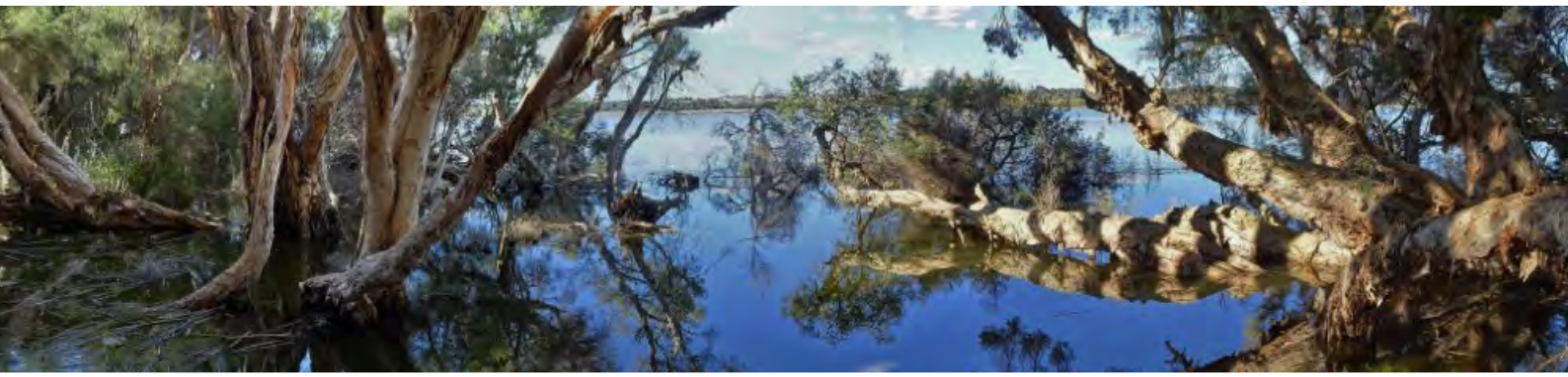
Yellagonga Integrated Catchment Management Plan 2021–2026











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Lake Joondalup

CONTENTS

CONTENTS 3

ABBREVIATIONS 4

EXECUTIVE SUMMARY 5

1.0 INTRODUCTION 7

1.1 Yellagonga Regional Park 7

1.2 Background 10

1.3 Yellagonga Integrated Catchment Management Plan 2021-2026 10

1.4 Strategic Context 11

2.0 YELLAGONGA CATCHMENT AREA 12

2.1 Introduction 12

2.2 Hydrology 12

2.3 Water Quality 20

2.4 Biodiversity 21

2.5 Threatening Processes 25

3.0 IMPLEMENTATION PLAN 36

3.1 Key Focus Areas 36

3.2 YICM Plan 2021-2026 Projects 37

3.3 Reporting and Review 38

4.0 PROJECT DETAILS 39

4.1 Joint Projects 39

4.2 Individual Projects 46

5.0 REFERENCES 56

Appendix 1 – Key Achievements of the YICM Plan 2015-2019 59

Appendix 2 – Strategic Context 63

ABBREVIATIONS

ASS	Acid Sulphate Soils
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
CoJ	City of Joondalup
CoW	City of Wanneroo
DBCA	Department of Biodiversity, Conservation and Attractions
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
ECU	Edith Cowan University
EPBC Act	*Environment Protection and Biodiversity Act 1999*
WAPC	Western Australian Planning Commission
YICM	Yellagonga Integrated Catchment Management
YRPM	Yellagonga Regional Park Management

EXECUTIVE SUMMARY

Yellagonga Regional Park is one of seven regional parks within the Swan Coastal Plain and is located approximately 20km north of Perth. Yellagonga Regional Park consists of a wetland chain including, from north to south, Lake Joondalup, Beenyup Swamp, Walluburnup Swamp and Lake Goollelal. The Yellagonga Regional Park is an area of high ecological significance including being a Bush Forever site, having Conservation Category Wetlands, and Lake Joondalup is also a Class 'A' Reserve.

The Yellagonga Regional Park is jointly managed by the Department of Biodiversity Conservation and Attractions (DBCA), and the Cities of Joondalup (CoJ) and Wanneroo (CoW); with the DBCA being responsible for the management of the majority of the land within the Park. Land tenure is also vested with the Conservation Commission of Western Australia, the Western Australian Planning Commission, with small sections owned by private landholders; particularly within the southern extent of the Park (see Figure 2).

The Park's co-managers, the DBCA, CoJ and the CoW recognise that land use practices in the surrounding catchment, from both past and present activities, can have detrimental effects on the wetlands of the Yellagonga Regional Park, and it is the shared responsibility of the co-managers to address the threats impacting the health of the Yellagonga Catchment Area. Impacts include water quality and quantity entering the wetlands, and threats to the ecological integrity and biodiversity of the Park.

In order to maintain and enhance the amenity, recreational, educational, scientific, and conservation values of Yellagonga Regional Park, for present and future generations, the *Yellagonga Integrated Catchment Management Plan (YICM Plan)* was developed to provide a comprehensive and integrated approach to managing the Park and its catchment.

The *YICM Plan* has continued to provide strategic direction for the two Cities to implement a wide range of initiatives within the catchment of the Park aimed to conserve the ecological values of the Yellagonga Regional Park. Since the *YICM Plan's* initial adoption by both Cities in 2009, the Plan was reviewed, updated and adopted again in 2015 to provide the *YICM Plan 2015-2019*.

The latest review and update provides for the current *YICM Plan 2021-2026*, a five-year life span allows for a comprehensive review of management actions, conservation outcomes and to assess current impacts and threats to the Yellagonga catchment. The review was undertaken in consultation with internal and external stakeholders, including the Yellagonga Regional Park Community Advisory Committee. The updated *YICM Plan* focuses on the management of key threats to the health of the Yellagonga wetlands in response to current environmental conditions, whilst building upon the knowledge gained through the implementation of the previous versions of the Plan.

Extensive historical and technical information regarding the Yellagonga Catchment can be found in the *YICM Plan 2009-2014 Part 1 Technical Report*.

A range of threats to the long-term viability of Yellagonga Regional Park remain, including the drying climate trend, poor water quality, invasive flora and fauna species, bushfires, plant pathogens and their spread, urban encroachment, remaining traditional stormwater drainage, habitat degradation and fragmentation. A potential threat to Lake Joondalup is water level rises. Lake Joondalup has a natural wetting drying cycle and permanent inundation from increased water levels poses a threat to those aspects of wetland ecology dependent on regular drying periods. This threat depends on climate change and activities which have the potential to affect ground water levels, such as the East Wanneroo development, and overland flow. The projects within the *YICM Plan* aim to address these threats.

Significant progress has been achieved over the past five years through the *YICM Plan 2015-2019* to address the key threats to the Park. Key achievements include:

- Ongoing water quality monitoring, which has produced reliable, long term water quality data for the catchment.
- The delivery of wide-ranging community education activities and initiatives.
- Coordinated pest animal control and conservation maintenance schedules.
- The completion of flora surveys for 278 hectares of remnant vegetation within the Park that have informed rehabilitation projects in key locations.
- Revegetation works in areas identified through the flora surveys.

This updated Plan aims to build upon the extensive monitoring and conservation management work undertaken in the Yellagonga catchment through the continued collaboration between the two Cities and the DBCA. The *Yellagonga Integrated Catchment Management Plan 2021-2026* provides the Park's co-managers with detailed direction required to manage the catchment in a sustainable manner to ensure the long-term protection of the Park for future generations.

The YICM Plan 2021-2026 will be implemented by the CoJ and CoW in partnership with the Yellagonga Regional Park key land manager, the DBCA.



Waterbirds, Yellagonga Regional Park

1.0 INTRODUCTION

1.1 Yellagonga Regional Park

Yellagonga Regional Park is one of seven Regional Parks within the Swan Coastal Plain and lies approximately 20km north of the Perth CBD. The Park is highly utilised for a diverse range of activities including exercise, social and family gatherings at the various landscaped parks and play spaces, its intrinsic environmental values and associated activities such as birdwatching, wildflower spotting, and photography.

The Park holds considerable cultural significance for the Mooro Noongar people as a place of hunting, gathering, social, ceremonial and recreational purposes, with the Park named after Yellagonga; who was a leader of the Wadjuk Noongar people North of the Swan River.[2] The location of the wetlands made them an important site in seasonal camping cycles between the ocean and the Perth foothills, and between Mount Eliza (King's Park) in Perth and the Moore River to the North, part of which now forms the Yaberoo Budjara Heritage Trail starting at Neil Hawkins Park in the Park.[1]

The eastern side of the Park was first settled by Europeans around 1850 and there are three sites listed on the State Register of Heritage Places: Perry's Paddock, Cockman House, and Luisini Winery. The Sorrento to Dongara Stock Route, gazetted in 1889, ran through the park following the track used by Yellagonga's people in their journeys to the north.[1]

In order to maintain and enhance amenity, recreational, scientific, educational and conservation values of the Park for present and future generations, an integrated catchment approach has been undertaken to provide a comprehensive and integrated approach to managing the Park and its catchment.

1.1.1 Yellagonga Catchment

All water bodies, whether a wetland, lake or river, receive water from the surrounding area. This area from which water flows into the water body is known as the catchment. Effective management of a water body requires management of the surrounding catchment. Integrated catchment management is about balancing use of the land, water and biological resources within a catchment, in a sustainable manner, by encouraging co-operation and co-ordination at all levels of government, in collaboration with the whole community on management of these resources.[1]

The Park consists of a wetland chain including, from north to south, Lake Joondalup, Beenyup Swamp, Walluburnup Swamp and Lake Goollelal which are all recognised as being Conservation Category Wetlands with Lake Joondalup also being a Class 'A' Reserve.[1] By taking an integrated catchment management approach to these wetlands, the CoJ, the CoW and the DBCA recognise that activities outside of their respective management areas will impact on the ecological integrity and biodiversity of the Park and the wetlands holistically, particularly through the movement of groundwater, surface water and stormwater.

Any land use within the catchment will impact to some extent on the quality and quantity of water entering the Park's wetlands, as well as impacting on flora and fauna communities within the Park. The catchment has a diverse range of current land uses comprised of residential developments, market gardens, aged care, grassland, orchards, poultry farms, horse agistment, pine tree lots, plant nurseries and various commercial developments (car yards, service stations, shopping centres etc.), all of which can impact on the Park.

[1] CALM *et al.* (2003)
[2] McGuire, M. I. (1996)



Figure 1 Location of the Yellagonga Regional Park[1]

The health of the Park and its wetlands is of high importance to both the local and wider communities as well as the stakeholders and organisations responsible for the management of the Park. The Park is identified as having significant regional value, particularly for:

- Providing habitat for flora and fauna including iconic local species such as the South-western Snake-necked Turtle *(Chelodina colliei)*, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris)* and Quenda *(Isoodon fusciventer)*.
- A Bush Forever site (299) registered by the Western Australian Planning Commission as containing regionally significant vegetation.
- Improving ecological function such as air quality, carbon capture, and soil health.
- Decreasing erosion, salinity, water pollution and noise pollution.
- Providing opportunity for recreational and cultural experiences.

In order to maintain and enhance amenity, recreational, scientific, educational and conservation values of the Park for present and future generations, an integrated catchment approach has been undertaken to provide a comprehensive and integrated approach to managing the Park.

1.1.2 Yellagonga Regional Park Tenure and Management Arrangements

The Yellagonga Regional Park is composed of land that is owned and managed by a number of different bodies. Lands owned by the Western Australia Planning Commission, those vested in the Conservation Commission of Western Australia, and Unallocated Crown Land are managed by the DBCA, with the CoJ and CoW having management orders over small areas of Crown Land within the Park; predominantly areas designated for recreation. There is also a small portion of land that remains privately owned with individual landholders responsible for the management of their own property.[3] The lakes themselves are managed by the DBCA.

Areas directly managed by the City of Joondalup equate to 13 hectares (ha). These include Neil Hawkins Park (4.2ha), Neil Hawkins Natural Area (4.7ha), and Picnic Cove Park (4.1ha).

Areas directly managed by the City of Wanneroo equate to approximately 50ha. These include Studmaster Park (2ha), Poinciana Park (2.5ha), Ariti Ave Foreshore (1.5ha), Scenic Park (10 ha), Rotary Park (6.5ha), Banyandah Park and Foreshore Reserve (7.8ha), and Lake Joondalup Foreshore Reserve North of Rotary Park (17.3ha).

The balance of land is managed by the DBCA.

While the land tenure for the Park is varied (see Figure 2), the management of the Park is shared by the DBCA and the Cities of Joondalup and Wanneroo in line with the *Yellagonga Regional Park Management (YRPM) Plan 2003-2013*. Effective environmental management requires working beyond management borders to address the threats to the Park holistically. Management actions throughout the Park must be undertaken in a coordinated approach with the Cities working together with the DBCA to undertake work on land managed by the DBCA, in addition to the land where the Cities possess management orders.

There are also a number of community groups, including conservation groups, who contribute to the on-ground management of the Park, in particular the Friends of Yellagonga Regional Park and the Woodvale Waters Friends of Beenyup Channel Group.

[3] CALM *et al.* (2003)

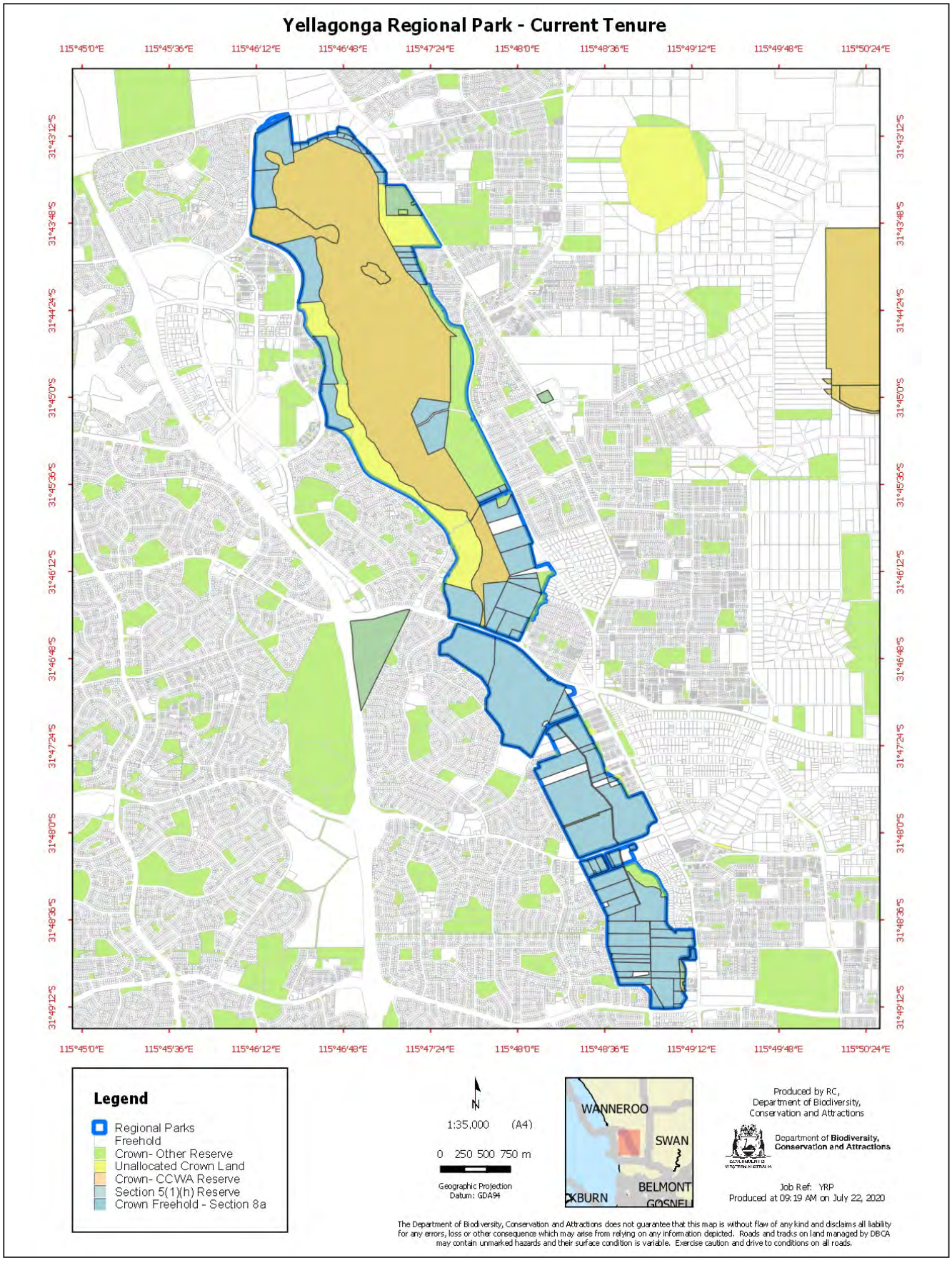


Figure 2 Land Tenure in Yellagonga Regional Park (DBCA 2020)

1.2 Background

This *Yellagonga Integrated Catchment Management Plan 2021-2026* has been developed within the context of the *Yellagonga Regional Park Management Plan 2003-2013* as well as the previous two versions of the *YICM Plan 2009-2014* and *YICM Plan 2015-2019*. The sections below provide background information on these previous plans and how they relate to the current *YICM Plan 2021-2026*.

1.2.1 Yellagonga Regional Park Management Plan 2003-2013

The *YRPM Plan 2003-2013* was developed by the then Department of Conservation and Land Management (CALM, now DBCA) with input from the CoJ and the CoW, "to provide broad direction for the protection and enhancement of the conservation, recreation and landscape values of Yellagonga Regional Park". One of the 'High Priority' strategies proposed in the Management Plan was the preparation of an integrated catchment management plan which was to be consistent with the overall direction of the *YRPM Plan 2003-2013*.[4]

The *YICM Plan 2021-2026* addresses the activities being undertaken within the catchment that affect the Park, while the management of the Park itself is guided by the *YRPM Plan 2003-2013*.

The *YRPM Plan 2003-2013* is still considered current in its content and management strategies and therefore is still being utilised to guide the management of the Yellagonga Regional Park.

1.2.2 Yellagonga Integrated Catchment Management Plan 2009-2014

The development of the initial *YICM Plan 2009-2014* and associated catchment management projects was initiated through a Partnership Agreement between the CoJ and the CoW who jointly funded the project and involved considerable input from the community and key stakeholders. This included two community workshops and the establishment and involvement of a Community Reference Group and a Technical Working Group. Key stakeholders included Friends of Yellagonga, Edith Cowan University, the then Department of Environment and Conservation (now DBCA) and the then Department of Water (now Department of Water and Environmental Regulation - DWER).

The *YICM Plan 2009-2014* comprised of two parts. Part 1: A technical report on the research and information collected during the two-year planning process and provided an assessment of the health of the Park and the catchment area. Part 2: An Implementation Plan and included 18 projects to be implemented within the catchment over the life of the Plan, to mitigate the key threatening processes and issues identified within the Yellagonga Regional Park.

Substantial progress was made in implementing the *YICM Plan 2009-2014* which resulted in the continued implementation of the updated *YICM Plan 2015-2019*.

1.2.3 Yellagonga Integrated Catchment Management Plan 2015-2019

Following the implementation and review of the *YICM Plan 2009-2014* an updated Plan to guide management of the Yellagonga Catchment was developed. The *YICM Plan 2015-2019* built upon the progress made during implementation of the first Plan and provided further management recommendations to ensure the long-term protection of the Yellagonga Regional Park with a focus on addressing the current and future impacts of climate change. Key highlights of the *YICM Plan 2015-2019* can be found in the Appendices of this document.

1.3 Yellagonga Integrated Catchment Management Plan 2021-2026

The updated *YICM Plan 2021-2026* expands upon the successes and lessons learnt from the previous two Plans by continuing projects that have proven to be of benefit to the health of the wetlands. Projects have been updated where necessary to ensure they remain relevant to the current environmental conditions of the Park and surrounding areas.

The updated Plan ensures the continued collaborative delivery of the projects that have proven to be effective in monitoring and improving the health of the Yellagonga wetlands.

[4] CALM *et al.* (2003) pp.1-2

1.3.1 Aim and Objectives of the Plan

The aim of the *YICM Plan 2021-2026* is to provide a holistic and long-term strategic plan to improve catchment health and protect the diverse values of the Park.

The objectives of the *YICM Plan 2021-2026* are:

Objective 1: To build upon the achievements, experiences and outcomes of the *YICM Plan 2015-2019* and continue to implement an integrated and effective approach to catchment management.

Objective 2: To work in partnership with key stakeholders to improve catchment management and protect and enhance the ecological values of the Yellagonga Regional Park.

Objective 3: Ensure positive environmental, social and economic outcomes for the Yellagonga Regional Park and its wetlands.

Objective 4: Consider the long-term protection of the Yellagonga Regional Park with a focus on addressing the current and future impacts of climate change.

1.3.2 Scope of the Plan

The *YICM Plan 2021-2026* aims to build upon the outcomes of the previous Plan to provide a guide for continuing to implement an integrated catchment management approach for the Yellagonga Catchment Area. As such the *YICM Plan 2021-2026* will:

- Continue to use the outcomes of the original community consultation process and technical review of scientific literature to inform its implementation.
- Provide a brief overview of the Yellagonga Catchment and its environmental condition.
- Outline key achievements from the implementation of the *YICM Plan 2015-2019*.
- Identify new and ongoing projects that continue the integrated catchment management approach.
- Provide opportunity for stakeholder and community input into the delivery of projects within the *YICM Plan 2021-202*6.

Responsibility for implementation of the *YICM Plan 2021-2026* lies primarily with the Cities of Joondalup and Wanneroo. The DBCA is a key partner in the delivery of a number of projects within the Plan that relate to the health of ecosystems within Yellagonga Regional Park. The implementation of the Plan will be more effective if strong partnerships with other government bodies including DBCA, educational institutions and the local community are maintained.

In 2013 the Yellagonga Catchment Working Group, comprising of representatives from the Cities of Joondalup and Wanneroo and the DBCA, was established to assist communications and commitment in working collaboratively on the YICM Plan. The Yellagonga Catchment Working Group focuses on key projects requiring collaboration from the three managing agencies and will continue ensuring the timely and effective implementation of the updated Plan.

1.4 Strategic Context

The management of the Yellagonga catchment and the implementation of the *YICM Plan 2021-2026* needs to consider the strategic context in which it operates including International legislation, Federal policy and legislation, State policy and legislation, Regional policy and local law and policy. Details of the relevant local, State and Federal plans and strategies are provided in Appendix 2.

2.0 YELLAGONGA CATCHMENT AREA

2.1 Introduction

The Park's catchment lies on the Swan Coastal Plain and is located approximately 20km north of central Perth. The surface water catchment area of the Park is estimated to cover an area of approximately 4,000ha.[5] The catchment is linked to the Park by surface flows via drainage infrastructure and groundwater flows. The catchment encompasses land on either side of the Park located in the Cities of Joondalup and Wanneroo and includes medium to high-density residential, commercial and light industrial development interspersed with green areas. Lakes Joondalup and Goollelal, and the swamps Beenyup and Walluburnup, are the receiving aquatic environments for water from this catchment via surface and groundwater flows.

The climate of the Swan Coastal Plain is described as Mediterranean, characterised by long hot dry summers and a shorter period of wet winter months. The annual mean maximum temperature is 24.8°C and the annual mean minimum temperature is 12.8°C. The hottest months are January (average of 31.2°C) and February (average of 31.6°C). The mean annual rainfall is 733.2mm with the wettest months being June (127.8mm) and July (144.5mm).[6] (Data collected from the Perth Airport weather station, from 1944-2019).

Soils and geology of the Perth metropolitan north-west corridor have been described by McArthur and Bartle (1975-1976). They describe the Park and catchment as lying over quaternary deposits known as the Spearwood Dune System, which presents as a low hilly and undulating landscape. The wetlands and surrounding catchment lie predominantly over Spearwood sand with some areas of Karrakatta limestone and Karrakatta sand. The Spearwood sands consist of some limestone outcrops with shallow brown soils and the Karrakatta limestone is characterised by bare limestone or shallow siliceous or calcareous sand over limestone. The Karrakatta sand is yellow, and limestone usually lies beneath this layer.[7]

A brief outline of the features of the Yellagonga Catchment and Regional Park are detailed below. Full details of the key components of the Yellagonga Catchment can be found in the *YICM Plan 2009-2014 Part 1 Technical Report*.

2.2 Hydrology

2.2.1 Groundwater Flow and Levels

Groundwater flows from northeast to southwest across the Swan Coastal Plain towards the Indian Ocean.[8] Inputs into the groundwater from land uses many kilometres to the east could eventually see impacts on the Park's wetlands. While a groundwater catchment boundary has not been fully defined, strategies can still be developed to address potential land use impacts on groundwater particularly given the high groundwater recharge rates found on the Gnangara Mound. The highest recharge rates occur over the Gnangara Mound, and range from 15-20%, reaching as high as 40% of rainfall as total net recharge,[9] which highlights the rapidity that any contaminants from land use over the Gnangara Mound may leach to groundwater.

Steep groundwater gradients occur to the east and west of the lake system and are steepest on the west side of the wetland system, becoming shallow heading west towards the ocean.[10] Given the relatively slow rate of groundwater flow, residence time of groundwater has implications for pollutant concentrations held within the lake systems.

[5] Ove Arup and Partners (1994)
[6] Bureau of Meteorology (2019)
[7] McArthur and Bartle (1975-1976)
[8] Department of Environment (2004)
[9] Department of Water (2008a)
[10] Congdon (1979)

2.2.2 Surface Water

Wetlands on the Swan Coastal Plain are generally surface expressions of an unconfined aquifer with water levels reflecting the rising and falling groundwater levels.[11] In the past, Lakes Joondalup and Goollelal have fluctuated and followed natural cycles of drying and filling, displaying patterns of long-term seasonal fluctuations according to climatic conditions.[12] However, Hamann (1992) suggests the wetlands are not exact surface expressions of the Gnangara groundwater system due to seasonal fluctuations in wetland depth that does not match seasonal changes in the groundwater table. The research has suggested that since urbanisation post 1975, an increasing volume of surface water has entered the wetlands via impervious and cleared surfaces, resulting in deeper lake systems. It is possible that increased overland flow will continue with further land clearing within the Yellagonga Catchment. Changes to the land use, such as urbanisation, within the groundwater and surface water catchment of the Park can also lead to groundwater level rise through increased recharge, reduced evapotranspiration, and reduced groundwater abstraction,[13] which could see water level rises within the Yellagonga wetlands. A drying climate trend however will also impact upon water levels and could lead to reduced surface water expression from groundwater and rainfall. Figure 3 provides an indicative surface water catchment boundary and the three DWER hydrographic subcatchments for the Park.

Surface flow through the Park's wetlands moves from south to north, but, as this habitat is now separated by roads dividing it into three sections; culverts and tunnels have been constructed to enable the surface water flow to mimic the natural hydrological regime. Water drains from Lake Goollelal into Walluburnup Swamp via a culvert under Hocking Road and Whitfords Avenue and flows north into Beenyup Swamp. Ocean Reef Road bisects Lake Joondalup into north and south sections. Flow between the two sections only occurs during the winter months via a culvert. There is no surface outflow from this wetland chain, but outflow occurs via groundwater in an east to west direction.[14]

2.2.3 Drainage

In a natural system, rainfall would infiltrate directly to groundwater with limited overland flow to wetlands. However, urbanisation has resulted in constructed roads and other impervious surfaces with traditional piped drainage networks and altered topography causing a significant alteration to the natural hydrological regime. For the Park's wetlands urbanisation has resulted in increased surface water run-off through drainage networks, bringing with it polluted water.[15]

In the current climate of diminished rainfall, increased evaporation and a reduction in recharge to groundwater, impervious surface contributions can be viewed as vital arterial flows for many wetlands, however the wetland ecology would require uncontaminated water entering the lakes. However, increased surface water run-off could also result in high water levels impacting on the natural wetting-drying cycle.

[11] Allen (1976)
[12] Hamann (1992)
[13] Urbaqua (2021)
[14] Ove Arup and Partners (1994)
[15] Kobryn (2001)

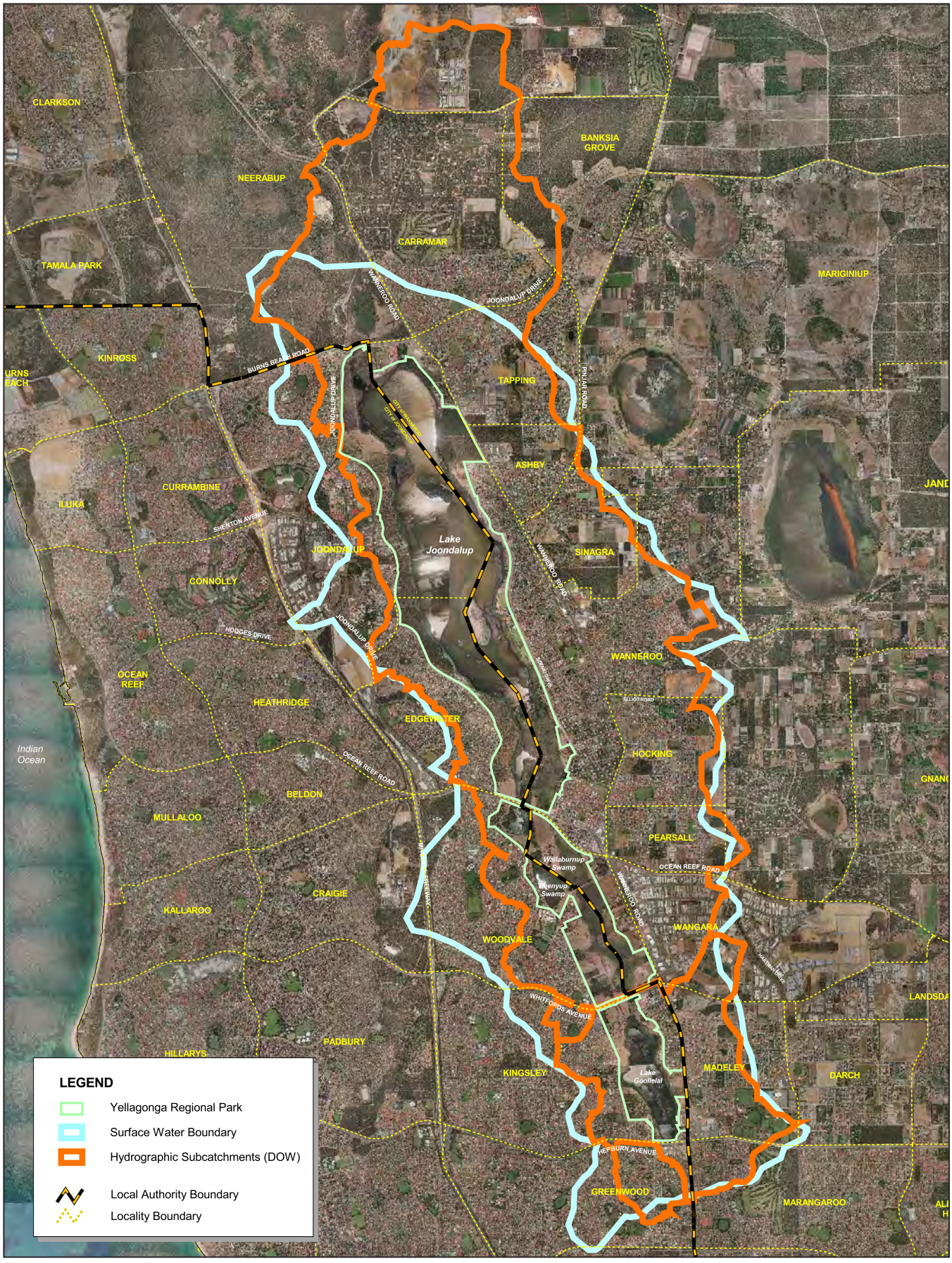


Figure 3 Indicative Surface Water Catchment Boundary 2008

2.2.4 Stormwater Drains

Stormwater drains are known to contribute significant nutrient loads into wetlands. There are 36 drainage outfalls into the Park, including piped outfalls, swales, sumps, and constructed wetlands. The CoW manages 22 drains, and the CoJ manages 14 drains. Main Roads Western Australia also manages drains and sumps along Wanneroo Road. Several of these drains feed directly into CoW drains, which eventually lead into the Park's wetlands.

The CoJ upgraded all outfalls within the City's boundaries that discharged directly into the Yellagonga Wetlands prior to the *YICM Plan 2009-2014*. This involved redirecting outfalls away from the wetlands with filtering systems. Although the remaining stormwater catchment points are sumps that do not discharge directly into the Park's wetlands, the City has identified the upgrade of these sumps in the Stormwater Drainage Program – Sump Beautification Program to consider best environmental outcomes.

The CoW commenced the retrofitting of stormwater infrastructure in 2009, beginning with the Wangara Industrial Area. Further investigations into the most viable upgrades to the stormwater infrastructure have commenced and will be undertaken over the next few years.



Stormwater Drainage Outfall

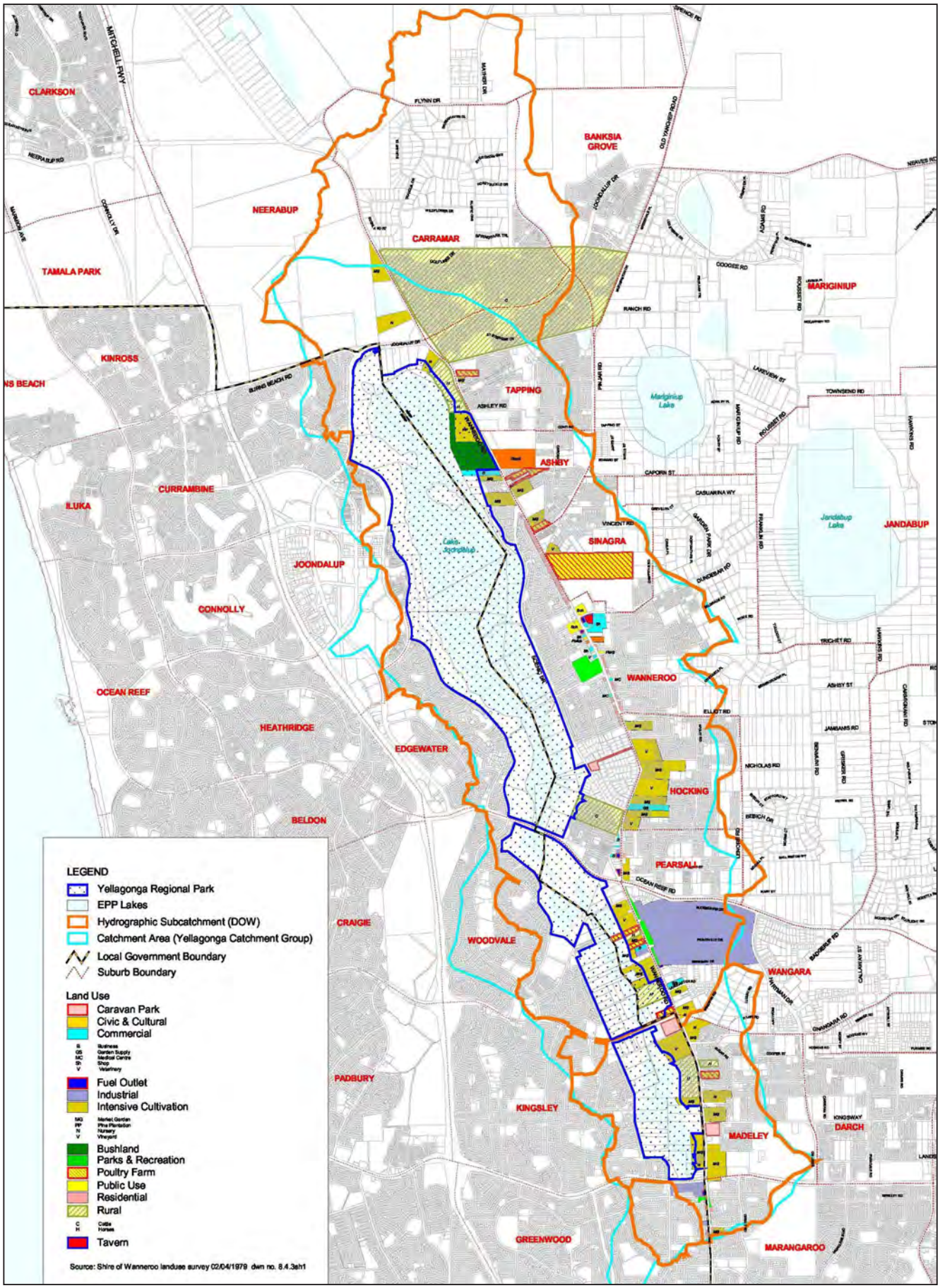


Figure 4 Past Land Uses to the East of Yellagonga Regional Park in 1979

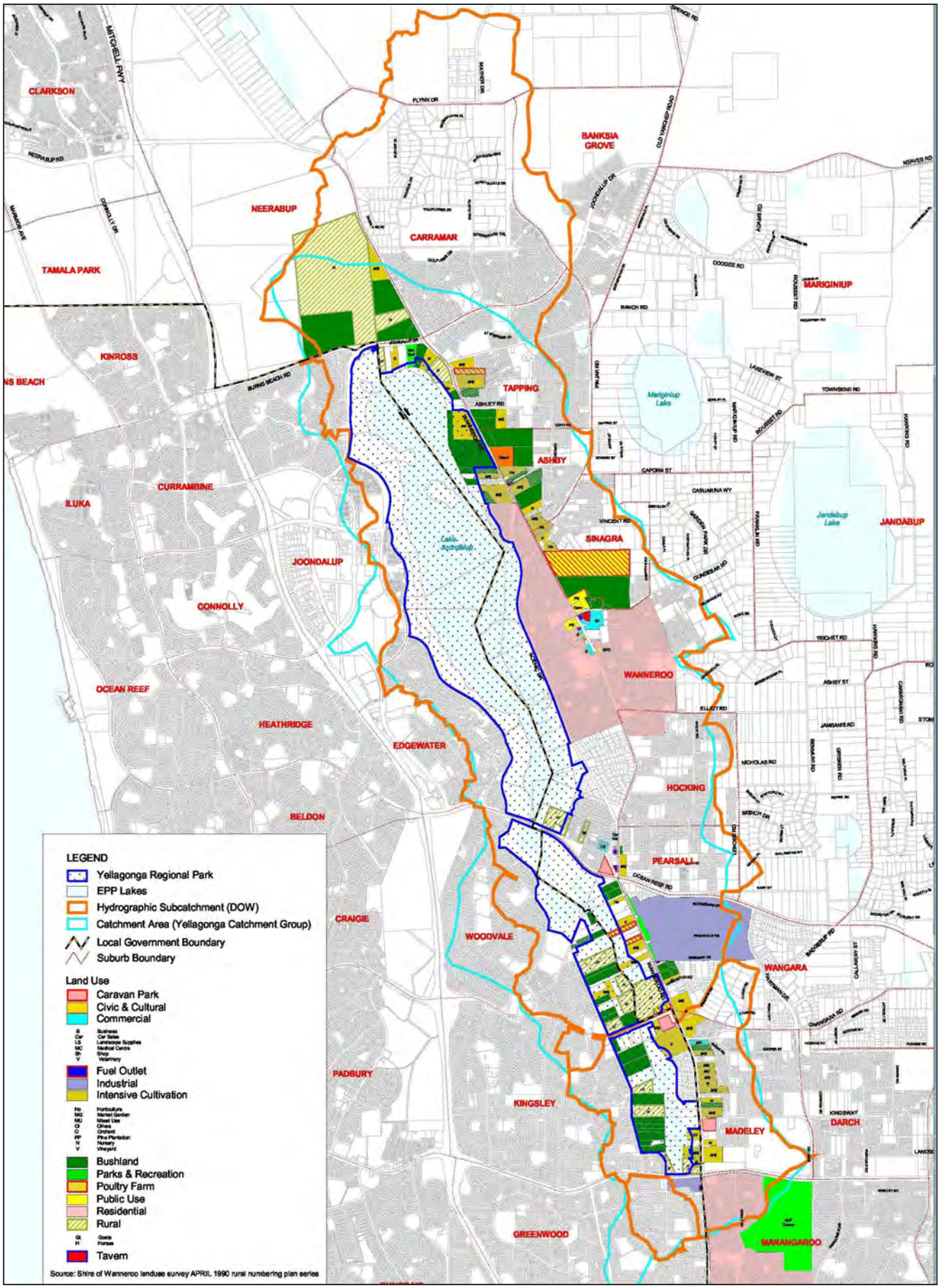


Figure 5 Past Land Uses to the East of Yellagonga Regional Park in 1990

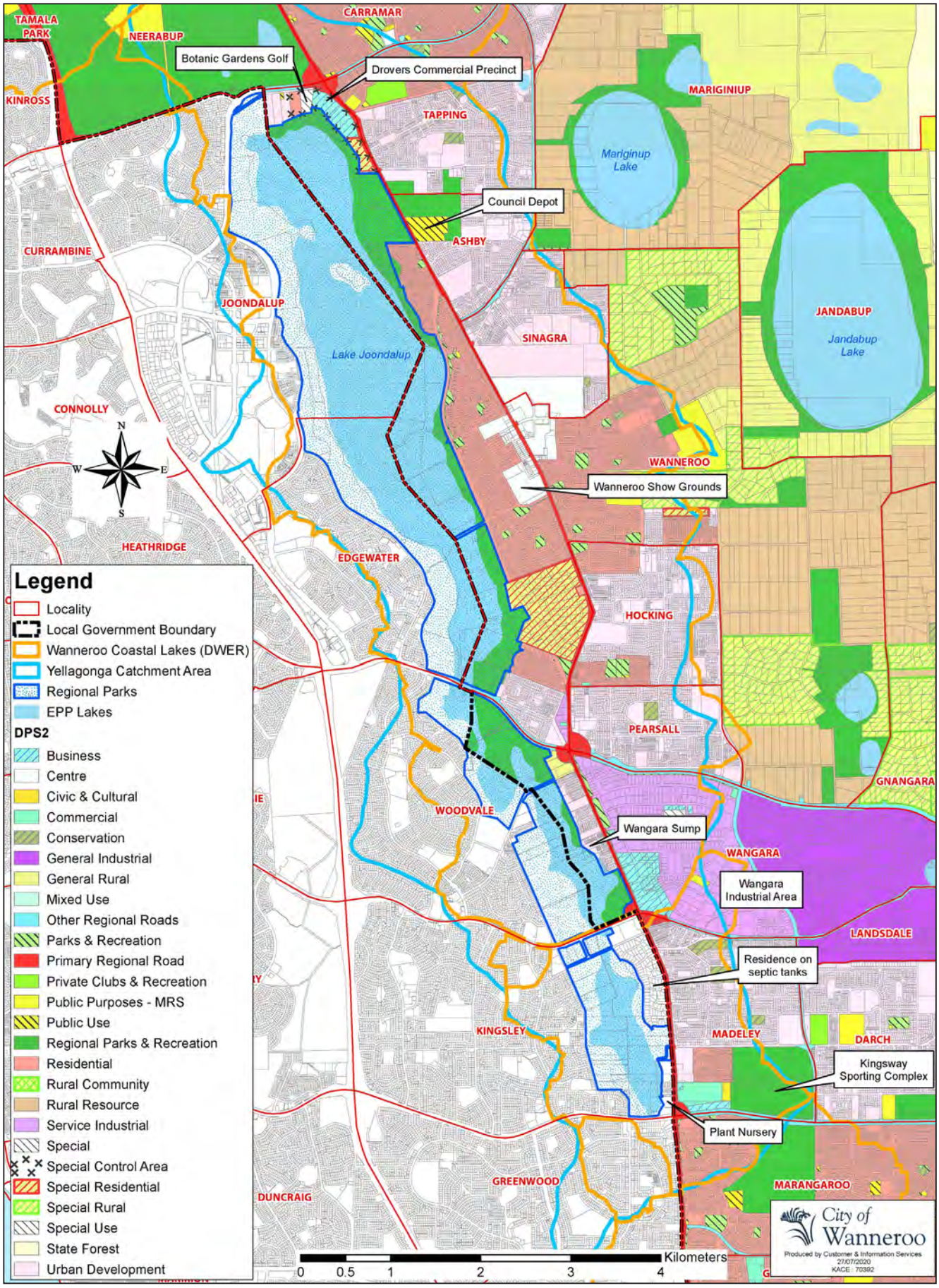


Figure 6 Current Land Uses to the East of Yellagonga Regional Park (2020)

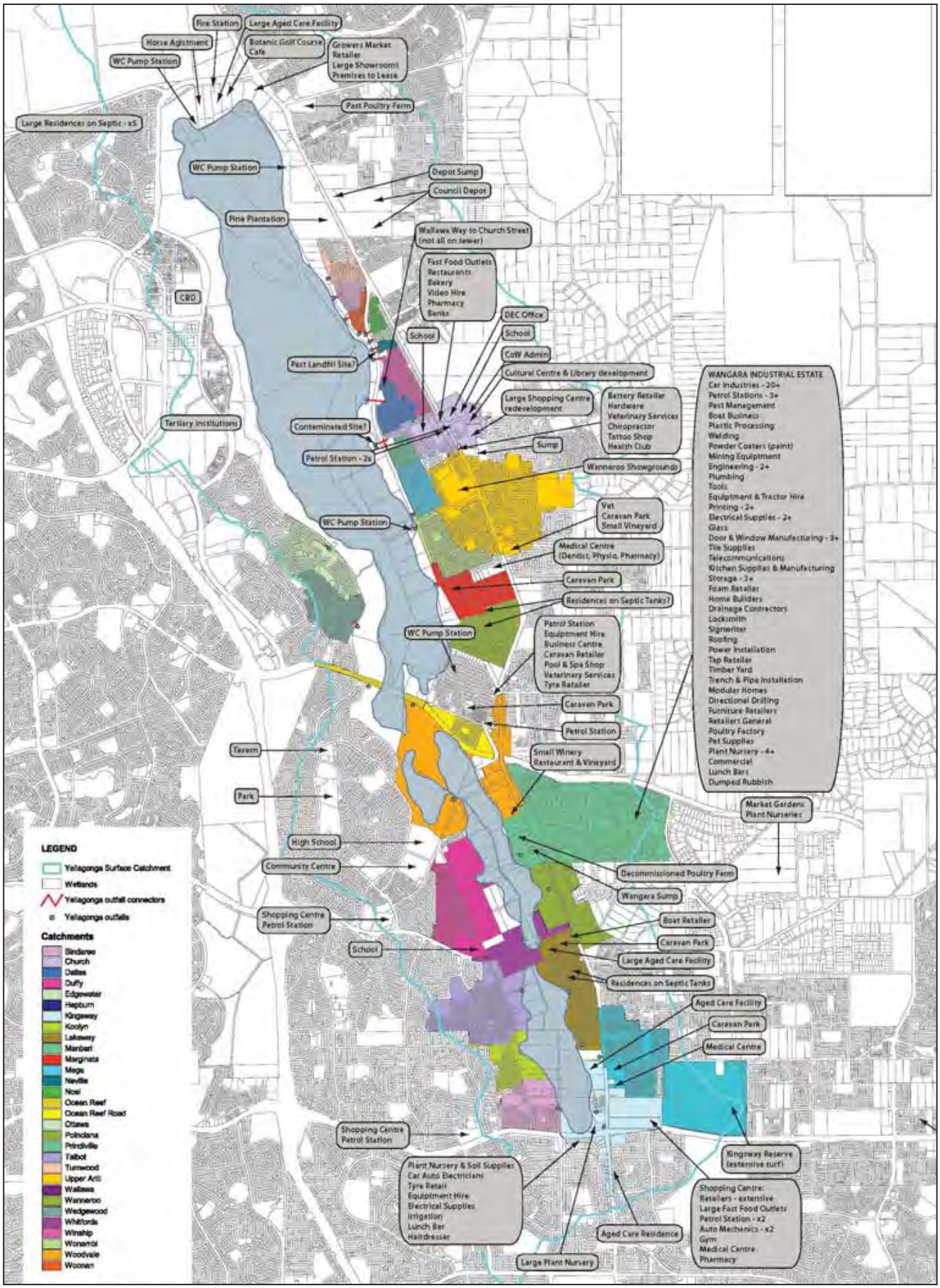


Figure 7 Drainage Sub-catchments in the Yellagonga Catchment Mapped 2008

2.3 Water Quality

2.3.1 Pollutants

Contaminants such as heavy metals, surfactants, hydrocarbons, nutrients, suspended solids, litter and pesticides are common substances in urban wetlands.[16,17,18] Pollutants and contaminants enter the Park's wetlands via stormwater run-off, groundwater flow and, to a lesser extent, rainfall.

Key water quality issues arising from pollutants that can impact on the Park's wetlands include:

- Nutrient enrichment resulting in eutrophication, algal blooms and midge outbreaks.
- Pollutants from toxicants (heavy metals, petroleum products, pesticides and herbicides, industrial and household chemicals) can cause compromised immune systems for wetland fauna, mutations, hormone disruption, reproductive interference, poisoning, injury, and death.
- Pollutants bound to sediments can be re-released in water leading to the mobility of these contaminants throughout food chains with unknown effects of bioaccumulation on wetland fauna. For example, heavy metals are mobilised under acidic conditions.
- Sedimentation and suspended solids reduce light penetration leading to restricted plant growth and smothering of flora and fauna.
- Litter is unsightly and can reduce light reaching some plants, with unknown effects of dyes and chemicals from printed materials, and possible choking / ingestion hazards for some wetland fauna such as freshwater turtles, macroinvertebrates and avian fauna.

The legacy issues of past land uses are considered to have an ongoing adverse impact on the Park's wetlands; these include market and commercial gardens, poultry industries and septic tanks (see Figures 4 and 5).

The Wangara Industrial Area is a current land use that may potentially have an adverse impact on the water quality of the Park's wetlands. Untreated stormwater has been draining into a compensating basin (the Wangara Sump) on the boundary of Walluburnup Swamp; though initial analysis through the Water Quality Monitoring and Improvement Program indicates the Wangara Sump is unlikely to be a major source of contaminants into the wetlands. The stormwater drainage infrastructure in this industrial area is in the process of being retrofitted to filter and redirect stormwater away from the Yellagonga Wetlands. Other present land uses include market gardens, septic tanks, diverse commercial uses, residential areas and the high use major and minor roads, which surround the Park. Some drainage subcatchments accommodate significantly more potentially polluting land uses than others as indicated in Figure 7. Pollutants potentially arising from these land uses can also enter the Yellagonga wetlands via groundwater movement.

2.3.2 Monitoring

Research and monitoring programs of surface and groundwater quality have been undertaken in the Park and in the surrounding catchment by the Edith Cowan University (ECU) Mine Water and Environment Research Centre (MiWER), since the initial implementation of the *YICM Plan 2009-2014* which included the Water Quality Monitoring Program and the Midge Steering Group Partnership Research projects.

Ongoing monitoring and research have continued to indicate high concentrations of nutrients and heavy metals in the surface and groundwater of the Yellagonga Wetlands that have exceeded the Australian and New Zealand Environment Conservation Council guideline values (risk to environment). Groundwater has been identified as a major source of nutrients and some metals into the wetlands, particularly through Beenyup Swamp.

The source of metals around a drain site north of Whitfords Avenue has been identified as being from acid sulphate soils, as well as from Lake Goollelal where low water levels have resulted in some acidification of the Lake's sediments.

[16] Davis *et al.* (1993)
[17] Bunny and Mouritz (1995)
[18] Whitely (2004)

On the ground initiatives have commenced following recommendations from the ECU MiWER including site specific acid sulphate soil investigations and revegetation works within the riparian zone of the wetlands.

The ongoing implementation of the Yellagonga Water Quality Monitoring Program is included within the *YICM Plan 2021-2026* to continue to provide consistent and comprehensive water quality data, analyses and recommendations upon which sound management decisions can be made.

2.4 Biodiversity

2.4.1 Flora

The vegetation communities within the Park have been identified as nine wetland communities (consisting of sedgelands, woodlands, open and closed forests) and five dryland communities (consisting of open and closed forest as well as woodlands). Much of the remnant vegetation has been altered with only a small area of *Melaleuca rhaphiophylla/Eucalyptus rudis* closed forest community in the northern-most section of the Park, identified as in 'Pristine' condition (according to the Keighery Scale 1994) by Regeneration Technology in 2002, however, more recent surveys undertaken in 2015 by Eco Logical Australia identified these areas as 'Excellent' indicating a decline in vegetation condition. Weeds remain a key threat in the Park.[19]

Three types of emergent vegetation exist within the Park: *Baumea articulata, Schoenoplectus validus*, and Bulrush (*Typha orientalis*). Bulrush, previously considered an introduced species was reclassified as being native to Western Australia by Keighery and McCabe in 2015. Bulrush is capable of aggressive invasion and can transform wetland ecosystems largely as a result of landscape modifications.[20] Altered hydrology to permanently wet and increased nutrient flow benefit Bulrush over other native sedges which prefer lower nutrient levels and seasonal drying.[20] Bulrush can rapidly change nutrient levels and water levels and flow, requiring active management to prevent it from becoming a weed.[20]



Dancing Spider Orchid *(Caladenia discoidea)*



Native Wisteria *(Hardenbergia comptoniana)*

[19] Regeneration Technology (2002)
[20] Keighery, G (2016)



Firewood Banksia (*Banksia menziesii*)

A clearing permit or exemption is required to undertake Bulrush control within its natural range, however exemptions under Schedule 6 Clause 3 of the *Environmental Protection Act 1986* (EP Act) allow the DBCA (including volunteers, and contractors) to undertake control works on DBCA managed land, such as in the Yellagonga Regional Park without requiring a permit.[21,22,23]

Fringing vegetation around the wetlands is fragmented, with some decline in *Eucalyptus rudis* and *Melaleuca rhaphiophylla* observed at Lake Goollelal as well as Lake Joondalup.[24] In 2021 a marked decline in the health of fringing *Melaleuca rhaphiophylla* at Lake Joondalup was observed, possibly due to a prolonged period of high water levels from 2017 onwards, however this needs further investigation. Weed invasion is also evident in the understorey of the wetlands' fringing vegetation, such as the highly invasive introduced grasses Kikuyu (*Pennisetum clandestinum*), Buffalo (*Stenotaphrum secundatum*) and Couch (*Cynodon dactylon*)[25] (see section 2.5.3 for more details on weeds).

A high proportion of the dryland vegetation that once surrounded the Park has been cleared for past and existing land uses such as agriculture and residential development. Tuart-Jarrah-Marri (*Eucalyptus gomphocephala – Eucalyptus marginata – Corymbia calophylla*) open forest exists as a patchy distribution in the west with some open forest to the north east of Lake Joondalup, with scattered Tuarts to the east of Walluburnup and Beenyup Swamps and northeast of Lake Goollelal. Banksia, Jarrah and Marri exists in an open forest along much of the south-eastern shore of Lake Joondalup with large areas cleared for recreational landscape along the eastern shores of Walluburnup and Beenyup Swamps and Lake Goollelal.[26]

Indicative DBCA Threatened Ecological Community distribution mapping from 2019 shows areas of the Park are likely to contain *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Threatened Ecological Communities (TEC), including: Banksia Woodlands of the Swan Coastal Plain, listed Priority 1 in WA and Endangered TEC under the EPBC Act, in patches of the eastern and southern areas of the Park, and Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain, listed Priority 3 in WA and Endangered TEC under the EPBC Act, in patches along the western side of the Park.

No Threatened flora species (Declared Rare Flora) or Priority flora species were recorded in the flora surveys conducted in 2015, 2016, and 2017 under the *YICM Plan 2015-2019*.

[21] Keighery, G. (2016)
[22] DBCA (2019)
[23] CALM *et al*. (2003)
[24] Department of Water (2008b)
[25] CALM *et al*. (2003)
[26] Regeneration Technology (2002)

2.4.2 Fauna

A formal register of fauna in the Park does not currently exist as no Park wide detailed fauna survey has been conducted, however, within the surface water catchment area at least seven sites with threatened fauna have been identified and others further east of the boundary have been listed by the DBCA. Two sites with threatened fauna have been identified within the Park.

Through the Atlas of Living Australia data base (accessed 2021) seven snake species have been identified within the Park including the Tiger Snake (*Notechis scutatus*), Carpet Python (*Morelia spilota*) and Dugite (*Pseudonaja affinis*)[27]. Fifteen lizard species (including Geckos, Monitor Lizards, and Legless Lizards) have also been identified such as the Australian Scincid Lizard (*Ctenotus fallens*), Bar-shouldered Ctenotus (*Ctenotus inornatus*), Yellow-bellied Skink (*Hemiergis peroni*), Burton's Legless Lizard (*Lialis burtonis*), as well as the Bobtail Lizard (*Tiliqua rugosa*).[28]

The South-western Snake-necked Turtle (*Chelodina colliei* – formerly *Chelodina oblonga*) exists within the lake systems. In temperate wetlands, freshwater turtles are top end predators and their overall health and presence is important in wetland ecology.

In surveys undertaken in 2011, Syrinx identified seven frog species including the Squelching Froglet (*Crinia insignifera*), Clicking Froglet (*Crinia glauerti*), Moaning Frog (*Heleioporus eyrei*), Western Banjo Frog (*Limnodynastes dorsalis*), Slender Tree Frog (*Litoria adelaidensis*) and the Motorbike Frog (*Litoria moorei*).[29] Five of these species were observed in 2020 in monitoring works undertaken for DWER by Bamford Consulting Ecologists.[30]

Mammals that have been recorded in the Park include the Western Grey Kangaroo (*Macropus fuliginosus*), Quenda (*Isoodon fusciventer*), Brushtail Possum (*Trichosurus vulpecula*), Short-beaked Echidna (*Tachyglossus aculeatus*) and the Native Water-rat, known as Moyitj or Rakali in Aboriginal languages (*Hydromys chrysogaster*), though no Native Water Rat activity was observed in targeted surveys undertaken by the DBCA in 2018. Species of microbat have also been recorded including the Gould's Wattled Bat (*Chalinolobus gouldii*) and White-striped Freetail Bat (*Tadarida australis*).[31] The Western Brush Wallaby (*Notamacropus irma*) has also historically been recorded in the Park.[31] Foxes, rabbits, and feral and roaming cats are pest mammals present in the Park and are discussed in section 2.6.8 Introduced Animals.[25]


Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)


Australian Wood Duck (*Chenonetta jubata*)


South-western Snake-necked Turtle (*Chelodina colliei*)


Burton's Legless Lizard (*Lialis burtonis*)

[27] Atlas of Living Australia (2019)
[28] Atlas of Living Australia (2019)
[29] Syrinx (2011)
[30] Bamford Consulting Ecologists (2021)
[31] CALM *et al.* (2003)



Slender Tree Frog (*Litoria adelaidensis*)

Five fish species have been observed in the Yellagonga lake systems: two native, and three exotic. Native species recorded are the Swan River Goby (*Pseudogobius olorum*) and the Western Pygmy Perch (*Edelia vittata*).[32] The exotic fish being the Mosquito Fish (*Gambusia affinis*), the European Carp (*Cyprinus carpio*), and Goldfish (*Carassius auratus*).[33]

The Park is important as a summer refuge and breeding habitat for many resident and trans-equatorial migratory water bird species.[33,34] Over 120 avian species have been recorded in the Park.[33] Bekle (1997) identified at least 37 water bird species during 1991-1993 (from the families: Anatidae, Podicipedidae, Anhingidae, Phalacrocoracidae, Pelecanidae, Ardeidae, Plataleidae, Rallidae, Scolopacidae, Recurvirostridae and Charadriidae). Combined results of surveys suggest there may be a decline in water bird species utilising the Park's wetlands. In addition to the water bird species found in the Park, there were 47 species of terrestrial birds identified in the park by Bamford and Bamford (1990).

Kinnear and Garnett (1997a) identified 121 macro-invertebrate taxa excluding the segmented worms (Annelida). The dominant groups were the ten-legged animals (from the order Decapoda such as shrimps and the small crustaceans) and true flies (from the order Diptera such as midges).

Considerable variability was found in distributions of macro-invertebrates throughout the wetlands, both spatially and temporally, but the greatest diversity and abundances of macro-invertebrates were typically found at South Lake Joondalup and Beenyup Swamp. In the annual macroinvertebrate monitoring conducted in spring for the DWER a decline in the number of Families was seen at Lake Joondalup in 2018 and 2019, with only nine and 11 Families recorded, respectively, (compared to the mean spring richness of 24 Families).[35] The surveys found a near complete lack of insects and beetles for these years. In 2020, the number of Families increased with 23 recorded, including a number of insect and beetle taxa absent in 2018 and 2019.

[33] CALM et al. (2003)
[34] Bekle (2007)
[35] Lette and Horwitz (2021)

2.5 Threatening Processes

2.5.1 Climate Change

Current Climate Change

The climate of south-west Western Australia has been undergoing significant change in recent decades. These changes include increased temperatures, increase in sea levels, decrease in rainfall, more intense storm events and increased storm surge.

The long-term trend in temperature for south-west Western Australia has been increasing over the past century, with the rate of warming higher since 1960.[36] In 2019 the mean annual temperature for Perth was 1.8°C above the long term (1961-1990) average and was the warmest year on record (since 1944) .

There have also been greater temperature extremes. The mean number of days over 35°C between 1944 and 2014, was 27.5, between 1981–2010 it was 28.5 and in 2019 there were 37.[37] In 2019 Perth Airport recorded three consecutive December days over 40°C and doubled its previous highest number of 40°C days.[38]

There is a strong drying trend between May to July over south-west Western Australia, with rainfall since 1970 around 20% less than the average between 1900 and 1969. Since 1999, this reduction has increased to around 26%.[39] In 2019 Perth Airport recorded 524.6mm which was its fourth-driest year since records commenced in 1944 and driest since 2010.[38] These changes have already impacted on the Yellagonga catchment and as a result, management responses will have to adapt accordingly.

Future Climate Change

Climate change is expected to continue although the extent of change will be dependent on both the amount of greenhouse gases that continue to be emitted and how the environment responds. Future projections have been developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BoM) which indicate that for the south-west of Western Australia temperatures will continue to increase while rainfall decreases.[36] Further details on these projections are provided in Table 1.

Table 1 Future Climate Change Projections for south-west Western Australia (Adapted from Hope *et al.* 2015)

2030	2090
0.5 – 1.2°C TEMPERATURE	**1.1 – 2.1°C TEMPERATURE** (intermediate emissions scenario) **2.6 – 4.2°C TEMPERATURE** (high emissions scenario)
EXTREME HEAT DAYS at a similar rate to mean temperature with a substantial increase in the temperature reached on hot days, the frequency of hot days, and duration of warm spells	
15% WINTER RAINFALL	**30% WINTER RAINFALL** (intermediate emissions scenario) **45% WINTER RAINFALL** (high emissions scenario)
INTENSITY OF EXTREME RAINFALL EVENTS (medium confidence) **Time spent in DROUGHT over the course of the century** (high confidence)	
CLIMATE CHANGE will result in harsher fire weather climate in the future (high confidence)	

Climate Change Impacts

[36] Hope *et al.* (2015)
[37] BoM (2020a)
[38] BoM (2020b)
[39] BoM, and CSIRO (2018)

Predicting the exact scale and nature of climate change at a local level and the resulting impacts is challenging and will depend on the response of local climate systems and the level of future greenhouse gas emissions. The Yellagonga wetlands are situated within the south-west corner of Western Australia, a global biodiversity hotspot and an area particularly vulnerable to climate change.

Expected climate change impacts for the Yellagonga wetlands are summarised in Table 2 adapted from the 2011 Report Card on Climate Change and Western Australian Aquatic Ecosystems developed through the National Climate Change Adaptation Research Facility.[40]

Table 2 Expected Climate Change Impacts and Potential Ecological Consequences for Yellagonga Wetland (Adapted from NCCARF, 2011)

Key Stressors	Anticipated Physical and Chemical Changes	Potential Ecological Consequences
Reduced rainfall Reduced runoff Declining groundwater Increased temperature Changes to seasonality	• Reduced water entering aquatic ecosystems via rain, surface runoff or groundwater inflow. • Less internal water movement. • Increased average and maximum water temperatures. • Increased evapotranspiration due to higher temperatures. • Changes in rates of chemical processes and equilibria. • Reduction in extent, depth and volume of wetlands and waterways. • Permanent systems becoming more seasonal and seasonal systems becoming episodic or disappearing. • Altered water regime (e.g. delayed onset of winter filling, premature drying, extended dry spells, and unseasonal rainfall due to cyclonic activity). • Changes to water quality due to changing quantity and quality of inflows. • Acidification through oxidation of acid sulphate soils (due to reducing water levels) and associated release of metals. • Increased fire risk (frequency and intensity).	• Overall reduction in biodiversity. • Progressive change from aquatic to terrestrial species and habitats. • Local shifts in species composition. Sensitive species may be lost due to changes in water availability, temperature, and water quality. Increase in temperature tolerant species, existing pests and exotic warm-water species. • Potential extinctions of endemic species unable to cope with the rate of change, especially those with poor dispersal mechanisms or in habitats affected by human activity. • Plant productivity will be affected by changes in temperature, water quality and higher CO_2 concentrations. • Potential increase in algal blooms, anoxia and fish kills. Potential increase in midges and mosquitoes. • Potential disruption of reproductive cycles of biota. Changes to seasonal migration triggers. Depletion of seed and egg banks. • Altered nutrient and carbon cycles.

[40] NCCARF (2011)



Aerial image of Yellagonga Regional Park

2.5.2 Altered Water Levels

Most wetlands on the Swan Coastal Plain, including those in Yellagonga Regional Park, are groundwater-dependent ecosystems. The seasonal and longer-term fluctuations in wetland water levels reflect the fluctuations in the underlying Superficial aquifer (the water table). In turn, the Superficial aquifer responds to the seasonal and inter-annual variability in rainfall, and to impacts from groundwater abstraction and changes in land use. The drying climate and abstraction of groundwater from the Gnangara groundwater system has resulted in long-term declining groundwater levels in some parts of the system. However, in the Yellagonga Regional Park, groundwater levels have been somewhat buffered from the declines seen elsewhere, partly due to its predominantly urban setting and the additional local recharge to groundwater because of urbanisation. On-going changes to land use such as increased land clearing, urbanisation, and a reduction in groundwater use for agriculture as a result of land use change could result in a rise in groundwater levels and in the surface water levels of the wetlands in the Park.

Water levels at Lake Joondalup have increased in recent years and are currently the highest they have been since the mid-1990s. Water levels at Lake Goollelal have fluctuated over time but are currently similar to levels recorded in the late 1980s.

Both Lake Goollelal and Lake Joondalup have statutory environmental water provision criteria set as minimum water levels under the *Environmental Protection Act 1986*, with the DWER being the agency responsible for meeting the minimum water level criteria. The current minimum water level criteria for Lake Goollelal is 26.0mAHD, and for Lake Joondalup is 15.8mAHD, though the DWER are proposing to raise both of these levels by 0.4m with the proposed changes to be outlined in the new Gnangara groundwater allocation plan, due to be released for public comment in 2021. They will also require assessment by the Environmental Protection Authority before the new criteria are implemented.

Though summer minimum levels at both lakes have improved in recent years, low minimum levels occurred at the lakes in years following very dry winters (such as those recorded in 2011 and 2016). Water quality monitoring showed an increased risk of acidification at both lakes in these years of low minimum levels. However, since 2016 these risks have abated as minimum levels have improved.

Wetland vegetation condition has been monitored every few years at Lakes Joondalup and Goollelal since the mid-1990s. The most notable change to vegetation health at the monitored sites has been the increased abundance of weed species, a common impact for wetlands in urban settings. Recent aerial imagery shows evidence of a decline in the health of fringing melaleucas, particularly around Lake Joondalup. The exact cause of this decline is unknown, though the prolonged high water levels may be exceeding the flood tolerance of the melaleucas.[41,42]

Local groundwater use near the Yellagonga Regional Park includes City irrigation of public open space, commercial irrigation for horticulture in rural areas east of the park and garden bore use by local households.

There is potential for the water levels of the Yellagonga wetlands to be impacted by planned development in East Wanneroo. Groundwater modelling projects that groundwater levels are likely to rise as a result of a combination of increased recharge from urbanisation and reduced abstraction as agricultural land uses begin to move out of the area. These rises have the potential to offset the impacts of reduced rainfall as a result of climate change, but also have the potential to increase water levels and cause further ecological impacts to the fringing vegetation at Lake Joondalup.



Apple of Sodom (*Solanum linnaeanum*)



Weed of National Significance: Bridal Creeper (*Asparagus asparagoides*)

2.5.3 Weeds

Weeds are undesirable plants and include exotic plants from overseas and native Australian plants from other regions within Western Australia, or from other parts of Australia.[43] These weeds may also be known as environmental or declared weeds. Given the highly altered landscape of the Yellagonga catchment, invasion of weeds from the catchment into the Park is an ongoing problem. In addition, given the extent of weed growth in the Park, propagation of weeds from within the Park also pose a threat to the ecological integrity of the Park.

Weeds can produce structural and compositional changes to the vegetation, degrade fauna habitat, and threaten persistence of fauna within the Park. Weeds also invade disturbed habitat, dominating post-fire succession and, in turn, promote susceptibility to fire re-occurrence.

Through the flora surveys undertaken under the *YICM Plan 2015-2019* weeds were prominent within most of the remnant vegetation surveyed and a number of significant weed species were identified within the Park including Bridal Creeper (*Asparagus asparagoides*) which is a Weed of National Significance, and four species classified as Declared Pests under the BAM Act; Arum Lily (*Zantedeschia aethiopica*), Apple of Sodom (*Solanum linnaeanum*), Noogoora Burr (*Xanthium strumarium*), and One-leafed Cape Tulip (*Moraea flaccida*).[44] Bleeding Heart Poplar (*Homalanthus novo-guineensis*), whilst not a Declared species, is a significant weed within the Yellagonga wetlands that is being targeted for control. Targeted control of priority weeds is a critical part of the on-going management of the Park.

41 Congdon and McCombe (1975)
42 WAWA (1995)
43 Keighery (2002)
44 DPIRD (2020)

2.5.4 Acid Sulphate Soils

Acid sulphate soils (ASS) are found naturally in the environment and are common around coastal areas, although they do occur inland. Coastal ASS are the result of historic sea level rises, in particular sea level rises during the Holocene (within the last 10,000 years), where sulphate in the seawater mixed with land sediments containing iron-oxides and organic matter forming extensive areas of iron sulfides. When these iron-sulfide rich soils and sediments come into contact with air (for example, through dewatering, excavation, lowered water table etc.), the iron sulfides react with water and oxygen to form iron compounds and sulfuric acid.[45]

In Western Australia, ASS typically occurs in water-logged conditions with soil types that include peat, pale grey Bassendean/Spearwood sands, or coffee rock and also in dark organic rich soils/muds. Soils of the Park and catchment are described as Potential Acid Sulphate Soils, with soils around the Park predicted to be Class 1 'High Risk ASS' occurring within 3m of the soil surface.

Disturbance of ASS results in acidification of surface waters, groundwater aquifers and the soil. Acidification enhances the mobility of metals,[46] in particular, aluminium and arsenic, which are highly toxic to wetland flora and fauna with potential impacts on human health. Acidic conditions in surface and groundwater can cause damage to infrastructure such as retaining walls, boardwalks, private dwellings as well as death of aquatic organisms in acidified wetlands.

Water quality monitoring undertaken under the *YICM Plan* identified that ASS likely occurs within the wetland. As a result, site specific ASS investigations were undertaken confirming their presence in the northern end of Lake Goollelal and southern region of Walluburnup Swamp. During periods of extreme low water levels and drying these areas become exposed, resulting in the formation of sulfuric acid leading to a lowering of the waters' pH and mobilisation of metals in the water body which is evident in the annual water quality monitoring. During wetter years where water levels remain at or above the preferred minimum water levels these areas are not exposed. Further investigation may be carried out through the Water Quality Monitoring and Improvement Program within the *YICM Plan 2021-2026*.

2.5.5 Plant Diseases

Plant pathogens are organisms such as bacteria, viruses, and fungi which cause disease in plants. Pathogens may be native or introduced and can be transported into and within a site through the movement of soils and plant materials.[47] The impact, and expression of pathogens differs based both on the species of pathogen and the host plant, as well as environment, and climatic condition.[48]

Dieback is a disease caused by introduced soil-borne water mould species from the Genus *Phytophthora*, most notably *P. cinnamomi*, commonly referred to as 'dieback,' which destroys many Australian native plant species in forests, woodlands and heathlands and can permanently reduce local biodiversity. *Phytophthora* dieback caused by *P. cinnamomi* is listed as a key threatening process to Australian biodiversity under the EPBC Act.[49] Whilst *P. cinnamomi* has not been recorded in the Park, *P. multivora* has been identified in one area of the Park, and a total of seven species of *Phytophthora* have been recorded within the CoJ through pathogen testing undertaken under the *City of Joondalup Pathogen Management Plan 2016*. *Phytophthora multivora* (named for its wide host range) is generally associated with spot deaths and areas of tree decline. Plant death can be rapid or a slow decline in crown health.[50]



Armillaria luteobubalina

[45] DEC (n.d)
[46] Van der Welle et al. (2007)
[47] City of Joondalup (2013)
[48] Arbor Carbon (2014)
[49] Commonwealth of Australia (2018)
[50] Barber, P. (2012)



Banksia species affected by pathogens at Naturaliste Park, Iluka

Pathogens are spread largely by human activity and water movement, and at present, there is no means of eradication. Control of *Phytophthora* is affected by limiting its spread, utilising various methods that prevent the transfer of soil particles, for example washing/scraping footwear, vehicle tyres and using dedicated wash-bay facilities. A number of plant species have been identified in the Park as being susceptible to *Phytophthora* dieback including Jarrah (*Eucalyptus marginata*), Banksia spp and Grass trees (*Xanthorrhoea preissii*).

Armillaria luteobubalina (*Armillaria*), also known as 'Honey Fungus' due to its honey coloured fruiting bodies, is a soil-borne fungus which causes root rot of a wide variety of plants. Many species of native flora are susceptible to *Armillaria*, and while *Armillaria* is native to Australia, it can cause major damage to natural ecosystems; such as those found in the Park. Unlike *Phytophthora*, which is spread via soil, *Armillaria* is spread through its woody food base, predominantly through root to root contact, though it can also be spread by root fragments, tree stumps, and other infected woody materials.[51,52] Whilst *Armillaria* has not been confirmed within the Park through laboratory analysis, field observations at Neil Hawkins Park indicate its presence.[53]

[51] Barber (2012)
[52] Forest Science Centre (2003)
[53] Barber (2017)

Pathogens such as *Phytophthora* and *Armillaria* can be introduced through materials bought in for maintenance and rehabilitation activities, such as mulch, soils, and seedlings, so it is important that raw materials be sought from accredited agencies and is pathogen free, and revegetation stock be purchased from nurseries that are accredited under the Nursery Industry Accreditation Scheme.

Pathogen management within the Park is to be monitored through the Local Biodiversity Project proposed in this *YICM Plan 2021-2026* in accordance with the *City of Joondalup Pathogen Management Pla*n.

2.5.6 Bushfires

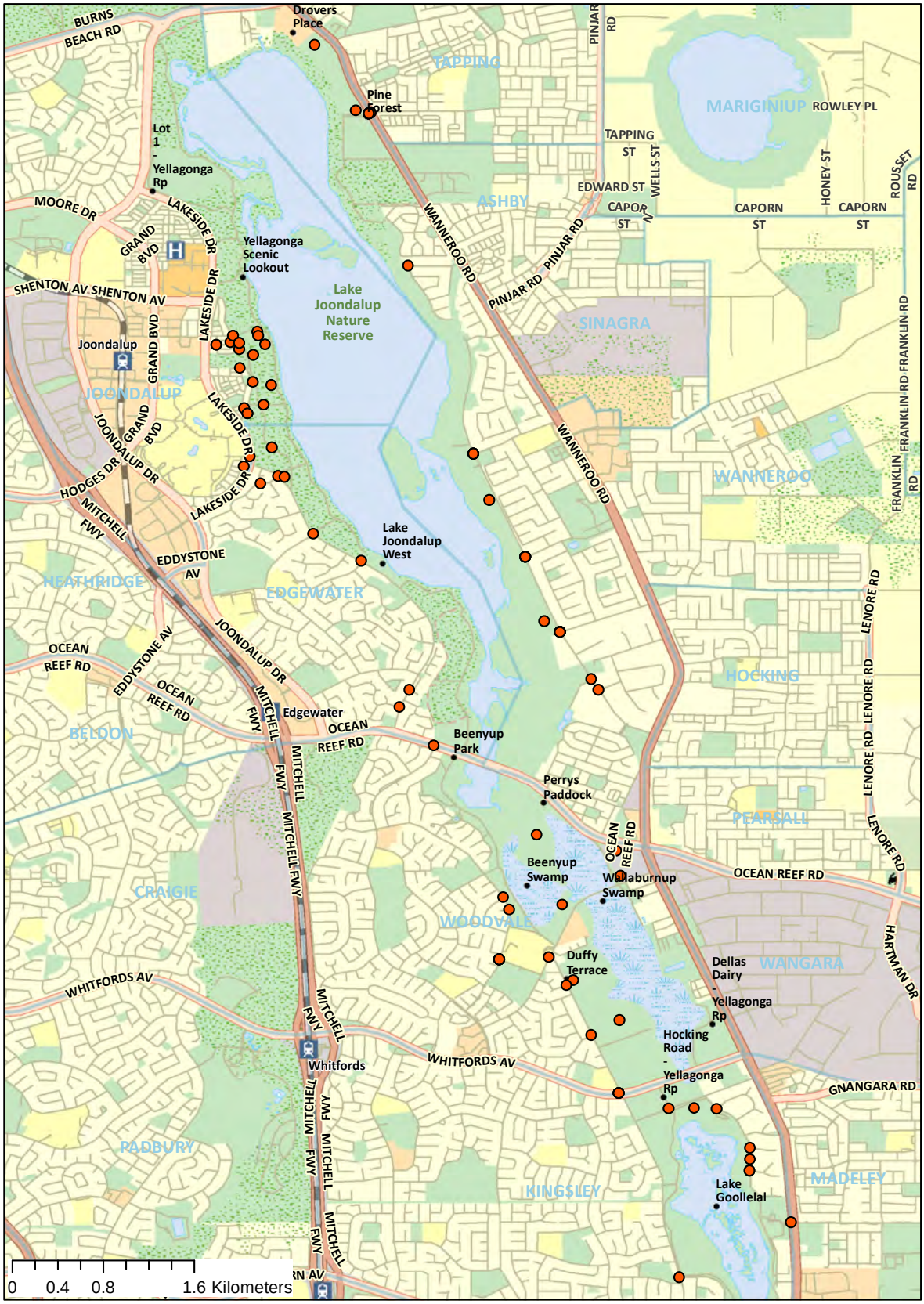
Whilst fire is a natural feature in the Australian landscape, excessive bushfires can devastate the Parks' vegetation, particularly when the frequency of bushfires reduces adequate time for natural regeneration. Bushfire can occur as a result of natural events such as lightning, though in urban areas such as the Park bushfires are more commonly the result of human activity, be it accidental, or deliberate. Human activities have increased the frequency of bushfire within urban bushland reserves such as the Park.

Past practices from Aboriginal burning may not have produced marked changes to ecosystem composition around wetlands,[54] however today, weed invasion post-fire is an ongoing issue for the Park. Weedy species are often coloniser species meaning they are the first to appear after disturbance events such as bushfire. Inappropriate bushfire regimes benefit these species and control of weeds is imperative after bushfire events to assist natural regeneration of native species. Bushfire also affects soil, which in turn may impact on water quality in wetlands.

[54] Bickford and Gell (2005)



Grass Tree Hazard Reduction Burn, Craigie Bushland



GOVERNMENT OF WESTERN AUSTRALIA

DFES Department of Fire & Emergency Services

Fires in the Yellagonga Regional Park.

Mappable Incidents only; July 2008 - June 2018
Points show approximate location, and may not represent the actual fire position

Produced by DFES OIS Branch
Contact: reports@dfes.wa.gov.au
Printed: 27 June 2018
File: Yellagonga_201806.mxd

Figure 8 Fires Reported in Yellagonga Regional Park 2008 - 2018



Post bushfire, northern Yellagonga Regional Park



Grass Tree Hazard Reduction Burn, Craigie Bushland

The changing climate of the south-west of Western Australia has resulted in climatic conditions that increase the risk of bushfire. Lower Winter rainfall and increasing average temperatures have led to longer 'bushfire seasons', which also results in fewer months during which fuel reduction burns can be undertaken. Drying and warming climate trends have also resulted in an increase in the extent of the landscape that is bushfire prone.

In addition to environmental impacts bushfire can cause significant damage to people and property.[55] Under the *Bush Fires Act 1984* the responsibility of preventing bushfires falls on the managing body of that land. The Park has multiple land managers and it is important that coordinated management activities are undertaken to prevent bushfires within the Park, which includes fuel reduction burns.

Whilst bushfire management is not undertaken through the *YICM Plan*, the Local Biodiversity Project will report on actions undertaken within the Park. Bushfire risk management is a key responsibility for local government, including meeting legislative obligations under the *Bush Fires Act 1954* and *Emergency Management Act 2005*. The City of Joondalup undertakes a number of ongoing bushfire risk management activities within City managed bushland areas as set out within the City's *Bushfire Risk Management Plan 2018-2023*. Activities include, firebreak installation and maintenance, weed control (mechanical and chemical), manual fuel load reduction and strategic hazard reduction burning. The City of Wanneroo currently manages bushfire through the City's Fire Protection Officers who assess fuel loads in the City's reserves and write prescriptions and undertake prescribed burns accordingly. The DBCA are responsible for fuel loads and bushfire management in its management areas. Works undertaken through the DBCA include the use of contractors to undertake manual fuels reduction (e.g. removal and mulching of weeds), undertaking mowing and slashing in open areas, and strategic fuel reduction burns in coordination with Department of Fire and Emergency Services and the two Cities.

2.5.7 Habitat Destruction and Fragmentation

On the Swan Coastal Plain much of the natural landscape has been cleared for urban development with natural habitat, including wetlands, now existing as small islands in a sea of urbanisation. The Park is separated by Ocean Reef Road and Whitfords Avenue and exists as three areas of natural habitat. While the terrestrial buffer for the most part is greater than 100m, much of this is highly altered with large areas dedicated to grassed parkland. The provision of adequate terrestrial buffers of natural vegetation is vital for overall health and functioning of wetland ecology.

The three separate areas of the Park are surrounded by roads and residential development which has resulted in reduced opportunities for terrestrial animals to disperse between habitats, restricting gene flow and contributions into the gene pool or 'rescue' for declining populations. Wide-ranging animals are those that are typically vulnerable as fragmentation often results in smaller habitats that cannot provide for all their needs, and these animals are the ones killed as they attempt to cross roads seeking alternative habitat.[56]

[55] EDOWA (2011)
[56] Noss and Csuti (1997)



European Honeybee (*Apis mellifera*). Photo credit: Bill Betts.

2.5.8 Introduced Animals

Foxes are found within, and in land surrounding the Park along with European Rabbits (*Oryctolagus cuniculus*) and feral and roaming domestic cats; with all three species listed as declared species under the BAM Act. The European Red Fox (*Vulpes vulpes*) is a non-selective feeder and survives well in a fragmented environment, and particularly well in the urban environment.[57] Foxes are known to predate on adults and the nests of South-western Snake-necked Turtles and are considered a major threat to the population within the Park. Cats (*Felis catus*) also pose a significant threat to the fauna within the Yellagonga Regional Park, whether they are classified as domestic, stray or feral. Predation by feral cats is listed as a key threatening process under the EPBC Act.[58]

While the fox is a declared animal and must be controlled by the landowner or a local government under the BAM Act, they need to be removed simultaneously with cats and rabbits. Both foxes and cats are non-selective feeders, with diet varying greatly depending on location, seasonality, and food availability; with rabbits being prey for both species where they co-occur.[56,59] Foxes appear to exert some predatory/competitive control over feral cats and, if only foxes are removed, feral cats will slip into this ecological niche.[60] Further to their introduced status, the interconnectivity between all three species drives the need for simultaneous control. An annual fox control program facilitated by DBCA is implemented in coordination with the two Cities and the Yellagonga Regional Park Community Advisory Committee. Despite on-going control within the Park, as well as bushland areas in the surrounding landscape, foxes continue to persist in the Park.

Unleashed dogs also negatively impact native fauna populations as they have a tendency to chase, disturb and harm wildlife.

[57] Saunders et al. (1995)
[58] DPIRD (2019)
[59] DPIRD (2018)
[60] Risbey (2000)

Other introduced animals in the Park include the European Honey Bee (*Apis mellifera*), Pigeons (Family – Columbidae), Geese (Family – Anatidae), Carp, and Goldfish. It is also likely that the Argentine Ant (*Linepithema humile*) is still present. The European Honey Bee presence within the Park is predicted to have a detrimental impact on native flora and fauna.[61] Carp and Goldfish have most likely been introduced to the wetlands through the illegal dumping of unwanted pets and pose a threat through predation, introduction of disease, habitat modification and reduction of water quality.[62]

The negative impacts of introduced birds is likely exacerbated by the feeding of wild birds within the Park,[61] which is illegal under the *Biodiversity Conservation Act 2016*. Whilst native to Australia, the Eastern Long-billed Corella (*Cacatua tenuirostris*), the eastern subspecies of the Little Corella (*Cacatua sanguinea*), and the Rainbow Lorikeet (*Trichoglossus moluccanus*) are all introduced species to Western Australia; with the Rainbow Lorikeet being a declared species under the BAM Act. All three species present a threat to local biodiversity through resource competition (food, and nesting hollows), and damage to habitat.

The *Regional Parks Pest and Problem Animal Control Plan* (DEC, 2006) provides recommendations for control methods for major pest and problem animals.


Little Corella (*Cacatua sanguinea westralensis*)


Fox (*Vulpes vulpes*)


Rainbow Lorikeets (*Trichoglossus moluccanus*)


Domestic Cat (*Felis catus*)


Predated turtle eggs

2.5.9 Vandalism and Rubbish Dumping

Whilst the majority of people who recreate within the Park appreciate the environmental and cultural values of the area, the issues of graffiti, dumping of rubbish and other forms of vandalism occur throughout the Park. The DBCA and the two Cities manage graffiti and rubbish removal on an ongoing basis.

Community initiatives such as interpretive signage, information brochures and tours have been designed to raise community awareness of the conservation significance and value of the Park and encourage the responsible use of the area.

[61] CALM *et al.* (2003)
[62] FRDC (2020)

3.0 IMPLEMENTATION PLAN

3.1 Key Focus Areas

Five Key Focus Areas have been developed to address the key issues in the Yellagonga Catchment. The Key Focus Areas and key issues were developed based on the key threats identified in the *YICM Plan 2021-2026* and consideration of the achievements, improved knowledge and outcomes as a result of implementing the *YICM Plans 2009-2014*, and *YICM Plan 2015-2019*. In addition, objectives have been developed for each of the Key Focus Areas in order to provide a clear direction for how the wetlands are managed and to ensure that the appropriate action is taken in response to each of the Key Issues. The Key Focus Areas and their respective Key Issues and Objectives are provided below.

Table 3 Key Focus Areas of the Plan and their Key Issues and Objectives

KEY FOCUS AREA	KEY ISSUES	OBJECTIVES
Water Quality	Water contaminants. Inappropriate stormwater infrastructure.	Improve the water quality of the Yellagonga Wetlands. Reduce opportunities for pollutants in water to enter the Yellagonga Wetlands.
Urban Planning and Development	Soil contamination. Acid sulphate soils. Inappropriate stormwater infrastructure.	Ensure that integrated catchment management is considered in the land use planning decisions of both Cities. Minimise the impacts on the Yellagonga Wetlands from soil contamination. Reduce opportunities for pollutants to enter the Yellagonga Wetlands.
Water Quantity	Climate change. Reduced water levels Increased water levels Increasing water consumption. Acid sulphate soils.	Ensure the availability of water for environmental uses within the Yellagonga Wetlands. Ensure water level rises have no significant adverse effect on the values of Lake Joondalup. Encourage water conservation within neighbouring land uses and the community.
Biodiversity	Climate change. Risk of pathogens spreading Invasive flora and fauna species. Increased incidence and intensity of bushfires. Habitat fragmentation and degradation. Lack of scientific data on fauna species. Lack of data on flora in some areas.	Conserve and enhance the biodiversity of the Yellagonga Regional Park to ensure healthy habitats for wildlife. Reduce incidences of bushfires within Yellagonga Regional Park. Reduce the incidence of weeds and pest animal species in Yellagonga Regional Park. Avoid the spread of pathogens and disease within Yellagonga Regional Park.
Community and Partnerships	Level of community awareness of the conservation needs of Yellagonga Regional Park. Incidences of rubbish dumping and vandalism.	Improve the community's awareness and understanding of the Yellagonga Catchment. Reduce negative uses of Yellagonga Regional Park.

3.2 YICM Plan 2021-2026 Projects

In order to achieve the aim and objectives of the *YICM Plan 2021-2026*, projects have been identified for each of the five Key Focus Areas (Tables 4 to 6 below). These projects will be implemented over the life of the Plan and will be subject to annual monitoring and review. Some of the projects are joint projects between the two Cities and others are individual projects. The DBCA provides input into the planning and implementation of each project as required and where applicable.

3.2.1 Joint Projects

Table 4 Joint projects to be undertaken in Partnership between the Cities of Joondalup and Wanneroo

KEY FOCUS AREA	PROJECT TITLE
Water Quality	Water Quality Monitoring and Improvement Program
	Midge Steering Group Partnership Research
Water Quantity	Water Conservation Project
Biodiversity	Local Biodiversity Project
Community and Partnerships	Strategic Partnerships

3.2.2 Individual Projects

City of Joondalup

Table 6 Individual Projects to be undertaken by the City of Joondalup

KEY FOCUS AREA	PROJECT TITLE
Water Quality	Stormwater Management
Biodiversity	Conservation Maintenance Schedule
Community and Partnerships	Yellagonga Education and Community Awareness

City of Wanneroo

Table 5 Individual Projects to be undertaken by the City of Wanneroo

KEY FOCUS AREA	PROJECT TITLE
Water Quality	Stormwater Management Plans
	Contaminated Sites
Urban Planning and Development	Local Planning Framework
	Planning Framework for the East Wanneroo Structure Plan
Biodiversity	Conservation Maintenance and Capital Works
Community and Partnerships	Yellagonga Community Awareness Program

3.3 Reporting and Review

Continued monitoring and evaluation of the *YICM Plan 2021-2026* will identify the progress and efficacy of projects, and have the ability to adapt to emergent issues, reconsidering the priority and scope of projects to ensure major benefits for the Yellagonga Catchment are achieved in the first five years of implementation.

The Plan will be reviewed annually and a major five-year review of the YICM Plan will commence in 2026 to identify further action needed to address additional and emergent threats in the catchment. These additional action areas will inform the subsequent incarnation of the Plan.

The two Cities will have shared responsibility for undertaking the review process.



Aerial image of Yellagonga Regional Park

4.0 PROJECT DETAILS

4.1 Joint Projects

Joint projects will be undertaken in partnership between the Cities of Joondalup and Wanneroo.

Water Quality Monitoring and Improvement Program

Project Description

There are a number of water quality issues arising from groundwater and surface water inputs. These include nutrient enrichment resulting in eutrophication, algal blooms and midge outbreaks; and toxicants such as heavy metals, petroleum products, pesticides, herbicides and industrial/household chemicals.

Monitoring and mapping of water quality entering into Yellagonga wetlands is vital to continued understanding of the movements and concentrations of contaminants.

Edith Cowan University Mine Water and Environment Research Centre has undertaken surface and groundwater quality monitoring and reporting for the two Cities since 2010. The monitoring provides details on the health of the water quality and recommendations to improve water quality are provided.

The Water Quality Monitoring Program is undertaken in liaison with the Midge Steering Group Partnership Research which shares the same goal of improving water quality.

Project Objectives

- Increase the understanding of contaminant inputs into Yellagonga wetlands.
- Provide data upon which sound management decisions can be made.
- Reduce negative impacts within the Yellagonga Catchment associated with poor water quality.

Scope

The project will:

- Continue scientific monitoring and investigations of groundwater and surface water in the Yellagonga Catchment and Park.
- Support scientific and education programs aimed at identifying and mitigating sources of contaminants.
- Collate, analyse, disseminate, and share data between managing authorities.
- Provide recommendations for on ground actions to improve water quality.
- Incorporate smart technology into water quality monitoring through engagement with the ‘Smart Monitoring and Management, Yellagonga Wetlands’ project in a way that maintains the integrity of the data.
- Acid sulphate soil investigation, mapping, and development of management options as the need arises to prevent or limit acidification of the wetland system.
- Create a dynamic water budget for the wetland system which when coupled with water quality data can be used to identify key sources of contamination and be used to determine the most cost effective treatment or containment strategies.

Targets / Timeframes

Monthly monitoring of surface water (during the wet season and less frequently in the dry) and bimonthly groundwater conducted and the Cities to receive annual reporting of water quality of the Yellagonga Wetlands by the end of June each year.

Project Partners

Edith Cowan University.

Department of Water and Environmental Regulation.

Water Conservation Project

Project Description

The Yellagonga Wetlands are a groundwater dependent system and as such affected by lower rainfall as a result of climate change. Continued reduced rainfall and use of groundwater has the potential to significantly affect the water levels and surrounding habitats of the Yellagonga Wetlands. In order to conserve this important wetland region and its inhabitants, a focus on water conservation is required, particularly groundwater consumption through bore water abstraction.

It is important to note that on-going land clearing and land use changes such as for the East Wanneroo development may lead to increased groundwater levels as a result of a combination of increased recharge from urbanisation and reduced abstraction as agricultural land uses begin to move out of the area. Increases in groundwater levels in the East Wanneroo area have the potential to cause water level rise in the Yellagonga wetlands.

Water level rise is a potential threat to Lake Joondalup as it has a natural wetting drying cycle and permanent inundation from increased water levels poses a threat to those aspects of wetland ecology dependent on regular drying periods. This threat is dependent on climate change and activities which have the potential to affect groundwater levels and overland flow such as the nature and rate of development.

Reports provided by ECU for the Yellagonga Water Quality Monitoring Program recommend that the preferred minimum water level for the Yellagonga Wetlands be managed and that options for the artificial water maintenance of Lake Goollelal be investigated to avoid acid sulphate soil exposure and contamination caused as a result of drying of the lake. The current minimum water level threshold for Lake Goollelal is 26.0mAHD, and Lake Joondalup is 15.8mAHD, To limit risks of acidification at the lakes, the DWER is proposing revised minimum level threshold of 26.4mAHD for Lake Goollelal and 16.2mAHD for Lake Joondalup, These revised thresholds will be published in the Gnangara groundwater allocation plan which is due for release for public comment in 2021.

As prolonged high water levels may also pose a risk to the health of the ecology of the wetlands, investigating setting a maximum water level target for Lake Joondalup may have value, particularly in relation to assessing risks and managing potential groundwater level rises as a result of urban development in East Wanneroo.

Project Objectives

- Ensure future survival of the Yellagonga Wetlands through water conservation.
- Maintain lake water levels above minimum water level requirements.
- Minimise risks of prolonged high minimum water levels impacting on the wetland's ecological values.
- Provide healthy wetland habitat for wildlife.
- Minimise the risk of acid sulphate soil exposure.
- Minimise nutrient enrichment and midge outbreaks.
- Provide visual amenity for the community.

Scope

The project will:

- Liaise with the DBCA and the DWER on the proposed revised minimum water level thresholds included in the Gnangara groundwater allocation plan.
- Investigate achieving the proposed higher minimum water levels through decreasing groundwater use, and environmentally sensitive stormwater drainage.
- Investigate the feasibility of artificial water maintenance for Lakes Goollelal and Joondalup should levels drop below the minimum water level threshold.
- Liaise with the DWER and the DBCA regarding on-going monitoring of water levels and any declines in wetland health due to high, or low water levels.
- Establish a community and industry water efficiency education program for suburbs within the Yellagonga Catchment in liaison with the DWER.
- Continue implementation of the City of Joondalup *City Water Plan 2016-2021*, City of Wanneroo *Water Conservation Plan*, and their successors.



Lake Joondalup

Targets / Timeframes

- Yellagonga Catchment community and industry water efficiency education program to be established by December 2023.
- City of Joondalup *City Water Plan* projects delivered in accordance with the Council approved *City Water Plan* and annual progress reports presented to Council by December each year.
- Continued delivery of the CoW *Water Conservation Plan* to ensure effective reduction in City water usage in parks and reserves within and around the Yellagonga Catchment.

Project Partners

Department of Biodiversity, Conservation and Attractions.

Department of Water and Environmental Regulation.

Midge Steering Group Partnership Research

Project Description

The CoJ, CoW and the DBCA, have a formal agreement for managing midge within the wetlands of the Yellagonga Regional Park. This agreement is formalised with the Midge Management Strategy Partnership Agreement 2020-2025. The Midge Steering Group, established as part of the partnership agreement, comprises representatives of each partner agency.

The Agreement is designed to encourage an effective and sustainable partnership for the purpose of managing nuisance midge within the wetland system of the Yellagonga Regional Park. The key objective is:

4.1 For control and management of nuisance midge within the wetland system of the Yellagonga Regional Park, through funding midge larval and water monitoring, nuisance reduction using pesticide application when required, other intervention strategies, research projects in an effort to better understand the factors contributing to the seasonal midge plagues and public information and education.

This Midge Steering Group Partnership Research project identified in this Plan focuses on the research component. The Midge Steering Group Partnership have organised numerous research projects of the Yellagonga Wetlands undertaken by Edith Cowan University Centre for Ecosystem Management to identify methods of:

1. Improving water quality within Lake Joondalup.
2. Reducing dependence on short term chemical treatments for the management of nuisance midge swarms.

Varied research projects have been developed since 2007 which have continued to indicate excessive quantities and key sources of nutrient inputs into the wetland system. Groundwater has been identified as a likely major source of nutrients into the Yellagonga Wetlands particularly through Beenyup Swamp. Since 2009 this research project has been undertaken in coordination with the YICM Water Quality Mapping and Monitoring Program.

The Midge Steering Group Partnership Research is undertaken in liaison with the Water Quality Monitoring Program which shares the same goal of improving water quality.

Project Objectives

- For control and management of nuisance midge within the wetland system of the Yellagonga Regional Park, through funding midge larvae and water monitoring, nuisance reduction using pesticide application when required, other intervention strategies, research projects in an effort to better understand the factors contributing to midge plagues and public information and education.

Scope

The Midge Steering Group will organise research projects that may include:

- The review of existing data to determine correlations between water quality, temperature, weather and other factors, with midge larvae numbers.
- Evaluating the feasibility for alternate intervention strategies.
- Further research into the influence of water quality, habitat, or other factors on the midge life cycle.
- Research relating to predictive capabilities for midge emergence that could enable better control.
- Research relating to the nutrient budget of the wetlands and linkage with nutrient contributors within the catchment.
- The effectiveness of S-Methoprene to control midge larvae within Lake Goollelal.

Research will be undertaken in coordination with the Water Quality Monitoring Program.

Targets / Timeframes

The Midge Steering Group will meet annually to discuss and review to details of the Agreement and accompanying Action Plan. All actions outlined in the Action Plan and related outcomes of each midge season shall be documented and provide feedback on the effectiveness of the Midge Agreement. Prior to the Midge Agreement expiring on 30 June 2025, it will be required to initiate a meeting inviting all partners to review the possible renewal of the Midge Agreement for a further five (5) year period.

Project Partners

Department of Biodiversity, Conservation and Attractions.

Local Biodiversity Project

Project Description

Within the Yellagonga Catchment Area there are numerous issues that have the potential to adversely impact on the Park's biodiversity values; these include altered bushfire regimes, weeds, pest animals, pathogens/disease and poor water quality.

While some of these threats are addressed through conservation maintenance schedules and site specific projects managed by the two Cities, DBCA and community groups, further work is required to address the key threats to the biological diversity of the Yellagonga Regional Park.

Project objectives

- Implement best practice fire management for the Park.
- Reduce the incidence of weeds in the Park.
- Reduce the occurrence of pest animals in the Park.
- Reduce the impact of water pollutants including exceeded levels of metals and other toxicants on wetland fauna.
- Avoid the spread of pathogens and disease within the Park.
- Increase the populations of local native fauna, with particular focus on the South-western Snake-necked Turtle (*Chelodina colliei*).
- Provide optimal habitat for a diversity of wildlife.
- Enhance water quality through biofiltration.

Scope

The project will:

- Develop and implement a *Working Group Project Plan* in partnership between the CoJ, CoW and DBCA to be signed by all three project partners and reviewed on an annual basis.
- Seek funding opportunities to undertake fauna and flora surveys in collaboration with the DBCA. These surveys are to include:
    - Local native and migratory fauna.
    - On-ground works to protect South-western Snake-Necked turtles and their habitat.
    - Pest animal sightings.
    - Vegetation condition.
    - Weed mapping.
    - Impact of exceeded levels of metals and other toxicants on fauna where possible.
    - Information to guide key performance indicators of native fauna composition and advice sought from DBCA of recommendations (if any) for appropriate native fauna species reintroduction, particularly Quenda.
- Identify and plan for sites requiring revegetation, and weed control works (guided by findings from surveys, conservation maintenance teams, DBCA, Yellagonga Regional Park Community Advisory Committee and tertiary institution recommendations).
- Develop a 'Yellagonga Biodiversity Management Plan' to capture works undertaken to date (e.g. flora surveys, revegetation) to assist with planning future project works.
- Seek collaborative opportunities to partner with key stakeholders on revegetation goals.
- Seek collaborative opportunities to partner with key stakeholders on fauna conservation goals.
- Implement the Conservation Maintenance Schedules of the two Cities and the DBCA in liaison with the co-managers, Friends of Yellagonga Regional Park, and other community groups.
- Continue coordination of pest animal management including fox, feral cat, rabbit and European Honey Bee in liaison with the DBCA.



Grasstree Hazard Reduction Burn

- Implement the following City of Joondalup Management Plans within the Park, and assess any gaps through the YICM Annual Review process:
  - o *Bushfire Risk Management Plan*.
  - o *Weed Management Plan*.
  - o *Pathogen Management Plan*.
- Implement the following City of Wanneroo Management Plans within the Park, and assess any gaps through the YICM Annual Review process:
  - o *Weed Management Policy*.
  - o Pathogen and fire management matters, through their inclusion in specific Management Orders, and tenders for natural areas for individual conservation reserves.

Targets / Timeframes

- Working Group Project Plan developed and signed by all parties once the *YICM Plan 2021-2026* has been endorsed by the two Cities Councils.
- Flora (weed mapping) surveys undertaken in priority areas of Yellagonga Regional Park by 2024-2025.
- Annual progress reporting against the City of Joondalup *Weed Management Plan* and *Pathogen Management Pla*n conducted in June of each year.
- City of Wanneroo *Weed Management Policy* review will take place bi-annually and Policy updated accordingly.
- *Yellagonga Biodiversity Management Plan* developed by December 2024.

Project Partners

Department of Biodiversity, Conservation and Attractions.

Education and research institutions.

Strategic Partnerships

Project Description

Keeping up to date with developments in the area of integrated catchment management will ensure that the Cities are implementing best practice approaches in managing the Yellagonga Wetlands. There are a number of government and non-government groups and educational and research organisations within Western Australia and Australia that focus on building the capacity of local government to manage wetland areas and reduce impacts from the wider catchment.

The Cities to continue investigating opportunities to partner with stakeholders, industry groups and research institutions to enable the Cities to build capacity and gain information relating to best practice approaches to integrated catchment management planning.

The Friends of Yellagonga Regional Park and Woodvale Waters Friends of Beenyup Channel Group are local groups of conservation volunteers that make a valuable contribution towards the conservation of biodiversity by helping to protect, preserve and enhance the site. The Friends of Yellagonga Regional Park conduct a variety of activities such as planting local species, removal of introduced plant species and site maintenance. The Cities support the Friends Group through the provision of training, information and financial assistance.

Information sharing regarding Yellagonga Regional Park is conducted with the community by both Cities liaising with the Yellagonga Regional Park Community Advisory Committee facilitated by the Department of Biodiversity, Conservation and Attractions.

Project Objectives

- To ensure that the Cities are well informed of developments in integrated catchment management.
- To achieve conservation goals for the Park in collaboration with key stakeholders.

Scope

The project will:

- Increase support for the Cities in implementing integrated catchment management activities.
- Increase knowledge of best practice approaches to integrated catchment management.
- Seek collaborative opportunities to partner with key stakeholders on conservation and educational initiatives for the Park.

Targets / Timeframes

Regular updates of *YICM Plan* projects provided by both Cities at the Yellagonga Regional Park Community Advisory Committee meetings held quarterly.

Project Partners

Department of Biodiversity, Conservation and Attractions.

Relevant State Government agencies.

Friends of Yellagonga Regional Park.

Woodvale Waters Friends of Beenyup Channel Group.

Education and research institutions.

4.2 Individual Projects

Individual Projects will be undertaken separately by the relevant City.

City of Joondalup Projects

Yellagonga Education and Community Awareness

Project Description

The City of Joondalup delivers community awareness and education initiatives through the City's Environmental Education Program (EEP). These initiatives target local residents and the broader community with an aim to enhance the appreciation of the conservation significance of this important local wetland region. Through the EEP Program the City provides experiences through free tours and activities focused on flora, fauna, Noongar cultural heritage, and wetland ecology.

Initiatives undertaken include World Wetlands Day initiatives, fauna awareness initiatives and programs to encourage responsible pet ownership.

The City is currently in the process of developing a Reconciliation Action Plan. The City will continue to engage Noongar providers to deliver cultural tours within the Park and continue to engage and work with local Noongar people in the development of educational materials relating to the Yellagonga Regional Park and its surrounds.

The Project's objectives and scope, outlined below, are specific to activities delivered in the Yellagonga Catchment.

Project Objectives

- Develop and implement initiatives and projects that aim to increase the community's understanding of environmental issues affecting the Yellagonga Catchment.
- Increase the community's access to ecotourism experiences by delivering biodiversity and cultural heritage related initiatives within the Yellagonga Catchment Area.
- Reduce adverse community impacts on the Yellagonga Wetlands through the provision of information and resources addressing the key threats to the area.

Scope

The project delivery for Yellagonga Regional Park will include:

- Tours and presentations to raise community awareness of the Park including flora, fauna, and Noongar Cultural Heritage tours.
- Sustainable gardening community workshops to encourage reduced water and fertiliser use and native plantings adjacent the Yellagonga Wetlands.
- Yellagonga school and community educational resources available on the City's website.
- Ongoing distribution and displays of existing and new brochures and posters to raise awareness of key Yellagonga conservation issues.
- Implementation of the Lake Goollelal Heritage Walk project.

Targets / Timeframes

Annual calendar of events to be developed and implemented by the City.

Project Partners

Department of Biodiversity, Conservation and Attractions.

Relevant tour guides.

Community groups.

State Government agencies.

Educational institutes.

Stormwater Management

Project Description

Urbanisation has resulted in many impervious surfaces, with traditional piped drainage networks and altered topography, which has significantly changed the natural hydrological regime in the Yellagonga Wetlands. The direct discharge of stormwater into wetlands via piped outfalls is considered to be an ongoing source of pollution into these systems.

The City of Joondalup completed an upgrade of all its outfalls in the Yellagonga Catchment as part of the implementation of the *YICM Plan 2009-2014*. To further improve the quality of water infiltrating to groundwater the City is delivering upgrades to sump infrastructure through the Stormwater Drainage Program - Sump Beautification Project. The project aims to further improve biofiltration of City sumps and increase amenity.

Project Objectives

- Manage quality and quantity of stormwater in the Yellagonga Catchment, prior to reaching Yellagonga Wetlands.
- Protect Yellagonga Wetlands from contaminants.
- Improvement of sumps adjacent the Yellagonga Wetlands within the City of Joondalup to effectively manage water quality and quantity.

Scope

The sumps will be assessed, ranked and prioritised based on criteria such as environmental impact, flooding risk and visual improvement. The Program for upgrading of sump infrastructure will occur in accordance with the City of Joondalup *Stormwater Management Policy*.

Targets / Timeframes

- Sump Beautification Projects are considered each year during the Capital Works budget process.

Project Partners

Department of Water and Environmental Regulation.

Conservation Maintenance Schedule

Project Description

The City of Joondalup has management responsibility for over 500ha of natural bushland contained within 108 reserves. The bushland is comprised of coastal vegetation, remnant bushland fragments in urban areas, and small areas of wetland vegetation. The City of Joondalup also undertakes extensive detailed surveys of their bushland as part of the Local Biodiversity Program. The bushland is prioritised for management according to the condition and ecological values of the site. The City of Joondalup managed sites in Yellagonga Regional Park include Neil Hawkins Park and a small section of bushland to the south and Picnic Cove Park. The majority of Yellagonga Regional Park is managed by the DBCA particularly through its conservation maintenance program.

The City's Conservation Maintenance Schedule includes the planning and implementation of conservation works to ensure its two sites within Yellagonga Regional Park are maintained and enhanced to achieve quality recreational amenity, optimal vegetation condition and wildlife habitat.

Shared information and coordination of conservation works are undertaken through the Yellagonga Regional Park Community Advisory Committee facilitated by the DBCA.

Project Objectives

- Maintain habitat for wildlife.
- Protect and enhance local native flora.
- Maintain recreational parks to a high standard.

Scope

The project will implement the City's Conservation Maintenance Schedule at City managed sites within the Park that ensures regular programmed visits to all sites.

Targets / Timeframes

Conservation maintenance activities implemented in accordance with the approved Conservation Maintenance Schedule. The Conservation Maintenance Schedule reviewed annually.

Project Partners

Department of Biodiversity, Conservation and Attractions.

City of Wanneroo Projects

Yellagonga Community Awareness Program

Project Description

Environmental education across the community is vital to promote ownership and appreciation of the local environment. The Yellagonga Ecotourism and Community Awareness Program will undertake education initiatives, targeting schools, residents, communities, and visitors to the City, to address key environmental issues and encourage greater environmental stewardship by the community.

Project Objectives

- Increase the community's understanding of contaminant inputs into Yellagonga wetlands.
- Provide data upon which sound management decisions can be made.
- Reduce number of negative incidences associated with poor water quality.

Scope

The project will:

- Engage the 'Beyond Gardens' team and arrange seminars and workshops that aim to encourage native landscaping and reduce fertiliser use in residential gardens.
- Develop a "Yellagonga Regional Park" information brochure for the City of Wanneroo.
- Continue implementation of the Light Industry Program with a focus on education and awareness for the automotive industry in the Wangara Industrial Area.
- Organise and run community events that benefit the wetland such as night stalks, spring guided walks, and winter planting days.

Targets / Timeframes

Community events and Ecotourism initiatives will be organised on a case by case basis throughout the year. Feedback on the number and type of events will be provided through the annual report to Council for *YICM Pla*n projects.

Project Partners

Department of Biodiversity, Conservation and Attractions.

Stormwater Management Plans

Project Description

Urbanisation has resulted in many impervious surfaces, with traditional piped drainage networks and altered topography, which has significantly changed the natural hydrological regime in Yellagonga Wetlands. The direct discharge of stormwater into wetlands via piped outfalls is considered to be an ongoing source of pollution into these systems. Some drainage sub catchments consist of potentially greater polluting land uses than others, such as industry, poultry farming and horticultural practices.

The CoW has undertaken a storm water masterplan study within the Yellagonga Regional Park to assess the effectiveness of previous catchment retrofitting works and to develop a roadmap for future upgrades.

The *YICM Plan* has detailed many of the early elements required in the development of a *Stormwater Management Plan* for the Yellagonga catchment. These include:

a) Stakeholder involvement and analysis of sub-catchments.

b) Identification of catchment characteristics, condition and practices.

c) Identification of the values of the receiving environment – Yellagonga Regional Park.

d) Identification of the stormwater threats.

e) Identification of priority sub-catchments for upgrade.

Formal and detailed management of the stormwater infrastructure within the Yellagonga catchment area has been set out within the City of Wanneroo's Corporate Business Plan (4 Year Capital Works Delivery Program and Action Plan) and the 20 Year – Long Term Financial Plan. The process will now be completed over the course of a number of years, with details of the process outlined in the scope of this project.

Project Objectives

- Manage quality and quantity of stormwater in the Yellagonga catchment, prior to reaching Yellagonga wetlands.
- Protect Yellagonga wetlands from contaminants.
- Upgrade all appropriate infrastructure in the catchment to effectively manage water quality and quantity.
- Consider a phased role out of the outcomes of the stormwater catchment study, subject to funding allocations.

Scope

The project will produce a *Stormwater Management Plan* for each sub-catchment within the Yellagonga catchment following the process outlined in the Department of Water's Stormwater Management Manual for Western Australia. Each *Stormwater Management Plan* will:

- Identify management objectives.
- Identify the management options.
- Develop management actions.
- Include an Implementation Plan.

In addition to the works to be carried out within the individual sub-catchments, the following is to be completed over the course of the project as a whole:

- Summarise past design strategies and extent to which they were implemented.
- Identify shortcomings/failings in previous strategies.
- Implement recommendations of the Gap Analysis and Stormwater Drainage Study.
- Monitor water quantity and quality of water entering the Wangara Sump.

Targets / Timeframes

Continue to carry out monitoring and data collection to inform future potential upgrade projects.

Ensure ongoing maintenance and monitoring of stormwater infrastructure within the Wangara Industrial Area to improve water quality entering the wetlands from Wangara.

Project Partners

Nil.

Contaminated Sites

Project Description

Historical and existing land uses may result in contamination of soils throughout the Yellagonga catchment. For example, the previous use of persistent pesticides or inappropriate disposal of industrial compounds may have an adverse effect on the quality of the groundwater entering the wetlands.

Lot 9005 Motivation Drive, Wangara has been classified as "Possibly contaminated, investigation required" by the DWER. Other suspected sites in the Yellagonga catchment on the Wanneroo side are yet to be classified by the DER.

Site investigations, involving sampling and analysis, were completed in August 2019 by environmental consultants for the City of Wanneroo owned contaminated site at Lot 9005 Motivation Drive, Wangara. The investigation reporting is being finalised for provision to the Contaminated Site Auditor for assessment and reporting to the DWER.

Project Objectives

- Identify any contaminated sites owned or managed by the CoW in the Yellagonga catchment.
- Remediate City owned or managed contaminated sites in the Yellagonga catchment.

Scope

The project will:

- Collate classification of City owned or managed potentially contaminated sites in the Yellagonga catchment.
- Engage consultants to conduct sampling and analysis of contaminated sites classified by the DWER as requiring further investigation.
- Develop plans for remediation works as necessary.

Targets / Timeframes

An Auditor's Report for Lot 9005 Motivation Drive was finalised and provided to the DWER in May 2021. Priority actions have been established for the City to undertake including further monitoring to be carried out into the future.

Project Partners

Department of Water and Environmental Regulation.

Conservation Maintenance and Capital Works

Project Description

The City of Wanneroo has over 140 conservation reserves under its control including Coastal reserves, numerous Wetland reserves and Bushland reserves. In all approximately 2,500ha of land are under management. In 2003, a Biodiversity Assessment was carried out on 94 conservation reserves in the City of Wanneroo, highlighting the management needs of these reserves to maintain or improve biodiversity values.

It was recognised that in order to manage the CoW's conservation areas in an environmentally responsible manner that staffing numbers needed to increase and formalised procedures be developed to reflect these environmental responsibilities.

The Capital Works component of this project will include the installation of infrastructure such as fencing and controlled access, wetland bank stabilisation, control of exotic flora species and planting and revegetation works.

The maintenance of reserves within the Yellagonga catchment includes pest and weed management, fire management, and extensive revegetation works.

Project Objectives

- Ensure that natural areas are maintained and enhanced.
- Improve and maintain habitat for local wildlife.
- Protect unique and diverse flora for future generations.
- Rehabilitate key areas of the Regional Park and its catchments.

Scope

The project will:

- Maintain and improve biodiversity values of conservation reserves and other natural areas managed by the City of Wanneroo within the Regional Park and associated catchments.
- Investigate resourcing opportunities that meet the above objectives.
- Ensure constant improvement on existing maintenance schedules and arrange regular programmed visits to all sites.
- Rehabilitate key areas managed by the City of Wanneroo within the Regional Park and surrounding catchments by undertaking the following:
    - o Revegetation.
    - o Pest and weed control.
    - o Habitat creation and development of fauna protection areas.

Targets / Timeframes

Maintenance Schedules for Conservation Reserves are to be reviewed monthly and aim to ensure that Conservation Reserves in the Yellagonga Catchment are attended to weekly to ensure hazards are identified and actioned in a timely manner.

Project Partners

Nil.

Local Planning Framework

Project Description

The City's Local Planning Framework refers to the various planning instruments which collectively guide the future land use and development in the City. The main elements of the current Framework are the *District Planning Scheme No.2 (DPS 2), Local Planning Policies (LPP's)* and *Structure Plans* prepared under DPS 2.

A new Framework is now being prepared that involves the preparation of a Local Planning Strategy, review of DPS 2 and its associated LPP's, and a review of a number of other City strategies and policies which are now considered dated.

Project Objectives

- To provide input into the preparation of the new Local Planning Framework aimed at ensuring that the new Framework has proper regard to, and includes appropriate measures for, the protection of the environmental values of Yellagonga Regional Park, particularly in respect to the planning and control of land use and development in the surface and groundwater catchment of the Yellagonga wetlands.

Scope

The *Local Planning Framework* will assist in reporting on the ability of new developments to meet the City's community aspirations and promises as set out in the *Local Planning Framework*. The key elements of the new Framework are:

- New Local Planning Strategy.
- New Local Planning Scheme No. 3.
- New and revised Local Planning Policies.

Targets / Timeframes

To have final versions of the *Local Planning Scheme No. 3* and the *Local Planning Strategy* submitted to the Western Australian Planning Commission for endorsement by the end of 2023. However, this is approximate and actual timing of the projects will depend on a range of factors.

Project Partners

Department of Planning, Lands and Heritage.

Planning Framework for the East Wanneroo Structure Plan Area

Project Description

In November 2020, the WAPC approved the *East Wanneroo District Structure Plan* (DSP) subject to the approval of the District Water Management Strategy (DWMS). The DWMS was subsequently approved in March 2021 and involves more detailed groundwater modelling for the East Wanneroo area. It is clear from the groundwater modelling undertaken to date that urban infill of this area (involving displacement of existing growers/ irrigators) will cause a significant rise in groundwater levels, unless appropriately managed.

This affects a broad area encompassing the DSP area, including the land to the west through to the Yellagonga wetlands, and it will be important that consideration is given to the possible implications of any proposed water management strategies on the Yellagonga wetlands.

Project Objectives

- To provide input into the preparation of the Planning Framework for the EWSP area, particularly its water management strategies, aimed at ensuring that the new framework has proper regard to, and includes appropriate measures for, the protection of environmental values of the Yellagonga Regional Park.

Scope

Key elements of the new Planning Framework which the above input will be important for are:

- New land use zonings under the Regional and Local Planning Schemes.
- New District Structure Plans.
- New Local Structure Plans.
- Environmental studies and Management Plans, in particular the water management strategies, prepared in support of, and in order to alleviate impacts of the above planning elements.

Targets / Timeframes

Rezoning of areas from their existing land uses to Urban under the Metropolitan Region Scheme (MRS) should occur by late 2022. Approval of District Structure Plans in the East Wanneroo area occurred in November 2020 subject to the approval of the DWMS which was approved mid-2021.

Project Partners

Department of Planning, Lands and Heritage.



Revegetation underway

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Appendix 1 – Key Achievements of the YICM Plan 2015-2019

Joint Projects

- **Water Quality Monitoring and Improvement Program**
  - Surface water of the Yellagonga Wetlands has been sampled on a monthly basis (during the wet season and less frequently in the dry) since 2010 to determine nutrient and metal levels to collate regular water quality data and assess the condition. Groundwater has been sampled since 2014.
  - Annual reporting of issues and recommendations to executive management.
  - Recommendations to research major pollutant source points and to improve water quality have been investigated or implemented to determine nutrient and metal levels.
  - The two Cities in collaboration with the DBCA, DWER and ECU commenced the Smart Monitoring and Management – Yellagonga Wetlands which aims to leverage smart technology to better manage and protect the Yellagonga wetlands. This project is supported by funding from the Australian Government's Smart Cities and Suburbs Program and is due for completion in late 2020.
- **Midge Steering Group Partnership Research**
  - Midge larvae sampling at Lake Joondalup and Lake Goollelal was conducted on a weekly basis from July/August – February/March from July 2015 - March 2021. Water level and temperature were recorded for each sampling event.
  - Spot treatments of Lake Goollelal using S-Methoprene occurred in 2016, 2017, 2018, and 2019, with between ca (circa) 5%-30% of the lake being treated each season.
  - The two Cities and DBCA maintained records of midge complaints received from residents.
  - Edith Cowan University engaged to undertake a study from 2018-2020 relating to adult midge emergence, providing information on emergence and distribution of nuisance swarms, compliment midge larvae monitoring and identify the effectiveness of the pesticide S-Methoprene.
  - Nuisance midge fact sheet maintained on the websites for both Cities from 2017, and information on managing midge was provided via media releases in 2017 to 2020.
- **Acid Sulphate Soils**
  - The production of the *Acid Sulfate Soil Management Framework for Site Goollela*l by Syrinx Environmental providing ASS management monitoring guidelines and recommendations for future reference should concerns of ASS exposure arise.
  - On-going monitoring of potential ASS impacts on water quality through the Water Quality Monitoring and Improvement Program.
  - The risks associated with disturbing ASS continue to be highlighted where applicable e.g. raising concern with the Water Corporation regarding their Groundwater Replenishment Scheme Beenyup pipeline project to be installed through the Yellagonga Catchment.
- **Vegetated Bund Construction (completed)**
  - A feasibility study was undertaken exploring strategies to improve the water quality of Southern Lake Joondalup (including the viability of a vegetated bund). This study was delivered by consultant Essential Environmental in liaison with the DBCA Regional Parks Unit.
  - Feasibility Study report *Option Analysis and Recommendations for Improved Nutrient Management* did not recommend installation of a vegetated bund, however it identified revegetation as beneficial to improve the uptake of nutrients as well as provide habitat and enhance biodiversity.
  - The Vegetated Bund Construction project is now complete and further initiatives to improve water quality, quantity and vegetation at the site will be undertaken through the Water Quality Monitoring and Improvement Program, Water Conservation Project and the Local Biodiversity Project.

- **Water Conservation Project**
  - Initial research undertaken (e.g. identification of residential and commercial monitoring bores) to guide a collaborative Yellagonga Catchment Working Group community and industry water efficiency education program.
  - The *City Water Plan 2016-2021* was completed in 2016. Key projects relevant to the Yellagonga Wetlands include:
  - New projects: Groundwater Classification Project; Water Efficiency Database; Weather Station Project and Leak Detection Project.
  - Existing projects: Low Rainfall Irrigation Management Plan; Irrigation Infrastructure Management; Review of Nutrient Management Practices; Stormwater Drainage Program; Stormwater Management Policy and Parks Redevelopment Program.
  - Progress of projects within the current City of Joondalup Water Plan 2012-2015 and City water conservation measures relevant to the Yellagonga Wetlands such as:
  - The CoJ has been operating within the allocation limits and license conditions of the DWER extraction licenses as identified in the City of Joondalup Groundwater Monitoring Program.
  - Two draft plans; Yellagonga Catchment Water Conservation Action Plan and draft Yellagonga Water Education Plan, were developed and presented to the Yellagonga Catchment Working Group Subcommittee (YCWGS).
- **Local Biodiversity Project**
  - Flora surveys were completed at six priority sites covering approximately 278ha of remnant vegetation within the Park.
  - A Rakali (*Hydromys chrysogaster*) survey undertaken in May 2018 at Lake Goollelal led by the DBCA in partnership with the City of Joondalup.
  - The *Revegetation Management Plan – South Lake Joondalup* was developed to guide weed control, and revegetation activities for this area.
  - Approximately 5ha of revegetation with local provenance species was implemented.
  - Priority weed control undertaken based on recommendations from flora surveys. Weed control was undertaken by the DBCA-RPU, the Cities of Joondalup and Wanneroo, and through the engagement of a contractor using working group funds.
  - Contribution towards fox control within the Park undertaking and additional four (4) weeks of control in 2020 and three weeks in 2021. Under the tri-agreement between the DBCA, and the Cities of Joondalup and Wanneroo four (4) weeks of fox control are undertaken annually through the engagement of a contractor.
- **Strategic Partnerships**
  - The South Lake Joondalup - Beenyup Channel revegetation project was delivered successfully in partnership with key stakeholders including DBCA, Friends of Yellagonga Wetlands, and Woodvale Waters Friends of Beenyup Channel Group.
  - The Cities have liaised with, and sought expertise from, state government agencies, universities and industry to obtain information on best practice in wetland conservation including:
  - Coordinating the collaborative government agency Yellagonga Smart Monitoring and Management Project for advanced monitoring technologies in the wetlands to guide conservation measures.
  - Liaison with DWER and UWA on a study sampling Lake Goollelal surface water to identify human waste associated with septic tank leaching.
  - Progress of the YICM Plan implementation is reported to the quarterly Yellagonga Regional Park Community Advisory Committee meetings. Collaborative planning on relevant conservation issues for the Park is also undertaken with this committee.

City of Joondalup Individual Projects

- **Yellagonga Ecotourism Community Awareness Program**
  - Responsible Pet Ownership Campaign.
  - Dogs on lead signs installed.
  - Feral and Wandering Cats sign installed.
  - Increased patrols by City Rangers along West side of the Park to police dogs off lead.
  - Dog Ownership, and Responsible Cat Ownership brochures produced by City Rangers.
  - Prevention of Hand Feeding Wildlife Campaign.
  - What Happens if I Feed Wild Birds? brochures distributed.
  - Please Do Not Feed the Wildlife signs up-graded at Neil Hawkins Park.
  - Yellagonga School Program.
  - Water Quality Awareness Program.
  - Business Awareness Program.
- **Yellagonga Ecotourism**
  - Yellagonga EcoTourism events are incorporated into the City's Think Green events calendar, Environmental News and Events e-newsletter, and relevant advertising.
  - Activities were also delivered through the Environmental Education Program, e.g. Nightstalk Fauna tours, Noongar bush tucker tours, BirdLife WA workshops.
- **Stormwater Management Plans**
  - The City of Joondalup completed retrofitting of all stormwater outfalls entering Lakes Joondalup and Goollelal within the City's boundaries by 2010.
  - Duffy Terrace Catchment works were completed in February 2020 to capture and infiltrate (at source) part of the overall catchment, reducing nutrient discharge to Walluburnup Swamp (via the Duffy Terrace outlet). Previous works in this catchment in 2009 included the installation of pollutant trap and settling basin to treat the Duffy Terrace outlet.
- **Local Biodiversity**
  - Biodiversity linkages reflecting plant communities and soil types between the Yellagonga Wetlands and the coast have been planted through the Iconic Landscaping Project.
  - Assistance and funding have been provided to BirdLife WA as part of their Connecting Urban Communities with Nature Project, with works having been undertaken to enhance green corridor links to the Park.
  - Pathogen sampling and mapping was undertaken at priority sites identified within the *Pathogen Management Plan 2013-2016*. This Plan was reviewed and a *Pathogen Management Plan 2018-2028* for internal operational use was completed in 2018.
  - A Pathogen Treatment Program was undertaken in spring 2018, with vegetation within 30 sites treated.
  - A *Bushfire Risk Management Plan 2018-2023* was produced for internal operational use with treatment strategies relevant to the Park identified to be implemented in liaison with the DBCA and DFES.
- **Conservation Maintenance Schedule**
  - Conservation maintenance of the City managed sites within the Park, Neil Hawkins Park (including 4.7ha of bushland south oh Neil Hawkins Park) and Picnic Cove, included weed mapping, ongoing weeding, planting, fencing and litter removal.
  - Continued co-funding of six-monthly fox control program in partnership with the CoW and DBCA.
  - Continued support of the Friends of Yellagonga Regional Park.

- **Climate Change Strategy 2014-2019**
  - Delivery of the Think Green Energy Program to promote energy conservation and climate change awareness to the community.
  - The City's *Stormwater Management Policy* updated to include recognition of climate change.
  - Energy and Water Audits undertaken making recommendations on water and energy conservation.
  - Significant progress towards implementation of the Coastal Adaptation Planning and Implementation Project.
  - Implementation of the Coastal Monitoring Program and the completion of a Baseline Monitoring Report to be used for future comparative analysis.
  - Continuation of the Renewable Energy Program.
- **Review of the City's Local Planning Strategy and Local Planning Scheme**
  - The City of Joondalup's *Local Planning Strategy* was adopted by Council at its July 2014 Meeting and was endorsed by the Western Australian Planning Commission in November 2017.
  - *Local Planning Scheme No.3* (LPS3) was approved by the Minister for Planning in October 2018 and is now in operation.
  - The majority of the land that was included in Schedule 5 of DPS2 are now included as 'Environmental Conservation,' giving those areas greater standing as they are now specifically set aside for local conservation.

City of Wanneroo Projects

- **Conservation Maintenance and Capital Works**
  - Continued management of key sites around the Yellagonga wetlands including weed control and revegetation works.
  - Continued co-funding of six-monthly fox control program in partnership with the CoW and DBCA.
  - Continued support of the Friends of Yellagonga Regional Park.
- **Contaminated Sites**
  - Commencement of on-site investigations of ground-water and soil to determine the extent of contamination of Lot 9005 Motivation Drive Wangara.
- **Stormwater Management Plans**
  - Upgrades of stormwater infrastructure have continued throughout the eastern side of the Wangara Industrial area.
  - Commencement of a 12 month monitoring program of key stormwater infrastructure within the Wangara Industrial area.
- **Yellagonga Ecotourism and Community Awareness Program**
  - In 2019 the City of Wanneroo commenced its Light Industry Program which aims to reduce contaminants entering groundwater and stormwater systems from non-residential land uses such as light industry and commercial areas through routine inspections of the Wangara Industrial Area. Between March 2017 and June 2021, a total of 255 inspections were conducted in the Wangara industrial area.
- **Local Biodiversity**

o The City of Wanneroo's revised *Local Biodiversity Plan (2018/19-2023/24)* was adopted by Council on 11 December 2018. The *Local Biodiversity Plan* (LBP) sets out a comprehensive list of actions that aims to protect and enhance biodiversity throughout the City.

- **Planning Framework for the East Wanneroo Structure Plan Area**
  - Rezoning of 2,200ha of land in East Wanneroo to Urban Deferred under the Metropolitan Region Scheme was completed in September 2018. In addition, a draft District Structure Plan (DSP) was released for comment in September 2019 and was approved in mid-2021. The draft DSP is supported by an Integrated Water Management Framework which is a precursor to a District Water Management Strategy which should provide a better indication as to how water levels in the Yellagonga wetlands might be affected by the urbanisation of the East Wanneroo DSP area.

Appendix 2- Strategic Context

Local Context

City of Wanneroo

The Strategic Community Plan 2017/18 – 2026/27 is the City of Wanneroo's long-term vision capturing the aspirations of the community and describing the City's objectives. It also provides strategic guidance to the City regarding priority focus areas and direction and informs the City's Corporate Business Plan. This is also the key document for Council to track and report back to the community on progress. The Plan includes four pillars, one of which is Environment. The aspiration identified for the Environment pillar is for 'A healthy and sustainable natural and built environment'.

The development and implementation of the *Yellagonga Integrated Catchment Management Plan 2021-2026* will help the CoW achieve this aspiration. Other CoW strategic documents, policies and local laws that are relevant to the *YICM Plan 2021-2026* are listed in Table 7.

Table 7 City of Wanneroo local law and policy relevant to the *YICM Plan 2021-2026*

Local Biodiversity Plan 2018/19-2023/24
Implementation of the Local Biodiversity Plan will help integrate biodiversity protection into land use planning, commit to ongoing action and new projects to improve biodiversity conservation.
Local Environment Strategy* (LES) *2019
The LES sets out the high level framework for all of the City's strategic environmental planning initiatives and promotes a balance between growth and the protection and enhancement of the natural and built environments.
Smart Growth Strategy 2005
Developed to more effectively manage growth in the City, in both new and existing suburbs. The strategy has six key principles, one of which is Long Term Health of the Environment.
***Local Planning Policy 4.1: Wetlands* (2010)**
The objectives of the Policy are to ensure development within the City of Wanneroo appropriately protects and manages the environmental attributes of wetlands and also recognises the value and benefit of wetlands to the local environment and community.
Feral Animal Control Program
The feral animal control program aims to improve and protect biodiversity within the City with a focus on feral rabbits and foxes. The program is undertaken in line with relevant legislation and is carried out in strategically selected City-managed conservation areas including areas within and adjacent to the Yellagonga Regional Park.
***Local Planning Policy 4.8: Tree Preservation Policy* (2006)**
To provide a mechanism to protect significant trees of the City within the following specified areas: vacant land and bushland which will be subject to future development; and existing and proposed public open space reserves.
Cats Local Law 2016 and Dogs Local Law 2016
Provide for the regulation, control and management of the keeping of animals within the City of Wanneroo. The effect of this local law is to establish the requirements with which owners and occupiers of land within the district must comply in order to keep animals and provides the means of enforcing the local law.

City of Joondalup

Joondalup 2022: Strategic Plan 2012-2022 is the City's long-term strategic planning document; outlining its commitment to achieving the vision and aspirations of its community and regional stakeholders. One of its key focus areas is the natural environment which contains the aspirational outcome:

The City is a global leader in adaptive environmental management. It works closely with the community to protect and enhance the natural environment, while celebrating and showcasing its natural assets to the world.

The development and implementation of the *Yellagonga Integrated Catchment Management Plan 2021-2026* will help the CoJ achieve this aspirational outcome. Other CoJ strategic documents, policies and local laws that are relevant to the *YICM Plan 2021-2026* are listed in Table 8.

Table 8 City of Joondalup Local Law and Policy Relevant to the YICM Plan 2021-2026

Strategic Community Plan 2012-2022
This Plan highlights the focus on preservation, conservation and accessibility of the City's natural assets and the importance of engaging with the community and regional stakeholders.
Environment Plan 2014-2019
Guides the City's strategic response to local environmental pressures. The purpose of the Plan is to ensure that the City's operations are delivered in an environmentally sustainable manner and that the City takes measures to effectively influence positive environmental behaviours within the community.
City Water Plan 2016-2021
Management of the City's water resources in a sustainable manner in order to decrease water consumptions, increase efficiency, and improve water quality.
Climate Change Strategy 2014-2019
Provides guidance to the City's climate change management activities and has a dual purpose of both mitigation (to continue to reduce greenhouse gas emissions to minimise the severity of climate change) and adaptation (to implement strategies to ensure the City is prepared and able to adapt to current and future impacts of climate change).
Bushfire Risk Management Plan 2018-2023
The Plan aims to provide a coordinated and efficient approach towards the identification, assessment, and treatment of assets exposed to bushfire related risk within the City of Joondalup.
Pathogen Management Plan 2018-2028
Guides the management of pathogens within the City to minimise the risk of pathogen introduction and spread.
Weed Management Plan 2016
Provides strategic ongoing weed management of the City's natural areas, parks, and urban landscaping areas.
Sustainability Policy
The objective of the policy is to outline the City's commitment to integrating sustainable practices into all local government functions and services.
Stormwater Management Policy
The objective of the policy is to ensure stormwater is managed to protect environmental, social and economic values and to facilitate the integration of water sensitive design principles into planning and development within the City of Joondalup.
Animals Local Law 1999 and Animals (Amendment) Local Law 2010
Provides for the regulation, control and management of the keeping of animals within the City of Joondalup. The effect of this local law is to establish the requirements with which owners and occupiers of land within the district must comply in order to keep animals and provides the means of enforcing the local law.

Regional Context

Table 9 Regional Policy Relevant to the YICM Plan 2021-2026

Bush Forever (2000)
Department of Planning The aim is to provide a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making. Yellagonga Regional Park is designated a Bush Forever site (299).
Bushland Policy for the Perth Metropolitan Region (State Planning Policy No.2.8) **(2010)**
The aim of the policy is to provide a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making.
Draft Gnangara Sustainability Strategy **(2009)**
A cross-government initiative working on an action plan that will ensure the sustainable use of water for drinking and commercial purposes and to protect the environment.
Gnangara: Groundwater Areas Allocation Plan **(2009)**
This water allocation plan aims to balance abstraction of groundwater with the need to retain water in the ground to meet ecological, social, and cultural needs, and provide for public and private use in the future.Note: the new plan is due to be released for comment in late 2021.

State Context

Table 10 State Policy and Legislation Relevant to the YICM Plan 2021-2026

Environmental Protection Act 1986
Provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.
Biodiversity Conservation Act 2016
Provides for the conservation and protection of wildlife.
Planning and Development Act 2005
Provide for a system of land use planning and development in the State and for related purposes.
Biosecurity and Agriculture Management Act 2007
The Act provides effective biosecurity and agriculture management for the State
Bushfires Act 1954
The Act makes for the provision for diminishing the dangers resulting from bushfires and for the prevention, control, and extinguishment of bushfires.
Cat Act 2011
The Act makes provision for the control and management of cats and promotes and encourages the responsible ownership of cats.
Dog Act 1976
The Act makes provisions for the control of dogs in public and private spaces and promotes responsible dog ownership.
Fish Resources Management Act 1994
The Act is the primary State legislation regulating the management of, and utilisations and conservation of fish (which includes all aquatic organisms except reptiles, birds, mammals, and amphibians) and their habitat.
Water Resources (State Planning Policy 2.9) **(2006)**
Provides clarification and additional guidance to planning decision-makers for consideration of water resources in land use planning strategy.
Better Urban Water Management Framework (2008)
Facilitates better management of urban water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning system and provides guidance on the implementation of State Planning Policy 2.9 Water Resources.
Securing Western Australia's water future – A position paper (2013)
Sets out a proposed legislative and policy framework to help deliver new water management solutions in Western Australia.

National Context

Table 11 National Policy and Legislation Relevant to the YICM Plan 2021-2026

Environment Protection and Biodiversity Conservation Act 1999
Is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places.
Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi, Commonwealth of Australia (2014)
This national threat abatement plan came into force on 31 January 2014 and addresses the key threatening process 'Dieback caused by the root-rot fungus Phytophthora cinnamomi, which is listed under the Commonwealth EPBC Act.
Australia's Biodiversity Conservation Strategy 2010 – 2030, Commonwealth of Australia (2010)
The Strategy is a guiding framework for biodiversity conservation for all sectors - government, business and the community. The Strategy sets out priorities which will direct efforts to achieve healthy and resilient biodiversity and provide us with a basis for living sustainably.
Australia's Biodiversity and Climate Change. A strategic assessment of the vulnerability of Australia's biodiversity to climate change. Commonwealth of Australia (2009)
Is an assessment of the vulnerability of Australia's biodiversity to climate change, commissioned by the Australian Government to help increase our understanding of how to help Australia's rich biodiversity adapt to climate change.
Australia's Native Vegetation Framework, COAG (2012)
This Framework is a joint initiative of the Australian, state and territory governments and outlines a coordinated national approach to native vegetation management and provides a mechanism through which the native vegetation management commitments agreed to by all Australian governments can be progressed.

International Context

Table 12 International Legislation Relevant to the YICM Plan 2021-2026

Japan Australia Migratory Birds Agreement (Australia Treaty Series 1981 No.6) **(JAMBA)**
The JAMBA agreement lists terrestrial, water and shorebird species which migrate between Australia and Japan. The agreement requires the parties to protect migratory birds and includes provisions for cooperation on the conservation of threatened birds.
China Australia Birds Agreement (Australian Treaty Series 1988 No.22) **(CAMBA)**
The CAMBA agreement lists terrestrial, water and shorebird species which migrate between Australia and China. The agreement requires the parties to protect migratory birds.
Republic of Korea-Australia Migratory Bird Agreement 2007 **(ROKAMBA)**
The ROKAMBA formalises Australia's relationship with the Republic of Korea in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat.
The Convention on the Conservation of Migratory Species of Wild Animals (1983) **(Bonn Convention)**
Is an intergovernmental treaty that aims to conserve terrestrial, aquatic and avian migratory species throughout their range. Migratory species which are native to Australia and are included in the appendices to the Bonn Convention.
The Convention on Wetlands of International Importance (1971) **(Ramsar Convention)**
Is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Australia currently has 65 wetlands of international importance listed under the Ramsar Conventions (Yellagonga is not one of them).