitats	Entire Council Area	-	-	Medium	Policy
26	Gawler Buffer East grassland restoration	Evanston South	3	$42,000	Medium	Projects
32	Evanston Park creek line restoration program	Evanston Park	10+	$190,000	Medium	Programs
13	Designate on-leash areas for dogs in locations of high/sensitive biodiversity	Reid, Gawler South	1	$7,000	Low	Projects
5	Grassland restoration along the Gawler East easements	Gawler East	5	$47,500	Low	Projects

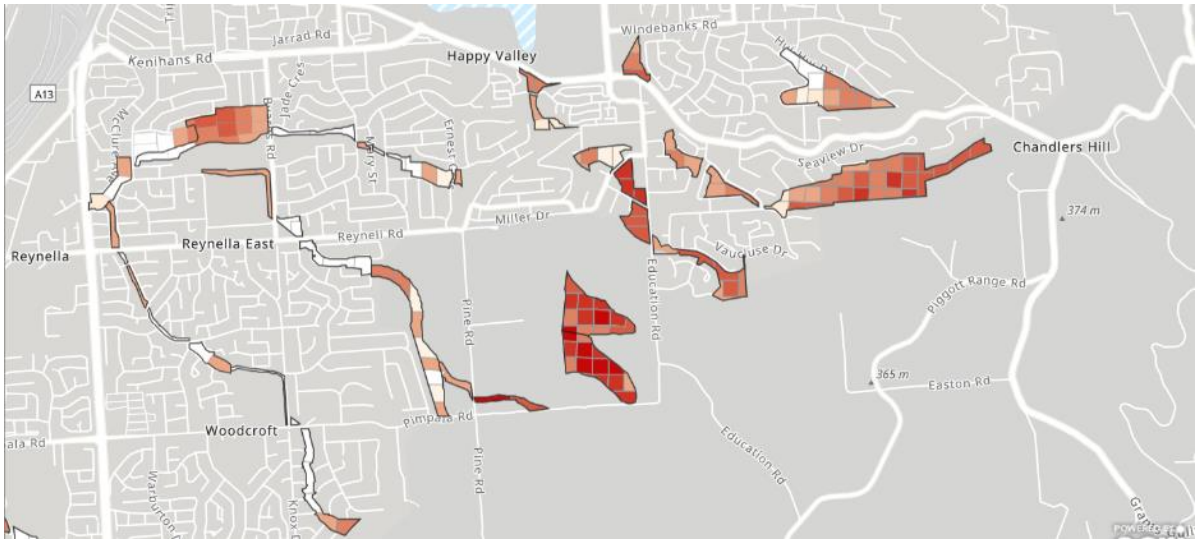
Rec. Number	Recommendation Title	Locality	Timeframe* (years)	Total Estimated Cost	Priority	Category
24	Water sensitive urban design	Gawler East, Gawler South, Evanston Park, Kudla	-	-	Low	Policy
27	Vadoulis Reserve corridor program	Gawler South	5	$160,500	Low	Programs
8	Targeted roadside woody weed control	mainly Evanston Gardens, Hillier, Kudla, Evanston South	10+	$100,000	Low	Programs
9	Diversify street trees	mainly Willaston, Gawler, Gawler West, Gawler East, Gawler South, Evanston, Evanston Gardens, Evanston Park	-	-	Low	Programs

*Up to a maximum of 10 years. Ongoing projects denoted with a '+', but estimated costs do not cover this period.

Digital Programs and Data Management

Comparison of Systems and Considerations

Prior to field assessments commencing Greening Australia consulted with the City of Onkaparinga and the City of Playford to understand their digital biodiversity management processes and tools. The City of Playford had adapted the City of Onkaparinga's methodology, with some minor amendments. In the City of Playford system council owned and managed open space was effectively divided up into equal sized quadrats/grids/cells. City of Onkaparinga has a gridded and a non-gridded mapping system. An example from the City of Onkaparinga in seen below, showing Olive (*Olea europaea*) weed densities.



The advantages of a gridded system are:

- No data bias relating to the surveyed area – all patches are identically sized,
- Fine grain resolution on variance within a patch can be measured and visualised, significantly improving interpretation.

The disadvantages of a gridded system are:

- High establishment costs – many monitoring events need to be undertaken,
- Difficult to determine where a cell ends, and another begins,
- grids don't align with natural boundaries or cadastral boundaries.

Given the resource requirements to maintain a gridded system it is not recommended that the Town of Gawler utilise that approach. Larger, irregular polygons which match natural or manmade features are more cost-effective and still provide a meaningful resolution of data. The existing polygons established during the survey for this report should be further refined to meet a suitable middle ground.

The City of Playford initially commenced their monitoring work using dedicated GPS handsets with a highly customised interface, but this proved problematic and was less efficient than a GPS enabled tablet.

The City of Onkaparinga used ESRI Arc GIS from the outset to collate their mapping data, which enabled a greater range of downstream interpretive tools such as the Storyboard

(http://onkaparinga.maps.arcgis.com/apps/MapSeries/index.html?appid=186c5f7333ec49dda8d7e3701984caa5). At the time of meeting with City of Playford they were considering a shift to the Arc GIS platform as it enabled an improved data input interface. This however was not easily compatible with the spatial systems used elsewhere in their administration.

Strategy for Maintaining Biodiversity Data

Currently the Town of Gawler has limited GIS capacity 'in house' and therefore maintaining and building upon the spatial dataset created through the field work underpinning this report is not possible in the short term. The level of use in biodiversity planning and management alone is unlikely to warrant the additional cost in training/recruitment, hardware and software. However, this may need to be reevaluated if circumstances changed, such as a significant new investment in biodiversity investment or recruitment of staff with pre-existing high levels of GIS ability. If the broader need across all council business was being evaluated this may become a more cost-effective proposition.

The existing dataset should be maintained in Council's storage for reference, noting that mapping/modelling/interpretation may need to be done by an external contractor. The data collected for this report should serve as a baseline for comparison at a future revision of this report in about 10 years.

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Appendix 1 – Field Data Sheet

The final version of the field data sheet.

Patch ID (From ArcGIS)				**Date**		
Vegetation Type:	Forest (>30% cover) Shrubland	Woodland (<30% cover) Reed Beds		Grassland Other:	Mallee	
Overstorey:						
Mid-Storey:						
Understorey:						
Inter-tussock Spaces:	Open	Congested	Closed	N/A		
Notes:						
Threatened Ecological Community **EPBC Community Class:**	Class A	Class B	Class C	None		
EPBC Fauna Present: **Species:**	Yes	Possibly	No			
Habitat Features Large Hollows	Small Hollows	Standing Dead Tree(s)		Fallen Logs		
Rock Outcrop, Crevice, Similar	Bare Soil (Non-riparian)	Bare Soil (Steep River Bank)				
Water-Ephemeral	Water-Permanent Pool					
Dieback (number or % estimate):						
Weed Cover:	1-50 plants, <5%	>50 plants, >5%	5-25%	26-50%	51-75%	>75%
Other Threats and Impact (e.g. Rubbish, erosion, unauthorised tracks):						
Notable Amenity Values (e.g. large red gums, views):						
Priority Actions:						
Overall Impression Score (1-10):						

This was appended with a checklist of around 400 common flora and fauna species.

Appendix 2 – Development Objectives and Principles of Development relating to Biodiversity

The Town of Gawler Development Plan (consolidated 20/2/18) (DTEI, 2018)

Objective 3: Development should minimise the threat and impact of bushfires on life and property while protecting the natural and rural character.

Objective 11: Conservation, preservation, enhancement or improvement of scenically attractive areas, including land adjoining scenic routes and riverine environments. Retention of the natural character of the Mount Lofty Ranges is of the utmost importance to present and future generations of city dwellers.

The natural slopes of the foothills and the wooded character of the face of the ranges rising to Mount Lofty, provide a pleasant contrast to the suburbs on the plains, and give Adelaide a special character.

It is necessary, therefore, that the face of the ranges and the skyline as seen from various points in the metropolitan area should retain a natural character. The ranges are still attractively wooded, providing areas of considerable beauty, readily accessible from the suburban plains. However, any action likely to diminish these wooded areas, such as subdivision into unduly small residential allotments, should be resisted in order to conserve biodiversity, avoid soil erosion and protect development from occurring in a bushfire prone area. Acquisition of suitable areas for public use would ensure their retention.

Tree planting should be encouraged, dwellings should be of good design and set well back from the roads. Advertisements should not mar the landscape and overhead services should be carefully sited against tree and hill backgrounds.

Watercourses, with their natural vegetation, are the most significant natural features on the Adelaide Plains. The trees and natural vegetation can add to the attractiveness of suburban areas and, wherever possible, these features should be incorporated in the layout of residential areas whilst also forming biodiversity corridors.

Land bordering watercourses along the Gawler River and North and South Para Rivers should be reserved for public use and rehabilitated and managed through conservation programmes. Buildings should be set well back, and front onto a road and reserve along a watercourse. River reserves should be used for public recreation and provide easy access for maintenance of the watercourse.

The character of the built-up area largely depends on the attractiveness of parks and recreation reserves, and every endeavour should be made to plant and develop reserves as soon as they become available. Reserves should be easily seen from adjoining roads, and housing development should not block out views or back onto reserves. Reserves should also be rehabilitated and managed through conservation programmes.

Objective 13: Retention of environmentally-significant areas of native vegetation.

Objective 14: Retention of native vegetation where clearance is likely to lead to problems of soil erosion, soil slip and soil salinization, flooding or a deterioration in the quality of surface waters.

Objective 15: Retention of native vegetation for amenity purposes, for livestock shade and shelter and native wildlife corridors.

Objective 16: Retention and maintenance of wetlands and existing native vegetation for its conservation, biodiversity, and habitat value and environmental management function.

32 The natural character of the North and South Para Rivers and Gawler River valleys should be retained and restored where affected by previous development.

33 Development should be undertaken with the minimum effect on natural features, land adjoining water or scenic routes or scenically-attractive areas.

34 Trees of historical or local significance and single trees or groups of trees of particular visual significance should be preserved and protected against disfigurement. If it is necessary to fell these trees, replanting should proceed as part of the development.

37 Native vegetation and roadside vegetation should be preserved and replanted with local indigenous species where practical and should not be cleared if it:

(a) provides important habitat for wildlife;

(b) has a high plant species diversity or has rare or endangered plant species and plant associations;

(e) has high amenity value;

(d) contributes to the landscape quality of an area;

(e) has high value as a remnant of vegetation associations characteristic of a district or region prior to extensive clearance for agriculture;

(f) is associated with sites of scientific, archaeological, historic, or cultural significance; or

(g) is growing in, or is characteristically associated with, a wetland environment.

38 Native vegetation should not be cleared if such clearance is likely to:

(a) create or contribute to soil erosion;

(b) decrease soil stability and initiate soil slip;

(e) create, or contribute to, a local or regional soil salinity problem;

(d) lead to the deterioration in the quality of surface waters; or

(e) create or exacerbate the incidence or intensity of local or regional flooding.

39 When clearance is proposed, consideration should be given to:

(a) retention of native vegetation for, or as:

(i) corridors or wildlife refuges;

(ii) amenity purposes

(iii) livestock shade and shelter; or

iv) protection from erosion along watercourses and the filtering of suspended solids and nutrients from run-off;

(b) the effects of retention on farm management; and

(e) the implications of retention or clearance on fire control.

40 Local indigenous plant species should be considered for landscaping, screening buffer planting and revegetation activities.

Objective 52: Retention, protection and restoration of the natural resources and environment.

Objective 53: Protection of the quality and quantity of South Australia's surface waters, including inland and underground waters.

Objective 54: The ecologically sustainable use of natural resources including water resources, ground water, surface water and watercourses.

Objective 55: Natural hydrological systems and environmental flows reinstated, and maintained and enhanced.

Objective 56: Development consistent with the principles of water sensitive design.

Objective 57: Development sited and designed to:

(a) protect natural ecological systems;

(b) achieve the sustainable use of water;

(e) protect water quality, including receiving waters;

(d) reduce runoff and peak flows and prevent the risk of downstream flooding;

(e) minimise demand on reticulated water supplies;

(f) maximise the harvest and use of stormwater;

(g) protect stormwater from pollution sources.

Objective 59: Native flora, fauna and ecosystems protected, retained, conserved and restored.

Objective 60: Restoration, expansion and linking of existing native vegetation to facilitate habitat corridors for ease of movement of fauna.

144 Development should be undertaken with minimum impact on the natural environment, including air and water quality, land, soil, biodiversity, and scenically attractive areas.

145 Development should ensure that South Australia's natural assets, such as biodiversity, water and soil, are protected and enhanced.

146 Development should not significantly obstruct or adversely affect sensitive ecological areas such as creeks and wetlands.

147 Development should be appropriate to land capability and the protection and conservation of water resources and biodiversity. Water Sensitive Design

148 Development should be designed to maximise conservation, minimise consumption and encourage reuse of water resources.

149 Development should not take place if it results in unsustainable use of surface or underground water resources.

150 Development should be sited and designed to:

(a) capture and re-use stormwater, where practical;

(b) minimise surface water runoff;

(e) prevent soil erosion and water pollution;

(d) protect and enhance natural water flows;

(e) protect water quality by providing adequate separation distances from watercourses and other water bodies;

(f) not contribute to an increase in salinity levels;

(g) avoid the water logging of soil or the release of toxic elements;

(h) maintain natural hydrological systems and not adversely affect:

(i) the quantity and quality of groundwater;

(ii) the depth and directional flow of groundwater;

(iii) the quality and function of natural springs.

151 Water discharged from a development site should:

(a) be of a physical, chemical and biological condition equivalent to or better than its predeveloped state;

(b) not exceed the rate of discharge from the site as it existed in pre-development conditions.

156 Stormwater management systems should preserve natural drainage systems, including the associated environmental flows.

157 Stormwater management systems should:

(a) maximise the potential for stormwater harvesting and re-use, either on-site or as close as practicable to the source;

(b) utilise, but not be limited to, one or more of the following harvesting methods;

(i) the collection of roof water in tanks;

(ii) the discharge to open space, landscaping or garden areas, including strips adjacent to car parks;

(iii) the incorporation of detention and retention facilities;

(iv) aquifer recharge.

160 Development should ensure watercourses and their beds, banks, wetlands and floodplains are not damaged or modified and are retained in their natural state, except where modification is required for essential access or maintenance purposes.

161 No development should occur where its proximity to a swamp or wetland will damage or interfere with the hydrology or water regime of the swamp or wetland.

162 A wetland or low-lying area providing habitat for native flora and fauna should not be drained, except temporarily for essential management purposes to enhance environmental values.

163 Along watercourses, areas of remnant native vegetation, or areas prone to erosion, that are capable of natural regeneration should be fenced off to limit stock access.

164 Development such as cropping, intensive animal keeping, residential, tourism, industry and horticulture, that increases the amount of surface run-off should include a strip of land at least 20 metres wide (30 metres wide in the case of the Gawler, North Para and South Para Rivers) measured from the top of existing banks on each side of a watercourse that is:

(a) fenced to exclude livestock;

(b) kept free of development, including structures, formal roadways or access ways for machinery or any other activity causing soil compaction or significant modification of the natural surface of the land;

(e) revegetated with locally indigenous vegetation comprising trees, shrubs and other groundcover plants to filter run-off so as to reduce the impacts on native aquatic ecosystems and to minimise soil loss eroding into the watercourse.

165 Development resulting in the depositing of an object or solid material in a watercourse or floodplain or the removal of bank and bed material should not:

(a) adversely affect the migration of aquatic biota;

(b) adversely affect the natural flow regime;

(e) cause or contribute to water pollution;

(d) result in watercourse or bank erosion;

(e) adversely affect native vegetation upstream or downstream that is growing in or adjacent to a watercourse.

169 Development should retain existing areas of native vegetation and where possible contribute to revegetation using locally indigenous plant species.

170 Development should be designed and sited to minimise the loss and disturbance of native flora and fauna and their breeding grounds and habitats.

171 The provision of services, including power, water, effluent and waste disposal, access roads and tracks should be sited on areas already cleared of native vegetation.

172 Native vegetation should be conserved and its conservation value and function not compromised by development if the native vegetation does any of the following

a) provides an important habitat for wildlife or shade and shelter for livestock;

(b) has a high plant species diversity or includes rare, vulnerable or endangered plant species or plant associations and communities;

(e) provides an important seed bank for locally indigenous vegetation;

(d) has high amenity value and/or significantly contributes to the landscape quality of an area, including the screening of buildings and unsightly views;

(e) has high value as a remnant of vegetation associations characteristic of a district or region prior to extensive clearance for agriculture;

(f) is growing in, or is characteristically associated with a wetland environment.

173 Native vegetation should not be cleared if such clearing is likely to lead to, cause or exacerbate any of the following:

(a) erosion or sediment within water catchments;

(b) decreased soil stability;

(e) soil or land slip;

(d) deterioration in the quality of water in a watercourse or surface water runoff;

(e) a local or regional salinity problem;

(f) the occurrence or intensity of local or regional flooding.

174 Development that proposes the clearance of native vegetation should address or consider the implications that removing the native vegetation will have on the following:

(a) provision for linkages and wildlife corridors between significant areas of native vegetation;

(b) erosion along watercourses and the filtering of suspended solids and nutrients from run-off;

(e) the amenity of the locality;

(d) bushfire safety;

(e) the net loss of native vegetation and other biodiversity.

175 Where native vegetation is to be removed, it should be replaced in a suitable location on the site with locally indigenous vegetation to ensure that there is not a net loss of native vegetation and biodiversity.

176 Development should be located and occur in a manner which:

(a) does not increase the potential for, or result in, the spread of pest plants, or the spread of any non-indigenous plants into areas of native vegetation or a conservation zone;

(b) avoids the degradation of remnant native vegetation by any other means including as a result of spray drift, compaction of soil, modification of surface water flows, pollution to groundwater or surface water or change to groundwater levels;

(e) incorporates a separation distance and/or buffer area to protect wildlife habitats and other features of nature conservation significance.

177 Development should promote the long-term conservation of vegetation by:

(a) avoiding substantial structures, excavations, and filling of land in close proximity to the trunk of trees and beneath their canopies;

(b) minimising impervious surfaces beneath the canopies of trees;

(e) taking other effective and reasonable precautions to protect both vegetation and the integrity of structures and essential services.

250 Land division design should:

(a) facilitate major storm drainage system to safely convey major stormwater flows;

(b) incorporate where practicable, provision for on-site stormwater detention, retention and use (including, where practicable, the collection and storing of water from roofs and communal car parks in appropriate devices);

(e) provide for on-site infiltration, where practicable, having regard to:

(i) availability of unsealed areas or areas which are not built-up;

(ii) the capacity of soils to absorb water;

(iii) the capacity of building footings on and adjacent to the site to withstand the likely effects of retained water; and

(iv) potential adverse impacts on the level of groundwater;

251 Land division design should integrate major storm drainage system with:

(a) creeks and vegetation;

255 Development should:

(a) protect existing locality features, including significant trees, other substantial vegetation, natural creek lines and items or features of conservation or heritage value;

(b) minimise the need for cut and fill;

(e) provide sufficient space for the planting of trees to:

(i) complement an existing treed landscape character; or

(ii) enhance the landscape character of a neighbourhood deficient in trees; or

(iii) screen areas of storage, service and parking; and

(d) where practicable and cost effective, protect trees from damage to their root systems.

Objective 88: Conservation of significant trees in Metropolitan Adelaide which provide important aesthetic and environmental benefit. Trees are a highly valued part of the Metropolitan Adelaide environment and are important for a number of reasons including high aesthetic value, conservation of bio-diversity, provision of habitat for fauna, and conservation of original and remnant vegetation. While indiscriminate and inappropriate significant tree removal should be generally prevented, the conservation of significant trees should occur in balance with achieving appropriate development.

322 Where a significant tree:

(a) makes an important contribution to the character or amenity of the local area; or

(b) is indigenous to the local area and/or a species is listed under the National Parks and Wildlife Act 1972 as a rare or endangered native species; or

(e) represents an important habitat for native fauna; or

(d) is part of a wildlife corridor of a remnant area of native vegetation; or

(e) is important to the maintenance of biodiversity in the local environment; or

(f) forms a notable visual element to the landscape of the local area;

development should preserve these attributes.

Recreation Zone

5 Strong thematic landscaping should be instituted on individual sites to improve the landscape, provide shade and shelter, create interest, provide habitat, retain existing native vegetation, use locally indigenous plant species in plantings where possible and define different activity areas.

Residential (Gawler East) Zone

Objective 4: Open space systems designed to provide multiple use reserve areas that promote water management, habitat retention and enhancement, and recreational linkages.

It is essential that development respects and enhances the natural attributes of the zone through the retention of significant views, creek lines, native vegetation and locations of ecological significance. Innovative and best practice solutions in respect to water reuse, grey water supply and stormwater management will be implemented.

A network of linear parks including cohesive pedestrian and bicycle movement corridors and visual links will be established between the new development and adjoining natural creek lines, public recreation areas, local shopping and community services and surrounding road networks.

Portion of the southern boundary of the zone is located adjacent to the Para Woodland Reserve. It is essential that development form an appropriate interface with the Para Woodland Reserve. The interface will act as a buffer between the residential area and the Reserve, balancing access, management of bushfire risk, management of potential invasion by pest plants, minimising the impact of domestic pets on native wildlife and as a provision of open space. The interface will vary in width as appropriate to meet the above criteria and will comprise of a combination of roads, paths, public open space and, where appropriate, areas of natural character for stormwater management. Where housing is included in the interface area it is expected that houses will address the Reserve. The interface area will be planted with locally indigenous species (mainly groundcovers and low shrubs) selected to minimise the bushfire risk by providing an area of reduced fuel hazard.

Residential Hills Zone

Objective 3: Open space systems designed to provide multiple use reserve areas that promote water management, habitat retention and enhancement, and informal recreational linkages.

It is essential that development respects and enhances the natural attributes of the zone through the retention of significant views, creek lines, native vegetation and locations of ecological significance. Innovative and best practice solutions in water reuse, grey water supply and stormwater management will be implemented.

Appendix 3 – Approved Plant Revegetation Lists

Grasslands and Grassy Woodlands

Botanic Name	Common Name	Comments
Acacia acinacea	Wreath Wattle	
Acacia pycnantha	Golden Wattle	
Acaena echinata	Sheep's Burr	
Actinobole uliginosum	Flannel Actinobole	
Ajuga australis f. A / f. Kapunda	Australian Bugle	
Allocasuarina verticillata	Drooping Sheoak	
Anthosachne scabra	Native Wheat-grass	
Argentipallium blandowskianum	Woolly Everlasting	
Aristida behriana	Brush Wire-grass	
Aristida contorta	Curly Wire-grass	
Arthropodium fimbriatum	Nodding Vanilla-lily	
Arthropodium strictum	Common Vanilla-lily	
Asperula conferta	Common Woodruff	
Atriplex semibaccata	Berry Saltbush	
Atriplex suberecta	Lagoon Saltbush	
Austrostipa acrociliata	Graceful Spear-grass	
Austrostipa blackii	Crested Spear-grass	
Austrostipa curticoma	Short-crest Spear-grass	
Austrostipa drummondii	Cottony Spear-grass	
Austrostipa elegantissima	Feather Spear-grass	
Austrostipa eremophila	Rusty Spear-grass	
Austrostipa flavescens	Coast Spear-grass	
Austrostipa gibbosa	Swollen Spear-grass	
Austrostipa multispiculis	Many-flowered Spear-grass	
Austrostipa nitida	Balcarra Spear-grass	
Austrostipa nodosa	Tall Spear-grass	
Austrostipa pilata	Prickly Spear-grass	
Austrostipa platychaeta	Flat-awn Spear-grass	
Austrostipa puberula	Fine-hairy Spear-grass	
Austrostipa scabra ssp. falcata	Slender Spear-grass	
Austrostipa setacea	Corkscrew Spear-grass	
Boerhavia dominii	Tar-vine	
Bothriochloa macra	Red-leg Grass	
Brachyscome graminea	Grass Daisy	

Brachyscome perpusilla	Tiny Daisy	
Bulbine bulbosa	Bulbine-lily	
Bursaria spinosa ssp. spinosa	Sweet Bursaria	
Caesia calliantha	Blue Grass-lily	
Calocephalus citreus	Lemon Beauty-heads	
Calostemma purpureum	Pink Garland-lily	
Calotis erinacea	Tangled Burr-daisy	
Carex bichenoviana	Notched Sedge	
Carex inversa	Knob Sedge	
Chamaescilla corymbosa var. corymbosa	Blue Squill	
Cheilanthes austrotenuifolia	Annual Rock-fern	
Cheilanthes distans	Bristly Cloak-fern	
Cheilanthes lasiophylla	Woolly Cloak-fern	
Cheilanthes sieberi ssp. sieberi	Narrow Rock-fern	
Chenopodium desertorum ssp. microphyllum	Small-leaf Goosefoot	
Chloris truncata	Windmill Grass	
Chrysocephalum apiculatum	Common Everlasting	
Chrysocephalum semipapposum	Clustered Everlasting	
Convolvulus angustissimus ssp. angustissimus	Australian Convolvulus	
Convolvulus angustissimus ssp. peninsularum	Grassland Convolvulus	
Convolvulus remotus	Grassy Convolvulus	
Cotula australis	Common Cotula	
Crassula colligata ssp. colligata	Stalked Crassula	
Crassula colligata ssp. lamprosperma	Stalked Crassula	
Crassula colorata var. acuminata	Dense Crassula	
Crassula colorata var. colorata	Dense Crassula	
Crassula decumbens var. decumbens	Spreading Crassula	
Crassula sieberiana	Sieber's Crassula	
Cryptandra campanulata	Long-flower Cryptandra	
Cryptandra sp. Floriferous (W.R.Barker 4131)	Pretty Cryptandra	
Cryptandra tomentosa	Heath Cryptandra	
Cullen australasicum	Tall Scurf-pea	
Cymbopogon ambiguus	Lemon-grass	
Cymbopogon obtectus	Silky-head Lemon-grass	
Cynoglossum suaveolens	Sweet Hound's-tongue	
Cyperus gymnocaulos	Spiny Flat-sedge	
Daucus glochidiatus	Native Carrot	
Dianella longifolia var. grandis	Pale Flax-lily	
Dianella revoluta var. revoluta	Black-anther Flax-lily	

Dichanthium sericeum ssp. sericeum	Silky Blue-grass	
Dichondra repens	Kidney Weed	
Digitaria ammophila	Spider Grass	
Digitaria brownii	Cotton Panic-grass	
Diuris behrii	Behr's Cowslip Orchid	
Dodonaea viscosa ssp. spatulata	Sticky Hop-bush	
Drosera glanduligera	Scarlet Sundew	
Drosera peltata	Pale Sundew	
Drosera whittakeri	Whittaker's Sundew	
Dysphania pumilio	Small Crumbweed	
Einadia nutans ssp. nutans	Climbing Saltbush	
Enchylaena tomentosa var. tomentosa	Ruby Saltbush	
Enchylaena tomentosa var. tomentosa	Ruby Saltbush	
Enneapogon nigricans	Black-head Grass	
Enteropogon acicularis	Umbrella Grass	
Eremophila longifolia	Weeping Emubush	
Erodium crinitum	Blue Heron's-bill	
Eucalyptus camaldulensis ssp. camaldulensis	River Red Gum	
Eucalyptus leucoxylon ssp. leucoxylon	South Australian Blue Gum	
Eucalyptus odorata	Peppermint Box	
Eucalyptus porosa	Mallee Box	
Euphorbia drummondii complex	Caustic Euphorbia	
Eutaxia microphylla	Common Eutaxia	
Gahnia lanigera	Black Grass Saw-sedge	
Geranium retrorsum	Grassland Geranium	
Glycine rubiginosa	Twining Glycine	
Gonocarpus elatus	Hill Raspwort	
Gonocarpus mezianus	Broad-leaf Raspwort	
Gonocarpus tetragynus	Small-leaf Raspwort	
Goodenia albiflora	White Goodenia	
Goodenia pinnatifida	Cut-leaf Goodenia	
Goodenia pusilliflora	Small-flower Goodenia	
Goodenia willisiana	Silver Goodenia	
Haloragis aspera	Rough Raspwort	
Helichrysum luteoalbum	Jersey Helichrysum	
Hyalosperma glutinosum ssp. glutinosum	Golden Sunray	
Hyalosperma semisterile	Orange Sunray	
Hypoxis glabella var. glabella	Tiny Star	
Isoetopsis graminifolia	Grass Cushion	
Juncus subsecundus	Finger Rush	
Kennedia prostrata	Scarlet Runner	

Lachnagrostis filiformis	Common Blown-grass	
Leiocarpa tomentosa	Woolly Plover-daisy	
Leiocarpa websteri	Narrow Plover-daisy	
Lepidosperma viscidum	Sticky Sword-sedge	
Leptorhynchos elongatus	Lanky Buttons	
Leptorhynchos orientalis	Eastern Annual Buttons	
Leptorhynchos squamatus ssp. squamatus	Scaly Buttons	
Leptorhynchos tetrachaetus	Little Buttons	
Leptorhynchos waitzia	Button Immortelle	
Levenhookia dubia	Hairy Stylewort	
Linum marginale	Native Flax	
Lomandra densiflora	Soft Tussock Mat-rush	
Lomandra effusa	Scented Mat-rush	
Lomandra micrantha ssp. micrantha	Small-flower Mat-rush	
Lomandra multiflora ssp. dura	Hard Mat-rush	
Lomandra nana	Small Mat-rush	
Lomandra sororia	Sword Mat-rush	
Lotus australis	Austral Trefoil	
Lotus cruentus	Red-flower Lotus	
Lycium australe	Australian Boxthorn	
Maireana brevifolia	Short-leaf Bluebush	
Maireana enchylaenoides	Wingless Fissure-plant	
Maireana rohrlachii	Rohrlach's Bluebush	
Malva preissiana	Australian Hollyhock	
Microseris lanceolata	Yam Daisy	
Microtis arenaria	Notched Onion-orchid	
Microtis unifolia	Onion-orchid	
Millotia myosotidifolia	Broad-leaf Millotia	
Minuria leptophylla	Minnie Daisy	
Neurachne alopecuroidea	Fox-tail Mulga-grass	
Ophioglossum lusitanicum	Austral Adder's-tongue	
Oxalis perennans	Native Sorrel	
Panicum effusum var. effusum	Hairy Panic	
Pimelea curviflora var. gracilis	Curved Riceflower	
Pimelea curviflora var. sericea	Curved Riceflower	
Pimelea glauca	Smooth Riceflower	
Pimelea micrantha	Silky Riceflower	
Pittosporum angustifolium	Native Apricot	
Plantago drummondii	Dark Plantain	
Plantago gaudichaudii	Narrow-leaf Plantain	
Plantago varia	Variable Plantain	

Poa crassicaudex	Thick-stem Tussock-grass	
Poa labillardieri var. labillardieri	Common Tussock-grass	
Podolepis canescens	Grey Copper-wire Daisy	
Podolepis jaceoides	Showy Copper-wire Daisy	
Podolepis rugata var. rugata	Pleated Copper-wire Daisy	
Pomaderris paniculosa ssp. paniculosa	Mallee Pomaderris	
Ptilotus erubescens	Hairy-tails	
Ptilotus nobilis ssp. angustifolius	Yellow-tails	
Ptilotus spathulatus	Pussy-tails	
Ranunculus lappaceus	Native Buttercup	
Rhagodia parabolica	Mealy Saltbush	
Rhodanthe corymbiflora	Paper Everlasting	
Rhodanthe laevis	Smooth Daisy	
Rhodanthe pygmaea	Pigmy Daisy	
Rumex brownii	Slender Dock	
Rumex dumosus	Wiry Dock	
Rytidosperma auriculatum	Lobed Wallaby-grass	
Rytidosperma caespitosum	Common Wallaby-grass	
Rytidosperma fulvum	Leafy Wallaby-grass	
Rytidosperma geniculatum	Kneed Wallaby-grass	
Rytidosperma pilosum	Velvet Wallaby-grass	
Rytidosperma racemosum	Slender Wallaby-grass	
Rytidosperma setaceum	Small-flower Wallaby-grass	
Scaevola albida	Pale Fanflower	
Sebaea ovata	Yellow Sebaea	
Senecio glossanthus	Annual Groundsel	
Senecio spanomerus	Mallee Groundsel	
Setaria constricta	Knotty-butt Setaria	
Setaria jubiflora	Warrego Summer-grass	
Sida corrugata var. angustifolia	Grassland Sida	
Sida corrugata var. corrugata	Corrugated Sida	
Solenogyne dominii	Smooth Solenogyne	
Sporobolus virginicus	Salt Couch	
Stackhousia monogyna	Creamy Candles	
Stackhousia subterranea	Creamy Candles	
Swainsona behriana	Behr's Swainson-pea	
Swainsona stipularis	Orange Swainson-pea	
Teucrium racemosum	Grey Germander	
Themeda triandra	Kangaroo Grass	
Thysanotus baueri	Mallee Fringe-lily	
Thysanotus patersonii	Twining Fringe-lily	

Tricoryne elatior	Yellow Rush-lily	
Tricoryne tenella	Tufted Yellow Rush-lily	
Velleia arguta	Toothed Velleia	
Vittadinia australasica var. australasica	Sticky New Holland Daisy	
Vittadinia blackii	Narrow-leaf New Holland Daisy	
Vittadinia cervicularis var. cervicularis	Waisted New Holland Daisy	
Vittadinia cuneata var. cuneata	Fuzzy New Holland Daisy	
Vittadinia gracilis	Woolly New Holland Daisy	
Vittadinia megacephala	Giant New Holland Daisy	
Wahlenbergia luteola	Yellow-wash Bluebell	
Wahlenbergia stricta ssp. stricta	Tall Bluebell	
Walwhalleya proluta	Rigid Panic	
Wurmbea dioica ssp. brevifolia	Early Nancy	
Wurmbea dioica ssp. dioica	Early Nancy	
Zygophyllum glaucum	Pale Twinleaf	

Wetlands

Botanic Name	Common Name	Comments
Acacia salicina	Native Willow	
Alternanthera denticulata	Lesser Joyweed	
Asperula conferta	Common Woodruff	
Atriplex suberecta	Lagoon Saltbush	On dry edges
Baumea arthrophylla	Swamp Twig-rush	
Baumea juncea	Bare Twig-rush	
Bolboschoenus caldwellii	Salt Club-rush	
Bolboschoenus medianus	Marsh Club-rush	
Callistemon sieberi	River Bottlebrush	
Calystegia sepium	Large Bindweed	
Carex bichenoviana	Notched Sedge	
Carex inversa var. inversa	Knob Sedge	
Centella cordifolia	Native Centella	
Cotula australis	Common Cotula	
Cycnogeton procerum	Water-ribbons	
Cyperus gymnocaulos	Spiny Flat-sedge	
Cyperus vaginatus	Stiff Flat-sedge	
Dichanthium sericeum ssp. sericeum	Silky Blue-grass	On dry edges or occasionally inundated
Dichondra repens	Kidney Weed	
Distichlis distichophylla	Emu-grass	
Duma florulenta	Lignum	
Eleocharis acuta	Common Spike-rush	
Eleocharis sphacelata	Tall Spike-rush	
Epilobium hirtigerum	Hairy Willow-herb	
Eragrostis infecunda	Blown-grass	On dry edges
Eucalyptus camaldulensis ssp. camaldulensis	River Red Gum	
Eucalyptus largiflorens	River Box	
Ficinia nodosa	Knobb Club-rush	
Geranium retrorsum	Grassland Geranium	On dry edges
Gonocarpus elatus	Hill Raspwort	On dry edges
Haloragis acutangula	Smooth Raspwort	On dry edges
Haloragis aspera	Rough Raspwort	On dry edges
Hydrocotyle verticillata	Shield Pennywort	
Juncus kraussii	Sea Rush	
Juncus pallidus	Pale Rush	
Juncus pauciflorus	Loose-flower Rush	
Juncus subsecundus	Finger Rush	
Juncus usitatus	Common Rush	

Leptospermum lanigerum	Silky Tea-tree	Not on plains
Lobelia anceps	Angled Lobelia	
Lythrum hyssopifolia	Lesser Loosestrife	
Malva preissiana	Australian Hollyhock	On dry edges
Thyridia repens	Creeping Monkey-flower	
Myoporum montanum	Native Myrtle	
Myoporum petiolatum	Sticky Boobialla	On dry edges
Myriophyllum sp.	Milfoil	
Nitraria billardierei	Nitre-bush	On dry edges or occasionally inundated
Phragmites australis	Common Reed	
Potamogeton pectinatus	Fennel Pondweed	
Pseudognaphalium luteoalbum	Jersey Cudweed	On dry edges
Samolus repens	Creeping Brookweed	
Schoenoplectus subulatus	Shore Club-rush	
Schoenoplectus validus	River Club-rush	
Selliera radicans	Shiny Swamp-mat	
Setaria jubiflora	Warrego Summer-grass	On dry edges or occasionally inundated
Triglochin striata	Streaked Arrowgrass	
Typha domingensis	Narrow-leaf Bulrush	

Appendix 4 – Flora Taxa Recorded for the Town of Gawler

"Last Recorded" denotes the dat of the last official record, including from this project. "Introduced" includes Australian native species presumed not to have occurred in the Town of Gawler area prior to European settlement.

Scientific Name	Common Name	Introduced Species	Last Recorded
Acacia acinacea	Wreath Wattle		2018
Acacia argyrophylla	Silver Mulga-bush	*	2000
Acacia baileyana	Cootamundra Wattle	*	2018
Acacia brachybotrya	Grey Mulga-bush	*	2018
Acacia cupularis	Cup Wattle		2018
Acacia cyclops	Western Coastal Wattle	*	2018
Acacia hakeoides	Hakea Wattle		2018
Acacia iteaphylla	Flinders Ranges Wattle	*	2018
Acacia ligulata	Umbrella Bush		2018
Acacia longifolia	Sallow Wattle	*	2018
Acacia melanoxylon	Blackwood	*	2018
Acacia myrtifolia	Myrtle Wattle	*	2018
Acacia notabilis	Notable Wattle		2018
Acacia oswaldii	Umbrella Wattle		2018
Acacia paradoxa	Kangaroo Thorn		2018
Acacia pendula	Weeping Myall	*	2018
Acacia provincialis	Swamp Wattle		2018
Acacia pycnantha	Golden Wattle		2018
Acacia retinodes	Wirilda		2018
Acacia rigens	Nealie		1953
Acacia salicina	Willow Wattle		2018
Acacia saligna	Golden wreath wattle	*	2018
Acacia sclerophylla var. sclerophylla	Hard-leaf Wattle		2018
Acacia stenophylla	River Cooba	*	2018
Acacia sp.	Wattle		2018
Acacia spinescens	Spiny Wattle		1891
Acacia verniciflua	Varnish Wattle		2018
Acacia victoriae	Elegant Wattle		2018
Acaena echinata	Sheep's Burr		2018
Acetosa vesicaria	Rosy Dock	*	1981
Adonis microcarpa	Pheasant's eye	*	1991
Agapanthus praecox	Agapanthus	*	2018
Agave americana	Century Plant	*	2018
Agonis flexuosa	Willow Myrtle	*	2018
Allium triquetrum	Three-cornered garlic	*	2015

Allocasuarina muelleriana ssp. muelleriana	Common Oak-bush		1962
Allocasuarina verticillata	Drooping Sheoak		2018
Alternanthera denticulata	Lesser Joyweed		2018
Alyxia buxifolia	Sea Box		2018
Amaranthus albus	Stiff Tumbleweed	*	2000
Amaranthus muricatus	Rough-fruit Amaranth	*	2005
Anigozanthos flavidus	Evergreen Kangaroo Paw	*	1848
Anredera cordifolia	Madeira vine	*	2015
Anthocercis angustifolia	Narrow-leaf Ray-flower		1980
Anthosachne scabra	Native Wheat-grass		2018
Aphelia gracilis	Slender Aphelia		1912
Apium graveolens	Wild Celery	*	2000
Aptenia cordiflora	Heartleaf Ice Plant	*	2018
Arctotheca calendula	Cape Weed	*	2018
Argentipallium blandowskianum	Woolly Everlasting		1910
Aristida australis	Wire-grass		2018
Aristida behriana	Brush Wire-grass		2018
Aristida contorta	Bunched Kerosene Grass		1967
Artemisia arborescens	Hedge artemisia	*	2018
Arthropodium fimbriatum	Nodding Vanilla-lily		2018
Arthropodium strictum	Common Vanilla-lily		2018
Arundo donax	Giant Reed	*	2018
Asparagus asparagoides	Bridal Creeper	*	2018
Asparagus officinalis	Asparagus	*	2018
Asparagus plumosus	Ferny Asparagus	*	1981
Asperula conferta	Common Woodruff		2018
Asphodelus fistulosus	Onion Weed	*	2018
Asteriscus spinosus	Golden Pallensis	*	2018
Atriplex nummularia	Old-man Saltbush	*	2018
Atriplex semibaccata	Berry Saltbush		2018
Atriplex suberecta	Lagoon Saltbush		2018
Austrostipa acrociliata	Graceful spear-grass		2009
Austrostipa blackii	Crested Spear-grass		2018
Austrostipa curticoma	Short-crest Spear-grass		2018
Austrostipa drummondii	Cottony Spear-grass		2018
Austrostipa elegantissima	Feather Spear-grass		2018
Austrostipa eremophila	Rusty Spear-grass		2018
Austrostipa flavescens	Swollen Spear-grass		2000
Austrostipa mollis	Soft spear-grass		2009
Austrostipa multispiculis	Many-flowered Spear-grass		1973
Austrostipa nitida	Balcarra Spear-grass		2009
Austrostipa nodosa	Tall Spear-grass		2018
Austrostipa pilata	Prickly Spear-grass		2000

Austrostipa platychaeta	Flat-awn Spear-grass		2018
Austrostipa puberula	Fine-hairy Spear-grass		2012
Austrostipa scabra ssp. Falcata	Delicate Spear-grass		2009
Avellinia michelii	Avellinia	*	1881
Avena barbata	Bearded Oat	*	2018
Azolla sp.	Water Fern	?	2018
Baumea juncea	Bare Twig-rusc		2018
Beyeria lechenaultii	Pale Turpentine Bush		1967
Billardiera cymosa ssp. cymosa	Sweet Apple-berry		1910
Boerhavia dominii	Tar-vine		2018
Bolboschoenus caldwellii	Salt Club-rush		2018
Bolboschoenus medianus	Marsh Club-rush		2018
Bothriochloa macra	Red-leg Grass		2018
Brachychiton populneus	Kurrajong	*	2018
Brachypodium distachyon	False Brome	*	2018
Brachyscome perpusilla	Tiny Daisy		1851
Brassica tournefortii	Wild Turnip	*	2018
Briza maxima	Large Quaking-grass	*	2018
Briza minor	Small Quaking-grass	*	2018
Bromus catharticus	Prairie Grass	*	2018
Bromus diandrus	Great Brome	*	2013
Bromus hordeaceus	Soft Brome	*	2013
Bulbine bulbosa	Bulbine-lily		2009
Bursaria spinosa ssp. spinosa	Sweet Bursaria		2018
Caesia calliantha	Blue Grass-lily		1848
Callistemon sp.	Bottlebrush	*	2018
Callistemon sieberi	River Bottlebrush		2018
Callitris gracilis	Southern Cypress Pine		2018
Callitris glaucophylla	White Cypress-pine	*	2018
Calocephalus citreus	Lemon Beauty-heads		2018
Calostemma purpureum	Pink Garland-lily		2018
Calystegia sepium	Large Calystegia		2018
Calytrix involucrata	Cup Fringe-myrtle		1953
Calytrix tetragona	Common Fringe-myrtle		1917
Capsella bursapastoris	Shepherds Purse	*	2000
Carex bichenoviana	Tufted Curly Sedge		2018
Carex inversa	Knob Sedge		2018
Carthamus lanatus	Saffron Thistle	*	2013
Cassinia arcuata	Drooping Cassinia		2018
Cassytha melantha	Coarse Dodder-laurel		2018
Catapodium rigidum	Rigid Fescue	*	2018
Cenchrus ciliaris	Buffel Grass	*	2012
Cenchrus clandestinus	Kikuyu	*	2018

Cenchrus longisetus	Feather-top	*	2018
Cenchrus setaceus	Fountain Grass	*	2018
Centella cordiflora	Native Centella		2018
Centaurea erythraea	European Centaury	*	2018
Cerastium glomeratum	Mouse-ear Chickweed	*	2000
Chamaecytisus palmensis	Tagasaste, Tree Lucerne	*	2018
Chasmanthe floribunda	Flames	*	2015
Cheilanthes austrotenuifolia	Annual Rock-fern		1967
Cheilanthes distans	Bristly Cloak-fern		2018
Cheilanthes lasiophylla	Woolly Cloak-fern		2018
Chenopodium album	Fat-hen	*	2018
Chenopodium desertorum ssp. microphyllum	Small-leaf Goosefoot		1967
Chenopodium glaucum	Glaucous Goosefoot	*	2018
Chloris truncata	Windmill Grass		2018
Chloris virgata	Feather fingergrass	*	1968
Chondrilla juncea	Skeleton Weed	*	2018
Choretrum chrysanthum	Golden Sour-bush		1968
Chrozophora tinctoria	Dyer's Litmus Plant	*	1998
Chrysanthemoides monilifera ssp. monilifera	Boneseed	*	2018
Chrysocephalum apiculatum	Common Everlasting		1968
Chrysocephalum semipapposum	Clustered Everlasting		2018
Cirsium vulgare	Spear Thistle	*	2018
Clematis microphylla	Old Man's Beard		2018
Coleonema pulchellum	Diosma	*	2018
Comesperma volubile	Love Creeper		1893
Convolvulus angustissimus ssp. angustissimus	Australian Convolvulus		2018
Convolvulus angustissimus ssp. peninsularum	Narrow-leaf Convolvulus		2018
Convolvulus arvensis	Field Bindweed	*	2018
Convolvulus remotus	Grassy Convolvulus		2018
Cotula australis	Common Cotula		1968
Conyza bonariensis	Flax-leaf Fleabane	*	2018
Conyza sumatrensis	Tall Fleabane	*	2018
Correa reflexa	Common Correa, Natuve Fucshia	*	*2018, c. 1980
Cortaderia selloana	Pampas Grass	*	2018
Cotoneaster sp.	Cotoneaster	*	2018
Cotula coronopifolia	Waterbuttons	*	2018
Cotyledon sp.		*	2018
Crassula colligata ssp. colligata	Stalked Crassula		2018
Crassula colligata ssp. lamprosperma	Stalked Crassula		2018
Crassula colorata var. acuminata	Dense Crassula		2018
Crassula decumbens	Spreading Crassula		2018

Crassula sieberiana	Sieber's Crassula		2018
Crassula tetragona ssp. robusta	Crassula	*	1981
Critesion murinum subsp. leporinum	Barley Grass	*	2000
Cryptandra sp. Floriferous (W.R.Barker 4131)	Pretty Cryptandra		1967
Cullen australasicum	Tall Scurf-pea		2018
Cymbopogon ambiguus	Lemon-grass		2018
Cymbopogon obtectus	Silky-head Lemon-grass		2000
Cynara cardunculus ssp. Flavescens	Artichoke Thistle	*	2018
Cynodon dactylon var. dactylon	Couch	*	2018
Cyperus eragrostis	Umbrella Sedge	*	2018
Cyperus gymnocaulos	Spiny Flat-sedge		2018
Cyperus vaginatus	Flat-sedge		2018
Dactylis glomeratus	Cock's-foot	*	2018
Dampiera rosmarinifolia	Rosemary Dampiera		1967
Datura stramonium	Common Thorn-apple	*	1934
Daucus glochidiatus	Native Carrot		1967
Dianella brevicaulis	Blueberry Flax-lily	*	2018
Dianella longifolia var. grandis	Yellow-anther Flax-lily		2018
Dianella revoluta var. revoluta	Black-anther Flax-lily		2018
Dichanthium sericeum	Silky Blue-grass		2018
Dichondra repens	Kidney Plant		2018
Digitaria ammophila	Spider Grass		2018
Digitaria brownii	Cotton Panic-grass		2018
Diplotaxis muralis	Wall rocket	*	1969
Distichlis distichophylla	Emu-grass		2018
Dittrichia graveolens	Stink-weed	*	2018
Dodonaea bursariifolia	Small Hop-bush		1948
Dodonaea viscosa ssp. Spatulata	Sticky Hop-bush		2018
Drosera glanduligera	Orange Sundew		2018
Drosera peltata	Hair Sundew		2018
Drosera whittakeri	Whittakre's Sun-dew		2009
Duma florulenta	Lignum		2018
Dysphania pumilio	Clammy Goosefoo		2018
Ecballium elaterium	Squirting Cucumber	*	2018
Echium plantagineum	Salvation Jane	*	2018
Ehrharta calycina	Perennial Veldt	*	2018
Ehrharta longiflora	Annual Veldt Grass	*	2018
Einadia nutans	Climbing Saltbush		2018
Eleocharis acuta	Common Spike-rush		2018
Emex australis	Thre-corner Jack	*	2018
Enchylaena tomentosa	Ruby Saltbush		2018
Enneapogon nigricans	Black-head Grass		2018
Epilobium hirtigerum	Hoary Willow-herb		2018

Enteropogon acicularis	Umbrella Grass		2018
Eragrostis barrelieri	Pitted Lovegrass	*	2015
Eragrostis cilianensis	Stink Grass	*	1936
Eragrostis curvula	African Love-grass	*	2010
Eremophila deserti	Turkey-bush		1968
Eremophila glabra	Tar Bush	*	2018
Eremophila longifolia	Weeping Emubush		2018
Eriobotrya japonica	Loquat	*	2018
Erodium crinitum	Blue Heron’s-bill		2018
Erodium moschatum	Musky Stork's-bill	*	2018
Eucalyptus camaldulensis	River Red Gum		2018
Eucalyptus cladocalyx	Sugar Gum	*	2018
Eucalyptus leucoxylon X	Hybrid Gum		2018
Eucalyptus leucoxylon ssp. leucoxylon	SA Blue Gum		2018
Eucalyptus odorata	Peppermint Box		2018
Eucalyptus platypus	Yate	*	2018
Eucalyptus phenax ssp. phenax	White Mallee		1973
Eucalyptus porosa	Mallee Box		2018
Eucalyptus sp.	Eucalypt	*	2018
Euphorbia maculata	Nodding spurge	*	1976
Euphorbia peplus	Radius Plant	*	2018
Euphorbia terracina	False Caper	*	2018
Eutaxia microphylla	Common Eutaxia		1967
Exocarpos aphyllus	Leafless Cherry		2018
Exocarpos sparteus	Slender Cherry		1996
Festuca arundinacea	Tall Fescue	*	2000
Ficinia nodosa	Knobby Club-rush		2018
Ficus carrica	Edible Fig	*	2018
Ficus macrophylla	Moreton Bay Fig	*	2018
Foeniculum vulgare	Fennel	*	2018
Fraxinus angustifolia ssp. Angustifolia	Desert Ash	*	2018
Freesia sp.	Freesia	*	2015
Fumaria capreolata	Fumitory	*	2018
Gahnia lanigera	Black Grass Saw-sedge		1967
Galenia pubescens var. pubescens	Coastal Galenia	*	2018
Galium murale	Small Goosegrass	*	2018
Gazania linearis	Gazania	*	2018
Genista monspessulana	Montpellier Broom	*	2018
Geranium retrorsum	Grassland Geranium		2018
Glischrocaryon behrii	Golden Pennants		1912
Gomphocarpus cancellatus	Broad-leaf Cotton-bush	*	2018
Gomphocarpus fruticosus	Narrow-leaf Cotton-bush	*	2018
Gonocarpus elatus	Hills Raspwort		2018

Gonocarpus tetragynus	Smooth Raspwort		2018
Gonocarpus mezianus	Hairy Raspwort		1859
Goodenia albiflora	White Goodenia		
Goodenia pinnatifida	Cut-leaf Goodenia		2018
Goodenia willisiana	Silver Goodenia		2009
Grevillea ilicifolia subsp. Ilicifolia	Holly-leaf Grevillea		
Grevillea lavandulacea ssp. lavandulacea	Spider-flower		1967
Grevillea robusta	Silky Grevillea	*	2018
Hakea carinata	Erect Hakea	*	2018
Hakea rostrata	Beaked Hakea	*	2018
Haloragis aspera	Rough Raspwort		2018
Haloragis acutangula f. subacutangula	Smooth Raspwort		2018
Hardenbergia violacea	Native Lilac	*	2018
Hedypnois rhagadioloides	Cretanweed	*	2000
Heliotropium europaeum	Potato Weed	*	2018
Helminthotheca echioides	Ox-tongue	*	2018
Hibbertia virgata	Twiggy Guinea-flower		1962
Hordeum leporinum	Hare barley	*	2018
Hordeum sp.	Barley-grass	*	2018
Hordeum vulgare	Barley	*	2018
Hyalosperma glutinosum ssp. glutinosum	Golden Sunray		1939
Hyalosperma semisterile	Orange Sunray		1967
Hydrocotyle verticillata	Shield Pennywort		2018
Hyparrhenia hirta	Coolatai Grass	*	2018
Hypericum gramineum	Rolled-leaf Hypericum		1850
Hypochaeris glabra	Smooth Cat's Ear	*	2000
Hypochaeris radicata	Rough Cat's Ear	*	2018
Hypoxis glabella var. glabella	Tiny Star		1967
Ipomoea indica	Morning Glory	*	2018
Iris X germanica	Bearded Iris	*	2018
Isoetopsis graminifolia	Grass Cushion		1967
Isolepis cernua	Nodding Club-sedge		2018
Isolepis congrua	Slender Club-sedge		1848
Juncus bufonius	Toad-rush		2017
Juncus kraussii	Sea Rush		2018
Juncus pallidus	Pale Rush		2018
Juncus pauciflorus	Loose-flower Rush		2000
Juncus subsecundus	Finger Rush		2009
Juncus usitatus	Common Rush		2018
Kennedia prostrata	Scarlet Runner		1967
Kickxia communta	Fluellen	*	2018
Kickxia elatine	Sharp-leaf Fluellen	*	2018
Kunzea pomifera	Muntries		1967

Lachnagrostis filiformis	Common Blown-grass		1940
Lactuca serriola f. serriola	Prickly Lettuce	*	2018
Lagunaria patersonia	Pyramid Tree	*	2018
Lampranthus glaucus	Noon-flower	*	2000
Lasiopetalum baueri	Slender Velvet-bush		1910
Lasiopetalum behrii	Pink Velvet-bush		1910
Lathrys tingitanus	Tangier Pea	*	2018
Leiocarpa tomentosa	Woolly Plover-daisy		2018
Leiocarpa websteri	Narrow Plover-daisy		2018
Lepidium africanum	Common Peppercress	*	2018
Lepidosperma viscidum	Sticky Sword-sedge		2018
Leptorhynchos elongatus	Lanky Buttons		1968
Leptorhynchos orientalis	Annual Buttons		1848
Leptorhynchos waitzia	Button Immortelle		1848
Leptospermum myrsinoides	Heath Tea-tree	*	2018
Leucopogon cordifolius	Heart-leaf Beard-heath		1893
Levenhookia dubia	Hairy Stylewort		1848
Limonium companyonis	Sea-lavender	*	2018
Limonium sinuatum	Notched Sea-lavender	*	2018
Lobelia anceps	Angled Lobelia		
Lolium rigidum	Wimmera Ryegrass	*	2018
Lolium sp.	Ryegrass	*	2012
Lomandra densiflora	Soft Tussock Mat-rush		2018
Lomandra effusa	Scented Mat-rush		2018
Lomandra leucocephala ssp. robusta	Woolly Mat-rush		1967
Lomandra micrantha ssp. micrantha	Small-flower Mat-rush		1967
Lomandra multiflora ssp. dura	Hard Mat-rush		2018
Lomandra nana	Small Mat-rush		2018
Lycium australe	Australian Boxthorn		2018
Lycium ferocissimum	African Boxthorn	*	2018
Lysimachia arvensis	Pimpernel	*	2018
Lythrum hyssopifolia	Lesser Loosestrife		2018
Lythrum salicaria	Purple Loosestrife		
Maireana brevifolia	Short-leaf Bluebush		2018
Maireana enchylaenoides	Wingless Fissure-plant		2018
Maireana rohrlachii	Rohrlach’s Bluebush		2018
Malva arborea	Tree mallow	*	2018
Malva nicaeensis	Mallow of Nice	*	2000
Malva parviflora	Small-flower Marshmallow	*	2018
Malva preissiana	Native Hollyhock		2018
Marrubium vulgare	Horehound	*	2018
Medicago polymorpha	Burr-medic	*	2018
Medicago truncatula	Barrel Medic	*	2018

Melaleuca acuminata ssp. acuminata	Mallee Honey-myrtle		1962
Melaleuca armillaris	Bracelet Honey-myrtle	*	2018
Melaleuca decussata	Totem poles	*	2018
Melaleuca lanceolata	Dryland Tea-tree		2018
Melaleuca nyssophila	Dwarf-leaf Honey-myrtle	*	2018
Melaleuca sp.	Tea-tree		
Microtis unifolia	Common onion orchid		1992
Mimulus repens	Creeping Monkey-flower		2018
Minuartia mediterranea	Slender Sandwort	*	1999
Moraea miniata	Two-leaved Cape tulip	*	2000
Moraea setifolia	Thread Iris	*	2018
Myoporum insulare	Common Boobialla		2018
Myoporum montanum	Boobialla		2018
Myoporum petiolatum	Sticky Boobialla		2018
Myoporum platycarpum ssp. Perbellum	Mallee Sandalwood		1967
Myosotis australis	Austral forget-me-not		2009
Myriophyllum amphibium	Broad water-milfoil		2009
Myriophyllum sp.	Water-milfoil		2018
Narcissus jonquilla	Jonquil	*	2000
Nassella neesiana	Chilean needle grass	*	2009
Nerium oleander	Oleander	*	1997
Nicotiana glauca	Tree Tobacco	*	2018
Nitraria billardierei	Nitre-bush		2018
Oenothera stricta	Evening Primrose	*	2018
Olea europaea ssp. Europaea	Olive	*	2018
Olearia sp.	Daisy-bush		1848
Olearia ramulosa	Twiggy Daisy-bush		2018
Oncosiphon suffruticosum	Calomba Daisy	*	2015
Opercularia turpis	Twiggy Stinkweed		1967
Orobanche cernua var. australiana	Australian Broomrape		
Opuntia ficus-indica	Indian Fig	*	2018
Opuntia monacantha	Barbary Fig	*	2018
Oxalis bowiei	Bowie Wood-sorrel	*	1982
Oxalis perennans	Native Sorrel		2018
Oxalis pes-caprae	Soursob	*	2018
Ozothamnus retusus	Notched Bush-everlasting		2018
Panicum capillare	Witch-grass	*	2018
Panicum decompositum	Australian Millet	*	2018
Panicum effusum var. effusum	Hairy Panic		2018
Panicum hillmanii	Witch-grass	*	1999
Panicum schinzii	Sweet Panic	*	1998
Panicum sp.	Panic/Millet		2012
Papaver sp.	Poppy	*	2018

Paraserianthes lophantha	Cape Leeuwin Wattle	*	2018
Parentucellia latifolia	Red Bartsia	*	2012
Paspalum dilatatum	Paspalum	*	2018
Petroselinum crispum	Parsley	*	2018
Phoenix sp.		*	2018
Phragmites australis	Common Reed		2018
Philotheca angustifolia ssp. Angustifolia	Narrow-leaf Wax-flower		1912
Phyla canescens	Lippia	*	2018
Pimelea micrantha	Silky Riceflower		2018
Pimelea serpyllifolia ssp. serpyllifolia	Thyme Riceflower		1996
Pimelea stricta	Erect Riceflower		1966
Pinus halepensis	Aleppo Pine	*	2018
Pinus pinea	Stone pine	*	2018
Pinus radiata	Radiata Pine	*	2018
Piptatherum miliaceum	Rice Millet	*	2018
Pittosporum angustifolium	Native Apricot		2018
Pittosporum undulatum	Sweet Pittosporum	*	2018
Plantago gaudichaudii	Swamp Plantain		1848
Plantago lanceolata	Ribwort	*	2018
Plantago major	Plantain	*	2018
Plantago varia	Variable Plantain		2009
Pleurosurus rutifolius	Blanket Fern		2018
Poa annua	Winter Grass	*	2000
Poa bulbosa	Bulbous Meadow-grass	*	2018
Poa crassicaudex	Thick-stem Tussock-grass		2012
Poa labillardieri var. labillardieri	Common Tussock-grass		2018
Podolepis canescens	Grey Copper-wire Daisy		1967
Podolepis rugata var. rugata	Pleated Copper-wire Daisy		1967
Polycarpon tetraphyllum	Allseed	*	2018
Polygala myrtifolia	Myrtle-leaf Milkwort	*	2018
Polygonum aviculare	Wireweed	*	2018
Pomaderris paniculosa ssp. Paniculosa	Mallee Pomaderris		1893
Populneus sp.	Poplar	*	2018
Portulaca oleracea	Common Purslane		2018
Potamogeton pectinatus	Fennel pondweed		2000
Prasophyllum occidentale	Riverina Leek-orchid		1848
Prasophyllum odoratum	Heath Leek-orchid		1850
Prostanthera behriana	Downy Mintbush		1920
Prunus dulcis	Almond	*	2018
Prunus sp.		*	2018
Pseudognaphalium luteoalbum	Jersey Helichrysum		2018
Pterostylis robusta	Large Shell-orchid		1968
Ptilotus nobilis ssp. angustifolius	Yellow-tails		2018

Ptilotus spathulatus	Pussy-tails		2018
Pyrorchis nigricans	Black Fire-orchid		1893
Quercus robur	Common Oak	*	2018
Ranunculus muricatus	Burr Buttercup	*	2018
Raphanus raphanistrum	Wild Radish	*	1997
Rapistrum rugosum subsp. Rugosum	Turnip Weed	*	2018
Reichardia tingitana	Reichardia	*	2018
Reseda lutea	Cut-leaf Mignonette	*	2018
Reseda odorata	Bastard rocket	*	1971
Retama raetam	White Weeping Broom	*	2018
Rhagodia candolleana	Sea-berry Saltbush	*	2018
Rhagodia crassifolia	Fleshy Saltbush	*	2018
Rhagodia parabolica	Mealy Saltbush		2018
Rhamnus alaternus	Italian Buckthorn	*	2018
Rhaponticum repens	Creeping Knapweed	*	1977
Rhodanthe corymbiflora	Paper Everlasting		
Rhodanthe pygmaea	Pigmy Daisy		1967
Ricinus communis	Castor Oil Plant	*	2018
Romulea rosea var. australis	Common Onion-grass	*	2018
Rosa canina	Dog Rose	*	2018
Rosa rubiginosa	Apple-scented rose	*	2018
Rostraria cristata	Annual Cat's-tail	*	2018
Rumex crispus	Curled Dock	*	2018
Rumex dumosus	Wiry Dock		2018
Rytidosperma auriculatum	Lobed wallaby-grass		2009
Rytidosperma caespitosum	Common Wallaby-grass		2018
Rytidosperma fulvum	Leafy Wallaby-grass		2009
Rytidosperma racemosum	Slender Wallaby-grass		2009
Rytidosperma setaceum	Small-flower Wallaby-grass		2018
Salsola australis	Buckbush		2018
Salvia verbenaca var. verbenaca	Wild Sage	*	2018
Sambucus nigra	Common Elder	*	1907
Samolus repens	Creeping Samolus	*	2018
Santalum acuminatum	Quandong		2018
Scabiosa atropurpurea	Pincushion	*	2018
Schinus molle	Pepper-tree	*	2018
Schismus barbatus	Mulga Grass	*	2018
Schoenoplectus pungens	Spiky Club-rush		2018
Schoenoplectus subulatus	Shore Club-rush		2018
Schoenoplectus validus	River Club-rush		2018
Sclerolaena diacantha	Grey Bindyi		1968
Sclerolaena birchii	Galvanised burr.	*	2018
Selleira radicans	Shiny Swamp-mat		2018

Sebaea ovata	Yellow Sebaea		1880
Sedum sediforme	Stonecrop	*	1987
Senecio angulatus	Creeping Groundsel	*	2018
Senecio glossanthus	Annual Groundsel		1968
Senecio pterophorus	African Daisy	*	2018
Senna artemisioides	Desert Senna		2002
Senna artemisioides ssp. artemisioides	Senna	*	2018
Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna		2018
Senna artemisioides ssp. petiolaris	Flat-leaf Desert Senna		2018
Senna artemisioides ssp. coriacea	Broad-leaf Desert Senna		2018
Setaria constricta	Knotty-butt Setaria		2018
Setaria jubiflora	Warrego Summer-grass		2018
Setaria verticillata	Whorled pigeon-grass	*	2000
Sherardia arvensis	Field Madder	*	2018
Sida corrugata var. angustifolia	Grassland Sida		2018
Sida corrugata var. corrugata	Corrugated Sida		2018
Sida intricata	Twiggy Sida		2018
Sisymbrium orientale	Indian Hedge Mustard	*	2015
Sisymbrium sp.	Wild Mustard	*	2018
Solanum elaeagnifolium	Silver-leaf Nightshade	*	2018
Solanum linnaeanum	Apple of Sodom	*	2018
Solanum nigrum	Black Nightshade	*	2018
Solanum simile	Kangaroo Apple	*	2018
Solenogyne dominii	Smooth Solenogyne		2009
Sonchus asper	Prickly Sow-thistle	*	2018
Sonchus oleraceus	Common Sow-thistle	*	2018
Sorghum halepense	Johnson Grass	*	2018
Sporobolus virginicus	Salt Couch		2018
Stackhousia monogyna	Creamy Candles		2016
Stackhousia subterranea	Grassland Candles		2018
Stellaria media	Chickweed	*	2000
Sueda australis	Austral Seablite		2009
Symphyotrichum subulatum	Aster-weed	*	2018
Tamarix parviflora	Tamarisk	*	2018
Taraxacum officinalis	Dandelion	*	2018
Templetonia retusa	Cockies Tongue	*	2018
Teucrium racemosum	Grey Germander		2018
Teucrium sessiliflorum	Mallee Germander		1957
Themeda triandra	Kangaroo Grass		2018
Thysanotus baueri	Mallee Fringe-lily		1967
Thysanotus patersonii	Twining Fringe-lily		1967
Tribulus terrestris	Caltop	*	2018
Trifolium angustifolium	Narrow-leaf Clover	*	2018

Trifolium arvense var. arvense	Hare’s-foot Clover	*	2018
Trifolium campestre	Hop Clover	*	2018
Triglochin procerum	Water Ribbons	*	2018
Triglochin striata	Streaked arrowgrass		2009
Tritonia siliqua	Tritonia	*	2018
Tropaeolum majus	Nasturtium	*	2018
Typha orientalis	Broadleaf cumbungi		c. 1847
Typha domingensis	Bul-rush		2018
Ulmus sp.	Elm	*	2018
Urtica urens	Stinging Nettle	*	2018
Valerianella discoidea	Lesser Cornsalad	*	2000
Velleia arguta	Toothed Velleia		2015
Verbascum virgatum	Green Mullein	*	2018
Verbena supina var. erecta	Trailing Verbena	*	2018
Vicia sativa ssp. Sativa	Common Vetch	*	2018
Vinca major	Blue Periwinkle	*	2018
Viola odorata	Violet	*	2018
Vitis coignetiae	Glory Vine	*	2018
Vittadinia blackii	Narrow-leaf New Holland Daisy		2018
Vittadinia cervicularis var. cervicularis	Waisted New Holland Daisy		2018
Vittadinia cuneata var. cuneata	Fuzzy New Holland Daisy		2018
Vittadinia gracilis	Woolly New Holland Daisy		2018
Vittadinia megacephala	Giant New Holland Daisy		2018
Vulpia bromoides	Squirrel-tail Fescue	*	2000
Vulpia myuros f. myuros	Rat's-tail Fescue	*	2018
Wahlenbergia luteola	Yellow-wash Bluebell		2018
Walwhalleya proluta	Rigid Panic		2018
Watsonia meriana var. bulbillifera	Bulbil Watsonia	*	2018
Watsonia meriana var. meriana	Bulbil Watsonia	*	1938
Withania somnifera	Winter Cherry	*	2018
Wurmbea dioica ssp. brevifolia	Early Nancy		1967
Xanthium spinosum	Bathurst Burr	*	2018
Xanthium strumarium	Californian Burr	*	2018
Yucca gloriosa	Yucca	*	2018
Zaluzianskya divaricata	Spreading Night-phlox	*	2000
Zantadeschia aethiopica	Arum Lily	*	2018
Zygophyllum aurantiacum ssp. aurantiacum	Shrubby Twinleaf		1967
Zygophyllum glaucum	Pale Twinleaf		2018

Appendix 5 – Fauna Taxa Recorded for the Town of Gawler

"Recorded" includes from records from SA Museum, Atlas of Living Australia and recognised sources e.g. bat records for 2016 at and near Clonlea Terry Reardon, fish records Native Fish SA, Waterwatch and photographs supplied.

Scientific Name	Common name	Introduced Species	Last Recorded
Fish and Allies			
Anguilla australis	Short-finned Eel		c. 2000
Carassius auratus	Goldfish	*	2011
Cyprinus carpio	European Carp	*	2018
Galaxias olidus	Mountain Galxia		1998
Galaxias maculatus	Common Galaxias		2013
Gambusia holbrooki	Eastern Gambusia	*	2018
Galaxias olidus	Mountain Galaxias		2004
Mordacia mordax	Murray Lamprey		c. 1970
Philypnodon grandiceps	Big-headed Gudgeon		2012
Pseudaphritis urvillii	Congolli		2018
Pseudogobius olorum	Bluespot Goby		c. 2007
Tinca tinca	Tench		
Frogs			
Crinia signifera	Common Froglet		2018
Limnodynastes dumerilii dumerilii	Banjo Frog		2012
Limnodynastes tasmaniensis	Spotted Marsh Frog		2005
Litoria ewingii	Brown Tree Frog		2018
Neobatrachus pictus	Burrowing frog		1998
Pseudophryne bibronii	Brown Toadlet		1996
Spiders			
Aganippe subtristis	Spider sp.		1992
Araneidae sp.	Orb Weaver		2018
Eriophora biapicata	Spider sp.		2018
Isopeda sp.	Huntsman		2018
Mygalomorphae sp. / Lycosidae sp.	Tunnel/ Trapdoor Spider		2018
Nephilia edulis	Golden Orb Weaver		2018

Birds			
Duck Hybrid sp.	Black Duck-Mallard hybrid		2013
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		1984
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		2013
Acanthiza reguloides	Buff-rump Thornbill		2018
Accipiter cirrocephalus	Collared Sparrowhawk		2018
Accipiter fasciatus	Brown Goshawk		2018
Acrocephalus australis	Australian Reed-Warbler		2018
Alauda arvensis	Eurasian Skylark	*	1999
Anas castanea	Chestnut Teal		1999
Anas gracilis	Grey Teal		1999
Anas superciliosa	Pacific Black Duck		2018
Anhinga novaehollandiae	Australasian Darter		2012
Anthochaera carunculata	Red Wattlebird		2018
Anthochaera chrysoptera	Little Wattlebird		2013
Anthochaera phrygia	Regent Honeyeater		1900
Anthus australis	Australian Pipit		2018
Aphelocephala leucopsis	Southern Whiteface		2010
Aquila audax	Wedge-tailed Eagle		2018
Ardea alba	Great Egret		2012
Ardea modesta	Eastern Great Egret		2010
Ardea pacifica	Pacific Heron		2011
Ardenna tenuirostris	Short-tailed Shearwater		1961
Artamus cyanopterus	Dusky Woodswallow		2018
Artamus superciliosus	White-browed Woodswallow		1960
Cacatua galerita	Sulphur-crested Cockatoo		2018
Cacatua sanguinea	Little Corella		2018
Cacatua tenuirostris	Long-billed Corella		2011
Cacomantis pallidus	Pallid Cuckoo		2011
Carduelis carduelis	European Goldfinch	*	2010
Ceyx azureus	Azure Kingfisher		1913
Chenonetta jubata	Maned Duck		2018
Cheramoeca leucosterna	White-backed Swallow		2015
Chloris chloris	European Greenfinch	*	2018

Chroicocephalus novaehollandiae	Silver Gull		1984
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo		2018
Cincloramphus cruralis	Brown Songlark		1984
Cincloramphus mathewsi	Rufous Songlark		1984
Circus assimilis	Spotted Harrier		2015
Climacteris picumnus	Brown Treecreeper		2018
Colluricincla harmonica	Grey Shrikethrush		2018
Columba livia	Rock Pigeon (Feral Pigeon)	*	2018
Coracina novaehollandiae	Black-faced Cuckoo-shrike		2018
Corcorax melanorhamphos	White-winged Chough		2012
Corvus bennetti	Little Crow		2014
Corvus coronoides coronoides	Australian Raven		2009
Corvus mellori	Little Raven		2018
Coturnix pectoralis	Stubble Quail		2018
Coturnix ypsilophora	Brown Quail		2018
Dacelo novaeguineae	Laughing Kookaburra		2018
Egretta novaehollandiae	White-faced Heron		2018
Elanus axillaris	Australian Kite		2015
Eolophus roseicapilla	Galah		2018
Epthianura albifrons	White-fronted Chat		2012
Falco berigora	Brown Falcon		2015
Falco cenchroides	Australian Kestrel		2018
Falco longipennis longipennis	Australian Hobby		2018
Falco subniger	Black Falcon		2012
Falco peregrinus	Peregrine Falcon		2018
Falcunculus frontatus	Crested Shrike-tit		2018
Fulica atra	Eurasian Coot		1998
Gallinula tenebrosa	Dusky Moorhen		2018
Gallirallus philippensis	Buff-banded Rail		2011
Gavicalis virescens	Singing Honeyeater		2018
Geopelia cuneata	Diamond Dove		1963
Geopelia placida	Peaceful Dove		2015
Glossopsitta concinna	Musk Lorikeet		2018
Glossopsitta porphyrocephala	Purple-crowned Lorikeet		2015

Grallina cyanoleuca	Magpie-lark		2018
Gymnorhina tibicen	Australian Magpie		2018
Haliastur sphenurus	Whistling Kite		1969
Hieraaetus morphnoides	Little Eagle		2018
Himantopus himantopus leucocephalus	Pied Stilt		2015
Hirundo neoxena	Welcome Swallow		2017
Lalage sueurii	White-winged Triller		2013
Malurus cyaneus	Superb Fairywren		2018
Malurus lamberti lamberti	Variegated Fairy-wren		1967
Malurus splendens melanotus	Splendid Fairy-wren		1904
Manorina flavigula	Yellow-throated Miner		2005
Manorina melanocephala	Noisy Miner		2018
Megalurus gramineus	Little Grassbird		2013
Melithreptus gularis	Black-chinned Honeyeater		2012
Melopsittacus undulatus	Budgerigar		2014
Merops ornatus	Rainbow Bee-eater		2018
Microeca fascinans	Jacky Winter		1998
Milvus migrans	Black Kite		2011
Mirafra javanica	Horsfield's Bush Lark		1984
Myiagra inquieta	Restless Flycatcher		2005
Neochmia temporalis	Red-browed Finch		2015
Neophema chrysostoma	Blue-winged Parrot		1967
Neophema elegans	Elegant Parrot		2010
Ninox boobook	Southern Boobook		2018
Nycticorax caledonicus	Rufous Night-Heron		2017
Ocyphaps lophotes	Crested Pigeon		2018
Oxyura australis	Blue-billed Duck		2015
Pachycephala pectoralis	Golden Whistler		2000
Pachycephala rufiventris	Rufous Whistler		2013
Pardalotus punctatus	Spotted Pardalote		2009
Pardalotus striatus	Striated Pardalote		2018
Passer domesticus	House Sparrow		2018
Pelecanus conspicillatus	Australian Pelican		2012

Petrochelidon ariel	Fairy Martin		2018
Petrochelidon nigricans	Tree Martin		2012
Petroica goodenovii	Red-capped Robin		2010
Phalacrocorax melanoleucos	Little Pied Cormorant		2014
Phalacrocorax sulcirostris	Little Black Cormorant		2018
Phalacrocorax varius	Pied Cormorant		2012
Phaps chalcoptera	Common Bronzewing		2005
Phoebetria palpebrata	Light-mantled Sooty Albatross		1981
Phylidonyris novaehollandiae	New Holland Honeyeater		2018
Platalea flavipes	Yellow-billed Spoonbill		2002
Platalea regia	Royal Spoonbill		2014
Platycercus elegans subadelaidae	Crimson Rosella (Adelaide)		2018
Platycercus eximius	Eastern Rosella		2018
Podargus strigoides	Tawny Frogmouth		2013
Porphyrio melanotus	Australasian Swamphen		2014
Porphyrio porphyrio	Purple Swamphen		2018
Psephotus haematonotus	Red-rumped Parrot		2018
Ptilotula ornata	Yellow-plumed Honeyeater		1999
Ptilotula penicillata	White-plumed Honeyeater		2018
Puffinus tenuirostris	Short-tailed shearwater		1961
Rhipidura albiscapa	Grey Fantail		2005
Rhipidura leucophrys	Willie-wagtail		2018
Sericornis frontalis	White-browed Scrubwren		1908
Smicrornis brevirostris	Weebill		2018
Spilopelia chinensis	Spotted Dove	*	2018
Streptopelia roseogrisea	Barbary Dove	*	2013
Sturnus vulgaris	Common Starling		2018
Tadorna tadornoides	Australian Shelduck		1839
Taeniopygia guttata	Zebra Finch		2000
Threskiornis molucca	Australian Ibis		2018
Todiramphus sanctus	Sacred Kingfisher		2018
Tribonyx ventralis	Black-tailed Nativehen		2005
Trichoglossus haematodus	Rainbow Lorikeet		2018
Tringa nebularia	Common Greenshank		1938

Turdus merula	Common Blackbird	*	2018
Tyto delicatula	Australian Barn Owl		2018
Vanellus miles	Masked Lapwing		2018
Zosterops lateralis	Silver-eye		2014
Molluscs			
Velesunio ambiguus	Balonne Freshwater Mussel		1900
Snails and Slugs			
Austrosuccinea sp.			
Ponderconcha murphyi			
Insects			
Achyra affinitalis	Cotton Web Spinner Moth		1941
Alcaeus varicornis	Acacia Shield Bug		2018
Agraptocorixa parvipunctata	Water Boatmen		1997
Agraptocorixa sp.	Water Boatmen		1995
Alphitobius diaperinus	Lesser Mealworm		1968
Amegilla sp.	Blue-banded bee		2018
Amitermes neogermanus	Termite		
Amnemus quadrituberculatus	Clover Root Weevil		1987
Anilara subcostata	a Beetle		
Anisops thienemanni	a Bug		1995
Anthicus clarkii	a Beetle		
Anthicus gawleri	a Beetle		
Anthicus kreusleri	a Beetle		
Anthicus monilis	a Beetle		
Anthicus myrteus	a Beetle		
Anthicus nigricollis	a Beetle		
Anthicus nitidissimus	a Beetle		
Anthicus sp.	a Beetle		
Anthicus wollastonii	a Beetle		
Apis mellifera	Honey Bee		2018
Asilidae sp.	Robber Fly		2018
Belenois java teutonia	Caper White		2018
Bubastes inconsistans	a Beetle		
Camponotus ephippium	an Ant		2003

Camponotus scotti	an Ant		1989
Camponotus sp.	an Ant		1973
Carenum odewahnii	a Scarab Beetle		
Castiarina distincta	a Beetle		
Castiarina flava	a Beetle		
Castiarina guttata	a Beetle		
Castiarina marginicollis	a Beetle		
Castiarina moribunda	a Beetle		
Castiarina piliventris	a Beetle		
Castiarina rubriventris	a Beetle		1989
Castiarina rufipennis	a Beetle		
Chalcolampra aenea	a Beetle		
Chileanthicus speciosus	a Beetle		
Clania sp.	Faggot Case Moth		2018
Coccinella transversalis	Transverse Ladybird		2018
Colletidae sp.	Short-Tongued Bee		2018
Coptotermes acinaciformis	Subterranean Termite		1975
Cruria donowani	Crow Moth		2018
Ctenisophus kreusleri	a Beetle		
Danus plexippus	Monarch Butterfly		2018
Delias aganippe	Wood White		2018
Diphucrania minutissima	a Beetle		
Diplacodes haematodes	Scarlet Percher Dragonfly		1895
Dolichoderus scabridus	a Doli Ant		1968
Dryophilodes subcylindricus	a Beetle		
Ectrephes formicarum	a Beetle		
Ellipsidion australe	Austral Ellipsidion Cockroach		2018
Emplesis munda	a Weevil		c. 1910
Escala insignis	a Cockroach		1949
Euconnus gawleri	a Beetle		
Euplectops odewahni	a Beetle		
Eurema smilax	Small Grass Yellow		2018
Eurymeloides pulchra	a Bug		1975
Harmionia conformis	Large Spotted Ladybird		2018

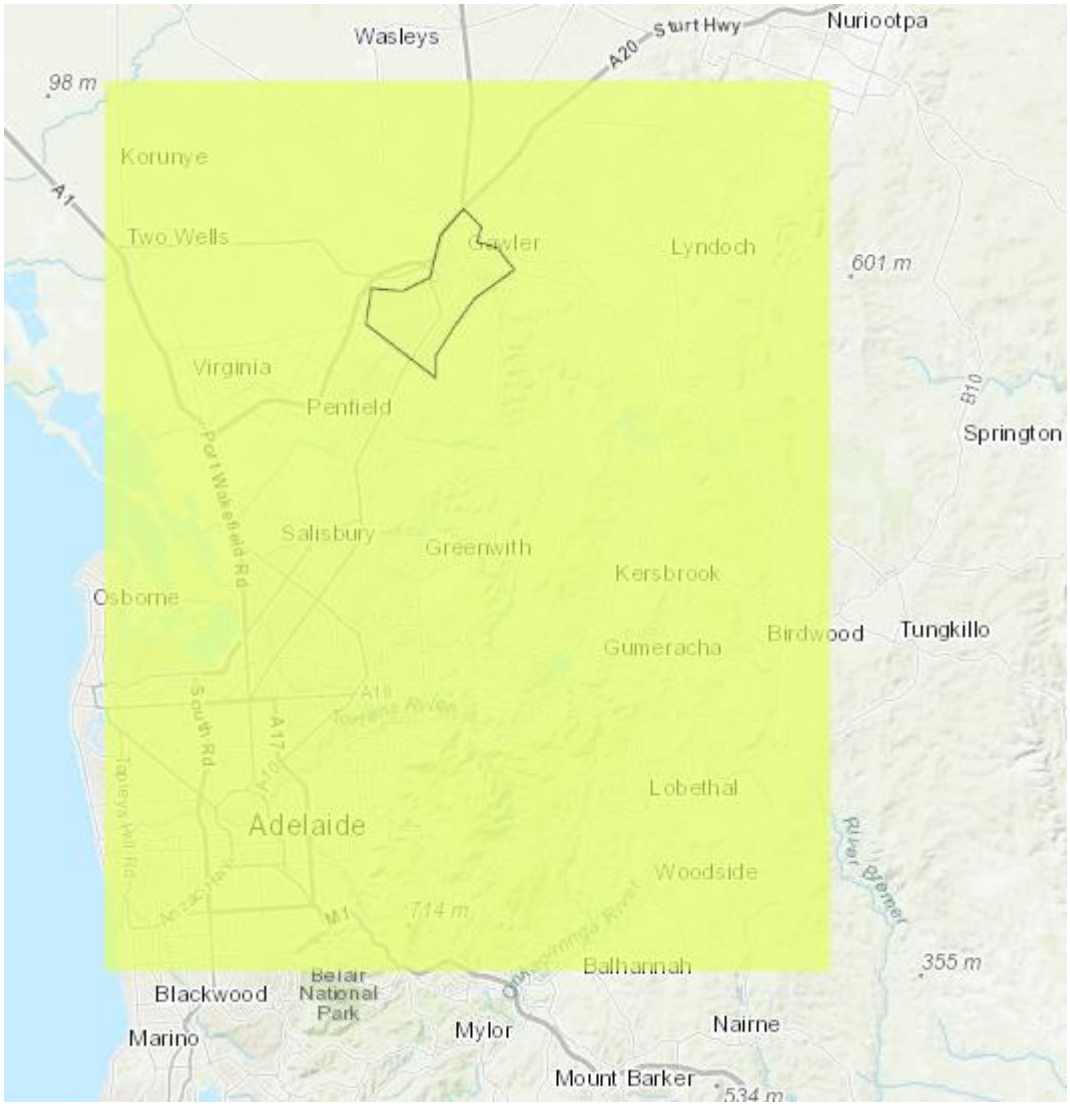
Hemicordulia tau	Tau Emerald		2018
Heteronympha merope	Common Brown		2018
Hyalarcta huebneri	Common Leaf Case Moth		1986
Ichneumonidae sp.	Ichneumon Wasp		2018
Iridomyrmex chasei	a Meat Ant		1968
Iridomyrmex purpureus	a Meat Ant		2018
Iridomyrmex sp.	a Meat Ant		2004
Ischnura aurora	Aurora Bluetail Damselfly		2018
Junonia villida calybe	Meadow Argus		2018
Laemostenus complanatus	Cosmopolitan ground beetle		
Lasioglossum sulthicum	a Halictid Bee		1952
Laxta granicollis	Bark Cockroach		1947
Lepisma saccharina	Silverfish		2018
Leucorhabda macrosticha	A Leucorhabda Moth		1927
Lycaenidae sp.	Blue Butterfly		2018
Macratria australis	a Beetle		
Mantidae sp.	Preying Mantid		2018
Mecynotarsus concolor	a Beetle		1867
Mecynotarsus kreusleri			1867
Melangyna sp.	Hoveryfly		2018
Melophorus sp.	an Ant		2003
Mesostruma loweryi	an Ant		c. 1970
Metallesthes unicolor	A Scarab Beetle		1986
Micromus tasmaniae	Brown Lacewing		2018
Micranthicus pulcher	a Beetle		
Micraspis furcifera	a Ladybird		2018
Microberosiris albus	a Weevil		
Micromus tasmaniae	Brown Lacewing		2018
Mictis profana	Crusader Bug		1989
Miocydus brevicornis	a Beetle		
Misophrice variabilis	a Weevil		c.1910
Monomorium kiliani	an Ant		1968
Monomorium sp.	an Ant		2003
Mordella dumbrelli	a Pintail Beetle		1989

Myocara australe	a Bug		1973
Myrmecia sp.	Inch Ant		2018
Myrmeleontida sp.	Antlion		2018
Nasutitermes sp.	Termite		2018
Naupactus leucoloma	White-fringed Weevil		1967
Niastama obscuritarsis	a Bug		c. 1910
Notoncus capitatus	an Ant		1973
Notoncus sp.	an Ant		1973
Omonadus floralis	Narrow-necked Grain Beetle		c. 1865
Ocybadistes walkeri	Southern Dart		2018
Onthophagus pentacanthus	Fivehorned Dung Beetle		1977
Orthetrum caledonicum	Blue Skimmer		2018
Orthorhinus cylindrirostris	Elephant Beetle		c. 1994
Paratrechina sp.	an Ant		2003
Pheidole sp.	Bigheaded ant		2003
Philobota sphenoleuca	a Philobota Moth		1907
Phyllotocus rufipennis	a Scarab Beetle		1947
Pieris rapae	Cabbage White		2018
Polistes sp.	Paper Wasp		2018
Pompilidae sp.	Spider Wasp		2018
Pyralidae sp.	Pyralid Moth		2018
Pseudocyclodinus glaber	a Beetle		
Pseudocyclodinus strictus	a Beetle		
Pseudocyclodinus unifasciatus	a Beetle		
Pseudofoenus sp.	Burrowing bee parasite		1990
Ranatra dispar	Needle Bug		c. 1910
Rheumatometra sp.	Water Strider		2018
Rhytidoponera mayri	a Beetle		c. 1910
Rhytidoponera metallica	a Beetle		2003
Rhytidoponera sp.	a Beetle		2004
Rhyzobius evansii	a Beetle		c. 1910
Sinoxylon anale	Auger Beetle		1993
Stigmacros sp.	an Ant		2003
Stigmodera sanguinosa	a Beetle		

Strumigenys cochlearis	an Ant		c.1910
Tiracerus excavipectus	a Beetle		c.1910
Tiracerus fortnumi	a Beetle		c.1910
Tiracerus mastersi	a Beetle		c.1910
Vanessa itea	Yellow Admiral		1954
Uraba lugens	Gum-leaf Skeletoniser		2018
Vespidae sp.	Mud Wasp		2018
Vespula germanica	European Wasp		2018
Villa sp.	Villa Bee Fly		2018
Zizena labradus	Grass Blue		2018
Mammals			
Antechinus flavipes	Yellow-footed Antechinus		1980
Austronomus (Tadarida) australis	White-striped Freetail Bat		2016
Bettongia lesueur	Burrowing Bettong		1945
Chalinolobus morio	Chocolate Wattled Bat		2016
Chalinolobus gouldii	Gould's Wattled Bat		2016
**Felis catus*	Cat	*	2018
Hydromys chrysogaster	Water-rat		2005
**Lepus europaeus*	European Hare	*	2018
Macropus fuliginosus	Western Grey Kangaroo		2018
Macropus robustus	Euro		1927
Mormopterus planiceps	Southern Freetail Bat		2016
**Mus musculus*	Mouse	*	2018
Nyctophilus geoffroyi	Lesser Long-eared Bat		1986
**Oryctolagus cuniculus*	European Rabbit	*	2018
Phascolarctos cinereus	Koala	*	2018
Pteropus poliocephalus	Grey-headed Flying-fox		
**Rattus norvegicus*	Brown Rat	*	2018
Tachyglossus aculeatus	Short-beaked Echidna		2012
Trichosurus vulpecula	Common Brushtail Possum		2018
Vespadelus darlingtoni	Large Forest Bat		2016
Vespadelus regulus	Southern Forest Bat		2016
**Vulpes vulpes*	Fox (Red Fox)	*	2018
Reptiles and Allies			

Aprasia pseudopulchella	Flinders Ranges Worm-lizard		2010
Chelodina longicollis	Long-necked Tortoise		2010
Christinus marmoratus	Marbled Gecko		2013
Cryptoblepharus ochrus	Eyrean Wall Skink		1969
Cryptoblepharus pannosus	Speckled Wall Skink		2018
Cryptoblepharus plagiocephalus	Péron's Snake-Eyed Skink		2010
Ctenotus spaldingi	Eastern Striped Skink		2018
Delma molleri	Olive Legless Lizard		2010
Egernia cunninghami	Cunningham's Skink		1950
Egernia striolata	Tree Skink		1969
Eremiascincus richardsonii	Broad-banded Sandswimmer		1950
Hemiergis decresiensis continentis	Three-toed Earless Skink		2018
Hemiergis peronii	Four-toed Earless Skink		2010
Lampropholis guichenoti	Garden Skink		2018
Lerista bougaainvillii	Bougainville's Skink		2010
Menetia greyii	Dwarf Skink		2018
Morethia obscura	Shrubland Morethia Skink		2010
Morethia boulengeri	Boulenger's Snake-Eyed Skink		2018
Notechis scutatus	Tiger Snake		2009
Parasuta flagellum	Little Whip Snake		2010
Pogona barbata	Eastern Bearded Dragon		2013
Pseudechis porphyriacus	Red-bellied Black Snake		2018
Pseudonaja textilis	Eastern Brown Snake		2018
Tiliqua rugosa	Sleepy Lizard		2018
Tiliqua scincoides	Eastern Bluetongue		2018
Worms and Flatworms			
Craspedella simulator			1989
Crustaceans			
Cherax destructor	*Yabbie*		2018

Appendix 6 – Climate Change Modelling Area



Modelled area for which the charts in the main body apply.

Modelling is derived from General Circulation Model: ©IPCC 2007: WG1-AR4: 1st Runs, A2 (high greenhouse gas concentration - CO_2) ad is related to the baseline period 1961-1990.

(Climate Wizard, http://climatewizard.ciat.cgiar.org/outputs/Gawler2065/)

Appendix 7 – Early References to the Nature of the Town of Gawler

Compiled, and with commentary, by Adrian Shackley.

Reid family commentary

The Reid family were the first settlers in Gawler at Clonlea on the North Para in February 1839 after Light Finniss & Co set out the Gawler Special Survey in January. Eliza Reid (later Mahony) describes her impressions of Gawler town in a later writing[1]-

"Looking from the hill [i.e. from the Gawler East escarpment] I thought it park like and beautiful, the fork being well marked with splendid gum trees along the banks of the rivers. The kangaroo grass was as high as corn, with a few flowers among it. Then a clump of wattle, with their lovely yellow balls, which scented the air. ...

Beyond Willaston was a dense forest of Mallee and pines — such fine trees, and so useful for our buildings. On our, land we never allowed a gum tree to be cut down except to build bridges. The water in the North Para was not as good as in the South. No shrubs grew along it, only reeds, which were most useful for thatching."

Eliza Reid on vegetation on the South Para on their early viewing.

"As far as we could get up the South Para it was, as well as the very fine gum trees, one mass of lovely shrubs Kennedia (with its purple flowers[2]), mimosa[3], clematis, and many others. No animal had destroyed them, as our cow, tied to the cart which contained the pigs and poultry, was the first grazing animal to cross this river, except, of course the explorers."

Eliza Reid's brother Ross Reid also recorded early experiences in Gawler in an interview with the Gawler Bunyip[4].

"There were plenty of kangaroos, wallabies, emus and opossums in those days…In Gawler itself there was very little timber, except on the banks of the rivers. There was trouble in crossing the streams until the bridges were built, as they were subject to floods, but I remember one year when the North Para did not run at all. The following year it was full of fish. In those days the North Para was a succession of holes, some of them 40 to 50 feet deep. There was a fair quantity of timber east of Gawler, especially when Sandy Creek was reached. The Gawler Plains were covered with kangaroo grass, and in lighting a fire on our way up the growth caught alight and there was an immense blaze".

Nathaniel Hailes *travelled widely, including to Gawler in 1839. In later recollections he wrote[5] providing an interesting description of the flora and fauna of the region "First glimpses of the bush":*

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[1] Reprinted in *The Bunyip*, 27 April 1928.

[2] Hardenbergia violacea – Happy Wanderer was in genus Kennedia at that time

[3] Old name for wattles and peas

[4] The Bunyip 25 June 1909 page 3

[5] *Hailes, Nathaniel - South Australian Register 13.2.1878 column 5f 5g*

"During the first few months of my residence in the colony the immediate suburbs of Adelaide had but partially resigned their bush characteristics. …Wallabies, wild turkeys, snakes and dingoes would present themselves to the equestrian or pedestrian traveller, gaze with astonishment at him and at the innovations being made on their ancient domains, and instantly bound, stride, or glide, according to their several tastes and habits, back into the neighbouring wilderness – that is if permitted to do so by the unscrupulous innovator.

"My first trip of any length was to Gawler. The distance thither by rail is 25 miles. At that time no habitation had been erected between North Adelaide and the town[6] which was honoured with the name of our second Governor. It consisted of three thatched cottages, one of which was the little inn afterwards designated "The Old Spot". …..

From Adelaide to Gawler, or vice versa, was at that time a disagreeable ride in extremely hot weather. The wayfarer traversed an open plain on which no human habitation had been erected between the two townships. To meet, overtake, or be overtaken by another traveller was a rare occurrence. In cool moist weather, when a grassy carpet variegated with flowers of diversified hues more gracefully distributed than could have been suggested than the most skilful designers of patterns was spread beneath you, the ride was pleasant enough. Then an emu, a kangaroo, but more frequently a bustard or two, would cross your path, and instantly retreat amid the belt of trees which continuously intervened between the apparently interminable plain and the shore of St. Vincent's Gulf [this describes Peachey Belt vegetation which stretched between Angle Vale and Penfield a few miles west of Main North Road]; and drinkable water could be found at convenient intervals. But when the soil was bare and dusty, an unveiled sun scorching from above, and water only obtainable at distant intervals, the ride was somewhat trying.

On the hill at the northern extremity of Murray Street, and where a populous graveyard has long existed, there existed even in 1839 a solitary mound which for me possessed some interest. It was unenclosed and without gravestone or other indication of its nature. As if the sod resented the violence done to its primeval repose the native grasses were already creeping over it and in part obliterating the contrast of colour which alone distinguished it from the neighbouring herbage."

Daniel Brock collected census data and travelled to many of the early farms and stations in the Survey region in 1843. Brock was one of many commentators who saw grasslands and reported dull and monotonous plains - tall trees and water were his European-centric preference. [7]

Page 18. 6 September 1843 *"Started from Adelaide Town at 11 am. Passing over a very monotonous road reached the [Little] Para, a small stream, about 2 pm …again onward. Still the same monotonous country, a low range of hills to the east bounded by an immense plain, to the west a belt of trees, and Gawler. …on crossing it [the South Para] the relief was great, arising from the picturesque appearances of the little settlement …the respectable stream meandering between banks which were dotted with gum."*

[6] This must be in second half of *1839 predating inn on Little Para*

[7] Brock, Daniel George (1843) Recollections of D.G.B. RGSSA starting at page 19.

South Australian Register (Adelaide, SA Wednesday 8 April 1846) page 3

"Some evil-disposed person or persons during the last week cut down a tree long known as "The Five-mile Tree," on the Gawler Plain. This tree, so remarkable from its isolated position, served the double purpose of a halting-place, and a visual relief to those travelling on this very monotonous portion of the North Road, [*now Main North Road*], where for miles around scarcely anything but the dreary plain is visible. The good folk of the North are very wrath on the subject of this vandal spoliation, and could they catch the wanton depredators would doubtless give them a severe drubbing."

Looking at the land immediately to the north and east of Gawler.

Edward Eyre travelled through Gawler in May 1839. He recorded leaving Gawler**:**[8]

"On the 3rd May [1839] we fairly commenced our journey, leaving all tracks behind and striking out due north by compass. We passed thro' a fine open district consisting of grassy lightly wooded country and open downs, the soil for the most part rich and good with small pieces of quartz scattered over the surface - timber box and casuarinae. To the eastward high ranges extended, a continuation of the Mt Lofty chain, skirted by open grassy hills in the front, we encamped for the night, after a stage of about fifteen miles, upon a large creek under a scrubby sandhill [Light River]

Edward Eyre made a second exploration north of Adelaide and through Gawler in 1840 - the one when he crossed the Nullarbor to Albany. Eyre camped just north of Gawler on the North Para and recorded leaving this camp on June 20:[9]

"June 20. — Having a long stage before us to-day, I moved on the party very early, leaving all roads, and steering across the bush to my sheep stations upon the Light. We passed through some very fine country, the verdant and beautiful herbage of which, at this season of the year, formed a carpet of rich and luxuriant vegetation. "

Daniel Brock also travelled north of Gawler in 1843 collecting census data and travelled to many of the early farms and stations including those comprising the 1839 Gawler Special Survey.

On 9 September 1843 Brock reported *"Walked up to the different stations on the N. Para."* – this would have included the properties comprising the Gawler Special Survey - including the Reid's sections at Clonlea and sections 12, 10, 14 and 15 which are part of the Survey area. Unfortunately, Brock produced no commentary on this day. But a negative inference that he could not report much that pleased his eye – consistent with Eliza Reid noting few shrubs and a lot of reeds along the North Para near Gawler.

11 September 1843 Brock headed north from Gawler:

Page 22 11 September 1840. *"Left Gawler Town for the north. I passed over some very monotonous country, very little but immense plains. Scattered here and there were wattle and peppermints trees."*[10]

Brock's reports of the well-timbered higher rainfall country around the Clare hills and through the Adelaide Hills and southern districts read very differently. Grasslands were seen by Brock as rather dreary by comparison.

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[8] Edward Eyre's *Autobiographical Narrative 1832-1839* Caliban 1984 at pages 195-6.

[9] Eyre, E. J. Journals of Expeditions of discovery into central Australia 1840-41 London 1845 at page 28

[10] *Ibid page 22*

Old Colonist In similar tone to Brock, wrote[11] (reprinted in **Colonists Copper and Corn)**

In January 1851, *"we left Templar's for Gawler Town, the distance to which is nine miles, five of them over a cheerless plain with nothing to note till we looked down of the valley of the [North] Para".*

****

In 1851 **Old Colonist** also wrote,[12]

"SKETCHES OF THE PRESENT STATE OF SOUTH AUSTRALIA. No. XXIV. — GAWLER TOWN to BLACKISTON.

February 26th - This morning we made an excursion on foot along the North Para, to visit Mr. Stephen King, an old colonist, about six miles from Gawler Town. The river had a great number of broad and long waterholes, which occurred at frequent intervals throughout our walk, as we kept almost always on one or other of the banks. After passing the farm of Mr. Patterson we came to a garden belonging to Mr. Stubbs, who, however, does not reside here. This garden, in part, was the earliest planted on any portion of the Gawler Survey. It has been very productive, and was at this time in a flourishing state in spite of the season. It was underlet to an individual whom we found there, and who made no question of its further success, as Gawler Town is deficient in garden supplies.

We continued over some hills and steep sheep-runs to Floraville, a station belonging to Mr. Younghusband, on which there is a pretty little villa-like dwelling, a sort of card-model fancy, occasionally occupied by the proprietor. A paddock at hand appeared to be entirely fenced with the kangaroo acacia. We had understood at Stubbs's that here was a good garden, with fruit-trees and flowers, of which we must have formed an erroneous impression, or have mistaken our informant. We thumped at the door of entrance under a porch thickly overgrown by the passion flower, but in vain; till, hearing some hammering at the top of the premises, we at last attracted the notice, of man mending the roof, and of him we asked for the garden. He pointed with his shingling hammer to the slip sloping from the front (of the width of the cottage by about three or four times, its length}, which he said was all the garden he knew of. It contained a few vines, some roses and other flowering plants, and an India-rubber tree. We had still several tiresome hills and two gullies to pass to reach Mr. King's sheep-farm, whose buildings and fences struck us as being in much better' order than those which we had seen near Gawler Town.

We partook of Mr. and Mrs. King's hearty hospitality, which included some very good wine and after dwelling upon a few old colonial reminiscences, dating back to the earliest period of the Gawler Survey, we walked out to notice a substantial stone building in progress as Mr. King's future dwelling, of two floors, with spacious sitting-rooms. When finished this certainly will be one of the best houses in the colony, though costly. Mr. King had a garden, good for its age, with fruit- trees and vines, though the latter had not been attended to, and their sorts were undiscriminated. They had been productive, but the crows were wholesale ravagers of this fruit. Mr. King and his family found their situation healthy and agreeable, and sociality takes a wide range here, as it will be seen when we state that at an evening party given by Mrs. Hallett in Arno Vale, Mr. and Mrs. King attended from hence, a distance of 14 miles, and Mr. and Mrs. Jacobs came to the same social meeting from an opposite distance of eight miles. We returned to Gawler Town over the hills by a road as direct as we could trace it, avoiding the river, but dipping upon a deep ravine with high banks, at a short distance before we came again to the Para, near Mr. Reid's."

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[11] Colonists Copper and Corn in the colony of South Australia 1850-51 (1983) Edited E.M. Yelland. Adelaide at page 143.

[12] South Australian Register Monday 21 July 1851 page 3

Special Survey information

The Special Survey process usually picked the eyes out of the land in an area. The survey locked up access to water resources in the first 4000 acres. The best land for farming was then added. For many areas selected these was a focus on land which could be cultivated without clearance of trees and areas where soils were richer. That pattern is apparent with the Gawler Special Survey. It can be expected that the land away from the North Para was chosen on the basis of good soils, moderate slopes and evidence of fertility derived from plants growing on the land.

Government Survey records

Original survey documents can provide information on land and vegetation prior to sale of Crown land for farming and sometimes later.

Hundred of Barossa Page 7, dated 26.11.1847 All of Gawler East from East Terrace to Concordia Road alignment – sections 5, 3073 to 3084 – called Spring Gully. No details on land condition or vegetation.

Hundred of Barossa Page 4, (dated 1.6.1853). Sections 732, 734 to 738. “All Good agricultural land, some wood.” These sections are all the land between Concordia Road and Kalbeeba Road north of Lyndoch Road.

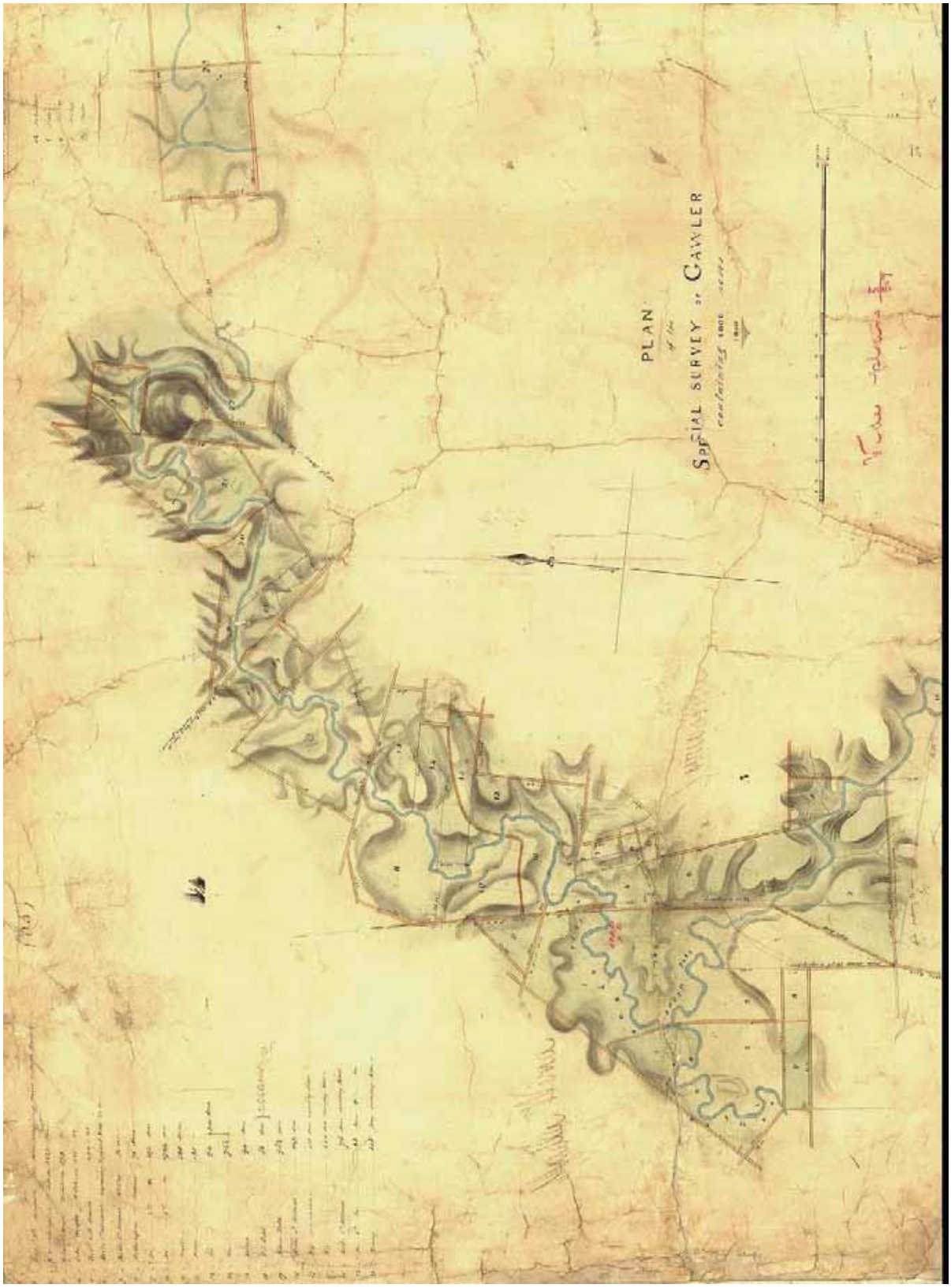
Hundred of Barossa Page 5 (also dated 1853) - sections 721 to 726 – all land north of Lyndoch Road and east of Teusner Road including both sides of Kalperi Road, McCallum Road and Mugge Road – all sections are labelled “good land”.

Hundred of Barossa Page 9 (date appears to be 1848). Sections 3038 and 3039 (now 263, 264 and 265 and part 3038), 3040, 3041 (now 261, 262), 3042, 3043, 3044 and 3045. Area north of Harris and Springbett Road, South of Bergen Road and west of Teusner Road. No details on land condition or vegetation.

For the Concordia area, Hundred of Barossa Paddock Book page 13 (date appears to be 1853) records sections of land north of Bergen and Concordia roads north to the Special Survey blocks as “good arable land” this covers sections 462, 272, 275, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474 in Hundred of Barossa.

Also, on Hundred of Barossa page 13 similar commentary on land south of Lyndoch Road in Gawler East, Para Woodland area – sections 482, 483 – “good pasture land”, 478 – “good arable land” and 480 and 481 – “good pasture land”.

In these early survey documents the absence of comment on water or trees and shrubs usually indicates that there was little or nothing significant to report. Surveyors were providing information to potential purchasers. The original Special Survey purchasers c. 1840 were mainly looking to ensure water supplies to assist grazing. Later land buyers were more related to cropping and were obviously keen to secure land which could be ploughed without needing to clear native vegetation. Hence the early sale of land in the late 1840s and early 1850s in areas without such difficulties. There was little labour and not much equipment apart from axes to clear trees. An activity to be avoided unless there was a good local market for wood.



Gawler Special Survey Plan 1839 by Light Finniss & Co. (courtesy SA Department of Planning and Transport) The bias for selecting land along the North Para is clear – land which was much less steep and with easier access to water because of the topography.

Appendix 8 – Details on SEB Offsetting

This is primarily adapted from resources on the Native Vegetaiton Council (NVC) website (https://www.environment.sa.gov.au/topics/native-vegetation).

In South Australia, all clearance of native vegetation requires approval in accordance with the Native Vegetation Act 1991 unless specified in the Native Vegetation Regulations 2017. In some instances, the clearance of native vegetation is required to be offset with a Significant Environmental Benefit (SEB) Area to compensate for the impact of the clearance. This can be achieved by establishing, managing and/or protecting native vegetation. This is what drives demand in the South Australian market for environmental offsets.

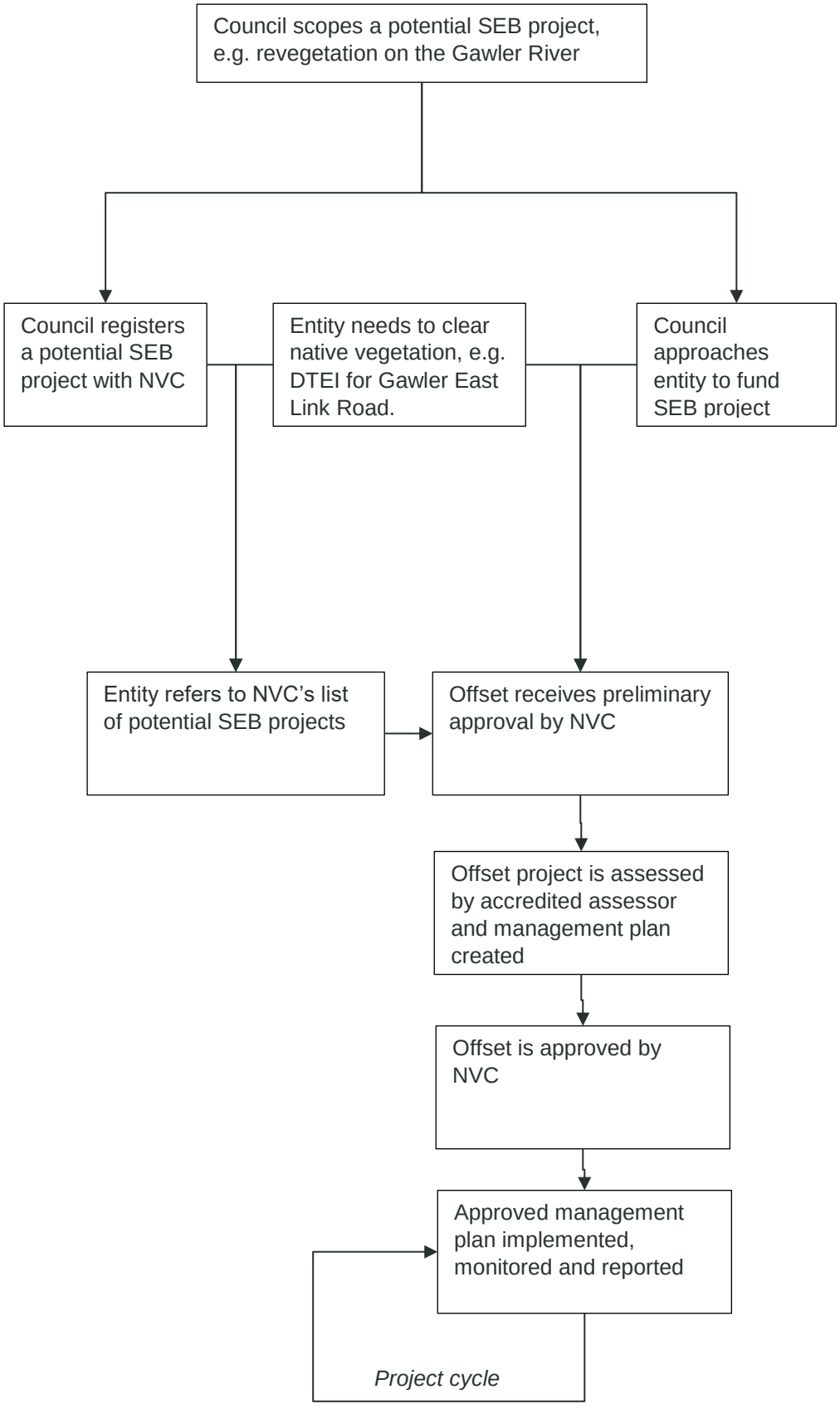
Activities which can create SEB credits include:

- Revegetation,
- Encouraging natural regeneration,
- Managing an existing area of native vegetation to improve condition,
- Or any combination of the above.

The proponent (i.e. Council) can register a potential SEB credit project which enables the NVC to match SEB credit purchasers with providers, or the proponent (i.e. Council) can liaise directly with potential SEB purchasers (e.g. developers, DPTI).

Once a potential SEB project is going to proceed, the proponent (i.e. Council) would need to engage an ‘accredited consultant’ to determine the number of SEB credits that a project is worth. This involves assessing the patch of vegetation and the activities that are to be delivered.

The activities need to be documented in a management plan


Council scopes a potential SEB project, e.g. revegetation on the Gawler River
Council registers a potential SEB project with NVC
Entity needs to clear native vegetation, e.g. DTEI for Gawler East Link Road.
Council approaches entity to fund SEB project
Entity refers to NVC's list of potential SEB projects
Offset receives preliminary approval by NVC
Offset project is assessed by accredited assessor and management plan created
Offset is approved by NVC
Approved management plan implemented, monitored and reported
Project cycle

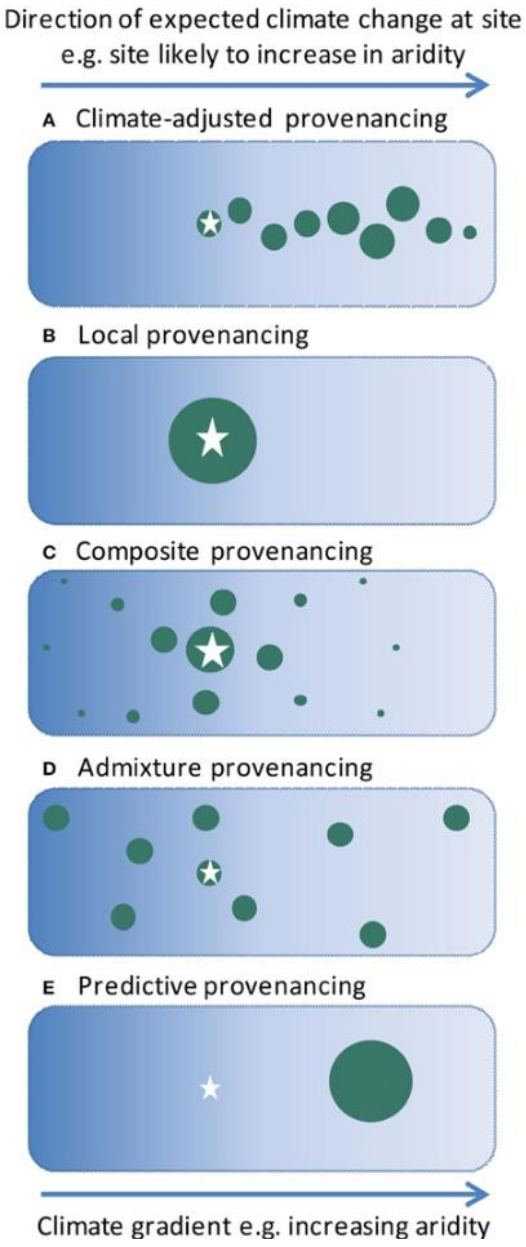
Appendix 9 – What is the Right Seed Collection Strategy?

Until relatively recently the prevailing wisdom amongst the revegetation industry was that local provenance seedlings, i.e. those from within about 10km of the intended planting location, were most suitable for planting as they were superior to plants from further afield, i.e. they would have a lower early mortality rate, grow to 'typical' form and produce viable progreny. The underlying assumption was that plant populations are highly adapted to the local climate, soil, altitude, diseases, pathogens and herbivores.

Genetic science has shed light on gene flow and inbreeding in populations of native species in connected and fragmented lasdscapes. This suggests that some species may become detrimentally inbred if only collected locally, reducing the health of local populations. Broadhurst et al (2008) suggested a "composite" provenance strategy whereby seed sourcing should concentrate less on local collection and more on capturing high quality and genetically diverse seed to maximize the adaptive potential of restoration efforts to current and future environmental change. Breed et al (2013) took this further by suggecting that where future conditions are unknown an "admixture" provenance strategy is the best approach, whereby a mixture of seeds across the entire range of a species, regardless of the planting site.

Whilst local seed may be suited to local conditions in a static environment, it is not necessarily so in a changing climate. Plantings with genetic material restricted to local populations may be poorly adapted to future climates, and therefore future local conditions. Prober et al (2015) suggest that appropriate "climate adjusted" provenance staregies should be used which combine genetic diversity and adaptability, and target projected climate change directions.

An alternative to this strategy, where the future conditions are relatively well known would be a "predictive" provenance strategy whereby a current analogue of the future site is found and the genetics from that site are used on the new planting site.

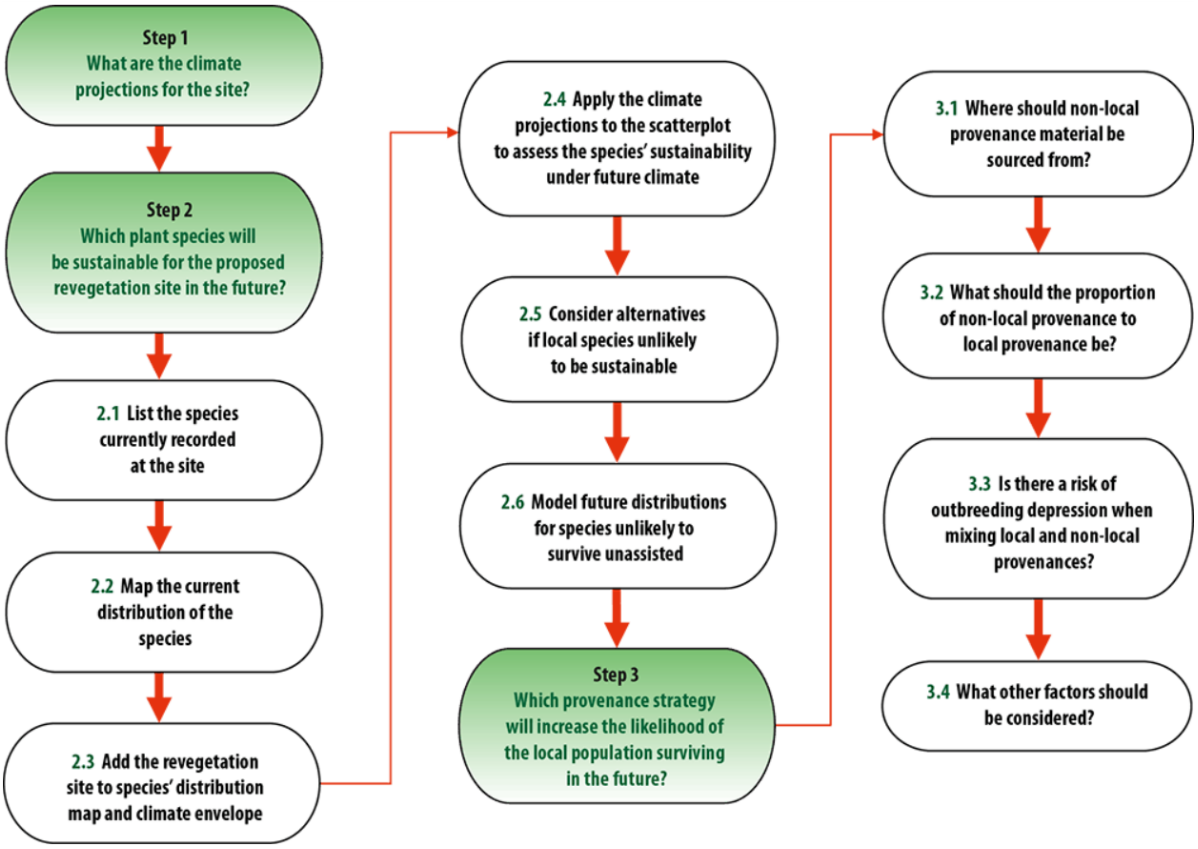


From Prober et al. 2015

But which strategy or strategies are best?

Of these 5 strategies, the riskiest are local provenancing and predictive provenancing as they use the 'all eggs in one basket' approach. The other three strategies spread the risk of selecting seed from a maladapted location.

Hancock et al (2018) developed a guide for decision makers to understand the tools that are available to help make a seed sourcing strategy decision.



From Hancock et al (2018).

However, it is broadly recognised that most practitioners are unlikely to have the capacity to complete such an exhaustive investigation prior to conducting a revegetation program. Instead the industry has generally moved towards a pragmatic approach which is a compromise between composite provenance and climate adjusted provenance strategies; the 70:20:10 rule. About 70% of seed from local sources, about 20% of seed from areas further afield, and about 10% of seed from climate adjusted analogues.

Breed, M. F., Steed, M. G., Otewell, K. M., Gardner, M. G., and Lowe, A. J. (2013). Which provenance and where? Seed sourcing strategies for revegetation in a changing environment. Conservation Genetics, 14:1-10.

Broadhurst, L.M., Lowe, A., Coates, D.J., Cunninghma, S.A., McDonals, M., Vesk, P.A. and Yates, C. (2008) Seed supply for broadscale restoration: maximizing evolutionary potential. Evolutionary Applications, 1(4):587-597.

Hancock, N., Harris, R., Broadhurst, L. and Hughes, L. (2018) Climate-ready revegetation. A guide for natural resource managers. Version 2. Macquarie University, Sydney.

Prober, S.M., Byrne, M., McLean, E.H., Steane, D.A., Potts, B.M., Vaillancourt, R.R. and Stock, W.D. (2015) Climate-adjusted provenancing: a strategy for climate-resilient ecological restoration. Frontiers in Ecology and Evolution.

Glossary of Technical Terminology and Abbreviations

CFS - Country Fire Service

Clearance – A process of removing vegetation by any means, e.g. mechanical (plough, chain, mow, etc.), chemical (herbicide), manual (hand removal, grazing) or burning.

CVA - Conservation Volunteers Australia

DCMB - Dog and Cat Management Board

DEW – Department for Environment and Water

DoEE - Department of the Environment and Energy

Dominant – For vegetation, a species which makes up a large portion of the plant biomass for a given stratum. Often this is the most visible plant species.

DPTI – Department of Planning, Transport and Infrastructure

Ecosystem Services – The benefits which natural processes have to human endeavors. E.g. predation of horticultural pest insects, pollination of crops.

GA - Greening Australia

GEC - Gawler Environment Centre

Generalist – Usually applied to animals which freely move between different habitats and can be equally encountered in these.

GEHA - Gawler Environment and Heritage Association

GIS - Geographic Information System. Essentially a way of combining location information to make maps.

GRFMA - Gawler River Floodplain Management Authority

Ground Layer - The plants which make up the leaf cover close to the ground. Also called the Understorey.

GRRR - Gawler River Riparian Restoration group

Herbs – non-woody and non-grass plants.

KLG - Kersbrook Landcare Group

Midstorey – Plants which do not form the canopy, but whose foliage is not close to the ground.

Native – Naturally occurring in an area. The definition breaks down a little where animals have naturally increased their range, i.e. without translocation, due to human interference, e.g. Corellas.

Naturalised – A plant which is not native to an area, but has established and can reproduce in situ without human intervention.

NFSA - Nature Foundation SA

NGRG - Native Grass Resource Group

NRAMLR – Natural Resources Adelaide and Mount Lofty Ranges

Overstorey – The plants which make up the highest canopy cover. Usually Eucalyptus, Callitris or Allocasuarina species.

Peri-urban – Areas at the interface of developed townscapes and open rural landscapes. Characterised by low density dwellings attached to landholdings.

Point Data – A type of data used in GIS which contains a single set of X and Y coordinates.

Polygon Data – A type of data used in GIS make a 2 dimensional shape from at least 3 X and Y coordinates as vertices.

Protection – Protection in a conservation sense can apply to a species or an area of land. For species it refers to listing them in a relevant act or associated regulations such as the EPBC Act or the NPW Act. For land it refers to gazetting that land for conservation purposes such as a 'national park', 'conservation park', etc. or protections afforded by meeting the criteria of the Native Vegetation Act or its regulations.

Refugia – An area of habitat retreat which persists in otherwise hostile conditions. In hydrological situations, it often refers to a permanent pool which persists over summer. In the climate change situations, it often refers to a location which is not expected to change as much as other areas.

Remnant – Vegetation which existed in a given location prior to European settlement or is directly descended from those plants and has established naturally, i.e. not planted.

Riparian – An environment in, or directly adjacent to, a wetland, river or creek where soil moisture is higher than the surrounding areas.

Rural – Characterised by open paddocks with very low levels of development.

Specialist – Usually applied to animals which have strict habitat preferences for a specific type of habitat, e.g. grasslands.

Status – The formal conservation status of a flora or fauna taxon as per the EPBC Act or the NPW Act.

Stratum – A layer of vegetation. E.g. overstorey, understory, etc.

Taxa / Taxon – A unit of classification of flora or fauna usually applied at the most specific taxonomic level, i.e. species or subspecies.

TFL - Trees For Life

Understorey – The plants which make up the leaf cover close to the ground. Also called the Ground Layer

Urban / Suburban – Areas with a generally high level of development, including residential and industrial.

Vegetation Structure – A description of vegetation type which usually follows a semi-standard naming method using a combination of dominant life form (e.g. trees, shrubs, grasses), height of dominant life form and density of tallest stratum.

Weed – usually defined as a plant in a place where it is not wanted, in this plan it is more defined as an environmental weed, which is naturalised and has negative impacts where it occurs.