Natural Area
CONSULTING MANAGEMENT SERVICES

# City of Joondalup

# Ocean Reef Foreshore Reserve Management Plan

**V1.2 – 25 November 2019**

Natural Area Holdings Pty Ltd
99C Lord Street, Whiteman, WA, 6076
Ph: (08) 9209 2767
info@naturalarea.com.au
www.naturalarea.com.au

## Disclaimer

Natural Area Holdings Pty Ltd, trading as Natural Area Consulting Management Services (Natural Area), has prepared this report for the sole use of the Client and for the purposes as stated in the agreement between the Client and Natural Area under which this work was completed. This report may not be relied upon by any other party without the express written agreement of Natural Area.

Natural Area has exercised due and customary care in the preparation of this document and has not, unless specifically stated, independently verified information provided by others. No other warranty, expressed or implied, is made in relation to the contents of this report. Therefore, Natural Area assumes no liability for any loss resulting from errors, omission or misrepresentations made by others. This document has been made at the request of the Client. The use of this document by unauthorised third parties without written permission from Natural Area shall be at their own risk, and we accept no duty of care to any such third party.

Any recommendations, opinions or findings stated in this report are based on circumstances and facts as they existed at the time Natural Area performed the work. Any changes in such circumstances and facts upon which this document is based may adversely affect any recommendations, opinions or findings contained in this document.



| | |
|---|---|
| **Document Title** | JOON R Ocean Reef Management Plan V1.2 |
| **Location** | Client Folders NAC/City of Joondalup/Ocean Reef Man Plan/Report/ |

| Draft/Version No. | Date | Changes | Prepared by | Approved by | Status |
|---|---|---|---|---|---|
| D1 | 15 August 2019 | New document | SH | BC | Draft for client comment |
| V1 | 09 October 2019 | CoJ comments | SH | SB | Superseded |
| V1.1 | 04 November 2019 | CoJ comments | SH | SB | Superseded |
| V1.2 | 25 November 2019 | CoJ comments | SH | SB | Final |

# Contents

# Acknowledgements

Natura Area Consulting Management Services (Natural Area) wish to acknowledge and that the following for assistance and input into the plan during its development:

- City of Joondalup staff
- Friends of North Ocean Reef/Iluka Foreshore.

# Abbreviations and Acronyms

| Abbreviation | Description |
|---|---|
| AASS | Actual acid sulphate soils |
| AHD | Australian Height Datum |
| BAM Act | *Biosecurity and Agriculture Management Act 2007* (WA) |
| BoM | Bureau of Meteorology |
| the City | City of Joondalup |
| CoJ | City of Joondalup |
| Cwlth | Commonwealth |
| DAFWA | Department of Agriculture and Food WA |
| DBCA | Department of Biodiversity, Conservation and Attractions (previously Department of Parks and Wildlife) |
| DEE | Department of the Environment and Energy (Cwlth) |
| DPaW | Department of Parks and Wildlife (WA) (now the Department of Biodiversity, Conservation and Attractions) |
| DPIRD | Department of Primary Industries and Regional Development (previously Department of Agriculture and Food WA |
| DRF | Declared rare flora |
| DWER | Department of Water and Environmental Regulation (previously Department of Environment Regulation) |
| EDOWA | Environmental Defenders Office of WA (Inc) |
| EPA | Western Australian Environmental Protection Authority |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) |
| FONORIF | Friends of North Ocean Reef /Iluka Foreshore |
| GIS | Geographical information system |
| GPS | Global positioning system |
| ha | Hectare |
| IUCN | International Union for Conservation of Nature |
| km | Kilometre |
| km/h | Kilometres per hour |
| m | Metre |
| $m^2$ | Square metres |
| MBCG | Mullaloo Beach Community Group |
| Natural Area | Natural Area Consulting Management Services |

| Abbreviation | Description |
|---|---|
| NAIA | Natural Area Initial Assessment |
| NIASA | Nursery Industry Accreditation Scheme Australia |
| NR Info | NR Info portal |
| PASS | Potential acid sulfate soils |
| PMST | Protected Matters Search Tool (DEE, Cwlth) |
| WA | Western Australia |
| WALGA | Western Australian Local Government Association |
| WAH | Western Australian Herbarium |
| WONS | Weeds of National Significance |

# Executive Summary

Natural Area Consulting Management Services (Natural Area) was contracted by the City of Joondalup (the City) to prepare a Management Plan for the Ocean Reef Foreshore Reserve. This Plan identifies management strategies that will assist the City with ongoing management of the Reserve over a ten-year period, with a focus on maintaining both the environmental and recreational values of the area. This Management Plan provides site-specific recommendations for management of the Ocean Reef Foreshore Reserve whilst maintaining consistency with the City's overarching *Coastal Foreshore Natural Areas Management Plan*.

The Ocean Reef Foreshore Reserve is made up of two portions located north (14.9 ha) and south (40.6 ha) of the Ocean Reef Marina within the suburb of Ocean Reef. The Reserve is located approximately 25 km north-west of the Perth Central Business District. The Reserve excludes the Water Corporation Reserve and the proposed Ocean Reef Marina development site. The study areas are bounded by Iluka Foreshore in the north, Mullaloo Foreshore in the south, Ocean Promenade and Ocean Reef Road to the east and the Indian Ocean to the west. The Reserve consists of wide vegetated dunes, sandy beaches at the north-west and south-west, and steep limestone cliffs along the remaining western border of the site.

The majority of the native vegetation at Ocean Reef Foreshore Reserve is in Excellent condition and is part of the regional ecological linkage chain that extends along the coast from Burns Beach in the north to North Beach in the south. A total of 121 flora species comprising one conifer, 26 monocotyledons and 94 dicotyledons were recorded during the 2018 spring flora survey; none were declared rare or priority listed species under the *Biodiversity Conservation Act 2016* (WA) and/or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). Four flora species were considered to be locally significant due to their scarcity on the Swan Coastal Plain, occurring at the furthest extent of their range or providing habitat to priority fauna species. A range of mammal (7), bird (29), reptile (8) and invertebrate (48) species were observed within the reserve during the fauna surveys undertaken by Natural Area in January 2019, including the Priority 4 listed Southern Brown Bandicoot (*Isoodon fusciventer*) and the threatened migratory bird species Whimbrel (*Numenius phaeopus*). The range and diversity of species recorded within the Reserve indicates a healthy ecological community.

A number of management actions are outlined within this Plan to address key environmental threats within the Ocean Reef Foreshore Reserve. Management actions are to be implemented over a ten-year period and include activities such as pathogen management, erosion control, weed control, revegetation, fire management, environmental education, and regular surveys for flora, fauna and fungi. After a five-year period, vegetation condition will be reviewed. Management actions will be implemented by the City of Joondalup in partnership with key stakeholders and community groups, where relevant.

# 1.0 Introduction

## 1.1 Background

The City of Joondalup is situated on the Swan Coastal Plain, approximately 30 km north of the Perth Central Business District. The City covers an area of 96.5 $km^2$ that encompasses a diverse range of natural areas including 17 kilometres of coastal foreshore, a chain of wetlands and a variety of bushland ecosystems (Figure 1). The City's southern boundary is approximately 16 kilometres from the Perth Central Business District and is bordered by the City of Wanneroo to the east and north, the City of Stirling to the south, and the Indian Ocean to the west.

There are a number of regionally, nationally and internationally significant natural areas located within the City including Yellagonga Regional Park and a number of Bush Forever sites that contain species of high conservation value, with Ocean Reef Foreshore Reserve making up part of Bush Forever Site 325. Significant natural areas adjacent to the City include Marmion Marine Park and Neerabup National Park.

The City of Joondalup is committed to conserving and enhancing the City's natural assets to ensure the long-term protection of the environment for future generations.

## 1.2 Natural Area Management Plans

The City is preparing Natural Areas Management Plans and associated Action Plans to provide strategic and operational management of the City's natural areas to protect native vegetation and ecosystems. Natural Areas Management Plans describe the potential environmental impacts and risks of activities and environmental threats in natural areas, and the associated management strategies that are implemented to minimise potential impacts.

Environmental threats have the potential to degrade natural areas and reduce biodiversity values. Environmental threats addressed in this plan include weeds, plant disease, fire, non-native fauna species, human impacts, access and infrastructure.

## 1.3 Study Area

The Ocean Reef Foreshore Reserve consists of two components of the coastal reserve situated north and south of the Ocean Reef Marina approximately 31 km north-west of the Perth Central Business District (CBD) (Figure 2), with the Ocean Reef Marina and a Water Corporation reserve excluded from the study area. The site is bounded by Iluka Foreshore in the north, Mullaloo Foreshore in the south, Ocean Promenade and Ocean Reef Road to the east and the Indian Ocean to the west. The northern portion covers 14.9 ha and is 0.95 km in length north-south, with east-west widths ranging from approximately 120 – 200 m. The southern portion of the covers 40.6 ha and is 1.2 km in length north-south, with east-west widths ranging from approximately 120 – 530 m.

### 1.3.1 Tenure

The Ocean Reef Foreshore Reserve is zoned as Parks and Recreation under the Metropolitan Regional Scheme[1] and the City of Joondalup Local Planning Scheme No. 3[2]. The Reserve is Crown Land with management orders assigned to the City of Joondalup.

### 1.3.2 Land Use

The main use of the Ocean Reef Foreshore Reserve is for passive recreation purposes, including walking, dog exercise, photography, nature watching, and passing through the site to access the beach areas for swimming.

[1] Department of Planning, Lands and Heritage (2019)
[2] City of Joondalup (2019)


**Figure 1:** Location of Ocean Reef Foreshore Reserve within the City of Joondalup


**Figure 2:** Site Location
Ocean Reef Foreshore Reserve

0 200 400 m

N

Natural Area
CONSULTING MANAGEMENT SERVICES

Client: City of Joondalup
Date: 27/05/2019
Created by: Harley Taylor

Image Source: Nearmap 2019
Datum: GDA 94

99C Lord Street
Whiteman WA 6068
(08) 9209 2767
info@naturalarea.com.au
www.naturalarea.com.au

## 1.4 Purpose

The purpose of the Ocean Reef Foreshore Reserve Management Plan is to:

- provide information to assist the City of Joondalup in prioritising maintenance schedules
- guide the future development of the City's Conservation Capital Works Program
- increase opportunities for grant funding by having a detailed schedule of projects
- provide guidance to the City's employees, contractors and Friends Groups operating within the Ocean Reef Foreshore Reserve.

## 1.5 Aims and Objectives

The aim of the Ocean Reef Foreshore Reserve Management Plan is to provide a framework to protect and enhance biodiversity values whilst maintaining appropriate community access and awareness of the natural area.

The objectives of the Ocean Reef Foreshore Reserve Management Plan area to:

- establish a baseline description of the environment to guide future environmental planning and recommend management actions
- outline key environmental threats and the impact they have on conservation and recreational values
- outline management actions to address key threats, including monitoring and reporting.

## 1.6 Strategic Context

In order to ensure the Ocean Reef Foreshore Reserve Management Plan complements other management initiatives within the City, relevant legislation, policies, guidelines and documents were reviewed and are summarised in this Section.

### 1.6.1 Local Government

***Strategic Community Plan***

The City of Joondalup's Strategic Community Plan 2012 – 2022 is the long-term strategic planning document, which outlines City's commitment to achieving the visions and aspirations of its community and stakeholders.

***Access and Inclusion Plan***

The Access and Inclusion Plan 2018 – 2021 outlines the City of Joondalup's approach to ensuring those people with a disability have equal access to services and facilities, including access to the natural environment.

***Environment Plan***

The City of Joondalup's Environment Plan 2014 – 2019 was developed to guide the City's strategic response to local environmental pressures.

***Bushfire Risk Management Plan 2017 – 2022***

The Bushfire Risk Management Plan 2017 – 2022 provides a risk-based approach to fire treatment and management within the City of Joondalup with the aim of reducing the risk of fire occurrence.

***Biodiversity Action Plan***

The City of Joondalup Biodiversity Action Plan 2009 – 2019 was prepared to provide direction for biodiversity management activities within the City, with retention and enhancement of biodiversity a key priority. Development of individual Natural Area Management Plans was included as a management action.


**Figure 3:** City of Joondalup Strategic Environmental Framework

***Local Biodiversity Program* (formerly *Perth Biodiversity Project*)**

The City of Joondalup was one of 32 Local Governments participating in the Western Australian Local Government Association's (WALGA's) Perth Biodiversity Project, which documented the local biodiversity within its boundaries. The aim of the program was to support Local Governments to effectively integrate biodiversity conservation into land use planning to protect and manage local natural areas.

As part of the Program, the City of Joondalup assessed all natural areas in 2004 and at later times using the ecological criteria of the Natural Area Initial Assessment (NAIA), resulting in a priority ranking of natural areas. The Natural Area Initial Assessments include desktop assessments and field surveys, with information documented, including:

- vegetation complexes
- threatened or significant flora or ecological communities
- structural plant communities
- weed species
- vegetation condition assessment
- ecological criteria ranking
- a viability estimate

- fauna species observed.

While funding for the program ceased in 2014, the assessment template continues to provide a useful assessment tool.

***Pest Plant Local Law 2012***

The purpose of the *Pest Plant Local Law 2012* is to prescribe pest plants within the City of Joondalup that are likely to adversely affect the value of the property in the district or the health, comfort or convenience of the inhabitants of the district.

Pest plants are generally highly adaptable and will establish quickly after a disturbance event such as fire, or through unrestricted access. If pest plants are allowed to establish, they have the potential to out-compete the City's unique floral biodiversity. The *Pest Plant Local Law 2012* requires the owner or occupier of private land within the City of Joondalup district to destroy, eradicate or otherwise control scheduled pest plants on notice by the City. Currently one weed species is scheduled under the Local Law – Caltrop (*Tribulus terrestris*). Caltrop was not identified in the Ocean Reef Foreshore Reserve during the 2018 and 2019 assessments carried out by Natural Area.

### 1.6.2 State Government

**Relevant Legislation, Policies and Documents**

***Aboriginal Heritage Act 1972***

The Act makes provision for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants. The Aboriginal Heritage Site 3673 Mullaloo Desert North is located in the southern portion of the Reserve.

***Biodiversity Conservation Act 2016***

The Act provides the statute relating to conservation and legal protection of flora, fauna and ecological communities. Five fauna species listed under the *Biodiversity Conservation Act 2016* are considered to either use or possibly use Ocean Reef Foreshore Reserve, these being:

- Australian Sealion (*Neophoca cinerea*) (mammal) – **Specially Protected Fauna**
- Black-striped Snake (*Neelaps calonotos*) (snake) – **Priority 3**
- Common Sandpiper (*Actitis hypoleucos*) (bird) – **Migratory Species**
- Southern Brown Bandicoot, Quenda (*Isoodon fusciventer*) (mammal) – **Priority 4**
- Graceful Sun Moth (*Synemon gratiosa*) (insect) – **Priority 4**
- Whimbrel (*Numenius phaeopus*) **– Migratory Species.**

Quenda were captured and observed, and the Whimbrel was observed during the January 2019 fauna survey undertaken by Natural Area[3]. The Graceful Sun Moth has been recorded in the Ocean Reef Foreshore Reserve.

[3] Natural Area Consulting Management Services, (2019)

***Biosecurity and Agriculture Management Act 2007***

The Act provides for the control of declared flora and fauna species (declared organisms) that are known to be a significant environmental threat and makes provision for the management, control and prevention of these declared plants and animals. No declared pests were recorded within Ocean Reef Foreshore during the 2018 and 2019 assessments.

***Bushfires Act 1954***

The Act makes provision for diminishing the dangers resulting from bush fires and for the prevention, control and extinguishment of bush fires.

***Cat Act 2011***

The Act makes provision for the control and management of cats and promotes and encourages the responsible ownership of cats. Cats may be seized where they are found wandering in public areas, such as Ocean Reef Foreshore Reserve, in accordance with the *Cat Act 2011* (WA).

***Dog Act 1976***

The Act makes provisions for the control of dogs in public and private spaces and promotes the responsible ownership of dogs. The Act requires dog owners to register their dogs and encompasses the ownership and keeping of dogs and the obligations and rights of dog owners. Local governments are responsible for administering, monitor compliance and enforcing the Act within their respective districts.

Dogs are not permitted within beach areas of Ocean Reef Foreshore Reserve and must be on a lead at all times on the coastal dual use path by Council resolution in accordance with the *Dog Act 1976* (WA).

***Environmental Protection Act 1986***

The Act provides authority to the Environmental Protection Authority (EPA) for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment in Western Australia.

***Heritage of Western Australia Act 1990***

The Act provides for and encourages the conservation of places that have significance to the cultural heritage in the State. The Heritage Place 25302 Rock Inscription is listed west of Resolution Way in the northern portion of Ocean Reef Foreshore Reserve.

***State Planning Policy 2.6 – State Coastal Planning Policy 2013***

The purpose of the policy is to provide guidance for decision making in the coastal zone throughout Western Australia, with objectives including:

- considering coastal processes during development
- identifying appropriate and sustainable land use
- providing for public use and access of coastal areas
- the development of coastal reserves to protect, conserve and enhance coastal biodiversity, ecosystem functioning, and indigenous and non-indigenous cultural significance.

***State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Region***
This policy aims to provide direction and an 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.

***State Planning Policy 3.7 – Planning in Bushfire Prone Areas***
This policy aims to implement effective risk-based land use planning and development to protect life and reduce the impact of bushfire on property and infrastructure, by identifying bushfire prone areas to be addressed in regard to bushfire risk management within strategic planning documents, strategic planning proposals, and subdivision and development applications.

***Government of Western Australia 'Bush Forever' Strategy 2000***
The Strategy identifies regionally significant bushland in the Perth Metropolitan Region to be retained, managed and protected forever. The Ocean Reef Foreshore Reserve forms part of Bush Forever Site 325, which extends from Burns Beach south to Hillarys.

***DBCA Swan Impact and Invasiveness Rating 2019***
The Department of Biodiversity, Conservation and Attractions, prepared the weed prioritisation process to assist with the on-ground management of weeds in a particular location, considering their ecological impact, rate of dispersal and population trend.

### 1.6.3 Federal Government

***Environment Protection and Biodiversity Conservation Act 1999***
The Act provides for the protection of the environment and the conservation of biodiversity, and for related purposes. Eight *Environment Protection and Biodiversity Conservation* (*EPBC*) *Act 1999* listed species have been recorded as occurring or potentially occurring within Ocean Reef Foreshore Reserve, these being:

- Australian Fairy Tern (*Sternula nereis nereis*) – **Vulnerable**
- Australian Sealion (*Neophoca cinerea*) – **Vulnerable**
- Bar-tailed Godwit (*Limosa lapponica baueri*) - **Vulnerable**
- Bar-tailed Godwit (*Limosa lapponica menzbieri*) – **Vulnerable**
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) – **Endangered**
- Curlew Sandpiper (*Calidris ferruginea*) – **Critically Endangered**
- Eastern Curlew (*Numenius madagascariensis*) – **Critically Endangered**
- Forest Red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*) - **Vulnerable.**

A Carnaby's Cockatoo was heard calling within Ocean Reef Foreshore Reserve during site assessments in May 2019. There is no suitable nesting or roosting habitat on site for black cockatoos, and only a small amount of foraging habitat is present in the presence of *Banksia sessilis* shrubs at the north of the Iluka portion of the Reserve.[4]

[4] Natural Area Consulting Management Services, (2019)

***Australia's Biodiversity Conservation Strategy 2010-2030***

The Strategy aims to protect biological diversity and maintain ecological processes and systems.

***Australian Weeds Strategy 2017-2027***

The *Australian Weeds Strategy 2017-2027* provides a strategic framework for managing weeds at a national level. As part of the implementation of the National Weeds Strategy, 32 Weeds of National Significance are identified as nationally agreed priority plant species for control and management based on the criteria of invasiveness and impact characteristics, potential and current area of spread and economic, environmental and social impacts. The Ocean Reef Foreshore Reserve contains no known Weeds of National Significance.

***Threatened Species Strategy 2015***

The *Threatened Species Strategy 2015* outlines the Federal Government's approach to threatened flora and fauna species recovery through reversing population declines.

### 1.6.4 International Conventions or Listings

***International Union for Conservation of Nature (IUCN) Red List of Threatened Species***

The ICUN Red List of Threatened Species™ provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the ICUN Red List Categories and Criteria. The Carnaby's Cockatoo (*Calyptorhynchus latirostris*) is an ICUN Red List species that has been recorded within the Mullaloo foreshore reserve to the south of Ocean Reef by Mullaloo Beach Community Group (MBCG) members. It was also heard calling and observed flying over the Ocean Reef Foreshore Reserve site during the 2019 fauna survey.

# 2.0 Description of Physical Environment

## 2.1 Geology, Soils and Landforms

### 2.1.1 Soils of the Swan Coastal Plain

The Ocean Reef Foreshore Reserve is situated within the City of Joondalup, which is located within the Swan Coastal Plain. The Swan Coastal Plain comprises two major divisions, namely Swan Coastal Plain 1 - Dandaragan Plateau, and Swan Coastal Plain 2 - Perth Coastal Plain. The Ocean Reef Foreshore Reserve is located within the Perth subregion. This area is characterised by areas of Jarrah and Banksia woodlands on sandy soils in a series of sand dunes, along with wetland areas, often within interdunal swales[5]. The majority of the soils of the Swan Coastal Plain are of alluvial (deposited by rivers) or eolian (deposited by wind) origin. A series of dune systems has been formed with the youngest being the Quindalup dunes nearest the coast, followed by the Spearwood Dunes and the oldest being the Bassendean Dunes furthest from the coast (Figure 5).

The site is situated within the Quindalup and Spearwood dune systems. It is predominantly in the Quindalup Dune System, which is typified by coastal dunes with calcareous deep sands and yellow sands. The Spearwood Dune system is situated in the south-east of the northern portion of the site (Figure 5). According to the Natural Resource Info (NRInfo) data maintained by the Department of Primary Industries and Regional Development (DPIRD) (2019), nine soil types exist on site (Table 1)[6].

The Reserve rises rapidly from sea level at the western edge to 26 m AHD in the north-east of the north portion, and to 30 m AHD in the north-east (Figure 4)[6]. Cliffs are situated to the north-west of the south portion of the Reserve and along the entire western side of the north portion and range from sea level to an average of 10 m AHD[5]. The south-west of the Reserve is associated with wide sandy beaches up to 50 m wide, whilst the remainder of the west side of the Reserve is associated with steep narrow limestone cliffs or rocky beaches up to 20 m wide (Figure 4). The width of vegetated dunes in the southern portion ranged from 120 – 530 m, whilst the narrower northern portion ranged from 120 – 200 m wide.

**Figure 4:** Wide vegetated dunes and sandy beaches (left), vegetated dunes with limestone cliffs (right)

[5] Mitchell, Williams and Desmond (2002)
[6] Department of Primary Industries and Regional Development (2019)

**Table 1:** Soil type descriptions

| Code | Soil Type | Description |
|---|---|---|
| 211Qu__Q2 | Quindalup South second dune Phase | The second phase. A complex pattern of dunes with moderate relief. Calcareous sands have organic staining to about 20 cm, passing into pale brown sand; some cementation below 1 m. |
| 211Qu__Q3 | Quindalup South third dune Phase | The third phase. Irregular dunes with high relief and slopes up to 20%. Loose calcareous sand with little surface organic staining and incipient cementation at depth. |
| 211Qu__Q4 | Quindalup South youngest dune Phase | The youngest phase. Irregular dunes with slopes up to 20%. Loose pale brown calcareous sand with no soil profile development. |
| 211Qu__Qp | Quindalup South deep sand flat Phase | Undulating landscapes with deep calcareous sands overlying limestone. Soils have dark grey-brown sand to about 50 cm and then pale brown sand. Remnants of hummocks are often present. |
| 211Qu__Qs | Quindalup South shallow sand flat Phase | Undulating landscapes with shallow calcareous sands over limestone and much rock outcrop. |
| 211Qu__Qu | Quindalup South unstable sand Phase | Presently unstable sand. |
| 211QuU_BEACH | Quindalup South water, beach Phase | Beach. |
| 211Sp__Kls | Karrakatta shallow soils Phase | Low hills and ridges. Bare limestone or shallow siliceous or calcareous sand over limestone. Dense low shrub dominated by *Dryandra sessilis*, *Melaleuca huegelii* and species of Grevillea. |
| 211Sp__Ky | Karrakatta Sand Yellow Phase | Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. Banksia spp. woodland with scattered emergent *Eucalyptus gomphocephala* and *Eucalyptus marginata* and a dense shrub layer. |

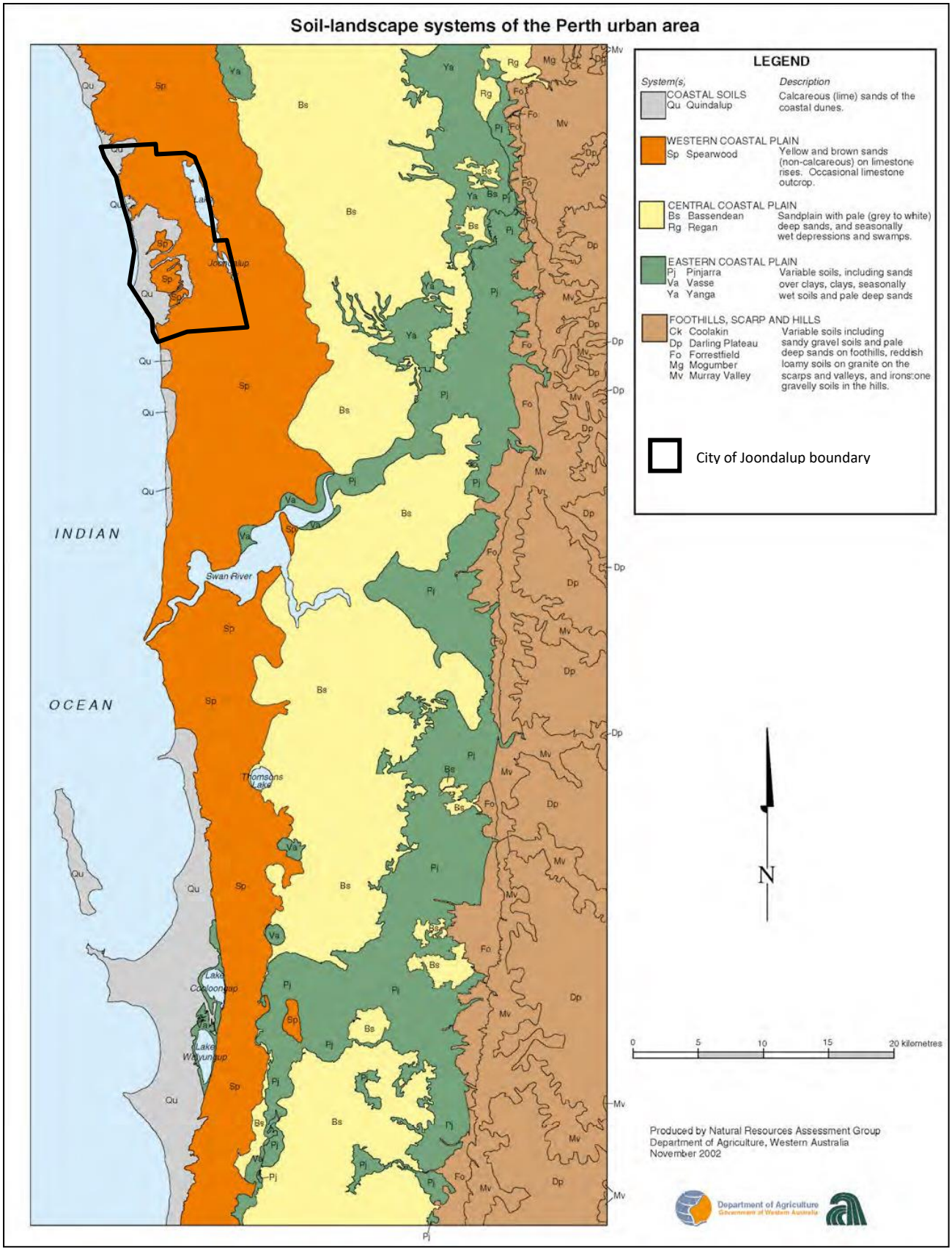



**Figure 5:** Soils of the Swan Coastal Plain (Department of Agriculture, 2002)

### 2.1.2 Acid Sulphate Soils

Acid sulphate soils are naturally occurring soils that contain iron sulphides, primarily in the form of pyrite materials, formed under waterlogged conditions in fresh and saline wetlands around Western Australia. If left and not exposed to the air, they do not pose a significant risk to humans or the environment. However, when exposed to air, sulphuric acid is formed, which can lead to the release of heavy metals into the surrounding environment[7].

Acid sulphate soils are categorised as potential acid sulphate soils (PASS) or actual acid sulphate soils (AASS). Potential acid sulphate soils have not been oxidised by exposure to air whilst actual acid sulphate soils have been disturbed or exposed to oxygen and become acidic[7]. The risk of acid sulphate soils is based on their likelihood of occurring within soil profiles and has been mapped by the Department of Water and Environmental Regulation (DWER), using available desktop information and limited ground-truthing within areas where intensive on-ground mapping and soil analysis work has been undertaken. Review of this mapping indicated that no potential acid sulphate soils are known or likely in the Ocean Reef Foreshore Reserve on the basis of origin of the geological units present, depth to groundwater and partial 'ground truthing' or onsite investigation.

### 2.1.3 Dune Erosion

The major function of vegetation within coastal dune systems is stabilising sand within dunes, with erosion occurring where vegetative cover is absent or reduced. Dunal erosion is a naturally occurring process on the coast, particularly during winter months when rainfall and wind speed increase. Human factors can increase the rate and extent of erosion via activities such as people and pets walking through the dunes instead of keeping to nominated accessways, or the installation of infrastructure in dune areas. Over time, projected climate change impacts are expected to include[8]:

- stronger winds during storm events, which can increase the potential for vegetation loss on dunes
- increased storm surge potential which could result in loss of foredunes
- lower rainfall, potentially leading to water stress on plants and impacts to flora and fauna habitat
- sea level rise and associated coastal inundation into current dunal locations.

Accordingly, erosion is likely to be an ongoing issue that will impact on rehabilitation and ongoing maintenance requirements.

Overall the Ocean Reef Foreshore Reserve was observed to be in good condition with regard to erosion during the 2018 and 2019 assessments carried out by Natural Area. A small number of isolated runoff areas where erosion was occurring were observed in the southern portion of the Reserve, with the main location along the dual use path in the dune swale south of the main lookout (Figure 6). Most of the erosion involved sand coming off the cleared edges of dunes onto the lower dual use path; these wash outs were not causing any real damage to the vegetated dunes, but should be monitored in future to ensure erosion is not increasing or causing damage to the vegetated dunes.

[7] Department Water and Environment Regulation (2015)
[8] City of Joondalup (2014b)

**Figure 6:** Runoff causing erosion off the dual use path into the adjacent dune swale

While the majority of the site is currently showing minimal signs of erosion, ongoing monitoring is recommended to prevent or mitigate any threatening processes that could result in future erosion. Considerations for management of erosion will include:

- areas affected
- causes
- natural, conservation and human values of the affected area
- priorities for action in terms of feasibility of success in the medium to longer term
- techniques used to restore or stabilise affected areas.

The City has undertaken a coastal hazard assessment[9], with the objective to update previous assessments and provide consistent assessment across the whole city. The City's Coastal Monitoring Program was established in 2015/16 to monitor shoreline movements over time. The Program aims to:

- provide valuable information that can be used to inform planning decisions in the coastal zone
- inform maintenance and asset replacement schedules of coastal infrastructure
- provide early warning of any increased vulnerability of assets
- guide the timing and need for coastal adaptation works
- identify the requirement for updates to hazard and vulnerability assessments

[9] MP Rogers & Associates P/L (2016)

- improve the City's understanding of coastal processes and monitor actual shoreline erosion compared to modelled erosion.

The Coastal Monitoring Program includes photo monitoring at identified sites every six months, shoreline mapping from aerial photography annually, beach profile surveys biennially and analysis and reporting biennially.

Erosion from both natural and human causes can largely be managed through sand stabilisation and access control. Revegetation and rehabilitation activities are often the most effective means of stabilising sand dune areas. These can include:

- applying appropriate revegetation techniques that will allow plants to become established and stabilise the soil
- erecting sand trap fencing that allows wind-borne sand to collect and create incipient dunes over time
- applying stabilising materials such as biodegradable jute or coir matting, brushing or mulch to exposed areas to provide a stable surface that will allow seedlings to become established and grow
- use of signage to provide information about erosion and the need to keep off the dunes
- establishing barriers to deter human (and pet) access to vegetated areas and allowing bare areas to regenerate.

### 2.1.4 Recommended Management Actions

| Action | Detail |
|---|---|
| Holistic consideration of erosion | Erosion issues to be considered holistically, with the most appropriate management option/s determined on a case by case basis, recognising that all exposed sand does not need to be covered by vegetation, reflecting what would occur within a natural environment. |
| Brushing | Brushing materials will be of suitable species that do not contain seed pods or other materials that can propagate and result in the presence of weeds at the site. |
| Early consideration of erosion | Address erosion issues as early as possible to avoid larger areas to be rehabilitated later. |
| Wider context | Consider erosion in the wider context of climate change impacts that could occur over time. |
| Post-storm monitoring | Undertake regular and post-storm monitoring of beach infrastructure including beach access ways, gazebos, fencing, bins and signage. |
| Operating budget | Ensure there is adequate annual operating budget for the repair and maintenance of beach infrastructure. |

## 2.2 Hydrology

### 2.2.1 Groundwater

The City of Joondalup is located on Perth's largest source of groundwater, the Gnangara Groundwater System (Gnangara Mound). It comprises four main aquifers (Figure 7)[10]:

- the superficial (shallow, unconfined)
- the Mirrabooka (deeper, semi confined)
- the Leederville (deep, mostly confined)
- the Yarragadee (deep, mostly confined).

The Gnangara Mound extends across most of the superficial aquifer, with the 'mound' referring to the water table creating a mound shape (Figure 7). Groundwater levels in the superficial aquifer have been declining over recent years due to pressure from extraction and the impacts of climate change.

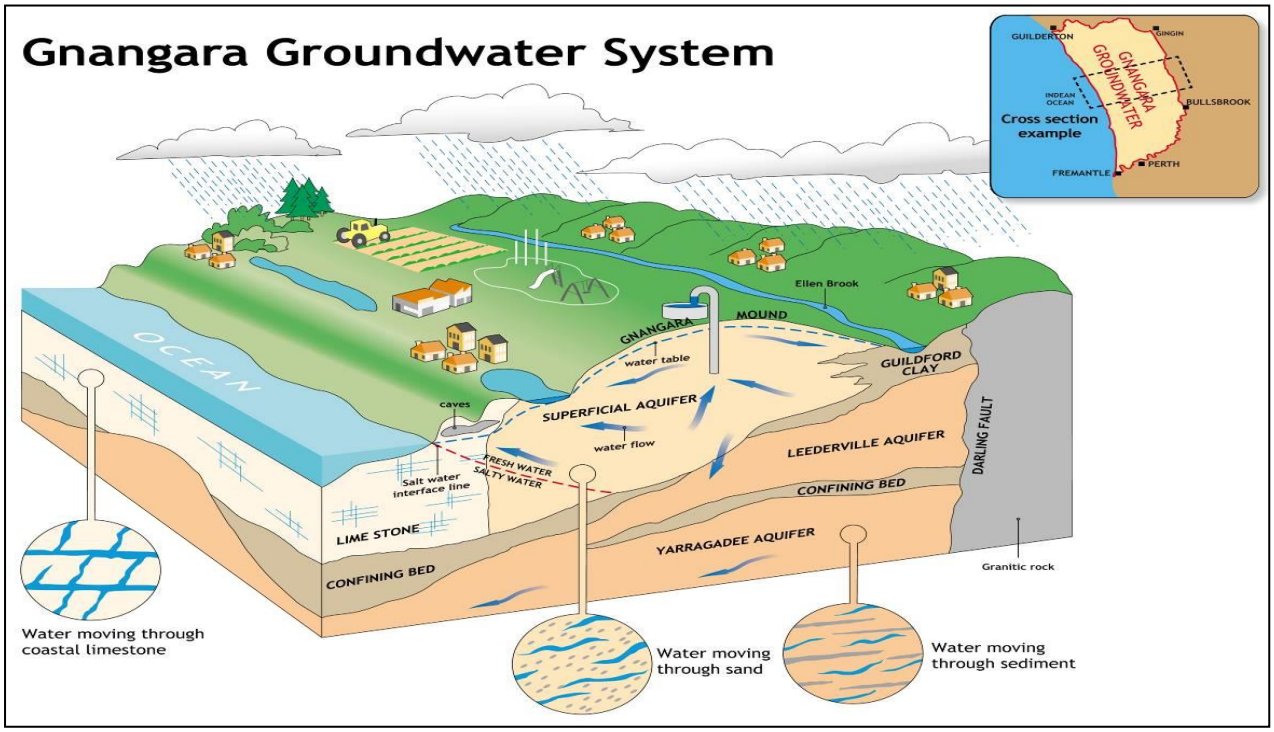



**Figure 7:** Gnangara Groundwater System[10]

### 2.2.2 Drainage

No natural or man-made water bodies are present within Ocean Reef Foreshore Reserve. Depth to groundwater in the site ranges from 0 m to 26.3 m below ground level[11], which is consistent with a site located on the coast where higher sand dunes present and groundwater discharges to the ocean (Figure 8).

[10] Department of Water (n.d.)
[11] Department of Water (2019)

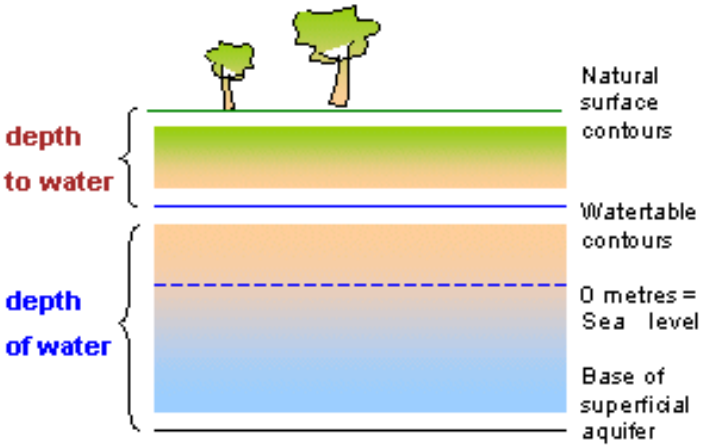



**Figure 8:** Groundwater Depth Explanation[12]

## 2.3 Climate

The City of Joondalup experiences a Mediterranean climate of hot dry summers with an average temperature of 30.9 °C during the day and mild wet winters with an average daytime temperature of 18.5 °C. The average annual rainfall from 1944 to 2019 was 765.3 mm, with approximately 80 percent of the annual rainfall occurring between the months of May and September (Figure 9)[13].

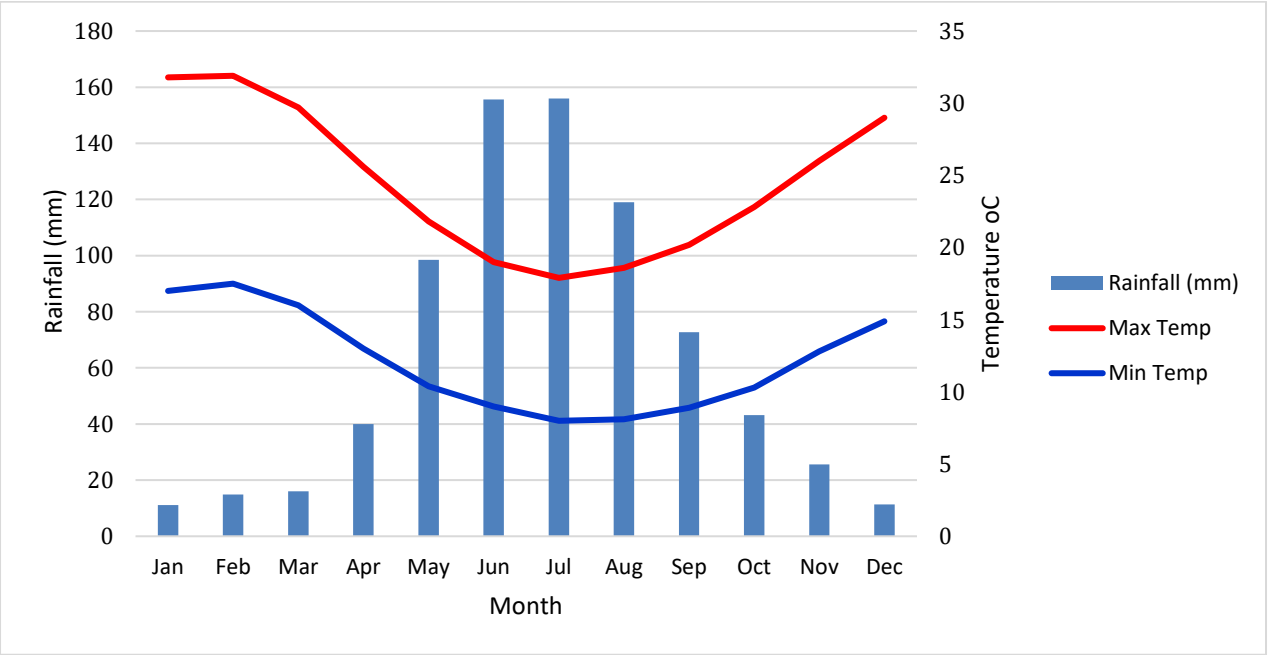



**Figure 9:** Climate data for Perth, Station ID 009021 (1944 – 2019)

[12] Department of Environment (2004)
[13] Bureau of Meteorology (2019)

### 2.3.1 Climate Change

The City of Joondalup is located in the south-west of Western Australia which is experiencing impacts associated with climate change such as rising temperatures, decreased rainfall and sea level rise. According to the Climate Commission, Western Australia's temperature has been steadily increasing since the 1950's, with an overall rise of approximately 0.8 $^{o}$C[14].

The City has developed the Climate Change Strategy 2014 – 2019[15] to guide climate change activities, both in terms of mitigation and adaptation, in coming years. Strategies adopted include:

- reduce greenhouse gas emissions
- offset carbon emissions
- improve understanding of future climate scenarios
- identify risks and how they can be managed
- support the community to prepare and adapt to climate change.

In addition, the City has developed a Coastal Infrastructure Adaptation Plan (CIAP), a Coastal Hazard Risk Management Action Plan (CHRMAP).

## 2.4 Vegetation

Flora and vegetation surveys were undertaken by Natural Area in November 2018 to inform the management plan, with outcomes provided in this section[16].

### 2.4.1 Vegetation Complexes

Vegetation complexes are classified by the soil and landforms contained in medium to large areas along the Swan Coastal Plain. Regional scale mapping indicates that the Ocean Reef Foreshore Reserve occurs within the 'Quindalup Complex' (Figure 10), which is a coastal dune complex consisting mainly of two alliances, namely the strand and foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata – Callitris preissii* and the closed scrub of *Acacia rostellifera*[17].

The pre-European extent remaining within the Swan Coastal Plain IBRA region for the Quindalup Complex is 55.38 %[18]. The pre-European extent remaining within the City of Joondalup is 12.55 %[19].

[14] Climate Commission (2011)
[15] City of Joondalup, (2014b)
[16] Natural Area Consulting Management Services (2019)
[17] Heddle *et al*. (1980)
[18] WALGA (2013)
[19] WALGA (2010)

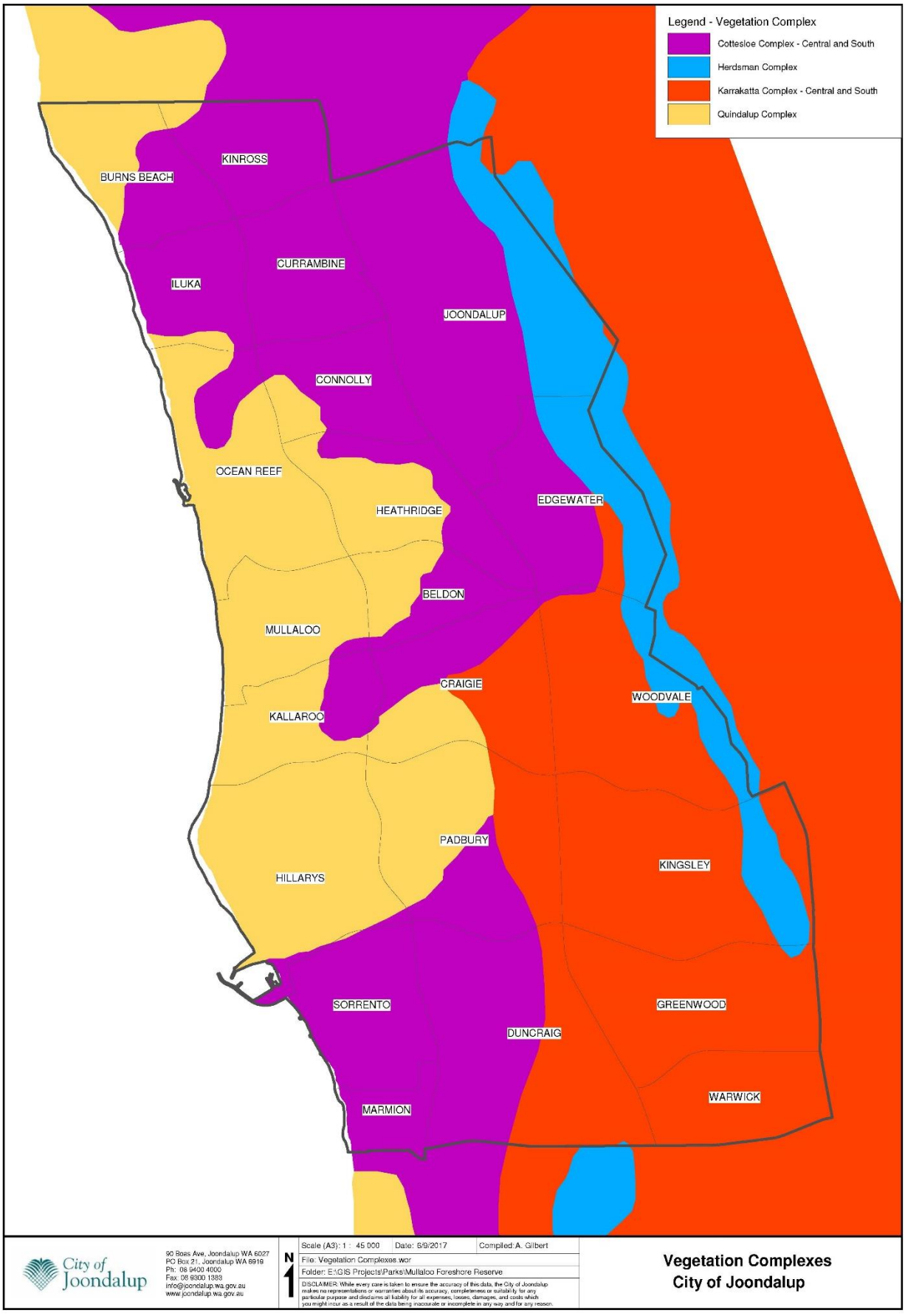



**Figure 10:** City of Joondalup Vegetation Complexes

### 2.4.2 Floristic Community Types

Bush Forever[20] identified two main floristic community types (FCTs) as being present within the Ocean Reef Foreshore Reserve:

- 29a – Coastal Shrublands on shallow soils (Priority 3) (sampled within Bush Forever Site 325)
- 24 – Northern Spearwood shrublands and woodlands (Priority 3) (inferred).

Statistical analysis carried out by Natural Area (2019)[21] as a component of the 2018-2019 flora, fauna and fungi survey determined that the *Melaleuca cardiophylla* Shrubland and Mixed Coastal Shrubland vegetation types were most similar to FCT 29a and the *Acacia rostellifera* Shrubland was most similar to FCT 24; details of the statistical analysis methodology and outcomes used by Natural Area to confirm the floristic community types present are provided in their 2019 report.

### 2.4.3 Vegetation Types

Four vegetation types were recorded within Ocean Reef Foreshore during the 2018 spring flora survey undertaken by Natural Area, these are described in Table 2 and illustrated in Figures 11 and 12. The dominant vegetation type on site is Mixed Coastal Shrubland. Vegetation communities do not include non-vegetated areas such as footpaths and carparks.

**Table 2:** Vegetation types within the Ocean Reef Foreshore

| Vegetation Type | Description | Photo |
|---|---|---|
| *Acacia rostellifera* Shrubland<br><br>(17.9 ha) | *Acacia rostellifera* Shrubland over mixed shrubland*; Scaevola crassifolia, Rhagodia baccata and Spyridium globulosum* and an understory of weedy grasses and herbs such as **Bromus diandrus* **Ehrharta longiflora,* and **Euphorbia terracina*. This vegetation type occurs on the tertiary dunes at the eastern edge of the site. |  |

[20] Government of Western Australia (2000)
[21] Natural Area Consulting Management Services (2019)

| Vegetation Type | Description | Photo |
|---|---|---|
| *Spinifex* Grassland<br><br>(0.5 ha) | *Spinifex hirsutus* and **Thinopyrum distichum* Grassland with sparse *Olearia axillaris* shrubs. This vegetation type occurs along the foredunes on the western edge of the site. |  |
| Mixed Coastal Shrubland<br><br>(26.6 ha) | Mixed Coastal Shrubland of *Olearia axillaris, Rhagodia baccata* and *Scaevola crassifolia* and other mixed shrubs over an understorey of weedy grasses and mixed herbs; This vegetation type occurs on the secondary and tertiary dunes along the entire length of the site. |  |
| *Melaleuca cardiophylla* Closed Heath<br><br>(7.7 ha) | Closed Heath of *Melaleuca cardiophylla* over *Leucopogon insulare* and mixed shrubs and an understorey of mixed herbs and weedy grasses. This vegetation type is situated on shallow sand over limestone. |  |


**Figure 11:** Vegetation Types Ocean Reef Foreshore Reserve (north)

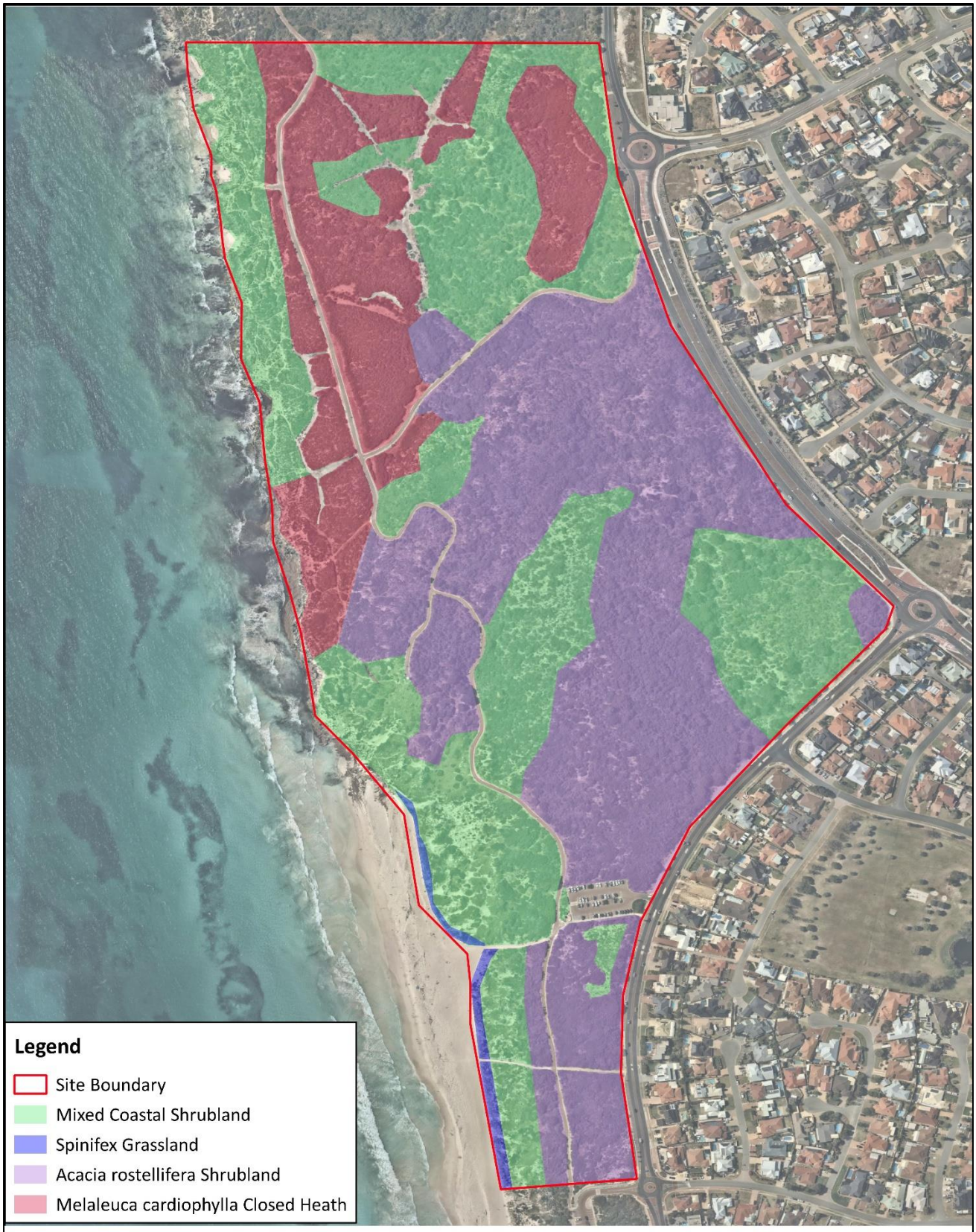



**Figure 12:** Vegetation Types Ocean Reef Foreshore Reserve (south)

### 2.4.4 Vegetation Condition

Vegetation condition assessments were undertaken in accordance with the scale attributed to Keighery (1994)[22] and included observations regarding native plant numbers, weed cover, native species diversity, amount of understorey, health condition of populations and physical disturbances such as fire and clearing; a copy of the rating scale is provided in Table 3.

**Table 3:** Vegetation condition ratings

| Category | | Description |
|---|---|---|
| 1 | Pristine | Pristine or nearly so, no obvious signs of disturbance. |
| 2 | Excellent | Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. |
| 3 | Very Good | Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing. |
| 4 | Good | Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing. |
| 5 | Degraded | Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing. |
| 6 | Completely Degraded | The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs. |

Source: Government of Western Australia (2000)

Vegetation condition ranged from Completely Degraded to Excellent for Ocean Reef Foreshore Reserve, with majority of the site classified as Excellent (Table 4; Figures 13 and 14); note areas assessed for vegetation condition do not include carparks and paths. Vegetation condition in the northern portion ranged from Good to Excellent (Figure 13). Areas of lower vegetation condition occurred in previously cleared areas or mobile foredune areas in the north-west of the site. The majority of this portion was assessed as being in Excellent condition with high vegetation cover and species diversity.

In the southern portion of the site the vegetation condition ranged from Completely Degraded to Excellent (Figure 14). The lower vegetation condition occurred within the Spinifex Heathland and the primary and secondary dunes located around the southern lookout where there is a lower native species cover and higher weed presence. Smaller areas of low vegetation cover occurred throughout the southern portion in areas that have previously been cleared and those that experience more disturbance, particularly informal paths through the vegetated blocks.

[22] Government of Western Australia (2000)

**Table 4:** Vegetation condition within Ocean Reef Foreshore

| Vegetation Condition | Completed Degraded | Degraded | Good | Very Good | Excellent | Total |
|---|---|---|---|---|---|---|
| **Northern Section** | | | | | | |
| **Area (ha)** | 0 | 0 | 0.6 | 1.6 | 12.1 | 14.3 |
| **Area (%)** | 0 | 0 | 4.2 | 11.2 | 84.6 | 100 |
| **Southern Section** | | | | | | |
| **Area (ha)** | 0.2 | 1.9 | 2.6 | 7.9 | 26.2 | 38.8 |
| **Area (%)** | 0.5 | 4.9 | 6.7 | 20.4 | 67.5 | 100 |
| **Study Area** | | | | | | |
| **Area (ha)** | 0.2 | 1.9 | 3.2 | 9.5 | 38.3 | 53.1 |
| **Area (%)** | 0.4 | 3.6 | 6.0 | 17.9 | 72.1 | 100 |

Vegetation condition assessments were undertaken by Natural Area in 2012[23] when preparing the City of Joondalup Foreshore Management Plan for the entire foreshore reserve. While it is not possible to quantify the changes due to the differing survey areas, improvements in vegetation condition were noted within the Ocean Reef Foreshore Reserve during the on-ground site assessments also carried out by Natural Area in 2018[24]. Improvements in condition are associated with improved vegetative cover and reduced weed presence.

[23] Natural Area Consulting (2013a)
[24] Natural Area Consulting Management Services (2019)

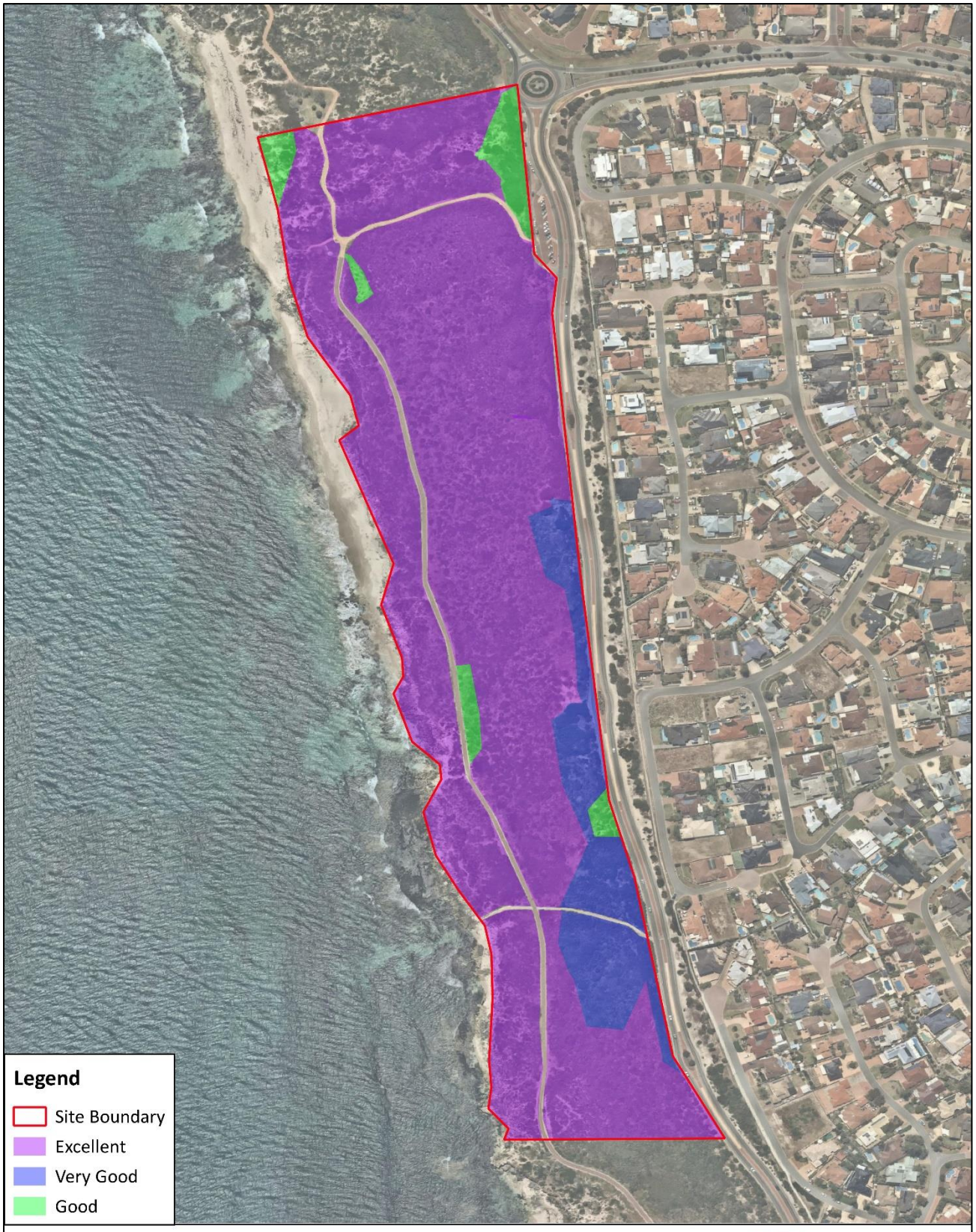



**Figure 13:** Vegetation Condition Ocean Reef Foreshore Reserve (north)

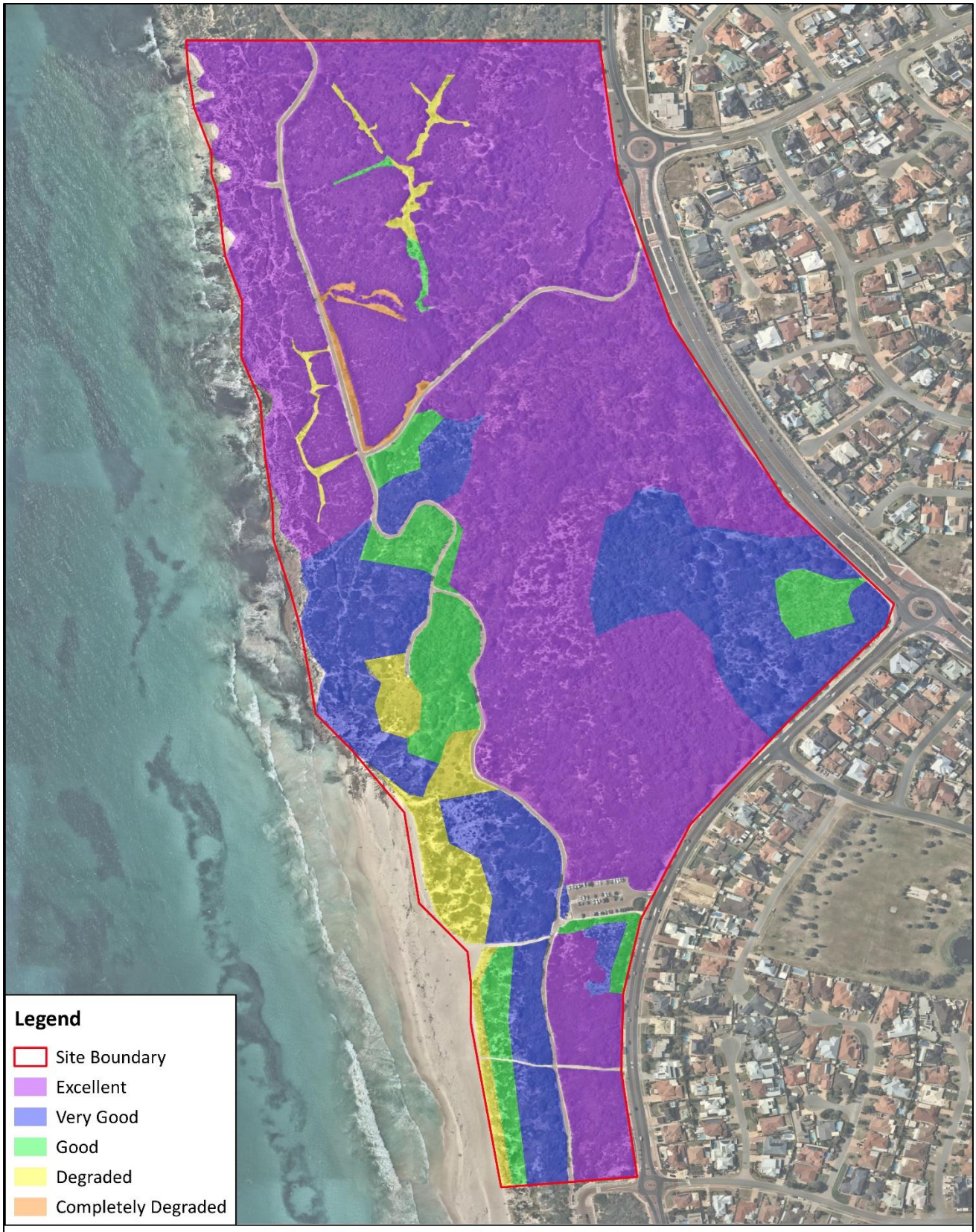



**Figure 14:** Vegetation Condition Ocean Reef Foreshore Reserve (south)

# 3.0 Biodiversity Management

Australia is one of 11 countries in the world which are described as 'megadiverse', these countries equate to less than 10% of the global surface but support over 70% of the biological diversity of the planet. Australia is home to 600,000 – 700,000 endemic species, which are found nowhere else on the earth[25]. The Ocean Reef Foreshore Reserve supports a range of flora and fauna species and provides an important ecological linkage to adjacent coastal reserves (Figure 20). The long-term protection of biodiversity values within the reserve is critical to this habitat. The protection and enhancement of biodiversity within the reserve also benefits the community through the provision of ecological services, including:

- the production of oxygen and capture of carbon dioxide
- noise and air quality regulation
- cooling urban environments
- supporting seed dispersal and pollination
- a number of recreational and cultural experiences[26].

A number of environmental threats pose a risk to the biodiversity of the Ocean Reef Foreshore Reserve, including:

- weeds
- pathogens and disease
- non-native fauna species
- human impacts
- access and infrastructure
- fire.

Management strategies have been established to mitigate the effects of key environmental threats and are discussed in the following sections. Additional environmental threats exist outside the scope of the Plan and thus not addressed, such as broader impacts associated with climate change and groundwater decline.

## 3.1 Flora

The Ocean Reef Foreshore Reserve is located in the Southwest Australian biodiversity hotspot, which is one of the world's 30 international biodiversity hotspots. Hotspots are areas that contain intact natural ecosystems that support a high diversity of local endemic species of plants and animals[27]. It extends from Shark Bay in the North to Israelite Bay in the south, covering 300,000 square kilometres with over 1,500 endemic plant species occurring within the region. Approximately 30 % of the original vegetation extent of this area remains, with habitat loss primarily due to agricultural expansion[25].

Flora surveys enable collection of scientific data related to the occurrence and distribution of flora species and vegetation communities. Information obtained is used as a baseline to monitor the ecological health of flora populations and vegetation communities. Natural Area was engaged to undertake a desktop and field

[25] Department of the Environment and Energy (2019a)
[26] City of Joondalup (2014a)
[27] Department of Biodiversity, Conservation and Attractions (2019a)

flora survey of the Ocean Reef Foreshore Reserve in November 2018. A total of 121 plant species were recorded within the Reserve, including 77 native (63.7 %) and 44 (36.3 %) introduced species[28].

### 3.1.1 Flora Survey Methodology

Desktop and on-ground flora survey activities at Ocean Reef Foreshore Reserve were undertaken by Natural Area in November 2018 in accordance with EPA *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (December 2016). The survey methodology undertaken included Natural Area botanists setting up a series of quadrats in each vegetation type and documenting[26]:

- the landscape characteristics including soil type, soil colour, aspect, slope, and topography
- leaf litter depth
- percentage vegetative cover and percentage bare ground
- recording vegetation type and condition
- presence of native and non-native flora species present, including significant flora, along with habit, life form, percentage cover and height
- walking the site to record incidental sightings of species not present in quadrats.

### 3.1.2 Native Flora

Native flora is an important part of the Ocean Reef Foreshore Reserve's natural ecosystem, providing habitat and resources for fauna present. A reduction in flora species or habitat can lead to a loss of fauna that depend on these species for resources and shelter. A total of 77 native flora species were recorded within the Reserve during the 2018 flora survey[26].

No threatened or priority species were recorded within the Reserve during the 2018 flora survey[26]. Five species considered locally significant were recorded; these are listed and discussed in Table 5. *Allocasuarina huegelii* was found in an isolated patch along the northern border south of the Marina. *Alyogyne huegelii* was located along the northern pathway south of Shenton Avenue with a small number of plants recorded. Several *Callitris preissii* trees were located at the northern end of the Reserve. *Lomandra maritima* was recorded throughout Reserve creating patches in areas with reduced shrub canopy.

**Table 5:** Significant flora in Ocean Reef Foreshore

| Species | Common Name | Significance[29] | Photograph |
|---|---|---|---|
| *Allocasuarina lehmanniana* | Dune Sheoak | Significant population for the Swan Coastal Plain. |  |

[28] Natural Area Consulting Management Services (2019)
[29] Government of Western Australia (2000)

| Species | Common Name | Significance[29] | Photograph |
|---|---|---|---|
| *Alyogyne huegelii* | Lilac Hibiscus | Significant population for the Swan Coastal Plain. |  |
| *Callitris preissii* | Rottnest Island Pine | Locally significant as it is at the northern extent of its range in for the Swan Coastal Plain. |  |
| *Lomandra maritima* | | Provides habitat for the Priority 4 listed Graceful Sun-moth (*Synemon gratiosa*). Many large mature plants occur within the Reserve. |  |
| *Melaleuca cardiophylla* | Tangling Melaleuca | This species is significant as it is at the southern extent of its range and is rare on the Swan Coastal Plain. |  |

### 3.1.3 Weeds

Weeds are plants that have colonised areas where they did not originally exist and can be non-local native or introduced species. An environmental weed generally grows and reproduces quickly and requires action to reduce its negative impact on economic, social and environmental values of the area. Weeds are commonly introduced and distributed within bushland areas through seed dispersal by water, wind, animals, fire, the dumping of garden waste, and human or vehicle movement in natural areas. Weeds can have major economic, environmental and social impacts in Australia and can[30]:

- displace native plant species
- alter nutrient cycling and soil quality within ecosystems
- harbour pest and diseases
- increase fire fuel loads
- impact negatively on native flora and fauna and their habitats
- compete with native species for resources.

A total of 45 weed species were recorded within the Ocean Reef Foreshore Reserve by Natural Area during the November 2018 surveys. No weeds of national significance (WoNS) or declared pests listed under the *Biosecurity and Agriculture Management Act 2007* (WA) (BAM Act) were recorded. Eleven species are listed on the City of Joondalup's priority weed list, namely

- Bearded Oat Grass (*Avena barbata*)
- Buffalo Grass (*Stenotaphrum secundatum*).
- Cape Weed (*Arctotheca calendula*)
- Geraldton Carnation Weed (*Euphorbia terracina*)
- Great Brome (*Bromus diandrus*)
- Guildford Grass (*Romulea rosea*)
- Hare's Tail Grass (*Lagurus ovatus*)
- Mediterranean Turnip (*Brassica tournefortii*)
- Petty Spurge (*Euphorbia peplus*)
- Prickly Lettuce (*Lactuca serriola*)
- Rose Pelargonium (*Pelargonium capitatum*)

Key weed species existing in the Reserve that are listed as being a City priority weed and/or those having a moderate or high priority rating according to the DBCA *Swan Impact and Invasiveness Ratings* are listed in Appendix 5, with recommended treatment strategies in Appendix 6. Note that the DBCA weed ranking list has no legal status but can be beneficial in informing management priorities for local land managers.

### 3.1.4 Weed Control and Restoration

The City of Joondalup encourages natural bushland regeneration through weed management and conservation fencing to allow the vegetation to re-establish itself to maintain species diversity and populations. Revegetation is undertaken using local provenance species on an as required basis in Degraded, Completely Degraded, or Good areas where further planting is considered to be beneficial. Revegetation is undertaken in conjunction with weed control to enhance revegetation success. Proposed revegetation areas, planting list and plant numbers are provided in Appendix 7.

[30] Department of the Environment and Energy (2019c)

### 3.1.5 Current Management Approach

The City undertakes an integrated approach to weed management, including:

- prevention of weed introduction through hygiene measures
- regular monitoring and reporting of weed populations
- on ground weed control, including prioritisation of natural areas and priority weeds to target
- community education initiatives
- fire prevention measures
- hand weeding by bushland friends group volunteers and contractors

Weed monitoring is conducted by the City every six months at the Ocean Reef Foreshore Reserve to establish the extent and distribution of weed species and to identify priority weeds. In accordance with Annual Maintenance Schedules and Weekly Maintenance Schedules developed by the City, on ground weed management occurs through weed spraying and hand weeding methods. In addition to this, contractors are engaged to spray weeds and hand weed. City of Joondalup personnel act in accordance with internal spraying procedures and conduct trials periodically to evaluate the most effective management methods. Resources, such as the DBCA FloraBase website or *Southern Weeds and their Control* (DAFWA Bulletin 4744), are also consulted in relation to weed control.

Environmental weeds are classified as priority by the City if they meet any of the following criteria:

- weed of national significance (WoNS)
- declared plant listed under the *Biodiversity and Agriculture Management Act 2007* (WA)
- high priority weed according to the Swan Impact and Invasiveness Ranking
- pest plant under the *Local Government Act 1995* (WA)
- major threat to vegetation
- major threat to the structure of vegetation communities
- contribute to a high fuel load, for example dry grasses.

A list of weeds and their priority rating according to the City and the DBCA *Swan Impact and Invasiveness Ratings* is provided in Appendix 5, with the recommended weed treatment methodology for high priority weed species detailed in Appendix 6.

The City of Joondalup's *Weed Management Plan* provides an ongoing strategic approach to the management of natural areas and parks in order to reduce the incidence of weeds. A number of education initiatives have been undertaken to increase awareness of weeds in the community, including:

- delivery of gardening workshops
- development and distribution of two weed brochures – *Environmental Weeds* and *Garden Escapees* (available in hard copy and on the City's website)
- weed education workshops for local Friends Groups.

### 3.1.6 Recommended Management Actions

To monitor, conserve and protect native flora in the Ocean Reef Foreshore Reserve, the following management actions are proposed.

| Action | Detail |
|---|---|
| Weed monitoring | Continue to undertake weed monitoring every six months |
| Targeted weed control | Continue to undertake a targeted weed control program, as described in Appendix 6 |
| Ongoing weed control | Continue to undertake a coordinated approach to regular weed control by implementing the Annual Maintenance Schedule |
| Targeted Weed Control | Continue to prioritise the control of high and very high priority weeds within the Ocean Reef Foreshore Reserve, determining the best method of control for these species. |
| Weed Management Plan | Continue to implement the City of Joondalup Weed Management Plan to provide an ongoing strategic approach to the management of natural areas in order to reduce the incidence of weeds. |
| Restoration | Conduct restoration as outlined in the Revegetation Strategy in Appendix 7. |
| Friends Group | Continue to support the activities of the FONORIF |

## 3.2 Fungi

It is estimated that there are 10 times more species of fungi than plants in the world, equating to approximately 140,000 fungi and 14,000 plant species in Western Australia. The amount of species of fungi present in bushland can be an indicator of ecosystem health. Fungi are strongly interconnected with plants and animals as fungi are recyclers that break down litter and debris to provide nutrients for plants. Native plants such as eucalypts, wattles and orchids have beneficial partnerships with fungi. Fungi also provide food and/or habitat for fauna such as bandicoots and other fauna including invertebrates[31].

Fungi surveys are important to provide baseline information, and to highlight changes in fungi occurrence over time. Undertaking surveys also enables comparison of ecological data with other City of Joondalup natural areas. The most common time to see the fruiting bodies of fungi is after autumn and winter rains.

### 3.2.1 Fungi Field Survey

No fungi species were recorded during on ground 2018 and 2019 surveys undertaken by Natural Area[32]. The optimum time to see fruiting bodies of fungi is after the first autumn/winter rains, and as this survey was undertaken in spring and summer it is likely the fruiting bodies would have already senesced. As fungi assist with decomposition and nutrient recycling processes within natural ecosystems, it is likely to be found in the leaf litter and vegetated dune areas within the site at optimal fruiting times. Fungi species likely to occur are expected to be similar to those observed within the Marmion Coastal Foreshore Reserve[33] and other City of Joondalup bushland areas.

[31] Bougher (2009)
[32] Natural Area Consulting Management Services (2019)
[33] Natural Area Consulting (2013b)

### 3.2.2 Current Management Approach

The City of Joondalup currently monitors fungi within the Reserve through incidental sightings of fungi species every 5 years as part of the flora and vegetation survey.

### 3.2.3 Recommended Management Action

To monitor fungi health in the Ocean Reef Foreshore Reserve, the following management action is proposed.

| Action | Detail |
|---|---|
| Opportunistic Fungi Survey | Continue to undertake opportunistic fungi sightings during other site activities. |

## 3.3 Plant Diseases

Vegetation can be subject to diseases that result in plant health decline and potentially death in the longer term. Pathogens are organisms such as fungi, bacteria and viruses that cause plant diseases; with many introduced into new areas through movement of infected plant material or soils, whilst some are naturally occurring in the soil. Some pathogens will result in rapid plant death while others will lead to the slow decline in plant health over time[34].

*Phytophthora* (dieback) is a water-borne fungus and the most common plant disease encountered on the Swan Coastal Plain, with the most common species encountered being *Phytophthora cinnamomi*. While *Phytophthora cinnamomi* is considered the most destructive, other varieties are being described which may have similar impacts, such as *Phytophthora multivora* which is known to attack a variety of species including *Eucalyptus gomphocephala*, *E. marginata, Agonis flexuosa,* and a range of Banksia species[35].

The nature of the vegetation within the Ocean Reef Foreshore Reserve, combined with the presence of limestone-based soils mean that P*hytophthora cinnamomi* presence is unlikely. However, *Phytophthora multivora* is known to be tolerant of alkaline conditions as it has been found in Tuart forests underlain by limestone soils south of Mandurah and as far as Cape Naturaliste, where it has been associated with individual spot deaths and areas of tree decline[36]. *Phytophthora multivora* has been recorded in urban areas of Perth, including inland dune systems and within the City's parks. If suspected within the foreshore reserve or other natural areas, it should be treated in the same manner as *Phytophthora cinnamomi*. Sampling undertaken by Arbor Carbon[37] in 2015 found *Phytophthora nicotianae* in one location at Tom Simpson Park in Mullaloo but has not been recorded within the Ocean Reef Foreshore. Sampling within the Ocean Reef Foreshore Reserve during 2013/2014 and 2016/2017 was negative for pathogens.

*Armillaria luteobubalina* has been previously identified within a number of the City's parks. Armillaria is a soil-borne fungus that causes root rot of a wide variety of plants including many species of native flora. The

[34] City of Joondalup (2012)
[35] Scott *et al*. (2009)
[36] Ibid.
[37] Arbor Carbon (2015)

fungus is native to Australia and can cause major damage to natural ecosystems. *Armillaria luteobubalina* is commonly known as the 'Honey Fungus' due to the colour of the fruiting body seen above the ground during certain times of the year (Figure 15). Fruiting bodies (mushrooms) are not evident at all infected sites and their presence is usually a sign that the fungus is well established in that area[38].

**Figure 15:** *Armillaria luteobubalina*

### 3.3.1 Current Management Approach

The City of Joondalup has developed a Pathogen Management Plan 2018 - 2028 to protect native vegetation and ecosystems by establishing the level of risk for areas to be infected by pathogens, prioritisation of areas and detail preventative and management actions to be implemented within the City, including guidelines for dieback-free purchasing of plant stock and materials and a hygiene procedure. The City has also developed Pathogen and Weed Hygiene Guidelines[39] and Purchasing Guidelines for the Supply of Landscaping Materials[40] to minimise the spread of pathogens.

### 3.3.2 Recommended Management Actions

To prevent disease and pathogen spread and protect biodiversity values at the Ocean Reef Foreshore Reserve, the following management actions are recommended.

| Action | Detail |
|---|---|
| Pathogen Management | Continue to implement recommendations from the Pathogen Management Plan that are applicable to the management of the Ocean Reef Foreshore Reserve, particularly in sites affected by pathogens. |
| Pathogen Management | Continue to implement *Pathogen and Weed Hygiene Guidelines* and *Purchasing of Landscaping Materials Guidelines* to prevent the introduction or spread of weeds or pathogens into the Ocean Reef Foreshore Reserve. |
| Pathogen Management | Continue to implement Pathogen Hygiene Conditions for Contractors that are applicable to the management of the Ocean Reef Foreshore Reserve. |

[38] Smith and Smith (2003)
[39] City of Joondalup (2016)
[40] City of Joondalup (2015)

## 3.4 Fauna

Fauna surveys were undertaken by Natural Area in January 2019[41] to establish a baseline of species inhabiting the Reserve and document their occurrence, extent and minimum population numbers. Note that the timing of the survey was constrained by factors outside the control of Natural Area such that it occurred later than the preferred October – December survey period. Outcomes of the Natural Area fauna surveys are presented in this section.

### 3.4.1 Fauna Survey Methodology

Fauna survey activities were undertaken in accordance with *EPA Technical Guidance – Terrestrial Fauna Surveys* (EPA, 2016). The survey activities were carried out over a five-day period between 21 and 25 January 2019; activities included:

- setting up modified traplines including flywire, funnel and pitfall traps along a series of 8 trap lines (at least 1 per habitat type); vegetation was placed in pitfalls and over funnel traps to provide protection from the elements
- setting up 16 Elliott traps and two cage traps, which were set up under vegetation and with shredded newspaper inside, and covered with hessian
- all trap and trap line locations recorded using a hand-held GPS and marked with flagging tape
- checking traps within 3 hours of sun rise, recording and releasing species present within the site
- undertaking a dusk survey to observe nocturnal species on 19 February 2019
- setting out six motion activated camera (left out for 5 weeks/ 35 days) to capture images of other animals that are unable to be trapped
- recording opportunistic sightings or signs of birds and mammals, including calls, tracks and scats
- recording opportunistic sightings and captures of invertebrates
- recording the outcomes of the trapping and observation activities.

### 3.4.2 Fauna Habitat

Four vegetation types were recorded by Natural Area within the Ocean Reef Foreshore Reserve during the November 2018 site assessments. These consisted of *Acacia rostellifera* Shrubland on secondary and tertiary dunes, *Spinifex* Grassland on foredunes, Mixed Coastal Shrubland on secondary and tertiary dunes throughout the site, and *Melaleuca cardiophylla* Closed Heath on shallow sands over limestone. In terms of habitat type, these vegetation communities can be classed as Quindalup dune mixed shrublands on sandy soils.

This habitat type supports a range of coastal shrubland birds, terrestrial reptiles and small mammals. No wetlands or open water bodies occur within the Reserve meaning there is no habitat for aquatic species aside from marine species. Amphibians may be able to travel to the site from nearby water sources in residential gardens or reserves. Large trees north of the southern carpark provide nesting and roosting habitat for birds.

[41] Natural Area Consulting Management Services (2019)

### 3.4.3 Native Fauna

Flora and fauna are interconnected in complex relationships with each other and other factors such as water, soil, climate and landscape. The decline of native fauna can cause the loss of plant species and changes to ecological communities; for example, the loss of pollinating fauna species can reduce or even cease plant reproduction. Similarly, the loss of plant species will impact on the type and number of fauna species that can be supported in a given locale. A total of 44 vertebrate fauna species were recorded on site including seven mammals (one native, six introduced), 29 birds (26 native, three introduced) and eight reptiles (all native). A total of 48 invertebrate species were recorded (at least three introduced).

**Mammals**

One native mammal, the Quenda or Southern Brown Bandicoot (*Isoodon fusciventer*), was captured within the Reserve during the 2018 survey (Figure 16, Appendix 4). Quenda is listed as a Priority 4 under the *Biodiversity and Conservation Act 2016* (WA). All other mammals recorded were introduced species.

**Figure 16:** Captured Quenda being released within Ocean Reef Foreshore

**Birds**

Twenty-six native bird species were recorded within the Reserve during the 2018 fauna survey activities (Figure 17). Most were common or moderately common to the area. One species, the Whimbrel (*Numenius phaeopus*), is listed as a migratory species under the *EPBC Act 1999* (WA), and is described as scarce in the South West of WA[42]. Seven species recorded are considered locally significant due to reduced populations and/or being habitat specialists with reduced distributions on the Swan Coastal Plain[43], these were:

- Collared Sparrowhawk (*Accipiter cirrocephalus*)
- New Holland Honeyeater (*Phylidonyris novaehollandiae*)
- Variegated Fairy-wren (*Malurus lamberti*)
- White-breasted Robin (*Eopsaltria georgiana*)
- White-browed Scrubwren (*Sericornis frontalis*)
- White-cheeked Honeyeater (*Phylidonyris niger gouldii*)

[42] Department of the Environment (2019)
[43] Government of Western Australia (2000)

- White-winged Fairy-wren (*Malurus leucopteris*).

White-cheeked Honeyeater (*Phylidonyris niger gouldii*)

Whimbrel (*Numenius phaeopus*)

White-winged Fairywren (*Malurus leucopteris*)

White-browed Scrubwren (*Sericornis frontalis*)

**Figure 17:** Significant birds in Ocean Reef Foreshore Reserve

**Reptiles**

A total of eight reptile species were recorded during the 2019 fauna surveys, of which two were snakes and six were lizards (Figure 18; Appendix 4). All species were native and common to the area, with no conservation significant species recorded. Reptiles captured ranged in age from juveniles to mature animals, indicating healthy breeding populations.

Elegant Slider (*Lerista elegans*)

South-western Spiny-tailed Gecko (*Strophurus spinigerus*)

Dugite (*Pseudonaja affinis*)

**Figure 18:** Examples of reptiles recorded in Ocean Reef Foreshore Reserve

**Amphibians**

No amphibians were recorded during the January 2019 fauna survey. This may be due to summer weather conditions at the time of the survey, as well as the distance to open water bodies, with none present within the Reserve.

**Invertebrates**

A total of 45 native invertebrate species were recorded during the 2019 fauna survey (Appendix 4), these were either opportunistically observed or were bycatch in pitfall and funnel traps. No conservation significant invertebrates were recorded, and most were relatively common in the area with multiple individuals captured across the extent of the site. Examples of invertebrates observed or captured in the Reserve are shown in Figure 19.

Silver-spotted Ochre (*Trapezites argenteoornatus*)

Jack Jumper Ant (*Myrmecia swalei*)

Hairy Piedish Beetle (*Helea perforata*)

**Figure 19:** Examples of invertebrates within Ocean Reef Foreshore Reserve

### 3.4.4 Non-native Fauna

Non-native fauna impact native fauna and flora through predation, competition for food and shelter, disease spread and habitat destruction. These impacts can result in the diminishing or extinction of native species[44]. Non-native animals such as cats, foxes, rabbits, mice, birds, millipedes and bees inhabit the City's bushland, wetland and coastal areas. Introduced species recorded during the 2019 surveys included six mammals, three birds and three invertebrates.

**Introduced Mammals**

A total of six introduced mammals were recorded during the 2019 fauna survey assessments with all captures on motion activated cameras set up throughout the reserve; the House Mouse (*Mus musculus*) was also captured in a pitfall trap in the northern portion of the Reserve. Two of the mammals recorded, the European Rabbit (*Oryctolagus cuniculus*) and the Red Fox (*Vulpes vulpes*), are listed as category C3 declared pests under the *Biosecurity and Agriculture Management Act 2007* (WA), which requires control by the land manager to reduce the abundance and spread of these species.

Domestic dogs (*Canis lupus familiaris*) are permitted on lead along the dual use pathways but are not permitted on the beach or vegetated areas within the Reserve. Dogs were observed being walked on and off

[44] DSEWPC (2012)

lead throughout the Reserve. Dogs can cause damage to the City's natural areas when walked off lead through:

- the creation and proliferation of informal tracks when roaming into bushland areas
- harassment of native animals such as reptiles, birds and mammals, potentially causing harm
- acting as a vector for the spread of soil-based pathogens and diseases if they dig and disturb soil
- dog droppings if not removed can contribute to nutrients within the site, encouraging weed growth and potentially polluting groundwater
- dog droppings can contain harmful bacteria, which may harm native fauna species such as Bobtails which are known to consume them.

Domestic and feral cats (*Felis catus*) pose a significant threat to native fauna when allowed to roam free in natural areas such as Ocean Reef Foreshore Reserve. Cats observed in the Reserve were likely the pets of nearby residents as they were wearing collars. Cats are nocturnal hunters and were captured on motion cameras within the site at night during the 2019 fauna survey period. Feral cats are attributed to be the major threat to mammalian fauna extinction in Australia. The Australian Wildlife Conservancy estimates that 'feral cats kill at least 75 million native animals every night across Australia'[45]. The Federal Government endorsed the National Declaration of Feral Cats as Pests in 2015. In order to combat this threat to native fauna populations, the Australian Government has set an objective through the Threatened Species Strategy 2015 for 2 million cats to be culled across Australia by 2020[43].

The *Cat Act 2011* (WA) indicates that owners are responsible for having their pet sterilised, registered with their local council, microchipped and kept inside from 6:00 pm at night. The Act enables the City of Joondalup to seize cats if they are reported to be on private properties without the permission of the owner; in accordance with those provisions, the City has commenced cat control activities in its foreshore reserves in 2017.

The City has a fox and rabbit control program and operates under the BAM Act to manage these non-native mammals at Ocean Reef Foreshore Reserve.

**Introduced Birds**

Three introduced birds were recorded during the 2018 and 2019 survey activities, namely the Laughing Turtle Dove (*Spilopelia senegalensis*), Spotted Turtle Dove (*Spilopelia chinensis*) and the Rainbow Lorikeet (*Trichoglossus moluccanus*). These are common species known to occur throughout the Perth metropolitan region. Introduced birds negatively impact native species by increasing competition for food, nesting hollows and other resources.

**Introduced Invertebrates**

Three introduced invertebrates were recorded within the Reserve during the 2019 fauna survey, namely the European Honey Bee (*Apis mellifera*), the Portuguese Millipede (*Ommatoiulus moreleti*) and the Rolling Slater (*Armadillidium vulgare*). All three species were very common, with the Honey Bee opportunistically observed throughout the site although no bee hives were recorded. The other two species were captured in

[45] Australian Wildlife Conservancy (2012/2013)

pitfall and funnel traps throughout the site. The Portuguese Millipede has few predators and is avoided by most animals due to the distasteful organic chemicals called quinones that they secrete when agitated; it is considered a pest at high population levels[46].

### 3.4.5 Ecological corridors

Naturally connected landscapes and ecosystems are generally more likely to be healthier than fragmented ones, supporting and protecting a greater diversity of fauna species, providing pathways for fauna movement and storing carbon more effectively than degraded landscapes[47]. The Ocean Reef Foreshore Reserve is part of an ecological linkage along the coastal strip that extends from Burns Beach south to North Beach and inland to Periwinkle Park, Korella Park Natural Area and Kallaroo Park Natural Area within the City of Joondalup (Figure 20); the ecological corridor also extends beyond the City boundaries and includes reserves such as Ern Halliday Reserve and Star Swamp.

### 3.4.6 Current Management Approach

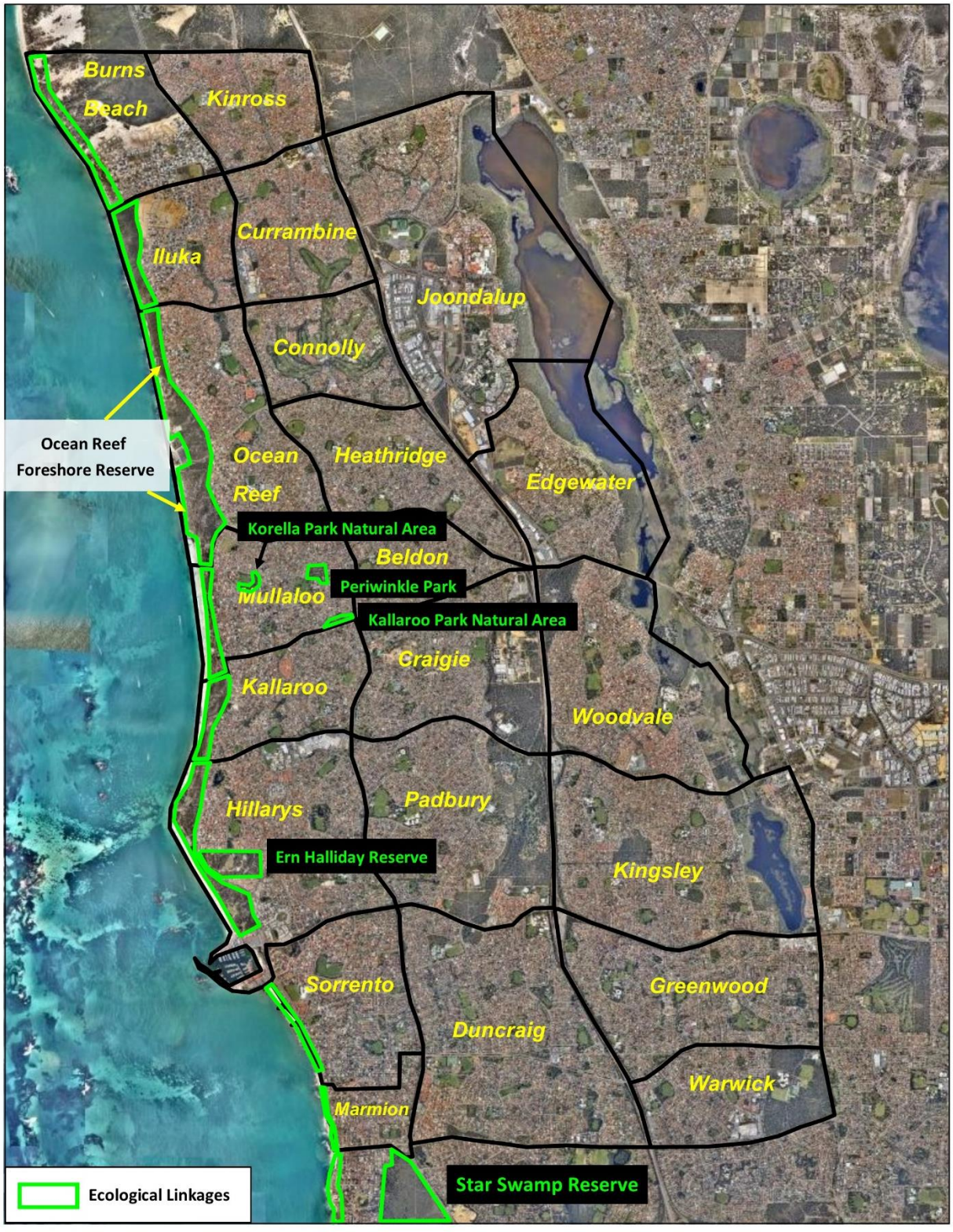
The City of Joondalup is implementing a number of management actions to monitor native fauna and address the environmental impacts of domestic and pest animals within the City's natural areas. Monitoring of native fauna occurs through fauna surveys. Control of non-native fauna is undertaken as required within bushland, wetland and coastal areas. Control methods employed include trapping, baiting and exclusion methods such as fencing.

The City's current management practices have greatly reduced the incidence of pest animal populations within the City, however continued and coordinated action is required to ensure that populations remain at controllable numbers and that the impacts on natural areas remain at a minimum. The City also promotes responsible pet ownership and encourages the community to ensure that domestic pets do not have a negative impact on the natural environment.

### 3.4.7 Recommended Management Actions

| Action | Detail |
|---|---|
| Fauna | Carry out follow-up fauna surveys in spring and a targeted invertebrate survey after five years. |
| Feral animal control | Continue to monitor feral animal populations and implement regular fox and rabbit control to reduce pressures on native fauna and flora. |
| Dog control | Dogs are controlled in accordance with the *Dog Act 1976* (WA) and City of Joondalup's policies and procedures in relation to removal on land managed by the City. |
| Cat Control | Continue cat control activities within the foreshore reserve in accordance with the provisions of the *Act 2011* (WA) and City of Joondalup's policies and procedures in relation to their trapping and removal on land managed by the City. |

[46] Department of Primary Industries and Regional Development (2019)
[47] NWCPAG (2012)




Client: City of Joondalup
Project: Ocean Reef Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 19/07/2019
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

**Figure: 20**

**Ecological linkages**

**Ocean Reef Foreshore Reserve**

0 N 2.0

kilometers

## 3.5 Social and Built Environment

### 3.5.1 History and Heritage

The Aboriginal Heritage Site 3673 Mullaloo Desert North is located in the southern portion of the Ocean Reef Foreshore Reserve[48]. The non-aboriginal Heritage Place 25302 Rock Inscription is listed west of Resolution Way in the northern portion of the Reserve[49].

### 3.5.2 Social Value

The Reserve provides numerous recreational activities to visitors including walking, dog walking, bird watching, picnicking, jogging and cycling along pathways and parkland. Water activities include swimming and surfing.

### 3.5.3 Access and Infrastructure

Access includes the dual use path, access to the beach and parking areas, while infrastructure includes parking, bins, bicycle racks, drink fountains, showers, lookouts, seating, and an ablution block. Each are discussed, with their locations shown in Figure 28.

**Parking**

There are two car parks within the Ocean Reef Foreshore Reserve that facilitate access to the parks, beaches and pedestrian pathways. One is located in the northern portion of the site off Ocean Reef Road south of the Shenton Avenue roundabout, with the second located off Oceanside Promenade approximately 200 m south of Key West Drive.

**Fencing**

Fencing is installed around the perimeter of vegetated bushland areas. Two types of fencing are present, namely pine posts with ringlock wire mesh and two high tensile string wires at the top, and PVC sleeves over pine posts, and chainmesh fencing along the paths to the beach and the front of the foredunes in the southern portion. Some of this fencing has been affected by erosion and has almost been completely buried by sand, this will be an ongoing issue in the area due to the highly mobile characteristics of the foredunes (Figure 21) and climate change. A number of sections along the dual use path are showing signs of wear with damaged or cut areas, sagging of wire and rust.

[48] Department of Planning, Lands and Heritage (2019a)
[49] Heritage Council (WA) (2019)

**Figure 21:** Fencing buried due to sand accretion on the beach and foredunes

**Access Points**

Formal access points are generally in good condition throughout the Reserve. However, several informal tracks into the vegetated dunes are present with these areas experiencing degradation, particularly at the access points leading to erosion in areas off the dual use path and other access ways. A geocache marker was recorded on one of the fence posts at the southern lookout; these markers encourage visitors to venture into the vegetated dunes in search of the geocaches, leading to further degradation of the dunes.


**Figure 22:** Geocache marker recorded near the southern lookout

**Paths and Trails**

Paths and tracks within the Ocean Reef Foreshore Reserve are generally in good condition. The southern access track requires maintenance due to plants suckering along the track; this and the two southern beach access pathways were also subject to erosion with sand infilling tracks from adjacent higher elevated dunes (Figure 23). This is an ongoing issue due to the high mobility of the foredunes from wind and water erosion in this area and is likely to be influenced by seasonal variations.

**Figure 23:** Pathway requiring maintenance (left), and subject to erosion (right)

**Access and Inclusion**

In a Survey of Disability, Ageing and Carers conducted in 2015, an estimated 22,400 people, or 13.9% of the population in the City of Joondalup have a disability and 16% have limitations or restrictions in core activities associated with communication, mobility or self-care, for which assistance is required. Even more of the population have a disability that restricts schooling or employment opportunities but does not limit their daily core activities[48].

The City of Joondalup has an Access and Inclusion Plan 2018 – 2021, outlining the City's holistic approach to increasing access and inclusion in the community for people of all ages, abilities and backgrounds. This plan includes strategies for all outcome areas including physical access to the natural and built environments, services, events and information. Additional services aim to aid people to engage and connect with their community to foster feelings of belonging[50]

Bitumen and concrete pathways provide adequate access for people with disabilities to gain access to the dual use pathway from carparks and roads. However, there are a few steeper inclines along the dual use pathway within the Reserve particularly near the southern lookout, which may affect access along the entire length of the dual use path within both portions of the Reserve. Access points to the beach are sandy tracks with some having stairs at the eastern end and do not allow access by those with disabilities. However, they can access lookout points from the top of the limestone cliffs.

**Water Sensitive Urban Design**

One drain enters the Reserve in the north portion just north of the footpath adjacent from Vigilant Terrace (Figure 24). No sumps are present in the Reserve and no drainage lines enter the south portion. No effects of drainage line entering the Reserve were observed.

[50] City of Joondalup (2018)

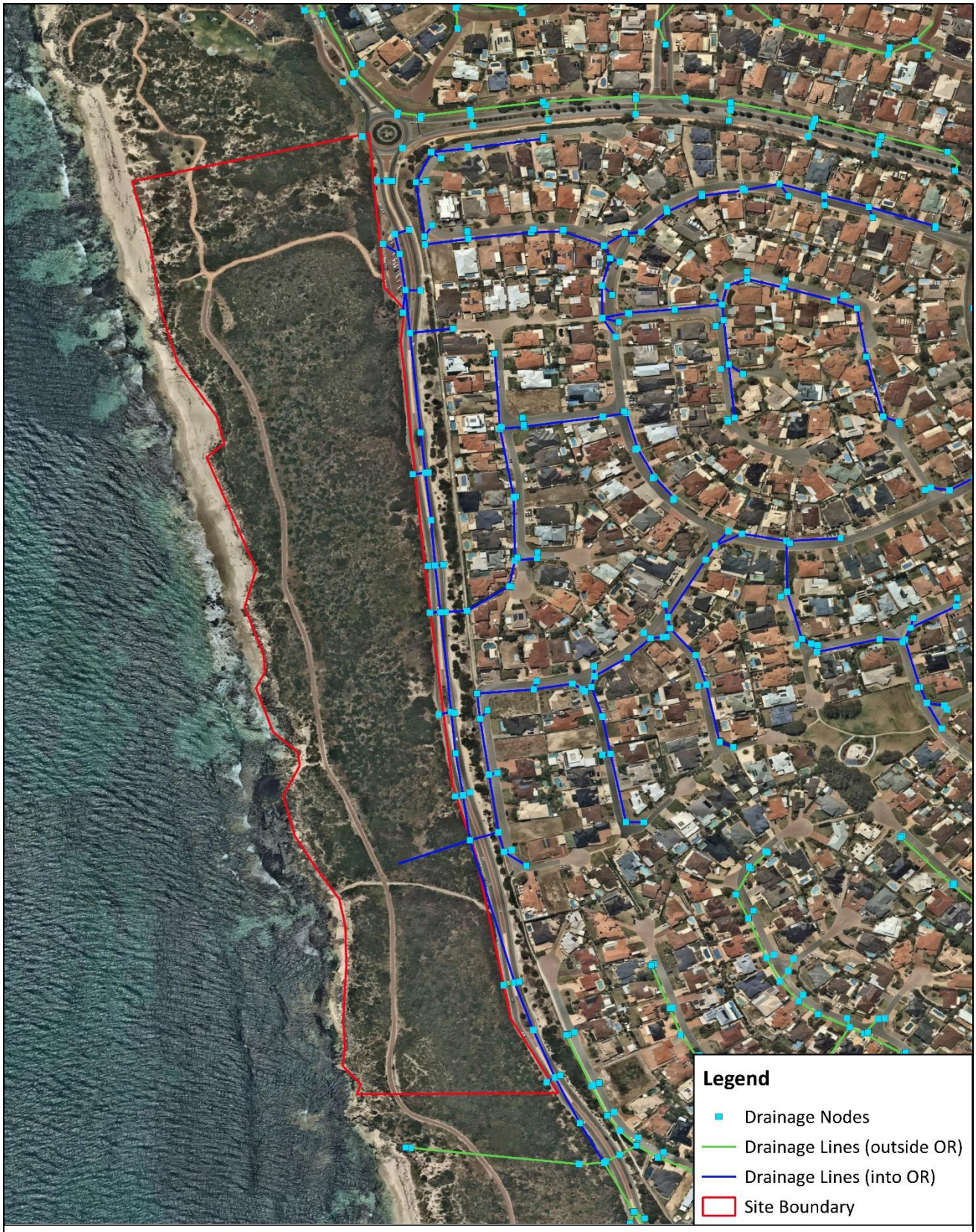



**Figure 24:**
Drainage Infrastructure
Ocean Reef Foreshore Reserve

**Signage**

Signage is utilised to convey a range of information to users of the Ocean Reef Foreshore Reserve. Signage informs users of flora and fauna present on site, safety precautions, conservation values, penalties that apply for unpermitted activities (i.e. unauthorised access, vandalism, smoking on the beach and taking dogs on the beach), permitted activities, directional signage (to signify locations and distances to amenities and exits), and appropriate uses of the dual use path (Figure 25). Current signage within the Reserve is adequate and mostly in good condition with a few faded and graffitied signs.


**Figure 25:** Examples of signage within the Ocean Reef Foreshore Reserve

**Toilets**

An automated ablution block with self-cleaning facilities is present in the southern carpark adjacent to the access way from the carpark to the dual use path and main beach access (Figures 26 and 28). It was in working order during the 2018 and 2019 assessments. The City is currently reviewing renewal options.


**Figure 26:** Automated toilet block

**Seating**

Bench seats are provided along the dual use path and near lookout points throughout the Reserve. Shaded seating areas are located at lookouts and on Iluka Beach adjacent the northern access pathway (Figure 28).

**Rubbish Bins**

Rubbish bins are located at each of the carparks and at access way entrance to the dual use pathways (Figure 28). No bins were present at the covered seating/picnic areas at the lookouts on or near Iluka Beach, with discarded cans and bottles being more prevalent in these areas. Overall, minimal rubbish was recorded for the majority of the Reserve during the 2018 and 2019 site assessments, with the majority being plastic bags, paper and cardboard on the periphery of vegetated areas adjacent to parkland areas and roads that had probably been blown in by the wind. The southern portion exhibited one area with a high concentration of rubbish north of the car park under the *Eucalyptus utilis* trees where multiple cubbies were recorded.

### 3.5.4 Anti-social Behaviour

Anti-social behaviour includes inappropriate use of the reserve and amenities, and activities such as graffiti, vandalism to property, construction of cubbies, destruction of natural and human assets, rubbish dumping, camping, and lighting of fires on the beach. Impacts of such activities included decreased aesthetics, damage to the vegetation through trampling and clearing, and increased maintenance costs to remove or repair damaged assets and infrastructure. There was some evidence of anti-social behaviour noted within the Ocean Reef Foreshore Reserve during the 2018 and 2019 site assessment activities, with cubbies, campfire

construction, rubbish dumping and vegetation destruction in the southern portion being the most obvious (Figure 27).

**Figure 27:** Examples of cubbies and rubbish dumping within the Reserve

### 3.5.5 Recommended Management Actions

To enhance the social and built environment in the Ocean Reef Foreshore Reserve, the following management actions are proposed:

| **Action** | Detail |
|---|---|
| Access and inclusion | Implement recommendations outlined in the Access and Inclusion Plan 2018 - 2021 as they apply to the Ocean Reef Foreshore Reserve |
| Fencing | Regularly review sand build up along the beach fence and arrange removal of excess sand when required. |
| Water erosion from drainage | Monitor the area where the drainage line enters the north portion of the reserve and restore if required |
| Signage maintenance | Continue signage inspections in conjunction with other monitoring activities in accordance with the Annual Bushland Schedule and repair or replace damaged or vandalised signs as required |
| Inappropriate signage | Remove any advertisement signage affixed to the fencing or other locations in the Reserve by business owners or individuals when observed. |
| Rubbish | Monitor rubbish around the reserve in accordance with the Annual Bushland Schedule, with removal occurring when observed. |
| Anti-social Behaviour | Monitor evidence of anti-social behaviour, promptly:<br>▪ removing any cubbies, or dumped rubbish<br>▪ repairing vandalised assets and/or infrastructure<br>▪ restoring damage to bushland areas as soon as possible after discovery. |

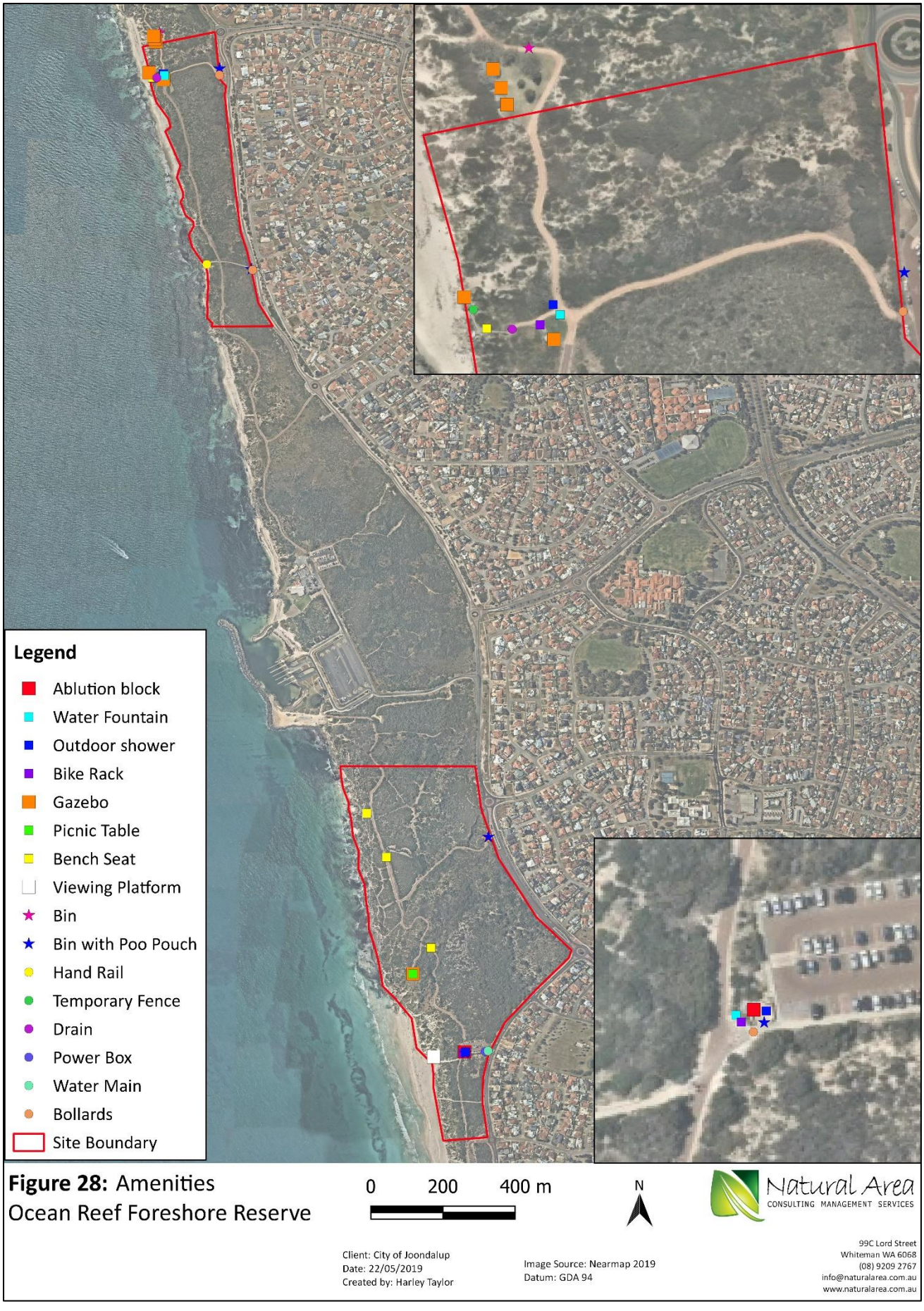



**Figure 28:** Amenities
Ocean Reef Foreshore Reserve

## 3.6 Fire Management

Fire is an important natural feature of the Western Australian landscape as it helps to shape the diversity of plant communities with many Australian native plants having adapted fire-reliant methods of reproduction. Human activities such as accidents and arson have resulted in an increased incidence of fire within many urban bushland reserves that threatens biodiversity, reduces the ability of native species to complete their lifecycle and can encourage the growth of fire promoting invasive weeds. A high intensity fire may damage infrastructure such as property, signage, fences and gates. Fire suppression methods may also compromise the environmental values of the Reserve, such as clearing native vegetation for firebreaks.

Bushfires are unplanned fires that can be caused by events such as lightning, planned burning operations, escape from industrial activities, damaged power transmission lines, discarded cigarette butts or deliberate arson. Bushfires can cause significant damage to people, property and the environment. Management of the Ocean Reef Foreshore Reserve is the responsibility of the City of Joondalup, which has a 'duty of care' to take all reasonable precautions to prevent any bushfire from spreading onto neighbouring property. The City of Joondalup does not currently have a prescribed burn management regime for the area. The Department of Fire and Emergency Services (DFES) work with the community and government to prevent, prepare for, respond to and recover from a diverse range of emergencies, including fire. There are numerous water hydrants located around the Reserve, which are installed and maintained by the Water Corporation.

**Objectives**

The objectives of fire management within the Ocean Reef Foreshore Reserve are to:

- protect life, property and environment in Ocean Reef, and adjacent residential areas
- fulfil obligations under the *Bush Fires Act 1954* (WA)
- protect the ecological and amenity values
- protect landscape values (including flora and fauna) from uncontrolled fire and inappropriate suppression techniques
- reduce the frequency, impact and area of unplanned fires
- minimise the spread of disease and weeds during fire-fighting operations and when establishing emergency firebreaks, and during post-fire clean-up activities
- minimise impacts on air quality.

**Fire Risk**

The fire risk within Ocean Reef Foreshore Reserve ranges from low in sandy, beach areas where the potential for fire spread is reduced, to a moderate – extreme risk in locations vegetated with coastal heath, shrubland and woodland vegetation due to their flammability. While fine fire fuels such as grasses, leaf litter, bark and small twigs increase the risk of ignition at the site, as this is a coastal area little leaf litter build up occurs reducing this risk in the area. Although, dry grasses in summer are more prevalent around the periphery of the bushland which increases fire risk in these areas. The highest fire risk for the site is from deliberately lit fires within the vegetated dunes and discarded cigarette butts (Figure 29). Thick vegetation, steep dunes and cliffs within the Reserve can pose safety risks to fire respondents, particularly if there is low visibility due to smoke. Fire fuel load assessments are carried out every year to determine fire risk based on

fuel load, assessments should be undertaken using the methodology described in the South Australian Department of Environment and Natural Resources *Overall Fuel Hazard Guide for South Australia*[51].

**Figure 29:** Cigarette butts recorded within the periphery of vegetated areas

**Fire Prevention**

The City of Joondalup implements a number of on ground measures to reduce the risk of fire, including:

- controlling access
- managing non-native flora (weed) species
- undertaking fuel load assessment and management
- maintaining and installing fire access tracks (fire access ways and strategic firebreaks).

Fuel load assessments are conducted annually at Ocean Reef Foreshore Reserve and the results used to inform fire management at the site. Weed control and maintenance of fire access tracks are conducted in accordance with the City's Annual Bushland Schedule. The City of Joondalup adopted the *Bushfire Risk Management Plan 2018 – 2023,* outlining the City's strategy for assessing fire risk, prevention, response and recovery. The City has also developed *Post-Fire Weed Management Guidelines* to mitigate the impact of weeds within the post fire environment of the City's natural areas and are implemented within the City's natural areas after a fire event.

**Fire Occurrences**

A review of historical aerial imagery from Landgate indicates that no fires occurred within the Ocean Reef Foreshore Reserve since 1965[52]; however, as there were up to 10 years or more in between photos prior to 1995 there is a possibility that fires may have occurred during these times. It is also probable that small fires will not show on aerial imagery. Two campfire remnants were recorded within the Reserve during the 2019 site assessment both occurring in the vegetated dunes (Figure 30), both were north of the southern carpark where majority of the cubbies were located.

[51] Department of Environment and Natural Resources (2012)
[52] Landgate (2019)

**Figure 30:** Fire pits observed in Ocean Reef Foreshore Reserve (2019)

**Fire Response**

The closest fire station is the Wanneroo Fire Station on Drovers Place, Wanneroo (approximately 5 km away) and they are responsible for suppressing fires within the Ocean Reef Foreshore Reserve. The Western Australian Police Force are responsible for the evacuation of residents and visitors, if required.

### 3.6.1 Recommended Management Actions

To prevent fire occurrences and minimise the environmental impact of fire occurrences in Ocean Reef Foreshore Reserve, the following management actions are proposed:

| Action | Detail |
|---|---|
| Assess fire fuel load | Continue to annually assess and report fire fuel load using the South Australian Overall Fuel Hazard Guide for South Australia or other suitable methodology to inform fire prevention actions required. |
| Bushfire Risk Management Plan | Continue to implement actions from the Bushfire Risk Management Plan 2018 – 2023 the outlines the City's strategy for assessing fire risk, prevention, response and recovery. |
| Monitor fire occurrences | Continue to monitor fire occurrences through mapping and updating Geographic Information System (GIS) layers detailing fire incidents and frequency to inform fire prevention actions. |
| Post Fire Weed Management | After fires, implement the Post Fire Weed Management Guidelines to aid regrowth of native species by selecting appropriate chemicals, targeting weeds if safe to do so, and spraying grasses. |
| Maintain fire access tracks and footpaths | Regularly inspect and maintain fire access tracks and footpaths as required. |

## 3.7 Education and Training

An important objective of this Plan is to ensure that the local community, visitors to the City's natural areas and those that manage the City's natural areas have the necessary awareness, knowledge, motivation and behaviour to assist in protecting the City's natural areas. Environmental objectives cannot be achieved through the actions of the City alone; the community can also affect the local environment in both positive and negative ways. Environmental outcomes require the support of an engaged community that is aware and participating in environmental activities.

The local community can protect and enhance Ocean Reef Foreshore Reserve through the following actions:

- contact the City of Joondalup if they are interested in initiating or participating in an environmental volunteer group such as the FONORIF to assist with bushland restoration and maintenance activities
- minimising access and disturbance to the site by staying on paths, not taking vehicles into natural areas, and not allowing dogs to run off-lead
- contain cats, particularly at night, and ensure they stay out of Ocean Reef Foreshore Reserve.
- planting local native species in gardens where possible
- avoid touching or feeding wildlife and picking wildflowers or native plants
- undertaking appropriate hygiene practices such as cleaning footwear when entering and leaving the site, removing any weed seeds attached to clothing and removing and disposing appropriately of dog excrement (may contain weed seed)
- not dumping garden rubbish or littering on site; litter could be collected from site when spotted, or people could organise or get involved with a Clean Up Australia Day event.

Schools are also an important avenue for raising awareness and interest in environmental issues and creating future community members that are aware of, appreciate and actively participate in local environmental management.

**Current Management Approach**

The City implements an Annual Environmental Education Program to address key environmental issues and encourage greater environmental stewardship by the community. The Environmental Education Program includes a Think Green Biodiversity campaign focussed on raising awareness of key environmental issues within the City and encouraging community participation in protecting the natural environment.

The City implements an Adopt a Coastline Program to give primary school students the opportunity to take part in an environmental program involving education, rehabilitation and conservation activities along the coastline including on-ground coastal activities such as weeding, planting and care of dune systems.

In order to educate the community about how they can protect natural areas, the City has developed a number of key brochures titled 'Being WEEDwise: Garden Escapees in the City of Joondalup', 'Being WEEDwise: Environmental Weeds in the City of Joondalup' and 'Protecting our Natural Areas and Parks'.

The City of Joondalup Natural Areas Team currently conducts regular plant identification training, including weed management. New members in the Natural Areas team undertake training for the identification and management of pathogens.

The City's Friends Groups are instrumental in assisting to protect, preserve and enhance significant bushland areas within the City and may also benefit from training related to pathogen hygiene and weed management. The FONORIF operate within Ocean Reef Foreshore Reserve.

### 3.7.1 Recommended Education and Training Management Actions

| Action | Detail |
|---|---|
| Environmental Education Program | Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as:<br>▪ pathogens<br>▪ weeds<br>▪ litter<br>▪ fire<br>▪ flora, fauna and fungi awareness<br>▪ prevention of hand feeding wildlife<br>▪ responsible pet ownership. |
| Adopt a Coastline | Continue implementing the Adopt a Coastline Program within Ocean Reef |
| Natural Areas Team Training | Conduct regular Natural Areas Team plant identification training, including weed management, to increase the effectiveness of weed control activities, as required. |

# 4.0 Implementation Plan

## 4.1 Auditing and Inspection

Inspections of the Ocean Reef Foreshore Reserve are conducted by the City of Joondalup as per the Annual Bushland Schedule.

## 4.2 Key Performance Indicators

A review of the Ocean Reef Coastal Foreshore Management Plan will be undertaken annually through reporting against progress made in implementing recommended management actions. Ongoing reporting against Council endorsed Natural Areas Key Performance Indicators will also be undertaken to ascertain whether current management practices are leading to positive environmental outcomes. These indicators will be measured and reported on an annual, biennial and five yearly basis as shown in Table 6.

**Table 6:** Natural Area Key Performance Indicators

| Key Performance Indicator | Source | Reporting Period |
|---|---|---|
| Density of weeds per area – expressed as a percentage. | Data obtained from site investigations of transects positioned within natural areas. | Annual<br>2019 – 2029 |
| Waste present in natural areas – items per hectare | This data is collected on an annual basis from ten of the City's reserves. | Annual<br>2019 – 2029 |
| Percentage of natural areas protected within City reserves | Areas (hectares) included in the City's proposed Conservation Reserves within the District/Local Planning Scheme 3 (previously Schedule 5 and City of Joondalup Bush Forever sites). | Annual<br>2019 – 2029 |
| Overall change in vegetation vigour (condition) per area – expressed as an increase or decrease in the Vegetation Condition Index (VCI) | Source- Data obtained from analysis of remote multi spectral imagery. The imagery is currently obtained every two years. | Biennial<br>(every two years)<br>2019<br>2021<br>2023<br>2025<br>2027<br>2029 |
| Canopy Cover – expressed as a percentage per natural area | Source- Data obtained from analysis of remote multi spectral imagery. The imagery is currently obtained every two years. | |
| Vegetation condition per area – expressed using the Keighery Scale of vegetation condition, expressed as a percentage for each classification (pristine to degraded). | Data obtained through onsite floristic survey undertaken to inform the review of the Management Plan; service provided by specialised consultants. | Five Yearly<br><br>2024 |

## 4.3 Management Plan Review

The Ocean Reef Foreshore Reserve Management Plan is to be reviewed every ten years. The next review is due to occur in 2024, which will include a flora, fauna and fungi survey.

## 4.4 Recommended Management Actions

A summary of the recommended actions is provided below.

| Biodiversity Conservation Area | Recommended Management Action | Detail |
|---|---|---|
| Physical Environment | Holistic consideration of erosion | Erosion issues to be considered holistically, with the most appropriate management options being determined on a case by case basis and recognising that all exposed sand does not need to be covered by vegetation, reflecting what would occur within a natural environment. |
| Physical Environment | Brushing | Brushing materials will be of suitable species that do not contain seed pods or other materials that can propagate and result in the presence of weeds at the site. |
| Physical Environment | Early consideration of erosion | Address erosion issues as early as possible to avoid larger areas to be rehabilitated later. |
| Physical Environment | Wider context | Consider erosion in the wider context of climate change impacts that could occur over time. |
| Physical Environment | Post-storm monitoring | Undertake regular and post-storm monitoring of beach infrastructure including beach access ways, gazebos, fencing, bins and signage. |
| Physical Environment | Operating budget | Ensure there is adequate annual operating budget for the repair and maintenance of beach infrastructure. |
| Flora | Weed monitoring | Continue to undertake weed surveys every six months. |
| Flora | Targeted weed control | Continue to undertake a targeted weed control program, as described in Appendix 6. |
| Flora | Ongoing weed control | Continue to undertake coordinated approach to regular weed control by implementing the Annual Maintenance Schedule. |
| Flora | Targeted Weed Control | Continue to prioritise the control of high and very high priority weeds within the Ocean Reef Foreshore Reserve, determining the best method of control for these species. |
| Flora | Weed Management Plan | Continue to implement the City of Joondalup Weed Management Plan to provide an ongoing strategic approach to the management of natural areas in order to reduce the incidence of weeds. |
| Flora | Restoration | Conduct revegetation as outlined in the Revegetation Strategy in Appendix 7. |
| Flora | Friends Group | Continue to support the activities of the FONORIF. |
| Fungi | Opportunistic fungi survey | Continue to undertake opportunistic fungi sightings during other site activities. |
| Pathogens | Pathogen Management | Continue to implement recommendations from the Pathogen Management Plan that are applicable to the management of the Ocean Reef Foreshore Reserve, particularly in sites affected by pathogens. |
| Pathogens | Pathogen | Continue to implement *Pathogen and Weed Hygiene Guidelines* and |

| Biodiversity Conservation Area | Recommended Management Action | Detail |
|---|---|---|
| | Management | *Purchasing of Landscaping Materials Guidelines* to prevent the introduction or spread of weeds or pathogens into the Ocean Reef Foreshore Reserve. |
| Pathogens | Pathogen Management | Continue to implement Pathogen Hygiene Conditions for Contractors that are applicable to the management of the Ocean Reef Foreshore Reserve. |
| Fauna | Fauna | Carry out follow-up fauna surveys in spring and a targeted invertebrate survey after five years. |
| Fauna | Feral animal control | Continue to monitor feral animal populations and implement regular fox and rabbit control to reduce pressures on native fauna and flora. |
| Fauna | Dog control | Dogs are controlled in accordance with the *Dog Act 1976* (WA) and City of Joondalup's policies and procedures in relation to removal on land managed by the City. |
| Fauna | Cat Control | Continue cat control activities within the foreshore reserve in accordance with the provisions of the *Act 2011* (WA) and City of Joondalup's policies and procedures in relation to their trapping and removal on land managed by the City. |
| Social and Built Environment | Access and inclusion | Implement recommendations outlined in the Access and Inclusion Plan 2018 – 2023 as they apply to the Ocean Reef Foreshore Reserve. |
| Social and Built Environment | Fencing | Regularly review sand build up along the beach fence and arrange removal when required. |
| Social and Built Environment | Water erosion from drainage | Monitor the area where the drainage line enters the north portion of the reserve and restore if required |
| Social and Built Environment | Signage maintenance | Continue signage inspections in conjunction with other monitoring activities in accordance with the Annual Bushland Schedule and repair or replace damaged or vandalised signs as required |
| Social and Built Environment | Inappropriate signage | Any advertisement signage affixed to the fencing or other locations in the Reserve by business owners or individuals be removed when observed. |
| Social and Built Environment | Rubbish | Monitor rubbish around the reserve in accordance with the Annual Bushland Schedule, with removal occurring when observed. |
| Social and Built Environment | Anti-social behaviour | Monitor evidence of anti-social behaviour, promptly:<br>▪ removing any cubbies, or dumped rubbish<br>▪ repairing vandalised assets and/or infrastructure<br>▪ restoring damage to bushland areas as soon as possible after discovery. |
| Fire Management | Assess fire fuel load | Continue to annually assess and report fire fuel load using the South Australian Overall Fuel Hazard Guide for South Australia or other suitable methodology to inform fire prevention actions required. |

| Biodiversity Conservation Area | Recommended Management Action | Detail |
|---|---|---|
| Fire Management | Implement Fire Management Plan | Continue to implement actions from the Bushfire Risk Management Plan 2018 – 2023 the outlines the City's strategy for assessing fire risk, prevention, response and recovery. |
| Fire Management | Monitor Fire occurrences | Continue to monitor fire occurrences through mapping and updating Geographic Information System (GIS) layers detailing fire incidents and frequency to inform fire prevention actions. |
| Fire Management | Post Fire Weed Management | After fires, implement the Post Fire Weed Management Guidelines to aid regrowth of native species by selecting appropriate chemicals, targeting weeds if safe to do so, and spraying grasses. |
| Fire Management | Maintain fire access tracks and footpaths | Regularly inspect and maintain fire access tracks and footpaths as required. |
| Education | Environmental Education Program | Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as:<br>▪ pathogens<br>▪ weeds<br>▪ fire<br>▪ flora and fauna awareness<br>▪ prevention of hand feeding wildlife<br>▪ responsible pet ownership. |
| Education | Adopt a Coastline Program | Continue implementing the Adopt a Coastline Program within Ocean Reef. |
| Education | Natural Areas Team Training | Conduct regular Natural Areas Team plant identification training, including weed management, to increase the effectiveness of weed control activities. |

# 5.0 References

Arbor Carbon, (2015), *Phase 2 Pathogen Sampling and Mapping Project – Final Report*, Unpublished report prepared for the City of Joondalup.

Australian Wildlife Conservancy, (2012/2013), *Feral cats: killing 75 million native animals every night, in Wildlife Matters – Issue 24*, retrieved May 2019 from: https://www.australianwildlife.org/wildlife-matters/issue-24-feral-cats-killing-75-million-native-animals-every-night/

*Biodiversity Conservation Act 2016* (WA)

*Biosecurity and Agriculture Management Act 2007* (WA)

Bougher, N, (2009), *Fungi of the Perth Region and Beyond: A Self-Managed Field Book*. Perth. Western Australia.

Brown, K., Brooks, B, (2002), *Bushland Weeds*. Greenwood, Western Australia: Environmental Weeds Action Network (Inc.).

Bureau of Meteorology, (2019), *Climate and Weather Statistics – Perth Airport (Station ID: 009021),* retrieve May 2019 from: http://www.bom.gov.au/climate/data/

*Cat Act 2011* (WA)

City of Joondalup (CoJ), (2018), *Access and Inclusion Plan 2018 – 2021*, retrieved May 2019 from: https://www.joondalup.wa.gov.au/kb/resident/daip-disability-access-and-inclusion-plan.

City of Joondalup (CoJ), (2017), *Bushfire Risk Management Plan 2017 – 2022*, unpublished report prepared by the City of Joondalup.

City of Joondalup (CoJ), (2014a), *City of Joondalup Environment Plan 2014-2019*, retrieved June 2019 from: http://www.joondalup.wa.gov.au/Files/8506%20Environment%20Plan%202014-2019%20Final%20WEB.pdf.

City of Joondalup (CoJ), (2014b), *Climate Change Strategy 2014 – 2019*, retrieved May 2019 from: http://www.joondalup.wa.gov.au/Files/Climate%20Change%20Strategy%202014-2019.pdf.

City of Joondalup (CoJ), (2019), *Local Planning Scheme No. 3*, retrieved May 2019 from: https://www.joondalup.wa.gov.au/wp-content/uploads/2018/10/Local-Planning-Scheme-No.-3.pdf

City of Joondalup (CoJ), (2012), *Pathogen Management Plan*, retrieved July 2019 from: http://www.joondalup.wa.gov.au/Files/7902%20COJ%20Pathogen%20Management%20Plan%202013-2016%20V4%20Single%20Column%20Web%20Version.pdf.

Climate Commission, (2011), *The Critical Decade: Western Australian Climate Change Impacts*, retrieved July 2019 from: https://www.climatecouncil.org.au/uploads/e0d4e50478b96d1a50c821b7b2c022a4.pdf.

Department of Biodiversity, Conservation and Attractions, (2019a), *Conservation Codes for Western Australian plants and animals,* Retrieved January 2019 from: https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities

Department of Biodiversity, Conservation and Attractions, (2018a), *FloraBase*, Retrieved November 2018 from: https://florabase.dpaw.wa.gov.au/.

Department of Biodiversity, Conservation and Attractions, (2019b), *Swan Impact and Invasiveness Ratings Summary,* Retrieved July 2019 from: https://www.dpaw.wa.gov.au/plants-and-animals/plants/weeds/156-how-does-dpaw-manage-weeds.

Department of the Environment and Energy, (2019a), *Biodiversity Hotspots*, retrieved from: https://www.environment.gov.au/biodiversity/conservation/hotspots.

Department of the Environment and Energy, (2019b), *Categories of Threatened Species*. Retrieved January 2019 from: http://www.environment.gov.au/biodiversity/threatened/species.html.

Department of the Environment and Energy, (2019c), *Weeds in Australia,* retrieved July 2019 from: https://www.environment.gov.au/biodiversity/invasive/weeds/index.html.

Department of Environment and Natural Resources, (2012), Overall Fuel Hazard Guide for South Australia, accessed November 2019 via: https://www.environment.sa.gov.au/managing-natural-resources/fire-management/bushfire-risk-and-recovery/assessing-fuel-hazards.

Department of Environment Regulation, (2015), *What are acid sulfate soils?*, retrieved May 2019 from: https://www.der.wa.gov.au/images/documents/your-environment/acid-sulfate-soils/fact_sheets/ass_fact_sheets1.pdf.

Department of Planning, Lands and Heritage, (2019), *Aboriginal Heritage Inquiry System*, retrieved May 2019 from: https://maps.daa.wa.gov.au/AHIS/

Department of Planning, Lands and Heritage, (2019b), Metropolitan Region Scheme, retrieved May 2019 from: https://www.dplh.wa.gov.au/mrs

Department of Primary Industries and Regional Development (DPIRD), (2019), *NRInfo: Soils and Contours*, viewed January 2019 from: https://www.agric.wa.gov.au/resource-assessment/nrinfo-western-australia.

Department of Primary Industries and Regional Development (DPIRD), (2019), *Pest Insects – Portuguese millipedes*, Retrieved may 2019 from: https://www.agric.wa.gov.au/pest-insects/portuguese-millipedes

Department of Water (DOW). (undated). *Gnangara Groundwater System*. Retrieved May 2015 from: http://www.water.wa.gov.au/water-topics/groundwater/understanding-groundwater/gnangara-groundwater-system.

Department of Water, (2019), Perth Groundwater Map, Accessed May 2019 from: https://maps.water.wa.gov.au/#/webmap/gwm.

*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
Environmental Protection Authority, (2016), *EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*, Environmental Protection Authority, Perth Western Australia

Environmental Protection Authority, (2016), *EPA Technical Guidance - Terrestrial Fauna Surveys*, Environmental Protection Authority, Perth Western Australia

Government of Western Australian, (2000), *Bush Forever, Volume 2*, Government of Western Australia, Perth, Western Australia.

Heddle, E.M., Loneragan, O.W. & Havel, J.J. (1980), *Vegetation Complexes of the Darling System, Western Australia*, In: *Atlas of Natural Resources, Darling System*, *Western Australia*, Department of Conservation and Environment, Perth, Western Australia.

Landgate, (2019), *Map Viewer Plus*. Retrieved July 2019 from: https://www0.landgate.wa.gov.au/maps-and-imagery/imagery/aerial-photography/aerial.

Mitchell, D., Williams, K., and Desmond, A., (2002), *Swan Coastal Plain 2* (S*WA2 – Swan Coastal Plain Subregion*). Retrieved January 2019 from: https://www.dpaw.wa.gov.au/images/documents/about/science/projects/waaudit/swan_coastal_plain02_p606-623.pdf

M P Rogers and Associates P/L, (2016), *Joondalup Coastal Hazard Assessment*, unpublished report prepared by M P Rogers and Associates for the City of Joondalup. Retrieved October 2017 from http://www.joondalup.wa.gov.au/Files/Joondalup%20Coastal%20Hazard%20Assessment%202016.pdf.

Natural Area Consulting, (2013a), *Joondalup Coastal Foreshore, Natural Areas Management Plan*. Unpublished report prepared for the City of Joondalup.

Natural Area Consulting, (2013b), *Marmion Coastal Foreshore Reserve Flora, Fauna and Fungi Survey*. Unpublished report prepared for the City of Joondalup.

Natural Area Consulting Management Services, (2019), *Ocean Reef Foreshore Flora, Fauna and Fungi Report*. Unpublished report prepared for the City of Joondalup.

National Wildlife Corridors Plan Advisory Group (NWCPAG), (2012), *National Wildlife Corridors Plan*, Canberra, Australia.

Scott, P., Burgess, T., Barber, P., Shearer, B., Stukely, M., Hardy, G., and Jung, T., (2009), '*Phytophthora multivora* sp. Nov., a New Species Recovered from Declining *Eucalyptus*, *Banksia*, *Agonis* and Other Plant Species'. in *Persoonia* 22, 2009:1 – 13.

Smith, I., and Smith, D., (2003), *Forest Fact Sheet – Armillaria Root Rot: A Disease of Native and Introduced Trees*, Forest Science Centre, Department of Sustainability and Environment, Victoria, available World Wide Web URL: http://www.dse.vic.gov.au/__data/assets/pdf_file/0013/102145/Armillaria_Root_Rot.pdf, accessed October 2013.

Western Australian Local Government Association (WALGA), (2010), *Native vegetation extent by vegetation complexes for each Local Government in Perth and Peel*, Retrieved June 2016 from: http://lbp.walga.asn.au/Publications.aspx.

Western Australian Local Government Association (WALGA), (2013), *Native vegetation on the Swan Coastal Plain*. Retrieved June 2016 from: http://pbp.walga.asn.au/Home.aspx.

# Appendix 1: Bush Forever Vegetation Structural Classes

| Life Form/Height Class | Canopy Percentage Cover | | | |
|---|---|---|---|---|
| | **100 – 70%** | **70 – 30%** | **30 - 10%** | **10 – 2 %** |
| **Trees over 30 m** | Tall closed forest | Tall open forest | Tall woodland | Tall open woodland |
| **Trees 10 – 30 m** | Closed forest | Open forest | Woodland | Open woodland |
| **Trees under 10 m** | Low closed forest | Low open forest | Low woodland | Low open woodland |
| **Tree Mallee** | Closed tree mallee | Tree mallee | Open tree mallee | Very open tree mallee |
| **Shrub Mallee** | Closed shrub mallee | Shrub mallee | Open shrub mallee | Very open shrub mallee |
| **Shrubs over 2 m** | Closed tall scrub | Tall open scrub | Tall shrubland | Tall open shrubland |
| **Shrubs 1 – 2 m** | Closed heath | Open heath | Shrubland | Open shrubland |
| **Shrubs under 1 m** | Closed low heath | Open low heath | Low shrubland | Low open shrubland |
| **Grasses** | Closed grassland | Grassland | Open grassland | Very open grassland |
| **Herbs** | Closed herbland | Herbland | Open herbland | Very open herbland |
| **Sedges** | Closed sedgeland | Sedgeland | Open sedgeland | Very open sedgeland |

(Source: Government of Western Australia, 2000)

# Appendix 2: Vegetation Condition Rating Scale

| Category | | Description |
|---|---|---|
| 1 | Pristine | Pristine or nearly so, no obvious signs of disturbance. |
| 2 | Excellent | Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. |
| 3 | Very Good | Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing. |
| 4 | Good | Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing. |
| 5 | Degraded | Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing. |
| 6 | Completely Degraded | The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs. |

(Source: Government of Western Australia, 2000)

# Appendix 3: Flora Species List Ocean Reef Foreshore

This flora list shows species identified by Natural Area during the 2018 flora survey within the Reserve. Taxa are sorted by class, family then species name.

- Denotes introduced species

| Family | Species | Common Name |
|---|---|---|
| | **Pinopsida (Pines and Conifers)** | |
| Cupressaceae | *Callitris preissii* | Rottnest Island Pine |
| | **Liliopsida (Monocotyledons)** | |
| Asparagaceae | *Acanthocarpus preissii* | |
| Poaceae | *Austrostipa flavescens* | |
| Poaceae | **Avena barbata* | Bearded Oat Grass |
| Poaceae | **Bromus diandrus* | Great Brome |
| Poaceae | **Catapodium rigidum* | Rigid Fescue |
| Poaceae | **Cenchrus echinatus* | Burrgrass |
| Haemodoraceae | *Conostylis candicans* subsp. *calcicola* | |
| Restionaceae | *Desmocladus flexuosus* | |
| Hemerocallidaceae | *Dianella revoluta* | Blueberry Lily |
| Poaceae | **Ehrharta longiflora* | Annual Veldt Grass |
| Cyperaceae | *Ficinia nodosa* | Knotted Club Rush |
| Poaceae | **Lagurus ovatus* | Hare's Tail Grass |
| Cyperaceae | *Lepidosperma costale* | |
| Cyperaceae | *Lepidosperma gladiatum* | Coast Sword-sedge |
| Poaceae | **Lolium rigidum* | Wimmera Ryegrass |
| Asparagaceae | *Lomandra maritima* | |
| Arecaceae | **Phoenix dactylifera* | Date Palm |
| Poaceae | *Poa poiformis* | Coastal Poa |
| Iridaceae | **Romulea rosea* | Guildford Grass |
| Poaceae | *Spinifex hirsutus* | Hairy Spinifex |
| Poaceae | *Spinifex longifolius* | Beach Spinifex |
| Poaceae | *Sporobolus virginicus* | Marine Couch |
| Poaceae | **Stenotaphrum secundatum* | Buffalo Grass |
| Poaceae | **Thinopyrum distichum* | Sea wheatgrass |
| Asphodelaceae | **Trachyandra divaricata* | |
| Hemerocallidaceae | *Tricoryne elatior* | Yellow Autumn Lily |
| | **Magnoliopsida (Dicotyledons)** | |
| Fabaceae | *Acacia cochlearis* | Rigid Wattle |

| Family | Species | Common Name |
|---|---|---|
| Fabaceae | *Acacia lasiocarpa* var. *lasiocarpa* | Panjang |
| Fabaceae | *Acacia rostellifera* | Summer-scented Wattle |
| Fabaceae | *Acacia saligna* | Orange Wattle |
| Fabaceae | *Acacia truncata* | |
| Fabaceae | *Acacia xanthina* | White-stemmed Wattle |
| Ericaceae | *Acrotriche cordata* | Coast Ground Berry |
| Myrtaceae | *Agonis flexuosus* | Peppermint Tree |
| Casuarinaceae | *Allocasuarina humilis* | Dwarf Sheoak |
| Malvaceae | *Alyogyne huegelii* | Lilac Hibiscus |
| Solanaceae | *Anthocercis littorea* | Yellow Tailflower |
| Asteraceae | **Arctotheca calendula* | Cape Weed |
| Asteraceae | **Arctotheca populifolia* | Dune Arctotheca |
| Asteraceae | **Arctotis stoechadifolia* | White Arctotis |
| Chenopodiaceae | *Atriplex cinerea* | Grey Saltbush |
| Chenopodiaceae | *Atriplex isatidea* | Coast Saltbush |
| Proteaceae | *Banksia dallanneyi* | Couch Honeypot |
| Proteaceae | *Banksia sessilis* | Parrot Bush |
| Orobanchaceae | **Bellardia trixago* | Bellardia |
| Brassicaceae | **Brassica tournefortii* | Mediterranean Turnip |
| Brassicaceae | **Cakile maritima* | Sea Rocket |
| Myrtaceae | *Calothamnus quadrifidus* | One-sided Bottlebrush |
| Aizoaceae | **Carpobrotus edulis* | Hottentot Fig |
| Aizoaceae | *Carpobrotus virescens* | Coastal Pigface |
| Lauraceae | *Cassytha racemosa* | Dodder Laurel |
| Casuarinaceae | *Casuarina obesa* | Swamp Sheoak |
| Gentianaceae | **Centaurium pulchellum* | |
| Ranunculaceae | *Clematis linearifolia* | |
| Polygalaceae | *Comesperma confertum* | |
| Polygalaceae | *Comesperma integerrimum* | |
| Crassulaceae | **Crassula glomerata* | |
| Convolvulaceae | **Cuscuta planiflora* | |
| Apiaceae | *Daucus glochidiatus* | Australian Carrot |
| Scrophulariaceae | **Dischisma arenarium* | |
| Scrophulariaceae | *Eremophila glabra* | Tar Bush |
| Myrtaceae | **Eucalyptus utilis* | |
| Euphorbiaceae | **Euphorbia peplus* | Petty Spurge |
| Euphorbiaceae | **Euphorbia paralias* | Sea Spurge |

| Family | Species | Common Name |
|---|---|---|
| Euphorbiaceae | **Euphorbia terracina* | Geraldton Carnation Weed |
| Santalaceae | *Exocarpos sparteus* | Broom Ballart |
| Frankeniaceae | *Frankenia pauciflora* | Seaheath |
| Papaveraceae | **Fumaria capreolata* | Whiteflower Fumitory |
| Fabaceae | *Gastrolobium nervosum* | |
| Fabaceae | *Gompholobium tomentosum* | Hairy Yellow Pea |
| Proteaceae | *Grevillea preissii* | |
| Fabaceae | *Hardenbergia comptoniana* | Native Wisteria |
| Lamiaceae | *Hemiandra glabra* | |
| Dilleniaceae | *Hibbertia racemosa* | Stalked Guinea Flower |
| Campanulaceae | *Isotoma hypocrateriformis* | Woodbridge Poison |
| Fabaceae | *Kennedia prostrata* | Scarlet Runner |
| Asteraceae | **Lactuca serriola* | Prickly Lettuce |
| Santalaceae | *Leptomeria preissiana* | |
| Asteraceae | *Leucophyta brownii* | |
| Ericaceae | *Leucopogon insularis* | |
| Ericaceae | *Leucopogon parviflorus* | Coast Beard-heath |
| Loganiaceae | *Logania vaginalis* | White Spray |
| Primulaceae | **Lysimachia arvensis* | Pimpernel |
| Malvaceae | **Malva parviflora* | Marshmallow |
| Brassicaceae | **Matthiola incana* | Common Stock |
| Fabaceae | **Medicago polymorpha* | Burr Medic |
| Myrtaceae | *Melaleuca cardiophylla* | Tangling Melaleuca |
| Myrtaceae | *Melaleuca huegelii* | Chenille Honeymyrtle |
| Myrtaceae | *Melaleuca lanceolata* | Rottnest Teatree |
| Myrtaceae | **Melaleuca nesophila* | Mindiyed |
| Myrtaceae | *Melaleuca systena* | |
| Fabaceae | **Melilotus indicus* | |
| Asteraceae | **Montanoa* sp. | Tree Daisy |
| Scrophulariaceae | *Myoporum insulare* | Blueberry Tree |
| Nitrariaceae | *Nitraria billardierei* | Nitre Bush |
| Onagraceae | **Oenothera drummondii* | Beach Evening Primrose |
| Olacaceae | *Olax benthamiana* | |
| Asteraceae | *Olearia axillaris* | Coastal Daisybush |
| Rubiaceae | *Opercularia vaginata* | Dog Weed |
| Urticaceae | *Parietaria debilis* | Pellitory |
| Geraniaceae | **Pelargonium capitatum* | Rose Pelargonium |

| Family | Species | Common Name |
|---|---|---|
| Phyllanthaceae | *Phyllanthus calycinus* | False Boronia |
| Thymelaeaceae | *Pimelea ferruginea* | |
| Asteraceae | *Pithocarpa cordata* | Tangle Daisy |
| Plantaginaceae | **Plantago lanceolata* | Ribwort Plantain |
| Chenopodiaceae | *Rhagodia baccata* | Berry Saltbush |
| Chenopodiaceae | *Salicornia quinqueflora* | Beaded Samphire |
| Santalaceae | *Santalum acuminatum* | Quandong |
| Goodeniaceae | *Scaevola crassifolia* | Thick-leaved Fan-flower |
| Goodeniaceae | *Scaevola nitida* | Shinning Fanflower |
| Asteraceae | **Senecio elegans* | Purple Groundsel |
| Asteraceae | *Senecio pinnatifolius* | |
| Caryophyllaceae | **Silene gallica* | French Catchfly |
| Asteraceae | **Sonchus oleraceus* | Common Sowthistle |
| Rhamnaceae | *Spyridium globulosum* | Basket Bush |
| Fabaceae | *Templetonia retusa* | Cockies Tongues |
| Aizoaceae | **Tetragonia decumbens* | Sea Spinach |
| Malvaceae | *Thomasia triphylla* | |
| Chenopodiaceae | *Threlkeldia diffusa* | Coast Bonefruit |
| Asteraceae | **Urospermum picroides* | False Hawkbit |

# Appendix 4: Fauna List Ocean Reef Foreshore

A complete list of fauna species recorded within Ocean reef is provided in the table below, showing results from the January 2019 fauna survey and opportunistic observations during the May 2019 management site assessment undertaken by Natural Area. Fauna lists are in species groups.

## Bird List

| Family | Species Name | Common Name | Conservation Status |
|---|---|---|---|
| Acanthizidae | *Sericornis frontalis* | White-browed Scrubwren | Locally significant |
| Accipitridae | *Elanus axillaris* | Black-shouldered Kite | |
| Accipitridae | *Accipiter cirrocephalus* | Collared Sparrowhawk | Locally significant |
| Cacatuidae | *Cacatua roseicapilla* | Galah | |
| Campephagidae | *Coracina novaehollandiae* | Black-faced Cuckoo-shrike | |
| Columbidae | **Spilopelia senegalensis* | Laughing Turtle Dove | |
| Columbidae | **Spilopelia chinensis* | Spotted Turtle Dove | |
| Corvidae | *Corvus coronoides* | Australian Raven | |
| Falconidae | *Falco cenchroides* | Nankeen Kestrel | |
| Falconidae | *Falco longipennis* | Australian Hobby | |
| Hirundinidae | *Hirundo neoxena* | Welcome Swallow | |
| Hirundinidae | *Cheramoeca leucosterna* | White-backed Swallow | |
| Laridae | *Thalasseus bergii* | Crested Tern | |
| Laridae | *Larus novaehollandiae* | Silver Gull | |
| Maluridae | *Malurus leucopteris* | White-winged Fairy-wren | Locally significant |
| Maluridae | *Malurus lamberti* | Variegated Fairy-wren | Locally significant |
| Meliphagidae | *Gavicalis virescens virescens* | Singing Honeyeater | |
| Meliphagidae | *Anthochaera carunculata* | Red Wattlebird | |
| Meliphagidae | *Phylidonyris novaehollandiae* | New Holland Honeyeater | Locally significant |
| Meliphagidae | *Lichmera indistincta* | Brown Honeyeater | |
| Meliphagidae | *Phylidonyris niger gouldii* | White-cheeked Honeyeater | Locally significant |
| Pandionidae | *Pandion haliaetus* | Osprey | |
| Petroicidae | *Eopsaltria georgiana* | White-breasted Robin | Locally significant |
| Phalacrocoracidae | *Phalacrocorax sulcirostris* | Little Black Cormorant | |
| Phalacrocoracidae | *Phalacrocorax various* | Australian Pied Cormorant | |
| Psittacidae | **Trichoglossus moluccanus* | Rainbow Lorikeet | |
| Rhipidura | *Rhipidura leucophrys leucophrys* | Willie Wagtail | |
| Scolopacidae | *Numenius phaeopus* | Whimbrel | MI (scarce in south west) |
| Zosteropidae | *Zosterops lateralis* | Silvereye | |

## Reptile List

| Family | Species Name | Common Name | Comments |
|---|---|---|---|
| Agamidae | *Pogona minor minor* | Western Bearded Dragon | Observed |
| Elapidae | *Pseudonaja mengdeni* | Western Brown Snake, Gwardar | Captured |
| Elapidae | *Pseudonaja affinis affinis* | Dugite | Captured |
| Gekkonidae | *Strophurus spinigerus* | Western Spiny-tailed Gecko | Observed |
| Scincidae | *Tiliqua rugosa* | Bobtail | Observed |
| Scincidae | *Lerista elegans* | Elegant Slider | Captured |
| Scincidae | *Ctenotus fallens* | West-coast Laterite Ctenotus | Captured |
| Scincidae | *Egernia kingii* | King's Skink | Photographed (TC5) |

## Mammal List

| Family | Species Name | Common Name | Comments |
|---|---|---|---|
| Canidae | *Canis lupus familiaris* | *Domestic Dog | Observed |
| Leporidae | *Oryctolagus cuniculus* | *European Rabbit | |
| Peramelidae | *Isoodon obesulus fusciventer* | Southern Brown Bandicoot | Tracks/observed/caught |
| Muridae | *Rattus rattus* | *Black Rat | Tracks/scats/photographed |
| Muridae | *Mus musculus* | *House Mouse | Tracks/caught |
| Felidae | *Felis catus* | *Domestic Cat | Photographed (TC5, TC3) |
| Canidae | *Vulpes vulpes* | *Red Fox | Photographed (TC5, TC3, TC4) |

## Invertebrate List

| Order | Family | Species Name | Common Name |
|---|---|---|---|
| Dermaptera | Anisolabididae | | Earwig |
| Hymenoptera | Apidae | **Apis mellifera* | European Honeybee |
| Araneae | Araneidae | *Nephila edulis* | Golden Orb Weaver |
| Araneae | Araneidae | *Eriophora biapicata* | Garden Orb Weaver |
| Isopoda | Armadillidiidae | **Armadillidium vulgare* | Roly-Poly |
| Blattodea | Blattidae | *Cutilia nigra* | Bush Cockroach |
| Blattodea | Blattidae | *Drymaplaneta semivitta* | Cockroach |
| Scorpiones | Buthidae | *Lychas marmoreus* | Marbled Scorpion |
| Hemiptera | Cicadellidae | *Physeema quadricincta* | Tick Tick Cicada |
| Hymenoptera | Coreidae | | Orange-edged Sap Beetle |
| Hymenoptera | Crabronidae | | Sand Wasp |
| Coleoptera | Cydnidae | *Adrisa sp.* | Burrowing Beetle |
| Araneae | Deinopidae | *Deinopis subrufa* | Ogre Spider |
| Araneae | Desidae | *Badumna insignis* | Black House Spider |
| Hymenoptera | Formicidae | *Camponotus sp.* | Ant |

| Order | Family | Species Name | Common Name |
|---|---|---|---|
| Hymenoptera | Formicidae | *Camponotus minimus* | Ant |
| Hymenoptera | Formicidae | *Myrmecia sp.* | Jumping Jack Ant |
| Hymenoptera | Formicidae | *Camponotus molossus* | Ant |
| Hymenoptera | Formicidae | *Iridomyrmex purpureus* | Meat Ant |
| Hymenoptera | Formicidae | *Rytidoponera* sp. | Rytidoponera sp. Ant 1 |
| Hymenoptera | Formicidae | *Rytidoponera* sp. | Rytidoponera sp. Ant 2 |
| Orthoptera | Gryllidae | | Brown Cricket |
| Orthoptera | Gryllotalpidae | *Gryllotalpa pluvialis* | Mole Cricket |
| Lepidoptera | Hesperiidae | *Trapezites argenteoornatus* | Silver-spotted Ochre |
| Julida | Julidae | **Ommatoiulus moreleti* | Portuguese millipede |
| Zygentoma | Lepismatidae | *Acrotelsella* sp. | Silverfish |
| Araneae | Lycosidae | *Venator immansueta* | Wolf Spider 1 |
| Araneae | Lycosidae | *Lycosa* sp. | Wolf Spider |
| Diptera | Muscidae | *Musca vetustissima* | Bush Fly |
| Hymenoptera | Mutillidae | *Ephutomorpha* sp. | Flower Wasp 1 |
| Hymenoptera | Mutillidae | *Ephutomorpha* sp. | Flower Wasp 2 |
| Araneae | Nemesiidae | *Aname mainae* | Trapdoor Spider |
| Lepidoptera | Pieridae | **Pieris rapae* | Cabbage White Butterfly |
| Hymenoptera | Pompilidae | *Cryptocheilus bicolor* | Great Orange Huntsman Wasp |
| Hymenoptera | Pompilidae | | Yellow Spotted Spider Wasp |
| Hymenoptera | Pompilidae | | Spider Wasp |
| Hymenoptera | Pompilidae | | Red Spider Wasp |
| Araneae | Salticidae | *Maratus spicatus* | Striped Blue-and-gold Western Peacock Spider |
| Araneae | Salticidae | | White jumping spider (female) |
| Araneae | Sparassidae | *Neosparassus* sp. | Badge Huntsman |
| Diptera | Syrphidae | *Simosyrphus* sp. | Hover Fly |
| Diptera | Tabanidae | *Tabanus australicus* | March Fly |
| Coleoptera | Tenebrionoidea | *Helea perforata* | Hairy Pie-dish Beetle |
| Coleoptera | Tenebrionoidea | *Pterohelaeus* sp. | Pie-dish Beetle |
| Lepidoptera | Thaumetopoeidae | *Trichiocercus sparshalli* | Sparshall's Moth caterpillar |
| Opilionida | Triaenonychidae | *Nunciella* sp. | Harvestman |
| Araneae | Zodariidae | *Pentasteron* sp. | Ant Eating Spider |
| Lepidoptera | | | Golden, green-eyed Moth |

# Appendix 5: Key Weed Species in Ocean Reef Foreshore Reserve

| Species Name | Common Name | Prioritisation | Photograph |
|---|---|---|---|
| *Arctotheca calendula* | Cape Weed | CoJ priority weed |  |
| *Avena barbata* | Bearded Oat | CoJ priority weed |  |
| *Brassica tournefortii* | Mediterranean Turnip | CoJ priority weed |  |
| *Bromus diandrus* | Great Brome | CoJ priority weed |  |

| Species Name | Common Name | Prioritisation | Photograph |
|---|---|---|---|
| *Carpobrotus edulis* | Hottentot Fig | High priority (DBCA Swan Environmental Weed List) |  |
| *Euphorbia paralias* | Sea Spurge | Moderate priority (DBCA Swan Environmental Weed List) |  |
| *Euphorbia peplus* | Petty Spurge | CoJ priority weed |  |
| *Euphorbia terracina* | Geraldton Carnation Weed | Moderate priority (DBCA Swan Environmental Weed List)<br>CoJ priority weed |  |

| Species Name | Common Name | Prioritisation | Photograph |
|---|---|---|---|
| *Gazania linearis* | Gazania | Moderate priority (DBCA Swan Environmental Weed List) |  |
| *Lactuca serriola* | Prickly Lettuce | High priority (DBCA Swan Environmental Weed List)<br>CoJ priority weed |  |
| *Lagurus ovatus* | Hare's Tail Grass | CoJ priority weed |  |
| *Pelargonium capitatum* | Rose Pelargonium | High priority (DBCA Swan Environmental Weed List)<br>CoJ priority weed |  |

| Species Name | Common Name | Prioritisation | Photograph |
|---|---|---|---|
| *Romulea rosea* | Guildford Grass | CoJ priority weed |  |
| *Stenotaphrum secundatum* | Buffalo Grass | High priority (DBCA Swan Environmental Weed List)<br>CoJ priority weed |  |
| *Tetragonia decumbens* | Sea Spinach | High priority (DBCA Swan Environmental Weed List) |  |
| *Trachyandra divaricata* | Trachyandra | Moderate priority (DBCA Swan Environmental Weed List) |  |

| Species Name | Common Name | Prioritisation | Photograph |
|---|---|---|---|
| *Urospermum picroides* | False Hawkbit | Moderate priority (DBCA Swan Environmental Weed List) |  |

# Appendix 6: Weed Management

Weed control is an ongoing management issue within the Ocean Reef Foreshore Reserve. Weed control contributes to the reduction of competition with native flora species for resources and results in enhanced vegetation condition, as well as improved native fauna habitat. The City of Joondalup personnel and contractors currently undertake weed control and are involved in the manual removal of weeds across the Reserve. Weed control activities will be undertaken in accordance with the City's operational procedures and guidelines, noting that the Weed Management Plan has been developed to guide these activities.

Weed management can be achieved through the use of manual, chemical, or biological treatment methods. Manual and chemical treatments are most commonly used remove weeds from coastal and terrestrial bushland areas. Characteristics of particular target species determine what weed control method is used. The presence of native flora will need to be taken into account when determining the most appropriate weed control technique for an area, especially the location of significant flora. The table below describes the different weed treatment types recommended for the species observed on site. Treatment rates were taken from the recommended rates from off label permit no. 13333 issued by the Australian Pesticides and Veterinary Medicines Authority (2012). It is recommended that herbicides such as metsulfuron and triasulfuron be used once a year at the recommended dose in the reserve to reduce residual effect in soils, which can lead to species becoming resistant to their effects and associated death of non-target species. Recommended treatments and treatment times are shown in the weed control methodology table (DBCA, FloraBase 2019; Brown and Brooks, 2002).

## Weed treatment types

| Treatment Number | Treatment Type | Targeted Species | Application Method and Comments |
|---|---|---|---|
| **1** | Glyphosate Spray | Annual and perennial grass and broadleaf weeds | Spot spray – non-selective |
| **2** | Selective grass herbicide (such as Quizalofop or Fusilade Forte) | Annual and perennial grasses | Spot spray, or overall spray in broad leaf host situations – selective grass spray |
| **3** | Metsulfuron | Annual broadleaf weeds and bulbs | Spot spray – semi selective |
| **4** | Glyphosate glove/Metsulfuron glove sponge wipe | One-leaf Cape Tulip | Wipe Leaves with sponge prior to or just on flowering |
| **5** | Triclopyr, Picloram, or Glyphosate | Woody weeds and trees | Cut and paint or basal bark (summer) |
| **6** | Manual removal /hand weeding | Carnation Weeds, Fleabane, Pigface, and similar | Gloves required due to caustic sap of Carnation Weed |
| **7** | Triasulfuron | Carnation Weeds, Brassicaceae weeds post emergence and other annual | Spot spray - selective |

(Source: DBCA, FloraBase 2019; Brown and Brooks, 2002)

## Weed Control Methodology

| Species Name | Common Name | Treatment Number | Timing |
|---|---|---|---|
| *Arctotheca calendula* | Cape Weed | 1 or 6 | June – November |
| *Arctotheca populifolia* | Dune Arctotheca | 1 or 6 | June – September |
| *Arctotis stoechadifolia* | White Arctotis | 1 or 6 | March – October |
| *Avena barbata* | Wild Oats | 2 | July – November |
| *Bellardia trixago* | Bellardia | 1 or 6 | June – September |
| *Brassica tournefortii* | Mediterranean Turnip | 1 or 7 | May – September |
| *Bromus diandrus* | Brome Grass | 2 | June – September |
| *Cakile maritima* | Sea Rocket | 1 or 6 | June – November |
| *Carpobrotus edulis* | Hottentot Fig | 1 or 6 | June – October |
| *Catapodium rigidum* | Rigid Fescue | 2 | June – September |
| *Cenchrus echinatus* | Burrgrass | 2 | June – September |
| *Centaurium pulchellum* | | 1 or 6 | September – October |
| *Crassula glomerata* | | 1 or 6 | June - August |
| *Cuscuta planiflora* | | 1 or 6 | June – September |
| *Dischisma arenaria* | | 1 or 6 | July – September |
| *Ehrharta longiflora* | Annual Veldt Grass | 2 | June – August (before flowering) |
| *Euphorbia paralias* | Sea Spurge | 1 or 6 | June – October |
| *Euphorbia peplus* | Petty Spurge | 1 or 6 | June – September |
| *Euphorbia terracina* | Geraldton Carnation Weed | 1, 6 or 7 | Manual: June – November<br>Herbicide: August – September |
| *Fumaria capreolata* | Whiteflower Fumitory | 3 or 6 | July – September |
| *Gazania linearis* | Gazania | 1 | June – October |
| *Lactuca serriola* | Prickly Lettuce | 1 or 6 | September – November |
| *Lagurus ovatus* | Hare's Tail Grass | 2 or 6 | Manual: July – December<br>Herbicide: June – August |
| *Lolium rigidum* | Wimmera Ryegrass | 1, 2 or 6 | July – October |
| *Lysimachia arvensis* | Blue Pimpernel | 1 | June – November |
| *Malva parviflora* | Marshmallow | 1 or 6 | Manual: April – September<br>Herbicide: April – June (only effective in early growth stages) |
| *Matthiola incana* | Common Stock | 1 or 6 | June - August |
| *Medicago polymorphus* | Burr Medic | 3 | July – August |

| Species Name | Common Name | Treatment Number | Timing |
|---|---|---|---|
| *Melaleuca nesophila* | Mindiyed | 5 or 6 | Year round |
| *Melilotus indicus* | | 3 or 6 | July – November |
| *Montanoa* sp. | Tree Daisy | 1 or 6 | Prior to, or at flowering |
| *Oenothera drummondii* | Beach Primrose | 1 | July – September |
| *Pelargonium capitatum* | Rose Pelargonium | 1 | June – October |
| *Phoenix dactylifera* | Date Palm | 5 or 6 | Year round |
| *Plantago lanceolata* | Ribwort Plantain | 1 or 6 | May – October |
| *Romulea rosea* | Guildford Grass | 3 | July – August |
| *Senecio elegans* | Purple Groundsel | 1 or 6 | October – November |
| *Silene gallica* | French Catchfly | 1 or 6 | June – September |
| *Sonchus oleraceus* | Common Sowthistle | 1 or 6 | Manual: June – November<br>Herbicide: June – September |
| *Stenotaphrum secundatum* | Buffalo Grass | 1, 2 or 6 | November – May |
| *Tetragonia decumbens* | Sea Spinach | 1 | June – October |
| *Thinopyrum distichum* | Sea Wheat | | June – September |
| *Trachyandra divaricata* | Trachyandra | 1 or 4 | June – August |
| *Urospermum picroides* | False Hawkbit | 1 or 6 | June – August |

## Implementation Schedule

A recommended implementation schedule is provided below outlining all the works set outlined in Appendix 5, 6 and 7. The schedule is set up for rehabilitation works to commence in the spring of 2020 with completion of prescribed works in 2023.

**Year 1 (2020)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glyphosate application | | | | | | ■ | ■ | ■ | ■ | | | |
| Grass selective application | | | | | | ■ | ■ | | | | | |
| Triclopyr or Picloram application | ■ | ■ | ■ | | | | | | | | | ■ |
| Metsulfuron application | | | | | | | | ■ | | | | |
| Triasulfuron application | | | | | | | | ■ | ■ | | | ■ |
| Hand Weeding | | | ■ | | | ■ | | | ■ | | | ■ |
| Revegetation all zones | | | | | | ■ | ■ | | | | | |
| Informal monitoring | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

**Year 2 (2021)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glyphosate application | | | | | | | | | | | | |
| Grass selective application | | | | | | | | | | | | |
| Triclopyr or Picloram application | | | | | | | | | | | | |
| Metsulfuron application | | | | | | | | | | | | |
| Triasulfuron application | | | | | | | | | | | | |
| Hand Weeding | | | | | | | | | | | | |
| Revegetation all zones (Infill) | | | | | | | | | | | | |
| Informal monitoring | | | | | | | | | | | | |

**Year 3 (2022)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glyphosate application | | | | | | | | | | | | |
| Grass selective application | | | | | | | | | | | | |
| Triclopyr or Picloram application | | | | | | | | | | | | |
| Metsulfuron application | | | | | | | | | | | | |
| Triasulfuron application | | | | | | | | | | | | |
| Hand Weeding | | | | | | | | | | | | |
| Revegetation all zones (Infill) | | | | | | | | | | | | |
| Informal monitoring | | | | | | | | | | | | |

**Year 4 (2023)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glyphosate application | | | | | | | | | | | | |
| Grass selective application | | | | | | | | | | | | |
| Triclopyr or Picloram application | | | | | | | | | | | | |
| Metsulfuron application | | | | | | | | | | | | |
| Triasulfuron application | | | | | | | | | | | | |
| Hand Weeding | | | | | | | | | | | | |
| Revegetation all zones (Infill) | | | | | | | | | | | | |
| Informal monitoring | | | | | | | | | | | | |

# Appendix 7: Restoration and Regeneration

The majority of the Ocean Reef Foreshore Reserve vegetation is in Excellent condition and therefore minimal revegetation is required for the site. Revegetation should focus on the degraded areas near the southern lookout north-west of the southern car park. This area has a high weed coverage and few natives present. The revegetation of this area is split into 4 areas, with vegetation recommended in a staged process in conjunction with weed control to reduce the potential for wind and water erosion in this primary and secondary dune area. Revegetation for the site has been split into the four following area and involves the installation of 5,605 plants:

- Area 1 – 3,680 $m^2$ (2,580 plants)
- Area 2 – 220 $m^2$ (155 plants)
- Area 3 – 1,170 $m^2$ (820 plants)
- Area 4 – 2,930 $m^2$ (2,050 plants).

Planting density of 1 plant/$m^2$ is recommended, taking into consideration existing native plants present planting numbers have been reduced for all of the areas with 70 % of the total areas to be revegetated. Tubestock is recommended to be:

- sourced from a NIASA accredited nursery
- grown from local provenance seed
- hardened off and in good condition prior to planting.

Note that some species are difficult to propagate and consideration will need to be given to the collection of suitable seed, with germination often taking more than one season. It is recommended that guarding and staking of new planting occurs to mitigate detrimental impacts of strong winds, salt spray and erosion due to the close proximity to the ocean. Guarding and staking also reduces potential herbivory by introduced rabbits. Indicative plant species numbers for the priority restoration areas are provided in the Table below, noting that the numbers will be lower than 1/$m^2$ in some areas to account for existing native vegetation.

Indicative Plant Numbers for Priority Restoration Areas

| Species | Form | Area 1 | Area 2 | Area 3 | Area 4 |
|---|---|---|---|---|---|
| *Acacia lasiocarpa* var. *lasiocarpa* | Small shrub | 200 | 10 | 50 | 150 |
| *Acacia truncata* | Small shrub | | 10 | 10 | 10 |
| *Acanthocarpus preissii* | Small shrub | 150 | 10 | 30 | 100 |
| *Acrotriche cordata* | Small shrub | 50 | | | 50 |
| *Anthocercis littorea* | Small shrub | 50 | | 10 | 20 |
| *Atriplex cinerea* | Shrub | 50 | | 10 | 20 |
| *Atriplex isatidea* | Shrub | 50 | | 10 | 20 |
| *Austrostipa flavescens* | Grass | | 10 | 20 | 20 |
| *Carpobrotus virescens* | Ground cover | 150 | 5 | 30 | 150 |
| *Clematis linearifolia* | Climber | | 10 | 20 | 20 |
| *Conostylis candicans subsp. calcicola* | Herb | 150 | | 20 | 100 |
| *Dianella revoluta* | Herb | | 10 | 20 | 20 |

| Species | Form | Area 1 | Area 2 | Area 3 | Area 4 |
|---|---|---|---|---|---|
| *Ficinia nodosa* | Sedge | 150 | | 50 | 50 |
| *Frankenia pauciflora* | Small shrub | 50 | | 20 | 20 |
| *Gastrolobium nervosum* | Small shrub | 50 | | 20 | 20 |
| *Grevillea preissii* | Small shrub | 50 | 10 | 20 | 10 |
| *Hardenbergia comptoniana* | Climber | 50 | | 20 | 50 |
| *Hemiandra glabra* | Small shrub | 150 | 10 | 30 | 150 |
| *Lepidosperma costale* | Sedge | 30 | | 10 | 20 |
| *Lepidosperma gladiatum* | Sedge | 50 | | 20 | 50 |
| *Leucophyta brownii* | Small shrub | 150 | | 30 | 150 |
| *Leucopogon insularis* | Small shrub | | | | 20 |
| *Leucopogon parviflorus* | Small shrub | | | | 20 |
| *Lomandra maritima* | Sedge | 50 | | 30 | 50 |
| *Melaleuca systena* | Small shrub | 150 | 5 | 50 | 150 |
| *Myoporum insulare* | Shrub | 50 | 10 | 10 | 50 |
| *Olearia axillaris* | Shrub | 200 | 10 | 50 | 150 |
| *Rhagodia baccata* | Shrub | 50 | 10 | 20 | 20 |
| *Scaevola crassifolia* | Shrub | 50 | 10 | 50 | 100 |
| *Scaevola nitida* | Shrub | 50 | 10 | 20 | 50 |
| *Senecio pinnatifolius* | Herb | 50 | 5 | 10 | 50 |
| *Sporobolus virginicus* | Grass | 150 | | 50 | 100 |
| *Spyridium globulosum* | Shrub | 50 | | 10 | 50 |
| *Templetonia retusa* | Shrub | 50 | 5 | 20 | 10 |
| *Threlkeldia diffusa* | Herb | 100 | 5 | 50 | 30 |
| | **Total Plant Numbers** | **2580** | **155** | **820** | **2050** |


**Map :** Revegetation Areas
Ocean Reef Foreshore Reserve

0 25 50 m

N

Natural Area
CONSULTING MANAGEMENT SERVICES

Client: City of Joondalup
Date: 22/05/2019
Created by: Harley Taylor

Image Source: nearmap 2019
Datum: GDA 94

99C Lord Street
Whiteman WA 6068
(08) 9209 2767
info@naturalarea.com.au
www.naturalarea.com.au