City of Cockburn

wetlands to waves

Yangebup and Little Rush Lakes Master Plan

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02.09.2019	A	Draft for Comment	P. Jordan
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Summary

1.1 Introduction

Yangebup Lake and Little Rush Lake Reserves are an important component of the Beeliar Regional Park and an important recreational asset for surrounding suburbs. The project area includes the bushland and foreshore of the reserves, the water bodies and the surrounding road reserves. The Yangebup Lake water body is not under City of Cockburn management, however is considered due to its relevance to management of the reserve.

1.2 Master Plan Preparation

The City of Cockburn's Strategic Community Plan 2016-2026 identifies five key strategic objectives which will help fulfil its vision. Two of these, *Economic, Social and Environmental Responsibility* and *Community, Lifestyle and Security* support the need to develop a master plan for Yangebup and Little Rush Lakes.

The Master Plan builds on previous management plans that have resulted in rejuvenation of the bushland and improvement of water quality over an extended period. Consultation was undertaken with a range of community and agency stakeholders the contributions of whom have assisted in development of the plan's recommendations.

1.3 Master Plan Vision

To protect, enhance and promote the natural and cultural values of Yangebup and Little Rush Lake Reserves enabling sustainable community use through the provision of a range of conservation, recreation and environmental education opportunities.

1.4 Master Plan Objectives

The Master plan objectives are to:

1. Ensure that any upgrades, development and activities undertaken within each reserve is consistent with the City of Cockburn Natural Areas Management Strategy.
2. Ensure that the parks are not degraded by ad hoc additions and activities that do not consider the parks in their entirety and their conservation status.
3. Foster a distinctive identity for the Reserves that is based on natural, conservation and community values.
4. Protect and enhance natural, environmental and conservation values and offer a sanctuary for local fauna.
5. Protect and enhance the cultural and heritage values of the reserves.
6. Provide guidance for the improvement of the water quality in each of the lakes in accordance with the City's Water Sensitive Urban Design (WSUD) and biofiltration initiatives.
7. Strengthen and progress each reserve as regional parks that are recognised by locals and the broader community as two of the best managed parks for conservation and natural uses in the Perth metropolitan area.

8. Suggest ways to improve regional pedestrian and cycle connectivity through and in proximity to the reserves.

The Master Plan includes Recommendations, a Concept Design and Priorities List for environmental management and infrastructure upgrades over a ten-year period.

Acknowledgements

We wish to thank the following stakeholder groups and agencies for their contribution to the Yangebup and Little Rush Lake master plans:

- Yangebup Progress Association
- South Lake Connect
- City of Cockburn Aboriginal Reference Group
- Department of Biodiversity, Conservation and Attractions (Regional Parks Unit)
- Beeliar Regional Park Community Advisory Committee
- Mater Christi Catholic Primary School
- BirdLife Australia

2 Management directions

2.1 Introduction

Yangebup Lake and Little Rush Lake Reserves possess regionally significant environmental and recreational values. The reserve wetlands form part of the eastern Beeliar Wetland Chain and are important habitat and ecological linkages in the City of Cockburn. The lakes are a valued recreational destination for nearby residents and some recreational infrastructure exists to support this. The increased urbanisation of surrounding areas and demand on reserves as a recreational destination requires enhancement of infrastructure that is balanced with habitat and conservation values.

The master plan presents direction for reserve management over a ten-year period from 2020 to 2030. The report includes a brief overview of the Reserves' history, a summary of community and stakeholder consultation undertaken as part of the project and an analysis of current conditions. Opportunities and recommendations for upgrades to recreational facilities and environmental management with priorities make up the remainder of the report.

2.2 Key Values

The overarching values of the reserves include habitat conservation and amenity for passive recreational uses. Natural areas in urban environments provide health benefits including improved air and water quality, help cities avoid temperature extremes and are linked to lower rates of chronic disease. Contact with nature has a positive impact on mental health and encouraging the use of the pedestrian and cycle network promotes activity and social participation. There are an enormous range of potential health and wellbeing benefits from contact with nature including crime reduction, psychological wellbeing, reduced stress, boosted immunity, enhanced productivity, improved mental health, reduced blood pressure, heart rate and cholesterol and spiritual development.

Areas of both reserves have in the past been extensively modified with environmental and recreational values degraded. This condition has improved considerably through management by the City of Cockburn and the reserves now support an array of flora and fauna and improved water quality. Management seeks to strengthen these values and realise the potential for the improvement of bushland and water quality and integration with reserves of the Beeliar Regional Park.

2.3 Project Area

The project area comprises of Yangebup Lake and Little Rush Lake Reserves and is located centrally to the City of Cockburn. The project area includes the reserves in addition to consideration of adjacent road reserves that provide public access and ecological buffers for reserve habitats. Combined, this amounts to approximately 200 hectares, of which 85.49 hectares are classified as bushland.

The wetlands of the project area form part of the Beeliar Wetlands Eastern Chain and are of high importance to ecological connectivity for the Beeliar Regional Park. Reserves to the north of the project area include South Lake and Bibra Lake and to the south include Kogolup Lake and Thompsons Lake Nature Reserve. Bibra Lake forms a major destination within the City and includes a number of recreational attractions. Thompsons Lake Nature Reserve to

the south is a RAMSAR classified wetland with high conservation value and has comparatively minimal recreational infrastructure.

The project area is located between the suburbs of Yangebup to the west, South Lake to the east and the light industrial area of Cockburn Central to the south-east. All areas discussed are under management by the City of Cockburn however the water body of Yangebup Lake is under the management of the Western Australian Planning Commission.

Throughout this report Yangebup and Little Rush Lake Reserves are referred to as the 'Reserves' that includes the main lots allocated to parks and recreation in the project area.

Map 1 Project Area

2.4 Policy Framework

2.4.1 The City of Cockburn

The City of Cockburn is responsible for managing the Reserves of Yangebup Lake and Little Rush Lake on behalf of WAPC (Western Australian Planning Commission). Due to the water quality in the Yangebup Lake the water body remains under the management of the WAPC. Reserve management is undertaken by City of Cockburn Staff in accordance with the City's Natural Area Management Strategy 2012-2022 (2018 review) and the Beeliar Regional Management Plan.

2.4.2 Natural Area Management Strategy

The City of Cockburn's Natural Area Management Strategy provides the overarching framework for management of the reserves. The strategy outlines the City's approach to managing its vested natural areas and building its capacity to maintain them for the conservation of biodiversity. There are 12 natural area management objectives with corresponding KPI's (Key Performance Indicators) to assess the performance of the City's management. The ultimate goal of the strategy is for all of the City's natural areas to have a vegetation condition rating of good or better based on the Keighery (1994) definition of vegetation condition. The condition is mapped every four years to determine the effectiveness of rehabilitation efforts.

In the Strategy's actively managed reserve classification, Little Rush Lake (Reserve 43) is identified as High Priority for rehabilitation and maintenance with 38.01 hectares of bushland and a total reserve area of 42.44 hectares. Yangebup Lake is a Medium Priority for rehabilitation and maintenance with 47.48 hectares of bushland and a total reserve area of 141.89 hectares.

The strategy provides the framework for management of the reserve's natural areas. Other City documents referenced by the strategy and forming its strategic alliance include:

- City of Cockburn Strategic Community Plan 2016-2026
- City of Cockburn Sustainability Strategy 2017-2022
- Long Term Financial Plan 2016-2026
- Public Open Space Strategy 2014-2024
- Urban Forest plan 2018-2028.

2.4.3 Beeliar Regional Park Management Plan (BRPMP)

The Reserves form part of the Beeliar Regional Park and are subject to the Beeliar Regional Park Management Plan that was prepared on behalf of the Conservation Commission of Western Australia in accordance with the Conservation and Land Management Act 1984. DBCA (Department of Biodiversity Conservation and Attractions) is responsible for coordinating the implementation of the Management Plan throughout the Reserves and the City of Cockburn manages Yangebup and Little Rush Lake Reserves adhering to the following directives of the Beeliar Regional Park Management Plan:

- Managing the Reserves for biodiversity conservation, and encouraging recreation and other uses to take place but only to the extent that they do not adversely impact on the other values of the Reserves

- Applying DBCA policies in managing the park
- Preparing a management plan for specific reserve areas in the context of implementing the Beeliar Regional Park Management Plan
- Establishing joint working parties that represent relevant managing agencies and the community for subsidiary plans
- Consulting with the Beeliar Regional Park Community Advisory Committee when preparing subsidiary plans and annual project lists for the reserves
- Supporting and where possible, seeking grant applications to undertake research within the reserves
- Encouraging the participation of volunteers, educational institutions and other organisations in research projects within the reserves.

Management zones 19, 20, 21 and 32 of the BRPMP encompass Yangebup and Little Rush Lake Reserves.

2.4.4 Bush Forever

Yangebup and Little Rush Lake is within an ESA (Ecologically Sensitive Area) corresponding with Bush Forever site 256, (Government of Western Australia 2000). The area contains the TEC (Threatened Ecological Community) Endangered Banksia Woodlands of the Swan Coastal Plain, known as the Banksia Woodlands TEC (Threatened Species Scientific Committee & DotEE 2016) that is protected under the Federal EPBC 1999 Act.

3 Consultation

3.1 Consultation Overview

In late February 2019, Ecoscape undertook consultation as part of the project's analysis phase to gain an understanding of how the Reserves are used for recreation and how they are currently perceived by the community. The aim of this process is to develop the master plan recommendations based on community and environmental values of the reserves and provide for expected visitor uses.

3.2 Key Stakeholders

The City of Cockburn identified a list of stakeholder groups to be consulted. Ecoscape together with the City of Cockburn attended meetings where the masterplan project was presented and feedback from stakeholders gathered in relation to the lakes significance to each group and their respective concerns. The following stakeholders were consulted:

- DBCA Regional Parks Unit
- City of Cockburn Aboriginal Reference Group
- Beeliar Regional Park Community Advisory Committee
- Yangebup Progress Association
- Connecting South Lake
- Cockburn Bike User Group
- City of Cockburn Disability Reference Group.

Project reporting to the City has included presentation of consultation findings and analysis to the Project Steering Group (PSG) comprising of the City's officers for review periods.

3.3 Engagement Principles And Process

In early 2019 consultation was undertaken by Ecoscape in collaboration with City of Cockburn staff using a number of techniques to engage with as broad a range of reserve users as possible. The consultation was structured in accordance with the City's Community Engagement Policy and involved meeting with key stakeholders, agencies, progress associations and members of the local community. Contact with the community was targeted towards users of the Reserves and users of the public open space and oval located in Yandjet Park adjacent to Mater Christi Church and primary school.

3.3.1 Surveys by the Lake

In February 2019 four 'Surveys by the Lake' were conducted at the reserve's peak use times. Ecoscape attended the site between 8:00-9:30am Sunday, 7:30-9:00 am Wednesday, 5:00-6:30pm Thursday and 5:00-6:30pm Sunday. Ecoscape engaged in discussion with users about their values and uses in relation to the site with some users also completing written versions of the online surveys. Observation was also made of the types of users that were encountered during the sessions.

The people observed using the reserve during these times were:

- Families with young children or infants, some with dogs

- Elderly couples and singles walking with and without dogs
- Women and men engaging in active use such as running and cycling
- Groups of 3-4 walking for exercise.

3.3.2 Stakeholder Meetings

Meetings with stakeholders were attended by Ecoscape and City of Cockburn staff. These involved presentation of a project overview to participants who were then invited to provide comment informally and also to provide responses using the 'Comment on Cockburn' online survey. An additional meeting was held with a past resident, Jeff Spencer, who had lived beside Little Rush Lake in a farmstead and could provide a historic account of the area's former uses and character.

3.3.3 Online Survey

An online survey was also conducted through the City's Comment on Cockburn website. 81 informed visitors engaged with the material provided and 37 responses were received.

3.4 Consultation Outcomes

The following engagement outcomes were provided by stakeholder during the consultation process and have been considered in the development of the master plan:

- Preserve the natural character, no need for large turf areas or urban development.
- Built form on eastern side of Yangebup Lake detracts from the scenic value of the area.
- More information about the flora, fauna and history of the reserve could be provided especially about the bird-life.
- Western side of the lake is more popular due to personal safety concerns about the eastern side. Antisocial behaviour deters visitors from going to some areas of the reserve.
- Artworks and interpretation on northern side of Yangebup Lake is appreciated.
- Better access to the water would be welcome however snakes are an issue for dogs, deterring some people going close to the water.
- More vantage points for viewing the lake would be appreciated, without detracting from the naturalness of the place.
- Small playgrounds and recent upgrades are appreciated. No need for large playgrounds.
- North Lake Road is a barrier to pedestrians and cyclists coming from the east.
- There is a lack of drinking water for people using the lakes to exercise.
- The former Yangebup Road alignment to the south of the lake is an important cycling connection between Yangebup and Cockburn ARC.

The following key themes were provided by the stakeholder groups:

- Access across North Lake Road from the suburb of South Lake is a challenge.
- Low awareness of the reserves from residents in South Lake.

- More tree planting and canopy using endemic species was desirable.
- More shrub and riparian species including bush tucker plants was desirable and could include educational opportunities and community building events.
- Living stream and bio filtration seen as positive to the reserve and users.
- Increase cycling numbers to Lakeland Senior High School to ease peak hour congestion with better paths through the reserve and connections across North Lake Road.
- More drinking fountains and toilet facilities were requested.
- There was a desire to see interpretive elements including:
    - Noongar history and stories including creation and bush tucker.
    - Settlement stories around the old farmsteads at Little Rush Lake and Yangebup Lake.
    - Signage showing birds of the area and potential for a bird hide to be located somewhere in the reserve.
- Paths to the Lake are desirable but would prefer double connections to DUP (Dual Use Path) rather than spurs.
- Fencing of the rail line perimeter at Little Rush Lake to stop trail bikes (as has been completed).
- A DUP inside the reserve along the Tamara Drive section seen as highly desirable to complete the lake circuit and provide safety for kids.
- Upgrade to the DUP's throughout the Reserves to make into an exercise loop like Bibra Lake to increase passive surveillance.

Image 1 Community consultation undertaken at Lot 8, Yandjet Park (left) and with local residents on paths around the lake (right)

4 Historical overview

4.1 Aboriginal Land Use And Significance

Yangebup and Little Rush Lakes traditionally provided important hunting, gathering and camping grounds for local Wadjuk Nyungar people who have occupied the area for 40,000 years. The area was occupied by the Beeliar People whose territory extended to the southern banks of the Derbarl Yerrigan, Swan River, and Canning Rivers.

Aboriginal occupation and use of the Swan Coastal Plain is well documented (O'Connor, Quartermaine and Bodney, 1989). Site surveys and oral evidence indicate that populations tended to congregate around wetland, riverine and estuarine features (Hallam, 1987). Permanent water was an important resource around which larger groups gathered to make use of the wide variety of food resources available: fish, waterbirds, frogs, turtles, marsupials and vegetable foods, including the roots of Typha, for which Yangebup Lake 'is named (from Yandjip, the Nyungar word for *Typha domingensis* the indigenous species of Typha) (O'Connor et al, 1989).

The alignment of North Lake Road, is recognised as an important track that links Fremantle Walyalup with Armadale and onwards to regional locations. More information about the Beeliar people in the Cockburn area can be found in the City of Cockburn publication Beeliar Boodjar An introduction to the Aboriginal History of the City of Cockburn.

Yangebup Lake (including Little Rush Lake) is a site of Aboriginal Cultural Significance registered with the Department of Aboriginal affairs. The site type (ID:18937) is Ceremonial, Mythological and Historical and includes the presence of plant resources and water source.

The high conservation value and spiritual significance of the lakes and surrounding bushland are important for ongoing education and dialogue about Wadjuk Nyungar traditional use and an ongoing custodial relationship with the reserves.

4.2 European History

The European settlement of the Yangebup and Little Rush Lakes area began in the 1880's. Settlers under the assisted immigration scheme were granted unoccupied land along the verges of the chain of lakes in the Yangebup area (Berson, 1978). In March 1889, James Barron was granted Cockburn location 406, an area of 110 acres on the east side of Yangebup Lake. At the same time John Healy was granted Cockburn location 334, an area of 200 acres, which adjoins the eastern boundary of Little Rush Lake. The 1890 survey map of these grants recorded the vegetation of these early selections as being Banksia and Grasstrees or Jarrah and Banksia (Berson, 1978). These early land grants around Yangebup Lake were used for a variety of agricultural purposes, including grazing of cows and sheep, poultry farms, piggeries and cropping.

Another notable part of the early post-settlement history of the Yangebup area were the Chinese market gardeners. These settlers diligently worked small areas to the south of Bibra Lake and in 1895 around the eastern part of Little Rush Lake. Berson (1978) records that the west side of Little Rush Lake up to Forrest Road had been taken up by Mr D Chen.

Around the turn of the century the Jandakot Agricultural Area as it was then known, was developed and all of the land surrounding Yangebup Lake had been selected. James Barron

had sold his land to Mr E Solne. Yangebup Lake itself and land to the west had become Cockburn Lots 298 and 299 of 292, 200 acres in size respectively, owned by John Baker.

Around this time market gardening became prominent in the Jandakot and Yangebup areas as settlers learnt to adapt their farming methods to the poor soils through the application of large amounts of manure. Market gardening remained popular until the 1920's when it declined in favour of dairy farming and general mixed farming.

The railway followed what is now the Parkes Street road reserve providing connection to Fremantle and goods for homesteads that were concentrated on the eastern side of the reserves. Jandakot station was located just eastward of Yangebup Lake Reserve's eastern extent.

In the early 1920's, a tramway was constructed extending south from the Jandakot Railway Station to Karnup to facilitate the development of the Group Settlement Scheme in the Peel Estate. Timber harvested in the Peel Estate region was transported out, and materials to support the Group Settlement Scheme transported in. However by late 1925, the need for the tramway had passed and the rails were pulled up. An enduring legacy of the tramway is a 32km long reserve that runs south from Yangebup Lake Reserve and remains largely intact to this day. A master plan developed in 2015 by the South West Group, the Cities of Cockburn, Kwinana and Rockingham proposes the development of a multi-use trail along this alignment.

A major change of direction for the Yangebup Lake area occurred in the 1920's when a wool scouring industry was located on the eastern side of the lake. The wool scourers was located at Yangebup Lake due to the quantity and quality of fresh water available for the scouring process. The wool scouring industry was to change the nature of Yangebup Lake as effluent was originally discharged directly into the lake. The Jandakot Wool Scourers expanded its operation over the next 40 years and associated industries, including skin drying and fell mongering with tailings pools established nearby. Several contaminants from the scourers operations are found in the sediment of the lake and include lead, chromium and arsenic. Human contact with the water body and disturbance of the sediments is discouraged.

Industrial uses at Little Rush Lake include the Jandakot Concrete Works that operated out of the Parkes Street address on the eastern side of the reserve. Since the concrete works closure the area has been used as an informal storage area by the City of Cockburn.

4.3 Recent History and Recreational Uses

After the Second World War settlement of the area ceased. Agricultural land uses had generally declined in the project area and horse agistment became common (Murdoch University, 1988). In the 1970's conservation land uses also appeared with the reservation of areas immediately surrounding North, Bibra and Yangebup Lakes as conservation and recreation Reserves under the MRS. From the 1980's onwards the majority of the land surrounding Little Rush and Yangebup Lakes was urbanised with the creation of the suburbs of South Lake and Yangebup. The effect of this urbanisation has been to alter local groundwater levels and the hydrology of the lakes and increase recreational demand on open spaces.

The South Jandakot Drainage Scheme was implemented in 1995 to mitigate impacts of urban stormwater runoff on the Beeliar Park eastern wetland chain, including Thompsons Lake, and saw an increase in untreated storm water entering Yangebup Lake via the piped drainage

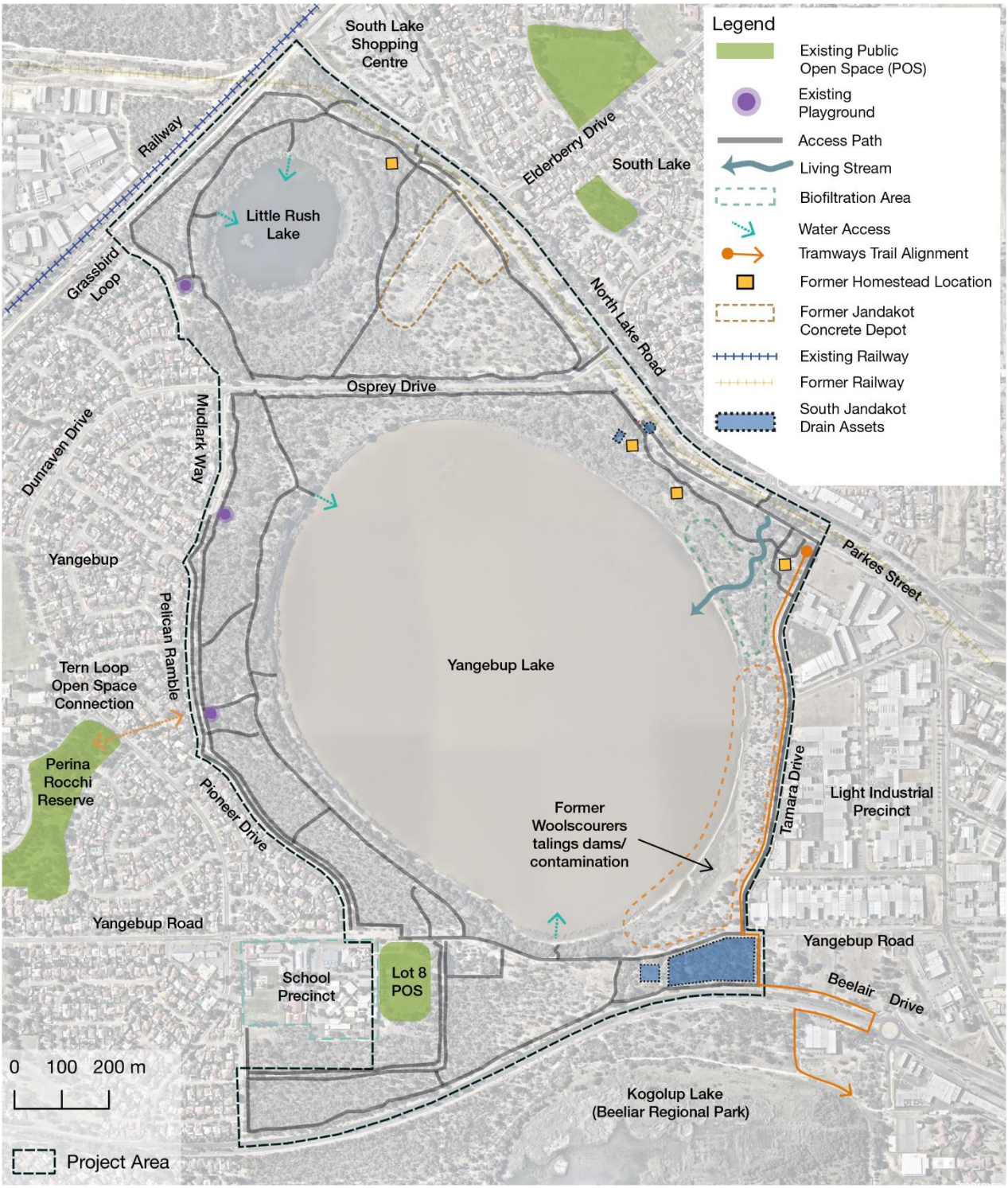
system. The newly elevated water levels affected fringing vegetation and resulted in the loss of several trees. The water level in the lake is controlled with a maximum depth set at 16.5 AHD. When water levels reach this height water is pumped to the ocean via the Woodman Point Waste Water Treatment Plant.

Over the years since implementation of the scheme fringing vegetation has now adapted to the new conditions with local specie returned to the fringing vegetation areas through revegetation programmes. The year-round existence of the water body provides important habitat for water birds as ephemeral wetlands around Perth dry up in summer.

Recently, the City has undertaken changes to structure planning of adjacent suburbs in response to the State's increased density targets. The Yangebup Revitalisation, 2017-2018, includes recommendations to include recreational connections to the Reserves including fitness and walking circuits connected to the suburb's open space network, notably from Perina Rocchi Reserve to Yangebup Lake via the Tern Loop public access way.

The Yangebup Road alignment was closed in the mid 1990's connecting bushland areas in the south of the reserve to the lake. The former roadway is now a bicycle commuter route between Yangebup and Cockburn Central West.

The following map shows current and past sociocultural elements of the reserves.

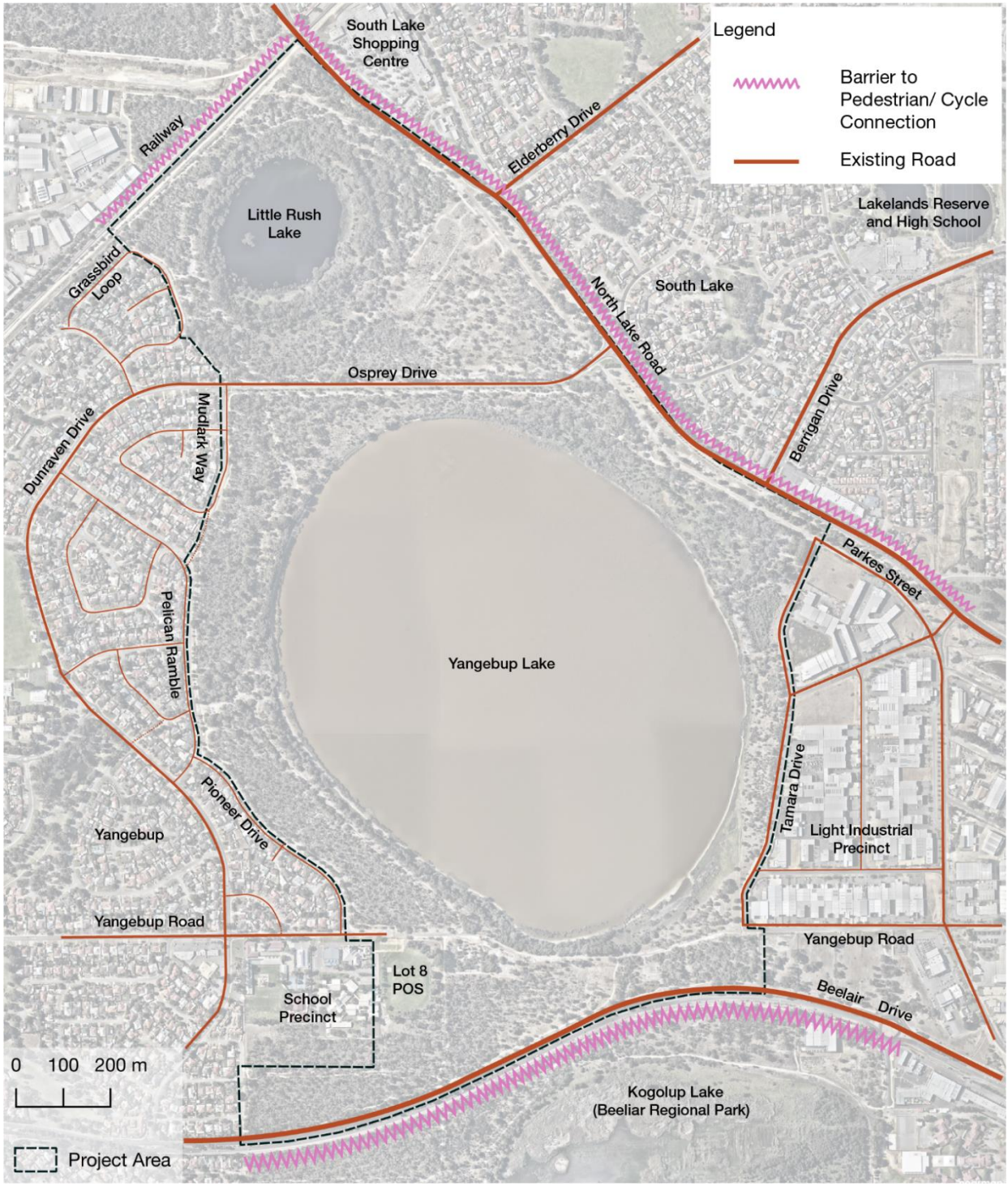


Map 2 Sociocultural Elements

5 Current Status of the Reserves

5.1 Surrounding Context

The reserves are bounded by the suburbs of Yangebup to the west and the suburb of South Lake to the east. To the south-east is the light industrial area of Cockburn Central. South of Yangebup Lake is Beeliar Regional Park bushland including Kogolup Lake and Thompsons Lake nature reserve. North of Little Rush Lake the railway reserve provides a significant physical barrier to Cocos Park and South Lake reserve beyond. North Lake Road forms a barrier along the reserve's eastern side with the Parkes street reserve running parallel.



Map 3 Surrounding Context

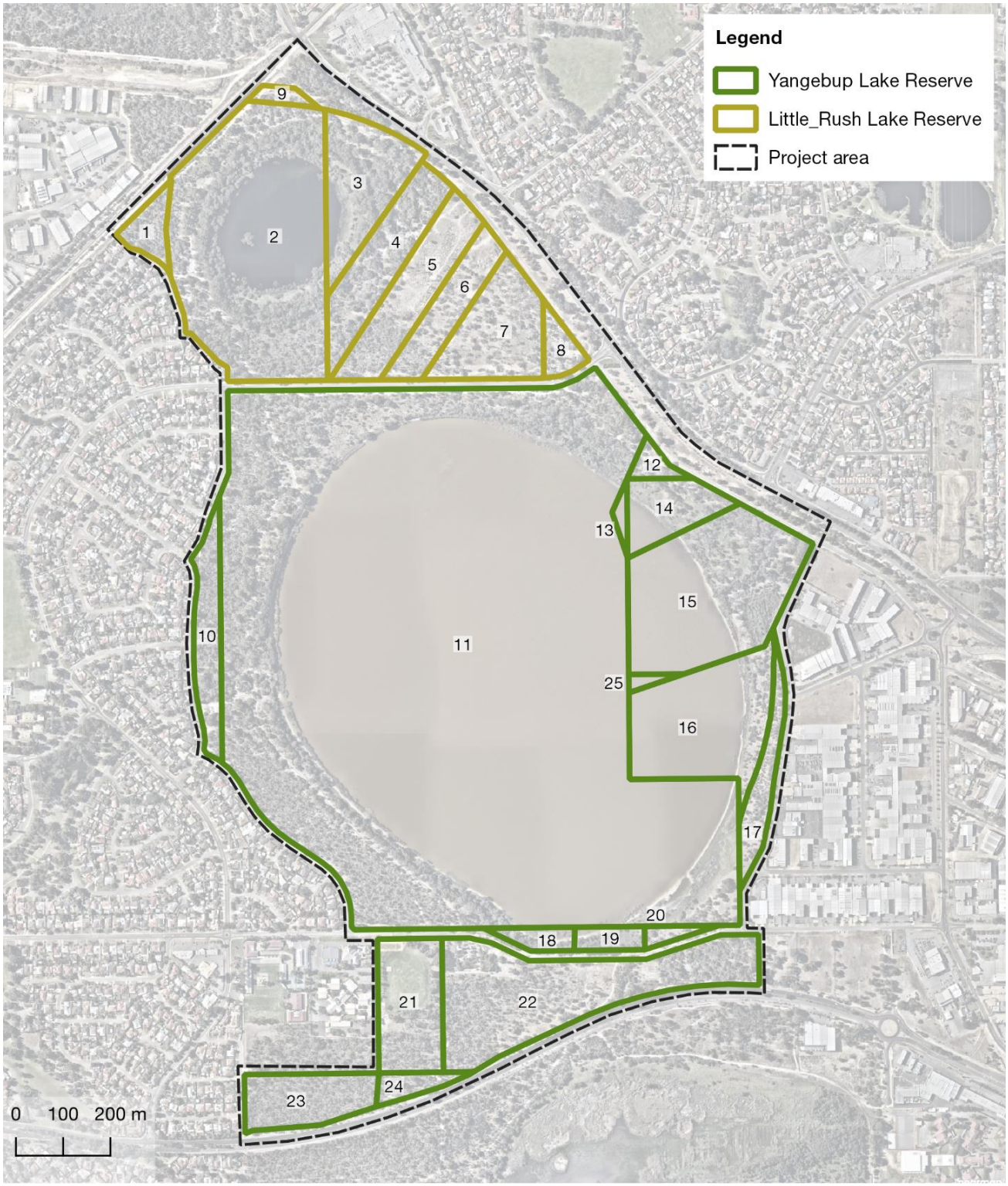
5.2 Tenure

The Regional Open Space is under the tenure of the Western Australian Planning Commission with land use purposes including Conservation and Protection and Natural Environment Uses. The Yangebup Lake water body remains under WAPC jurisdiction due to the contaminants occuring in the lake's sediment.

Water Corporation assets occur throughout the Reserves and include drainage infrastructure associated with the South Jandakot Drainage Scheme and sewerage infrastructure located on the west side of Yangebup Lake and North east of Little Rush Lake. A new subsurface sewer line is proposed in lot 4 of the eastern side of the Little Rush Lake with works to be undertaken by Water Corporation in the near future

Little Rush Lake includes Samuel Caporn Reserve that is located in the north west of the reserve between the lake and Grassbird Loop and, for the purpose of the master plan, is integrated with the bushland of the reserve.

Surrounding roads are managed by the City of Cockburn. The Beeliar Regional Park to the south, Lake Kogolup and Thompsons Lake Nature Reserve are managed by DBCA.



Map 4 Reserve Tenure

Reference	Street Number	Address	Lot	Reserve	Status	Area (ha)
Little Rush Lake						
1	39839R	Grassbird Loop	2882	R 39839	RESERVE	1.0364
2	630L	Osprey Drive	630		FREEHOLD	17.1411
3	2L	Parkes Street	2		FREEHOLD	4.4616
4	3L	Parkes Street	3		FREEHOLD	4.057
5	135	Parkes Street	4		FREEHOLD	4.0646
6	127	Parkes Street	5		FREEHOLD	2.658
7	6L	Parkes Street	6		FREEHOLD	4.1369
8	27950R	North Lake Road	4391	27950	RESERVE	0.3967
9	810L	Pioneer Drive	810		FREEHOLD	100.912
Yangebup Lake						
10	299L	Pelican Ramble	299		CROWN	2.5143
11	810L	Pioneer Drive	810		FREEHOLD	100.912
12	0	PARKES ST	0		FREEHOLD	0.559297
13	0	PARKES ST	0		FREEHOLD	0.270665
14	111	Parkes Street	1		FREEHOLD	2.3927
15	125	Parkes Street	2		FREEHOLD	10.1821
16	10L	Hammond Road	10		FREEHOLD	7.049
17	49078R	Tamara Drive	8001		RESERVE	1.8196
18	12L	Yangebup Road	12		FREEHOLD	0.7082
19	13L	Yangebup Road	13		FREEHOLD	0.7133
20	677	Yangebup Road	677		CROWN	0.391818
21	342	Yangebup Road	8		FREEHOLD	3.8825
22	403L	Beeliar Drive	403		FREEHOLD	9.773
23	48313R	Beeliar Drive	4913		RESERVE	2.9221
24	48313R	Beeliar Drive		R 48313	RESERVE	0.801
25	197	Rockingham Road	CP3		FREEHOLD	0.0072

Table 1 Land titles/ lots included in the Project Area

5.3 Climate

5.3.1 Climate

The south west of Western Australia experiences a Mediterranean-type climate of mild, wet winters and warm to hot, dry summers. The climate of the region is strongly influenced by the position of a band of high pressure known as the sub-tropical ridge. For much of the year the ridge is located to the south allowing the east or south easterly winds to prevail. During the cooler months the ridge periodically moves to the north allowing cold fronts to pass over the west coast and deliver much of the annual rainfall. The Swan Coastal Plain (SCP) typically receives 800-900 mm of annual precipitation and 5-6 nearly dry months per year (Beard 1990).

The closest near-coastal Bureau of Meteorology (BoM) recording site is Jandakot Airport (station 009172, operating since 1972, and approximately 2 km north of the survey area). The mean annual rainfall is 823.5 mm, most of which falls in May to September. February is the hottest month, with a mean maximum temperature of 31.6°C. July is the coldest month, with a mean maximum temperature of 17.9°C and mean monthly minimum of 6.8°C (BoM 2017, accessed 11 October 2017).

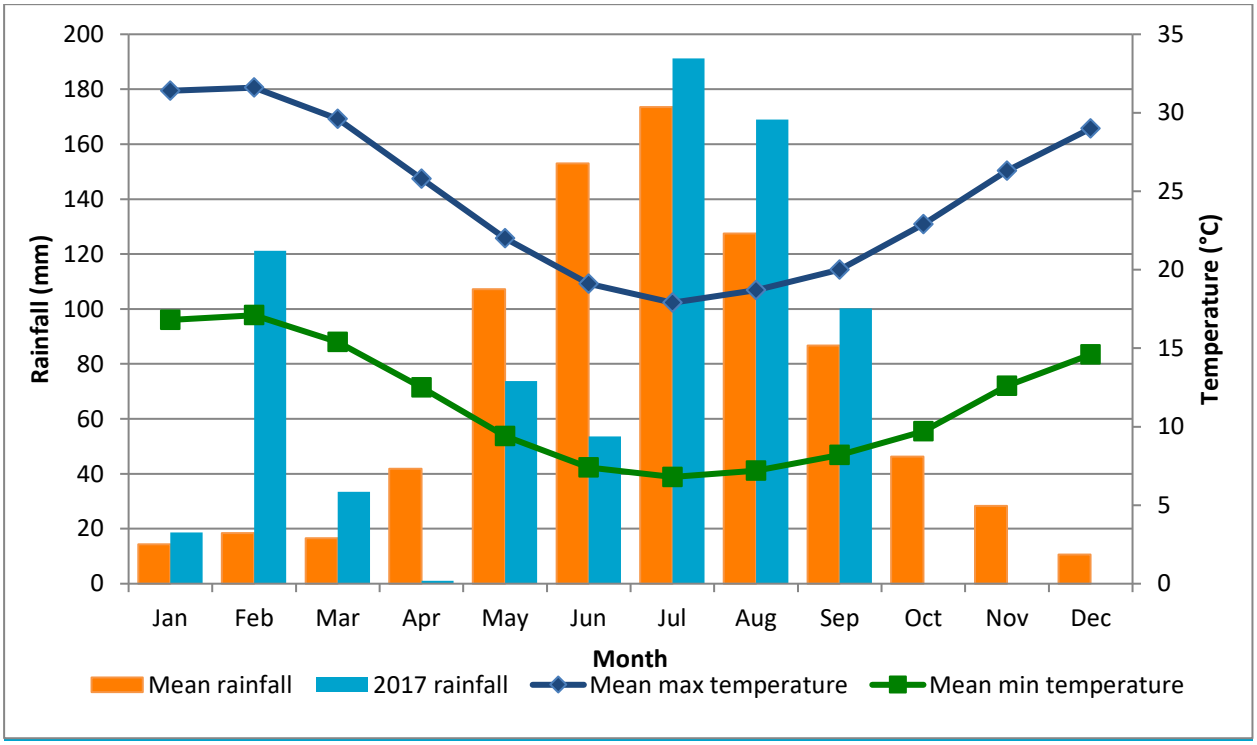


Figure 1 Rainfall and Temperature Data: Jandakot Aero BoM station

5.3.2 Climate change

Observation data from the Australian Bureau of Meteorology indicates an upward trend in average temperatures in Western Australia and, in addition, there has been a downward trend in average annual rainfall particularly during late autumn and early winter. For wetland areas this results in a reduction in the amount of groundwater recharge and increase in evaporation and evapotranspiration. The prolonged dry conditions are likely to have adverse effects on vegetation and fauna adapting to changing conditions, changes in the distribution of species within the reserve and losses in habitat and biodiversity. It is expected that the trend will result in upland plant communities progressively moving into wetland areas. The effects of climate change are also evident in the increased intensity of rainfall events with higher volumes of

precipitation experienced in shorter periods of time resulting in erosion and competitive advantages for some weed species.

5.4 Geology, Geomorphology and Soils

5.4.1 Geology

There are no surface expressions of the geological formations which underlie the project area as they are covered by superficial deposits of Aeolian (wind borne) origin. However, the underlying rock is sedimentary in nature and consists of Mesozoic shales and siltstones known as the Osborne and Leederville formations.

5.4.2 Geomorphology

Yangebup and Little Rush Lakes lie along the boundary of two geomorphic elements. To the west is the relic Spearwood dune system characterised by a degraded surface of aeolian origin. The Spearwood dune system runs parallel to the coast varying in width from 4 to 12 km. It is relatively undulating and reaches heights of 50 m AHD. To the east are the Bassendean relic dunes, similarly of a degraded surface of aeolian origin. The Bassendean dunes have a subdued relief of low hills with wetland and dampland areas in the interdunal swales. Both of these relic dune systems are of Pleistocene age and were created as a result of the accumulation and subsequent distribution of beach sands on successive shorelines (Murdoch University, 1988). Within the project area the wetland basins formed in the interdunal depressions between the two relic dune units. The location of the wetlands between the two dune systems indicates they were formed separately. All slopes in the project area are flat (0% to 3 %) to gentle (3% to 10%). The steepest areas with slopes up to 10% occurring in the south-west section of Yangebup Lake parallel to Pioneer Drive.

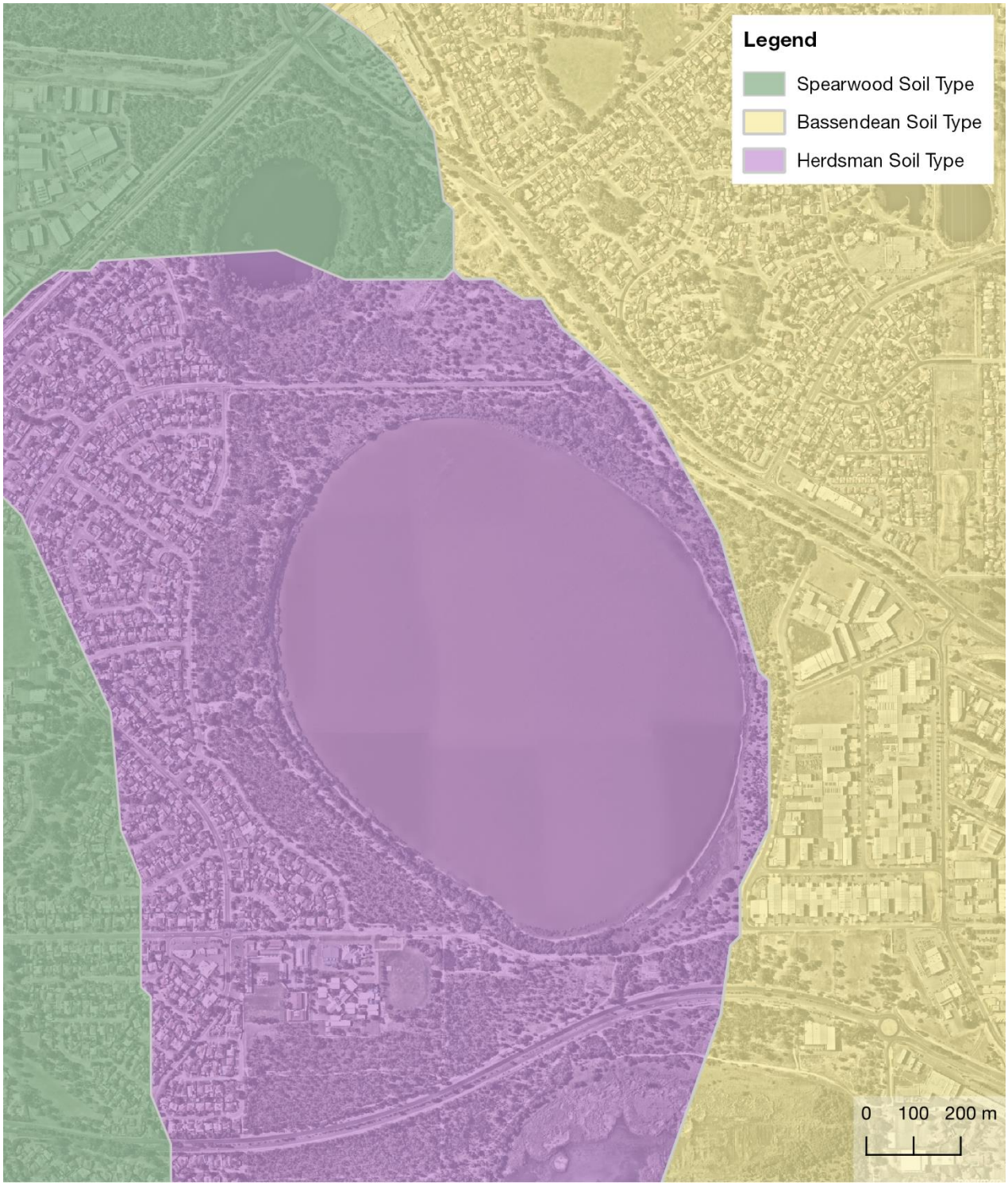
5.4.3 Soils

The project area straddles the boundary of two soil types including the Spearwood soils to the west and the Bassendean soils to the east. The Spearwood soils are derived from the Spearwood relic dune system and consists of pale yellowish-brown medium to coarse grained sub-angular quartz particles with traces of feldspar. They are moderately sorted and of residual origin (Gozzard, 1983) The Bassendean soils are derived from the Bassendean relic dunes. These sands are light grey at the surface; turning yellow at depth and consist of fine to medium grade sub-angular quartz particles. They are moderately well sorted, again of aeolian origin (Gozzard, 1983).

The wetland areas which occur at the boundaries of these two soil types have different soils due to the high water tables and vegetative cover. The Herdsman soil type that occurs near swamps consists of sandy silt which are darkish brown to grey and disseminated fine grain quartz sands, with variable clay content. They are of lacustrine origin, have a high water content and are often flooded.

Apart from the Herdsman soil type, the soil types are naturally infertile and have very low nutrient and water retention capacities. The Bassendean soils are particularly poor and their large particles size (90% are 0.2mm to 2.0 mm) and low clay content make them prone to rapid leaching of fertilisers.

As part of the Beeliar wetland chain, the Reserves sit on the margin between the coastal aeolian sands, such as the Karratta soil type and the inland Bassendean soil type. The Herdsman soil type, typical of wetlands in the Perth region is also prevalent.



Map 5 Soils of the Project Area

5.5 Hydrology, Surface and Subsurface

Yangebup and Little Rush Lakes form part of the eastern chain of the Beeliar Wetlands located approximately 6 km inland from the coast. Both of these lakes are typical of the basin wetlands that have been formed in interdunal depressions between the remnant Spearwood and Bassendean Dune systems.

These two wetlands are classed as Lakes (Semeniuk, 1987) in that the floor of the wetland basin is permanently inundated. Surrounding both lakes are sumpland and dampland areas. A discrete dampland area also exists south east of Little Rush Lake which is characterised by

vegetation species that occur where there is less than 5 m to groundwater. Lake conditions are changing due to a drier climate with less rainfall and more evaporation. In the case of Yangebup Lake, the managed stormwater inputs from the South Jandakot Drainage Scheme and outflow to Cockburn Sound maintain the water body surface at a constant level of 16.5 AHD managed by Water Corporation. Yangebup Lake has surface water year-round whilst Little Rush Lake is ephemeral and dries up in summer months.

The South Jandakot Drainage Management Plan was prepared in 1990. Its primary function is to protect the Beeliar wetlands from the adverse impacts of urban stormwater by diverting drainage water from new urban areas away from Kogolup and Thompsons Lakes to minimise nutrient inputs and maintain water levels in these wetland areas. Diverted water is transported by the South Jandakot Drain to Yangebup Lake and is currently discharged directly into the water body there. The maximum water level in the lake is controlled by pumping excess water to Cockburn Sound via the Woodman Point Waste Water Treatment Plant emergency outfall.

Elevated areas of the Reserves present low lying and gently undulating landform comprising of unconsolidated sand soils. Areas that lack vegetation or are adjacent to hard pavements are prone to erosion especially on slopes.

5.5.1 Groundwater and Acid Sulphate Soils

The Perth Groundwater Map (Government of Western Australia & Department of Water and Environmental Regulation, 2017) was reviewed, and identified the following features:

- the depth from ground level to the watertable varied from less than 2 m
- there is a high to moderate Acid Sulphate Soil (ASS) Risk <3 m from the surface close to the lakes and the eastern portion of the project area.
- the groundwater salinity of the superficial aquifers is in the 500-1000 mg/L range in the project area
- the survey area is within the Lake Coogee catchment. There are no rivers or other surface drainage features associated with the survey area.

5.5.2 Wetlands

The interaction of the seasonally wet climate of the Swan Coastal Plain with its undulating topography, geomorphology, variable soil properties, surface and groundwater flows (now extensively modified by agricultural and urban development, water extraction and active management), creates and maintains temporary and permanent waterways and wetlands (DoW 2009). These have important ecological, cultural and other values that are protected by legislation at State and Commonwealth level.

A review of the DBCA Geomorphic Wetlands Swan Coastal Plain dataset identifies the project area is associated with two geomorphic wetlands including Yangebup Lake and Little Rush Lake. Both lakes are Conservation Category Wetlands.

5.6 Ecology

Yangebup Lake and Little Rush Lake Reserves are two individual wetlands comprising open water, riparian and upland endemic vegetation ranging in condition from excellent to completely degraded. The reserves provide habitat for a range of flora and fauna; some of this is the original bushland structure however a majority is the result of the City's bushland rehabilitation efforts following the cessation of agricultural and industrial processes in the study area. Ecological function has therefore historically been diminished and allowed to recuperate in the past 30 years however urban pressures on ecological function still exist. The scale and

broad shape of the reserves allows for significant core areas and a range of habitats to occur providing refuge for flora and fauna.

The reserves of the Beeliar Regional Park rely on ecological connectivity to ensure genetic diversity can be maintained. The reserves connectivity with surrounding natural areas is diminished due to roads and rail running in west-east directions. Promoting linkages to ensure the flow of genetic material between natural areas is an important part of Reserve management to safeguard long term species survival and the ability to adapt to environmental changes. This ranges from revegetation using local native seed to enabling fauna movement using overpasses and underpasses at road crossings.

5.6.1 Significant Biodiversity

Significant biodiversity occurs within the reserves. The mapped vegetation type Banksia Woodland has an increased significance following the listing of the Threatened Ecological Community (TEC) Banksia dominated woodlands of the Swan Coastal Plain IBRA region (Threatened Species Scientific Committee & Department of the Environment and Energy 2016). This community is commonly known as the Banksia Woodlands TEC and defines the Banksia woodlands occuring in the project area.

Yangebup Reserve contains the following Priority Ecological Communities as inferred or sampled by Bush Forever (Government of Western Australia 2000) including:

21b: Southern Banksia attenuata woodlands (P3);

21c: Low-lying Banksia attenuata woodlands or shrublands (P3);

22: Banksia ilicifolia woodlands (P2).

23b: Banksia attenuata – Banksia menziesii woodlands (P3);

24: Northern Spearwood shrublands and woodlands (P3);

25: Southern Swan Coastal Plain Eucalyptus gomphocephala – Agonis flexuosa

woodlands (P3);

29a: Coastal shrublands on shallow sands (P3);

29b: Acacia shrublands on taller dunes (P3);

30b: Quindalup Eucalyptus gomphocephala and/or *Agonis flexuosa* woodlands (P3).

Source: *Vegetation Condition, Floristic Community and Weed Mapping in the City of Cockburn, V2, EcoLogical June 2016*

5.7 Existing vegetation

Much of the original natural vegetation found at Yangebup and Little Rush Lakes has been disturbed over time. In certain areas these changes have been dramatic, resulting in a loss of both structural and floristic diversity and replacement by exotic species. The Reserves retain a number of distinct vegetation communities that have been further enhanced through rehabilitation work. Original plant communities still existing in the Reserves include:

5.7.1 *Melaleuca teretifolia* woodland

This community is found at Little Rush Lake and Yangebup Lake primarily within the water body in limited occurrence. It forms a low woodland occurring as an inner ring some 20m from the water's edge.

5.7.2 *Eucalyptus rudis* woodland

To a variable extent the foreshore fringes of both Little Rush and Yangebup Lakes contain *Eucalyptus rudis* woodland. The woodland varies in density and width and contains trees of mixed age. The understorey varies according to the level of disturbance and revegetation measures. The understorey contains native plant and rush species however in some areas is dominated by weed species *Pennisetum cladestinum* (Kikuyu) and *Ehrharta calycina* (Perennial Veldt Grass).

5.7.3 *Eucalyptus rudis/Melaleuca priesianna* woodland

This community occurs slightly inland from *Eucalyptus rudis* Woodland in most areas. It consists of an upper storey of *Eucalyptus rudis* and *Melaleuca priessiana.* The understorey is variable in this community depending on the level of disturbance. In areas in good condition it is dominated by rush species such as *Baumea sp., Lepidospenna efusium* and *Juncus pallidus* in places. In winter wet depressions on the south-eastern corner near the intersection of Osprey Drive and Parkes Street, the understorey consists of the above rush species as well as *Acacia pulchella*, *Pimelea rosea*, *Xanthorrhoea priessii* and various exotic species such as *Ehrharta calycina* (Perennial Veldt Grass) and *Euphorbia peplus*.

5.7.4 *Melaleuca priessiana/Banksia ilicifolia* woodland

This community is limited in extent but is in very good condition and occurs on the south-western fringes of Little Rush Lake. It contains an upper storey of tall Paperbarks (*Melaleuca priessiana*), with a small tree layer of the Banksia species (*Banksia ilicifolia*, *Banksia attenuata*, *Banksia menziesii*). The mid-level understorey consists of *Jacksonia furcellata*, *Jacksonia stembergiana* and *Astartia fascicularis*. The small shrubs layer is dominated by *Hypocalymma angustifolium* and various Restionaceous species. Herbs including *Anigozanthos manglesii* (Kangaroo Paws), various Orchids, *Drosera sp*. also occur. This community is in very good condition and is of high local conservation value.

5.7.5 *Tuart/Jarrah/Banksia* woodland

This community dominates the drier more upperland areas surrounding the wetland system. It is located on the western areas of Yangebup Lake and on the southern areas of Little Rush Lake. It consists in the upper storey of Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*), Marri (*Eucalyptus calophylla*), Sheoak (*Allocasuarina fraseriana*) as well as various Banksia species such as Candle Stick Banksia (*Banksia attenuata*), which is generally the most common, Menzies Banksia (*Banksia menziessii*), and in some cases Banksia ilicifolia and Bull Banksia (*Banksia grandis*). Taller shrub species include *Jacksonia furcellata,*

Jacksonia stembergiana and small patches of *Kunzea ericifolia*. The understorey includes a shrub layer which consists of *Macrozamia reidlii, Xanthorrhoea priessiana* and smaller shrubs such as *Hypocalymma robustum* (Swan River Myrtle), *Hibbertia hypericoides*, *Pimelea rosea*, *Petrophile linearis, Conostylis sp., Gompholobwn tomentoswn, Patersonia occidentalis, Burchardia umbellata,* various fringed lilies and other species. Spider Orchids have been sighted along tracks. The understorey is very diverse in some places, particularly where disturbance has been minimal. Some areas are in relatively good condition, particularly those further inland from the tracks, however due to repeated fires the area has generally been invaded by exotic species, particularly veldt grass *Ehrharta calycina*.

5.7.6 Jarrah/Banksia woodland

This community is fairly limited in extent and appears to be associated with higher upland areas where the soil is deeper and limestone occurs at depth. Here Jarrah occurs in quite dense stands with some very mature specimens. It is supported in the upper storey by *Allocasuarina fraseriana, Banksia attenuata and Banksia menziesii*. The understorey is dominated by *Jacksonia furcellata* and *Jacksonia stembergiana* as well as high densities of Balga (*Xanthorrhoea priessii*). The understorey also contains native herbaceous and shrub species. Small shrubs include *Hibbertia hypericoides*, *Astroloma pallidum, Pimelea rosea, Scavoela pallidus, Petrophile linearis* and herbs including *Burchardia umbellata, Conostylis pallidus,* various *Lomandra sp., Scaevola canescens* and *Dianella revoluta*. Exotic species include *Ehrharta calycina* (Veldt Grass), *Pelagonium capitatum* (Pelagonium) *and Ursinia anthemoides*.

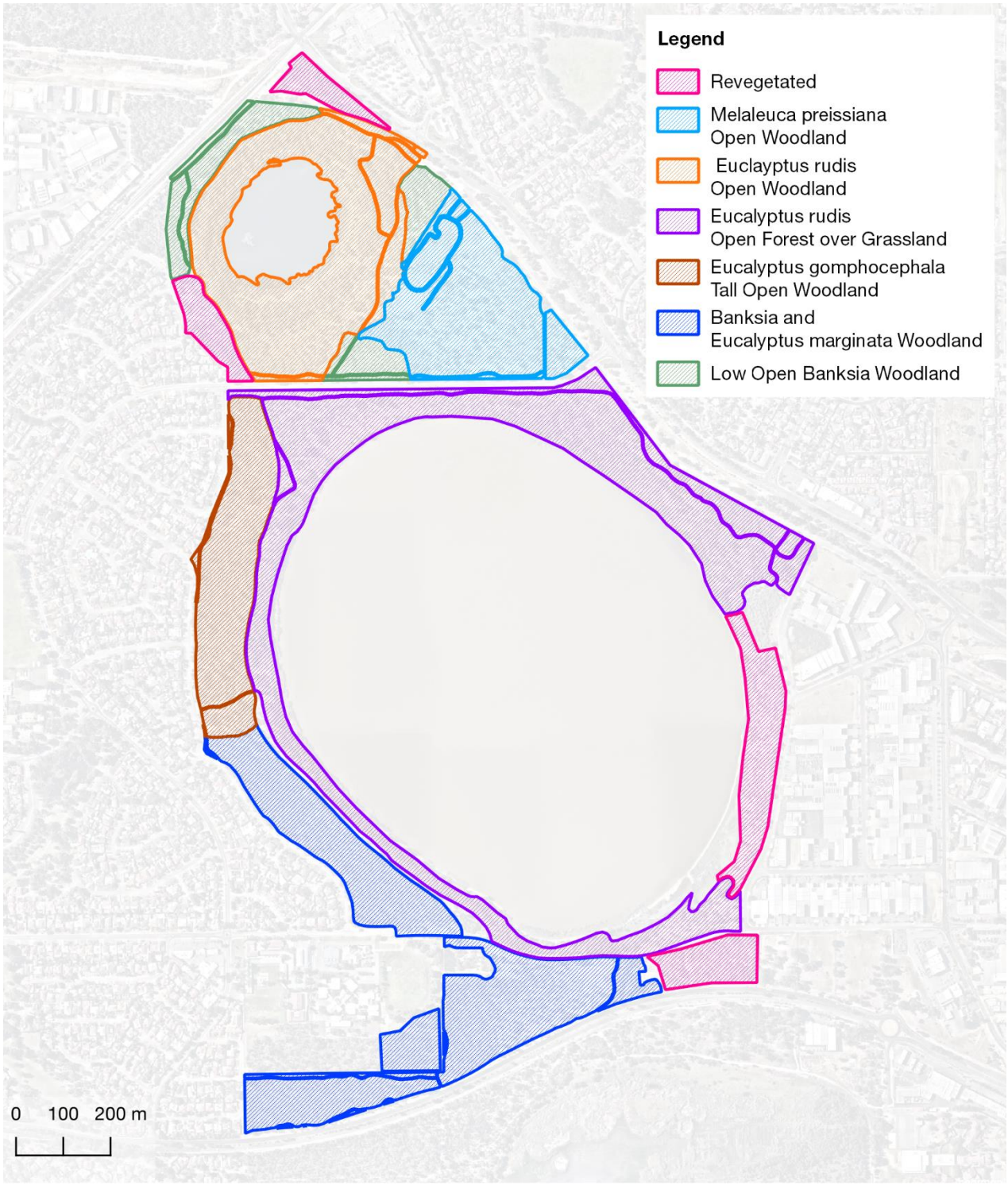
5.7.7 Disturbed areas

While a number of vegetation communities occur within the project area, large portions of the Lake's natural vegetation has been cleared for agricultural use, the construction of infrastructure, e.g. sewerage lines and adjacent industrial use. Grazing, particularly of horses, has occurred on the southern and eastern fringes of Yangebup Lake that resulted in the complete loss of the native understorey and replacement by exotic weed species. These primarily include *Cynodon dactylon* (Couch), *Pennisetum cladestinum* (Kikuyu Grass), *Avena fatua* (Wild Oats), *Arctotheca calendula* (Cape Weed) and various other dicotyledon weeds.

On the western side of Yangebup and Little Rush Lakes the construction of a sewer line in the 1980's resulted in significant loss of native vegetation. Subsequent rehabilitation programs introduced a new suite of species most of which are not native to the project area. These include *Eucalyptus camaldulensis, Melaleuca quinquinerva, Melaleuca nesophylla* as well as other non-native Melaleuca and Eucalyptus species.

On the eastern side of Little Rush Lake in the land formerly occupied by the Jandakot Concrete Works the vegetation over is extensively modified from that which originally occurred. Overstorey is entirely removed and vegetative cover consists of introduced species *Pennesitum setaceum* (Fountain Grass).

Map 6 overleaf shows the vegetation communities of the Reserves and Map 7 shows vegetation condition.



Map 6 Vegetation Communities

Map 7 Vegetation Condition

Image 2 Existing vegetation in the Reserves. Jarrah Banksia woodland on rise overlooking the site (top left) *Banksia menzesii* (top right). Large Tuart, *Eucalyptus gomphocephala* by Yangebup Lake (bottom left) *Juncus sp* at water's edge, Yangebup Lake (bottom right)

5.8 Fauna

The Reserves provide habitat for a significant number of avian, terrestrial and aquatic fauna in wetlands and open woodland habitat types. The predominant open woodland habitat is suitable for Black Cockatoo foraging and supports other generalist bird species, ground dwelling reptiles and mammals such as Quenda. Closer to the wetlands the vegetation supports large amphibians such as frogs as well as aquatic bird life. Improving the connectivity between reserves is an objective of the City of Cockburn to help breeding populations interact with those in the project area.

5.8.1 Avian Fauna

The Beeliar wetlands serve as an important breeding ground and summer refuge for a diverse bird population including trans-migratory wading birds. Yangebup Lake, which has water year-round is particularly important in providing this refuge. BirdLife Australia has provided bird monitoring data from January 2008 to January 2018 indicating 65 different bird species were

sighted at Little Rush Lake and 114 species at Yangebup Lake. Refer to Appendix 5 for Birdata Species List.

Waterbirds

Waterbirds are those that are generally found around or on the water body of the wetland. Yangebup Lake is a wetland of local and regional importance for waterbirds in the south-west of Western Australia. Waterbird species make use of open shallow expanses of water and open deep expanses of water, habitats which are particularly common within the project area, at Yangebup Lake where a variety of duck species can be observed.

Bush Birds

Bush birds include all species that are not always associated with wetlands but may make use of seasonally inundated or damp locations in addition to general bushland habitats.

Bush bird species of note are the Scarlet Robin, Golden Whistler, Grey Shrike Thrush and Splendid Fairy Wren which are reasonably common within the project area. The reserve's bushland areas also provide foraging habitat for larger birds such as Red Tailed Black Cockatoo and Carnabys Black Cockatoo.

5.8.2 Mammals

The Yangebup Lake area is known to support at least two species of native mammal. The most abundant and possibly widespread of these is the Quenda or Southern Brown Bandicoot (*Isoden obesulus*). Southern Brown Bandicoots are locally abundant around the northern perimeter of Yangebup and around the south, west and east sides of Little Rush Lake and they move between these two areas crossing Osprey Drive possibly via a culvert. Bandicoots are able to make use of a wide variety of habitat types, though their general preference is for low vegetation of variable density up to one metre high (Stoddart and Braithwaite, 1979). Preferred habitats also have some tree cover. Bandicoots eat frogs, spiders, grubs, caterpillars, beetle larvae and other invertebrates. They have sometimes been known to include eggs and vegetable matter (bulbs, corms and tubers) in their diet (Thomas, pers. comm). Bandicoots are crepuscular, i.e. they are most active in the early morning and evening.

Bandicoot populations at nearby wetlands have been observed to breed all year round, though predominantly in the winter and spring months. It has been found that shorter breeding seasons occur when population densities are higher (Thomas, 1991). Young become independent when they are about the size of a mouse and are heavily predated by cats, foxes, snakes and raptors. Small sub-adults are known to disperse into new habitat areas until they are able to establish a home range (Stoddart and Brathwaite, 1979). Bandicoots have been found to live for between two and four years. The bandicoot population within the project area may be threatened by feral predators, habitat loss and road deaths.

The other native mammal known from the project area is the Brush-tailed Possum which inhabits tall Eucalypts within the project area. The Brush-tailed Possum is a species that is seldom seen due to is nocturnal existence in the canopy of taller trees. The recent inclusion of a fauna overpass over Beeliar Drive has been made to provide a safe connection between the possum populations at Yangebup Lake and Kogolup Lakes.

Bat species occur at the lake with probable species including the White Striped Mastiff Bat (*Tadarida australis*) and the Chocolate Wattled Bat (*Chalinolobus morio*). It is unlikely that there are any remnant populations of macropods, though both the Western Grey Kangaroo

and Brush Wallaby would have certainly once occurred in the area. The last recorded population of kangaroos at the Yangebup Lake area was seen in the 1970's. Brush (or Black Gloved) Wallabies still inhabited the Little Rush Lake area until a fire in the area in 1990.

5.8.3 Amphibians and Reptiles

Six species of amphibians representing two families and four genera have been recorded from the wetlands in the project area. All of the frog species recorded need surface fresh water for breeding. The tree frogs *Litoria adelaidensis* and *Litoria moorei* tend to predominantly inhabit the wetland areas, whereas the Moaning Frog (*Heleioporus egrei*) is often found several kilometres from surface fresh water. The Moaning Frog is able to inhabit dry areas due to its burrowing habit and the fact that it can move to wetland areas during the winter months for breeding.

21 reptile species have been recorded from the Yangebup Lake and Little Rush Lake area (Murdoch University, 1988).The reptile fauna assemblage comprises one species of turtle, the South Western Snake-necked Turtle, (*Chelodina oblonga*). This species is common within Yangebup Lake and can often be seen near the surface of the lake. The Snake-necked Turtle lays up to ten eggs in sandy areas surrounding the lake in early summer. Turtles are at risk when crossing roads, e.g. Osprey Drive, to lay their eggs or migrate between wetlands.

The largest reptile group found at Yangebup Lake are the skinks with up to nine species having been recorded from the area. In addition to the skink, three species of Pygopod or Legless Lizard, two species of Goanna and one species each of Dragon, Gecko and Blind Snake are thought to inhabit the area. The skink population is at risk of predation from cats. The Elapid snakes are represented by the Dugite (*Pseudonga affinis*) and the Tiger Snake (*Notechis scutatus occidentalis*), both of which are highly venomous and can present a danger to people using the area, particularly if they are approached. There is also one species of Banded Snake, *Vermicella bertholdi*. This small nocturnal snake is commonly referred to as a 'Bandy Bandy' snake, due to the conspicuous colouration bands which encircle its body.

5.8.4 Midges

Historically Midges, (Chironomidae), have been a nuisance for nearby residents during summer months when swarms occur. Midges significantly compromise recreational values of the area and nearby neighbourhoods and occasionally require control under the City's Integrated Midge Control Strategy. The ongoing restoration of ecological function and improvement of water quality is helping to reduce the impacts of midge and requirement for treatment.

5.9 Threats and Threatening Processes

Threats and threatening processes occur in the reserve that have the potential to compromise the ecological function of habitat and the viability of recreational uses that rely on the amenity provided by natural areas.

5.9.1 Invasive Animals

Invasive animal and plant species occur throughout the project area and are managed in accordance with the City's Natural Area Management Strategy. These include:

- Feral animals and foxes that predate on native fauna
- European Bees that colonise bird nesting roosting locations such as hollows

- Introduced bird species that compete with native species for foraging and roosting locations
- Nuisance midge that adversely impact on recreational users and nearby residences.

5.9.2 Invasive Vegetation and Weeds

The following key species are identified as threats to the environmental and recreational values of the reserve.

- Introduced grass species including Perennial and Annual Veldt grasses
- Amazon Frogbit in Little Rush Lake currently under treatment
- Non-native *Eucalyptus* and *Melaleuca* species that have naturalised in the reserve
- Invasive weed species entering the wetlands via urban storm water.

Weeds are managed in accordance with the City's Natural Areas Management Strategy which aims to replace weed infestations with native vegetation cover incrementally and restore bushland areas to avoid re-infestation.

5.9.3 Fire

Fire is an ongoing concern throughout the Reserves and can threaten people and property in addition to disturbance of bushland areas due to hot, uncontrolled burns. This is evident in the bushland area west of Yangebup Lake that experienced a fire in 2015.

5.9.4 Erosion

The Spearwood and Bassendean soil types may be unconsolidated, loose and prone to erosion on slopes and in proximity to hard pavements. This is increased due to the trend towards more frequent rainfall events of increased intensity that cause scouring and washouts, especially if the ground is disturbed by bicycle or foot traffic and vegetation is damaged. Specific areas where erosion is noted includes:

- Beeliar Drive road embankments
- Runoff from Yangebup Rd shared path
- Limestone path alongside Pioneer Drive.

Image 3 Example of erosion caused by stormwater runoff on hard surfaces with mitigation shown on right.

5.9.5 Water Quality

The reserve's water quality is impacted by urban stormwater runoff that carry excess nutrients, hydrocarbon and heavy metal contamination in addition to past industrial contamination from the wool scourers operations on the eastern side of Yangebup Lake. Poor water quality due to excess nutrients has lead to recurring problems with eutrophication and nuisance midge that affect residents and visitors to the lakes in summer.

The City of Cockburn Natural Area Management Strategy aims to enhance wetland water quality and reduce erosion in conservation areas which has been implemented in the Reserves in a number of ways that include:

- Revegetating riparian areas
- Removing invasive species such as *Typha orientalis* and replacing with less invasive native species
- Installing gross pollutant traps and nutrient stripping basins
- Converting drains into living streams.

Developing these to further improve water quality is expected under the master plan and may include use of the southern fenced area as a nutrient stripping basin for inflow from the South Jandakot Drainage Scheme that currently enters Yangebup Lake untreated. Development of this concept requires further discussion and coordination with Water Corporation.

Water quality throughout the Beeliar wetlands is affected by urbanisation and climate change and there is potential for surplus water from Yangebup Lake to be piped to Bibra Lake to help minimise the adverse effects to wetland habitats in a drying climate.

Image 4 Water conditions in the reserve including Little Rush Lake (top left) the living stream at Yangebup Lake (top right) Water Corporation assets (bottom left) and fringing vegetation at Yangebup Lake (bottom right).

5.9.6 Salinity/Acidity

The groundwater salinity of the superficial aquifers is in the 500-1,000 mg/L range in the project area. Historically, Yangebup Lake has had influx of saline waters from the wool scourers (in addition to arsenic, nitrogen and phosphorous) that operated on the eastern side of the lake affecting rushes and fringing vegetation. The vegetation has recovered due to rehabilitation efforts and improved water quality management.

There is a high to moderate Acid Sulfate Soil (ASS) Risk <3 m from the surface close to the lakes and in the eastern portion of the project area. Proposed building works in these areas which may include landscape structures and pavements need to be cognisant of the risk and avoid disturbance of the affected soil stratum.

5.9.7 Impacts From Undesirable Uses

Undesirable activity includes illegal off-road trail bikes that damage tracks and trails, illegal dumping in bushland areas and graffiti on City assets such as signs and furniture. There is also evidence of bicycle use on trails with the creation of jumps on informal trails, especially in the bushland west of Yangebup Lake which is causing erosion of the trail surface. Bicycle riding is accepted as a beneficial community activity however management to avoid damage

to natural areas is required. Provision of an area designated for bicycle use may help alleviate the issue in bushland.

Image 5 Damage in the reserve due to bicycles (left) and illegal dumping (right).

5.10 Vulnerability to Change

5.10.1 Climate Change

The eastern chain of the Beeliar Wetlands is dependent on seasonal rainfall to allow surface expression of ground water in wetlands and lakes that is vital to ecological function. The trend towards a drier climate poses a threat to the wetlands as ground water is reduced and drier conditions become the norm.

5.10.2 Water Availability

In recent years Yangebup Lake has had a persistent water body due to inputs from the South Jandakot Drainage Scheme. There is potential for surplus water to be directed to Bibra Lake to alleviate the impact of ongoing drier conditions caused by declining groundwater levels and reduced rainfall. Further work and studies of impacts and approvals will be required before this can occur.

Bores for irrigation of open space are to adhere to regulations in accordance with DWER bores in proximity to wetlands including exclusion zones and the Cockburn Groundwater Allocation Plan. The Groundwater Allocation Plan aims to account for climate change and the impact of reduced rainfall on groundwater availability and minimise the risks of taking groundwater from dependent ecosystems such as lakes and wetlands.

5.10.3 Species Distribution/New Species

It is expected that continuation of the trend towards drier climate and more infrequent rainfall events may see more upland plant species moving into what were once wetland areas. Revegetation including vegetation monitoring will provide information on how plant communities are responding to changing conditions.

Fauna is susceptible to changing conditions and the availability of suitable habitat. Connections for fauna between the Reserves and surrounding bushland areas should be strengthened so movement is possible increasing access to other breeding populations and

habitat areas. There are currently structures that allow for this, two underpasses formed from pipes that allow for the movement beneath roads and one overpass spanning Beeliar Drive that was installed in 2019. The underpasses are culvert pipes one of which is under Osprey Drive and the other under Beeliar Drive. Both underpasses are in disrepair and are not ideally suited for fauna use as there are broad, exposed areas at the entries where predator attacks may occur. Fauna use of the underpasses is to be monitored once they have been upgraded.

Image 6 Existing fauna connectivity and roosting opportunities in the reserve including Osprey Underpass, bat roosting box in bushland and the new possum bridge over Beeliar Drive.

5.10.4 Fire

Fire poses a risk for the Reserves due to environmental weeds. Weeds can increase the intensity of fire in bushland areas which in turn leads to more weeds being established after a fire unless intensive weed control is undertaken. Controlled burns may be used in the reserves to help control weeds but only if funding is available for at least two years of weed control following the burn to manage re-infestation.

PVG (Perennial Veldt Grass) is prevalent on the Reserves eastern and southern sides. These areas will be targeted for weed control and revegetation in the future.

Fire Response Plans for the Reserves have been developed in accordance with the City's Natural Areas Management Strategy. 3m wide fire breaks are installed and maintained to meet legal requirements.

5.10.5 Dieback

Dieback, (*Phytophthora cinnamomi*) has been identified in Yangebup Lake and Little Rush Lake Reserves and care needs to be taken to avoid transfer to other areas. When entering Reserves and undertaking works, staff and contractors are expected to follow correct hygiene procedures. Firebreaks are paved in limestone as the high pH supresses Phytophthora Dieback. Recording of outbreaks and treatment are to be done in accordance with the City's Natural Area Management Strategy.

5.10.6 Dog walking

Dog walking is a very popular pastime that is permitted in the reserves. Dogs are required to be on leads at all times due to the reserves' conservation zoning.

6 Landscape and Recreation Review

6.1 Recreational Amenity in the Project Area

Recreational amenity can be attributed to the natural conditions of the area and the infrastructure that supports visitation and use. It includes biophysical elements such as vegetation and landform in addition to built form such as paths, furniture and playgrounds. The following review of the reserve's recreational amenity supports the recommendations made in the master plan.

6.1.1 Overstorey, Trees

Trees that occur within the study area provide an overstorey that ranges in height from tall Tuarts and Jarrah to smaller Banksia species. Fringing the wetlands the paperbark species *Melaleuca priessiana* and Flooded Gums *(Eucalyptus rudis)* form woodlands that contribute to the visual appeal and interest of the lakes. Throughout the reserve, trees provide shade and shelter and opportunities to encounter fauna in roosting hollows and nesting boxes.

Existing exotic trees such as *Jacaranda mimosifolia* are present in the south-eastern corner of the site signifying a prior homestead in the location (the Davison Homestead). These are valuable indicators of past use and have the potential to contribute to the area's recreational amenity.

Some tree plantings are non-local native species that were planted with the installation of the sewer line on the western side of Yangebup Lake and in the Parkes Street reserve near Little Rush Lake. These include *Eucalytus camaldulensis* and other non-local eucalypt species.

Several groves of *Acacia saligna* planted alongside the shared path on the western side of Yangebup Lake are likely to reach senescence in five to ten years. Replacement of these trees with a longer lived species should be considered to ensure the pathway remains and attractive environment for users.

6.1.2 Understorey

The natural vegetation and flora of the area displays a variety of scale, form, density and texture that contributes to the Reserves' character. This ranges from fringing vegetation at the wetland edge including rushes and sedges to banksia woodland species on the uplands areas where Zamia Palm and grass trees are present.

The eastern edge of both Yangebup and Little Rush Lakes contain extensive grassed areas (Perennial Veldt Grass) with scattered tall trees presenting a rural character. Vegetation in the former Jandakot Cement Works area, located east of Little Rush Lake, is extensively modified and denuded, which presents an opportunity for rehabilitation in combination with a compatible recreational use.

Image 7 Cultural vegetation examples Former Davison homestead Jacaranda avenue (top left) Lemon scented gums at Osprey Drive avenue (top right) Grassy woodlands on Parkes Street reserve at Little Rush lake (bottom left) bushland regeneration (bottom right)

6.1.3 Topography

The landform of most of the study area is low lying and gently undulating. Gentle rises (1-5°) occur between Little Rush Lake and Yangebup Lake and on the eastern side of Yangebup Lake around Tamara Drive. The steepest grades are encountered at the ridge south-west of Yangebup Lake with level changes from 15 m AHD at the Lake's edge to 33 m AHD at the Reserves' highest point near the Yangebup Road terminus. Slopes between are in the order of 5-10°.

6.1.4 Visual Catchments and Vistas

Visual catchments occur throughout the site and range from expansive views over Yangebup Lake to contained views and landscape spaces bounded by woodland along the Reserves' shared paths. The lakes are the main focal points of the area. The broad expanse of Yangebup Lake has a grand scale that contrasts with the more discrete natural spaces encountered when travelling around the lake. The water body is glimpsed from surrounding paths and can be seen most clearly from the elevated ground in the south-west corner of the reserve.

Views of Little Rush Lake have a more enclosed character owing to the smaller size of the water body and the presence of mature woodlands with understorey for the full perimeter of

the wetland. The former Jandakot Cement Works has minimal vegetation cover giving an open character to the area and the woodland on the reserve's south-east corner has minimal understorey allowing visibility to be unhindered a significant distance into the bushland.

Vistas in the study area occur at Lake Yangebup from the main ridgeline on the western side of the reserve that runs parallel to Pioneer Drive. Views of the lake, CBD and the hills can be obtained and westward across Yangebup suburb. During community consultation light industrial development on the western side of the lake was identified as a visual element that detracted from the visual amenity however natural growth of revegetation on the eastern side of the lake is screening this and will continue to do so in the future.

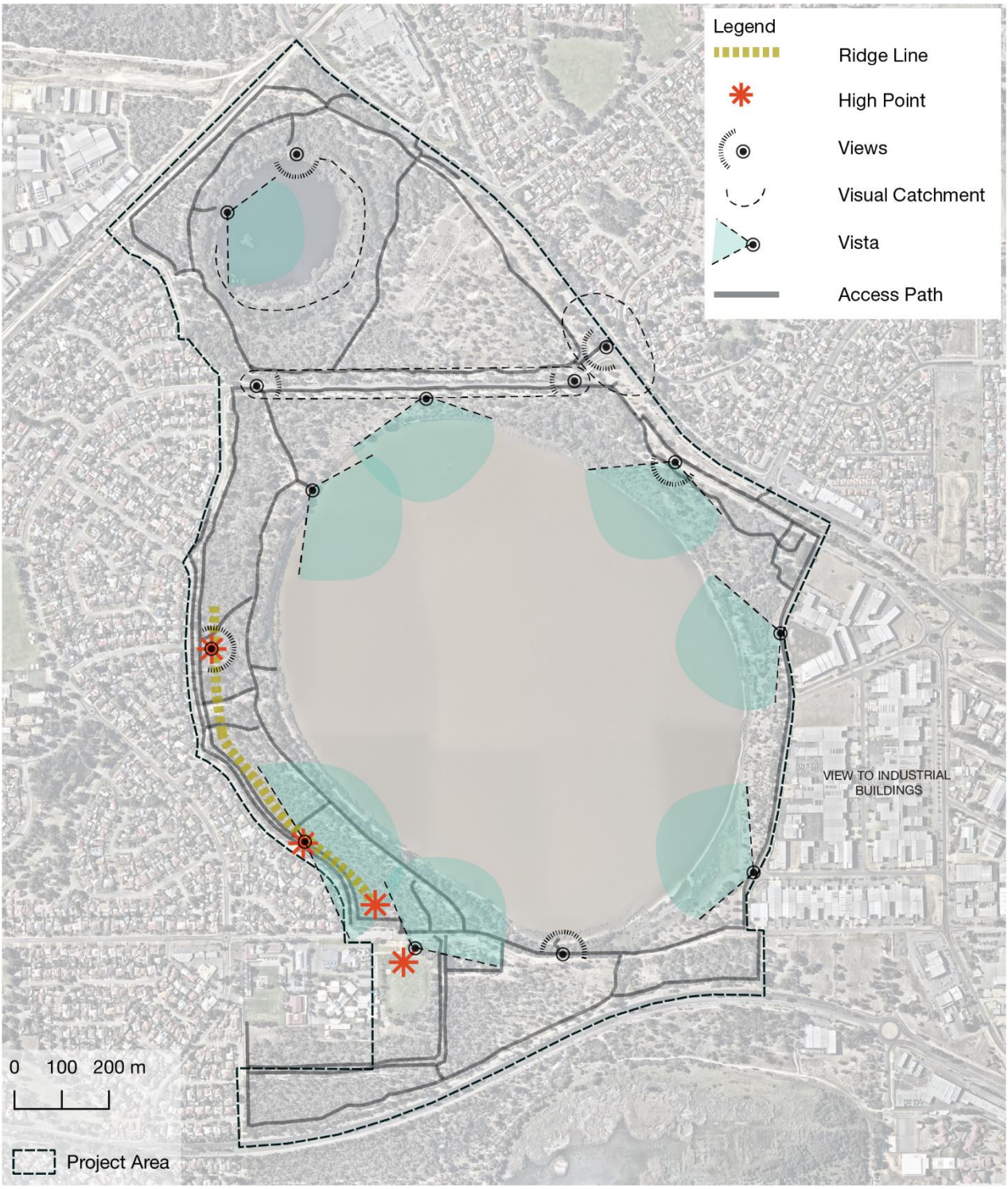
Paths around the lake are generally informal in character and accompanying landscape spaces are defined by canopy trees and low understorey vegetation on both sides. Generally horizontal visibility along paths is good and strikes a balance between allowing visibility of oncoming traffic, important for a feeling of personal safety, and defined lengths that provide a sense of variety.

Views from the southern portion of the reserve include the lake, gravel paths and areas that were historically cleared lend a rural quality due to the openness of the space and minimum of modern elements in the fore and mid-ground of the viewshed.

Avenues views exist on the site at Osprey Drive, Parkes Street Reserve and the former Yangebup Road alignment south of the lake. The avenues contrast in structure with the natural forms and spaces of wetlands and bushland. Osprey Drive is the most well-defined of these and provides an entry environment to the suburb of Yangebup with a linear experience and regular tree spacing. Parkes Street reserve, following the former rail alignment and, Yangebup Road traversing the southern section of the Reserve, are other notable examples.

Image 8 Lake views in the project area

Image 9 Osprey Drive entry environment (left) and avenue (right)



Map 8 Visual Catchments and Vistas

6.2 Existing Recreational Facilities

6.2.1 Recreational Facility Provision and Use

Recreational facilities exist in the project area and include:

- Shared paths
- Small, local playgrounds
- Minimal furniture
- A bird hide on the western side of the lake
- Lot 8 oval and exercise equipment
- Minimal interpretive signage
- Public artwork.

Generally, the Reserves are used for passive recreational purposes including:

- Dog walking (on lead)
- Jogging/ running including school cross-country events
- Sports (at Lot 8 oval)
- Play
- Bicycling on shared path and informal trails
- Nature appreciation including birdwatching
- Science/education.

6.2.2 Quality and Service Level of Facilities

Existing recreational facilities have been planned and managed by the City in accordance with the Beeliar Regional Park Management Plan and current recreational offerings are largely compatible with this. Recreational demands of the area are changing and will affect future provision of facilities bought about by the increasing density of surrounding suburbs and changes in the types of recreational activity. In addition, much of the infrastructure in the Reserves such as paths seating, shelters and signage are reaching the end of their functional life and require replacement, or do not meet current standards for accessibility. For the majority of the reserve, upgrades are expected to replace the current level of provision rather than increasing the amount of recreational amenity.

6.2.3 Future Potential

Access to the Reserves is concentrated on the western side of the lakes due to the strong pedestrian links with Yangebup and ease of access. The eastern side of the lake has less visitation and North Lake Road is a significant barrier to residents of the suburb of South Lake. There is a general perception of decreased personal safety on the eastern side of the lake which deters people from walking in the area. The eastern side possesses a number of locations of environmental and historic interest that have good potential for passive recreational development in keeping with the reserve management objectives.

The following possible upgrades should be considered:

- The former Jandakot Cement Works site next to Little Rush Lake that is extensively modified and has lower conservation values than other areas of the reserve has potential as an urban bicycle park. Further detailed consultation would be undertaken before any such facility was constructed. Access would be provided from the shared paths and conservation fencing would be installed to protect adjacent bushland areas.
- Davison Homestead and Tramways Terminus on the Eastern side of Yangebup Lake that includes the original homestead avenue planting of Jacarandas and is located next to the living stream, biofiltration basins and bird hide.
- The Osprey Drive entry environment from North Lake Road provides the only eastern entry to Yangebup and could provide better presentation for the suburb and reserve
- The Parkes Street road reserve may provide a suitable location for a shared path connection from Cockburn Central West to Bibra Lake also providing improved accessibility from South Lake neighbourhoods.
- Spencer Homestead next to Little Rush Lake provides an opportunity for interpretation of former habitation of the locality.

Recreational facilities on the western side of the Reserves are more developed due to the proximity of the suburb. There are some locations to access the lakes but none with universal access compliance. Boardwalk access to the lake, that can be used for recreational, educational and research purposes, should be explored and, as part of this process, include extensive consultation with the Aboriginal community to ensure culturally sensitive construction methods are used. There is also possibility to capitalise on views across the lake from the top of the rise near Pioneer Drive with a lookout deck however installation of any such structure needs to take into consideration the impacts on bushland there.

6.2.4 Playgrounds

There are four existing playgrounds in the Project Area representing adequate provision of locations however the condition of them vary. Small playgrounds at Mudlark Way and Gull Way have recently undergone upgrades with new equipment with a natureplay theme. The Grassbird Loop playground is in poor condition due to its age and should be a priority for replacement.

All existing playgrounds present issues for access and inclusion compliance. These include a lack of accessible play equipment and furniture in addition to non-compliant level changes near seating. Future upgrades should aim to address these compliance issues.

Image 10 Existing playgrounds Mudlark Way (top left) Gull Way (top right), Grassbird Loop (bottom left) and Yandjet Park (bottom right)

Image 11 Urban bike park example in Leeds, a compact singletrack with jumps and feature (top).The former Jandakot Cement Works has the potential to host an urban bike park due to degraded condition.

6.2.5 Furniture

Furniture includes seating, tables, shelter, bins and other fixtures that support recreational uses. The Reserves do not have regular seating or rest points which gives the perception of long distances along the path network. The lack of seating opportunities along shared paths and the condition of existing bench seats is a deterrent for potential visitors that require frequent rest stops. There is also a lack of shelter for shade and rain protection at destinations throughout the reserve. Existing shelters are inaccessible for wheelchair users due to the lack of paved surfaces. There is potential for informal seating elements such as salvaged logs that complement the reserve's bushland character to be included at frequent locations along pedestrian path ways.

Image 12 Existing shelter with integrated bench

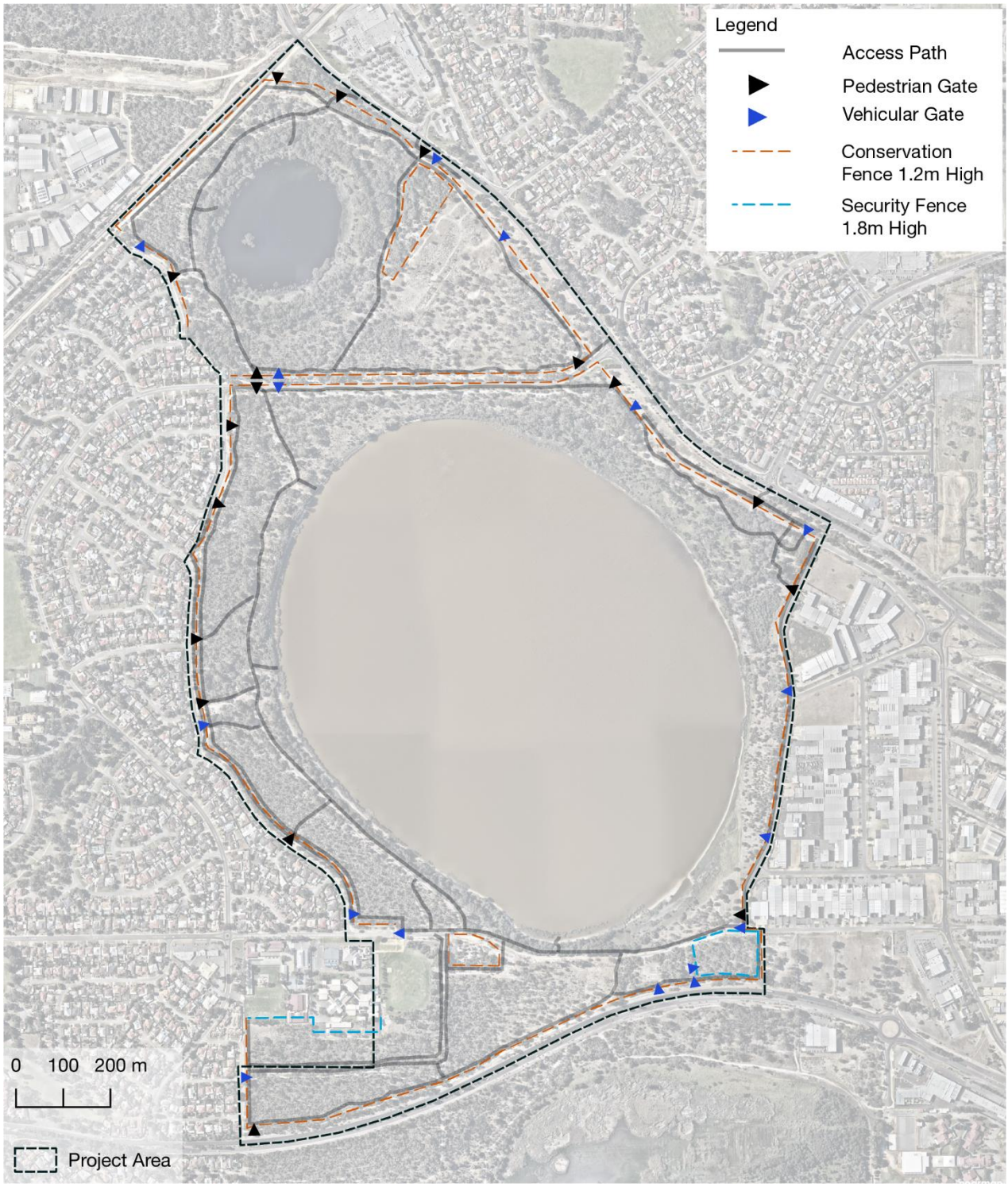
6.2.6 Fencing

Perimeter fences are generally post-and-wire conservation fencing with treated pine strainer posts and star picket posts at regular intervals. The fencing is practical, low visibility and in keeping with the character of the reserves. Some fencing includes mesh designed to direct fauna to safe crossing points.

The conservation fencing is generally effective in restricting the access of illegal off-road vehicles, allowing internal areas to be mostly unfenced except for areas under revegetation which offers protection from rabbits. Heavy-duty chain link fencing has been installed between Little Rush Lake and the rail reserve to stop illegal off-road vehicle access and seems to be proving effective. Conservation fencing has the additional benefit of directing fauna to wildlife underpasses reducing the possibility of road deaths and injury.

Fence heights are generally around 1.2m which helps maintain a feeling of openness throughout the Reserves. The use of 1.8m security fencing occurs in the south-east corner of Yangebup reserve around Water Corporation assets. New fencing in the reserve should avoid high and visible fencing including chain link, barbed wire and garrison style fencing.

The perimeter fencing is effective in controlling access by illegal off-road vehicles however there are some points where ongoing access is an issue including Lot 8 POS at Yangebup Lake and the Grass Bird Loop frontage at Little Rush Lake. It is recommended that perimeter fencing of these areas is installed or upgraded to provide greater control.



Map 9 Reserve Fences and Entry Points

Image 13 Conservation fence type used throughout the Reserves. Little Rush lake (left) Yangebup Lake (right)

6.3 Access, Circulation and Connectivity

6.3.1 Parking

Parking is provided for the Reserves at a number of locations however parking bays are not formalised. The main parking areas around the reserve include:

- Yangebup Road (Lot 8) adjacent to Mater Christie Primary School
- Parkes Street and Tamara Drive intersection
- Osprey Drive and North Lake Road intersection
- Former Jandakot Cement Works.

These areas provide an adequate supply of parking for the Reserves now and into the future however the areas would benefit from formalisation with landscape treatments and installation of wayfinding signage.

6.3.2 Path Connectivity

The Reserve path network is generally in good condition and well connected. Most of the paths are used recreationally and meander through the Reserves with a relaxed character. Some routes are more direct and preferred by commuters such as the former Yangebup Road alignment south of Yangebup Lake and the diagonal path through Little Rush Lake Reserve that provides access from Yangebup to the South Lake shopping centre. There is potential to improve the path network and access through the Reserves and encourage pedestrian and cycle use. This may have the benefit of reducing congestion at weekday peak times during school drop-offs.

The Parkes Street road reserve is an open space corridor that provides a buffer for the Reserves from North Lake Road. There is an opportunity to extend the shared path from its current end point east of Yangebup Lake to connect to the shared path from Bibra Lake through the reserve. This would complete a gap in the regional path network, encourage use of the Reserve's eastern side and improve accessibility for South Lake Residents coming from crossing points such as Thomas Street, Glenbawn Drive (Osprey Drive intersection) Elderberry Drive and the Lakes Centre.

The shared path network provides a continuous loop around the lakes however the section along Tamara Drive is outside the reserve and pedestrians must use the footpath along the road. Providing a path within the reserve was considered but negative impacts on the revegetated area and bird habitat was deemed to substantial and the existing footpath will remain as the pedestrian access at this time.

There are minimal path connections to the water body from which to experience the lakes close-up. Opportunities occur on spur paths from the shared path to the water's edge at the north western side of both lakes. At Little Rush Lake the path is inundated in winter when water levels rise cutting-off pedestrian use.

Path Gradients throughout the site are gentle and commonly fall between 2 to 3 % and rarely exceed 5% in the upland areas away from the wetlands. Gradients greater than this should be avoided to minimise erosion issues

Map 10 shows the path network in the Reserves.

6.3.3 Path Conditions

The Reserves' present a range of paved paths and unsealed tracks for walking and cycling. Hard surfaces include asphalt and concrete and unsealed surfaces, include stabilised limestone and natural sand-soil. Sealed paths are typically black asphalt, in the case of shared paths, or compacted stabilised limestone for unsealed tracks. Other informal paths have evolved through pedestrian and bicycle use, particularly through the bushland between Pioneer Drive and Yangebup Lake.

6.3.4 Paved Paths

Asphalt path surfaces are in reasonable condition, however edges are soft and crumbling in some areas or are being raised by tree roots. Future upgrades of the paths should be appropriately scaled to the volume of traffic and anticipated use. The current shared path width (2.5m) should be acceptable for upgrades in most locations, however the shared path following the former Yangebup Road should be 3m width due to the higher frequency of commuter traffic accessing Cockburn Central West. Some path intersections are indirect, resulting in desire lines being formed as users cut across corners. The design of path upgrades should include consideration of ways to optimise intersections for pedestrian and cycle movement.

Image 14 Informal paths west of Yangebup Lake suitable for light pedestrian use only.

Image 15 Path Conditions in the reserve including: asphalt shared path at Yangebup Lake (top left), concrete path at Grassbird Loop playground (top right), path condition Yangebup Lake (bottom left), Tamara Drive footpath (bottom right).

6.3.5 Unsealed Tracks

Unsealed limestone tracks are predominantly firebreaks and are in varying condition based on location, gradient and age. They are predominantly located in the southern section of the Yangebup reserve but also along Pioneer Drive and on the Northern Perimeter of Little Rush Lake. Issues affecting unsealed tracks include erosion, compaction, scouring and waterlogging.

The limestone tracks are important for firefighting purposes, maintenance access and provision of a more natural walk trail experience for reserve users. Due to these uses more frequent monitoring of the tracks should be considered to maintain a good condition.

In the southern section of Yangebup Lake, a duplication of the firebreak occurs on the reserve boundary shared with Mater Christi School primary School. The duplicate track should be removed and rehabilitated.

Map 10 Path Network

6.3.6 Reserve Entry Points

The presentation of the entrances into the reserve are generally uninviting due to the amount of security, barriers and regulatory signage coupled with the lack of wayfinding signage and amenity at these points.

Image 16 Cockburn Bicycle User Group using a chicane entry to the reserve. Some users have difficulty moving through the barriers. Photo credit: Cockburn Bike User Group

The existing chicanes on pedestrian entries have been installed to restrict illegal off-road trail bikes from accessing the reserve's natural areas. They consist of 3 grab rails aligned in close proximity to make trail bike access difficult. They are effective at this, however it has been identified during the consultation that they restrict some users from entering the reserve including bicycles, prams and disabled users. It would be worthwhile trialling modification of obstacles at major thoroughfares to see if the entries can be made more navigable while still restricting trail bike entry.

Reserve entry points have a variety of signage placed on gates and posts. Additionally, wayfinding and orientation signage is not present which gives an uninviting first impression to reserve visitors. Consolidation of signage and inclusion of wayfinding signage at entry points would enhance these locations.

6.3.7 Reserve Presentation

The visual qualities of the reserves range from natural woodlands and wetlands to a rural character. Much of the existing furniture and signage is in poor condition and there is no consistent design evident.

Materials used in upgrades should aim for a strong connection with the bushland and wetland landscape. Materials may include timber, galvanised steel and natural tones. The eastern side of the lake has historic elements such as homestead sites and the old railway alignment that could provide inspiration for form or material, however new designs should to take inspiration but not to replicate historical styles. Materials throughout should aim for durability in addition to aesthetic value and avoid high ongoing maintenance costs or frequent replacement.

New paths surfaces should meet relevant standards and include red asphalt for shared paths, concrete for some minor paths and crushed limestone on management tracks. Smaller, sand surface tracks should be preserved. The appeal of exercise circuits, such as the one at Bibra Lake that includes, signage totems and ground graphics can also encourage active use of the path network and should be incorporated into any signage plan.

Image 17 Materials and detail of landscape structures that are sympathetic to the natural environment and easy to maintain, examples from Cockburn Central West

6.4 Signage

Signage occurs throughout the reserve at entry points and locations of interest. Signage has built up over time and there are a range of suites resulting in unclear messaging. The signage includes:

- Reserve signage from the DBCA Regional Parks
- Locality signage from the City of Cockburn
- By-law signage at reserve entries
- Interpretive signage at places of interest
- Public artwork signage plinths

Wayfinding signage should be provided at key decision-points throughout the reserves with map information provided at major entries. This would then be supported by smaller signs and

markers in the reserve to assist in orienting visitors. There is a good spread of interpretive signage throughout the reserve but the signs have reached the end of their functional life with a majority having faded, illegible panels. Replacement of the signs in combination with new signs at relevant destinations should be undertaken to capitalise on the Reserve's educational opportunities.

A signage and interpretation plan should be developed for the Reserves to address issues and needs. The plan should use the City's signage style guide and be coordinated with interpretation signage to ensure a consistent appearance.

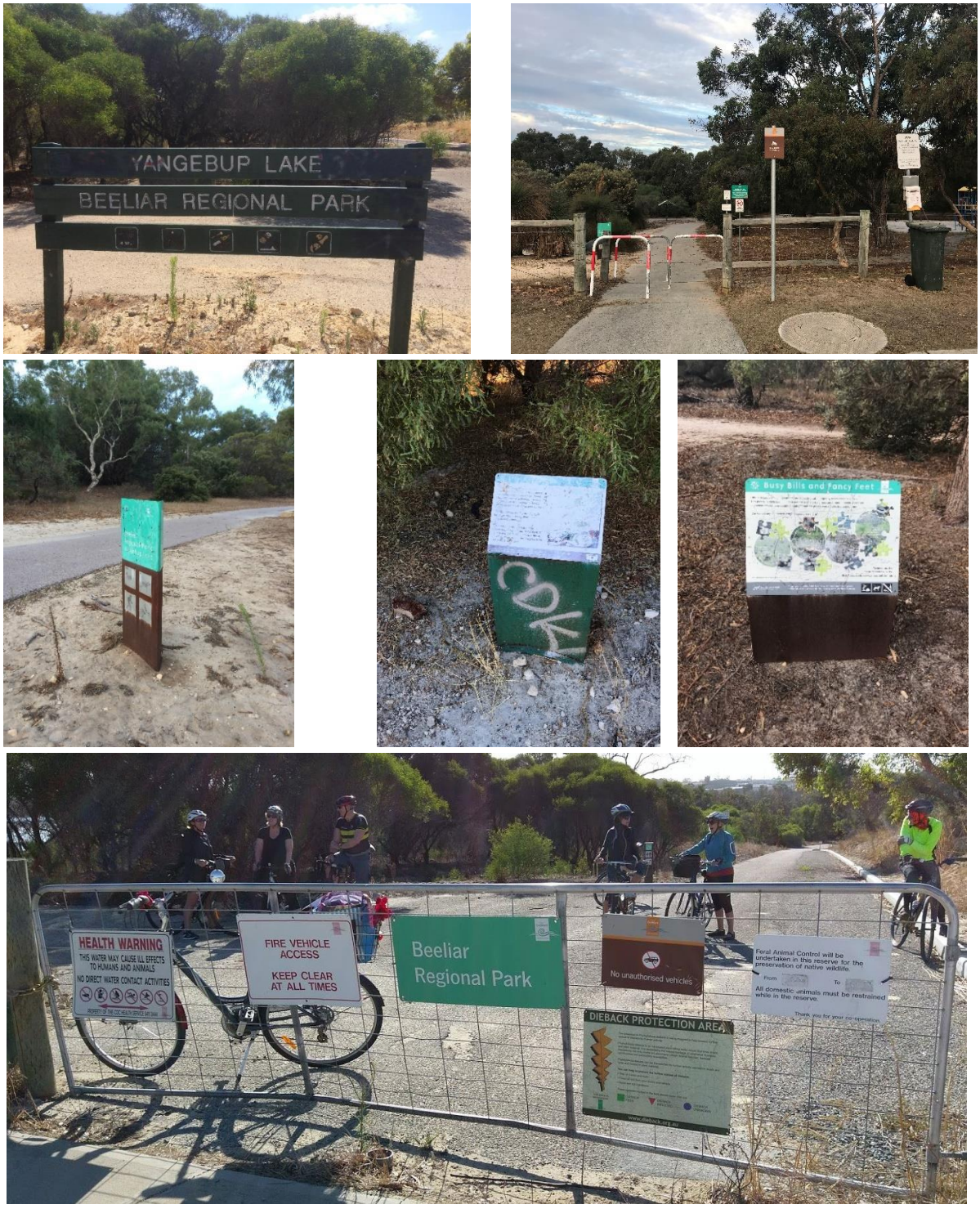


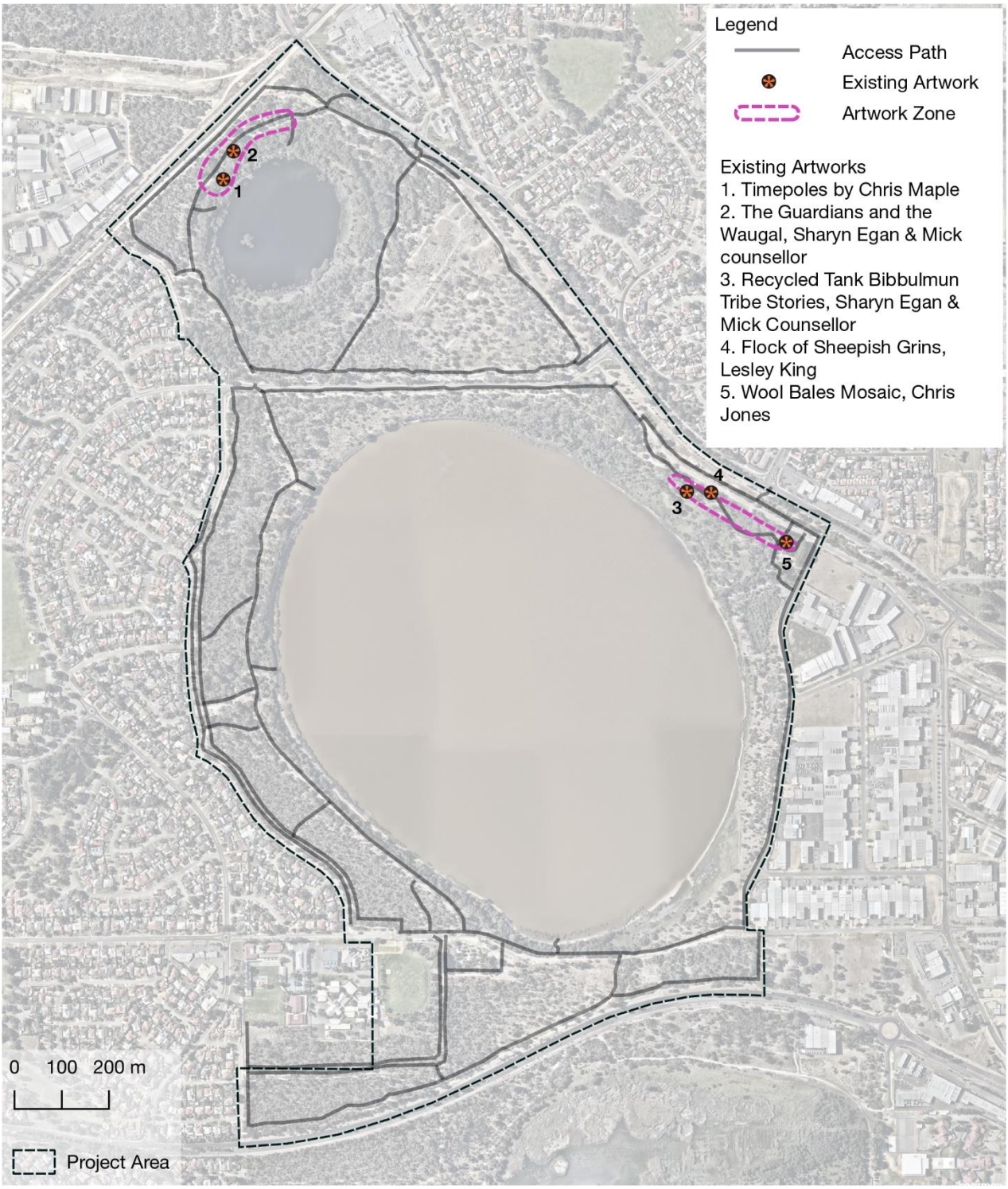
Image 18 Examples of signage throughout the Reserves including: older signage (top left), sign clutter at entry points (top right), Beeliar Regional Park signage, interpretive and information signage in poor condition (center). Regulatory signage at Yangebup Drive entry, photo credit: Cockburn Bike User Group

6.1 Public Art

Public artwork has been installed in the eastern portion of Yangebup Lake and north of Little Rush Lake. The artwork at Yangebup Lake includes pieces depicting Nyungar stories and prior agricultural uses of the area. At Little Rush Lake some of the artworks have perished. The remaining pieces have been relocated above the lake's high water-line.

Opportunities for new artwork exist throughout the reserve. No artworks occur on the western side of the lake and there is potential for public art to be developed at nodes and paths throughout the Reserves. The Osprey Drive entry point is also a potential location for a large art piece installed in conjunction with landscape upgrades.

Image 19 Public art in the reserve. Bibbulmun Tribe Stories by Sharyn Egan and Mick Counsellor (top left) Flock of Sheepish Grins by Lesley King (top middle), Beeliar Wetlands Heritage Trail by Yangebup Primary School students (top right), Wool Bales Mosaic by Chris Jones (bottom right), Time Poles by Chris Maple (bottom centre), artwork signage plinth (bottom right).



Map 11 Existing Public Artwork

6.2 Special Interest Features

6.2.1 Birdwatching

Birdwatching occurs year-round and the Reserves are well-known destinations in the metropolitan area. Facilities for bird watching have been provided in the newly installed bird hide on the eastern side of the lake. Bird nesting boxes have been installed throughout the reserves.

6.2.2 Education (Schools)

There are several local schools that use the Reserves for educational purposes and sports events such as cross-country runs. Lake visits are undertaken by schools to observe flora and fauna of the area. The bushland areas are also important in describing traditional Aboriginal occupation in the area. Development of a signage and interpretation plan would provide further support to educational uses.

6.2.3 Education (Tertiary)

University and TAFE institutions use the area for educational purposes. With many students undertaking assorted monitoring in both reserves. The City encourages educational institutions to participate in management activities.

6.2.4 Dog walking

Dog walking is a very popular pastime that is permitted in the reserves. Dogs are required to be on leads at all times due to the reserves' conservation zoning.

7 Concept Plan

7.1 Concept Design

A Concept Design has been developed for the master plan that provides the general locations and extents of upgrades presented in the recommendations. Refer to Appendix 1: Master Plan Concept. for the following plans:

- CP01: Recreational Infrastructure Plan
- CP02: Signage and Interpretation Plan
- CP03: Environmental Management Plan

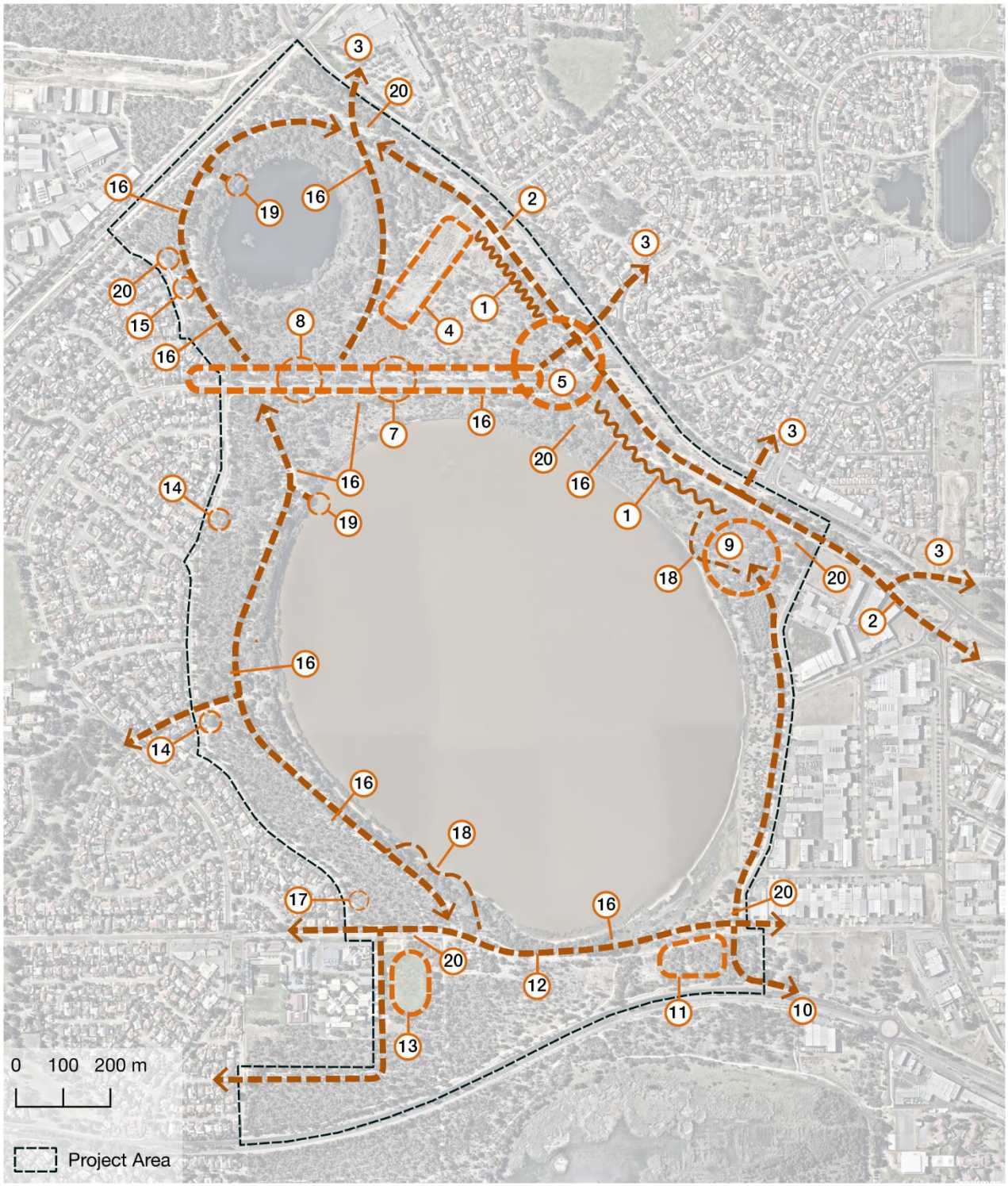
The plans are accompanied by the Priorities List provided in Appendix 2.

7.2 Opportunities

A number of opportunities have been identified that can maintain the character of the reserves while enhancing the visitor experience. The opportunities present overarching principles and the rationale for the Master Plan recommendations. The opportunities are presented here with a diagrammatic map showing their locations.

1. Activate the eastern side of the Reserves with improved circulation and additional passive recreational destinations that are in keeping with the Beeliar Regional Park Management Plan.
2. Improve the Parkes Street north-south connectivity by extending the North Lake Road shared path adjacent to Little Rush Lake.
3. Improve east-west connectivity across North Lake Road at key intersections through improved pedestrian refuges and pedestrian phases at traffic light intersections and path connections to the Parkes Street reserve shared path
4. Create an urban bike park at the Jandakot Cement Works site that capitalises on the modified, post-industrial character of the location and includes some recreational amenity eg. shelter, grass and planting. Any such proposal will require further detailed consultation and fencing to restrict access to bushland areas.
5. Create an entry point for Yangebup Lake at the intersection of Osprey Drive and North Lake Road that celebrates the bushland and suburb with landscape planting, improved shared path connections, landscape works, public art and water sensitive design incorporating the existing sump.
6. Enhance Osprey Drive entry to Yangebup Lake including turf and tree plantings on northern side of the road reserve.
7. Construct a central pedestrian and bike crossing point at the entrance to Osprey Drive with a refuge island to create better a better connection between the reserves for recreational use.
8. Establish fauna underpasses and overpasses on Osprey Drive to allow better connections for wildlife in the reserves.

9. Provide an amenity node at former Davison Homestead/ Tramways Terminus location that celebrates the former use and the nearby biofiltration/ living stream. Include a trail head for the Tramways Trail. Upgrade and relocate existing wooden bridge and provide new iconic design to act as an additional attractant to this node.
10. Provide a connection from the south-west Corner of Yangebup Lake Reserve to the shared path on the southern side of Beeliar Drive to allow access to Thompsons Lake Reserve, Tramways trail and Cockburn Central West.
11. Include a biofiltration area as part of a treatment train for the South Jandakot Drainage scheme using an existing fenced sump area in the south east corner of Yangebup Lake.
12. Upgrade the shared path to enhance the connection of Yangebup to Cockburn Central and promote cycle trips.
13. Upgrade the surrounds of existing playgrounds to improve accessibility.
14. Upgrade the Grass Bird Loop playground with new equipment, amenities and landscape with a nature play theme.
15. Provide seating options alongside shared paths for more frequent rest stops.
16. Include viewing opportunities at the high point of Yangebup Lake Reserve.
17. Provide public access to the lake water body that is universally accessible using boardwalks, bridges or paving. Boardwalk proposals would include extensive consultation with the Aboriginal community and construction methods would involve options rather than piling such as floating or suspended structures.
18. Maintain informal paths to the water body for recreational and research use.
19. Upgrade and improve entry points throughout to make the reserves more inviting.
20. Develop and implement a reserve-wide signage and interpretation plan to improve wayfinding and interpretation.
21. Install public art in key locations to enhance the visitor experience of the reserves
22. Continue ongoing dialogue with local residents and stakeholders to ensure they are informed of consultation feedback periods, impending works and management operations that may affect access and use of the reserves.



Map 12 Opportunities

7.3 Revegetation and Amenity Planting

It is recommended that revegetation planting continues in degraded areas throughout the Reserves with amenity planting occurring at recreational nodes and entry points. Planting in the Reserves should:

- Enhance existing bushland and wetland habitat
- Improve water quality through biofiltration where practical
- Enhance the landscape and recreational experiences for visitors.

Only native endemic plant species should be used to provide habitat for local fauna.

7.3.1 Revegetation

Revegetation is an important component for rehabilitating degraded natural areas of bushland and wetland in the reserves. The objective of revegetation is to lift all bushland areas to a level of ‘good’ condition in accordance with the Keighery 1994 definition of vegetation condition as identified in the Natural Area Management Strategy.

Active revegetation and weed control should be undertaken using the basic principles of the Bradley method as per the City of Cockburn Natural Area Management Strategy. The underlying principles of the method are:

- Work from areas in good condition to ones in poor condition.
- Minimise disturbance while working to avoid creating conditions suitable to weed invasion.
- Let the rate of natural regeneration determine the rate of weed removal. This is important as over-weeding will leave large bare areas that can be re-invaded by more or different weed species.

The objectives of revegetation are to:

- Reinstate indigenous flora and vegetation communities.
- Reduce or remove all disturbance factors originating in the revegetated area or externally.
- Create self-sustaining naturally regenerating vegetation communities.

Revegetation planting should occur in those areas identified in vegetation condition report as ‘degraded’ and ‘completely degraded’ starting close to areas of good quality vegetation and working outwards. In addition areas that have undergone revegetation in the past may require additional infill planting.

In accordance with the Natural Area Management Strategy reserve conditions are to be condition mapped every four years to assess the effectiveness of revegetation and rehabilitation works.

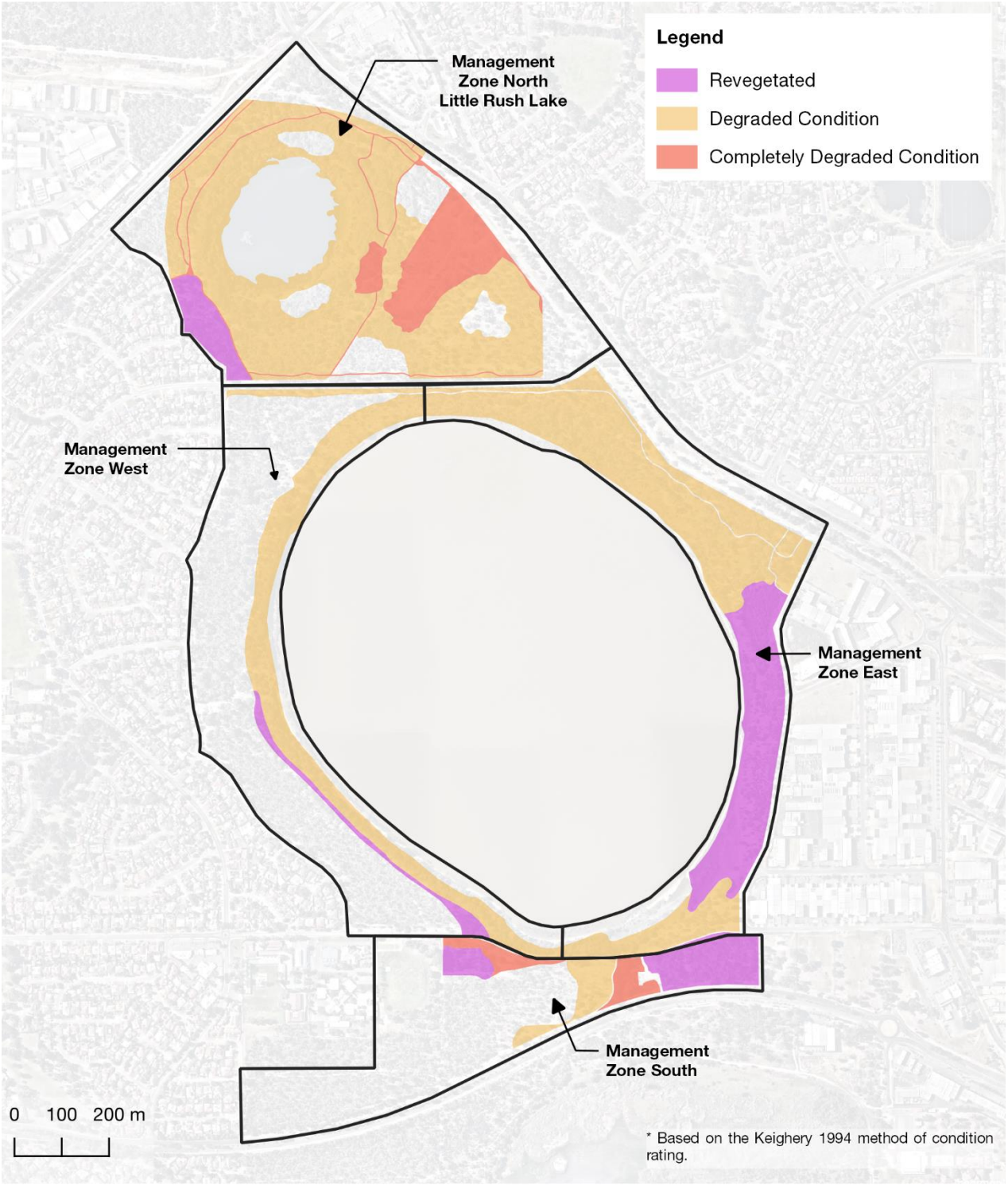
7.3.2 Rehabilitation Management Zones

It is recommended that rehabilitation commences in four distinct management zones working from the good quality vegetation outwards in each zone. It is expected that the City's staff will review locations in these zones to target the best locations for revegetation based firstly on the vegetation condition maps and secondly on the local priority areas.

The management zones are defined as:

- Western Zone: Including the western side of Yangebup Lake
- Northern Zone: Including Little Rush Lake Reserve and northern portion of the Parkes Street reserve
- Eastern Zone: Including the eastern side of Yangebup Lake and southern portion of the Parkes Street reserve
- Southern Zone: Including the southern portion of Yangebup Lake Reserve.

Image 20 Example of revegetation planting (left) and amenity planting (right).



Map 13 Proposed Rehabilitation Management Zones

7.3.3 Amenity Planting

Amenity planting should occur around recreational nodes such as car parks, playgrounds and recreational destinations. Amenity planting should be of a higher level of presentation and meet additional criteria such as the preservation of sight lines for vehicle safety and passive security. Amenity planting should use a local native species palette derived from the native plant communities within the reserve.

7.4 Monitoring

Monitoring of revegetated areas is to be undertaken in line with the City's Natural Areas Management Strategy that supports mapping for bushland condition every four years. The results of bushland mapping accompanied by targeted surveys should be used to determine the effectiveness of bushland rehabilitation works with follow up works undertaken where vegetation condition of 'good', in accordance with the Keighery 1994 method of assessment, has not been achieved.

7.5 Research

Research is an important ongoing component of natural area management in the Reserves and provides valuable information regarding bushland condition, regeneration efforts, fauna and water quality. The information from research undertaken by the City, tertiary institutions and NGO's provides an understanding of the reserve's resilience in response to climate change and urban pressures.

Wetlands are key areas for research that may include:

- Monitoring of water quality
- Aquatic and amphibian fauna surveys
- Water and migratory bird surveys.

It is recommended that the City supports and encourages research activities in both reserves.

7.6 Review

7.6.1 Master Plan Review

The Master plan for Yangebup and Little Rush lakes has been created to allow for a 10-year timeframe from 2020 to 2030. A review of the master plan should be undertaken in 5 years to ensure it aligns with other City strategies and objectives.

7.7 Supplementary Plans and Programs

The works recommended in the master plan are expected to occur over a 10-year timeframe. Works have been scheduled based on priority over this time frame in the Priorities List provided in Appendix 2.

8 Recommendations

8.1 Overview

Recommendations for upgrades and management of the Reserves are provided in Table 2 below.

Recreation infrastructure upgrades include:

- Activity nodes
- Circulation (including management and recreation infrastructure)
- Signage
- Public Art

Environmental Management includes:

- Bushland restoration including weed management, revegetation and maintenance
- Fauna management e.g. overpasses, underpasses and nesting boxes.

A priorities list has been prepared for the master plan recommendations. Refer to Appendix 2: Master Plan Priorities. Recommendations will be implemented as funding is made available.

8.2 Recreation Infrastructure Recommendations

The following table presents the master plan recommendations for recreational infrastructure. Recommendations are either at specific locations or are Reserve Wide (RW). Refer to Appendix 01: Master Plan Concept for locations.

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale	Timing
1.0	Activity and Amenity				
1.1	Yangebup Road entry	Yangebup West	Upgrade entry point including path surfaces, furniture and potential public art location.	POS including oval and playground to be upgraded. Celebrate the entry to Yangebup Lake reserve at the key entry point near School Precinct and Yangebup Shops.	2021
1.2	Lot 8 Public Open Space	Lot 8	Upgrade POS and provide connections to Yangebup Lake reserve. Include extension of the Pioneer Drive footpath and crossing for access to the schools and connection to the new shared path south of the POS.	Upgrade POS to meet the City's provision standards. (Refer to Lot 8 Concept Design POS including oval and playground to be upgraded).	2021
1.3	Yangebup Lake lookout	Yangebup West	Investigate the feasibility of a deck structure with furniture, interpretation and paths connected to the Yangebup Road entry.	Opportunity to capitalise on views at the high point in the reserve that could be undertaken if existing vegetation is not adversely impacted.	2028

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale	Timing
1.4	Yangebup Lake boardwalk	Yangebup West	Investigate the feasibility of a boardwalk on the lake edge including furniture and interpretation. Boardwalk construction would include extensive consultation with the Aboriginal community and options rather than piling should be considered such as floating or suspended structure to avoid disturbance of the lake bed.	There is limited access to the water on the south-western side of Yangebup Lake and universal access opportunity exists here.	2029
1.5	Gull Way playground	Yangebup West	Upgrade furniture and surfaces to provide universal access to all areas surrounding play equipment.	Playground has recent upgrades, however universal access for play area and furniture is compromised by surface treatments and level changes. Improvements to play ground and surrounds including access and soft landscape treatments.	2023
1.6	Mudlark Way playground	Yangebup West	Upgrade furniture and surfaces to provide universal access to all areas surrounding play equipment.	Playground has recent upgrades, however universal access for play area and furniture is compromised by surface treatments and level changes. Improvements to play ground and surrounds including access and soft landscape treatments	2024
1.7	Grassbird Loop playground	Little Rush Lake	Upgrade the local playground with proprietary and nature play elements to the City's standard local park provision. Ensure universal access to play area and furniture.	Playground has reached end of functional life and is in disrepair including surrounding surfaces and furniture. Provide upgrades to the playground in accordance with the City's open space provision standards.	2023
1.8	Former Jandakot Cement Works	Little Rush Lake	Provide recreational destination such as urban bike park, shade shelters and furniture in the degraded area. Provide visibility from North Lake Road and coordinate works with Water Corporation sewer works in the area. Undertake detailed consultation prior to any construction and fence the facility from bushland areas ensuring access is from dual use paths only.	Site is a large environmentally-degraded area that has potential for recreational use such as an urban bike trail area. Repurpose the degraded area of the former depot site for recreational use in combination with weed control and revegetation. The area has a proposed sewer line to be installed by Water Corporation in the near future.	2022
1.9	Davison Homestead Park	Yangebup East	Provide a passive recreational activity node including amenities, barbeque, shelter and formalised parking. Design to reference the old homestead and existing avenue of Jacarandas. Include interpretive walk and signage on nutrient stripping basin.	Opportunity for an activity node with passive recreational amenities including parking and picnic facilities. The area is significant due to the Davison Homestead that was situated there and the terminus of the tramways trail. Improve usage of the eastern corner of Yangebup reserve by providing increased amenity capitalising on the existing homestead trees, Tramways Trail terminus and the biofiltration initiatives near the lake.	2020

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale	Timing
1.10	Living stream bird hide	Yangebup East	Install boardwalk and path connection to existing bird hide.	Opportunity to provide connection to the water on the eastern side of the lake connected to biofiltration, living stream elements and recently installed bird hide.	2024
1.11	Eastern entry node	Yangebup East	Provide upgrades to eastern entry including seating, paving and landscape treatments. Incorporate wayfinding and interpretation signage elements.	Eastern reserve entry is uninviting and has low amenity. There is potential to encourage use by nearby workers on lunch breaks during weekdays by providing some amenity such as seating and landscaping to create an inviting entry environment at Yangebup Road east.	2027
1.12	Pathway seating	All	Provide seating with backs, armrests and concrete bases level to adjacent surfaces at frequent rest points throughout the Reserves at maximum 200 metre distance apart. Replace all existing bench seats and site in close proximity to paths ensuring universal access. Provide additional informal seating opportunities such as salvaged logs alongside paths and at recreation nodes.	There is minimal seating providing rest-points along pathways throughout the Reserves reducing the potential for visitation by people of all abilities. In addition, the concrete slabs at the base of existing bench seats are typically higher then surrounding surfaces. Some bench seats don't have armrests making them difficult for elderly users. Provide seating at frequent rest-points along pathways throughout the Reserves at maximum 200 metre distance apart located with consideration of alignment to the path, views and pathway intersections.	2021
2.0	Access and Circulation				
2.1	Yangebup Road parking area	Yangebup West	Formalise parking at Yangebup Road Terminus in accordance with Lot 8 Design.	Parking area at the terminus of Yangebup Road that provides for school and church in addition to reserve users. Provide formalised parking with water sensitive urban design treatments that are aligned with water quality improvements at the reserve.	2020
2.2	Davison Homestead parking area	Yangebup East	Formalise parking in tandem with development of the Davison Homestead Park.	Parking is currently informal within the cul-de-sac at the eastern terminus of Parkes Street. Provide formalised parking with water sensitive urban design treatments that are aligned with water quality improvements at the reserve.	2020
2.3	Osprey Drive parking area	Yangebup East	Provide formalised parking at Osprey Drive entry.	Informal parking area not clearly defined. Provide formalised parking with water sensitive urban design treatments that are aligned with water quality improvements at the reserve.	2021

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale	Timing
2.4	Little Rush Lake parking area	Little Rush Lake	Provide formalised parking in Parkes Road reserve with access from North Lake Road.	Little Rush Lake reserve has no designated parking area. Improve parking for the Little Rush Lake. Provide formalised parking with water sensitive urban design treatments that are aligned with water quality improvements at the reserve.	2022
2.5	Shared path upgrade, west	Yangebup West	Replace shared path with 2.5m wide asphalt path to allow for pedestrian and cycle traffic.	Existing shared path surface is in disrepair in areas and will need replacement and upgrade in coming years. Provide an asphalt shared path that meets the requirements of users and management. Adjust junctions and intersections to provide legible connections and minimise damage to surrounding areas.	2024
2.6	Shared path upgrade, north	Little Rush Lake	Replace shared path with 2.5m wide asphalt path to allow for pedestrian and cycle traffic.	Existing shared path surface is in disrepair in areas and will need replacement and upgrade in coming years. Provide an asphalt shared path that meets the requirements of users and management. Adjust junctions and intersections to provide legible connections and minimise damage to surrounding areas.	2025
2.7	Shared path upgrade, east	Yangebup East	Replace shared path with 2.5m wide asphalt path to allow for pedestrian and cycle traffic.	Existing shared path surface is in disrepair in areas and will need replacement and upgrade in coming years. Provide an asphalt shared path that meets the requirements of users and management. Adjust junctions and intersections to provide legible connections and minimise damage to surrounding areas	2023
2.8	Shared path upgrade, south	Yangebup South	Replace shared path with 3m wide red asphalt path between Yangebup Road car park and Tamara Drive. Encourage commuter cycling connection between Yangebup and Cockburn Central. Install new accessible seating at regular intervals of approximately 200m, face towards view where possible.	Existing shared path surface is in disrepair in areas and will need replacement and upgrade in coming years. Provide an asphalt shared path that meets the requirements of users and management. Adjust junctions and intersections to provide legible connections and minimise damage to surrounding areas. Provide 3m width to allow for commuter traffic between Yangebup and Cockburn Central West.	2020
2.9	Parkes Street shared path, north	Parkes Street reserve	Provide 3m wide red asphalt shared path along Parkes Street reserve with Osprey Drive crossing connections and landscaping.	Opportunity to extend the Parkes Street reserve between Osprey Drive and the North Lake Road pedestrian crossing to improve activation, passive surveillance and connectivity. Improve the regional shared path connection on Parkes Street and activation of the reserve's eastern side. Consider improvements to pedestrian access from South Lake across North Lake Road.	2026

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale	Timing
2.10	Parkes Street shared path, east	Parkes Street reserve	Provide 3m wide red asphalt shared path between North Lake Road and Parkes Street using the existing alignment wherever possible and realign reserve boundary fence to be on inside of the path alignment.	Existing shared path on North Lake Road is disconnected from the shared path on Parkes Street. Opportunity to provide a shared path connections between Cockburn Central and Bibra Lake. Improve the regional shared path connection on Parkes Street and recreational activity of the reserve's eastern side.	2026
2.11	Osprey Drive entry environment	Parkes Street reserve	Upgrade verge landscape treatments and shared path crossing, landscape treatments for the existing sump and grassing of the Osprey Drive northern verge.	Opportunity to improve Yangebup's eastern entry environment at the intersection of Osprey Drive and North Lake Road including landscape treatments, and consideration of pedestrian and cycle crossing point. Improve the intersection with landscape treatments and water sensitive urban design of the existing sump. Consider landmark public art to be integrated with the design.	2021
2.12	New bushland/ lake path	Yangebup West	Provide a 2.5m wide unsealed path alongside the lake for pedestrian use.	Legibility of the connection between the western shared path and Osprey Drive could be improved to encourage pedestrian movement into eastern side of the Yangebup reserve.	2027
2.13	Osprey Drive new crossing	Yangebup West	Provide a pedestrian and cycle connection with refuge island mid-way along Osprey Drive. Upgrade to be implemented if the former cement works is developed as a recreational destination.	Opportunity to improve pedestrian/cycle connection between Yangebup and Little Rush Lakes with a mid-point crossing of Osprey Drive. Note: more applicable if the former cement works becomes a recreation destination which would benefit from a more direct route to Yangebup.	2025
2.14	Unsealed track, Pioneer Drive	Yangebup West	Inspect tracks and repair damage caused by erosion, compaction, scouring and waterlogging.	Erosion and sand from surrounding areas has spread across the path and made conditions boggy.	2027
2.15	Unsealed tracks, south	South	Inspect tracks and repair damage caused by erosion, compaction, scouring and waterlogging. Remove duplicate tracks and rehabilitate.	Track surfaces in southern areas have become degraded by erosion. Tracks are used by management and for walking.	2027
2.16	Chicane entries (reserve-wide)	All	Adjust chicanes to allow entry for all reserve users. Consider redesign of entry barriers.	Chicanes at reserve entry points are uninviting and deter access of some users including cyclists and disabled users.	2023
2.17	Maintenance access gates (reserve-wide)	All	Review maintenance gate locations and adjust during upgrades to parking.	Gate, signage and fencing present uninviting entry points to the Reserves where combined with public access.	2023

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale	Timing
2.18	Living stream bridge crossing	Yangebup East	Upgrade bridge to be suitable for maintenance vehicle access. Relocate existing bridge to a point further along the living stream closer to the lake as part of the pedestrian loop to the new bird hide. The new upgraded bridge should also be iconic such as a key stone design to act as a focal point for visitors.	Existing bridge is not suitable for maintenance vehicle access needed in the biofiltration areas.	2024
2.19	Tamara Drive footpath	Yangebup East	Install tree plantings and revegetation in the verge using endemic native tree species. Allow for views of the lake and rest points at key locations. Consider installation of chain-link fencing along kerb line of path to provide a safety barrier for young users based on example at Progress Drive Bibra Lake.	Footpath along Tamara Drive is located outside of the reserve and is unappealing to pedestrians due to minimal shade and possible risks to young users.	2024
2.20	Grassbird Loop Fence	Little Rush Lake	Replace conservation fencing at Grass Bird Loop perimeter to provide an effective barrier to off-road vehicles	Fence along Grass Bird Loop is in disrepair and is a frequent access point for illegal off-road vehicles.	2020

Item	Element/ Location		Reserve	Recommendation	Description/ Rationale	Item
3.0	Signage, Wayfinding and Interpretation					
3.1	Signage and interpretation plan	All	Develop a signage and interpretation plan for wayfinding that is coordinated with interpretive signage and the City of Cockburn Signage Style Guide.	Signage throughout the Reserves is predominantly regulation and bylaws with minimal user orientation and wayfinding signage present. Improve the reserve's orientation and wayfinding at key locations including entry points and at car parks. Signage plan is to be coordinated with interpretive signage and the City of Cockburn Signage Style Guide.		2021-2025
	Interpretive signage throughout the reserve	All	Provide interpretive signage throughout the Reserves to present themes and stories related to indigenous and historic use, flora, fauna and environmental initiatives at places of interest. Connect with educational opportunities for local schools.	Much of the reserve's interpretive signage has reached the end of its useful lifespan and needs replacement. Signage is weathered, vandalised and content is illegible. Rejuvenate interpretive signage throughout the Reserves with a new signage suite displaying existing themes and stories in addition to newly developed ones.		2021-2025
	Existing signage at entry points	All	Consolidate by-law and regulatory signage as part of the signage strategy. Minimise potential for further additional signs.	Bylaw and regulation signage are located at entry points resulting in 'sign clutter' and contributing to unwelcoming entry environments.		2021-2025
	Signage at entry points and car parks	All	Provide signage with maps showing locations at key entry points and car parks. Large signs to be located at car parks and medium signs at other entry points.	Wayfinding and orientation poorly defined at current entry points and parking locations. Provide signage that orients users at key entry points and car parks.		2021-2025

Item	Element/ Location		Reserve	Recommendation	Description/ Rationale	Item
	Universal design principles	All	Provide signage developed with universal design principles including potential use of QR code information for mobile technology.	Conventional signage is not accessible for some disabled reserve users. Provide signage that is compliant with DDA and universal access standards.		2021-2025
	Regional pedestrian and cycle network	All	Provide signage for regional routes and destinations in accordance with Travel Smart and Department of Transport classifications for the City.	Regional pedestrian/ cycle routes and destinations are not well known. Provide signage that informs users of regional routes and destinations.		2021-2025
3.2	Online information	All	Update Explore Cockburn information for online information about destinations and attractions at the reserves.	Explore Cockburn' has information regarding cultural and natural attractions of the area. Include upgrades and improvements at the Reserves on the City's online information site Explore Cockburn.		2021-2025
3.3	Yangebup Revitalisation Plan Fitness Loops	Yangebup West/ East/ South	Add ground graphic distance markers for Yangebup Lake fitness loops on path.	Fitness loops not defined in reserve. Use fitness loops identified in the Yangebup Revitalisation Strategy to define running and walking circuit around Yangebup Lake.		2021-2025
3.50	Existing artwork signage	Little Rush Lake/ Yangebup East	Relocate and refurbish existing artwork signage to be 1m from shared path to ensure signage can be read.	Existing artwork signage is located too far from the path for passers-by to read.		2020
4.0	Public Artwork					
4.1	Public artwork on western side of Yangebup Lake	Yangebup West	Undertake public artwork at key locations on western side of lake i.e. entry points and playgrounds.	No public artwork is located on the western side of Yangebup Lake. Identify opportunities and locations for public artwork by established artists and community that can implemented on the western side of the lake.		2025

Item	Element/ Location		Reserve	Recommendation	Description/ Rationale	Item
4.2	Former Jandakot Cement Works	Little Rush Lake	Include public artwork that explore former use of the reserve in development of the recreational use. Consider artworks from established artists and community sources such as school students.	There is an opportunity for public artwork if the area is developed for recreation purpose. Implement possible public artwork(s) that explore former use of the reserve and new recreational uses.		2024
4.3	Parkes Street reserve	Parkes Street reserve	Provide interpretive elements and public artwork along Parkes Street shared path when installed.	The former railway alignment that supplied local homesteads is historically relevant and an opportunity for an artwork/ interpretation. Celebrate former railway alignment along Parkes Street reserve.		2027
4.4	Tramways terminus	Yangebup East	Include artwork at the Tramways terminus in the Davison Park site.	The tramways trail is a regional trail link with historic significance		2023
4.5	Osprey Drive Entry	Parkes Street reserve	Commission a landmark public artwork for the intersection to be installed during upgrades to the Osprey Drive entry environment	The Osprey Drive and North Lake Road is a highly visible entry to Yangebup. Capitalise on the intersection with a landmark public art work in the Parkes Street reserve as part of upgrades for the entry environment.		2021

Table 2 Master plan recommendations for Recreational infrastructure in the reserves

8.3 Environmental Management Recommendations

The following table presents the master plan recommendations for environmental management of the reserves. Recommendations are either at specific locations or Reserve Wide (RW). Refer to Appendix 01: Master Plan Concept for locations.

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale
1.0	Weed Management			
1.1	Weed control (Reserve-wide)	All	Undertake weed control in accordance with the City of Cockburn Natural Areas Management Strategy.	Weeds are prevalent in areas throughout the Reserve and a weed management strategy, aligned with current practices in the Reserve needs to be developed. Continue weed control activities targeting priority weed species and preventing rehabilitation areas being re-invaded while native vegetation is established through revegetation strategy.
1.2	Weeds in fire-affected area	Yangebup West	Undertake weed control in fire affected areas.	Substantial grassy weeds in fire affected areas of the Banksia woodland alongside Pioneer Drive. Reduce weed loads in areas with minimal overstorey cover due to recent fires.
1.3	Little Rush Lake weed control	Little Rush Lake	Continue treatment for Amazon Frogbit and other aquatic weed species in Little Rush Lake.	Amazon Frogbit (*Limnobium laevigatum)* infestation has been found in water body and treated. Remove Amazon Frogbit infestation from Little Rush Lake.
1.4	Grasses in bushland areas	Little Rush Lake	Undertake weed control of grass infestations in bushland areas in tandem with revegetation programme to minimise reinfestation and maintain fauna habitat value.	South eastern corner of little Rush Lake Reserve and Parkes Street road Reserve around the former cement works have significant grass weed infestations affecting bushland and increasing bushfire fuel loads. Reduce grass species infestations from bushland areas and undertake revegetation with local native plant species in a managed approach.
1.5	Weed management monitoring (Reserve-wide)	All	Ongoing monitoring in accordance with City management procedures to determine what weed species are present and map the location and distribution of weed species.	Monitor weed management to confirm where successful.
2.0	Revegetation			
2.1	Revegetation plan (Reserve wide)	All	Undertake revegetation in accordance with the City's Natural Areas Management Strategy using management zones defined in this report.	Vegetation is in varying condition throughout the Reserves. Rehabilitation is required to enhance vegetation and create habitat
2.2	Acacia saligna groves	Yangebup West	Provide revegetation planting to western side of shared path including overstorey and groundcover vegetation.	Mature *Acacia saligna* beside the shared path are reaching end of life span with minimal understorey or succession overstorey species. Revegetate areas alongside the shared path to provide habitat, shade and amenity.
2.3	Former Jandakot Cement Works	Little Rush Lake	Revegetate areas of site in conjunction with design for recreational use. Provide amenity plantings for shade in addition to creating habitat.	Extensively modified landscape due to former industrial use. Consider opportunity to rehabilitate/ revegetate the area in conjunction with new recreational use.

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale
2.4	Duplicate access tracks	Yangebup South	Revegetate duplicate access track.	Duplicate track is not required and reduces the environmental values of the area
2.5	Revegetation monitoring (Reserve wide)	All	Ongoing monitoring in accordance with City management procedures.	Understanding of revegetation programme effectiveness is required to inform ongoing development of the plan's aims and objectives. Monitor revegetation areas to confirm success of planting and additional management requirements.
3.0	Fire Management and Emergency Access			
3.1	Fire management (Reserve wide)	All	Manage fuel loads through weed reduction and revegetation plan. Regularly update Fire Response Plans	To minimise the risk of bush fire in the Reserves and allow for the protection of life, property and environment by emergency services.
	Fuel load management (Reserve wide)	All	Remove fuel sources such as weeds from the Reserves to reduce risk of fire spreading, especially near to adjacent properties. Due to size of Reserve 'cool burns' should be considered where weed loads can be reduced and funding is available for 2 years intensive weed control	Significant fuel loads are generated from annual grass weed species growing throughout lower condition areas of the Reserve.
3.2	Emergency vehicle access (Reserve wide)	All	Maintain conditions of the Reserve's perimeter and internal fire breaks.	Emergency vehicle access required to all areas in the event of a bushfire for response to endangerment and containment of fire spread. Maintain fire breaks suitable for a maintenance vehicle or 'fast attack' appliance (light tanker).
4.0	Water Quality and Drainage			
4.1	Yangebup Lake biofiltration	Yangebup East	Continue biofiltration work at living stream locations. Provide vehicle access for future harvesting of plant biomass.	Biofiltration channels and basins use wetland plant species to filter nutrients from Yangebup Lake. Harvest and replant biofiltration areas at 2 year intervals. Basin and surrounding access design to facilitate harvesting of plant biomass.
4.2	Jandakot Drain biofiltration	Yangebup South	Work with Water Corporation to retrofit existing outlet to allow water treatment before water enters the lake. Site with perimeter chain-link fence is a possible treatment site.	The South Jandakot Drainage Scheme discharges directly into Yangebup Lake without treatment. Provide a treatment train for water entering the lake, including a biofiltration area in the existing sump connected to Yangebup Lake.
4.3	Beeliar Drive runoff erosion	Yangebup South	Provide erosion control to Beeliar Drive batters including planting and longitudinal swale channel at base of embankment.	Runoff from the Beeliar Drive batters causing erosion depositing sand/ soil in the Reserve. Resolve runoff and erosion caused by Beeliar Drive batters.
4.4	Shared path runoff infiltration	Yangebup South	Install a landscaped basin at the base of the shared path to harvest storm water runoff from path providing infiltration and visual amenity.	Significant erosion is occuring at the bottom of the shared path from Yangebup Road to the lake shared path. Develop runoff capture point at base of shared path as a swale.

Item	Element/ Location	Reserve	Recommendation	Description/ Rationale
4.5	Nuisance Midge	Yangebup West	Undertake actions as identified in the Integrated Midge Control Strategy.	Nuisance midge affect some homes on the western side of Yangebup Lake. Reduce impact of nuisance midge on Yangebup residents living near to the lakes.
4.6	Yangebup Lake Water Quality Monitoring	All	Ongoing monitoring in accordance with City management procedures.	Ongoing water quality monitoring. Check water quality on a regular ongoing basis to monitor nutrients and contaminants and to check progress of management actions.
4.7	Little Rush Lake Water Quality Monitoring	All	Ongoing monitoring in accordance with City management procedures.	Ongoing water quality monitoring. Check water quality on a regular ongoing basis to monitor nutrients and contaminants to check progress of management actions.
5.0	Fauna			
5.1	Osprey Drive new fauna overpass	Little Rush Lake /Yangebup West	Install fauna overpass across Osprey Drive to allow possums to cross safely.	No canopy connections exist for tree dwelling fauna to cross safely across the Osprey Drive road reserve. Provide for tree climbing fauna, such as possums, to cross Osprey Drive safely.
5.2	Osprey Drive new fauna underpass	Little Rush Lake /Yangebup West	Install new culvert type fauna underpass with landscape habitat treatments to provide shelter and direct fauna to underpass entry points.	No fauna underpass exists on western end of Osprey Drive reducing opportunities for fauna to cross between the reserves. Provide underpass access beneath Osprey Drive to connect the Reserves.
5.3	Beeliar Drive fauna underpass	Yangebup South	Reinstate and upgrade fauna underpass at Beeliar Road and consider landscape treatments to improve habitat at entry points.	Fauna underpass to Lake Kogolup has been buried by road batter sand and is not accessible for turtles. Provide underpass access at Beeliar Drive to connect Yangebup Lake to Kogolup Lake bushland reserve.
5.4	Beeliar Drive fauna bridge	Yangebup South	Undertake monitoring of fauna overpass for use by wildlife.	Fauna overpass installed across Beeliar Drive
5.5	Bat and bird boxes	All	Install additional bat and bird boxes in suitable locations away from predators and disturbance. Box design should be such as to deter colonisation by bees.	Bat and Bird box provide additional nesting locations in the Reserve to make up for loss of trees with appropriate nesting hollows.
5.6	Fox and cat control	All	Continue to undertake feral animal control in both reserves. Continue investigation of cat control zones in the reserves	Foxes and cats (free ranging domestic) are predators affecting a range of native mammal, bird and reptile species. Manage foxes and cats coming into the Reserves.
5.7	European Bee control	All	Remove hives from the Reserve using the City's standard management procedures.	Invasive European Honey Bees can displace native bird species through the construction of hives in and around nesting hollows. Keep the Reserve bushland free from European Honey Bee colonisation.

Table 3 Master plan recommendations for environmental management of the reserves

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Report Appendices