City of Joondalup

City of Joondalup
Draft Craigie Bushland Management Plan

Contents

Acknowledgements

- Arbor Carbon;
- Department of Biodiversity, Conservation and Attractions ;
- Department of Fire and Emergency Services;
- Eco Logical Australia;
- Friends of Craigie Bushland;
- University of Western Australia;
- Water Corporation.

Please formally acknowledge the City of Joondalup if you choose to use any of the content contained within the Draft Craigie Bushland Management Plan.

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The City of Joondalup has to the best of its knowledge used the most up to date information and datasets available to inform the development of the Draft Craigie Bushland Management Plan.

Acronyms

Acronym / Abbreviation	Definition
AHD	Australian Height Datum
BAM Act	Biosecurity and Agriculture Management Act 2007
BoM	Bureau of Meteorology
CALM	Department of Conservation and Land Management
CAMBA	China-Australia Migratory Bird Agreement
the City	City of Joondalup
CoJ	City of Joondalup
CPSM	Centre for Phytophthora Science and Management
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DEPI	Department of Environment and Primary Industries
DFES	Department of Fire and Emergency Services
DoEE	Department of the Environment and Energy
DoW	Department of Water
DBCA	Department of Biodiversity, Conservation and Attractions
DPC	Department of Premier and Cabinet
DWG	Dieback Working Group
EDOWA	Environmental Defender's Office Western Australia (Inc)
ELA	Eco Logical Australia
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation Act 1999
EWSWA	Environmental Weed Strategy for Western Australia
FCT	Floristic Community Type
GIS	Geographic Information System
ha	Hectare
IOCI	Indian Ocean Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
mAHD	Elevation in metres with respect to the Australian Height Datum
NAIA	Natural Areas Initial Assessment
No.	Number
MRS	Metropolitan Region Scheme
NWCPAG	National Wildlife Corridors Plan Advisory Group
PEC	Priority Ecological Community
PUBF	Perth Urban Bushland Fungi project
PMST	Protected Matters Search Tool
Syrinx	Syrinx Environmental PL
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
UWA	University of Western Australia

WA	Western Australia
WALGA	Western Australian Local Government Association
WC Act	Wildlife Conservation Act 1950
WONS	Weeds of National Significance

Executive Summary

The Draft Craigie Bushland Management Plan outlines a framework for the environmental management of Craigie Bushland for the next 10 years.

Craigie Bushland is located approximately 19km north of the Perth Central Business District in the suburb of Craigie. The reserve covers approximately 56 hectares (ha) of bushland, containing a permanent fenced area of approximately 42 ha. The site is bounded by the Water Corporation Beenyup Wastewater Treatment Plant to the north, the Mitchell Freeway to the east, the Craigie Leisure Centre and Whitfords Avenue to the south and several streets containing residential housing are located to the west.

The fenced area was established in 2010 and in 2013 Quenda (also known as Southern Brown Bandicoot) (*Isoodon obesulus fusciventer*) were first translocated into the fenced area.[1] The Quenda were removed from Ellen Brook Nature Reserve in Upper Swan and the Twin Swamps Nature Reserve in Bullsbrook as part of the conservation management actions for the Western Swamp Tortoise (*Pseudemydura umbrina*).[2]

Craigie Bushland is classified as a City of Joondalup Major Conservation Area and is ranked in the City's top five bushland areas, due to its high biodiversity values. Craigie Bushland contains regionally significant vegetation and is recognised for its regional environmental significance by being designated as a Bush Forever site, by the Western Australian Planning Commission in 2000. Craigie Bushland forms part of Bush Forever site 303, in conjunction with Hepburn Heights Conservation Area, Pinnaroo Valley Memorial Park and parts of the Beenyup Wastewater Treatment Plant and Mitchell Freeway bushland.

As part of the development of the Draft Craigie Bushland Management Plan, a flora, fauna and fungi survey was conducted in spring and summer 2016. The results of this survey were combined with previous surveys to develop a comprehensive species list and ecological assessment of the site.

The flora assessment undertaken in 2016 identified three vegetation communities existing at the site. These include *Banksia* woodland with Tuart, Open Marri Forrest and Tall open shrubland. In September 2016, the *Banksia* woodlands on the Swan Coastal Plain were Federally listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a Threatened Ecological Community (TEC). An assessment in accordance with the EPBC Act *Approved Conservation Advice* indicated the site contains this Threatened Ecological Community.

The majority of the native vegetation on site is in very good to good condition, with portions of the vegetation also rated as in excellent condition.

Ecological surveys at Craigie Bushland indicate an accumulated 215 native flora species (including one priority species and six Bush Forever significant species of the Perth

[1] Lohr and Valentine (2017)
[2] Burbidge et al. (2010)

Metropolitan Region), five native mammals, 36 native birds (including two species of conservation significance), 17 native reptiles and 201 assumed native invertebrate species.

Environmental threats have the potential to degrade natural areas and reduce biodiversity values. Environmental threats addressed in this Plan include weeds, plant diseases, bushfire, non-native fauna species, risks associated with native fauna management, human impacts, antisocial behaviour, access and infrastructure. A total of 96 weed species, six non-native mammals (including the domestic dog and domestic/feral cat), nine non-native birds and four non-native invertebrates have been identified at Craigie Bushland.

In order to address the key environmental threats at Craigie Bushland a number of management actions are outlined within the Plan.

Recommended management actions for the next 10 years include regular weed control, feral animal monitoring and control, annual bushfire fuel load assessments, monitoring fauna, flora, weed and fungi through field surveys and the development of a *Fauna Management Plan* to address the sustainable management of existing native fauna populations within Craigie Bushland. This Plan also recommends the implementation of associated City Plans such as the City's *Pathogen Management, Weed Management* and *Bushfire Risk Management Plans*.

Management actions will be implemented in partnership with key stakeholders in particular the Friends of Craigie Bushland. The University of Western Australia and the Department of Biodiversity, Conservation and Attractions will continue to be consulted on the management of fauna at the site.

1.0 Introduction

1.1 Background

The City of Joondalup ('the City') is situated along the Swan Coastal Plain, with the Joondalup City Centre being located 30 km from the Perth Central Business District. The City covers an area of 99 km^2 which encompasses a diverse range of natural areas including 17km of coastal foreshore, a chain of linear freshwater wetlands and a variety of bushland ecosystems (as shown in Figure 1).

The City's southern boundary is located approximately 16 km from the Perth Central Business District, and is bounded 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 the Yellagonga Regional Park and a number of Bush Forever sites which contain species of high conservation value. Significant natural areas adjacent to the City include the Marmion Marine Park and the Neerabup National Park.

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

1.2 Natural Area Management Plans

The City has developed Natural Area Management Plans to provide strategic ongoing management of the City's natural areas and protect native vegetation and ecosystems.

Environmental threats have the potential to degrade natural areas and reduce biodiversity values. Environmental threats addressed in this Plan include weeds, plant diseases, bushfire, non-native fauna species, risks associated with native fauna management, human impacts, site access and infrastructure.

Natural Areas Management Plans describe the ecological values of a natural area and the potential environmental impacts, risks and threats to that area and recommend associated management strategies that will be implemented to minimise identified potential impacts.

1.3 Study Area

The study area for the Craigie Bushland Management Plan is Craigie Bushland (also referred to as Craigie Open Space) located in the suburb of Craigie, within the southern municipal boundary of the City of Joondalup. The site encompasses an area of 56 ha with a permanent fenced area of approximately 42 ha. Craigie Bushland has been recognised for its regional environmental significance by being designated as a Bush Forever site (303).[3,4]

[3] Government of Western Australia (2000a)
[4] Government of Western Australia (2000b)

1.3.1 Location

Craigie Bushland is part of a remnant bushland corridor which includes bushland to the north and south including the Pinnaroo Valley Memorial Park and the Hepburn Heights Conservation Area. This remnant bushland corridor encompasses Bush Forever site 303. Craigie Leisure Centre is located to the south of Craigie Bushland with access available to the Craigie Leisure Centre from Whitfords Avenue. Warrandyte Park is located to the north west and can be accessed via a short walk along the western boundary. Residential streets to the west of Craigie Bushland include Britannia Way, Sterling Close, Unicorn Place, Lotus Close and Addingham Court. To the east, Craigie Bushland abuts the Mitchell Freeway for approximately 1km.

1.3.3 Land Tenure

Craigie Bushland is Crown Land managed by the City of Joondalup.

An approximate 1.3ha parcel of land within the north west of Craigie Bushland is owned and managed by the Water Corporation in conjunction with the Beenyup Waste Water Treatment Plant (Figure **2**).

1.3.4 Land Uses

Previous Land Use

Up until 1901 the suburb of Craigie was used as a stock route[5] and up until the 1960's the area was used for grazing by dairy cows. Aerial photographs from this time show the absence of roads and residential houses. In the 1970's a golf course was considered for Craigie Bushland with deliberations lasting until 1999 due to conflicting views with some residents wanting to maintain the site as bushland, whilst others were supporting the development of a golf course. In June 1999, the City of Joondalup formally rejected the plan to develop an eighteen hole golf course in Craigie Bushland.[5]

The suburb name of Craigie may possibly be linked to Scotland as there are at least four places named Craigie in Scotland. It has been suggested the suburb of Craigie may have been named to honour a well known family who set up a stud park named 'Craigie Park' in the early 1900s.[5]

Current Land Use

The main uses of Craigie Bushland are for passive recreational purposes such as walking, the use of the Quindalup Dune Pathway and Stairs for fitness purposes, nature appreciation and the area surrounding the fence is frequently used for dog exercising. In 2013, a population of Quenda were translocated into the fenced area of Craigie Bushland. Nearby properties to Craigie Bushland are zoned as R20 Low Density Residential.

[5] City of Joondalup (2002)

The Water Corporation Beenyup Wastewater Treatment Plant abuts Craigie Bushland in the north. The Treatment Plant services Perth's rapidly developing northern suburbs. It is designed to treat up to 135 million litres of wastewater a day, which currently services about 660,000 people. It is forecast to service 750,000 people by 2030.[6]

The Beenyup Wastewater Treatment Plant site contains Australia's first groundwater replenishment scheme. The Treatment Plant is an advanced secondary treatment facility treating domestic wastewater from North Whitfords, Hamersley and Burns Beach wastewater schemes.[7]

The first stage of the scheme has the capacity to recharge up to 14 billion litres of recycled water into groundwater supplies each year. The second stage will include duplication of the 14 billion litre recycling plant and construction of new recharge bores and associated recharge pipeline in the north-east side of the Beenyup Plant.[7]

When complete in 2019, the scheme will have the capacity to recharge 28 billion litres of water into groundwater supplies, providing a new climate independent water source to boost much needed drinking water supplies.[7]

[6] Water Corporation (no date a)
[7] Water Corporation (no date b)

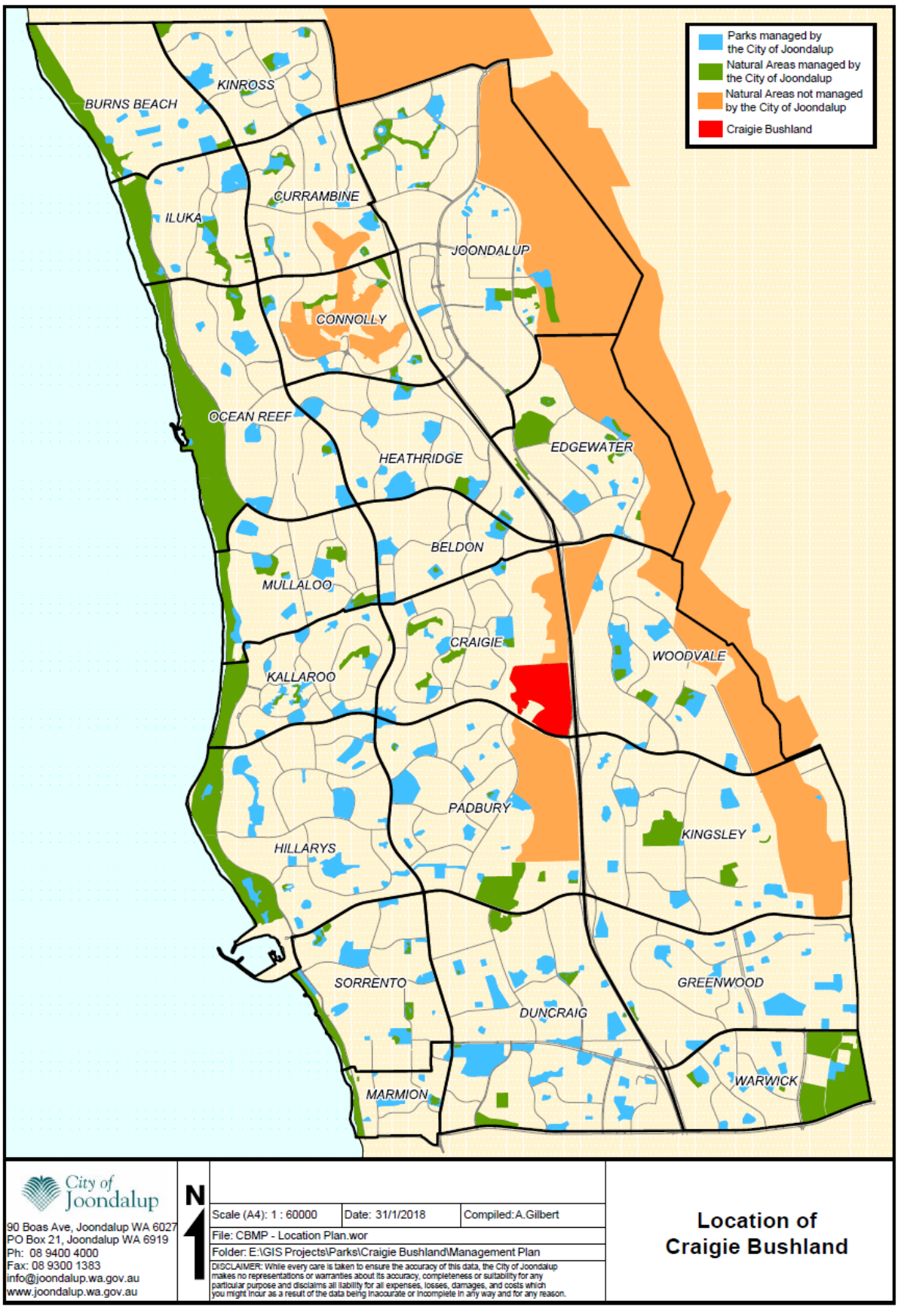

Figure 1: Location of Craigie Bushland in City of Joondalup

Figure 2: Map of Study Area (Landgate Aerial Image – August 2017)

1.4 Aim and Objectives

The aim of the Draft Craigie Bushland 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 Draft Craigie Bushland Management Plan are to:

- Present relevant historical and current information related to the management of Craigie Bushland.
- Establish a baseline description of the Craigie Bushland environment to guide future environmental planning and recommended management actions.
- Outline key environmental threats and the impact they have on conservation and recreation values.
- Outline management actions to address key environmental threats including monitoring and reporting.

1.5 Purpose

The purpose of the Draft Craigie Bushland 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 and information to City employees, contractors, stakeholders and Friends Groups operating within Craigie Bushland.
- Provide mechanisms to raise community awareness of the ecological values of Craigie Bushland whilst protecting and enhancing biodiversity values.

1.6 Strategic Context

Metropolitan Region Scheme

The Metropolitan Region Scheme (MRS) was established in 1962 by the then Metropolitan Regional Planning Authority. The MRS sets out the broad zones and reservations for the whole Perth Metropolitan Region. The Parks and Recreation reservation applies to Craigie Bushland, which refers to land with regional significance for ecological, recreation or landscape purposes.

The City of Joondalup Draft Local Planning Scheme No.3

Local Planning Schemes are required to reflect reservations under the MRS. Therefore, the current City of Joondalup *District Planning Scheme No.2* reflects Craigie Bushland as reserved for Parks and Recreation. The City of Joondalup *Draft Local Planning Scheme No. 3* (LPS3) was endorsed by Council in 2017 and will supersede *District Planning Scheme*

No.2 once approved by the Minister for Planning and published in the Government Gazette. The City of Joondalup *Local Planning Scheme No. 3* (LPS3) will continue to reflect the reservation of Craigie Bushland as Parks and Recreation, in accordance with the current MRS.

Draft Perth and Peel Green Growth Plan for 3.5 million

In December 2015 the West Australian State Government released the *draft Perth and Peel Green Growth Plan for 3.5 million* (*draft Green Growth Plan)*. Craigie Bushland is included as a proposed specific conservation commitment, with the reserve being included within the proposed expansion of the state conservation estate. Under the proposed *Green Growth Plan*, Craigie Bushland would be classified as a 'conservation reserve'.

Conservation reserves are areas of Crown land set aside for the protection and conservation of biodiversity and/or natural or cultural heritage values. There are three main types of conservation reserves in Western Australia – nature reserves, national reserves, and conservation reserves. [8] [9]

City of Joondalup Strategic Environmental Framework

The aim of the Draft Craigie Bushland Management Plan aligns with the City of Joondalup Strategic Environmental Framework outlined in Figure 3. Details of the relevant local, State and Federal legislation, policies, plans and strategies are outlined in Appendix 1.

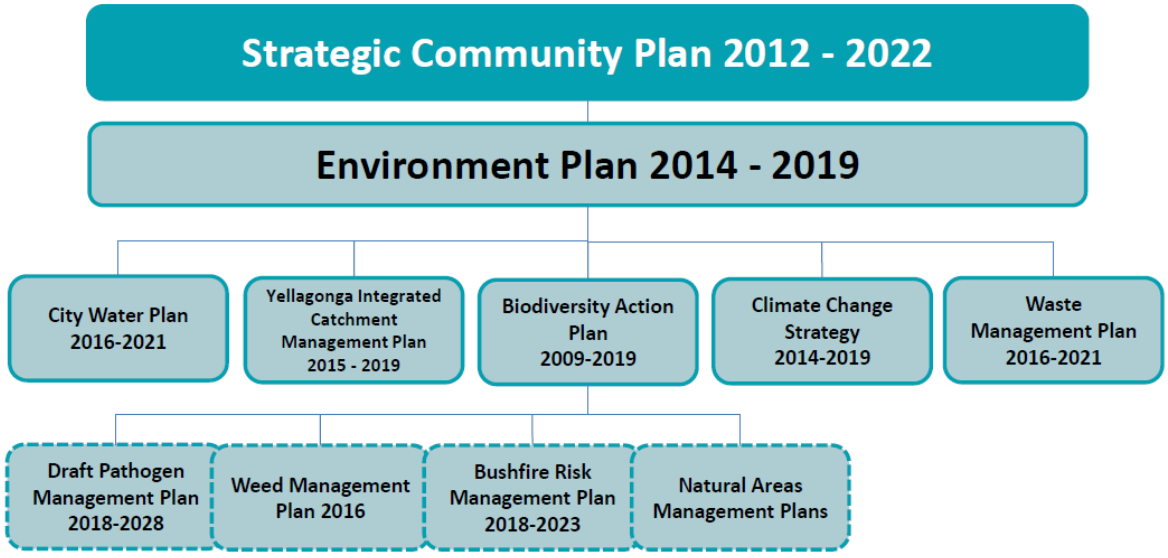

Figure 3: City of Joondalup Strategic Environmental Framework

1.7 Stakeholder Consultation

The City is working in partnership with key stakeholders to manage Craigie Bushland. During the development of this Plan, the City has consulted with a number of key external

[8] Department of Premier and Cabinet (2015)
[9] Department of Planning (2016)

stakeholders including the Friends of Craigie Bushland, the University of Western Australia, the Department of Biodiversity, Conservation and Attractions, the Department of Fire and Emergency Services and the Water Corporation.

Further targeted consultation with the following key external stakeholders will include:

- Department of Biodiversity, Conservation and Attractions.
- Department of Fire and Emergency Services.
- Department of Planning, Lands and Heritage.
- Craigie Resident and Community Association Inc.
- Friends of Craigie Bushland.
- Friends of Hepburn Heights and Pinnaroo Bushland Inc.
- Friends of Shepherds Bush.
- Friends of Warwick Bushland.
- Local Schools: Craigie Heights, Beldon, Whitford Catholic, Springfield and Bambara Primary Schools and St Stephen's School.
- Pinnaroo Valley Memorial Park.
- University of Western Australia.
- Water Corporation.
- Western Australian Local Government Association.
- Western Australian Planning Commission.

2.0 Description of the Physical Environment

2.1 Geology, Soils and Landforms

Soils of the Swan Coastal Plain

Craigie Bushland is situated in the City of Joondalup which is located within the Swan Coastal Plain. Craigie Bushland is characterised as containing regionally significant *Banksia* and Jarrah open woodland communities with the occasional occurrence of *Allocasuarina fraseriana* (Sheok) and Tuart trees.[10] The majority of the soils of the Swan Coastal Plain are formed by material deposited by rivers and wind. A series of dune systems have been formed with the youngest dunes being the Quindalup Dunes nearest the coast, followed by the Spearwood Dunes and the oldest Bassendean Dunes are farthest from the coast, as shown in Figure 4.[10]

Craigie Bushland is located within the Spearwood Dune System and comprises of sand derived from Tamala Limestone.[11] The Spearwood Dunes have a core of sandy aeolianite with a capping of secondary limestone (Tamala Limestone, predominantly calcarenite) overlain by yellow brown siliceous sands with weak podzol development.[12,13] The Spearwood Dunes are believed to have formed around 40,000 years ago and comprise of red/brown,

[10] Eco Logical Australia (ELA) (2017)
[11] Gozzard cited in ELA (2016)
[12] McArthur and Bettenay cited in Syrinx (2012)
[13] Government of Western Australia (2004)

yellow and pale yellow/grey sands. The Spearwood Sand Phase is characterised by undulating dunes with rocky crests of Aeolian sand over limestone, as in Figure 5.[14]

The Quindalup System is described as coastal dunes of the Swan Coastal Plain, with calcareous deep sands and yellow sands, dominated by coastal scrub.[15] The Quindalup System has formed recently and exhibits undulating and dramatic landscape features.[16] The Quindalup dunes are underlain by the Safety Bay Sands formation, which comprises calcareous soils also derived from Tamala limestone.[17]

Topography of the site is dominated by an interdunal swale between a large Quindalup dune on the western edge of the study area and a lower Spearwood dune in the east.[18] Craigie Bushland is predominantly flat with a gentle slope in the eastern half (sloping east to west) and a steep dune along the western boundary (sloping west to east down to the flat).[10]

The land contours of Craigie Bushland range from 15-34 m Australian Height Datum (AHD),[19] as shown in Figure 10.

Acid Sulfate Soils

Acid Sulfate Soils are categorised as Potential Acid Sulfate Soils or Actual Acid Sulfate Soils. Potential Acid Sulfate Soils have not been oxidised by exposure to air whilst Actual Acid Sulfate Soils have been disturbed or exposed to oxygen and become acidic.[20]

Potential Acid Sulfate Soils are naturally occurring soils and sediments that contain iron sulphides. Potential Acid Sulfate Soils are predominantly found in low-lying coastal wetlands and tidal flats and are harmless when left undisturbed. Exposure to air can cause the iron sulfides in Potential Acid Sulfate Soils to react with oxygen and water producing Acid Sulfate Soils with high concentrations of iron and sulfuric acid, which can lead to other contaminants, such as heavy metals and arsenic being released into the surrounding environment.[20]

There is no known risk of Acid Sulfate Soils in Craigie Bushland.[13] The risk of Acid Sulfate Soils is based on the likelihood of Potential Acid Sulfate Soils occurring within soil profiles and has been mapped by the Department of Biodiversity, Conservation and Attractions using available desk-top information and limited ground-truthing, within areas where intensive on-ground soil mapping and soil analysis work has been undertaken. The mapping undertaken has found that Acid Sulfate Soils are not known or expected to occur in the environment of Craigie Bushland on the basis of the geological units present, depth to groundwater and partial “ground truthing” or onsite investigation. Within the City of Joondalup, areas of high to

[14] DAFWA cited in ELA (2013)
[15] DAFWA cited in ELA (2017)
[16] Government of Western Australia 2000 cited in ELA (2017)
[17] Semeniuk et al. cited in ELA (2017)
[18] Natural Area Consulting (NAC) (2011)
[19] Government of Western Australia 2009 cited in ELA (2017)
[20] DEC (no date)

moderate acid sulfate soil risk are predominantly in wetlands or areas adjacent to wetlands, as shown in Figure 6.[20] [21]

[21] Landgate (2006)

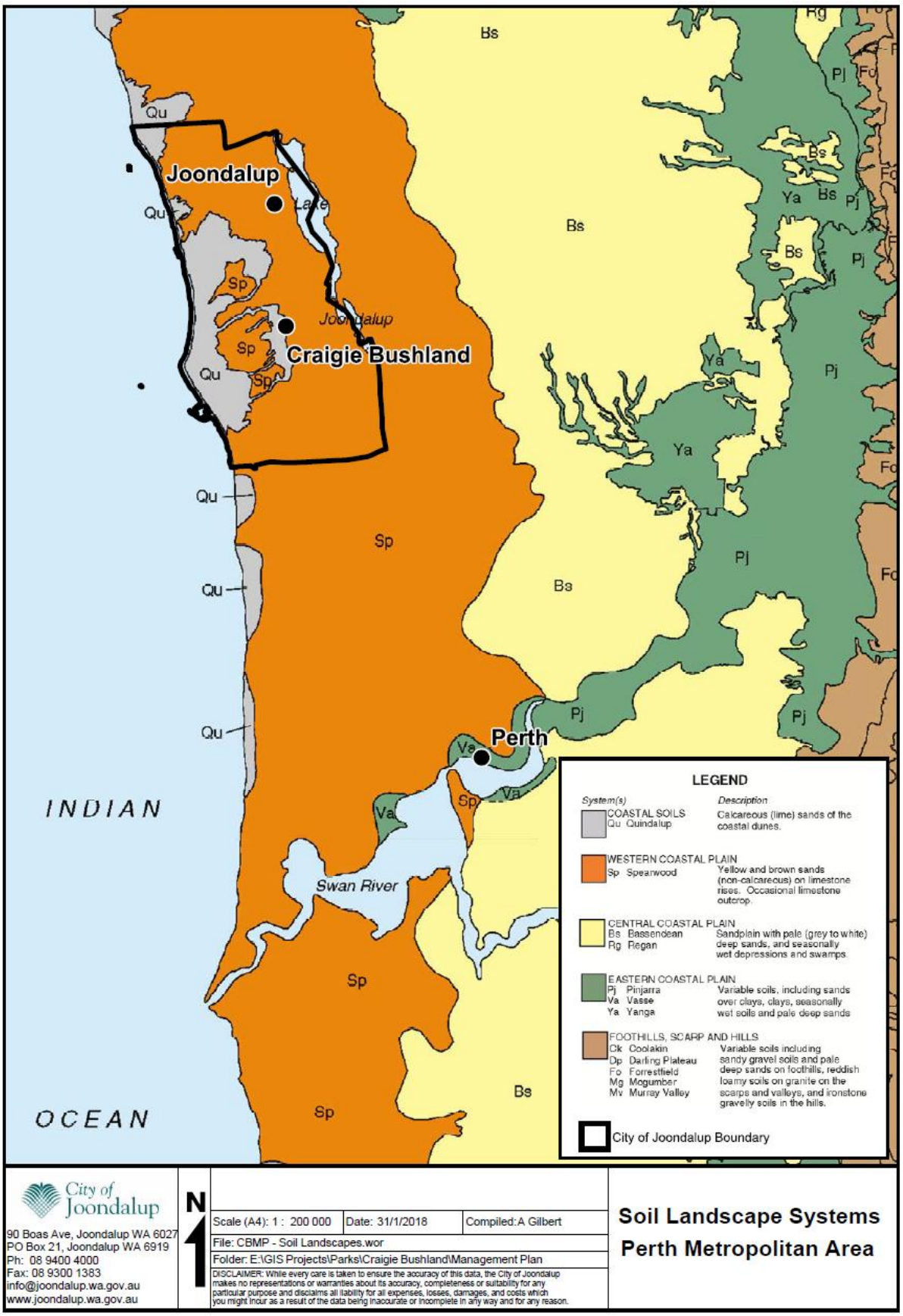

Figure 4: Soils of the Swan Coastal Plain (sourced from Department of Agriculture 2002)

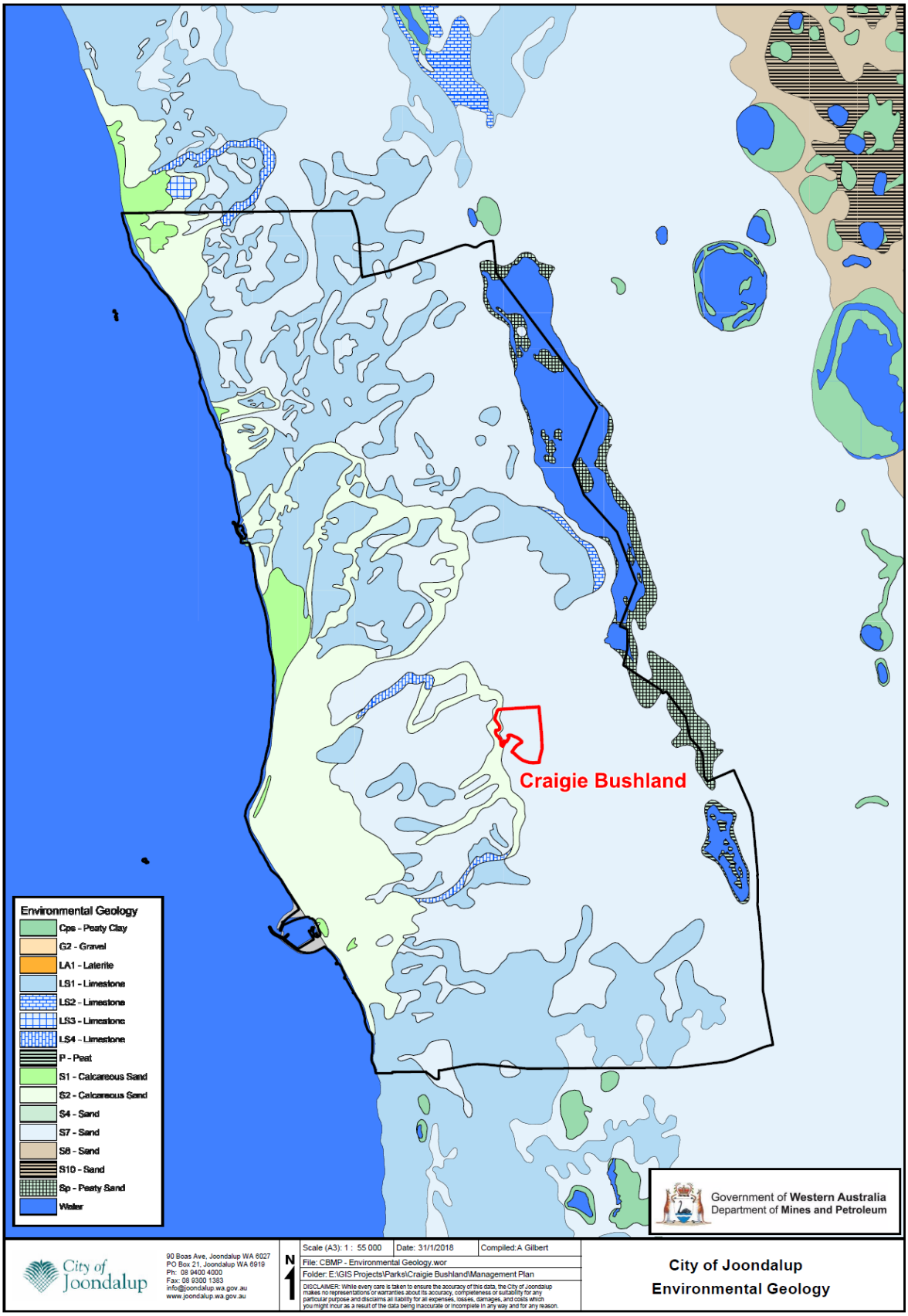

Figure 5: City of Joondalup Environmental Geology (sourced from Department of Mines and Petroleum 2013)

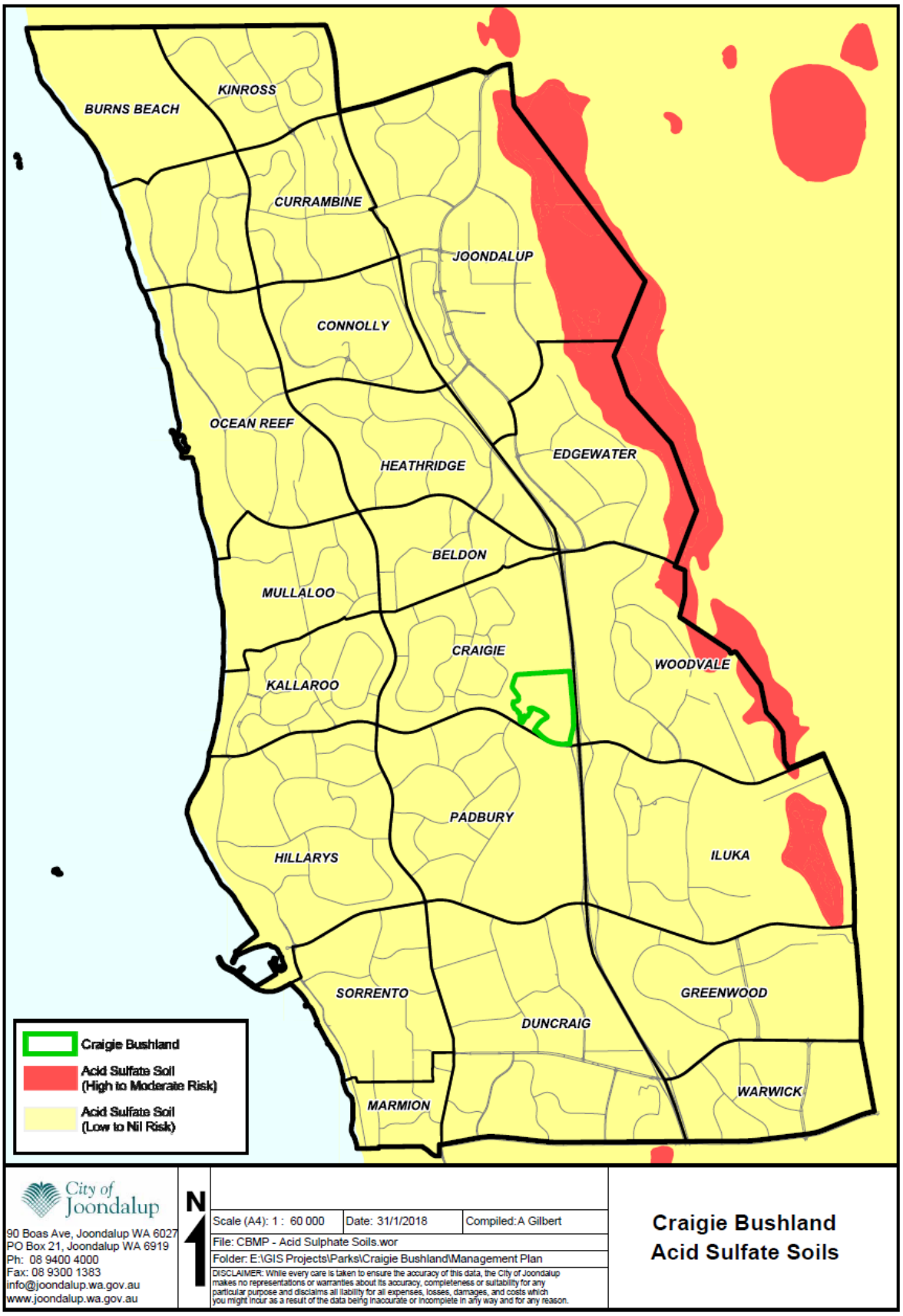

Figure 6: Craigie Bushland Acid Sulfate Soil Risk

2.2 Hydrology

Groundwater

The City of Joondalup is located on Perth's largest source of groundwater, the Gnangara Groundwater System, comprising four main aquifers: superficial Gnangara Mound (shallow, unconfined), Mirrabooka (deeper, semi-confined), Leederville (deep, mostly confined) and the Yarragadee (deep, mostly confined). The Gnangara Mound extends across most of the superficial aquifer and refers to the water table creating a mound shape, as shown in 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.[22] There is a natural seasonal variance in Perth's groundwater system due to annual rainfall recharge, as shown in Figure 8.

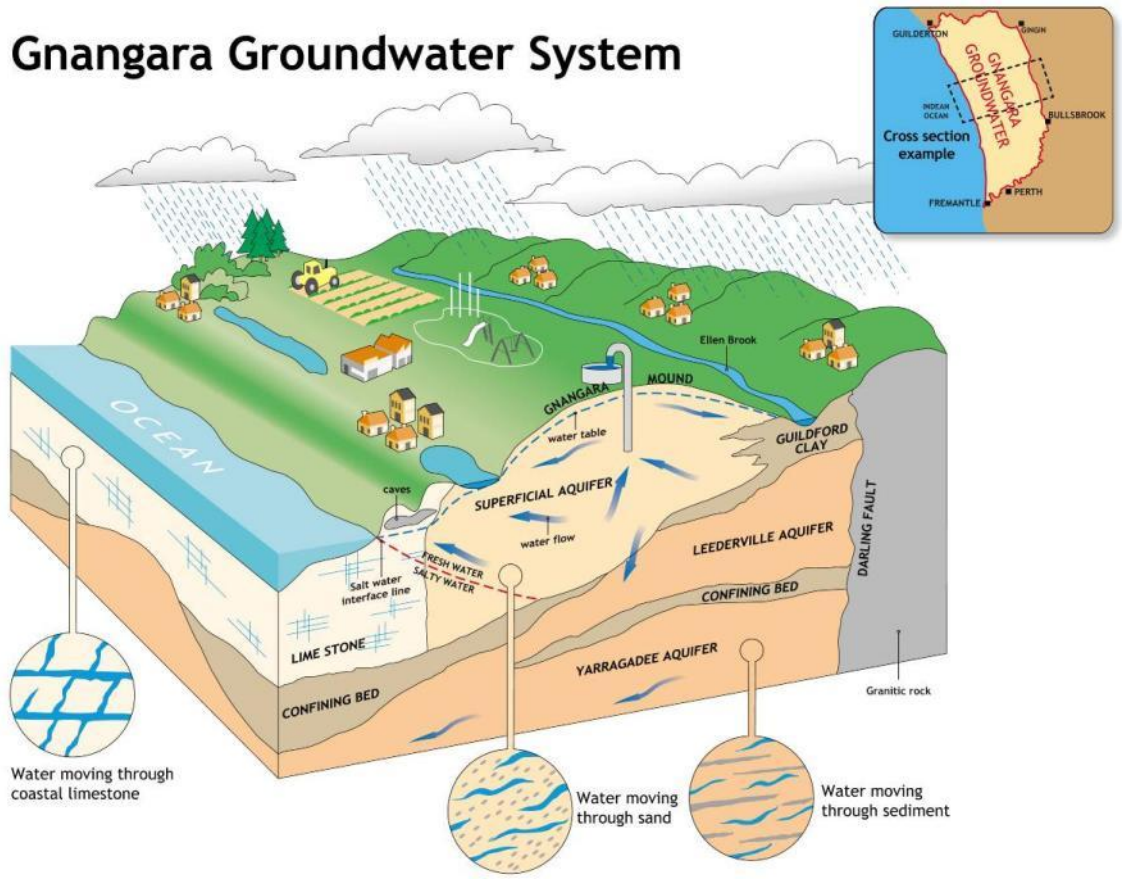

Figure 7: Gnangara Groundwater System (sourced from Government of Western Australia 2015a)

[22] City of Joondalup (2016)

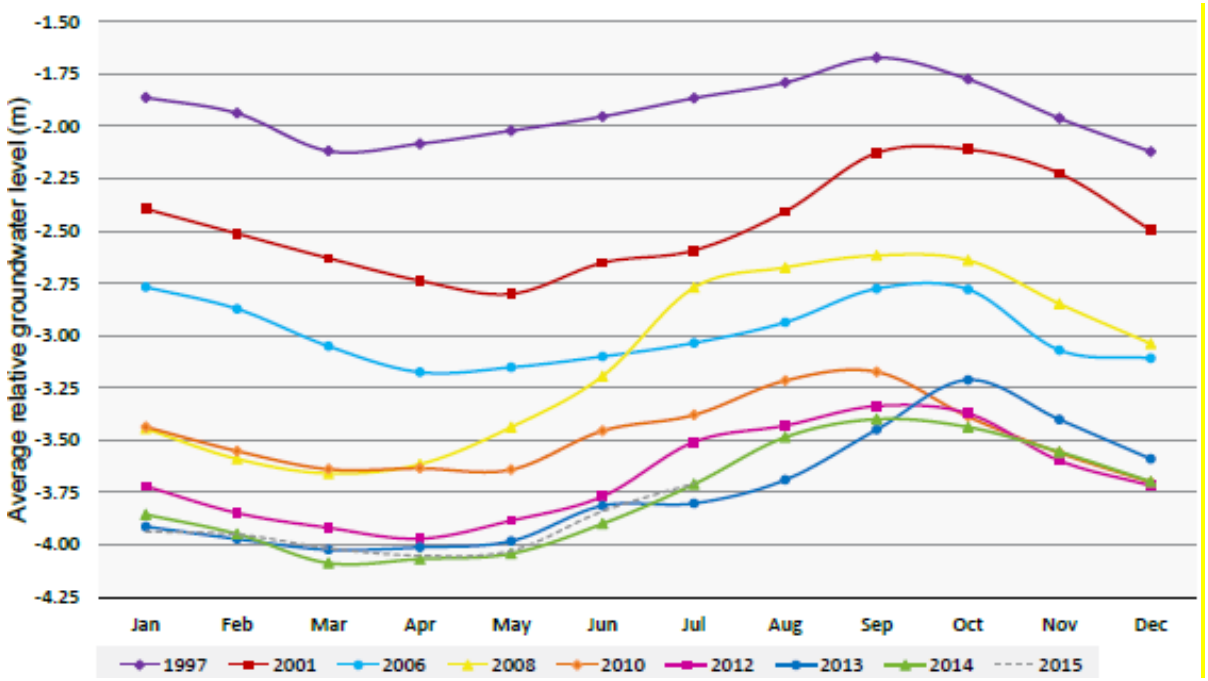

Figure 8: Gnangara Mound Average Relative Groundwater Levels (sourced from DoW 2015)

It is likely that plant species located in the centre of Craigie Bushland utilise groundwater as the depth from ground level to the watertable is approximately 7m.[23] In general, some plant species (usually larger tree species) in the Perth metropolitan area within approximately 10m of groundwater are likely to access the water table.[24]

The average depth to the water table in the east and west corner varies from 8m to 21m respectively, with a +/- range of 3m seasonal variance.[13, 23] Depth to water is the depth from the natural surface contours to the water table (see Figure 9). Groundwater salinity at Craigie Bushland is considered fresh (250 – 500 TDS in mg/L).[23]

[23] Government of Western Australia (2015b)
[24] A Paton (DoW) 2013, pers. comm., 26 March

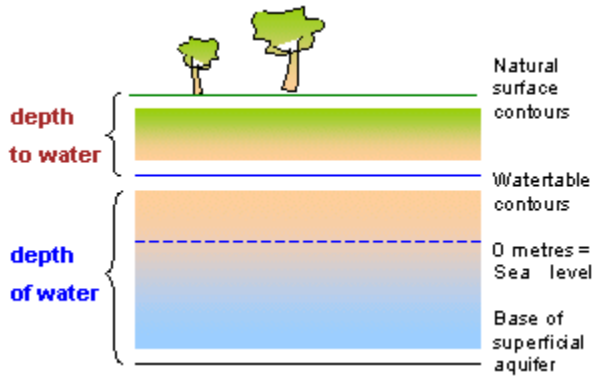

Figure 9: Groundwater Depth Explanation (sourced from Government of Western Australia 2004)

Groundwater levels are commonly at their highest at the end of winter, following winter rainfall recharge and decline through summer due to decreased rainfall, bore extraction and evapotranspiration (plant use). [13]

No current information is available on groundwater levels located directly beneath Craigie Bushland. There are three groundwater bores located within Craigie Bushland, however the last groundwater level measurements were taken in 1979.[23]

The City does not undertake monitoring of groundwater levels at Craigie Bushland, however the Department of Water and Environmental Regulation has been monitoring groundwater bores located within a few kilometres of Craigie Bushland since 1992. Water level data from these monitoring bores is available publicly from the Department of Water and Environmental Regulation *Water Information Reporting* website.

The effect of long-term persistent hydrological change can cause changes in vegetation community composition and structure, with a potential loss of some species and a gradual replacement by more drought-tolerant species. The rate (m/yr) and magnitude (metres) of groundwater level change are also relevant to potential vegetation impact. [25]

The use of groundwater for domestic irrigation through bores is deemed suitable in the area and is supported in preference to scheme water. The area has a low iron staining risk. [14] [23]

Stormwater Drainage

Stormwater consists of runoff from rainfall and material mobilised and dissolved in its path of flow. Stormwater is channelled and collected in sumps and swales to recharge the superficial aquifer and prevent the spread of weeds, pollutants, pathogens and sediment to vegetation. [26]

Sumps allow some stormwater to infiltrate retention basins, detain the water, collect sediment and over time the water is absorbed back into groundwater. Most sumps are steeply graded rectangular excavations with an inflow at the bottom. The majority of sumps

[25] Loomes and Froend (no date)
[26] DoE (2004)

in the City are fenced off in the interest of community safety due to the potential for rapid stormwater inflow. [27]

Craigie Bushland contains several drainage lines and a sump. The drainage lines within Craigie Bushland enter a sump located in the southwest corner of the site, as shown in Figure 10. The Craigie Bushland catchment area is approximately 390,000 m^2.

The sump located in the southwest of Craigie Bushland was converted into an artificial wetland in July 2012. The management of the artificial wetland within Craigie Bushland is included within the *City of Joondalup Wetland Management Plan*. Drainage from the Craigie Leisure Centre car park is fed into the sump during summer. A clay liner was installed during the construction of the sump to increase water retention. Non-local vegetation species were removed and revegetation with appropriate species occurred in winter 2014 and 2016.

Motorbike frogs have been heard calling from around the area, indicating the conversion of the sump into an artificial wetland has been valuable in providing habitat for local fauna.

[27] Grose and Hedgcock (no date)

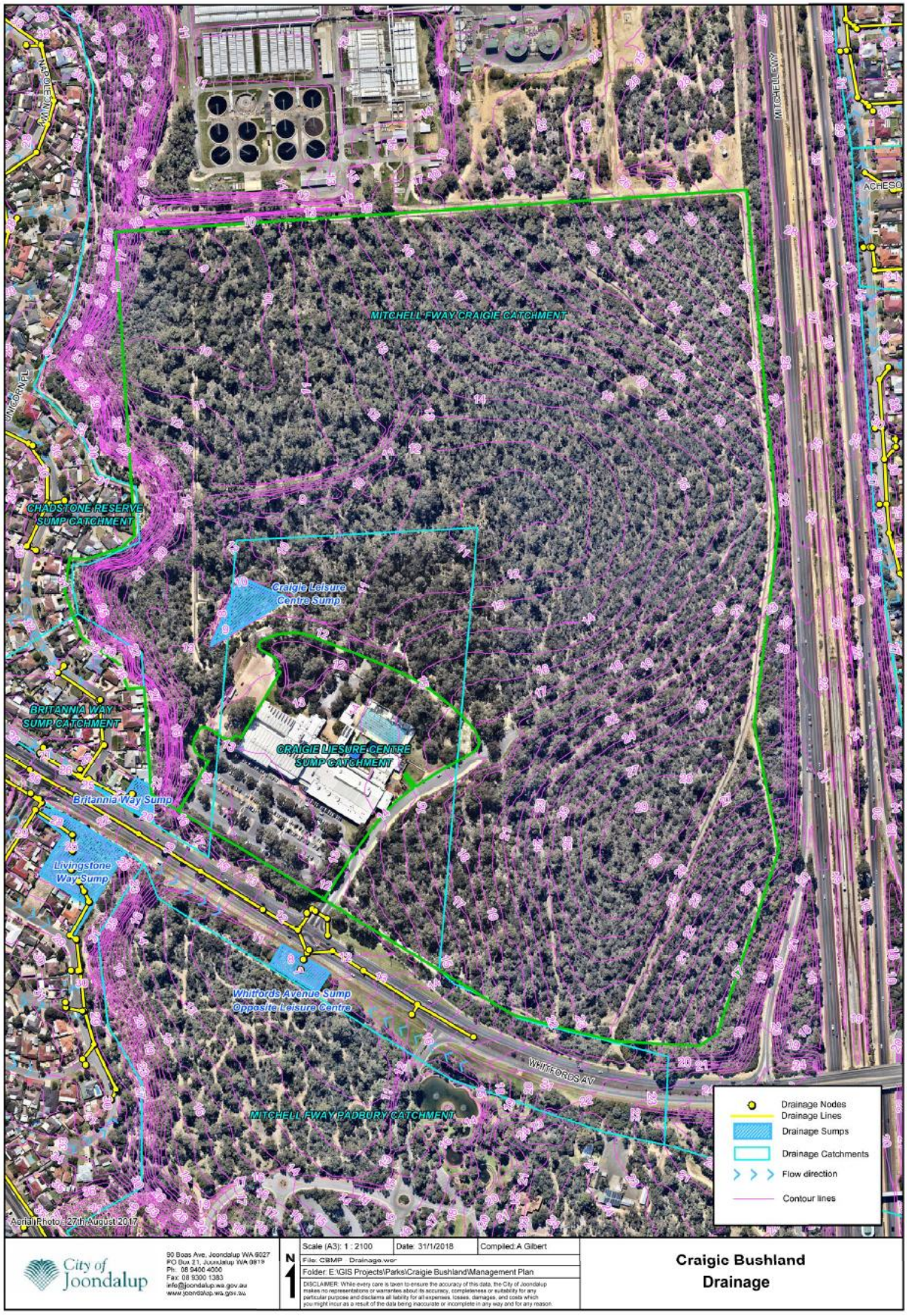

Figure 10: Craigie Bushland Drainage

2.3 Climate

The City of Joondalup is located in the Perth subregion and is subject to a warm Mediterranean climate of hot dry summers and mild wet winters.[28]

In the Perth metropolitan area mean minimum and maximum temperatures range from approximately 4.4°C to 18.4°C in winter (July) to 21°C to 34.6°C in summer (February).[29]

Mean monthly rainfall has been sourced from the Perth Airport Weather Station located approximately 30 km southeast of Craigie Bushland.

The average annual rainfall from 1993 to 2003 was 716 mm and from 2004 to 2017 approximately 666 mm was recorded, indicating an annual decrease of approximately 50 mm in the past two decades. Approximately 76% of the annual rain falls between the months of May to September, as shown in Figure 11.[30]

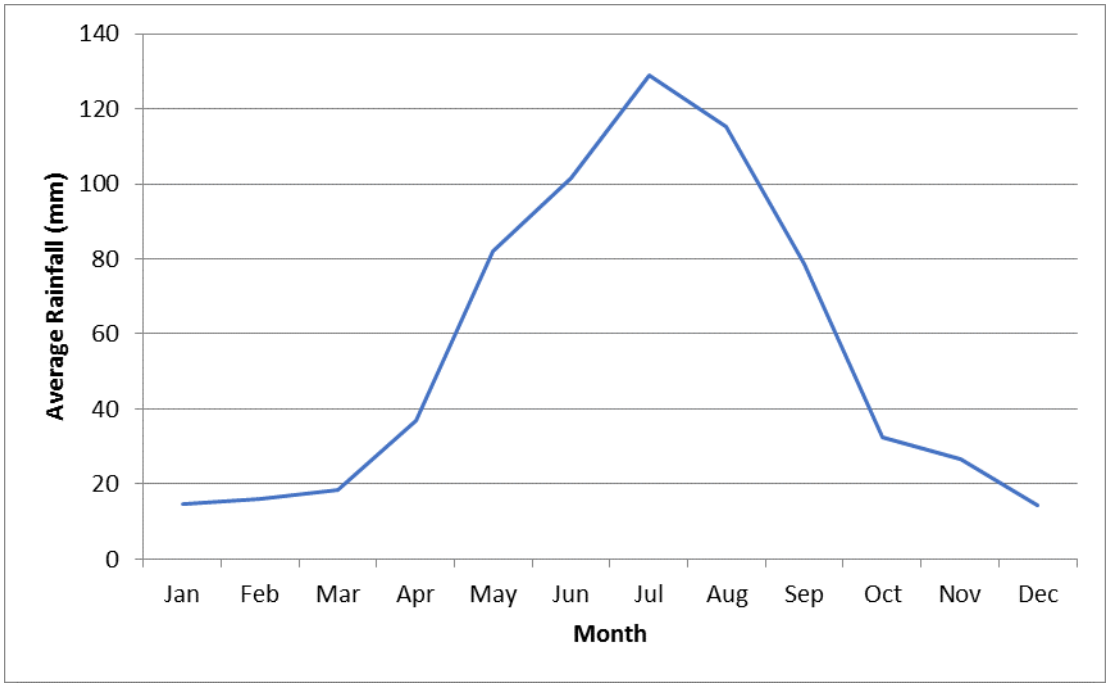

Figure 11: Mean Monthly Rainfall Recorded at Perth Airport Weather Station 2004-2017 (sourced from BoM 2018a)

Locally, the closest weather station to Craigie Bushland, is the Wanneroo Weather Station which is located approximately 7 km northeast of the site. The local area is recorded to receive a mean annual rainfall of approximately 797 mm (data from 1905-2017),[31] compared to 766 mm recorded at the Perth Airport Weather Station (data from1944-2017).[30] However it should be noted that the data for the Wanneroo Weather Station is not as comprehensive as

[28] Mitchell et al. cited in ELA (2017)
[29] BoM cited in ELA (2017)
[30] BoM (2018a)
[31] BoM (2018b)

the data available for the Perth Airport Weather Station, as a number of gaps exist in the Wanneroo Weather Station data (as a result of failure in observation equipment, unavailability of observer (where observations are taken manually) or due to an event producing suspect data).[31]

Current Climate Change

The City of Joondalup is located in the southwest of Western Australia, an area that is already being impacted by the effects of climate change particularly through rising temperatures, decreasing rainfall and gradual sea level rise.

The long term trend in mean temperature, daytime maximum temperatures and overnight minimum temperatures for southwest Western Australia have all increased by 1.1°C between 1910 and 2013.[32]

The mean maximum temperature at Perth Airport Weather Station between 1945 and 2016 is shown in Figure 12.[33]

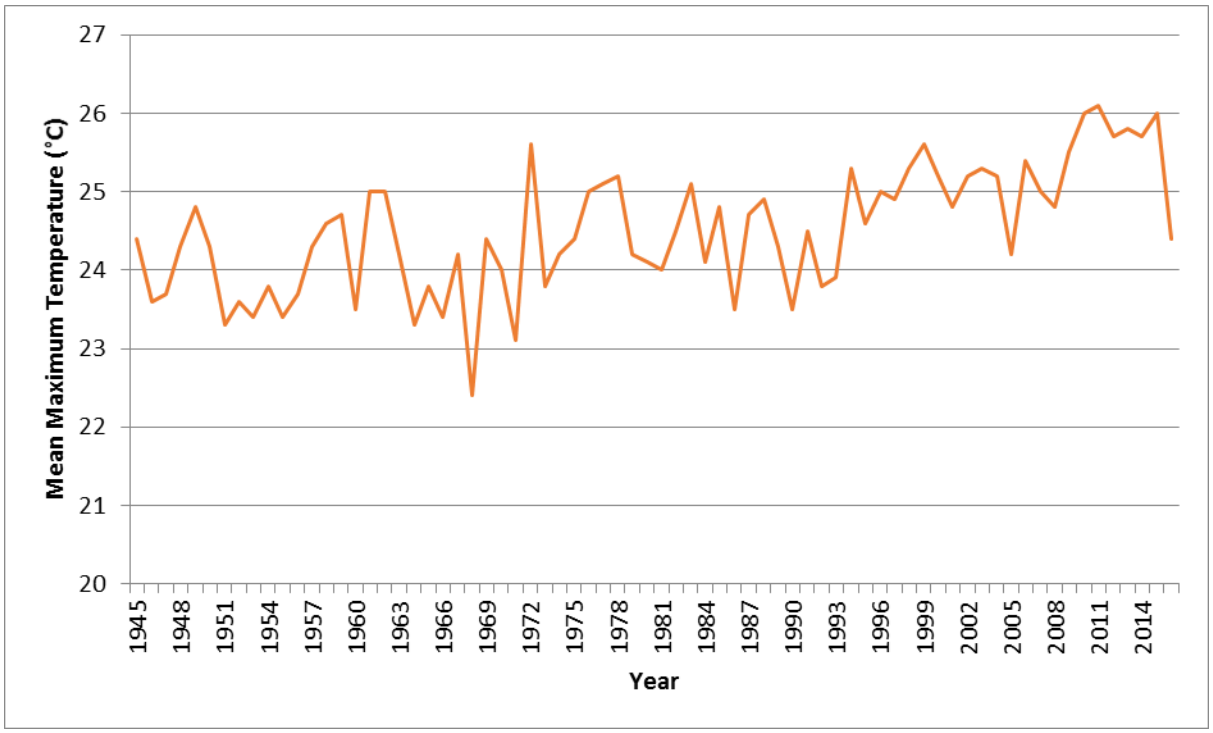

Figure 12: Mean Maximum Temperature Recorded at Perth Airport Weather Station 1945-2016 (sourced from BoM 2018c)

In addition, the May to July rainfall has reduced by around 19% since 1970 in the southwest of Western Australia.[34]

Figure 13 shows the mean annual rainfall at Perth Airport between 1975 and 2017.[35]

[32] Hope et al (2015)
[33] BoM (2018c)
[34] BoM and CSIRO (2016)

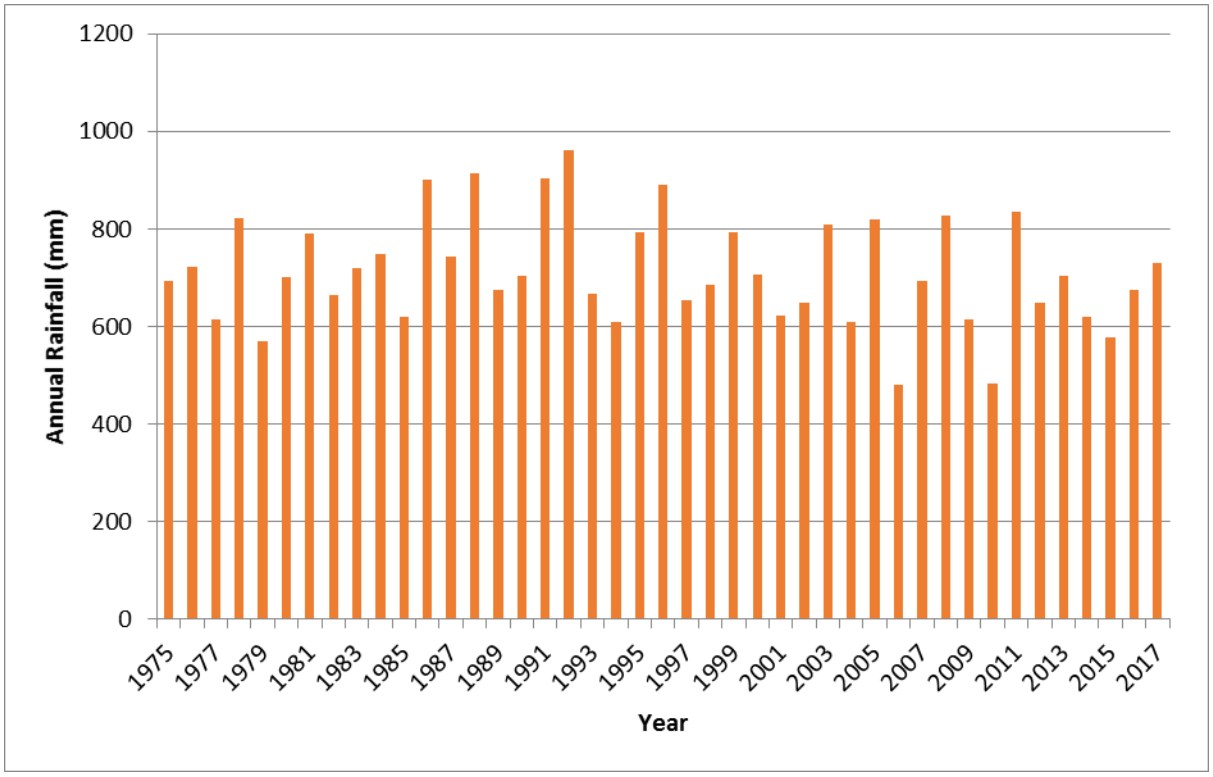

Figure 13: Mean Annual Rainfall Recorded at Perth Airport Weather Station 1975-2017 (sourced from BoM 2018c)

Future Climate Change

The hotter drier climate within the southwest Western Australian region is impacting on bushland areas and ecosystems, particularly through reduced water availability. Adaptation to the drying climate is critical, particularly as the impacts of climate change may increase in the future.

The City has adopted a future climate scenario in its *Climate Change Strategy 2014-2019,* based on the best available science and best-practice climate adaptation planning. Under this scenario in 2070 the City of Joondalup will have hotter, drier and windier summers with the number of days over 35°C nearly doubling. Winters will be drier, warmer and less windy as a result of fewer low pressure systems, see
Table 1. More extreme weather events are also predicted, including more frequent and severe droughts.[35]

[35] CSIRO (2007)

Climate Change Scenario for the City of Joondalup in 2070
2.7°C ⇧ Temperature
Extreme Heat days ⇧ from 28 to 54
19% ⇩ Rainfall
7% ⇧ Potential Evaporation
Wind Speed ⇧ 8% in Summer ⇩ 14% in Winter
2% ⇩ Relative Humidity
1.4% Solar Radiation

Table 1: Climate Change Scenario for the City of Joondalup in 2070

Note: Climate Change projections for Perth in 2070 compared to 1990 under a high emissions scenario (A1FI). The projections have been generated using data from 23 climate models and global warming estimates IPCC Fourth Assessment Report 2007[32]

The future changes to the climate are expected to have the following impacts on local bushland areas:

- Increase threats to the natural environment such as incidence of weeds, bushfire and disease;
- Changes to habitats and distribution patterns of species. A drier climate will result in reduced water availability for ecosystems and fauna and flora species; and
- Greater occurrence of extreme weather events such as heat-waves and intense storms.

Whilst climate change is difficult to address directly, many of the management actions in this Plan focus on maintaining vegetation resilience and will assist to minimise the effects of climate change.

2.4 Vegetation

Vegetation Complexes

Vegetation complexes are classified by the soil and landforms contained in medium to large areas. Regional scale mapping shows the study area is classified as having Karrakatta Complex – Central and South (Figure 14).[36]

This complex is described as predominantly open forest of *Eucalyptus gomphocephala* (Tuart) - *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri) and woodland of *Eucalyptus marginata* (Jarrah) - *Banksia* species. This vegetation complex currently has 23% of its pre-European extent remaining within the portion of the mapping extent within the Swan Coastal Plain IBRA region.

It is reported the pre-European extent of the Karrakatta Complex-Central and South comprised of 2,703 ha within the City of Joondalup local government boundary, however only 340 ha (12%) currently remains within the City. The Karrakatta Complex-Central and South exists within the municipal boundaries of approximately 25 local government authorities.[37]

The Karrakatta Complex-Central and South vegetation complex covers 28% of the proportion of vegetation within the City (figures are approximate).[37]

The State Government's Bush Forever Strategy (2000) aims to protect 51,000 ha of regionally significant vegetation within the Swan Coastal Plain portion of the Perth Metropolitan Region. The State Government has established targets under Bush Forever which aim to protect at least 10% of each of the 26 vegetation complexes, to achieve a comprehensive representation of all the ecological communities originally occurring in the region.[3,38,39] The Strategy identifies 287 bushland sites. Craigie Bushland was identified as part of an area of regionally significant vegetation required to meet retention targets, along with adjoining bushland within the Pinnaroo Valley Memorial Park, Hepburn Heights Conservation Area and bushland within the Water Corporation Beenyup Wastewater Treatment Plant and Mitchell Freeway, encompassing approximately 140 ha of remnant bushland. These sites collectively form Bush Forever site 303: Whitfords Avenue Bushland, Craigie/Padbury.[4]

Due to the limited extent of the Karrakatta Complex – Central and South vegetation complex remaining within the Perth Metropolitan Region, it is important to retain bushland within Craigie Bushland for its conservation value.

[36] Heddle et al. cited in ELA (2017)
[37] Government of WA (2017a)
[38] WALGA (2010)
[39] Government of Western Australia cited in ELA (2016)

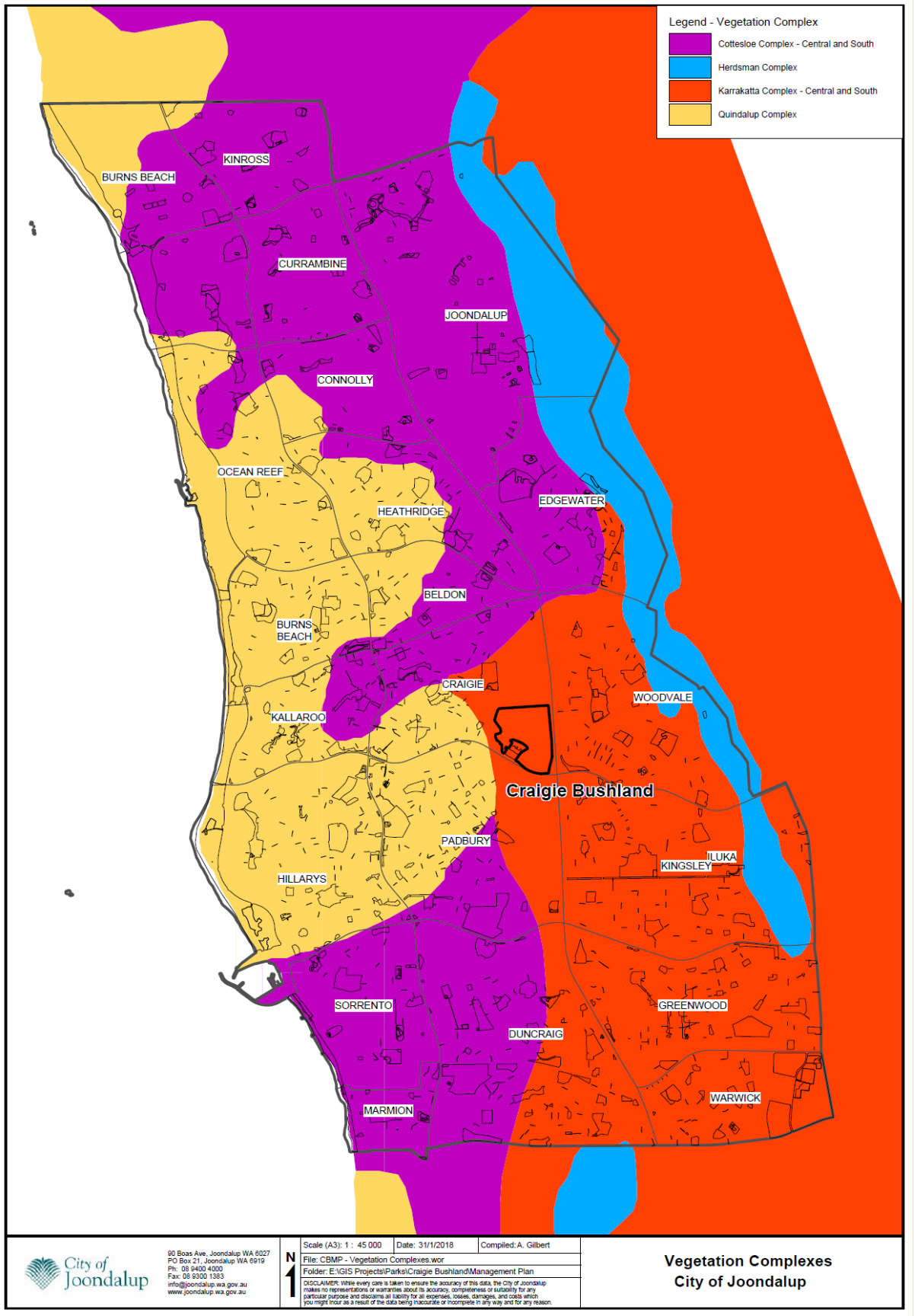

Figure 14: City of Joondalup Vegetation Complexes

Floristic Community Types

The vegetation of the Swan Coastal Plain has been systematically surveyed and grouped into Floristic Community Types (FCTs). This floristic analysis defined 30 FCTs with some groups further subdivided, with a total of 43 types and sub-types recognised.[40]

The Spearwood Dunes unit supports FCTs 24, 25, 26a, 26b, 27 and 28. The following FCTs were inferred to occur in the study area through the State Government's Bush Forever assessment in 2000:

- FCT 24 – Northern Spearwood shrublands and woodlands.
- FCT 26b - Woodlands and mallees on limestone.
- FCT 28 – Spearwood *Banksia attenuata* or *B. attenuata – Eucalyptus* woodlands.
- FCT 29a - Coastal shrublands on shallow sands.[4]

Although these FCT were inferred to be present within Craigie Bushland this was not likely supported by field sampling. These FCTs were likely inferred to occur at Craigie Bushland based on the floristics of the general area and the site's geographic location, therefore this does not necessarily indicate that these FCTs exist at the site.

The spring (September) 2016 flora field survey conducted by consultants Eco Logical Australia identified the following FCTs at Craigie Bushland. These FCTs were further determined using statistical analysis.

- FCT 28 – Spearwood *Banksia attenuata* or *B. attenuata – Eucalyptus* woodlands.
- FCT 29b - *Acacia* shrublands on taller dunes, southern Swan Coastal Plain

FCT 28 is currently listed as a Priority 3 (iii) PEC by the State Government Department of Biodiversity, Conservation and Attractions (DBCA),[41] indicating it is made up of large and /or widespread occurrences, however is under threat of modification due to disturbance.[42]

Occurences of FCT 28 may also meet the criteria in the *Approved Conservation Advice for the Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community* (TEC) that is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).[43] An assessment was undertaken by Eco Logical Australia (ELA) in spring 2016 in accordance with the *Conservation Advice for the Banksia Woodlands of the Swan Coastal Plain* TEC. The results of the assessment indicated the *Banksia Woodlands of the Swan Coastal Plain* TEC exists at Craigie Bushland.[10]

FCT 28 is largely restricted to the Spearwood landform. The average *species richness for FCT 28 is 55.2 native species per quadrat and average weed frequency is eight species per

[40] Gibson et al. cited in ELA (2016)
[41] DBCA (2017a)
[42] DEC (2013) and DPaW (2017)
[43] DoEE (2016)

quadrat.[10] The quadrats surveyed by ELA recorded an average of 43.6 native species per quadrat with an average of eight weeds per quadrat. Most of the ELA quadrats recorded the typical species that represent FCT 28 and that are known to occur in >75% of Gibson et al. (1994) quadrats in that FCT.[10]

Gibson et al. (1994) quadrat data were from quadrats established in the best condition and most species rich sites, therefore lower species numbers are expected when sampling occurs in more fragmented areas with poorer vegetation condition.[44]

FCT 29b is currently also listed as a Priority 3 (i), Priority Ecological Community (PEC) by the Department of Biodiversity, Conservation and Attractions.[41] A Priority 3 (i) PEC is defined by the DBCA as 'communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation.'[42]

FCT 29b is largely restricted to the Quindalup Dune System. Average species richness for quadrats established by Gibson et al. (1994) in FCT 29b is 35.6 native species per quadrat with a low average weed frequency at 3.4 weeds per quadrat. The quadrats surveyed by ELA recorded an average of 27 native species per quadrat with an average of seven weeds per quadrat. FCT 29b does not have consistent dominants, but species such as *Acacia lasiocarpa* and *Melaleuca systena* are common indicator species of this FCT. The typical species that represent FCT 29b which are known to occur in >75% of Gibson et al. (1994) quadrats were recorded within some of the ELA quadrats, along with other dominants such as *Acacia rostellifera, Acanthocarpus preissii, Rhagodia baccata* and *Lomandra maritima*.[10,44]

Following the flora survey undertaken by consultants, Eco Logical Australia in spring 2016, FCT30a *Callitris preissii* forests and woodlands was also identified by the Department of Biodiversity, Conservation and Attractions as possibly present in Craigie Bushland. This FCT is listed as a TEC in WA.[45] The assumption is based on the presence of *Callitris preissii* that occurs within the ELA mapped vegetation community MsAhAiSgCc – Tall Open shrubland in Good condition (using the Keighery Vegetation Scale) and occurs on dunes and swales bordering the western boundary of Craigie Bushland. Based on historical information, the *Callitris preissii* is considered to occur naturally and likely not to have been planted in the bushland area.

In October 2017, the Federal Department of the Environment and Energy (DEE) released for public comment the *Draft Conservation Advice for the Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain*, following public nomination to list them under the EPBC Act as a Critically Endangered TEC.[46]

Several FCTs can contain Tuart, including FCT 28 - Spearwood *Banksia attenuata* or *B. attenuata – Eucalyptus* woodlands. In some instances, particularly on the Spearwood Dune

**Species richness relates to the number of different species present within a floristic community (rather than the quantity of each species present).*

[44] Gibson et al. cited in ELA (2016)

[45] DPaW (2016)

[46] DoEE (2017)

System, both *Banksia* Woodlands and Tuart Woodlands and Forests may be present.[47] Therefore there is potential for the proposed Tuart Woodlands and Forests proposed TEC to also be present at Craigie Bushland. Should the Minister for the Environment decide to list this ecological community under the EPBC Act, a targeted assessment using the EPBC Act *Approved Conservation Advice* will need to be undertaken to confirm its presence (as per the *Banksia* Woodlands TEC assessment).

Whilst FCTs can be a useful way of describing assemblages of flora species, or defining Threatened or Priority Ecological Communities on the Swan Coastal Plain, structural vegetation community descriptions are more commonly used.

Vegetation Communities

To inform the development of the **Craigie Open Space Urban Bushland Management Plan*, an ecological survey was undertaken by Allen et al. in 1994. This survey reported Craigie Bushland contains examples of *Banksia*, Jarrah (*Eucalyptus marginata*) and Tuart (*Eucalyptus gomphocephala*) woodlands which provide habitat for a wide variety of vertebrate, invertebrate fauna and birds.

Allen et al. (1994) further described the vegetation that exists in Craigie Bushland is becoming a rare and special feature in the Perth metropolitan region. The remnant native *Banksia*, Jarrah and Tuart woodland is an example of disappearing landsapes that once dominated and characterised the Swan Coastal Plain.[48]

Natural Area Consulting in 2011 also conducted an ecological survey identifying a number of vegetation units. Most recently, during the spring 2016 field survey Eco Logical Australia (ELA) identified three vegetation communities within Craigie Bushland. The methodology used to distinguish, report and name vegetation units and/or communities by Allen et. al (1994), Natural Area Consulting (2011) and ELA (2016) vary due to different methodologies used to determine dominant species within a vegetation unit or community. The vegetation units determined by ELA are used to inform this Plan, however a summary of previous vegetation units identified at Craigie Bushland are provided in Appendix 6.

The three vegetation units and the area they cover within Craigie Bushland as identified by ELA is described in full in Table 2 and shown in Figure 15. The main vegetation community existing within Craigie Bushland, consisting of 82% of the site is identified as *Banksia* woodland with Tuart.

*The *Craigie Open Space Urban Bushland Management Plan* was developed by Allen et al. in 1994 to meet the requirements for an Environmental Management Project assessment at Edith Cowan University, Joondalup campus.

[47] Department of the Environment and Energy cited in DoEE (2017)
[48] Allen et al.(1994)

Vegetation Unit Type Reference	Vegetation Unit Description	Site Coverage
EgBaXpGtMpCc - *Banksia* woodland with Tuart	*Banksia attenuata*, *Eucalyptus marginata* and *Allocasuarina fraseriana* low woodland with emergent *Eucalyptus gomphocephala* over *Xanthorrhoea preissii* shrubland over *Gompholobium tomentosum* and *Hibbertia hypericoides* subsp. *hypericoides* very open shrubland over *Mesomelaena pseudostygia* open sedgeland over *Conostylis candicans* subsp. *candicans*, *Desmocladus asper* and *Lagenophora huegelii* very open herbland	45.94 ha or 82%
CcBgXpDa - Open Marri forest	*Corymbia calophylla* open forest over *Banksia grandis* low open woodland over *Xanthorrhoea preissii* and *Jacksonia sternbergiana* open shrubland over *Desmocladus asper* and *Lomandra preissii* very open herbland	5.82 ha or 10.4%
MsAhAlSgCc - Tall open shrubland	*Melaleuca systena* and *Santalum acuminatum* tall open shrubland over *Allocasuarina humilis* shrubland over *Acacia lasiocarpa* and *Acanthocarpus preissii* very open shrubland over *Schoenus grandiflorus* very open sedgeland over *Conostylis candicans* subsp. *candicans*, *Desmocladus asper* and *Lomandra maritima* very open herbland.	3.54 ha or 6.3%

Table 2: Vegetation Community Types at Craigie Bushland

Vegetation Protected under State and Federal Legislation

Threatened Ecological Communities

Threatened Ecological Communities (TECs) can be protected under Federal or State legislation.

Federal Threatened Ecological Communities

Threatened Ecological Communities protected under Commonwealth legislation fall under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and are recognised as a matter of National Environmental Significance. Any action that is likely to have a significant impact on listed TECs under the EPBC Act must be referred to the Minister for Environment and undergo an environmental assessment and approval process.[49]

The Commonwealth protected *Banksia Woodlands of the Swan Coastal Plain* TEC occurs at Craigie Bushland based on the assessment undertaken in 2016 by Eco Logical Australia in accordance with the *Approved EPBC Act Conservation Advice* and is identified as the

[49] DoEE (no date a)

Banksia woodland with Tuart vegetation community in Table 2 and Figure 15.[10] [43] The *Banksia* Woodlands of the Swan Coastal Plain TEC is listed under the Endangered category, meaning the ecological community is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).[49]

In 2017 the Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain were nominated for inclusion as a TEC, under the Critically Endangered category of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The proposal to list this ecological community under the Critically Endangered category suggests the community is susceptible to an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years). An assessment to list the community under the EPBC Act is being undertaken and is expected to be completed in 2018.[50] The findings of the assessment may result in increased importance and protection of the vegetation present at Craigie Bushland.

State Threatened Ecological Communities

The *Biodiversity Conservation Bill* 2015 was introduced to State Parliament on 25 November 2015, and passed on 13 September 2016. The Bill became the *Biodiversity Conservation Act* 2016 upon receiving Assent by the Governor of Western Australia on 21 September 2016. The Act will eventually fully replace both the *Wildlife Act* 1950 and the *Sandalwood Act* 1929. The *Biodiversity Conservation Act* greatly increases the protection for threatened species and introduces a new protection for Threatened Ecological Communities.
However the provisions that replace those existing under the *Wildlife Act* and *Sandalwood Act* (including threatened species listings) and their associated Regulations cannot be brought into effect until the necessary Biodiversity Conservation Regulations have been made. The Biodiversity Conservation Regulations are currently being developed.[51]

Whilst the Biodiversity Conservation Regulations are not yet enacted, the Western Australian *Environmental Protection Act 1986* and its associated Clearing of Native Vegetation Regulations (2004) currently protect State listed Threatened Ecological Communities.

Callitris preissii forests and woodlands are listed in Western Australia as a TEC under the category Vulnerable (B),[45] meaning the community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.[52]

State Priority Ecological Communities

The Department of Biodiversity, Conservation and Attractions is responsible for listing Priority Ecological Communities (PECs) in Western Australia.

The Commonwealth EPBC Act protected *Banksia* Woodlands of the Swan Coastal Plain TEC is also listed as a PEC in Western Australia. This PEC is listed under Priority 3 (iii),

[50] DoEE (no date b)
[51] Government of Western Australia (2017b)
[52] DEC (2013)

indicating it is made up of large and /or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range.[41]

The Tall open shrubland vegetation community identified by Eco Logical Australia in their 2016 survey is described as *Acacia* shrublands on taller dunes, southern Swan Coastal Plain and is also listed as a PEC. This PEC is listed under Priority 3 (i),[41] indicating it is known from several to many occurrences, many which are not under immediate threat.[42] This PEC was identified on the western boundary of Craigie Bushland, see Table 2: Vegetation Community Types at Craigie Bushland and Figure 15.

Vegetation Condition

Vegetation condition assessments include observations regarding the numbers of native species, weed cover, vegetation structure, species diversity, health condition of vegetation present and physical disturbance.

The Keighery Scale is a tool used to rate the condition of vegetation from “Pristine” to “Completely Degraded”, as detailed in Appendix 5. To assess the vegetation condition at the site, the City of Joondalup conducted a Natural Areas Initial Assessment (NAIA) in April 2004, followed by Natural Area Consulting (NAC) and ELA in September 2011 and 2016 respectively. These vegetation conditions assessments are presented in Table 3.

Year	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded	Total
September 2016 (ELA)	0%	18.8%	43.8%	26.5%	1.6%	9.3%	100%
September 2011 (NAC)	0%	0%	14.6%	78.9%	6.2%	0.3%	100%
April 2004 (CoJ)	25%	30%	25%	15%	5%	0%	100%

Table 3: Craigie Bushland Vegetation Condition Assessment (2004, 2011 and 2017) using the Keighery Scale

Additionally the State Government’s Bush Forever Strategy in 2000, rated the vegetation condition of Craigie Bushland as more than 75% Very Good to Excellent, less than 30% Good to Degraded, with areas of severe localised disturbance.

The most recent vegetation condition as reported by ELA in their 2016 assessment indicated the vegetation at Craigie Bushland ranged from “Excellent” to “Completely Degraded”, based on the Keighery (1994) vegetation scale, with the majority of the bushland in “Very Good” condition (43.8 %), as shown in Table 4 and Figure 16.

Vegetation Condition Scale	Percentage of Area	Details
"Excellent"	18.8%	Areas in "Excellent" condition occurred in the north-east and southern portions of the site. These areas had higher native flora species diversity and sparse, non-aggressive weeds.
"Very Good"	43.8%	"Very Good" areas occurred where remnant vegetation was intact with fewer weeds or impacts from other disturbances and were prominent throughout the centre of the bushland, located away from site boundaries and tracks.
"Good"	26.5%	Areas in "Good" condition occurred on either side of cleared tracks and the along the outside boundary of the site.
"Degraded"	1.6%	One small pocket of vegetation in the centre of the bushland and another small area surrounding the artificial wetland was categorised as "Degraded."
"Completely Degraded"	9.3%	"Completely Degraded" areas comprised largely of cleared tracks and two small pockets of vegetation, one in the south-west which had a significant presence of aggressive weeds and the other in the north-east of the study area which had altered vegetation structure from previous clearing.

Table 4: Details of Eco Logical Australia Vegetation Condition Assessment (September 2016) using the Keighery Scale

Based on the condition assessments conducted at Craigie Bushland, there has been an increase in the condition of "Excellent" and "Very Good" vegetation in 2016, in comparison to previous years.

The amount of "Degraded" vegetation has also decreased, however the "Completely Degraded" vegetation rating has increased. This is attributed to the vegetation assessment undertaken by Eco Logical Australia in 2016 incorporating cleared tracks and paths under the "Completely Degraded" condition rating, whereas the vegetation condition assessment undertaken by Natural Area Consulting in 2011 and the NAIA by the City of Joondalup in 2004 did not include tracks and paths in their assessments, as shown in Table 3.

Variances in the condition of the vegetation can also be attributed to differing interpretations of the Keighery Scale definitions by assessors. Other external factors such as different seasonal timings of vegetation assessments, frequency and intensity of recent bushfire occurrences and other disturbances such as the incidence of weeds may also result in variances in vegetation condition assessments.

Eco Logical Australia reported that a range of disturbances exist within Craigie Bushland which is somewhat reflected in the condition of the vegetation.

Disturbances such as clearing, unauthorised paths/trampling, weed invasion, rubbish and garden refuse dumping and altered bushfire regimes have altered the remnant vegetation structure and native species diversity through direct removal/damage to vegetation and increased exposure to edge effects. Observations were made in some areas of health decline in some *Banksia*, Jarrah and Marri, which are susceptible to disease/pathogen attack.

High resolution multi-spectral imagery has been obtained for the City of Joondalup in November 2015 and November 2017 and analysed to measure canopy cover and change in vigour of vegetation for the City's key conservation areas. Vegetation vigour relates to vegetation health and is measured using a Vegetation Condition Index (VCI). The vegetation vigour change in Craigie Bushland over a two year period is shown in Figure 17. Some areas of the site have increased in vegetation vigour indicated by blue colour, such as the western side, whilst other areas have demonstrated a decline in vigour indicated by red colour.

Vegetation Cover

In November 2017, the height of the majority of vegetation cover at Craigie Bushland is 0-3m (38%), with approximately 24% of the vegetation having a height of 3-10m and approximately 12% of the vegetation having a height of 10 metres or more, as shown in Figure 18. Since 2015, there has been an approximate 4.5% increase in the total vegetation cover at Craigie Bushland, with each of the above vegetation height categories increasing in cover in 2017.

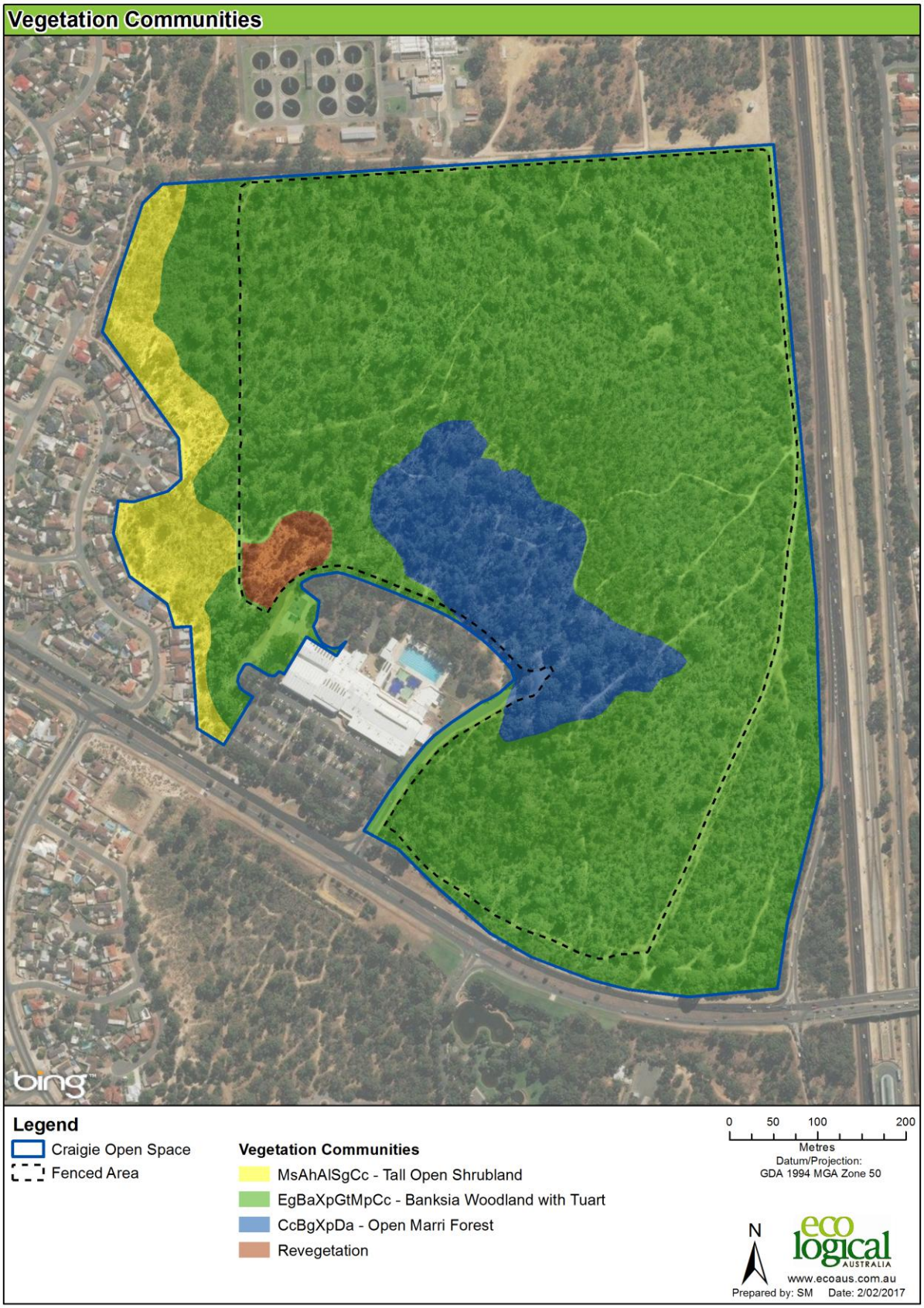

Figure 15: Craigie Bushland Vegetation Communities (sourced from ELA 2017)

Figure 16: Craigie Bushland Vegetation Condition – September 2016 (sourced from ELA 2017)

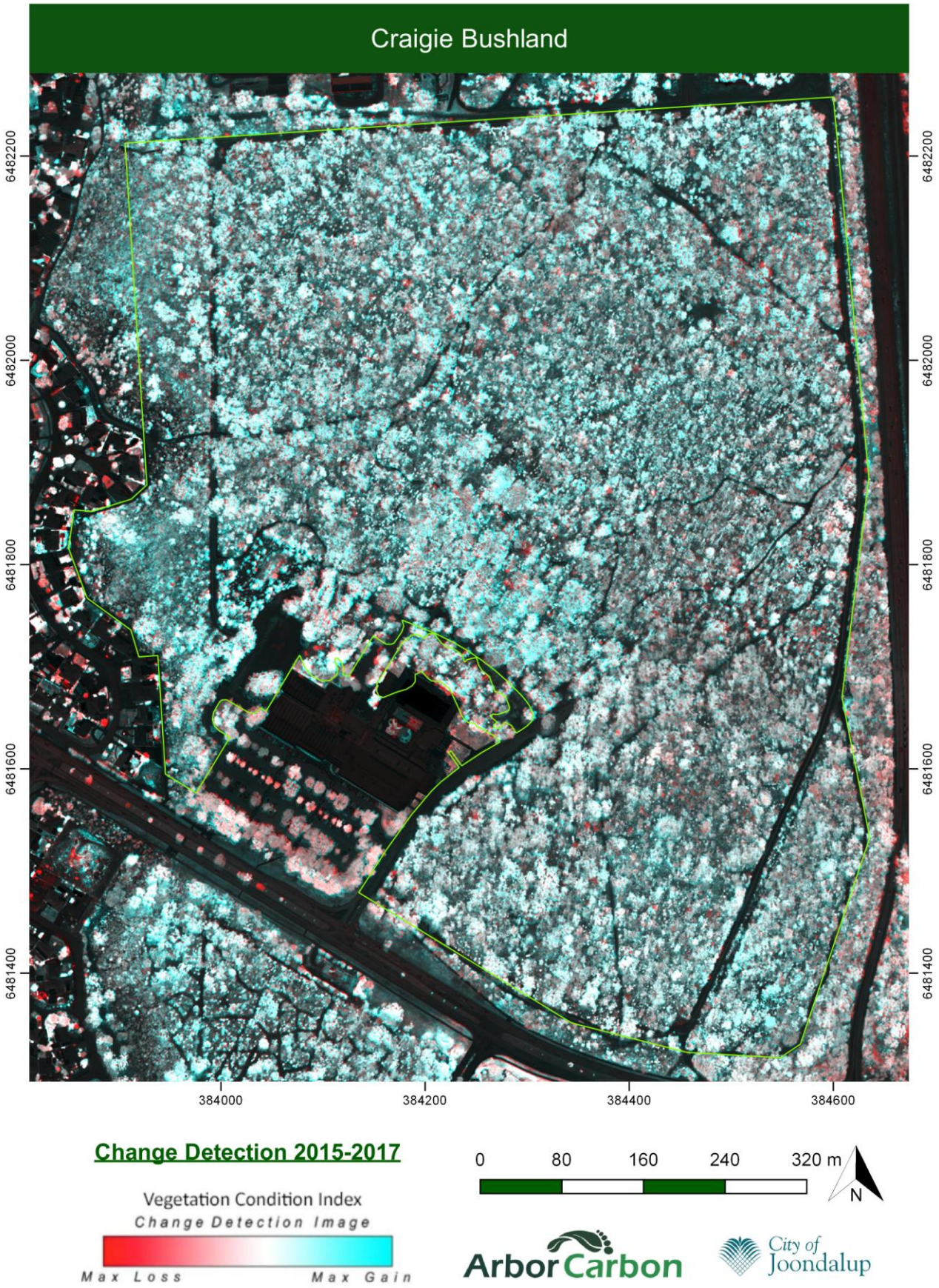

Figure 17: Craigie Bushland Vegetation Condition Change Oct 2015 – Oct 2017 (Arbor Carbon 2018)

Figure 18: Craigie Bushland Vegetation Cover (Arbor Carbon 2018)

3.0 Biodiversity Management

Craigie Bushland supports an array of flora and fauna species, including species listed as priority based on their endangered, threatened and migratory status. The long term protection of biodiversity values within Craigie Bushland is critical to ensure the conservation of this important bushland habitat. The protection and enhancement of biodiversity within Craigie Bushland also benefits the community through the provision of ecosystem services such as:

- the production of oxygen and capture of carbon dioxide;
- noise and air quality regulation;
- cooling of urban environments;
- regulation of freshwater supplies;
- generation and maintenance of topsoil;
- generation and recycling of nutrients;[53]
- control of pests and diseases;
- supporting seed dispersal and pollination;
- providing a genetic store;[54] and
- a number of recreational and cultural experiences.[55]

There are a number of environmental threats that pose a risk to the biodiversity of Craigie Bushland. The key environmental threats at Craigie Bushland addressed in this Section include:

- Weeds;
- Pathogens and disease;
- Management of fauna species;
- Human impacts;
- Access and infrastructure; and
- Bushfire.

Management actions to address the key environmental threats have been established and are discussed in the following sections. The development of a Fauna Management Plan is proposed to address the fauna populations existing at the site.

3.1 Flora

Craigie Bushland is located within the southwest Australia biodiversity hotspot. Southwest Australia, from Shark Bay in the north to Israelite Bay in the south, is one of 35 biodiversity hotspots in the world with over 1,500 endemic plant species occurring in this region.

[53] Burbidge (2004)
[54] Millennium Ecosystem Assessment (2005)
[55] City of Joondalup (2012)

Approximately 30% of the original vegetation extent of this area remains, with habitat loss being primarily due to agricultural and urban expansion and biological factors such as feral animals, weeds and the plant pathogen *Phytophthora cinnamomi*.[56] [57]

Flora surveys enable collection of scientific data related to the occurrence and distribution of flora species and vegetation communities. Information obtained from flora surveys is used as a baseline to monitor the ecological health of flora populations and vegetation communities.[56]

To inform the development of this Plan, the City engaged consultants, Eco Logical Australia (ELA), to undertake a desktop and field flora survey of Craigie Bushland in September, 2016.

The design of the flora survey was aligned with methodology outlined in EPA *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (2004) and the EPA and the Department of Biodiversity, Conservation and Attractions (formerly Department of Parks and Wildlife) *Technical Guide – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* (2015).

The survey was undertaken in accordance with the requirements of the Western Australian (WA) *Environmental Protection Act 1986* (EP Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The survey methodology included the use of 10m x 10m quadrats and opportunistic sampling of species not recorded within the quadrats, to inform a species inventory of the study area. Thirteen quadrats were installed within the study area, following analysis of aerial imagery, review of previous City of Joondalup field survey reports and ground-truthing.

The optimal time for surveying is spring for native flora and winter for weeds. A total of 392.9 mm of rainfall was received in the three months prior to the flora survey in September.[28] This is below the long-term average for the period June – August (448.4 mm), however is significantly higher than was received in 2014 and 2015 for the same period (186.1 mm and 257.2 mm respectively). The rainfall received in 2016 resulted in ideal flora survey conditions on the Swan Coastal Plain.[11]

Previous flora surveys conducted in Craigie Bushland include:

- Allen et al., Craigie Open Space Urban Bushland Management Plan (1994).
- Draft Craigie Public Open Space Management Plan (1999).
- City of Joondalup (CoJ) Natural Area Initial Assessment (NAIA) (2004).
- Natural Area Consulting, (NAC) Flora, Fauna and Fungi Survey Report –Craigie Bushland (2011).

In the 2016 survey, ELA recorded a total of 205 flora taxa at Craigie Bushland. This total included 144 native (70%) and 61 (30%) introduced taxa. The taxa comprised 54 families

[56] Conservation International (2017)
[57] DoEE (no date c)

and 145 genera. The most commonly occurring families were Fabaceae (27 taxa), Asteraceae (18 taxa) and Proteaceae (18 taxa). *Acacia* (Fabaceae) and *Banksia* (Proteaceae) were the most common genera with seven and six taxa respectively.[10]

The number of flora species recorded by Eco Logical is comparable to the number of species recorded in surveys undertaken in Craigie Bushland by Allen et al. (1994) who recorded a total 188 species, with 134 being native and 54 introduced and Natural Area Consulting (2011) who recorded 240 total species, with 171 being native and 69 introduced.

The combination of results from historic flora surveys at Craigie Bushland indicates a total of 311 flora species have been recorded at the site, 215 of these species have been identified as native and 96 have been identified as non-native.

This is representative of the Western Australian Government's Bush Forever Strategy (2000) which reported 235 native taxa and 66 introduced taxa exist within Bush Forever site 303, which is estimated to be more than 85% of the flora expected to occur within the area.

Native Flora

Native flora is an important part of the Craigie Bushland ecosystem. The loss of native plant species can lead to a loss of fauna that depend on flora for food and shelter. A total of 215 native flora species have been recorded at Craigie Bushland (see Appendix 2).

The number of native flora species recorded at Craigie Bushland is comparable to the number of species recorded in similar bushland areas nearby. The diversity is also considered to be very good for remnant vegetation in a built-up urbanised area.[10]

Jacksonia sericea (Waldjumi), a Priority 4 flora species listed by the Department of Biodiversity, Conservation and Attractions has been recorded at Craigie Bushland. This species is fairly common on the Swan Coastal Plain and has been recorded from 85 locations over a range of approximately 100 km, from Wanneroo in the north to Mandurah in the south.[58] Priority 4 species are defined as species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected flora lists for other than taxonomic reasons These species require regular monitoring.[52]

Jacksonia sericea is also listed in Bush Forever as a significant flora species of the Perth metropolitan area due to it being endemic to the Swan Coastal Plain.[4]

An additional six species have been recorded at the site which are considered to be of significance as detailed in Bush Forever as they are rare, poorly known, have restricted distribution and/or other features such as being at the limit of their known range.[4]

Bush Forever significant species recorded at Craigie Bushland include:

- *Allocasuarina lehmanniana* (Dune Sheok);
- *Callitris preissii* (Rottnest Island Pine);

[58] NatureMap cited in ELA (2017)

- *Conospermum triplinervium* (Tree Smokebush);
- *Hibbertia cuneiformis* (Cutleaf Hibbertia);
- *Lechenaultia linarioides* (Yellow Leschenaultia)*;* and
- *Melaleuca cardiophylla (*Tangling Melaleuca)

Although *Conostylis aculeata* (Prickly Conostylis) was recorded at the site, it was not recorded to be the *Conostylis aculeata* subsp. *cygnorum*, which is listed as Bush Forever significant flora. However *Conostylis aculeata* subsp. *cygnorum* has been located within Bush Forever site 303, at Hepburn Heights Conservation Area and also at Bush Forever site 39, Shepherds Bush Reserve in Kingsley.

Bush Forever (2000) reported the *Callitris preissii* at the site is the most northern population along the Swan Coastal Plain. This was also indicated in Allen et al. (1994) which reported the *Callitris preissii*, *Allocasuarina lehmanniana* and *Santalum acuminatum* (Quandong) occurring on site along the western boundary as locally significant due to occuring at the extreme of their range and due to insufficient reservation of Quindalup vegetation types.[59]

Other Bush Forever significant flora listed as occurring within Bush Forever site 303 but not recorded during ELA's 2016 survey of Craigie Bushland include:

- *Sarcozona bicarinata*;
- *Ricinocarpus glaucus*;
- *Grevillea preissii*;
- *Diplopeltis huegelii* subsp. *huegelii;* and
- *Trymalium ledifolium* subsp. *ledifolium*.

Ricinocarpus glaucus and *Trymalium ledifolium* subsp. *ledifolium* have previously been recorded at Craigie Bushland in other survey efforts (not ELA 2016).

Examples of priority and Bush Forever significant species recorded in Craigie Bushland in the ELA 2016 survey is shown in Appendix 3.

Weeds

Weeds are exotic or native species that grow in ecosystems where they did not originally belong. Weeds are commonly introduced and distributed within bushland areas through the dispersal of seed by water, wind and animals such as birds, bushfire, through dumping of garden refuse, and by human or vehicle movement in natural areas.

Weeds have major economic, environmental and social impacts in Australia and can:

- displace native plant species;
- alter ecosystems, nutrient recycling and soil quality;
- harbour pests and diseases;
- increase fuel loads for bushfires;
- impact negatively on fauna and flora and their habitats; and

[59] G.J Keighery (1993), pers comm. cited in Allen et al. (1994)

- compete with native species for space, water and nutrients.[60]

Over 28,000 known alien plant species have been introduced to Australia with approximately 10% now being established in the environment.[61] Garden plants are the main source of Australia's weeds, accounting for 66% of recognised weed species.[60]

A combined total of 96 weed species have been recorded at Craigie Bushland (see Appendix 2), based on flora surveys undertaken by Eco Logical Australia (2016), Natural Area Consulting (2011), CoJ NAIA assessment (2004) and Allen et al (1994).

In the most recent flora survey undertaken by Eco Logical Australia in spring 2016, 61 out of the 205 flora taxa recorded at Craigie Bushland were weed species, this represents approximately 30% of the total species recorded during the survey, which is typical of urban bushland.[10]

From these 61 weed species, 32 have been identified as priority species.

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

- Weed species listed as a Weed of National Significance (WONS) by the Australian Government;

- The weed species is listed as a Declared Pest Plant according to the *Biosecurity and Agriculture Management Act 2007*;

- The weed species is rated as High Priority in regards to its ecological impact and rapid invasiveness according to the Department of Biodiversity, Conservation and Attractions *Draft Weed Prioritisation Process for the Swan Region (2013)*. A high level of ecological impact includes causing acute disruption of ecological processes, dominating and/or significantly altering vegetation structure, composition and function of ecosystems, while rapid invasiveness refers to the rate of spread of a weed in native vegetation, encompassing factors of establishment, reproduction and long distance dispersal (>100 m);[62]

- The weed species is listed as a Pest Plant under the City's *Pest Plant Local Law 2012*; and

- The City of Joondalup has determined that the weed species; poses a major threat to vegetation or the structure of vegetation communities; is likely to lead to a significant outbreak of individual weed species; and/or contribute to a high fuel load (e.g. grasses). These species are classed as priority weeds in the City of Joondalup.

During the 2016 survey, weeds were recorded using density coverage percentages ranging from less than 5%, to 6-30%, 31-60% and more than 61%.

[60] DoEE (no date d)
[61] Groves, Boden and Lonsdale (2005)
[62] DPaW (2013)

The Asteraceae and Poaceae families recorded the highest number of weed species and the highest cover of priority weeds was recorded along the western boundary of the site, primarily adjacent to the residential boundary. *Fumaria capreolata* (Whiteflower Fumitory) was prevalent throughout the southwestern area of the site adjacent to the residential boundary in the over 60% cover range and also recorded occurences in all the other percentage cover categories. Most occurences were recorded along the edges, however a small number of infestations were also recorded within the bushland.

It is possible that some weed species were introduced to the area through illegal garden waste dumping or garden escapees. An example of this may be *Gazania linearis*, which was recorded predominantly on the residential property/bushland interface.

Many weed species are also adjacent to disturbed areas, particularly along the edges of pathways and informal tracks. Priority weeds which predominantly occurred along the edges of paths, tracks and in disturbed areas included *Avena barbata* (Bearded Oat), *A. fatua* (Wild Oat), *Brassica tournefortii* (Mediterranean Turnip), *Euphorbia peplus (*Petty Spurge), *Lactuca serriola* (Prickly Lettuce) and *Pelargonium capitatum* (Rose Pelargonium).

Perrenial Veldt Grass (*Ehrharta calycina*) and Annual Veldt Grass (*E. longiflora*), *Euphorbia terracina* (Geraldton Carnation Weed), *Hypochaeris glabra* (Smooth Cats-ear) and *Lachenalia reflexa* (Cape Cowslip / Yellow Soilder), were widespread throughout the bushland. These species mostly occurred in low densities of <5% throughout, however there were some isolated occurrences where cover was 6-30%, 31-60% or >60%.

Moraea flaccida (Onel-leaf Cape Tulip), a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* was recorded during the 2016 survey. *Moraea flaccida* is also listed a priority weed by the City of Joondalup and the Department of Biodiversity, Conservation and Attractions due to its ecological impact and rapid invasiveness.

Moraea flaccida was recorded in 2016 to be widespread throughout Craigie Bushland in low densities, with all locations at which the species was recorded having <5% cover. The species was noted as having slightly higher cover in the northwestern quarter of the site, however the cover did not exceed 5%. The only area where this species was not recorded was in the vegetation community which occurs on the dune landform along the western boundary.

Previously in 2011, Natural Area Consulting reported the occurrence of *Solanum linnaeanum* (Apple of Sodom) at the site. This species is also listed as a Declared Pest under the *Biosecurity and Agriculture Management Act 2007*. Based on mapping undertaken at the time of survey, it appears only an isolated specimen existed within the southern edge of the site. This species was not recorded in 2016.

Examples of identified priority weeds are illustrated in Appendix 7 and their recommended weed treatment methodology is detailed in Appendix 8, which is used by the City of Joondalup for on ground management of priority weeds.

Current Management Approach

The City's current approach to monitoring, conserving and protecting native flora in Craigie Bushland is outlined below.

Site Assessments

Flora surveys are conducted approximately every 5-10 years in Craigie Bushland to record the occurrence and distribution of flora species and vegetation communities. Information obtained from flora surveys is used to monitor the ecological health of flora populations and vegetation communities on site.

Weed Management

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

- Preventing weed introduction through weed 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.
- Bushfire prevention measures.

Weed Monitoring

The following table outlines the various weed monitoring methods undertaken by the City in Craigie Bushland.

Weed Monitoring Method	**Detail**
Monthly weed inspections	Monthly weed inspections are conducted at Craigie Bushland to establish the extent and distribution of weed species and to identify priority weeds. Monthly weed inspections are used to inform on ground weed management programs.
Annual weed percentage cover monitoring	The City monitors the percentage cover of environmental weeds in Craigie Bushland on an annual basis, measured by three transects within the reserve.
Flora surveys	Flora surveys are conducted every 5-10 years in Craigie Bushland. Flora surveys include mapping of priority weeds and a vegetation condition assessment. The vegetation condition assessment (see Figure 16) also informs weed management as the vegetation in the best condition can be prioritised for weed control. Comparisons will be made between flora surveys to assess site changes every 5-10 years.

The City annually monitors the percentage of weed cover in Craigie Bushland. In 2014 a methodology was established which included taking measurements of weed density from the centre, interior and edges of the reserve. In 2014, 2015 and 2017 the percentage cover of weeds in Craigie Bushland was approx. 7% in each year. In 2016 the percentage cover of weeds was almost double this amount (13%), this could be attributed to the unseasonal late spring rains causing increased weed growth (see Figure 19).

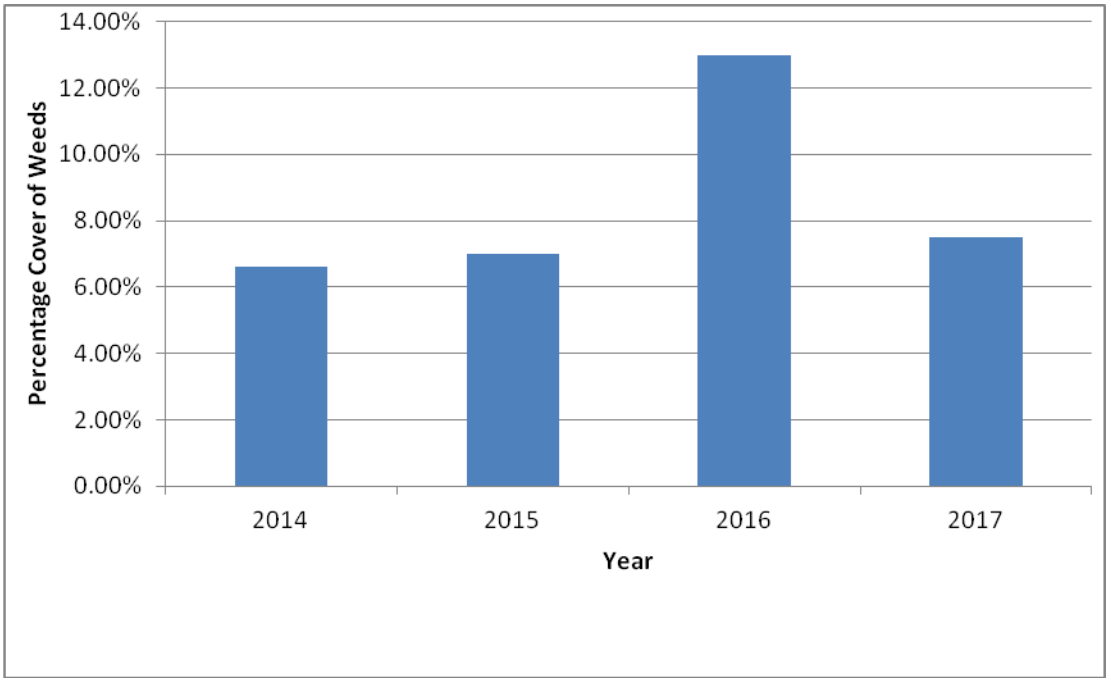

Figure 19: Percentage Cover of Weeds in Craigie Bushland (2014-2017)

In recent years, the City has reported an increase in the presence of the following priority weed species at Craigie Bushland: Perrenial Veldt Grass (*Ehrharta calycina*), Annual Veldt Grass (*E. longiflora*), *Fumaria capreolata* (Whiteflower Fumitory) and *Lachenalia reflexa* (Cape Cowslip / Yellow Solider).

Weed Control

In accordance with the City's Annual Bushland Schedule, on ground weed management in Craigie Bushland occurs through weed spraying and hand weeding methods. In addition to this, the Friends of Craigie Bushland undertake hand weeding activities and contractors are engaged to spray weeds and hand weed. City of Joondalup staff use a weed spraying procedure and conduct weed control trials periodically to evaluate the most effective weed management methods.

The City of Joondalup utilises resources such as the Government of Western Australia's Florabase website, the *Western Weeds, A guide to the Weeds of Western Australia* book or *Southern Weeds and their Control* (DAFWA Bulletin 4744) and stays abreast of latest research and new practices through attending workshops targeted to land managers and liaising with other organisations responsible for weed management.

The *City of Joondalup Weed Management Plan* was developed in 2016 and provides an ongoing strategic approach to weed management across the City to reduce the incidence of weeds.

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 property in the district or the health, comfort or convenience of the inhabitants of the district.

Pest plants are generally highly adaptable, out compete native species and spread easily, leading to quick establishment, particularly after a disturbance event such as bushfire, or through unrestricted access. If pest plants are allowed to establish they have the potential to decrease the City's unique floristic diversity.

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).

Caltrop has become a large problem for many local governments in the Perth metropolitan area and in southwest WA. It is now listed as a prescribed pest plant under the *Local Government Act 1995* in many Council managed areas.[63]

Caltrop has not been recorded at Craigie Bushland.

Community Education

A number of education initiatives are undertaken to raise the awareness of weeds in the community, these include:

- Delivery of Gardening Workshops, promoting the use of native species in residential gardens;
- Development and distribution of brochures including *Environmental Weeds*, *Garden Escapees, Protecting our Natural Areas and Parks* and a series of *Growing Locals* brochures (available in hard copy and on the City's website); and
- Educational workshops for Friends Groups as required.

Revegetation

The City of Joondalup encourages natural bushland regeneration through weed management and conservation fencing, to allow natural regeneration to occur and vegetation to re-establish itself. This is important in maintaining species diversity and populations.

[63] DBCA (2017b)

The City supports revegetation in degraded or completely degraded areas using direct seeding techniques with local provenance seeds and seedlings, as required.

Recommended Flora Management Actions

The City of Joondalup manages weeds throughout its natural areas. To monitor, conserve and protect native flora in Craigie Bushland, the following management actions are proposed:

Action	Details
Flora survey	Undertake a follow up flora survey in spring to supplement previous flora surveys, within 5 years. Make comparisons between flora surveys to assess site changes every 5-10 years. Include an opportunistic survey for fungi during flora surveying.
Investigate planting trees (and vegetation) for habitat	Investigate planting Tuart (*Eucalyptus gomphocephala*) and Marri (*Corymbia calophylla*) trees in Craigie Bushland to provide nesting and roosting habitat and a feeding resource in the long term for Carnaby's Black-Cockatoos.[64] Investigate planting other species of local trees and shrubs (such as Jarrah, *Banksia* and *Hakea* species) to provide opportunities for nesting sites and shelter for fauna.
Revegetation	Support revegetation being conducted in degraded or completely degraded areas using local provenance species, as required.
Monthly weed inspections	Continue monthly weed inspections to establish the extent of weeds and to identify priority weed species.
Annual weed percentage cover monitoring and reporting	Monitor and report on the percentage cover of environmental weeds in Craigie Bushland on an annual basis, using three quadrats.
Weed control	Continue to undertake a coordinated approach to regular weed control by implementing the Natural Areas Annual Maintenance Schedule.
Weed Management Plan	Continue the implementation of the *City of Joondalup Weed Management Plan* to deliver an ongoing strategic approach to reduce the incidence of weeds in Craigie Bushland and across the City.

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.[65] Fungi is an important part of an ecosystem as they recycle and break down organic matter and debris to provide nutrients for plants. Many plants can thrive in poor soils because they have beneficial connections with fungi. The amount of species of fungi present in bushland

[64] DEC (2011a)
[65] Bougher (2009)

can be an indicator of ecosystem health.[66] Fungi also provide food and habitat for animals such as bandicoots and other marsupials as well as invertebrate species.[67]

Research into the importance of fungi is leading to the discovery of how fungi can help reduce the likelihood of the extinction of plants, animals and the loss of ecological communities.[67]

Fungi surveys are important in providing baseline information and to highlight changes in fungi occurrence over time. Undertaking fungi surveys also enables the comparison of ecological data with other natural areas within the City of Joondalup.

Fungi Survey (2016)

In early September 2016 Craigie Bushland was opportunistically surveyed by consultants Eco Logical Australia for fungi. Incidental sightings were also recorded during the flora survey in mid September and fauna surveys in October and December 2016.

The optimum time for fungi surveys is in autumn or winter after substantial rainfall.[68]

Approximately 393 mm of rainfall was received in the three months prior to the fungi survey in September 2016.[28] This is below the long-term average for the period June – August (approx. 448 mm), however it is significantly higher than what was received in 2014 and 2015 for the same period (186 mm and 257 mm respectively). Therefore it was deemed to be suitable conditions to undertake the fungi survey.[11]

The City of Joondalup has reported fungi observations at the site, although no formal records of this have been kept.

A total of nine fungi species were identified within Craigie Bushland during the 2016 survey. Six were saprotrophic (decomposer) fungi that occurred on dead wood, rotting logs and stumps, while the other three were mycorrhizal fungi, which grow in symbiotic relationships with many plants, particularly trees.[69]

Fungi life forms recorded during the survey include gilled, bracket, puff ball and a slime mould. None of the fungi species recorded during the survey are of conservation significance.

Pycnoporus coccineus was the most frequently observed fungi species, recorded opportunistically at eight locations throughout Craigie Bushland. All other taxa were observed only once.

The low number of fungi species recorded is likely due to the weather conditions in the lead up time to the survey. Fungi fruiting times are highly variable in temperate regions with different species responding to various climatic events. Some species fruiting coincides with

[66] Robinson (no date)
[67] DPaW (no date)
[68] Urban Bushland Council (2016)
[69] Fuhrer cited in ELA (2017)

bursts of rainfall or humidity while others fruit following substantial periods of rain. As there was little rain which fell in the days prior to the survey, the conditions may have inhibited several species from fruiting at that time. However, higher long term rainfall (but not above average) than what was received in previous years is believed to have favoured fruiting of species which were detected during this survey.[10]

Previous Fungi Surveys

The Perth Urban Bushland Fungi (PUBF) project started in 2004 as a community initiative in response to growing public interest about local fungi. The aims of the PUBF project were to raise awareness about the role of fungi in the ecosystem, increase the capacity of the community to confidently identify fungi and conduct surveys of fungi in bushland areas to collect baseline data, with the objective of integrating fungi into biodiversity management strategies.[70]

In 2005, Warwick Open Space located approximately 8 km southeast of Craigie Bushland was assessed as part of the PUBF project and recorded 47 species of fungi.[70]

In 2010 the PUBF project undertook a fungi walk in five selected urban bushland areas, which included Craigie Bushland. Thirty five attendees participated on the walk and a cumulative total of 297 fungi were recorded by the PUBF project during their efforts in 2010.[71]

An incidental fungi survey was undertaken by Natural Area Consulting in August and September 2011 at Craigie Bushland, resulting in approximately 26 species, however eight species could not be identified. Natural Area Consulting conducted a comparison against three other reserves located in close vicinity to Craigie Bushland, these included Warwick Open Space, Trigg Bushland and Mindarie Foreshore Reserve to determine if the fungi species encountered at Craigie Bushland were common within other nearby reserves. Natural Area Consulting reported that seven species recorded at Craigie Bushland were not listed as occurring within these nearby reserves, indicating the potential number of fungi that could occur in the region may be marginally higher than expected.[18]

In September 2012, the City engaged the same consultants (ELA) to undertake a fungi survey at Warwick Open Space. Three species of fungi were recorded during this survey.[72]

In August and September 2013, the City engaged consultants, Syrinx Environmental PL, to undertake a fungi survey at Hepburn Heights Conservation Area (part of Bush Forever site 303), located 3 kms south of Craigie Bushland. Fourteen species of fungi were recorded during this survey.[73]

The list of fungi recorded in Craigie Bushland in 2016 including photographic examples are provided in Appendix 12.

[70] Perth Urban Bushland Fungi Project (2005)
[71] Urban Bushland Council (2010)
[72] City of Joondalup (2013a)
[73] City of Joondalup (2015a)

Current Management Approach

The City of Joondalup monitor fungi in Craigie Bushland through recording incidental sightings of fungi species during the City's 5-10 yearly flora surveys.

Recommended Fungi Management Action:

To monitor fungi health in Craigie Bushland, the following management action is proposed:

Action	Details
Fungi survey	Continue monitoring and reporting on fungi health during flora survey activities.

3.3 Plant Diseases

Organisms such as fungi, bacteria and viruses that cause plant diseases are known as pathogens. Whilst some pathogens are naturally occurring within the soil, others have been introduced to the environment through the movement of plant materials and soils.[74]

The symptoms produced by plants that are affected by pathogens vary depending upon the species of pathogen, host species, environment and climatic conditions. Some pathogens can live in the soil for a long period without impacting the health of plants, whilst others can cause rapid death or result in a slow, perennial decline in health.[75]

Phytophthora dieback refers to the disease caused by the introduced plant pathogen *Phytophthora cinnamomi*. While there are numerous species of *Phytophthora*, the most aggressive species affecting native plants throughout southwestern Western Australia is *Phytophthora cinnamomi*. Previously *Phytophthora* dieback was commonly referred to as 'Jarrah dieback' as Jarrah (*Eucalyptus marginata*) trees were one of the first plant species observed to be impacted by *P.cinnamomi*.[76] However as the pathogen has become more widespread, up to 22% of plant species in southwestern Western Australia are likely to be susceptible to the pathogen,[77] thus the term *Phytophthora* dieback is most appropriate when describing *P.cinnamomi.*[78]

Whilst *Phytophthora cinnamomi* is the most common species of *Phytophthora* dieback within Western Australia, other species of *Phytophthora* are common in urban areas of Perth.

Pathogen sampling of the City's natural areas and parks has been conducted in accordance with the *City of Joondalup Pathogen Management Plan 2013-2016* and has recovered a number of pathogen species, including:

[74] City of Joondalup (2013b)
[75] Arbor Carbon (2014)
[76] DWG (no date)
[77] CPSM (2012)
[78] Arbor Carbon (2015)

- *Phytophthora alticola*
- *Phytophthora arenaria*
- *Phytophthora asparagi*
- *Phytophthora boodjera*
- *Phytophthora multivora*
- *Phytophthora nicotianae*
- *Pythium* species (*irregulare, heterothallicum, mamillatum* and *spiculum*)
- *Armillaria luteobubalina* (Honey Fungus).
- Other weak pathogens which do not require management.

Phytophthora nicotianae was previously recorded within Craigie Bushland and *Phytophthora multivora* has been recorded in close proximity to the site.

Phytophthora nicotianae has been identified in herbaceous and woody plants used in agriculture and horticulture, although it is now considered established within natural ecosystems in Western Australia. The pathogen is widely found within nursery stock and therefore has a higher probability of infecting urban parks and reserves, rather than natural areas due to the introduction of nursery stock and soil through planting programs and the regular use of machinery and vehicles. *Phytophthora nicotianae* is associated with large lesions at the base of *Eucalyptus* trees and causes collar rot of *Grevillea* species. *Phytophthora nicotianae* has also been identified as causing fine root death of numerous other native plant species.[75]

Phytophthora multivora is a common pathogen in urban areas of Perth, particularly along the inland dune systems. It is widespread throughout the southwest of Western Australia with a similar distribution to *Phytophthora cinnamomi*. *Phytophthora multivora* is named due to its wide host range, including *Banksia* and *Eucalyptus* species. *Phytophthora multivora* can cause rapid death of plants or a slow, perennial decline in the health of the tree crown and is commonly associated with individual spot deaths and areas of tree decline.[75]

Botryosphaeriaceous fungi are considered as weak dormant pathogens meaning they will exist within healthy trees without causing disease, unless the tree experiences stress such as drought, wounding, extreme climatic events or insect predation. These fungi have commonly been confirmed across the City's parks and natural areas through pathogen sampling and have in most cases been associated with distinct lesions causing decline or death of individual plants. [79]

Armillaria luteobubalina has also been identified within a number of areas within the City of Joondalup. *Armillaria* is a soil-borne fungus that causes root rot of a wide variety of plants including many species of native flora. The fungus is native to Australia and can also 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, as shown in Figure 20. 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.[75]

[79] Arbor Carbon (2016)

At present there is no reliable mechanism for the complete eradication of *Phytophthora* species and the control of *Armillaria luteobubalina* is both expensive and labour intensive.[82]

Figure 20: Fruiting Bodies of *Armillaria luteobubalina* (sourced from CoJ 2013a)

Current Management Approach

The City of Joondalup has previously developed a *Pathogen Management Plan 2013-2016* to protect native vegetation and ecosystems by establishing the level of risk for areas to be infected by pathogens, prioritise 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 further developed *Pathogen and Weed Hygiene Guidelines* and *Purchasing of Landscaping Materials Guidelines* to minimise the spread of pathogens. The City of Joondalup is currently developing a *Pathogen Management Plan 2018-2028.*

The following table outlines findings from observations and pathogen sampling conducted at Craigie Bushland.

Sampling Date	Pathogen Sampling Results
March 2004	***Phytophthora nicotianae* was identified** Soil and tissue sampling of vegetation at Craigie Bushland resulted in the presence of *Phytophthora nicotianae* from an individual *Banksia* specimen. It was reported that an old tree stake was found in the ground where the *Phytophthora nicotianae* was identified suggesting the pathogen may have been introduced through revegetation activities. The site was re-sampled to determine if any other *Phytophthora* species were also present, however the proceeding sampling did not recover any *Phytophthora* species, therefore it is possible that the *Banksia* specimen initially sampled may have been the only affected plant.[80]
May 2014	**Negative *Phytophthora* results** No *Phytophthora* species were recovered through laboratory sampling, however symptoms of vegetation decline were observed in species susceptible to *Phytophthora*. However, *Holocryphia eucalypti* and *Pestalotiopsis* sp. fungi belonging to the latent pathogen family *Botryosphaeriaceae* and other saprophytic fungi (meaning they survive on dead organic material) were identified. Some older Banksia trees within Craigie Bushland display symptoms of *Botryosphaeriaceous* fungi.[75]
September 2016	**Signs of Health Decline** The Craigie Bushland flora survey found that some species were showing signs of health decline, in particular *Banksia*, Jarrah and Marri, which are susceptible to disease/pathogen attack. It was also further reported that tree deaths may be a result of altered bushfire regimes where bushfires have occurred in an inappropriate season or frequency.
January 2017	**Negative *Phytophthora* results** No *Phytophthora* species were recovered through laboratory sampling, however symptoms of vegetation decline were observed in species susceptible to *Phytophthora*.[81]

Additionally, in 2012 an assessment of the Water Corporation land located approximately 600m from the northern boundary of Craigie Bushland confirmed the presence of *Phytophthora multivora.* Whilst this occurrence was not within Craigie Bushland, the close vicinity poses a risk of pathogen spread to the site.[82]

Given the previous record of *Phytophthora nicotianae* within Craigie Bushland and the presence of *Phytophthora multivora* in close proximity to the site, it is important the City of Joondalup manages the threat of pathogens in Craigie Bushland.

[80] Dunne for the DWG (2004)
[81] ArborCarbon (2017)
[82] Ecologica Environment (2013)

Recommended Pathogen Management Action:

To prevent pathogen and weed spread and protect biodiversity values at Craigie Bushland, the following management actions are proposed:

Action	Details
Pathogen Management	Continue to implement the recommendations from the *City of Joondalup Pathogen Management Plan* that are applicable to the management of Craigie Bushland, including implementation of relevant operational and procurement guidelines.
Education and Training	Liaise with key stakeholders working in Craigie Bushland about hygiene practices and training.

3.4 Fauna

Fauna surveys document the occurrence, distribution and population of fauna species. Information from fauna surveys is used as a baseline to monitor the health of fauna species.

The City engaged consultants, Eco Logical Australia (ELA), to undertake a fauna survey of Craigie Bushland in October and December 2016. As part of the fauna survey, ELA reviewed data from previous surveys provided by the City of Joondalup to inform their study.

The fauna survey design was aligned with *EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (2004), the principles outlined in *EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (2002), the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010) and the *EPBC Act referral guidelines for three Threatened Black Cockatoo species* (2012).

The fauna survey method included a variety of sampling techniques, both systematic and opportunistic. Systematic trapping was conducted over two phases with four nights in October and four nights in December at six trapping transects. Two trapping transects were established outside the fenced area, and four trapping transects were established within the fence. The first phase (October 2016) of the fauna survey used standard trapping methods including pitfall, funnel, Elliott, cage and motion camera traps, whilst the second phase (December 2016) used pitfall, funnel and motion camera traps.

Other fauna survey methods included a bird census at each transect, a bat survey, hand searches, opportunistic sampling and observations and a nocturnal search (over one night).

The optimum season for fauna detestability in the south west bioregions is spring. Trapping periods of 5 to 7 nights are recommended to show species diversity, richness trends and provide reliable indications of species composition and abundance data.

The following conservation significant species were recorded in Craigie Bushland during the 2016 fauna survey:

- Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris)*, listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act).
- Rainbow Bee-eater (*Merops ornatus*), listed as Migratory and protected by International Agreement under *Wildlife Conservation Act (1950).*
- Quenda (also known as Southern Brown Bandicoot) (*Isodon obesulus fusciventer*), listed as a Priority 4 species (Rare, Near Threatened and other species in need of monitoring) by the Department of Biodiversity, Conservation and Attractions.

A number of other fauna studies have been for Craigie Bushland. These include:

- Allen et al., Craigie Open Space Urban Bushland Management Plan (1994).
- Draft Craigie Public Open Space Draft Management Plan (1999).
- City of Joondalup (CoJ) Natural Area Initial Assessment (NAIA) (2004).
- Birds Australia through the Perth Biodiversity Project, Craigie Open Space Survey Report (2006).
- Natural Area Consulting, Flora, Fauna and Fungi Survey Report –Craigie Bushland (2011).
- McLeod and Hudson, Craigie Bushland Native Animal Reserve Camera Monitoring (2015).
- Other historic records and anecdotal reports which refer to fauna within Craigie Bushland are incorporated and these are referenced accordingly within this Plan.

It should be noted the *Draft Craigie Public Open Space Draft Management Plan* (1999) was developed by the City of Joondalup in partnership with the Friends of Craigie Bushland at the time.[83,84] The document was not finalised and still remains in draft form, thus the information is not verified.

The document utilises the results of the ecological surveying undertaken by Allen et al. (1994) to inform the *Craigie Open Space Urban Bushland Management Plan,* however makes further references to fauna observations which have been used within this Plan.

The combination of results from the 2016 fauna survey undertaken by Eco Logical Australia and previous fauna assessments indicate the following species inhabit Craigie Bushland –

- Five native mammals;
- 36 native birds (including 2 species of conservation significance);
- 17 native reptile species; and
- An estimated 201 native invertebrates.

In addition, the following non-native fauna have been identified at Craigie Bushland –

- Six mammals (including the domestic dog and domestic/feral cat);

[83] Cherie Wood (2002) Verbatim interview, CoJ (2014)
[84] Wanneroo Times Newspaper (2000)

- Nine birds (includes species that are outside their natural geographic range and have become naturalised in the Perth region); and
- Four known invertebrate species.

The full fauna species list is provided in Appendix 9.

Fauna Habitat

Craigie Bushland provides an important area of remnant fauna habitat within the City of Joondalup. The vegetation community and habitat resources it contains support a relatively diverse and species rich assemblage of native birds and reptiles.[10] Craigie Bushland is a valuable regional ecological link and is also considered to have high local conservation value within the City.

The vegetation condition at Craigie Bushland ranges from "Excellent" to "Completely Degraded."

Areas along tracks and path edges, boundaries and cleared areas are susceptible to high levels of weed invasion. In some small scale areas, weed invasion has significantly altered the structure of remnant vegetation through displacing native species. This was evident particularly along the southwest boundary adjacent to the residential properties.[11]

The different vegetation communities within Craigie Bushland provide foraging and nesting habitat for a diversity of nectar and seed eating birds, as well as habitat for the mammals species present at the site and a range of reptiles and invertebrates. The larger trees such as the Eucalyptus *gomphocephala* (Tuart), *Eucalyptus marginata* (Jarrah), *Allocasuarina fraseriana* (Sheok) and *Corymbia calophylla* (Marri) provide foraging, roosting and nesting opportunities for birds whilst also providing canopy cover in the form of shelter to ground dwelling animals within Craigie Bushland. The mid and lower shrub vegetation such as *Xanthorrhoea preissii* (Grass Tree), *Santalum acuminatum* (Quandong), *Hibbertia hypercoides* (Yellow Buttercups) also provide shelter and nesting opportunities whilst species such as *Desmocladus asper* and *Lomandra maritima* which form the herbaceous layer are vital habitat for reptiles and invertebrates.

The 2016 ecological survey described three main vegetation communities within Craigie Bushland, these are referred to as *Banksia* woodland with Tuart, Open Marri Forest and Tall open shrubland associated with the Quindalup Dune System on the western side of the bushland.

Vegetation, trees, leaf litter, soil, fungi, sticks, logs and dead trees at Craigie Bushland provide habitat for fauna to nest, shelter, forage and roost.

Carnaby's Black-Cockatoos Habitat

The vegetation community throughout the study area provides high quality foraging habitat for Carnaby's Black-Cockatoo (Carnaby's), with Jarrah, Marri, *Banksia, Grevillea* and *Hakea* species all known species utilised by the Carnaby's.[11]

Evidence of chewed *Banksia* cones and observations of foraging by the Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris)* were recorded at Craigie Bushland during the 2016 survey. The diversity of flora species present at Craigie Bushland, particularly those belonging to the Proteaceae family, provide excellent foraging habitat for these Cockatoos.[10, 85]

The large Tuart (*Eucalyptus gomphocephala*) trees at Craigie Bushland provide potential breeding and roosting habitat for Carnaby's Black-Cockatoos. During the 2016 survey, Carnaby's Black-Cockatoos were observed perching and calling in Tuart trees. Tuarts take 200 years to develop hollows that are a suitable size for nesting.[86] Many Tuart trees on the Swan Coastal Plain have died in the past 20 years due to stress factors such as the lowering of the water table, insect infestations and fungal pathogens.[87] Planting of Tuart trees in Craigie Bushland may provide habitat for nesting and roosting in the long term for Carnaby's Black-Cockatoos.

Carnaby's Black-Cockatoos were also observed perching in dead stags (old, dead trees with no foliage). There are a number of dead or declining mid storey and upper storey trees at Craigie Bushland. These large trees (dead or alive) provide habitat for nesting, shelter and protection for fauna and should be retained on site.

Whilst no known breeding has been observed at Craigie Bushland, a known roost site occurs just to the south of Craigie Bushland within the Pinnaroo Valley Memorial Park. There has been an increase in recent years of Carnaby's Cockatoos breeding on the Swan Coastal Plain.[10]

In 2015, students at Edith Cowan University, Joondalup campus located approximately 6 km north of Craigie Bushland, discovered a pair of Carnaby's Black-Cockatoos nesting in a hollow of a dead tree in a car park. It was the first recorded breeding site of the Carnaby's Black-Cockatoos in Perth since European settlement.[88] Subsequently in 2016, ECU installed several artificial nesting boxes, resulting in five nesting pairs of Carnaby's and a number of chicks have now been record to hatch.[89]

This experience has proven the importance of retaining large old and also dead trees in urban areas for their habitat values, as this can support breeding of native species and subsequently assist in their long term survival.[88]

Forest Red-tailed Black Cockatoo Habitat

Whilst not observed at the site, the Commonwealth EPBC Act listed Vulnerable Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) is considered likely to occur at Craigie Bushland based on known local occurrence[90] and the abundance of suitable foraging habitat

[85] DEC (2011b)
[86] DEC (2010)
[87] Matusick, Hardy and Ruthrof (2012)
[88] ECU (2016a)
[89] ECU (2016b)
[90] DPaW cited in ELA 2017

present, such as Marri and Jarrah nuts which provide a common local food source for the species on the Swan Coastal Plain.[10]

Rainbow Bee-eater Habitat

The conservation significant Rainbow Bee-eater has also been recorded at Craigie Bushland. Rainbow Bee-eaters have been observed perching and foraging in close proximity to the Quindalup dunes located in the west of the site. Craigie Bushland provides an abundance of food during the spring-summer breeding period when the Rainbow Bee-eater migrates to the southwest of WA.[10] Disturbed areas such as bare sand or along the boundaries of lawned areas where there is a clearing provide potential nesting sites for this species. Rainbow Bee-eaters usually build a nest located closeby to mature trees to allow for perching to watch over nests. [10] [91] Although an opportunistic search for Rainbow Bee-eater nesting burrows during the 2016 fauna survey did not result in any findings, Rainbow Bee-eaters are locally known to nest in close vicinity to Craigie Bushland.

Quenda Habitat

In 2013, a population of 46 Quenda (42 from Ellen Brook Nature Reserve and four from Twin Swamps Nature Reserve) were translocated into the fenced area of Craigie Bushland.[1]

Quenda are one of the few remaining native mammals that still persist within remnant habitat on the Swan Coastal Plain.[92]. They are considered ecosystem engineers capable of turning over nearly 4 tonnes of soil per individual per year and their continued persistence in landscapes may be important for maintaining ecosystem processes.[93]

Quenda are omnivores and forage for subterranean food such as fungi and invertebrates.[94] Craigie Bushland, with its dense understorey provides plenty of foraging habitat for Quenda. Quenda have established a successful breeding population within the fenced area and appear to be successfully breeding outside the fenced area also.[10]

Invertebrate Habitat

The Quindalup dune shrublands contain relatively high densities of *Lomandra hermaphrodita* and *Lomandra maritima*, the food source for the priority fauna species, the Graceful Sun Moth (*Synemon gratiosa*). This species has previously been recorded within Craigie Bushland[11] and also at Hepburn Heights Conservation Area,[95] (located approximately 3 km south of Craigie Bushland), although no Graceful Sun Moths were observed during surveys in spring 2011 and 2016. However this is expected as the species is only detectable for a relatively short period of time in autumn (usually March) each year.[96]

[91] DoEE (no date e)
[92] Wilson et al. (2012)
[93] Valentine et al. (2013); Valentine et al. (2017)
[94] DEC (2012); VanDyck and Strahan (2008)
[95] ELA (2016)
[96] Bishop et al. cited in ELA 2017

Craigie Bushland provides an extent of very good quality remnant native bushland habitat with a rich diversity of flora species present.[11] This in turn is believed to be supporting a high diversity of invertebrate species which is reflected by the number of invertebrates recorded opportunistically during the survey and also by the fairly diverse reptilian assemblage present.

Ecological Linkages

The *Draft Craigie Public Open Space Management Plan* (1999) reported the original mammal fauna of the Swan Coastal Plain consisted of 35 species and has declined to 15 species in recent years.[97] In order to protect the existing fauna populations within Craigie Bushland and regionally across the Swan Coastal Plain, ecological linkages must be maintained.

Naturally connected landscapes and ecosystems are generally healthier, protect a diversity of species, provide pathways for species movement and can store carbon more effectively than degraded landscapes.[98]

Craigie Bushland forms part of Bush Forever site 303, encompassing approximately 140 ha of remnant bushland.[3] Craigie Bushland is situated between two north-south ecological corridors and forms a direct ecological link to nearby Bush Forever sites containing remnant bushland including the Beenyup Waste Water Treatment Plant (part of Bush Forever site 303), which connects to the Woodvale Nature Reserve (managed by the DBCA; Bush Forever site 407), Yellagonga Regional Park (Bush Forever site 299) and Neerabup National Park in the north. The southern part of the ecological corridor connects Lilburne Park and Hepburn Heights Conservation Area and Pinnaroo Valley Memorial Park (also part of Bush Forever site 303). Both ecological corridors have main arterial roads dividing the landscape, as shown in Figure 21.

Craigie Bushland is situated proximally to other important City of Joondalup Major Conservation Area local bushland remnants, namely Hepburn Heights Conservation Area in the south and Shepherds Bush Reserve in the southeast. It provides habitat connectivity for many species, particularly woodland birds and this is important for the continued presence of a range of local bird species, including the Carnaby's Black-Cockatoo. The occurrence of the Carnaby's Black-Cockatoo and the Rainbow Bee-eater highlight the foraging and potential breeding value of the study area.[10]

[97] How and Dell cited in Draft Craigie Public Open Space Management Plan (1999)
[98] NWCPAG (2012)

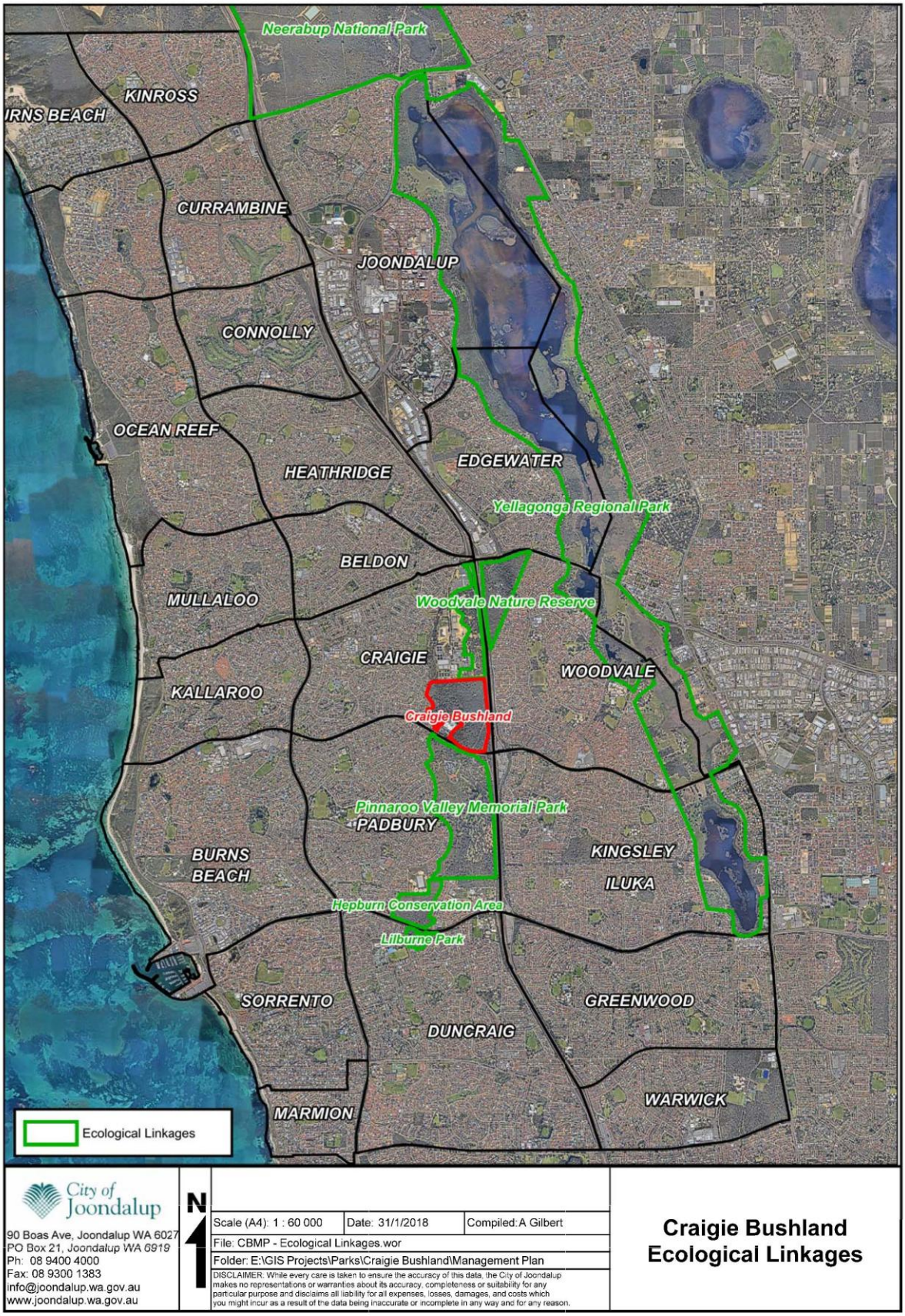

Figure 21: Ecological Linkages near Craigie Bushland

Native Fauna

Fauna and flora are interconnected in complex relationships with each other and with factors such as soil, water, climate and landscape. The decline of native fauna can cause loss of plant species and changes to ecological communities.[60] Alternatively, the decline of native flora can cause loss of fauna species.

Mammals

Five native mammals have been recorded at Craigie Bushland, Gould's Wattled Bat (*Chalinolobus gouldii*), Common Brushtail Possum (*Trichosurus vulpecula*), Western Brush Wallaby (*Macropus irma*), Western Grey Kangaroo (*Macropus fuliginosus*) and Quenda (*Isodon obesulus fusciventer)*.

Gould's Wattled Bat

Gould's Wattled Bat (*Chalinolobus gouldii*) is one of approximately 75 species of bat in Australia. These native mammals fall into two main groups: the megabats and the microbats. Two groups of bat occur in Western Australia, flying-foxes (megabats) and insectivorous bats (microbats). The Gould's Wattled Bat is a common microbat in the Perth area. Bats can be useful for pest control, feeding on moths, beetles, mosquitoes, invertebrate larvae, flying ants and other invertebrates.[99]

The Eucalypt and *Callitris preissii* (Rottnest Island Pine) trees provide suitable breeding and roosting habitat for Gould's Wattled Bat.[100] Although the size of the bushland at Craigie Bushland is limited, the high mobility and the known occurrence of the species across the metropolitan area, indicate the Gould's Wattled Bat may utilise the habitat at Craigie Bushland for breeding and foraging.[10]

Common Brushtail Possum

Common Brushtail Possum *(Trichosurus vulpecula)* was recorded within the fenced area via motion cameras during the 2016 survey. It is unclear whether the footage captured via the motion cameras depict two separate individuals or the same individual moving across the site. Given the species' relatively small home range sizes (1-15 ha).[10] Monitoring undertaken utilising motion cameras by the Friends of Yellagona (for the Friends of Craigie Bushland) in 2014 and 2015 has also recovered the presence of the Common Brushtail Possum.[101] It is likely the fence is benefiting the Common Brushtail Possum due to the removal of predation risk.

The discovery of Common Brushtail Possum is considered locally significant, as this species did not appear on any database searches or in the literature review undertaken by consultants Eco Logical Australia during their 2016 survey. Records of this species within

[99] DEC (2007)
[100] Burnett Mary Regional Group (2018)
[101] McLeod and Hudson (2015)

the northern metropolitan area are rare, however evidence of the species was recorded in 2011 in Yellagonga Regional Park.[102]

Western Brush Wallaby

Western Brush Wallaby *(Neomacropus irma)* is listed by the Department of Biodiversity, Conservation and Attractions as a Priority 4 species (Rare, Near Threatened and other species in need of monitoring) and is uncommon in the Perth region. [63, 103]

Allen et al. (1994) indicated the Western Brush Wallaby occurred commonly in Craigie Bushland. However it was also reported the population of both the Western Brush Wallaby and Western Grey Kangaroo appeared small and highly susceptible to further habitat modification, in particular noting on several occasions unleashed dog exercising resulting in the pursuit of both kangaroos and wallabies was observed, resulting in stress to the animal and the potential predation of juveniles. Recreational use of vehicles was also reported to be a threat to the population due to the high speed the vehicles were observed to be travelling.[48]

There are no recent records of the Western Brush Wallaby at Craigie Bushland.

Western Grey Kangaroo

Western Grey Kangaroos (*Macropus fuliginosus*) are known to utilise both the fenced and unfenced areas of Craigie Bushland. Due to the large resident population of Western Grey Kangaroos at Pinnaroo Valley Memorial Park, it is likely that some individuals use the unfenced portions as habitat linkages to move between areas of bushland.[10]

During feral animal control investigations in 2013, two kangaroos were observed in the fenced area. Only one individual was observed within the fenced area during the 2016 fauna survey[10] and through monitoring undertaken by the Friends of Yellagonga (for the Friends of Craigie Bushland) in 2014-2015,[101] however up to three individuals have been observed within the fenced area by the City of Joondalup, including a young joey in 2017.

The Western Grey Kangaroo was reported to be abundant within Craigie Bushland by Allen et al. (1994). The *Draft Craigie Public Open Space Management Plan* (1999) stated a mob of 12 kangaroos inhabit Craigie Bushland and the adjoining bush at the Beenyup Wastewater Treatment Plant, often spending the days in the quieter compound of the Beenyup Treatment Plant and the nights at Craigie Bushland.

It is unlikely the Western Grey Kangaroos existing within the enclosed area can move in and out of the fenced area without assistance, such as a breach in the fence or a gate left open. This could have a number of negative impacts on the individuals within the fenced area. If breeding is occurring within the fenced area, the *carrying capacity could be exceeded,

**Carrying capacity refers to the maximum population size (number of individuals) supported indefinitely by a given environment (without causing permanent damage) (Begon et al. (1990)).*

[102] Syrinx and Bamford Consulting Ecologists (2011)
[103] Government of WA (2018)

which could cause ecological impacts such as over grazing of native species and new shoots, and dispersal of weeds. It also poses threats to the welfare of the animals in the event of a bushfire and issues relating to inbreeding.[10]

It is difficult to ascertain if the kangaroos within the fenced area may be feeding on non native or native flora, as the impact of grazing does not appear to be significant. Grazing on native species may have adverse impacts on natural recruitment, regeneration and surrounding vegetation. Whilst grazing on non native species may benefit surrounding native vegetation, resulting in an ecological benefit due to weed reduction. As kangaroos are known to graze mostly on grasses, this could also consequently result in a reduction of the bushfire fuel load within Craigie Bushland.

Quenda (Southern Brown Bandicoot)

The DBCA have listed the Quenda (otherwise known as the Southern Brown Bandicoot) (*Isoodon obesulus fusciventer)* as a Priority 4 species (Rare, Near Threatened and other species in need of monitoring). A closely related sub species, *Isoodon obesulus obesulus* referred to as the Southern Brown Bandicoot (eastern) or Southern Brown Bandicoot (southeastern) occurs in New South Wales, South Australia and Victoria. *Isoodon obesulus obesulus* is listed as Endangered under the Commonwealth EPBC Act.[104] Threats to Quenda include loss of habitat, predation by introduced predators (e.g. European Red Fox and cats) and fire in fragmented habitat.[105] In addition, they appear to be vulnerable to spatial isolation.[106] Although Quenda were once common throughout southwest Western Australia, due to a combination of habitat loss and predation by introduced predators, they are now absent from many areas, or persist in low numbers.

Home range estimates for Southern Brown Bandicoot species (*Isoodon obesulus)* vary from 0.5 – 6.0 ha and although these animals are typically solitary, they often have overlapping home ranges.[107] While searching for underground food Quenda create small scale disturbances in the form of foraging pits in the soil and have been identified as one of Australia's persisting digging mammals; with its digging activities implicated in a range of potential ecosystem services.[108] Quenda have a backward opening pouch which assists with reducing soil falling onto their pouch young during digging activities. Eight teats are arranged in an incomplete circle and the pouch can accommodate one to six (usually two to four) young in a litter.[105, 109]

The Quenda that were translocated into Craigie Bushland originally inhabited Nature Reserves that are considered strongholds for the Western Swamp Tortoise (*Pseudemydura umbrina*; also referred to as Western Swamp Turtle).[1] The turtle species is listed as Critically Endangered under the Western Australian State *Biodiversity Conservation Act 2016* and the Commonwealth EPBC Act and is on the International Union for Conservation of Nature and Natural Resources (IUCN) Global Red List of Threatened Species.[2] Additionally the Western

[104] DoEE (2018)
[105] DEC (2012)
[106] Ramalho et al. (2018)
[107] Broughton and Dickman (1991)
[108] Valentine et al (2013) and Valentine et al (2017)
[109] Van Dyck and Strahan 2008

Swamp Tortoise is considered the most critically endangered reptile in Australia[110] and has the smallest surviving population of any Australian reptile.[2] The Western Swamp Tortoise inhabits shallow, ephemeral winter-wet swamps on the Swan Coastal Plain, most of which have been cleared or drained for agricultural purposes and urbanisation.[2] In addition to habitat loss, the turtles are considered vulnerable to predation from introduced predators, such as the European Red Fox (*Vulpes vulpes*). To protect remaining wild populations of the turtle from predation by the European Red Fox, predator proof fencing was installed around sections of Twin Swamp and Ellenbrook Nature Reserves.[2]

An unintentional consequence of the construction of the predator proof fence was the protection of the existing Quenda population from fox predation within these reserves. Quenda have also been implicated in predating on the turtles[2] and while digging for food, Quenda may disturb the turtle nests or predate the turtle eggs.[111] As part of the Western Swamp Tortoise Recovery Plan, a conservation management action involves trapping and translocation of Quenda from Ellen Brook and Twin Swamps Nature Reserves to alternative suitable habitat. Through this program, Quenda have been translocated to a number of sites throughout the Swan Coastal Plain and in 2013, an opportunity arose for the City of Joondalup to receive a Quenda as part of the translocation process, with 46 Quenda being translocated into Craigie Bushland.[1]

Since the Quenda were translocated into Craigie Bushland the University of Western Australia (UWA) in partnership with the DBCA undertake quarterly monitoring (four times per year) of the Quenda population for research purposes as there is limited information on the success of translocated Quenda populations. In addition to population studies, a number of research projects are examining the role of Quenda as ecosystem engineers at Craigie Bushland.[112] These studies have included investigation into the interaction of Quenda on the surrounding ecosystem, the potential changes to ecosystem processes caused by the digging actives of Quenda (e.g. changes in leaf litter loads)[113] and what may be attracting Quenda to Western Swamp Tortoise nests.[111] It is envisaged, from 2018 onwards the UWA may reduce its monitoring efforts to twice per year.[112]

The University of Western Australia have commenced investigating population analysis and carrying capacity of the Quenda at Craigie Bushland. Twenty two of the original translocated Quenda from 2013 have been recaptured at Craigie Bushland, whilst 113 new individuals have been captured during monitoring activities. Statistical analysis is still underway, but preliminary results indicate that there is likely between 80-120 quenda residing in Craigie Bushland. All individuals captured have been healthy, and 42% of females captured have contained pouch-young.

Although enclosed (fenced) urban bushland areas with successful feral animal control provide refugees for native fauna populations which may facilitate successful breeding and subsequent population growth, there are also a number of risks associated with this, that apply to Craigie Bushland.

[110] Government of WA, Perth Zoo (no date)
[111] Bowler unpub. UWA Honours thesis (2016)
[112] Valentine personal comm. November (2017)
[113] Ryan unpub. UWA Masters thesis (2017)

A breeding pair and a female with pouch young were observed outside the fenced area on the western boundary during the 2016 fauna survey.[10] This suggests that Quenda may either be relocating outside the fence when they are juvenile as the smaller size facilitates movement through the fene or accessing the area outside of the fence whilst gates are left open. It is also possible that Quenda have always existed outside the fenced area or have been translocated as a result of urban development activities. Nonetheless the observation of breeding Quenda outside the fence suggests the habitat available is suitable for sustaining a Quenda population and indicates the possible dispersal of the Quenda population within the enclosed area into adjacent habitat.[10]

Given the current Quenda numbers at Craigie Bushland and the suggested home range estimates, it is likely the enclosed area at Craigie Bushland may not sustain population growth as a result of continued breeding. Additionally, with the reduced threat of predation within the fenced area, there is a possibility of the population exceeding the carrying capacity. Carrying capacity is poorly understood for the Quenda and it is likely to differ depending on the landscape context of the bushland, such as the quality of habitat available. Therefore dispersal of Quenda into adjacent habitats in the future may be necessary to ensure the ongoing persistence of the species at the site.

Genetic variation and the risk of the existing Quenda population inbreeding at Craigie Bushland may also become a long term management issue. Quenda are vulnerable to the process of spatial isolation[106] that may lead to loss of genetic diversity. It is believed on at least one occasion Quenda have been relocated into Craigie Bushland from an unknown origin. Although there are associated management issues with the 'dumping' of wildlife in urban bushland areas, in terms of genetic variation and population viability, this may have some advantages. However further translocations different to the original locations the Quenda population were translocated from in 2013, must be managed and implemented in a sustainable manner to ensure the long term survival of the existing population.[112]

Bushfires may also impact the long term survival of the Quenda and the other fauna species existing within Craigie Bushland, in particular the fauna inhabiting the enclosed area. The retention of fallen logs and understorey vegetation will aid in the protection of fauna in the event of a fire, as these microhabitats may provide shelter during a fire.[10]

In order to address potential risks and environmental threats that may impact existing mammalian populations within Craigie Bushland, the development of a *Fauna Management Plan* is recommended to identify the long-term sustainable management of the fauna. See *Recommended Fauna Management Actions* below.

Reptiles

A total of 17 reptile species have been recorded at Craigie Bushland via field surveys. The most common being species from the Scincidae family (skinks) which commonly occur across the Swan Coastal Plain in bushland reserves and suburban gardens.

The majority of reptile specimens trapped were considered to be in good physical condition and for two reptile species, the majority of captures comprised sub-adults (Common Dwarf Skink (*Menetia greyii*) and Two-toed Earless Skink (*Hemiergis quadrilineata*)). None of the captured reptiles were considered hatchlings or neonates.

The Western Bearded Dragon (*Pogona minor minor*) was recorded by Allen et al. in 1994 and Natural Area Consulting (NAC) in 2011 but was not surveyed by Eco Logical in 2016. Furthermore NAC recorded the South-western Spiny-tailed Gecko (*Strophurus spinigerus*) and Allen et al. located the Dugite (*Pseudonaja affinis*) at Craigie Bushland during their respective surveying efforts but these species were not recorded by Eco Logical Australia in 2016. However the Jan's Banded Snake (*Simoselaps bertholdi*) was recorded in 2016 but was not in the previous surveying activities. This species is considered common throughout dune systems and sandy *Banksia-Eucalyptus* woodlands, although is often recorded in low numbers.

Two burrows most likely belonging to Bungarra (*Varanus gouldii*) were observed (but not trapped) during the 2016 survey, one looking to be active and one recently unused.[10]

Amphibians

Although no amphibians have been recorded via field surveying at Craigie Bushland, during maintenance activites the City of Joondalup has observed the calls of the Motorbike Frog *(Litoria moorei)* surrounding the artificial wetland in the southwest of the site in summer 2015.

Allen et al. (1994) indicated the Turtle Frog (*Myobatrachus gouldii*) is likely to occur in Craigie Bushland based on its presence in the local area in similar vegetation communities. Eco Logical Australia also supported this indicating both the Turtle Frog and Western Banjo Frog (*Limnodynastes dorsalis*) have been recorded approximately 2 km south of Craigie Bushland in Hepburn Heights.[114] The Turtle Frog has also been recorded in Warwick Open Space Bushland[115] located 8 km southeast of the site and occurs in other bushland remnants on the Swan Coastal Plain, as the Turtle Frog does not rely on surface water for breeding.[10]

The *Draft Craigie Public Open Space Management Plan* (1999) reported that some frogs were found in the back yards of residences in Eleanor Court and Britannia Avenue on the boundary of Craigie Bushland.

Birds

A total of 36 native birds have been recorded at Craigie Bushland, including the endangered Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and the migratory Rainbow Bee-eater (*Merops ornatus*), both of conservation significance.

[114] CoJ 2015 cited in ELA (2017)
[115] ELA 2013 cited in ELA (2017)

The Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris)* is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and the Rainbow Bee-eater (*Merops ornatus*) is listed as Migratory and protected by International Agreement under the *Wildlife Conservation Act (1950)* of Western Australia (see Appendix 10).

In addition to the bird survey undertaken in 2016 by Eco Logical Australia to inform this Plan, previous bird census studies at Craigie Bushland include:

- Natural Area Consulting conducted an opportunistic survey during spring 2011;
- Allen et al. conducted a 35 hour bird survey during the month of September 1994; and
- Birds Australia through the Perth Biodiversity Project (PBP) undertook a comprehensive monthly targeted bird survey between February 2005 and January 2006.

Carnaby's Black-Cockatoos

Carnaby's Black-Cockatoos (Carnaby's) are endemic to the southwest of Western Australia and are listed on state, national and international threatened species lists. The *Banksia*, *Hakea* and Marri species on site provide a significant food source which Carnaby's use for foraging. Carnaby's Black-Cockatoos nest in hollows of smooth-barked eucalypts, including Tuarts (*Eucalyptus gomphocephala*) and Marris (*Corymbia calophylla*) which are found on site.[64]

Carnaby's were recorded at Craigie Bushland during all of the above bird surveys (in 2016, 2011, 2005-2006 and 1994). Other records held by the DBCA also indicate Carnaby's have been recorded across the site. During the 2016 survey, this species was observed foraging on *Banksia attenuata* cones, flying overhead, and perching in tall Tuart trees.

The vegetation community throughout Craigie Bushland provides high foraging habitat for the Carnaby's Black-Cockatoo as well as the Forest Red-tailed Black Cockatoo. This includes Jarrah, Marri, *Banksia sessilis*, *B. attenuata, B. menziesii*, and *Hakea* species, which are all primary foraging species for Carnaby's Black-Cockatoo.[116] The Marri and Jarrah are also a very common local food source for the Forest Red-tailed Black Cockatoo on the Swan Coastal Plain.[10]

The large Tuart trees within Craigie Bushland provide potential breeding and roosting habitat for Carnaby's Black-Cockatoo. [10, 64] Artificial hollows could be installed in trees such as Tuart or Marri to encourage Carnaby's Black-Cockatoos or Forest Red-tailed Black Cockatoos to nest, however research indicates that they are most successful when placed where Carnaby's are already known to breed. Further research is still required to ascertain whether it is possible to encourage the birds to breed in areas where they currently aren't breeding. Artificial hollows have been used successfully at Murdoch University and Edith Cowan University campuses. Artificial hollows require regular monitoring due to competitors for

[116] BirdLife Australia (no date a)

nests including European Honey Bees, Galahs, non-native Corellas and Rainbow Lorikeets.[117]

Due to the Endangered status of the Carnaby's Black-Cockatoo (and the Vulnerable status of the closely related Forest Red-tailed Black Cockatoo) combined with the limited remaining vegetation within the Perth Metropolitan Area, it is important that good quality vegetation and a diversity of flora species known to be used by the Endangered Carnaby's Black-Cockatoo is maintained for habitat at Craigie Bushland.

Rainbow Bee-eaters

The Rainbow Bee-eater builds nests in sandy banks and digs tunnels approximately 90 cm long which lead to a nesting chamber, making it vulnerable to trampling by humans or dogs or predation by foxes and cats.[118] Rainbow Bee-eaters were recorded during the 2016, 2011 and 1994 bird surveys. Craigie Bushland provides an abundance of food (bees) during the spring-summer breeding period for when the Rainbow Bee-eater is present in the southwest of WA.[11] Monitoring for Rainbow Bee-eater nesting sites through monthly inspections and the installation of fencing and signage around exposed nesting sites may decrease trampling of nests by humans or dogs and non-native fauna.

Southern Boobook Owls

Southern Boobook Owls (Ninox novaeseelandiae) are a locally significant species and a study investigating their population in the Perth metropolitan area is currently being undertaken. This species was recorded during the 2011 bird survey and although it was not recorded during the 2016 bird survey, it has recently through the development of this Plan, been reported to have been heard in the evenings at Craigie Bushland. It should be noted that Southern Boobook Owls along with several other nocturnal avian species are most active in the evening and minimal surveying was undertaken in the evening at Craigie Bushland, therefore limited data is available for nocturnal species.

In 2015 Southern Book Owls were recorded breeding in a large mature Tuart tree (*E.gomphocephala*) at Shepherds Bush Reserve in Kingsley, located 3 kms south of Craigie Bushland. The tree was observed to contain feral bees which are known to impact bird species particularly Owls and Cockatoos utilising nest hollows. These birds are often found dead or engulfed by feral bees competing for the same hollow.[119]

In March 2016, a nest box targeting Southern Boobook Owls was installed in Craigie Bushland, as part of the study looking at the population across the Perth metropolitan area. Another 14 nest boxes were installed in addition to Craigie Bushland in urban bushland reserves across Perth. During monitoring activities in late 2016 and 2017, the non-native Kookaburra (*Dacelo novaeguinea*) was observed nesting in the box.[120]

[117] DPaW (2015)
[118] Birdlife Australia (no date (b))
[119] M Lohr (2016), PhD candidate ECU University, email 19 May
[120] S Cherriman (2018), Insight Ornithology, email 29 January

Retaining large mature trees containing known and potential nesting hollows, along with the management of feral bees and non-native bird species is recommended to improve nesting opportunities for Southern Boobook Owls,[119] Carnaby's Black-Cockatoos and other native birds.

Other Native Birds

The surveying undertaken in 2005-2006 through the Perth Biodiversity Project indicated 11 species recorded were of conservation significance. These included the Carnaby's Black-Cockatoo, Brown Goshawk (*Accipiter fasciatus*) , Little Eagle (*Hieraaetus morphnoides)*, Splendid Fairy-wren (*Malurus splendens)*, Inland Thornbill (*Acanthiza apicalis)*, Yellow-rumped Thornbill (*Acanthiza inornata*) and some honeyeaters. Golden Whistler (*Pachycephala occidentalis)*, a species reported to be uncommon in northern areas of the Swan Coastal Plain and in the Perth metropolitan area was also recorded.

Birds recorded during the 2016 survey include a range of nectar feeders such as Red Wattlebird (*Anthochaera carunculata*), insectivores such as Weebill (*Smicrornis brevirostris*), *Pardalotus striatus* (Striated Pardalote), Western Gerygone (*Gerygone fusca*), and Yellow-rumped Thornbill (*Acanthiza inornata*) and larger omnivorous species such as Australian Magpie (*Cracticus tibicen*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Grey Butcherbird (*Cracticus torquatus*).

The Weebill and Yellow-rumped Thornbill are considered significant birds by Bush Forever as they are habitat specialists with a reduced distribution on the Swan Coastal Plain.[4,121]

Parrots were the most commonly observed birds across the site, including the Carnaby's Cockatoo, Twenty-eight Parrot (*Platycercus zonarius*) and the non native Galah (*Cacatua roseicapilla*), Little Corella (*Cacatua sanguinea*) and Rainbow Lorikeet (*Trinchoglossus moluccanus*). These non native species are decribed further below under *Non-native Fauna*.

Two raptors, Square-tailed Kite (*Hamirostra isura*) and Brown Goshawk (*Accipiter fasciatus*) were also observed flying above the site during the 2016 bird survey.

The remaining species recorded at Craigie Bushland are considered widespread throughout the south-west of WA and are considered locally common on the northern Swan Coastal Plain.[10]

Invertebrates

Invertebrates are animals without backbones such as insects, worms and molluscs. Invertebrates constitute more than 95% of all living animal species, with Australia having documented 100,000 species and an estimated 200,000 undescribed invertebrate species.[122] Some invertebrates are important indicators of ecosystem health, such as ants (seed dispersers), bees (pollinators) or spiders (top invertebrate predators).[123]

[121] Birds Australia for PBP (2006)
[122] DBCA (no date)
[123] V Framenau (2012), email, 9 July

Invertebrates recycle organic matter, putting it back into circulation for use by other parts of the ecosystem and are instrumental in controlling the numbers of other species.[122]

An estimated 201 invertebrate species, of which four could be identified as being non-native were recorded opportunistically or as bycatch during fauna surveys undertaken in 2016, 2011 and 1994. The majority of invertebrate species recorded were spiders and beetles.[10]

The invertebrates recorded during the survey, in the majority of cases were only able to be identified to the taxonomic order level, therefore it is assumed based on their limited identification that these species were native, although this is not confirmed.

Graceful Sun-moth

The conservation significant Priority 4 Department of Biodiversity, Conservation and Attractions listed Graceful Sun-moth (*Synemon gratiosa*) has previously been recorded in the study area[124] and suitable habitat for the species was identified by consultants during field surveys both in 2011 and 2016.[10, 18]

During their 2011 field survey Natural Area Consulting reported a large population of *Lomandra maritima* and *L. hermaphrodita* exist at Craigie Bushland which provides habitat for the Graceful Sun Moth.[18]

Although *Lomandra maritima* was recorded by Eco Logical Australia in their 2016 field survey, *L. hermaphrodita* was not observed as this species is only detectable for a relatively short period of time in autumn (usually March) each year.[125]

The Graceful Sun Moth is generally active between mid February and early April. The results of targeted surveys in 2010 by the Department of Environment and Conservation (now Department of Biodiversity, Conservation and Attractions) recorded the species at the site.[18,19]

Native Snails

A local newspaper article in 1999 published that Craigie Bushland was home to 'a rare indigenous snail that lives in the ground litter of *Banksia* woodland,'[126] although limited information could be found on the presence of this species to verify its occurrence.

However based on the vegetation health and optimal habitat conditions available at the site, it is likely that the native snail species *Bothriembryon bulla* (Land Snail) and / or *B.kendricki* (Kendricks Land Snail) exist in Craigie Bushland.[127] Several other species belonging to the *Bothriembryon* genus are listed as Extinct or Priority One (known from a few locations and potentially at risk) or Priority Two (known from a few locations and not adequately sampled) by the DBCA.

[124] DPaW cited in ELA (2017)
[125] Bishop et al. cited in ELA (2017)
[126] Wanneroo Times Newspaper (1999b)
[127] C.Whisson, 2018, Western Australian Museum, pers. comm., 22 January

A targeted survey in winter[127] (optimal timing to observe these species) may assist in confirming the presence of *Bothriembryon* species, however opportunistic observations during Quenda monitoring and flora surveys and during maintenance activities at Craigie Bushland may also assist in confirming its presence.

Non-native Fauna

Non-native fauna impact native fauna and flora through predation, competition for food and shelter, spreading diseases and destroying habitat. These impacts can result in the diminishing or extinction of native species. [128]

Non-native animals such as cats, foxes, rabbits, rats, mice, birds, millipedes, ants and bees inhabit the City's bushland, wetland and coastal areas.

Mammals

Australia is home to some of the world's most unique animals. More than 80 per cent of our mammals occur nowhere else on earth,[129] however Australian mammals are becoming extinct at an alarming rate due to non-native (feral animal) predation.[130]

Non-native mammals can harass, predate and cause health issues through the spread of disease to native mammal populations in Craigie Bushland.[10] Dogs, foxes and cats in particular can pursue large mammals such as kangaroos, often resulting in stress and harm to the animals.

Six non-native mammals have been recorded at Craigie Bushland. These species include European European Red Fox (*Vulpes vulpes*), the Feral or Domestic Cat (*Felis catus*), Rabbit (*Oryctolagus cuniculus*), Black Rat (*Rattus rattus*), House Mouse (*Mus musculus*) and Domestic Dog (*Canis lupus*).

European Red Fox

In 2013, an investigation into feral animals was conducted by an external contractor. The results indicated evidence of European Red Fox (*Vulpes vulpes*) activity on the periphery of Craigie Bushland in the area between the Mitchell Freeway on the eastern side and also on the southern boundary along Whitfords Avenue, 1.5 kms from Craigie Bushland. It was suggested foxes may be accessing the area from the northern ecological linkages available at Woodvale Nature Reserve and Yellagonga Regional Park.

In 2014 and 2015, the Friends of Yellagonga (for the Friends of Craigie Bushland) deployed motion cameras in Craigie Bushland and did not capture any footage of rabbits, foxes or feral cats.

[128] Australian Government, DoE (no date)
[129] Australian Government, DoE (2015a)
[130] Australian Wildlife Conservancy (2014)

During the 2016 fauna survey undertaken by Eco Logical Australia, fox activity was captured on a motion camera outside the fence on the eastern side of the study area, between the predator proof fence and the Mitchell Freeway.

In 2017, the City of Joondalup undertook a fox investigation on land surrounding Craigie Bushland, which identified foxes were travelling through the nearby Pinnaroo Valley Memorial Park and roaming around the land surrounding the eastern side of the fenced area (adjacent to the Mitchell Freeway). One fox was removed from the Pinnaroo Valley Memorial Park following a small trapping effort.

Domestic Dog

The fenced area in Craigie Bushland does not allow dog (*Canis lupus*) exercising, however dogs are permitted on lead outside the fenced area.

During the 2016 survey, dogs were commonly observed being walked on the outskirts of the fenced area. No dogs were observed within the fenced area.

Domestic animals such as dogs have the potential to cause damage to the City's natural environment, particularly when exercised off-lead within natural areas.

Dogs can spread pathogens if they disturb the soil, particularly around trees which may contain soil-based diseases. Dog droppings, if not removed, contribute a significant amount of nutrients to the site, encouraging weed growth and potentially polluting groundwater. Some dog droppings contain harmful bacteria.[131]

The City Rangers undertake targeted patrols at Craigie Bushland to ensure dogs are kept on leads whilst exercised outside of the fenced area and their droppings are collected.

Domestic and Feral Cat

Domestic and feral cats (*Felis catus*) have the potential to cause significant environmental harm when allowed to roam within urban natural areas. The Action Plan for Australian Mammals (2012) and a report published by the US National Academy of Sciences (2014) ranked feral cats as the highest threat to Australia's mammals.[132] [133] Their threat factor was more than double that of European Red Foxes, the next highest threat, and triple that of habitat loss and fragmentation. Feral cats have contributed to the extinction of at least 28 mammal species since they first arrived in Australia and continue to cause severe decline to Australia's native fauna population.[132]

The Australian Wildlife Conservancy estimate 'feral cats kill at least 75 million native animals every night across Australia.'[130]

[131] Victoria State Government (2017)
[132] Commonwealth of Australia (2015)
[133] Woinarski et al cited in Commonwealth of Australia (2015)

In order to combat this threat to native fauna populations, the Federal Government in 2015 endorsed the *National Declaration of Feral Cats as Pests*.[134] The Australian Government has also set an objective through the *Threatened Species Strategy 2015*, for 2 million cats to be culled across Australia by 2020.

The Feral or Domestic Cat (*Felis catus*) has not been recorded at the site since Allen et al. (1994), however given the proximity to housing, it is likely that cats would enter Craigie Bushland on an occasional basis.[10]

Under the *Cat Act 2011* the City of Joondalup may seize cats if they are reported to be on private property without the consent of the owner/occupier. The *Cat Act 2011* encourages responsible pet ownership by ensuring cats are registered, sterilised and micro chipped.

Rabbit

Rabbits (*Oryctolagus cuniculus*) are common within the City's coastal and bushland areas and have the potential to damage large areas of native vegetation. Rabbits also reduce the effectiveness of bushland rehabilitation activities by feeding on newly planted seedlings and as they are often predated on by foxes, rabbits can attract foxes to certain areas.

It is believed no foxes or cats currently inhabit the fenced area of Craigie Bushland.

The City has a fox and rabbit control program and operates under the *Cat Act 2011* to manage these non-native mammals within the City's natural areas.

Black Rat

The Blak Rat (*Rattus rattus*) was recorded by Allen et al. (1994), by the Friends of Yellagonga (for the Friends of Craigie Bushland) during 2014-2015 monitoring activities[101] and in the 2016 survey undertaken by ELA.

House Mouse

The House Mouse (*Mus musculus*) is widespread and established in the suburbs of Perth.[10]

Both the Black Rat and House Mouse can introduce and spread disease to native mammal populations, however it should be noted that only one individual of each species was recorded during the 2016 survey at Craigie Bushland.[10]

<u>Birds</u>

A total of nine non-native species of birds have been recorded at Craigie Bushland including *Trichoglossus haematodus* (Rainbow Lorikeet), *Columba livia* (Domestic Pigeon), *Dacelo novaeguineae* (Laughing Kookaburra), *Streptopelia chinensis* (Spotted Turtle Dove) *Streptopelia senegalensis* (Laughing Turtle-dove), *Cacatua roseicapilla* (Galah), *Cacatua*

[134] Australian Government, DoE (2015b)

sanguinea (Little Corella), *Cacatua tenuirostris* (Eastern Long-billed Corella) and *Cacatua galerita* (Sulphur-crested Cockatoo).

Rainbow Lorikeets

Rainbow Lorikeets are a Declared Pest in WA under the *Biosecurity and Agriculture Management Act* 2007 and subject to control (C3 – management) in the Perth metropolitan area. This species was one of the most commonly occurring birds recorded in Craigie Bushland during the 2016 survey. They compete with native species for hollows and for food, are aggressive when defending their nests and pose a risk of disease spread as they are carriers of Psittacine Beak and Feather Disease which can be spread to native birds[135] (See Appendix 11).

Numerous stags (dead trees) and large Tuart trees with hollows are occupied by Rainbow Lorikeets in Craigie Bushland. Consultants, Eco Logical Australia reported it was difficult to listen for bird calls during the 2016 bird survey due to the noise made by Rainbow Lorikeets. Rainbow Lorikeets also pose a threat to nectar feeding birds and other animals due to food competition.[99]

Since Rainbow Lorikeets were first released in Western Australia in the 1960's the population and distribution of the species has increased rapidly.[136] BirdLife WA reports Rainbow Lorikeets were first recorded at Lake Joondalup in 1991. In February 2016 Rainbow Lorikeet roost sites were counted in the Perth metropolitan area and a single roost in Edgewater had approximately 1,005 Rainbow Lorikeets present. Other roosts nearby also hosted Rainbow Lorikeets. Several Rainbow Lorikeets were seen nesting in artificial nest boxes.[137] They are known to kill the nestlings of other species.[138]

The Department of Agriculture and Food WA (DAFWA) estimate Rainbow Lorikeets damage approximately $3 million worth of commercial fruit crops each year in southwest Australia. [138] As a result, Rainbow Lorikeets are being controlled to a containment line to ensure that the species does not establish within the major fruit production areas of the southwest such as Margaret River. Rainbow Lorikeets are found from Yanchep to Mandurah but are more densely populated in the inner metropolitan areas.[137]

Galahs

Galahs and Little Corellas were also observed in high numbers during the 2016 survey. The majority of Little Corellas observed were within the bushland surrounding the Craigie Leisure Centre. Many Galahs and Little Corellas were also nesting in hollows of large Tuart trees and dead stags, reducing opportunities for vital habitat for the conservation significant Carnaby's Black Coackatoo and other native bird species using hollows for nesting purposes.

[135] DAFWA cited in ELA (2016)
[136] Chapman cited in BirdLife WA (2017)
[137] BirdLife WA (2017)
[138] Cook cited in BirdLife WA (2017)

The Department of Biodiversity, Conservation and Attractions considers the Galah (*Cacatua roseicapilla*) a pest species, as it has expanded its range where it does not naturally occur such as in the Perth metropolitan area.[10,139] It is believed habitat clearing in its natural geographic range and the escape and release of aviary birds has contributed to its presence in Perth.[140]

Little Corellas

Corella species have also been recorded hybridising in the wild and this loss of genetic purity between the species and subspecies is considered a threatening process to Western Australia's endemic native Corellas and Cockatoos.[141]

The Little Corella (*Cacatua sanguinea)* and Eastern Long-billed Corella (*Cacatua tenuirostris*) have become established in WA, despite not naturally occurring in the state.[142]

Laughing Kookaburra

The Laughing Kookaburra (*Dacelo novaeguineae*) and Spotted Turtle-dove *(Streptopelia chinensis*) were also observed quite frequently through Craigie Bushland during the 2016 bird survey. The Laughing Kookaburra has been widely introduced into Western Australia and Tasmania where they breed in tree hollows that would usually be used by parrots and owls. Laughing Kookaburras also prey on small reptiles, mammals and nestlings of other birds, placing undue pressure on these native species.[143]

Sulphur-crested Cockatoo

Allen et al. recorded the Sulphur-crested Cockatoo (*Cacatua galerita*) during the September 1994 bird survey, although this species has not been recorded since. The Sulphur-crested Cockatoo is also listed as a Declared Pest in WA under the *Biosecurity and Agriculture Management Act* (2007).

Introduced birds such as Rainbow Lorikeets, Little Corellas and Galahs compete with native fauna for tree hollows. This is of significant concern given the increased use of nesting trees by Carnaby's Black-Cockatoo on the Swan Coastal Plain.

<u>Invertebrates</u>

Of the 201 invertebrate taxa recorded in the study area, four were able to be identified as introduced invertebrate species. These include the European Honey-bee (*Apis mellifera*), Portuguese Millipede (*Ommatoiulus moreletii*), Cabbage White butterfly *(Pieris rapae*) and Variable White Mediterranean Snail (*Theba pisana*).

[139] DEC cited in ELA (2017)
[140] DEC (2009)
[141] DBCA cited in ELA (2017)
[142] DBCA (2017c)
[143] Birdlife Australia (no date (c))

Portuguese Millipedes

Portuguese millipedes were first recorded in Western Australia in 1986 and are now widespread in southwest WA. They feed on organic matter such as leaf litter and are not known to impact native flora or fauna. Portuguese millipedes can reach high population levels and be a domestic nuisance when they invade homes and gardens.[144]

This species is known to be distasteful and therefore avoided by many predators. It plays a useful role in breaking down organic matter in the soil, however is considered a pest when it reaches high population levels. This species has become widespread across the Perth metropolitan area in both bushland and suburban areas.[145]

Portuguese millipedes are attracted to light at night and this is presumably why they invade homes. There are a number of biological, chemical and physical controls residents surrounding Craigie Bushland can implement to reduce the impact of Portuguese millipedes around their home. These measures include limiting the amount of light released from the home at night (i.e. drawing curtains), reducing the amount of organic matter surrounding the home, such as moving compost piles and removing leaf litter away from the home and installing smooth barriers around the home, as the species cannot travel along smooth surfaces. Biological controls such as predation by other insects and chemical measures such as insecticides, can also be used to reduce Portuguese millipede numbers surrounding residential properties.[146]

European Honey Bees

European honey bees are frequently observed in Craigie Bushland nesting in large mature tree hollows. The European honey bee (*Apis mellifera*) is common within the City's natural areas and may impact upon native flora and fauna through competing for nectar with a wide range of native birds and important native invertebrate pollinator species (including native bees) for floral resources. It can disrupt natural pollination processes and displace endemic wildlife from tree hollows. The young chicks of native birds restricted to their nests are also believed to be susceptible to harmful multiple stings.

European honey bees are feral animals, however, they are also important to Australian horticulture and agricultural industries, with approximately 65% of agricultural production in Australia being dependent on pollination by European honey bees.[147]

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 such as foxes and rabbits is undertaken annually within selected bushland, wetland and coastal areas. Fox and rabbit control methods employed include biological and

[144] Widmer (2006)
[145] DAFWA cited in ELA (2016)
[146] DAFWA (2017)
[147] Rural Industries Research and Development Corporation (no date)

chemical control, trapping, baiting and exclusion methods such as fencing. Fox control is conducted when fox warrens are identified on site.

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 acceptably low.

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. The fenced area in Craigie Bushland is designated as a place where dogs are prohibited at all times and the area surrounding the fenced area is a designated dog on-lead area by Council resolution in accordance with the *Dog Act* 1976. Cats may be seized where they are found wandering in public areas, such as Craigie Bushland, in accordance with the *Cat Act 2011*.

Key stakeholders, the Friends of Craigie Bushland and the University of Western Australia inform the City of Joondalup of results following research studies, investigations, observations and field activities undertaken at Craigie Bushland related to fauna management.

Recommended Fauna Management Action:

It is recommended a Fauna Management Plan is developed for Craigie Bushland in consultation with key stakeholders, the Friends of Craigie Bushland, the University of Western Australia and the Department of Biodiversity, Conservation and Attractions, identifying key management actions to ensure the long term health and survival of existing fauna populations.

The Fauna Management Plan should address:

- Carrying capacity and population growth;
- Genetic variability, fauna health and animal ethics; and
- Long-term planning, risk management and roles and responsibilities of relevant land managers and authorities responsible for fauna management at Craigie Bushland.

The following management actions are also proposed in addition to the development of a Fauna Management Plan to monitor and protect native fauna in Craigie Bushland.

Action	**Details**
Develop a *Fauna Management Plan*	Develop a *Fauna Management Plan* in consultation with key stakeholders to ensure the long-term health and survival of existing fauna populations at Craigie Bushland. Key issues to be addressed within the *Fauna Management Plan* include roles and responsibilities of relevant land managers and authorites and risk management in response to population growth and potential environmental impacts.

Action	Details
Fauna survey	Undertake a follow up fauna survey, in mid-late spring to supplement previous fauna surveys, within 10 years, including a targeted winter opportunistic survey for invertebrates.
Quenda monitoring	Continue liaisons with the University of Western Australia on research and monitoring being conducted on the Quenda population.
Rainbow Bee-eater nesting sites	Continue to monitor for Rainbow Bee-eater nesting sites through monthly inspections and install fencing and signage around exposed nesting sites to decrease trampling of nests by humans or dogs.
Feral animal control	Continue to monitor feral animal populations and implement regular control to reduce pressures on native fauna and flora. Remove feral beehives if they are identified on site and are accessible.
Patrols to ensure dogs are kept on leads and owners are cleaning up after their dogs	Continue targeted patrols by City Rangers to ensure dogs are kept on leads and their droppings are collected.

3.5 Social and Built Environment

History and Heritage

Craigie Bushland is not registered on State or Federal Indigenous heritage inventory databases, however a place of heritage has been lodged to the Department of Planning, Lands and Heritage to the north of Craigie Bushland within the Beenyup Waste Water Treatment Plant referred to as 'Beenyup Marked Tree.'[148]

Beenyup is reported to be an Indigenous word meaning 'digging place of abundant native potatoes.'[149]

Previous reports indicate there are no records of archaeological surveys, therefore the Department of Indigenous Affairs is unaware of any sites of cultural significance in Craigie Bushland.[5]

Social Value

Urban natural areas can provide social, psychological, physical and spiritual benefits and play a role in community health, wellbeing and quality of life. Some of the benefits of urban natural areas for the community include:

- Reduction of mental fatigue and stress
- Provide opportunities for reflective thought, peace and quiet
- Create opportunities for informal social interactions
- Provide opportunities for activities that can increase physical health
- Assists to reduce the crime rate by relaxing people and encouraging people to be outdoors.[150]

Australians have reported they would be willing to pay an average of $35,000 more (approximately 7%, assuming a base value of $500,000) to live in a home in a 'green' neighbourhood, with a third of Australians willing to pay an extra $100,000 or more to live in a 'green' area. Approximately two thirds of Australians would prefer to buy a home in a nature-filled neighbourhood, even if it cost them more to do so. Living in a home with a 'green' neighbourhood is important to Australians, even more important than proximity to work, shops and public transport.[151]

User surveys provide information on the reasons why people visit Craigie Bushland, the number of people and frequency of visits and enable a more targeted environmental education campaign regarding bushland management.

In 2012 a Visitor Usage Survey was undertaken in Craigie Bushland, resulting in the completion of 29 survey questionnaires. The results of the Survey indicated visitors to

[148] Department of Planning, Lands and Heritage (2018)
[149] Gentilli 1998 cited in City of Joondalup (2002)
[150] Tarran (2006)
[151] Planet Ark (2014)

Craigie Bushland use both the area outside the fence (stairs and paths around the perimeter of the fence) and the area inside the fence. The majority of survey participants reported they visited the site once a week or more, with almost all respondents indicating they visited Craigie Bushland for the purpose of exercise (walking, jogging), walking a dog and for nature appreciation (enjoyment of the natural environment). The Survey reported respondents emphasised the quality of the natural environment existing within Craigie Bushland.[152]

Additionally, previous records suggest in 1999 an environmental survey was conducted which resulted in 89% of respondents indicating Craigie Bushland is 'an important bushland area' and 72% stating they want it kept 'as natural as possible.'[153,154]

In 2014, dogs were prohibited from entering the area inside the fence, today the area outside of the fence is frequently used for dog exercising. The area outside of the fence is also used for walking and running, with many patrons using the popular 'Quindalup Dunes' Pathway and Stairs for fitness purposes and as a thoroughfare to adjoining Warrandyte Park and the residential area on the western boundary.

The current main uses of the fenced area at Craigie Bushland are for passive recreational purposes such as walking and nature appreciation.

Craigie Bushland has had a history of active Friends groups. In 1999, a Friends of Craigie Bushland group was initiated through the leadership of a local resident who was concerned about the accumulation of rubbish and unauthorised vehicles threatening local wildlife and damaging native vegetation. With the support of the City of Joondalup, the Friends of Craigie Bushland, consisting of approximately 12 members was formed. The group was active in the planning of the reserve, holding bush care days and leading bush walks.[5,155]

In 2015, the current Friends of Craigie Bushland was re-established. The group works in partnership with the City of Joondalup to maintain, enhance and promote the ecological values of the site.

Access and Infrastructure

The Craigie Leisure Centre directly abuts Craigie Bushland in the south. It was first constructed in 1988 and renovations have occurred after this time to facilitate the installation of geothermal heated swimming pools and enhancement works to cater for the number of members using the Centre. The Craigie Leisure Centre is managed by the City of Joondalup.

A small skate park is located in the south of Craigie Bushland, outside the fenced area adjoining the Craigie Leisure Centre over flow car park.

[152] Orsini and Associates (2012)
[153] Wanneroo Times Weekend Newspaper, , 2 November (1999)
[154] Wanneroo Times Newspaper, 2 November (1999a)
[155] Wanneroo Times Newspaper, 7 September (1999b)

In 2009 the Quindalup Dunes Pathway and Stairs were constructed on the western boundary of the site. The Quindalup Dunes Pathway and Stairs includes two timber stair pathways connecting the western side of Craigie Bushland to the adjoining residential area and Warrandytre Park. The northern stairs are 100 m and the southern stairs are 55 m long, see Figure 30 for their location. The project was a joint initiative by the City of Joondalup and the Water Corporation in response to vegetation trampling and human impacts in the area.[156] Water Corporation funded the northern stairs, the associated pathway at the top of the stairs and the fencing adjacent to the pathway and the City of Joondalup funded the southern stairs.

Craigie Bushland contains power, lighting, water and sewerage utilities and infrastructure, such as fencing, paths, seating and a water fountain.

Utilities

Several public utilities operate within or surrounding Craigie Bushland, as shown in Figure 22, Figure 23 and Figure 24.

Power and Lighting

Craigie Bushland has power and lighting infrastructure surrounding the site, as shown in Figure 22.

Water

Figure 23 outlines the public hydrants and distribution mains surrounding Craigie Bushland. The public hydrants are owned, serviced and maintained by the DFES in conjunction with the Water Corporation.

Sewerage

Figure 24 shows the Water Corporation sewerage infrastructure in place surrounding Craigie Bushland. The Water Corporation maintain the sewerage infrastructure on an as required basis.

[156] Joondalup Times Newspaper, 15 September 2000

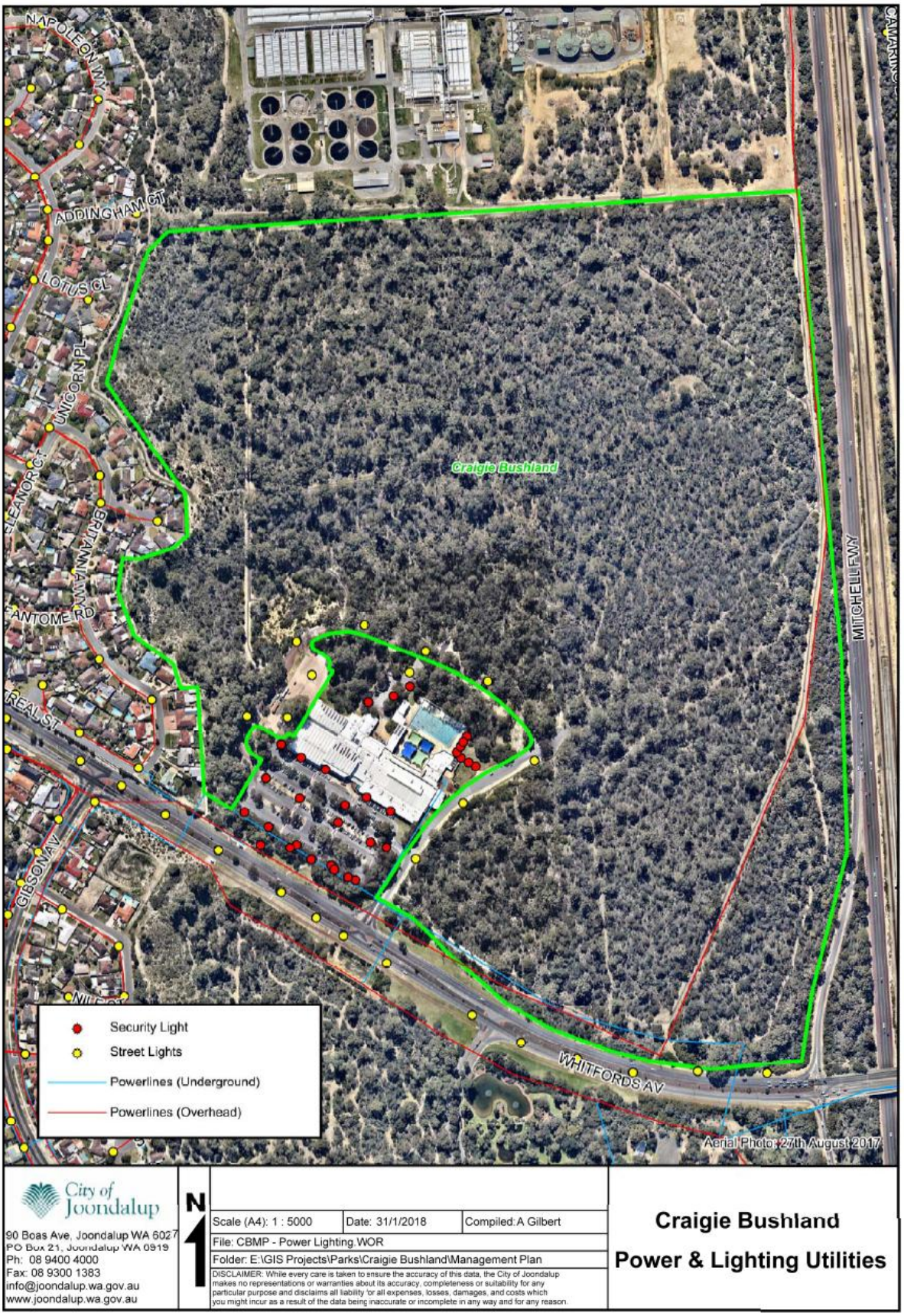

Figure 22: Craigie Bushland Power and Lighting Utilities

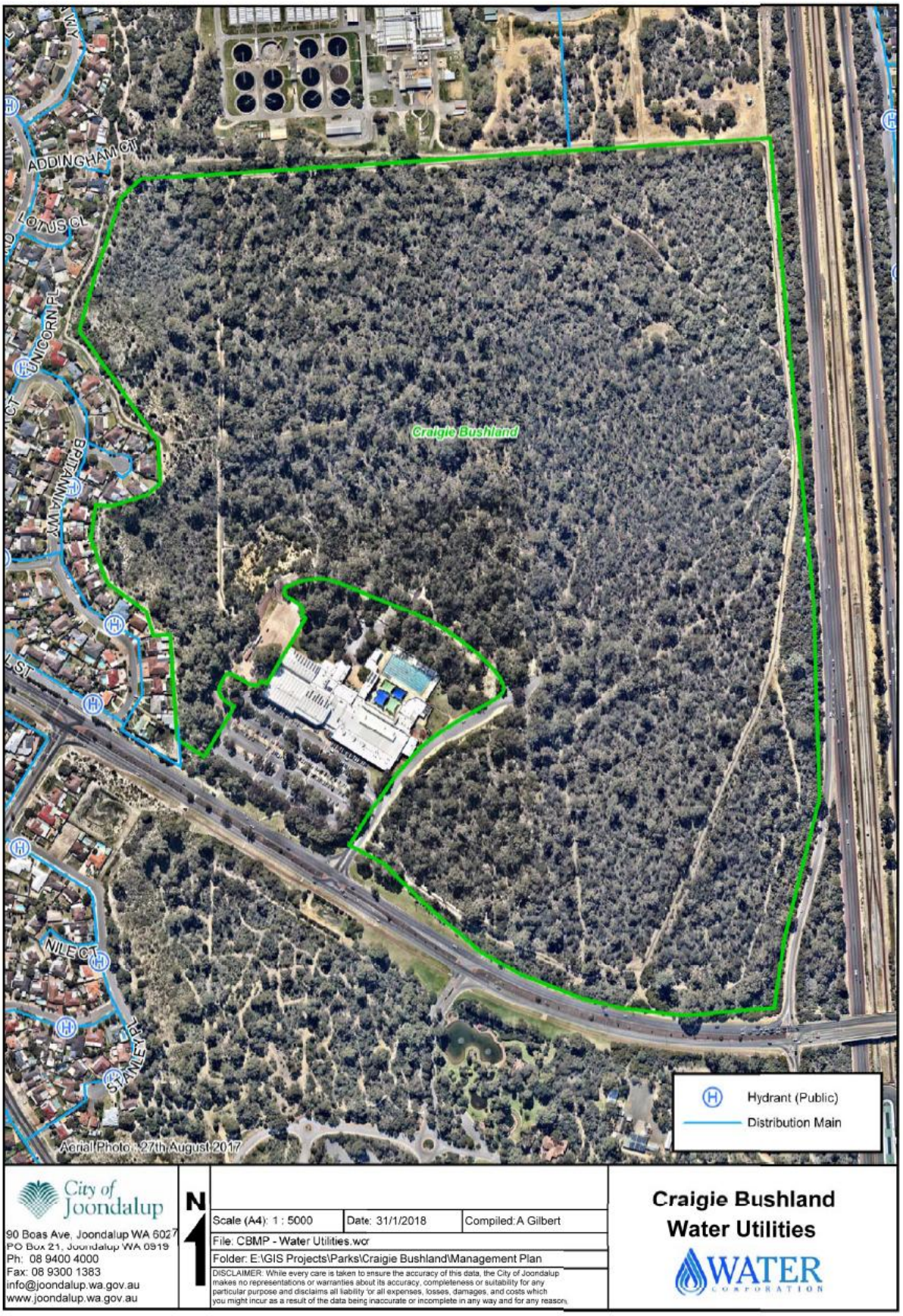

Figure 23: Craigie Bushland Water Utilities

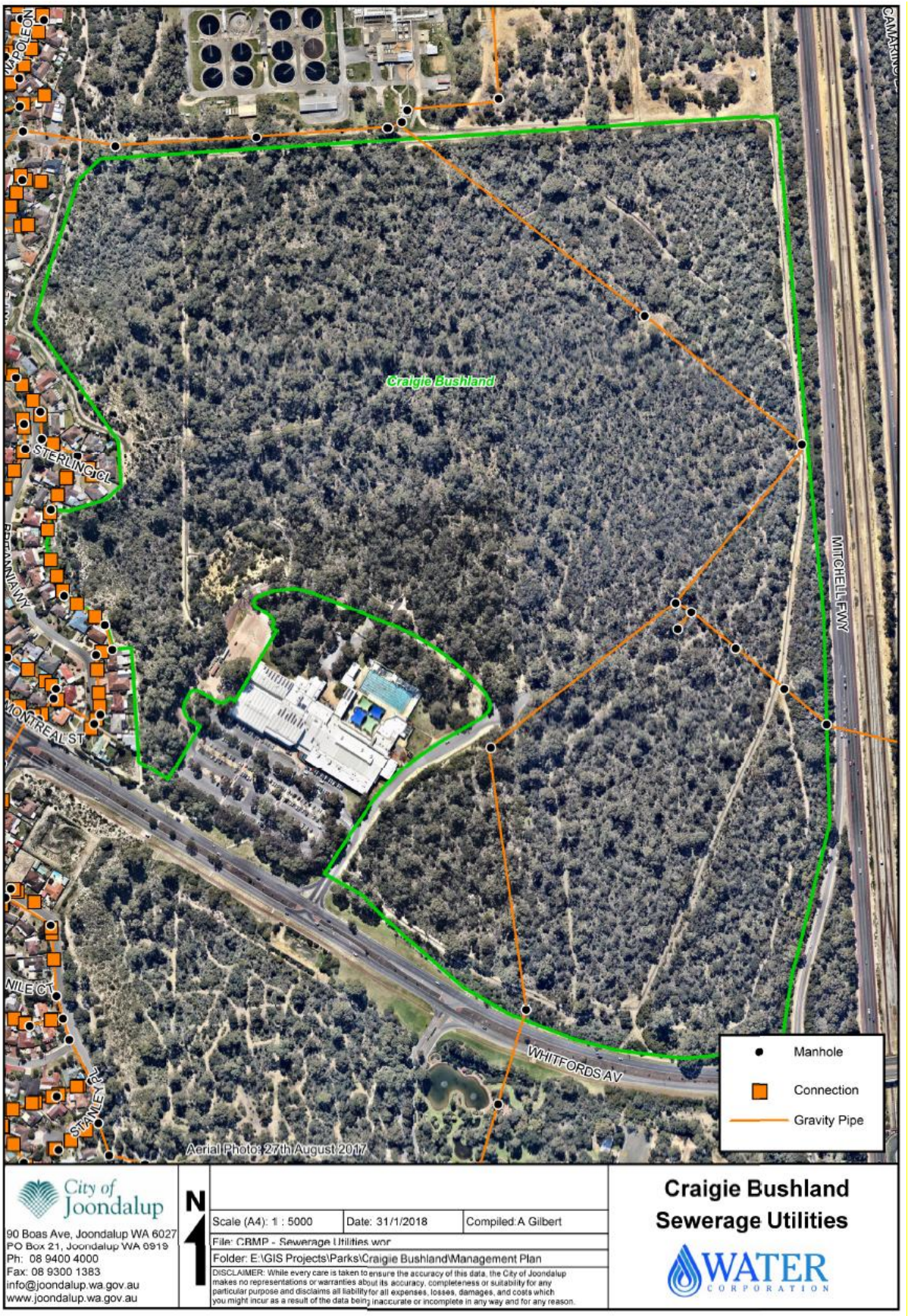

Figure 24: Craigie Bushland Sewerage Utilities

Fencing

Predator proof fencing was installed at Craigie Bushland in 2010. The fencing encompasses approximately 42 ha of the 56 ha Craigie Bushland reserve (see Figure 25 and Figure 30). It is constructed from cyclone mesh fencing and is 3 km long and 2.1 m high. There are nine vehicle access gates leading into the fenced area and 11 pedestrian gates. The fence was designed to eliminate the risk of feral animals such as foxes and cats entering the area and contains a 600 mm overhang.

Conservation fencing using timber post and plastic coated galvanised chain mesh or ring lock fencing surround the outer perimeter of Craigie Bushland (located on the outside of the predator proof fence).

Galvanised chain mesh fencing also exists on the northern boundary of Craigie Bushland delineating the boundary of the Water Corporation land.

Fencing is inspected on a monthly basis and repairs are conducted as required. Overhanging branches and vegetation build up next to the fence is monitored and pruned to ensure introduced fauna can not gain access into the enclosed area.

Figure 25: Predator proof fencing on the perimeter of the enclosed area at Craigie Bushland

Access Points

Access points allow people to enter natural areas that are fenced off and often give access to paths. There are numerous access points in Craigie Bushland, as shown in Figure.

Pedestrian access gates into the Craigie Bushland non-enclosed area open with farm gates and kissing gates or vehicular gates. Pedestrian and vehicular access gates into the Craigie Bushland enclosed area are manufactured out of the same cyclone mesh material as the predator proof fencing to minimise the risk of non-native fauna gaining entry.

Paths and Trails

Paths in Craigie Bushland are used for access by pedestrians and to a lesser extent by cyclists. Paths are also used for bushfire access ways and bushland management and maintenance purposes. The paths in Craigie Bushland are mostly used by pedestrians. Sections of the southern path within the enclosed area are asphalt however all other paths are constructed from limestone.

Some unauthorised tracks / trampling exist within the bushland. Motorbikes have been observed using the bushland within the fenced area. The use of informal tracks and the disturbance of soil caused by riding motorbikes has the potential to spread and establish weeds and pathogens and reduce healthy vegetation condition.

The current gates allow pedestrian access however gates that allow easy access on site can also allow motorbikes to enter.

Currently the limestone paths in Craigie Bushland allow limited accessibility, however the asphalted paths in the southern section facilitate better access for people of all abilities. The paths can be accessed from entries in the north and south of the site, with the southwestern entry points also connecting to the Craigie Leisure Centre.

Access and Inclusion

In the Survey of Disability, Ageing and Carers conducted in 2012, 31,400 people, or 18.73% of the population in the City of Joondalup currently have a core activity limitation associated with communication, mobility or self-care, for which assistance is required. A further 5,800 or 3.4% of the population have a disability that restricts schooling or employment opportunities but does not limit their daily core activities.[157]

A recommendation is included in the *Walkability Plan 2013-18* to 'maintain existing internal and external trails to meet trail useability and accessibility standards'.[158]

The City of Joondalup has an *Access and Inclusion Plan 2015-2017*, outlining that 'the City is committed to including people with disability through the continuous improvement of access to its information, facilities and services.'[157]

[157] CoJ (2015b)
[158] CoJ (2013c)

Signage

Signage is important to encourage appropriate use of the site and inform the community about the ecological values of Craigie Bushland. There are numerous signs at Craigie Bushland on the periphery of the site and near the main entrances, detailing information such as the name of the site and that the site is managed by City of Joondalup. Craigie Bushland is also referred to as 'Craigie Open Space.'

This Plan promotes the use of 'Craigie Bushland' as the name of the site, due to its association as a bushland reserve and its high conservation value.

Directional signage uses maps to indicate trails, entrances and infrastructure. Interpretive signage increases awareness of the ecological values of the bushland. The City has developed a *Signage Strategy* to guide the provision of information and interpretive messages within the City's natural areas. As part of the *City's Walkability Plan 2013-2018*, five interpretive signs, one primary, two secondary and 15 directional signs were installed in June 2017. All signs were installed along designated pathways or formal entrances, as shown in Figure 26 and Figure 30.

Figure 26: Interpretive sign at Craigie Bushland

Signs indicating the closest exit are also located within the enclosed area.

There are signs installed on the pedestrian access ways into the enclosed area raising awareness about the presence of the Quenda named as 'Threatened Species Protection Programme in Operation.' There are also signs leading into the enclosed area indicating 'dogs are prohibited at all times and fines apply.'

There are other signs located in Craigie Bushland indicating rubbish dumping is prohibited and signs leading to the Quindalup Dunes Pathway and Stairs. Unauthorised access signage is also displayed on the Water Corporation fence on the northern boundary of Craigie Bushland.

Toilets

There are no toilet facilities on site, however toilets are located at the Craigie Leisure Centre located in the south.

Parking

Parking is available at the Craigie Leisure Centre car park and overflow parking is also available adjacent to the southwestern primary entry point into Craigie Bushland. Frequently visitors to Craigie Bushland park their vehicles along the road access way adjacent to the skate park located behind the Craigie Leisure Centre.

Seating

Craigie Bushland contains seven bench seats. The slats used to construct these seats are made from recycled wood composite.

Seating is available near the five interpretive signs to allow for visitors to sit and read the information displayed on the signage and two seats are also located at the top of the southern Quindalup Dunes Pathway and Stairs, as shown in Figure 27 and Figure 30.

Figure 27: Bench seating at Craigie Bushland

Antisocial Behaviour

There is a history of suspicious bushfire activities, dumping of garden refuse and abandoned vehicles, motorbike riding and cubby houses / camp sites being built in Craigie Bushland, resulting in damage to surrounding vegetation and impacts to the healthy vegetation condition of the site. Monthly inspections are conducted and if cubbies or camp sites are identified, they are dismantled by the City of Joondalup as required.

Additionally City Rangers conduct targeted patrols of Craigie Bushland as part of the City Rangers patrol regime, with their presence forming active surveillance of the bushland and adjoining recreational land.

Rubbish

The City annually monitors the amount of litter present in Craigie Bushland. In 2014 a methodology was established which included calculating the number of items of litter present per hectare, measured by three transects from the centre, interior and edges of the reserve. The amount of litter present per hectare was the lowest in 2014 and in 2015 and 2017 the same amount (5.5 items) of litter was present in both years. In 2016, there was an increase in the amount of litter. It can be difficult to ascertain why this increase may have occurred but it can likely be attributed to unauthorised use of the bushland (Figure 28).

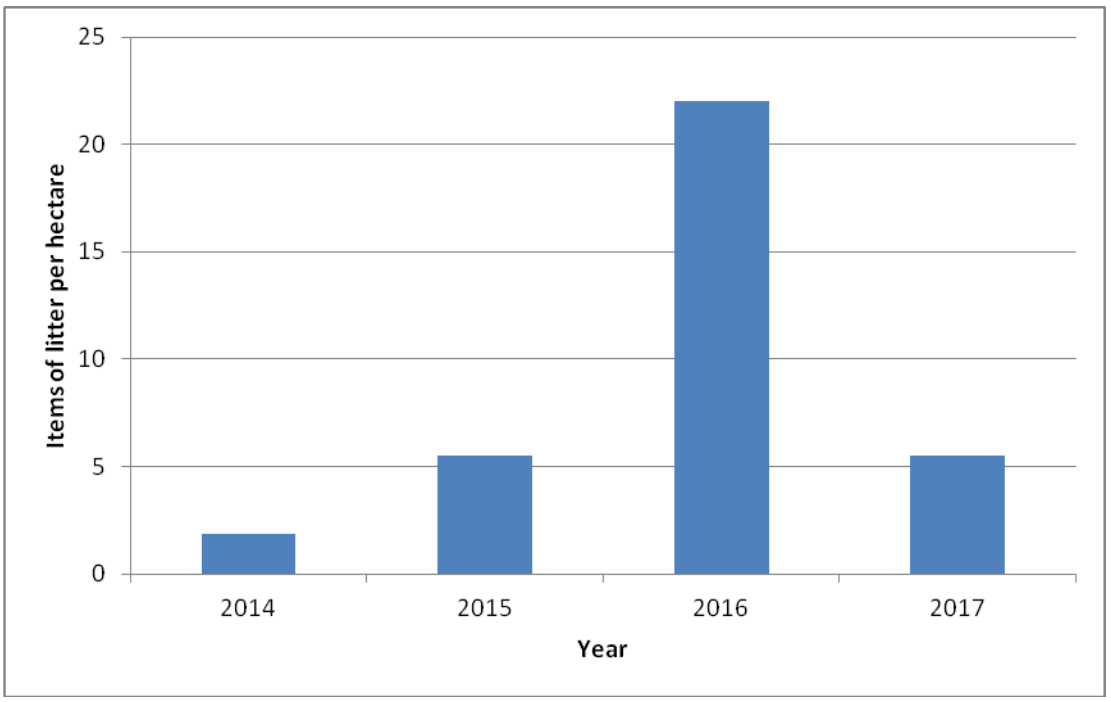

Figure 28: Amount of Litter Present within Craigie Bushland (2014-2017)

Rubbish bins are generally installed in locations where people gather to socialise or undertake recreational activities. Dog waste bins are generally installed in locations where people walk their dogs and can also be used to dispose of general rubbish. A bin is located at the primary entry into Craigie Bushland in the southwest of the site. Another bin is located at the rear of the overflow Craigie Leisure Centre car park, where the majority of visitors to

Craigie Bushland park their vehicles. A bin is also located in close vicinity at the front entrance to the Craigie Leisure Centre (see Figure 30).

Litter can have negative impacts on flora and fauna. Litter is collected by the City on an as needed basis, sometimes in conjunction with hand weeding activities. Frequently litter is found when cubby houses are dismantled.

Water Sensitive Urban Design

A sump is located at Craigie Bushland in the southwest corner of the site behind the Craigie Leisure Centre car park (see Figure 10).

The sump in Craigie Bushland has been developed to provide a vegetated swale in the form of an artificial wetland in keeping with the surrounding bushland to provide a water source for fauna. Currently no further development of the sump is proposed.

Rehabilitation of the sump commenced in 2014 using local native seedlings and in winter 2016 further planting occurred in partnership with the Friends of Craigie Bushland.

Figure 29: Converted sump into an artificial wetland using local wetland flora species at Craigie Bushland

Recommended Social and Built Environment Management Actions:

To enhance the social and built environment in Craigie Bushland, the following management actions are proposed:

Action	Details
Monitor fencing	Maintain both predator proof and conservation fencing on an as needed basis (informed by monthly inspections) to protect the fauna populations and native vegetation within the site.
Monitor and maintain signage	Continue to monitor and maintain signage to ensure it is in good condition and provides appropriate information.
Investigate closure and rehabilitation of informal tracks	Investigate closure and rehabilitation of informal tracks that are used infrequently to protect vegetation.
Monitor and report litter	Monitor and report the amount of litter present in Craigie Bushland on an annual basis.
Dismantle cubby houses and camp sites	Dismantle cubby houses and camp sites as required to discourage vegetation degradation and littering in the surrounding area.
Patrols undertaken by City Rangers	Conduct targeted patrols of Craigie Bushland as part of the City Rangers patrol regime, as a form of active surveillance of the bushland and adjoining land used for recreational purposes.

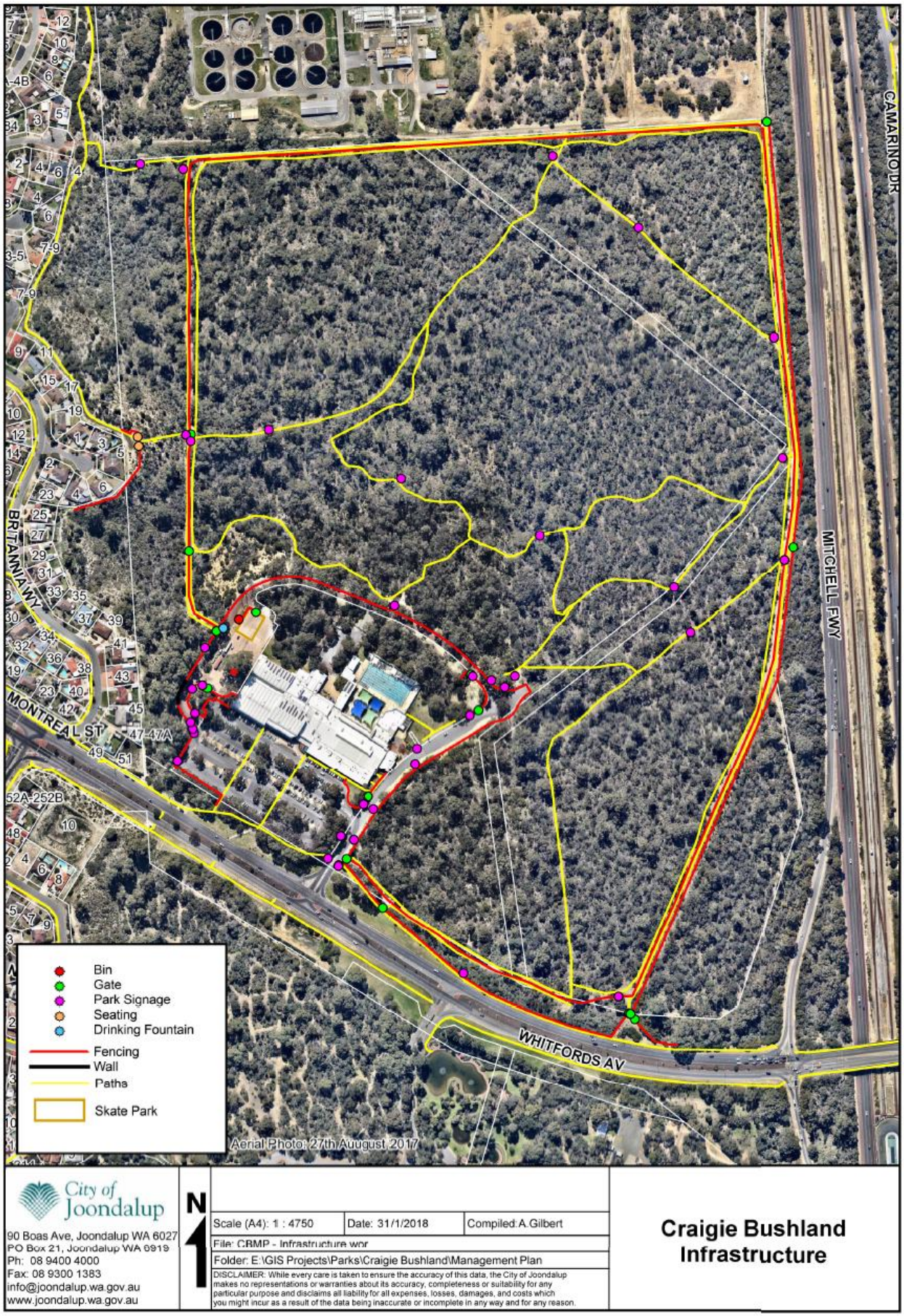

Figure 30: Infrastructure at Craigie Bushland

3.6 Bushfire Management

Bushfire is an important natural feature of the Western Australian landscape. Bushfire helps to shape the diversity of plant communities with many native plants having developed bushfire related adaptations over time, for example bushfire expedites many species to flower or germinate.

Before Aboriginal people populated the Australian continent approximately 40,000 to 60,000 years ago, the major cause of bushfires would have been lightning. Aboriginal people learnt to harness the naturally recurring bushfire caused by lightning and other sources to their advantage, which resulted in skilful burning of landscapes for many different purposes, such as to gain access to difficult areas, promote the development of food plants, for cooking, warmth and signalling and attracting animals for hunting.[159]

Although there are benefits to bushfire, an increase of bushfire occurrences particularly in the same area over a short period of time, referred to as bushfire intervals or measured as time since last bushfire, has the potential to adversely impact flora and fauna populations.

Human activities such as accidents and arson have resulted in increased incidences of bushfire within many urban bushland reserves, which can encourage growth of highly flammable and invasive weeds.

The climate in the southwest of Western Australia has become warmer and drier and is likely to continue to dry, with lower winter rainfall and increased average temperatures resulting in a longer 'bushfire season' and a greater proportion of the landscape that is sufficiently dry enough to burn.[160] [161]

Bushfires can be caused by events such as lightning, unplanned effects from controlled 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.[162] In 2015 the State Government released *State Planning Policy 3.7, Planning in Bushfire Prone Areas* and corresponding guidelines in response to several extreme bushfire events in Australia.

Under the *Bush Fires Act 1954*, local government has the responsibility of preventing bushfires, hence bushfire management of Craigie Bushland is the responsibility of the City of Joondalup. The City of Joondalup has a "duty of care" to take all reasonable precautions to prevent any bushfire from spreading onto neighbouring properties.

The Department of Fire and Emergency Services (DFES) are responsible for responding to bushfires and work with the community and local government to provide education on hazard risk management to prevent, prepare for, respond to and recover from a diverse range of emergencies.[163] [164]

[159] DBCA (2015)
[160] DBCA (2014)
[161] City of Joondalup (2014)
[162] EDOWA (2011)
[163] DFES (2018)

The DFES have developed a *Fire Pre-Plan for the Urban Bushland Area of Craigie Bushland* including site specific information on ecologically sensitive areas, risk management strategies, hazards, communications plan and bushfire suppression strategy and tactics. The Fire Pre-Plan is updated by the DFES annually in conjunction with key stakeholders including the City of Joondalup.[165]

There are numerous public water hydrants located around Craigie Bushland which are installed and maintained by the Water Corporation and DFES, as shown in Figure.

Undertaking bushfire management within Craigie Bushland will help to:

- Protect life, property, critical infrastructure and the environment in Craigie Bushland and adjacent residential areas and privately owned buildings.
- Fulfil obligations under the *Bush Fires Act 1954* and other bushfire related legislation.
- Protect the ecological (flora and fauna) values of Craigie Bushland and ensure long term survival of native wildlife populations.
- Maintain landscape and amenity values from uncontrolled bushfires and inappropriate suppression techniques.
- Reduce the frequency, impact and area of unplanned bushfires.
- Minimise the spread of disease and weeds during bushfire fighting operations and when establishing firebreaks.
- Minimise impacts on regional air quality.

Bushfire Risk

Fuel load assessments are undertaken at Craigie Bushland annually. The latest fuel load assessment was conducted at Craigie Bushland in September 2017. The assessment indicated the majority of the site has a fuel load between the range of 11-15 tonnes per hectare. The fuel load assessment was undertaken according to the methodology within the Department of Fire and Emergency Services *Visual Fuel Load Guide for the Swan Coastal Plain and Darling Scarp* (2015).[166] The annual fuel load assessment results are used to inform the bushfire management of the site.

In 2017 the City of Joondalup developed a *Bushfire Risk Management Plan* in order to provide an ongoing strategic approach to the management of bushland areas and to reduce the incidence of bushfire within the City.

As part of the development of the City's *Bushfire Risk Management Plan*, the City carried out a Strategic Bushfire Risk Assessment which categorised assets across the City into four key areas; human, economic, environmental and cultural. A two stage (desktop and field assessment) risk analysis was undertaken for each asset which included assessment of a number of criteria to determine the overall risk of bushfire occurrence for each asset.

[164] DFES (2016a)
[165] DFES (2016b)
[166] DFES (2015)

Following the determination of the overall risk for each asset and the priority for treatment, mitigation strategies that can be implemented to reduce the risk of bushfire have been examined and management recommendations have been included within the Plan.

The City of Joondalup *Bushfire Risk Management Plan* is an internal operating document as it focuses on day-to-day management and informs maintenance activities.

Bushfire Occurrences

Previous reports indicate small bushfires both accidental or deliberate in nature have frequently occurred in Craigie Bushland.

Bushfire records from 2002 suggest bushfires have frequently occurred within or in close vicinity to the Craigie Bushland site, however many have been caused by cigarettes from passing vehicles along nearby Whitfords Avenue or the Mitchell Freeway and have not intruded into Craigie Bushland. Although some bushfires are believed to be deliberately lit, particularly around the Craigie Leisure Centre or adjoining Warrandyte Park. There has been a reduction in the frequency of bushfires since 2015. This could be due to factors such as the DFES bushfire awareness campaigns and the high level of patronage at the Craigie Leisure Centre acting as passive surveillance of suspicious activity. Records of bushfire occurrences at Craigie Bushland are detailed in Table 5.

The City of Joondalup collates information related to bushfire incidents on the City's Geographic Information System (GIS). Monitoring of bushfire occurrences and detailing bushfire incidents and frequency through mapping may inform bushfire prevention actions in relation to areas that may be targeted by suspicious/deliberate bushfire activities.

Dates	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**
Bushfire Occurrences	0	0	1	4	3	0	0	1	1	2	3	0	1	0	2	3

Table 5: Bushfire Occurrences at Craigie Bushland 2002-2017 (DFES 2018)

Bushfire Response

The closest Fire and Rescue Service Station is located at the Duncraig Fire Station on Hepburn Avenue in Duncraig and this Service Station is responsible for suppressing bushfires within Craigie Bushland. The Western Australia Police are responsible for the evacuation of residents and visitors, if required.

Bushfire Recovery

Weed control is revised after bushfire incidents to ensure maximum natural regeneration and regrowth by selecting appropriate chemicals, targeting weeds if safe to do so and spraying weedy grasses using targeted approaches in accordance with the City's Weed Management Plan.

Current Management Approach

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

- Controlled access;
- Weed (invasive) species management;
- Annual fuel load assessments;
- Annual inspection, maintenance and if required installation of further bushfire access tracks (bushfire access ways and strategic firebreaks).

The City's Bush Fire Control Officers conduct annual inspections of bushfire access tracks from 1 November to 31 December. All bushfire access tracks must be installed and maintained by 31 October.

Annual fuel assessments (fuel load and bushfire hazards) are used to inform on-going bushfire management of the site.

Weed control and maintenance of bushfire access tracks are conducted in accordance with the City's Annual Bushland Schedule.

The City has also developed *Fire Weed Management Guidelines* for the City's natural areas to mitigate the impact of weeds within the post bushfire environment. These Guidelines are implemented within the City's natural areas after a bushfire event.

Recommended Bushfire Management Actions:

To prevent bushfire occurrences and minimise the environmental impact of bushfire occurrences in Craigie Bushland, the following management actions are proposed:

Action	**Details**
Implement the City's *Bushfire Risk Management Plan*	Implement the management actions identified in the City's *Bushfire Risk Management Plan* applicable to Craigie Bushland.
Undertake Fuel Assessments	Undertake annual Fuel Assessments (fuel load and bushfire hazards) and report fuel load and overall fuel hazard rating using the DFES approved Victorian Government *'Overall Fuel Hazard Assessment Guide'* to inform bushfire prevention actions.
Inspect, install and maintain firebreaks, bushfire access tracks and footpaths as required	Inspect, install and maintain firebreaks, bushfire access tracks and footpaths as required, including weed control and pruning of vegetation, by implementing the Annual Bushland Schedule.
Monitor bushfire occurrences	Monitor bushfire occurrences through mapping and updating Geographic Information System (GIS) layers detailing bushfire incidents and frequency to inform bushfire prevention actions.

Action	Details
Assess weed control techniques after bushfire incidents and implement *Fire Weed Management Guidelines*	Revise weed control after bushfire incidents to ensure maximum natural regeneration and regrowth by selecting appropriate chemicals, targeting weeds if safe to do so and spraying weedy grasses using backpacks, to reduce the infestation of weeds in natural areas after a bushfire.

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 Craigie Bushland through the following actions:

- Participation in the Friends of Craigie Bushland environmental volunteer group to assist with bushland restoration and maintenance activities;
- Minimising access and disturbance to the site by staying on paths, not taking motorbikes and/or other vehicles into natural areas and ensuring dogs are kept on a lead at all times;
- Contain cats, particularly at night and ensure they stay out of both the fenced and unfenced areas of Craigie Bushland;
- Planting local, native species in gardens where possible to enhance connectivity to nearby vegetation at Craigie Bushland and other natural areas;
- Avoid interference with 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 refuse or littering on site. Litter could be collected when spotted and the community could organise or participate in a Clean Up Australia Day event at the site.

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. There are a number of schools (such as Craigie Heights, Beldon, Whitford Catholic, Springfield and Bambara Primary Schools and St Stephen's School) within close proximity to Craigie Bushland which creates possible bushland learning opportunities for students.

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.

As part of the Environmental Education Program, the City has developed an Adopt a Bushland Program for students from years 4 to 7 to provide an interactive educational bushland management program. The abovementioned schools may wish to deliver activities encouraged in the Adopt a Bushland program.

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 conduct regular plant identification training, including weed management. New members in the Natural Areas Team undertake training in the management of pathogens.

The City's Friends Groups are instrumental in enhancing, protecting and preserving key natural areas within the City, including Craigie Bushland. The City works in partnership with Friends Groups to support their operational activities and in identifying training needs.

Recommended Education and Training Management Actions:

To increase community awareness and training opportunities regarding natural areas management, the following actions are proposed:

Action	**Details**
Environmental Education Program	Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as: • pathogens; • weeds; • litter; • bushfire; • fauna, flora and fungi awareness; • preventing interference with wildlife; and • responsible pet ownership.
Support the 'Friends of Craigie Bushland'	Support the Friends of Craigie Bushland group and encourage community participation in the management of this natural area.

Action	Details
Adopt a Bushland program	Promote the utilisation of the Adopt a Bushland program to encourage stewardship and increase awareness of the environment within the City of Joondalup.
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.
Friends Groups training	Provide training to the Friends of Craigie Bushland and other City of Joondalup Friends groups as needed.

4.0 Implementation Plan

To ensure the Craigie Bushland Management Plan is being implemented in an effective and timely manner the following steps will be undertaken:

- Monthly weed inspections;
- Natural Area Key Performance Indicators will be reported on in the City of Joondalup Annual Report;
- Scientific research;
- Field monitoring; and
- Review of the Management Plan.

4.1 Inspections

- Weed inspections are conducted by the City of Joondalup once every 4 weeks.
- The predator proof fence at Craigie Bushland is inspected on a monthly basis by the City of Joondalup.
- Bushfire fuel load assessments of Craigie Bushland are undertaken annually by the City's Bush Fire Control Officers.

4.2 Monitoring and Reporting

A review of the Craigie Bushland Management Plan will be undertaken annually through reporting against progress made in implementing recommended management actions.

Ongoing reporting against Council endorsed Natural 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.

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 2018/19- 2023/24
Waste present in natural areas – items per hectare	This data is collected on an annual basis from ten of the City's reserves.	Annual 2018/19- 2023/24
Percentage of natural areas protected within City reserves	Areas (hectares) included in the City's proposed Conservation reserves within the District/Local Planning Scheme (previously Schedule 5 and City of Joondalup Bush Forever sites).	Annual 2018/19- 2023/24
Overall change in vegetation vigour (condition) per area – expressed as an increase or decrease in the Vegetation Condition Index (VCI)	Data obtained from analysis of remote multi spectral imagery. The imagery is currently obtained every two years.	Biennial (every two years) 2019/2020 2021/2022 2023/2024
Canopy Cover – expressed as a percentage per natural area	Data obtained from analysis of remote multi spectral imagery. The imagery is currently obtained every two years.	Biennial (every two years) 2019/2020 2021/2022 2023/2024
Vegetation condition per area (using the Keighery Scale of vegetation condition, see Appendix 5), expressed as a percentage for each classification (pristine to completely degraded).	Data obtained through on site floristic survey undertaken to inform the review of the Management Plan, service provided by specialised consultants.	Five Yearly 2021/2022

Table 6: Natural Area Key Performance Indicators

4.3 Scientific Research and Monitoring

Quenda surveys are currently undertaken by the University of Western Australia at Craigie Bushland for scientific and research purposes and to report on the health of the existing Quenda population. Further information on fauna monitoring at Craigie Bushland will be included in the *Fauna Management Plan* identified as a *Recommended Management Action* within this Plan.

A comprehensive flora survey reporting on the vegetation condition, vegetation communities, native flora, priority flora listed under Federal and State legislation and weed species is to be conducted in 2021/2022. Comparisons to previous surveys will be made to assess site changes over time.

4.4 Management Plan Review

The implementation of the Craigie Bushland Management Plan will be reported on annually and a comprehensive review will occur every 10 years. The next review is due in 2028/2029.

4.5 Summary of Recommended Management Actions

Biodiversity Conservation Area	Recommended Management Action	Detail	Timeframe
Flora	Flora survey	Undertake a follow up flora survey in spring to supplement previous flora surveys, every 5 years. Make comparisons between flora surveys to assess site changes every 5-10 years. Include an opportunistic survey for fungi during flora surveying.	5-10 years
	Investigate planting trees (and vegetation) for habitat	Investigate planting Tuart (*Eucalyptus gomphocephala*) and Marri (*Corymbia calophylla*) trees in Craigie Bushland to provide nesting and roosting habitat and a feeding resource in the long term for Carnaby's Black-Cockatoos.[64] Investigate planting other species of local trees and shrubs (such as Jarrah, *Banksia* and *Hakea* species) to provide opportunities for nesting sites and shelter for fauna.	Within 1-2 years
	Revegetation	Support revegetation being conducted in "Degraded" or "Completely Degraded" areas using local provenance species, as required.	Ongoing
	Monthly weed inspections	Continue monthly weed inspections to establish the extent of weeds and to identify priority weed species.	Monthly / Ongoing
	Annual weed percentage cover monitoring and reporting	Monitor and report on the percentage cover of environmental weeds in Craigie Bushland on an annual basis, using three quadrats.	Annual / Ongoing
	Weed control	Continue to undertake a coordinated approach to regular weed control by implementing the Natural Areas Annual Maintenance Schedule.	Ongoing

Biodiversity Conservation Area	Recommended Management Action	Detail	Timeframe
Flora	Weed Management Plan	Continue the implement the *City of Joondalup Weed Management Plan* to deliver an ongoing strategic approach to reduce the incidence of weeds in Craigie Bushland and across the City.	Ongoing
Fungi	Fungi survey	Continue monitoring and reporting on fungi health during flora survey activities.	5-10 years (opportunistic during flora/fauna surveys)
Pathogens	Pathogen Management	Continue to implement the recommendations from the *City of Joondalup Pathogen Management Plan* that are applicable to the management of Craigie Bushland, including implementation of relevant operational and procurement guidelines.	Ongoing
	Education and Training	Liaise with key stakeholders working in Craigie Bushland about hygiene practices and training.	Within 1-2 years
Fauna	Develop a *Fauna Management Plan*	Develop a *Fauna Management Plan* in consultation with key stakeholders to ensure the long-term health and survival of existing fauna populations at Craigie Bushland. Key issues to be addressed within the *Fauna Management Plan* include roles and responsibilities of relevant land managers and authorites and risk management in response to population growth and potential environmental impacts.	Within 3 years
	Fauna survey	Undertake a follow up fauna survey to supplement previous fauna surveys, within 10 years, including a targeted winter opportunistic survey for invertebrates.	Within 10 years
	Quenda monitoring	Continue liaisons with the University of Western Australia on research and monitoring being conducted on the Quenda population.	Ongoing
	Rainbow Bee-eater nesting sites	Continue to monitor for Rainbow Bee-eater nesting sites through monthly inspections and install fencing and signage around exposed nesting sites to decrease trampling of nests by humans or dogs.	Ongoing

Biodiversity Conservation Area	Recommended Management Action	Detail	Timeframe
	Feral animal control	Continue to monitor feral animal populations and implement regular feral animal control to reduce pressures on native fauna and flora. Remove feral beehives if they are identified on site and are accessible.	Ongoing
	Patrols to ensure dogs are kept on leads and owners are cleaning up after their dogs	Continue targeted patrols by City Rangers to ensure dogs are kept on leads and their droppings are collected.	Ongoing
Social and Built Environment	Maintain fencing	Maintain both predator proof and conservation fencing on an as needed basis (informed by monthly inspections) to protect the fauna populations and native vegetation within the site.	Monthly / Ongoing
	Monitor and maintain signage	Continue to monitor and maintain signage to ensure it is in good condition and provides appropriate information.	Ongoing
	Investigate closure and rehabilitation of informal tracks	Investigate closure and rehabilitation of informal tracks that are used infrequently to protect vegetation.	Ongoing
	Monitor and report litter	Monitor and report the amount of litter present in Craigie Bushland on an annual basis.	Annual / Ongoing
	Dismantle cubby houses and camp sites	Dismantle cubby houses and camp sites as required to discourage vegetation degradation and littering in the surrounding area.	Ongoing
	Patrols undertaken by City Rangers	Conduct targeted patrols of Craigie Bushland as part of the City Rangers patrol regime, as a form of active surveillance of the bushland and adjoining land used for recreational purposes.	Ongoing

Biodiversity Conservation Area	Recommended Management Action	Detail	Timeframe
Bushfire Management	Implement the City's *Bushfire Risk Management Plan*	Implement the management actions identified in the City's *Bushfire Risk Management Plan* applicable to Craigie Bushland.	Ongoing
	Undertake Fuel Assessments	Undertake annual Fuel Assessments (fuel load and bushfire hazards) and report fuel load and overall fuel hazard rating using the DFES approved Victorian Government *'Overall Fuel Hazard Assessment Guide'* to inform bushfire prevention actions.	Annual / Ongoing
	Inspect, install and maintain firebreaks, bushfire access tracks and footpaths as required	Inspect, install and maintain firebreaks, bushfire access tracks and footpaths as required, including weed control and pruning of vegetation, by implementing the Annual Bushland Schedule.	
	Monitor bushfire occurrences	Monitor bushfire occurrences through mapping and updating Geographic Information System (GIS) layers detailing bushfire incidents and frequency to inform bushfire prevention actions.	Ongoing
	Assess weed control techniques after bushfire incidents and implement *Fire Weed Management Guidelines*	Revise weed control after bushfire incidents to ensure maximum natural regeneration and regrowth by selecting appropriate chemicals, targeting weeds if safe to do so and spraying weedy grasses using backpacks, to reduce the infestation of weeds in natural areas after a bushfire.	Ongoing

Biodiversity Conservation Area	Recommended Management Action	Detail	Timeframe
Education and Training	Environmental Education Program	Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as: • pathogens; • weeds; • litter; • bushfire; • flora, fungi and fauna awareness; • preventing hand feeding of wildlife; and • responsible pet ownership.	Ongoing
	Support the Friends of Craigie Bushland	Support the Friends of Craigie Bushland group and encourage community participation in the management of this natural area.	Ongoing
	Adopt a Bushland program	Promote the utilisation of the Adopt a Bushland program to encourage stewardship and increase awareness of the environment within the City of Joondalup.	Ongoing
	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.	Ongoing
	Friends Groups training	Provide training to the Friends of Craigie Bushland and other City of Joondalup Friends groups as needed.	Ongoing

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6.0 Appendices

Appendix 1 – Relevant Local, State and Federal Legislation, Policies, Plans and Strategies

Appendix 2 – Craigie Bushland Flora Species List

Appendix 3 – Craigie Bushland Key Flora

Appendix 4 - Conservation Codes for Western Australian Flora and Fauna

Appendix 5 – Keighery Scale Definitions

Appendix 6 – Historical Vegetation Units surveyed at Craigie Bushland

Appendix 7 - Examples of Priority Weed Species at Craigie Bushland

Appendix 8– Craigie Bushland High Priority Weed Species Management

Appendix 9 – Craigie Bushland Fauna Species List

Appendix 10 – Craigie Bushland Key Fauna

Appendix 11 – Craigie Bushland Example of Non-native Fauna

Appendix 12 – Craigie Bushland Fungi Species List – 2016 Survey

Appendix 1 – Relevant Local, State and Federal Legislation, Policies, Plans and Strategies

Local Government

The purpose of the Craigie Bushland Management Plan aligns with the environmental aims and objectives of a number of City of Joondalup Plans including:

Strategic Community Plan

The City of Joondalup *Strategic Community Plan 2012-2022* highlights the focus on preservation, conservation and accessibility of the City's natural assets and the importance of engaging with the community and regional stakeholders.

Environment Plan

The *City of Joondalup Environment Plan 2014-2019* provides strategic direction in the delivery of environmental initiatives within the City of Joondalup.

Biodiversity Action Plan

The *City of Joondalup Biodiversity Action Plan 2009 – 2019* provides direction for the City's biodiversity management activities and details the development of individual Natural Areas Management Plans as an action.

City of Joondalup District Planning Scheme No. 2

The current City of Joondalup *District Planning Scheme No.2* recognises Craigie Bushland as reserved for Parks and Recreation. The City of Joondalup D*raft Local Planning Scheme No.3* was endorsed by the City of Joondalup Council in 2017 and will supersede *District Planning Scheme No.2* once approved by the Minister for Planning and published in the Government Gazette.

The City of Joondalup *Draft Local Planning Scheme No.3* will continue to reflect the reservation of Craigie Bushland as Parks and Recreation, in accordance with the current Metropolitan Regional Scheme.

City of Joondalup Pest Plant Local Law 2012

Under the *Biosecurity and Agriculture Management Act 2007* and the *Local Government Act 1995*, the Council of the City of Joondalup made the *Pest Plant Local Law 2012* to require the owner or occupier of private land within the City of Joondalup district to destroy, eradicate or otherwise control pest plants within a specified time. Caltrop (*Tribulus terrestis*) is designated as a pest plant.

Caltrop has not been identified in Craigie Bushland.

Local Biodiversity Program (formerly Perth Biodiversity Project)

The City of Joondalup is one of 32 local governments participating in the Western Australian Local Government Association's (WALGA's) Local Biodiversity Program. The aim of the Local Biodiversity Program is to support local governments to effectively integrate biodiversity conservation into land use planning to protect and manage local natural areas.

As part of the Local Biodiversity Program, the City of Joondalup assessed all natural areas from 2004 onwards using the ecological criteria of the Natural Area Assessment process, resulting in a priority ranking of natural areas. The City of Joondalup assesses major conservation, high priority and medium priority natural areas approximately every 5-7 years using this assessment tool.

Natural Area Assessments include a desktop assessment and field survey and document information such as:

- vegetation complexes;
- threatened or significant flora or ecological communities;
- structural plant communities;
- weed species;
- vegetation condition assessment;
- ecological criteria rankings;
- a viability estimate; and
- fauna species observed.

Craigie Bushland is one of the City's five Major Conservation Areas due to the high biodiversity values of the area.

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.

Craigie Bushland is not listed on any State or Federal Indigenous heritage inventory or register.

Biosecurity and Agriculture Management Act 2007

The Act gives provision to control the entry, establishment, spread and impact of certain organisms that have or may have an adverse effect on other organisms, human beings, the environment, agricultural activities or related commercial activities. Pests, including plants, are declared under the Act as prohibited organisms.

Bushfires Act 1954

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

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 Craigie Bushland, in accordance with the *Cat Act 2011*.

Dog Act 1976

The Act makes provisions for the control of dogs in public and private spaces and promotes the responsible ownership of dogs.

Dogs are prohibited in the enclosed area of Craigie Bushland. The area outside the enclosed area is designated place where dogs must be on a lead at all times by Council resolution in accordance with the *Dog Act 1976*.

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.

Wildlife Conservation Act 1950 (WC Act)

The Act provides the statute relating to conservation and legal protection of flora and fauna.

Under the *Wildlife Conservation Act* 1950, the following species utilise Craigie Bushland:

- Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*);
- Rainbow Bee-eater (*Merops ornatus*); and
- Quenda (*Isodon obesulus fusciventer*).

One priority flora species listed under the *Wildlife Conservation Act 1950* has been recorded at Craigie Bushland, *Jacksonia sericea*. The Department of Biodiversity, Conservation and Attractions (DBCA) uses the International Union for Conservation of Nature for assigning species to threat categories. Under the DBCA Conservation Code, *Jacksonia sericea* is categorised as Priority Four (Rare, Near Threatened and other species in need of monitoring).

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* received approval by the State Parliament on 21 September 2016 and will eventually fully replace both the *Wildlife Act* 1950 and the

Sandalwood Act 1929. The *Biodiversity Conservation Act* greatly increases the protection for threatened species and introduces a new protection for Threatened Ecological Communities. However the provisions that replace those existing under the *Wildlife Act* and *Sandalwood Act* (including threatened species listings) and their associated Regulations cannot be brought into effect until the necessary Biodiversity Conservation Regulations have been made. The Biodiversity Conservation Regulations are currently being developed.

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.

Craigie Bushland is designated as a Bush Forever site (303). Seven species identified in Craigie Bushland are listed as naturally occurring significant flora of the Perth Metropolitan Region:

- *Allocasuarina lehmanniana* (Dune Sheok);
- *Callitris preissii* (Rottnest Island Pine);
- *Conospermum triplinervium* (Tree Smokebush);
- *Hibbertia cuneiformis* (Cutleaf Hibbertia);
- *Jacksonia sericea (Waldjumi)* (also a Priority 4 species under the WC Act) ;
- *Lechenaultia linarioides* (Yellow Leschenaultia)*;* and
- *Melaleuca cardiophylla (*Tangling Melaleuca)

Perth and Peel Green Growth Plan for 3.5 million (draft) (Green Growth Plan).

The *Green Growth Plan* delivers a comprehensive environmental program for the protection of both Commonwealth matters of national environmental significance and State environmental values. The draft *Green Growth Plan* provides a comprehensive approach to the avoidance and mitigation of environmental impacts and a committed Conservation Program that will deliver significant improvements to the protection and management of the environment as the Perth and Peel regions grow to a population of 3.5 million people.

State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Region

The *State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Region* 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

The *State Planning Policy 3.7 – Planning in Bushfire Prone Areas* (SPP 3.7) seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on new property and infrastructure. SPP 3.7 applies to all higher order strategic planning documents, strategic planning proposals, subdivision and development applications located in designated bushfire prone areas.

DPaW Draft Weed Prioritisation Process 2013

The DPaW conducted a weed prioritisation process for weeds in each DPaW region, with the aim being to establish a species-led and an asset-protection-based approach to weed management, focussing on infestations of species which are considered to be high impact, rapidly invasive and still at a population size which is feasible to eradicate or contain to a manageable size. The weed prioritisation process is based on the Environmental Weed Census and Prioritisation, Swan Natural Resource Management Region project (Bettink and Keighery 2008) and the Environmental Weed Strategy of Western Australia (DPaW 1999). The assessment prioritises weeds using criteria of potential distribution, current distribution, ecological impact, invasiveness and feasibility of control to rate weeds as very high, high, medium, low, negligible, further assessment required or alert.

Craigie Bushland contains 26 high priority weeds rated as high priority due to their ecological impact in the DPaW Weed Prioritisation Process for the Swan Region 2013.

Federal Government

Relevant Legislation and Strategies

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.

The *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* listed endangered Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and *Banksia* Woodlands of the Swan Coastal Plain Threatened Ecological Community has been recorded in Craigie Bushland.

Australia's Biodiversity Conservation Strategy 2010-2030

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

Weeds of National Significance (WONS) (1999 and 2012)

The Australian Government endorsed a list of 20 WONS in 1999 and a further 12 were added in 2012. 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.

Craigie Bushland contains no known Weeds of National Significance.

Threatened Species Strategy 2015

The long-term goal of the Australian Government's Threatened Species Strategy is to recover threatened plants and animals. The Strategy provides guidance into how the

Australian community can work together to protect threatened animals and plants, both now and into the future.

The Strategy contains a a five-year Action Plan, which outlines on-ground actions and measurable targets to turn around the decline of threatened species. The Action Plan focuses on:

- Tackling feral cats
- Creating safe havens for species most at risk
- Improving habitat
- Intervening in emergencies to avert extinctions.

International Conventions or Listings

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

The IUCN Red List of Threatened Species™ provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria.

One endangered IUCN Red List species has been recorded in Craigie Bushland, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*).

Appendix 2 – Craigie Bushland Flora Species List

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
								Craigie Bushland (ELA 2016)	Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW		Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Aizoaceae	**Carpobrotus edulis*	Hottentot Fig						+	+	+	+		+
Aizoaceae	**Galenia pubescens* var. *pubescens*										+		+
Aizoaceae	*?*Aptenia cordifolia*										+		
Aizoaceae	*Carpobrotus* sp. (sterile)					•					+		
Aizoaceae	*Sarcozona bicarinata*			P3			•						
Amaranthaceae	*Ptilotus drummondii*	Narrowleaf Mulla Mulla				•			+	+	+	+	+
Amaranthaceae	*Ptilotus manglesii*	Pom Poms							+	+	+		+
Amaranthaceae	*Ptilotus polystachyus*	Prince of Wales Feather						+	+	+	+	+	+
Amaranthaceae	*Ptilotus stirlingii*	Stirling's Mulla Mulla										+	
Anarthriaceae	**Schinus terebinthifolius*	Brazilian Pepper				•		+		+	+		
Anarthriaceae	*Lyginia imberbis*										+		
Apiaceae	**Foeniculum vulgare*	Fennel									+		
Apiaceae	*Daucus glochidiatus*	Australian Carrot						+		+	+		
Apiaceae	*Eryngium pinnatifidum* (formerly *Eryngium*	Blue Devils						+	+	+	+		+

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
	rostratum)												
Apiaceae	*Homalosciadium homalocarpum*							+	+	+	+		
Apiaceae	*Xanthosia huegelii*							+		+	+		
Araliaceae	*Hydrocotyle blepharocarpa*										+		
Araliaceae	*Trachymene coerulea* subsp. *coerulea*										+		
Araliaceae	*Trachymene pilosa*	Native Parsnip						+	+	+	+		+
Asparagaceae	**Agave americana*	Century Plant						+	+	+			+
Asparagaceae	**Asparagus aethiopicus*					•							
Asparagaceae	**Lachenalia reflexa*	Cape Cowslip				•		+		+	+	+	+
Asparagaceae	*Acanthocarpus preissi*					•		+		+	+	+	+
Asparagaceae	*Dichopogon capillipes*								+				
Asparagaceae	*Lomandra ?hermaphrodita*										+		
Asparagaceae	*Lomandra ?micrantha* subsp. *micrantha* (sterile)										+		
Asparagaceae	*Lomandra caespitosa*	Tufted Mat Rush							+	+	+		
Asparagaceae	*Lomandra hermaphrodita*					•		+		+	+		
Asparagaceae	*Lomandra maritima*					•		+		+	+	+	+
Asparagaceae	*Lomandra micrantha*							+		+	+		

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
	subsp. *micrantha*												
Asparagaceae	*Lomandra preissii*							+	+	+			
Asparagaceae	*Lomandra* sp. (sterile)										+	+	
Asparagaceae	*Lomandra* sp. *caespitosa/suaveolens* (sterile)										+		
Asparagaceae	*Lomandra suaveolens*							+	+	+	+		
Asparagaceae	*Sowerbaea laxiflora*	Purple Tassels				•		+	+	+	+		+
Asparagaceae	*Thysanotus arenarius*								+	+	+		
Asparagaceae	*Thysanotus dichotomus*	Branching Fringe-lily											+
Asparagaceae	*Thysanotus manglesianus*	Fringed Lily						+	+	+	+		+
Asparagaceae	*Thysanotus multiflorus*									+			
Asparagaceae	*Thysanotus patersonii*	Twining Fringe-lily						+		+			
Asparagaceae	*Thysanotus sparteus*							+		+	+		
Asparagaceae	*Thysanotus thyrsoideus*									+			
Asparagaceae	*Thysanotus triandrus*									+		+	+
Asphodelaceae	**Asphodelus fistulosus*								+	+			
Asphodelaceae	**Trachyandra divaricata*	Dune Onion Weed						+		+	+		+
Asteraceae	**Arctotheca calendula*	Cape Weed						+	+		+		+

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Asteraceae	**Arctotheca populifolia*	Dune Arctotheca				•							
Asteraceae	**Arctotis stoechadifolia*	African daisy				•		+		+			
Asteraceae	**Conyza bonariensis*	Flax leaf Fleabane									+	+	+
Asteraceae	**Conyza parva*	Fleabane				•		+		+			
Asteraceae	**Conyza sumatrensis*	Fleabane				•		+					
Asteraceae	**Cotula turbinata*	Funnel Weed							+				+
Asteraceae	**Osteospermum ecklonis*								+	+	+		
Asteraceae	**Dittrichia graveolens*	Stinkwort										+	
Asteraceae	** Dittrichia viscosa*					•							
Asteraceae	**Galinsoga parviflora*	Potato Weed				•							
Asteraceae	**Gazania linearis*	Gazania				•		+	+	+	+		
Asteraceae	**Hypochaeris glabra*	Smooth Catsear						+	+	+	+		+
Asteraceae	**Hypochaeris radicata*	Flat Weed						+		+	+		
Asteraceae	**Lactuca serriola*	Prickly Lettuce						+		+	+		
Asteraceae	**Monoculus monstrosus* (formerly *Tagetes minuta; Osteospermum clandestinum)*	Southern Cone Marigold						+		+	+		
Asteraceae	**Osteospermum ecklonis*	Cape marguerite						+		+			
Asteraceae	**Senecio vulgaris*	Common				•		+					

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
								Craigie Bushland (ELA 2016)	Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW		Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
		Groundsel											
Asteraceae	**Sonchus oleraceus*	Common Sowthistle						+	+	+	+		
Asteraceae	**Taraxacum officinale*	Dandelion											+
Asteraceae	**Urospermum picroides*	False Hawkbit						+	+	+	+		+
Asteraceae	**Ursinia anthemoides* subsp. *anthemoides*	Ursinia						+	+	+	+		+
Asteraceae	*?*Chrysanthemum* sp. (garden escapee)										+		
Asteraceae	*Asteridea pulverulenta*	Common Bristle Daisy							+				
Asteraceae	*Cotula australis*	Common Cotula									+		
Asteraceae	*Helichrysum luteoalbum*	Jersey Cudweed				•							+
Asteraceae	*Lagenophora huegelii*							+	+	+	+		+
Asteraceae	*Olearia axillaris*	Coastal Daisybush				•		+		+	+		+
Asteraceae	*Pithocarpa cordata*									+	+		
Asteraceae	*Podolepis gracilis*	Slender Podolepis						+		+	+		+
Asteraceae	*Podotheca angustifolia*	Sticky Longheads									+		
Asteraceae	*Podotheca chrysantha*	Yellow Podotheca									+		
Asteraceae	*Podotheca gnaphalioides*	Golden Longheads				•		+	+	+	+		

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Asteraceae	*Quinetia urvillei*									+	+		
Asteraceae	*Senecio pinnatifolius* var. *latilobus*										+		
Asteraceae	*Senecio* sp. (unresolved taxonomy)(WAH)										+		
Asteraceae	*Waitzia suaveolens*	Fragrant Waitzia							+		+		+
Brassicaceae	**Brassica tournefortii*	Mediterranean Turnip				•		**+**	+	+	+		+
Brassicaceae	**Cakile maritima*	Sea Rocket				•							
Brassicaceae	**Diplotaxis tenuifolia*	Sand Rocket											+
Brassicaceae	**Heliophila pusilla*	Heliophila				•		**+**			+		+
Brassicaceae	**Raphanus raphanistrum*	Wild Radish											+
Campanulaceae	**Wahlenbergia capensis*	Cape Bluebell						**+**	+		+		
Campanulaceae	**Cuscuta epithymum*										+		
Campanulaceae	*Wahlenbergia gracilenta*	Annual Bluebell				•					+		
Caprifoliaceae	**Centranthus macrosiphon*	Pretty Betsy						**+**		+	+		
Caryophyllaceae	**Cerastium glomeratum*	Mouse Ear Chickweed						**+**	+	+	+		+
Caryophyllaceae	**Petrorhagia dubia* (formerly *Petrorhagia velutina)*							**+**	+	+	+	+	

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
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Caryophyllaceae	**Polycarpon tetraphyllum*									+			
Caryophyllaceae	**Sagina apetala*	Annual Pearlwort				•							
Caryophyllaceae	**Silene gallica* var. *gallica*								+		+		
Caryophyllaceae	**Stellaria media*	Chickweed						+			+		
Casuarinaceae	*Allocasuarina fraseriana*	Sheoak						+	+	+	+	+	+
Casuarinaceae	*Allocasuarina humilis*	Dwarf Sheoak						+	+	+	+	+	+
Casuarinaceae	*Allocasuarina lehmanniana subsp. lehmanniana*					•		+		+		+	+
Celastraceae	*Tripterococcus brunonis*							+		+	+		
Centrolepidaceae	*Centrolepis drummondiana*									+	+		
Chenopodiaceae	**Chenopodium macrospermum*					•							
Chenopodiaceae	*Rhagodia baccata* subsp. *baccata*	Berry Saltbush				•		+		+	+	+	+
Colchicaceae	*Burchardia congesta (formerly Burchardia umbellata)*							+	+	+	+	+	+
Convolvulaceae	**Cuscuta epithymum*										+		
Convolvulaceae	**Dichondra micrantha*					•							
Crassulaceae	**Crassula alata*					•							

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
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Crassulaceae	**Crassula glomerata*	Stonecrop				•		+	+	+	+		
Crassulaceae	**Crassula thunbergiana*									+			
Crassulaceae	*Crassula colorata*	Dense Stonecrop				•					+		
Crassulaceae	*Crassula decumbens*										+		
Cupressaceae	*Callitris preissii*	Rottnest Island Pine				•		+		+	+		+
Cyperaceae	**Cyperus tenellus*							+					
Cyperaceae	**Isolepis marginata*									+	+		
Cyperaceae	*Cyathochaeta teretifolia*			P3			•						
Cyperaceae	*Ficinia nodosa*	Knotted Club Rush				•				+			+
Cyperaceae	*Isolepis marginata*	Coarse Club-rush						+			+		
Cyperaceae	*Lepidosperma angustatum*											+	+
Cyperaceae	*Lepidosperma calcicola*					•					+		
Cyperaceae	*Lepidosperma costale*										+		+
Cyperaceae	*Lepidosperma gladiatum*							+		+		+	+
Cyperaceae	*Lepidosperma leptostachyum*							+	+	+	+		
Cyperaceae	*Lepidosperma scabrum*										+		
Cyperaceae	*Lepidosperma squamatum*							+	+	+	+		

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Cyperaceae	*Mesomelaena pseudostygia*					•		+	+	+	+	+	
Cyperaceae	*Mesomelaena stygia*												+
Cyperaceae	*Schoenoplectus validus*	Lake Club-rush				•							
Cyperaceae	*Schoenus clandestinus*							+	+	+	+		
Cyperaceae	*Schoenus curvifolius*									+	+		+
Cyperaceae	*Schoenus grandiflorus*					•		+	+	+	+	+	+
Cyperaceae	*Schoenus latitans*												+
Cyperaceae	*Tetraria octandra*							+		+	+		+
Cyperaceae	*Tetraria* sp. Chandala (G. J. Keighery 17055)			P2			•						
Dilleniaceae	*Hibbertia cuneiformis*	Cutleaf Hibbertia			•			+		+	+		
Dilleniaceae	*Hibbertia hypericoides*	Yellow Buttercups						+	+	+	+		+
Dilleniaceae	*Hibbertia racemosa*				•			+	+	+	+	+	+
Dilleniaceae	*Hibbertia spicata* subsp. *leptotheca*			P3			•						
Dilleniaceae	*Hibbertia subvaginata*							+		+			
Dilleniaceae	*Hibbertia vaginata*									+		+	
Droseraceae	*Drosera erythrorhiza*							+		+			+
Droseraceae	*Drosera erythrorhiza* subsp.								+		+		

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
	erythrorhiza												
Droseraceae	*Drosera glanduligera*	Pimpernel Sundew									+		
Droseraceae	*Drosera macrantha*										+		+
Droseraceae	*Drosera macrantha* subsp. *macrantha*							**+**		+			
Droseraceae	*Drosera paleacea*	Dwarf Sundew				•							
Droseraceae	*Drosera pallida*	Pale Rainbow								+	+		+
Droseraceae	*Drosera x sidjamesii*			P1			•						
Ericaceae	*Astroloma ciliatum*									+	+		
Ericaceae	*Astroloma pallidum*	Kick Bush						**+**	+	+	+	+	+
Ericaceae	*Conostephium minus*	Pink-tipped Pearl flower				•							
Ericaceae	*Conostephium pendulum*							**+**		+	+		
Ericaceae	*Conostephium preissii*										+	+	
Ericaceae	*Leucopogon maritimus*			P1		•	•						
Ericaceae	*Leucopogon parviflorus*					•		**+**		+	+	+	+
Ericaceae	*Leucopogon polymorphus*					•					+		
Ericaceae	*Leucopogon propinquus*							**+**		+	+	+	+
Ericaceae	*Leucopogon* sp.								+				

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Euphorbiaceae	**Euphorbia peplus*	Petty Spurge						+	+	+	+		
Euphorbiaceae	**Euphorbia terracina*	Geraldton Carnation Weed				•		+	+	+	+	+	+
Euphorbiaceae	**Ricinus communis*												+
Euphorbiaceae	*Monotaxis grandiflora*	Diamond of the Desert						+		+			
Euphorbiaceae	*Monotaxis grandiflora* var. *grandiflora*								+		+		
Euphorbiaceae	*Ricinocarpos glaucus*							+		+	+	+	+
Euphorbiaceae	*Ricinocarpos undulatus*								+				
Fabaceae	**Acacia dealbata*										+		
Fabaceae	**Acacia iteaphylla*	Flinders Range Wattle						+		+	+	+	
Fabaceae	**Acacia pycnantha*									+			
Fabaceae	**Lupinus angustifolius*	Narrowleaf Lupin						+		+			
Fabaceae	**Lupinus cosentinii*	Sandplain Lupin						+	+	+	+		+
Fabaceae	**Medicago littoralis*								+				
Fabaceae	**Medicago polymorpha*	Burr Medic						+		+			
Fabaceae	**Trifolium arvense*	Haresfoot Clover						+	+	+	+		
Fabaceae	**Trifolium campestre*	Hop Clover						+	+	+	+	+	+

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Fabaceae	**Trifolium dubium*	Suckling Clover											+
Fabaceae	**Trifolium hirtum*	Rose Clover				•							
Fabaceae	**Trifolium subterraneum*	Subterranean Clover								+			+
Fabaceae	**Vicia sativa*	Common Vetch						**+**	+	+	+		+
Fabaceae	*Acacia benthamii*			P2		•	•				+		
Fabaceae	*Acacia cochlearis*					•					+		
Fabaceae	*Acacia cyclops*	Coastal Wattle				•		**+**	+	+	+	+	+
Fabaceae	*Acacia lasiocarpa*							**+**		+		+	
Fabaceae	*Acacia lasiocarpa* var. *lasiocarpa*					•							
Fabaceae	*Acacia lasiocarpa* var. *sedifolia*					•							
Fabaceae	*Acacia pulchella*	Prickly Moses						**+**		+			+
Fabaceae	*Acacia pulchella* var. *glaberrima*								+		+		
Fabaceae	*Acacia rostellifera*							**+**	+	+	+		+
Fabaceae	*Acacia saligna*					•		**+**		+		+	+
Fabaceae	*Acacia saligna* subsp. *saligna*								+		+		

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Fabaceae	*Acacia stenoptera*											+	
Fabaceae	*Acacia truncata*					•					+	+	+
Fabaceae	*Acacia willdenowiana*					•		+	+	+	+		+
Fabaceae	*Acacia xanthina*	White-stemmed Wattle				•							
Fabaceae	*Bossiaea eriocarpa*	Common Brown Pea						+		+	+	+	+
Fabaceae	*Daviesia decurrens*							+		+		+	+
Fabaceae	*Daviesia divaricata*	Marno								+		+	
Fabaceae	*Daviesia divaricata* subsp. *divaricata*					•			+		+		+
Fabaceae	*Daviesia nudiflora*							+	+	+	+	+	+
Fabaceae	*Daviesia nudiflora* subsp. *nudiflora*							+					
Fabaceae	*Daviesia triflora*							+	+	+	+	+	+
Fabaceae	*Gastrolobium capitatum (*formerly *Nemcia capitata)*							+		+	+	+	+
Fabaceae	*Gompholobium aristatum*												+
Fabaceae	*Gompholobium tomentosum*	Hairy Yellow Pea				•		+	+	+	+	+	
Fabaceae	*Hardenbergia comptoniana*	Native Wisteria				•		+	+	+	+	+	+

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Fabaceae	*Hovea pungens*	Devil's Pins				•				+	+		
Fabaceae	*Hovea trisperma*	Common Hovea						+	+	+	+	+	+
Fabaceae	*Isotropis cuneifolia*							+		+			+
Fabaceae	*Isotropis cuneifolia* subsp. *cuneifolia*										+		
Fabaceae	*Jacksonia calcicola*					•		+		+	+		
Fabaceae	*Jacksonia furcellata*	Grey Stinkwood				•			+		+		
Fabaceae	*Jacksonia sericea*			P4		•	•	+	+	+		+	+
Fabaceae	*Jacksonia sternbergiana*	Stinkwood						+	+	+	+	+	+
Fabaceae	*Kennedia coccinea*	Coral Vine				•							
Fabaceae	*Kennedia prostrata*	Scarlet Runner				•		+	+	+	+	+	+
Fabaceae	*Sphaerolobium medium*										+		
Fabaceae	*Templetonia retusa*										+	+	
Fabaceae	*Viminaria juncea*	Swishbush				•							
Geraniaceae	**Erodium botrys*	Long Storksbill						+	+		+		+
Geraniaceae	*?*Pelargonium capitatum* (immat.)										+		
Geraniaceae	**Pelargonium capitatum*	Rose Pelargonium				•		+	+	+	+		+
Goodeniaceae	*Dampiera linearis*	Common Dampiera									+		

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Goodeniaceae	*Dampiera triloba*			P3			•						
Goodeniaceae	*Lechenaultia linarioides*							+		+	+	+	+
Goodeniaceae	*Scaevola ?thesioides* subsp. *thesioides* (sterile)										+		
Goodeniaceae	*Scaevola canescens*	Grey Scaevola				•		+	+	+	+	+	+
Goodeniaceae	*Scaevola crassifolia*												+
Goodeniaceae	*Scaevola globulifera*					•							
Goodeniaceae	*Scaevola paludosa*												+
Goodeniaceae	*Scaevola repens*							+		+		+	
Goodeniaceae	*Scaevola repens* var. *angustifolia*										+		
Goodeniaceae	*Scaevola repens* var. *repens*								+				
Goodeniaceae	*Scaevola thesioides* subsp. *thesioides*									+	+		+
Gyrostemonaceae	*Tersonia cyathiflora*	Button Creeper									+		
Haemodoraceae	*Anigozanthos humilis*	Catspaw						+	+	+	+		+
Haemodoraceae	*Anigozanthos manglesii*	Mangles Kangaroo Paw									+		
Haemodoraceae	*Anigozanthos viridis* subsp. *terraspectans*	Dwarf Green Kangaroo Paw	VU	VU	•								

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Haemodoraceae	*Conostylis aculeata*	Prickly Conostylis				•		+		+		+	+
Haemodoraceae	*Conostylis aculeata* subsp. *cygnorum*					•			+		+		
Haemodoraceae	*Conostylis candicans* subsp. *candicans*					•		+		+			+
Haemodoraceae	*Conostylis bracteata*			P3		•	•						
Haemodoraceae	*Haemodorum laxum*							+	+	+			
Haemodoraceae	*Haemodorum paniculatum*	Mardja				•					+		+
Haemodoraceae	*Haemodorum spicatum*							+		+	+		
Haemodoraceae	*Phlebocarya ciliata*								+				
Haloragaceae	*Glischrocaryon aureum*	Common Popflower									+		
Hemerocallidaceae	*Caesia micrantha (*formerly *Caesia parviflora)*	Pale Grass-lily						+	+	+	+		+
Hemerocallidaceae	*Corynotheca micrantha*	Sand Lily						+	+	+	+	+	+
Hemerocallidaceae	*Dianella revoluta*	Blueberry Lily						+				+	+
Hemerocallidaceae	*Dianella revoluta* subsp. *divaricata*					•				+			
Hemerocallidaceae	*Dianella revoluta* var. *revoluta*								+		+		
Hemerocallidaceae	*Tricoryne elatior*	Yellow Autumn Lily						+		+	+		+

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Iridaceae	**Chasmanthe floribunda*	African Cornflag				•							+
Iridaceae	**Ferraria crispa*								+	+	+		
Iridaceae	**Freesia alba x leichtlinii*	Freesia						+	+		+		
Iridaceae	**Gladiolus caryophyllaceus*	Wild Gladiolus						+	+	+	+		+
Iridaceae	**Hesperantha falcata*					•							
Iridaceae	**Ixia maculata*										+		
Iridaceae	**Moraea flaccida (*formerly *Homeria flaccida)*	One-leaf Cape Tulip				•		+	+	+	+	+	+
Iridaceae	**Romulea rosea*	Guildford Grass						+	+	+	+	+	+
Iridaceae	**Sparaxis bulbifera*								+				
Iridaceae	**Sparaxis pillansii*	Harlequin Flower				•							
Iridaceae	*Orthrosanthus laxus* var. *laxus*	Morning Iris						+	+	+	+	+	+
Iridaceae	*Patersonia occidentalis*	Purple Flag						+			+		
Juncaceae	*Juncus pallidus*	Pale Rush				•							
Juncaceae	*Luzula meridionalis*	Field Woodrush				•				+	+		+
Juncaginaceae	*Triglochin isingiana*										+		
Lamiaceae	*Dasymalla axillaris*		CR	CR			•						
Lamiaceae	*Lavandula dentata*							+		+			

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Lamiaceae	*Hemiandra pungens*	Snakebush				•		+		+		+	+
Lauraceae	*Cassytha flava*					•					+		
Lauraceae	*Cassytha pomiformis*										+		
Lauraceae	*Cassytha racemosa*							+		+			+
Lauraceae	*Cassytha racemosa* var. *?racemosa* (no fruit)										+		
Loranthaceae	*Nuytsia floribunda*	Christmas Tree									+		
Malvaceae	**Malva parviflora*	Marshmallow									+		
Moraceae	**Morus alba*							+					
Myrtaceae	**Agonis flexuosa*										+		
Myrtaceae	**Callistemon citrinus*	Crimson Bottle-brush								+			
Myrtaceae	**Chamelaucium uncinatum*	Geraldton Wax				•		+	+	+	+		
Myrtaceae	**Leptospermum laevigatum*	Coast Teatree								+			
Myrtaceae	**Melaleuca nesophila*	Freeway Melaleuca						+		+	+		+
Myrtaceae	*Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425)			P1		•	•						
Myrtaceae	*Calothamnus quadrifidus*	One-sided Bottlebrush						+		+			

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Myrtaceae	*Calothamnus quadrifidus* subsp. *quadrifidus*					•			+		+		
Myrtaceae	*Calothamnus sanguineus*					•		+		+			
Myrtaceae	*Calytrix fraseri*	Pink Summer Calytrix				•							
Myrtaceae	*Corymbia calophylla*	Marri						+	+	+	+		+
Myrtaceae	*Eucalyptus conferruminata*									+			
Myrtaceae	*Eucalyptus decipiens* subsp. *decipiens*					•					+		
Myrtaceae	*Eucalyptus erythrocorys*									+			
Myrtaceae	*Eucalyptus foecunda*	Narrow-leaved Red Mallee				•							
Myrtaceae	*Eucalyptus gomphocephala*	Tuart				•		+	+	+	+	+	+
Myrtaceae	*Eucalyptus marginata* subsp. *marginata*	Jarrah				•		+	+	+	+	+	+
Myrtaceae	*Hypocalymma robustum*	Swan River Myrtle						+	+	+	+		+
Myrtaceae	*Kunzea glabrescens*							+		+	+		
Myrtaceae	*Melaleuca cardiophylla*					•		+		+			
Myrtaceae	*Melaleuca huegelii*							+					+
Myrtaceae	*Melaleuca systena* (formerly *Melaleuca*					•		+	+	+	+	+	+

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	acerosa)												
Oleaceae	**Olea europaea*					•				+	+	+	
Onagraceae	**Oenothera drummondii*	Beach Evening Primrose				•							+
Onagraceae	**Oenothera mollissima*												+
Orchidaceae	**Disa bracteata*	South African Orchid						+		+			
Orchidaceae	*Caladenia arenicola*					•		+	+	+	+		
Orchidaceae	*Caladenia attingens* subsp. *attingens*									+			
Orchidaceae	*Caladenia flava*	Cowslips				•		+		+	+		+
Orchidaceae	*Caladenia georgei*									+			
Orchidaceae	*Caladenia huegelii*		EN	EN	•		•						+
Orchidaceae	*Caladenia latifolia*	Pink Fairy Orchid						+		+	+		+
Orchidaceae	*Caladenia longicauda*	Common White Spider Orchid									+		
Orchidaceae	*Caladenia longicauda* subsp. *calcigena*					•		+		+			
Orchidaceae	*Diuris* ?sp. Eneabba (A.H. Burbidge 3941) (immat.)										+		
Orchidaceae	*Diuris corymbosa*							+	+	+			

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Orchidaceae	*Diuris longifolia*	Common Donkey Orchid											+
Orchidaceae	*Diuris magnifica*					•				+	+		
Orchidaceae	*Diuris micrantha*	Dwarf Bee-orchid	VU	VU	•								
Orchidaceae	*Diuris purdiei*	Purdie's Donkey-orchid	EN	EN	•								
Orchidaceae	*Drakaea elastica*	Glossy-leafed Hammer-orchid	EN	EN	•								
Orchidaceae	*Drakaea micrantha*	Dwarf Hammer-orchid	VU	VU	•								
Orchidaceae	*Elythranthera brunonis*	Purple Enamel Orchid				•							
Orchidaceae	*Leptoceras menziesii*	Rabbit Orchid				•				+			+
Orchidaceae	*Microtis media* subsp. *media*							**+**		+	+		
Orchidaceae	*Prasophyllum hians*										+		
Orchidaceae	*Pterostylis barbata*									+			
Orchidaceae	*Pterostylis brevisepalum*									+			
Orchidaceae	*Pterostylis recurva*	Jug Orchid								+			
Orchidaceae	*Pterostylis ?*sp. 'short sepals' (W. Jackson BJ269) (senescent)										+		

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Orchidaceae	*Pterostylis vittata*	Banded Greenhood						+		+	+		+
Orchidaceae	*Pyrorchis nigricans*					•			+	+	+		+
Orchidaceae	*Thelymitra fuscolutea*	Leopard Orchid				•							
Orchidaceae	*Thelymitra* sp.									+			
Orchidaceae	*Thelymitra variegata*			P2			•						
Orobanchaceae	**Orobanche minor*	Lesser Broomrape				•			+				+
Oxalidaceae	**Oxalis pes-caprae*	Soursob						+	+		+		
Oxalidaceae	**Oxalis purpurea*										+		
Papaveraceae	**Fumaria capreolata*	Whiteflower Fumitory						+	+	+	+		+
Phyllanthaceae	**Phyllanthus tenellus*					•							
Phyllanthaceae	*Phyllanthus calycinus*	False Boronia				•		+	+	+	+	+	+
Phyllanthaceae	*Poranthera microphylla*	Small Poranthera							+		+		
Pittosporaceae	*Billardiera ?fraseri* (sterile)										+		
Pittosporaceae	*Marianthus paralius*			T		•	•						
Pittosporaceae	*Pittosporum angustifolium*					•							
Pittosporaceae	*Pittosporum ligustrifolium*					•							
Poaceae	**Aira caryophyllea*	Silvery Hairgrass							+				+

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Poaceae	**Avena barbata*	Bearded Oat						+	+	+	+		
Poaceae	**Avena fatua*	Wild Oat						+				+	+
Poaceae	**Briza maxima*	Blowfly Grass						+	+	+	+	+	+
Poaceae	**Briza minor*	Shivery Grass									+		
Poaceae	**Bromus diandrus*	Great Brome						+	+	+	+	+	+
Poaceae	**Bromus madritensis*	Madrid Brome							+				+
Poaceae	**Cenchrus ciliaris*	Buffel Grass				•							
Poaceae	**Cortaderia selloana*	Pampas Grass				•							+
Poaceae	**Cynodon dactylon*	Couch						+	+	+	+		
Poaceae	**Ehrharta calycina*	Perennial Veldt Grass						+	+	+	+	+	+
Poaceae	**Ehrharta longiflora*	Annual Veldt Grass						+	+	+	+	+	+
Poaceae	**Eragrostis curvula*	African Lovegrass						+		+			
Poaceae	**Hordeum leporinum*	Barley Grass							+				+
Poaceae	**Lagurus ovatus*	Hare's Tail Grass				•		+	+	+	+	+	+
Poaceae	**Lolium perenne*												+
Poaceae	**Lolium rigidum*									+			+
Poaceae	**Pentameris airoides* subsp. *airoides*				•						+		

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Poaceae	**Piptatherum miliaceum*												+
Poaceae	**Poa annua*												+
Poaceae	**Polypogon monspeliensis*												+
Poaceae	**Thinopyrum distichum*					•							
Poaceae	**Vulpia ?muralis* (immat.)										+		
Poaceae	**Vulpia bromoides*	Squirrel Tail Fescue								+			
Poaceae	*Austrostipa compressa*									+	+		+
Poaceae	*Austrostipa elegantissima*										+		
Poaceae	*Austrostipa flavescens*							**+**	+	+	+	+	
Poaceae	*Austrostipa mundula*			P3		•	•						
Poaceae	*Austrostipa nitida*					•							
Poaceae	*Austrostipa semibarbata*												+
Poaceae	*Austrostipa tenuifolia*					•							
Poaceae	*Heteropogon contortus*	Bunch Speargrass				•							
Poaceae	*Microlaena stipoides*	Weeping Grass						**+**		+	+		+
Poaceae	*Poa drummondiana*										+		
Poaceae	*Poa porphyroclados*												+
Poaceae	*Poaceae* sp. (sterile)										+		

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Poaceae	*Rytidosperma caespitosum (*formerly *Austrodanthonia caespitosa)*										+		
Poaceae	*Rytidosperma occidentale (*formerly *Austrodanthonia occidentalis)*											+	
Poaceae	*Spinifex hirsutus*	Hairy Spinifex				•							
Polygonaceae	**Emex australis*	Doublegee				•			+	+	+		+
Polygonaceae	*Persicaria decipiens*					•							
Portulacaceae	*Calandrinia calyptrata*							+		+			
Portulacaceae	*Calandrinia corrigioloides*									+	+		
Portulacaceae	*Calandrinia granulifera*	Pygmy Purslane									+		
Primulaceae	**Lysimachia arvensis (*formerly *Anagallis arvensis)*	Pimpernel						+	+	+	+		+
Proteaceae	*Grevillea leucopteris*							+		+			
Proteaceae	*Adenanthos sericeus*	Woolly Bush								+			
Proteaceae	*Banksia attenuata*	Slender Banksia						+	+	+	+	+	+
Proteaceae	*Banksia dallanneyi* var. *dallanneyi (*formerly *Dryandra lindleyana)*							+	+	+	+		
Proteaceae	*Banksia grandis*	Bull Banksia						+	+	+		+	+

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Proteaceae	*Banksia ilicifolia*	Holly-leaved Banksia				•							
Proteaceae	*Banksia menziesii*	Firewood Banksia				•		+	+	+	+	+	+
Proteaceae	*Banksia nivea*												+
Proteaceae	*Banksia prionotes*							+		+	+	+	+
Proteaceae	*Banksia sessilis*					•						+	+
Proteaceae	*Banksia sessilis* var. *cygnorum*							+	+	+	+		
Proteaceae	*Conospermum stoechadis*	Common Smokebush								+			
Proteaceae	*Conospermum triplinervium*	Tree Smokebush						+		+	+		+
Proteaceae	*Grevillea ?preissii*										+		
Proteaceae	*Grevillea crithmifolia*					•		+		+	+		+
Proteaceae	*Grevillea olivacea*									+			
Proteaceae	*Grevillea preissii* subsp. *preissii*							+		+	+		
Proteaceae	*Grevillea* sp. Ocean Reef (D. Pike Joon 4)			P1			•						
Proteaceae	*Grevillea vestita* subsp. *vestita*							+	+	+	+	+	+
Proteaceae	*Hakea costata*	Ribbed Hakea				•							

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Proteaceae	*Hakea laurina*									+			
Proteaceae	*Hakea lissocarpha*	Honey Bush				•		+	+	+	+	+	+
Proteaceae	*Hakea prostrata*	Harsh Hakea						+	+	+	+	+	+
Proteaceae	*Hakea trifurcata*	Two-leaf Hakea				•		+		+			
Proteaceae	*Persoonia saccata*							+		+	+		+
Proteaceae	*Petrophile axillaris*				•					+			
Proteaceae	*Petrophile brevifolia*										+		
Proteaceae	*Petrophile linearis*	Pixie Mops						+	+	+	+		+
Proteaceae	*Petrophile macrostachya*							+	+	+	+	+	+
Proteaceae	*Petrophile media*										+	+	
Proteaceae	*Petrophile serruriae*											+	+
Proteaceae	*Stirlingia latifolia*	Blueboy									+	+	+
Proteaceae	*Synaphea spinulosa* subsp. *spinulosa*							+		+	+	+	+
Ranunculaceae	*Clematis linearifolia*							+		+		+	+
Ranunculaceae	*Clematis pubescens*	Common Clematis				•							
Restionaceae	*Alexgeorgea arenicola*										+	+	+
Restionaceae	*Alexgeorgea nitens*							+		+	+		+
Restionaceae	*Desmocladus ?fascicularis*										+		

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
	(poor material)												
Restionaceae	*Desmocladus asper*					•		+		+	+		
Restionaceae	*Desmocladus fasciculatus*												+
Restionaceae	*Desmocladus flexuosus*							+	+	+	+	+	+
Restionaceae	*Hypolaena pubescens*												+
Rhamnaceae	*Spyridium globulosum (*formerly *Spyridium tridentatum)*	Basket Bush				•		+		+	+	+	
Rhamnaceae	*Stenanthemum notiale* subsp*. chamelum*							+	+	+	+		
Rhamnaceae	*Trymalium ledifolium* var*. ledifolium*					•		+		+			+
Rubiaceae	**Galium murale*	Bedstraw, Small Goosegrass						+	+		+		
Rubiaceae	*Opercularia vaginata*	Dog Weed				•		+	+	+	+	+	+
Rutaceae	*Diplolaena dampieri*	Southern Diplolaena			•								
Rutaceae	*Philotheca spicata*	Pepper and Salt									+		
Rutaceae	*Rhadinothamnus anceps*					•							
Santalaceae	*Exocarpos sparteus*					•		+		+	+	+	+
Santalaceae	*Santalum acuminatum*	Quandong				•		+		+		+	+

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Scrophulariaceae	**Dischisma arenarium*					•				+	+		
Scrophulariaceae	**Nemesia strumosa*					•							
Scrophulariaceae	*Eremophila glabra*							+		+			+
Scrophulariaceae	*Eremophila glabra* subsp. *albicans*							+					
Scrophulariaceae	*Myoporum insulare*					•		+		+	+		+
Solanaceae	**Solanum linnaeanum*	Apple of Sodom				•				+			
Solanaceae	**Solanum nigrum*	Black Berry Nightshade				•		+	+	+	+		+
Solanaceae	*Anthocercis littorea*	Yellow Tailflower						+		+	+	+	
Stylidiaceae	*Levenhookia pusilla*										+		
Stylidiaceae	*Stylidium androsaceum*										+		
Stylidiaceae	*Stylidium araeophyllum*								+				
Stylidiaceae	*Stylidium brunonianum*	Pink Fountain Triggerplant						+		+			+
Stylidiaceae	*Stylidium calcaratum*	Book Triggerplant						+		+			+
Stylidiaceae	*Stylidium carnosum*									+			
Stylidiaceae	*Stylidium hesperium*					•					+		
Stylidiaceae	*Stylidium neurophyllum*										+		
Stylidiaceae	*Stylidium paludicola*			P3		•	•						

Family	Scientific name	Common name	Conservation status[1]		Database searches			Source					
									Previous surveys / Natural Area Field Assessments				
			EPBC ACT	WC Act/ DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Craigie Bushland (NAC 2011)	Hepburn Heights (CoJ 2015)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Stylidiaceae	*Stylidium repens*	Matted Triggerplant						+	+	+	+	+	
Stylidiaceae	*Stylidium rigidulum*										+		
Stylidiaceae	*Stylidium schoenoides*	Cow Kicks							+		+		
Thymelaeaceae	*Pimelea ?sulphurea (sterile)*										+		
Thymelaeaceae	*Pimelea argentea*	Silvery Leaved Pimelea				•							
Thymelaeaceae	*Pimelea calcicola*			P3			•						
Thymelaeaceae	*Pimelea leucantha*								+		+		
Thymelaeaceae	*Pimelea sulphurea*	Yellow Banjine						+		+	+	+	+
Unknown	*Tree sp. (horticultural)										+		
Violaceae	*Hybanthus calycinus*	Wild Violet				•		+	+	+	+		+
Xanthorrhoeaceae	*Xanthorrhoea preissii*	Grass tree						+	+	+	+	+	+
Zamiaceae	*Macrozamia riedlei*	Zamia						+	+	+	+		+

[1] VU = Listed as 'Vulnerable', EN= 'Endangered' and CR='Critically Endangered' under the EPBC Act and/or WC Act and P = Priority Flora listed by Parks and Wildlife

Appendix 3 – Craigie Bushland Key Flora

Priority and Significant Flora at Craigie Bushland

Name	Common Name	Conservation Code	Image
Jacksonia sericea	Waldjumi	Priority Four DBCA, Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photo: ELA, 2016
Allocasuarina lehmanniana	Dune Sheok	Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photos: C.Hortin (WA Herbarium no date)
Callitris preissii	Rottnest Island Pine	Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photos: R. Davis (WA Herbarium no date)
Conospermum triplinervium	Tree Smokebush	Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photos: M. Hislop (WA Herbarium no date)

Name	Common Name	Conservation Code	Image
Hibbertia cuneiformis	Cutleaf Hibbertia	Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photos: C. Hortin, T. Tapper and K.R. Thiele (WA Herbarium no date)
Lechenaultia linarioides	Yellow Leschenaultia	Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photos: K.C. Richardson (WA Herbarium no date)
Melaleuca cardiophylla	Tangling Melaleuca	Significant Flora of the Perth Metropolitan Region, Bush Forever Strategy (2000)	 Photos: K.C Richardson (WA Herbarium no date)

Note: For further explanations on Conservation Codes, refer to Appendix 4.

Appendix 4 – Conservation Codes for Western Australian Flora and Fauna

Specially protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

Code	Definition
T	**Threatened species** Published as Specially Protected under the Wildlife Conservation Act 1950, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). ***Threatened fauna*** is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act. ***Threatened flora*** is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.
CR	**Critically endangered species** Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EN	**Endangered species** Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
VU	**Vulnerable species** Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EX	**Presumed extinct species** Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
IA	**Migratory birds protected under an international agreement** Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.
CD	Conservation dependent fauna Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as

	threatened. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.
OS	Other specially protected fauna Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

Sourced from Department of Parks and Wildlife – current to May 2017

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Code	Definition
1	**Priority 1: Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
2	**Priority 2: Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey
3	**Priority 3: *Poorly-known species*** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
4	**Priority 4: *Rare, Near Threatened and other species in need of monitoring*** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These

	species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Sourced from Department of Parks and Wildlife – current to May 2017

The City of Joondalup has added a Category listed as Locally Significant to reflect locally significant native species within the City of Joondalup. Locally Significant species are defined below.

Code	Definition
LS	**Locally Significant (LS) - City of Joondalup** Taxa within the City of Joondalup who are at risk of predation or extinction from within the City due to a variety of environmental and external factors. These populations are in need of conservation and monitoring, thus are classed as Locally Significant species within the City of Joondalup.

Appendix 5 – Keighery Scale Definitions

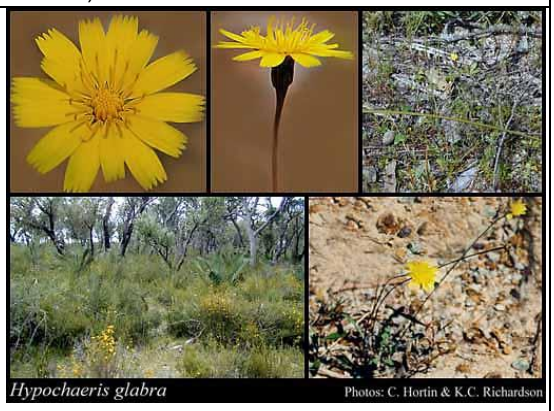
Vegetation Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non- aggressive species.
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
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.
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 some very aggressive weeds at high density, partial clearing, dieback and grazing.
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 ‘ land cleared’ with the flora comprising weed or crop species with isolated native trees or shrubs.

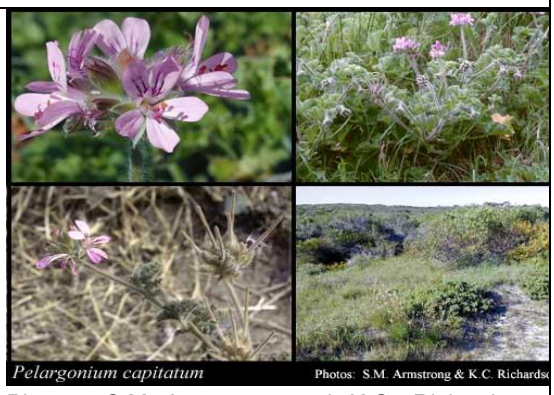
Sourced from Keighery1994

Appendix 6 – Historical Vegetation Units surveyed at Craigie Bushland

Assessor:	**Vegetation unit name**		
	Mixed heathland		
Allen et al. (1994)	*Eucalyptus*/ *Allocasuarina*/*Banksia* woodland open forest consisting of the following four sub-communities:	**Sub-community name:**	*Eucalyptus marginata*, *E. gomphocephala*, *E. calophylla* (now *Corymbia calophylla*), *Banksia attenuata*, *B. grandis* and *Allocasuarina fraseriana* woodland to open forest.
			Banksia attenuata, *B. grandis* and *Eucalyptus gomphocephala* woodland.
			Banksia menziesii, *B. attenuata*, *Eucalyptus marginata*, *E. gomphocephala* and *Allocasuarina fraseriana* woodland.
			Mixed Heathland commonly including *Acacia pulchella, A.truncata, Heminadra pungens* and *Lepidosperma gladiatum*.
Assessor:	Tall Tuart Woodland		
Natural Area Consulting (2011)	*Lepidosperma gladiatum* Sedgeland		
	Tall shrubland		
	Banksia prionotes Woodland		
	Marri Forest		
	Banksia Woodland		

Appendix 7 - Examples of Priority Weed Species at Craigie Bushland

Name	Common Name	Conservation Code	Image
Ehrharta calycina	Perennial Veldt Grass	High priority (DPaW Swan Region), Priority (CoJ)	 Photos: S.M. Armstrong (WA Herbarium no date)
Euphorbia terracina	Geraldton Carnation Weed	High priority (DPaW Swan Region), Priority (CoJ)	 Photos: J.Dodd and K.R. Thiele (WA Herbarium no date)
Hypochaeris glabra	Smooth Cats ear	High priority (DPaW Swan Region), Priority (CoJ)	 Photos: C.Hortin and K.C Richardson

Lupinus cosentinii	Blue Lupin	High priority (DPaW Swan Region), Priority (CoJ)	 Photos: J. Dodd and J.F. Smith (WA Herbarium no date)
Moraea flaccida	One-leaf Cape Tulip	Declared pest (BAM Act), High priority (DPaW Swan Region), Priority (CoJ)	 Photos: R. Knox and K.C. Richardson (WA Herbarium no date)
Pelargonium capitatum	Rose Pelargonium	High priority (DPaW Swan Region), Priority (CoJ)	 Photos: S.M Armstrong and K.C. Richardson (WA Herbarium no date)

Appendix 8 – Craigie Bushland High Priority Weed Species Management

Latin Name	Common Name	Type of Weed	Status/Notes	Treatment Type	Optimal Treatment Timing (WA Herbarium)
Acacia iteaphylla	Flinders Ranges Wattle	Trees and shrubs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, cut and paint stem	December to May
Arctotheca calendula	Capeweed	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate	June to November
Avena barbata	Bearded Oat	Grasses	High priority (DPaW Swan Region), Priority (CoJ)	Quizalofop	July to October
Avena fatua	Wild Oat	Grasses	Priority (CoJ)	Quizalofop	August to September
Brassica tournefortii	Meditteranean Turnip	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Hand weeding	August to September
Bromus diandrus	Great Brome	Grasses	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, Quizalofop	June to August
Carpobrotus edulis	Hottentot Fig	Herbs	High priority (DPaW Swan Region)	Hand weeding	All year
Centranthus macrosiphon	Pretty Betsy / Spanish Valerian	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Metsulfuron	July-September
Conyza sumatrensis	Tall Fleabane	Herbs	Priority (CoJ)	Glyphosate	June-November
Cynodon dactylon	Couch	Grasses	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, Quizalofop	November-February
Ehrharta calycina	Perennial Veldt Grass	Grasses	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate	June to August
Ehrharta longiflora	Annual Veldt Grass	Grasses	Priority (CoJ)	Quizalofop	August-November

Euphorbia peplus	Petty Spurge	Herbs	Priority (CoJ)	Metsulfuron, Hand weeding	May to November
Euphorbia terracina	Geraldton Carnation Weed	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Triasulfuron, Hand weeding	June to August spray, June to November hand weeding
Freesia alba x leichtlinii	Freesia	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Metsulfuron	July to August
Fumaria capreolata	Whiteflower Fumitory	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Metsulfuron, Glyphosate	July to September
Gazania linearis	Gazania	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, Hand weeding	June to December spray, All year hand weeding
Gladiolus caryophyllaceus	Wild Gladiolus	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Hand weeding, hand wipe with Metsulfuron	July to September
Hypochaeris glabra	Smooth Cats ear	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, Hand weeding	May to October
Hypochaeris radicata	Flat Weed	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate	June to September
Lachenalia reflexa	Cape Cowslip	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Metsulfuron	June to August
Lactuca serriola	Prickly Lettuce	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Metsulfuron, Glyphosate, Hand weeding	September-November
Lagurus ovatus	Hare's Tail Grass	Grasses	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate	June to August
Lupinus angustifolius	Narrowleaf Lupin	Herbs	Priority (CoJ)	Hand weeding	July to September
Lupinus cosentinii	Blue Lupin	Herbs	High priority (DPaW	Hand weeding	June to September

			Swan Region), Priority (CoJ)		
Moraea flaccida	One-leaf Cape Tulip	Herbs	Declared pest (BAM Act), High priority (DPaW Swan Region), Priority (CoJ)	Metsulfuron	July to August
Oxalis pes-caprae	Soursob	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, Metsulfuron	June to July
Pelargonium capitatum	Rose Pelargonium	Herbs	High priority (DPaW Swan Region), Priority (CoJ)	Glyphosate, Metsulfuron, Hand weeding	June to October
Romulea rosea	Guildford Grass	Grasses	Priority (CoJ)	Metsulfuron	July-August
Schinus terebinthifolius	Brazilian / Japanese Pepper	Trees and shrubs	Priority (CoJ)	Paint stem with Triclopyr/Picloram, Hand weeding	December-February
Trifolium campestre	Hop Clover	Herbs	Priority (CoJ)	Hand weeding	August-January

Note: The Craigie Bushland High Priority Weed Species Management table was created using the following criteria

- Weed species listed as a Weed of National Significance (WONS) in 1999 and 2012 by the Australian Government;
- The weed species is listed as a Declared Pest according to the *Biosecurity and Agriculture Management Act 2007.*
- The weed species is listed as High Priority in regards to its ecological impact and rapid invasiveness according to the DPaW Weed Prioritisation Process for the Swan Region (2013);
- The City of Joondalup has determined that the weed species poses: a major threat to vegetation and the structure of vegetation communities or is likely to contribute to a high fuel load (e.g. grasses). These species are classed as High Priority weeds in the City of Joondalup.

Appendix 9 – Craigie Bushland Fauna Species List

Family (Order)	Scientific name	Common name	Conservation status[1]		Database searches			Source						
								Craigie Bushland (ELA 2016)	Previous surveys / Natural Area Field Assessments					
			EPBC Act	WC Act/DPaW	PMST	NatureMap	DPaW		Shepherds Bush (ELA 2016)	Hepburn Heights (CoJ 2015)	Craigie Bushland (NAC 2011)	Craigie Bushland Birds Australia (PBP 2006)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
MAMMALS														
Canidae	**Canis lupus*	Dog			•	•		+		+	+		+	
	**Vulpes vulpes*	European Red Fox			•			+		+				
Dasyuridae	*Dasyurus geoffroii*	Chuditch	VU	VU	•									
Felidae	**Felis catus*	Cat			•	•				+				+
Leporidae	**Oryctolagus cuniculus*	Rabbit			•	•				+			+	+
Macropodidae	*Macropus fuliginosus melanops*	Western Grey Kangaroo				•		+	+	+			+	+
	Macropus irma	Western Brush Wallaby		P4		•								+
Molossidae	*Autonomous australis*	White-striped Free-tailed Bat								+				
Muridae	*Hydromys chrysogaster*	Water-rat		P4		•								
	**Mus musculus*	House Mouse			•	•		+		+	+			+
	**Rattus norvegicus*	Brown Rat, Norway Rat			•									

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	**Rattus rattus*	Black Rat			•	•		+						+
Peramelidae	*Isoodon obesulus fusciventer*	Southern Brown Bandicoot, Quenda		P4		•		+						
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum						+						
Pseudocheiridae	*Pseudocheirus occidentalis*	Western Ringtail Possum	VU	EN	•									
Tachyglossidae	*Tachyglossus aculeatus acanthion*	Short-beaked Echidna				•								
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat				•		+	+	+				
BIRDS														
Acanthizidae	*Acanthiza apicalis*	Broad-tailed Thornbill (Inland Thornbill)				•						+		+
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill				•		+		+		+		
	Acanthiza inornata	Western Thornbill				•				+				
	Acanthiza uropygialis	Chestnut-rumped Thornbill				•								
	Gerygone fusca	Western Gerygone				•		+	+			+	+	+

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	Sericornis frontalis	White-browed Scrubwren				•								+
	Smicrornis brevirostris	Weebill				•		+	+	+		+		+
Accipitridae	*Accipiter fasciatus*	Brown Goshawk				•		+	+		+	+		
	Accipiter cirrocephalus	Collared Sparrowhawk				•								
	Aquila audax	Wedge-tailed Eagle				•								
	Circus approximans	Swamp Harrier				•								
	Haliastur sphenurus	Whistling Kite				•								
	Hamirostra isura	Square-tailed Kite						+						
	Hieraaetus morphnoides	Little Eagle				•						+		
Acrocephalidae	*Acrocephalus australis*	Australian Reed Warbler				•								
Alcedinidae	**Dacelo novaeguineae*	Laughing Kookaburra				•		+	+	+	+	+		+
	Todiramphus sanctus	Sacred Kingfisher				•						+		+

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	Anas gracilis	Grey Teal				•								
	**Anas platyrhynchos*	Mallard			•	•								
	Anas rhynchotis	Australasian Shoveler				•								
	Aythya australis	Hardhead				•								
	Anas superciliosa	Pacific Black Duck				•					+			+
	Biziura lobata	Musk Duck				•								
	Chenonetta jubata	Australian Wood Duck				•					+	+		+
	Cygnus atratus	Black Swan				•								
	Malacorhynchus membranaceus	Pink-eared Duck				•								
	Oxyura australis	Blue-billed Duck		P4		•								
	Stictonetta naevosa	Freckled Duck				•								
	Tadorna tadornoides	Australian Shelduck, Mountain Duck				•								+

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Apodidae	*Apus pacificus*	Fork-tailed Swift	M	IA	•									
Ardeidae	*Ardea modesta*	Eastern Great Egret	M	IA	•	•								
	Ardea ibis	Cattle Egret	M	IA	•	•								
	Ardea pacifica	White-necked Heron				•								
	Nycticorax caledonicus	Rufous Night Heron				•								
Cacatuidae	*Calyptorhynchus latirostris*	Carnaby's Cockatoo	EN	EN	•	•		+	+	+	+	+		
	Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	VU	•	•								
	**Cacatua galerita*	Sulphur-crested Cockatoo				•								+
	Cacatua pastinator	Western Long-billed Corella				•								
	**Cacatua roseicapilla*	Galah				•		+	+	+	+	+		+
	**Cacatua sanguinea*	Little Corella				•		+	+	+	+	+		+
	**Cacatua tenuirostris*	Eastern Long-billed Corella				•					+	+		+

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Cracticidae	*Cracticus torquatus*	Grey Butcherbird				•		+	+	+	+	+	+	+
	Cracticus tibicen	Australian Magpie				•		+	+	+	+	+		+
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike				•		+	+	+	+	+		+
	Lalage tricolor (sueurii)	White-winged Triller				•								
Columbidae	**Columba livia*	Domestic Pigeon			•	•			+					+
	Ocyphaps lophotes	Crested Pigeon				•								
	**Streptopelia chinensis*	Spotted Turtle-Dove			•	•		+	+	+		+		
	**Streptopelia senegalensis*	Laughing Turtle-Dove			•	•		+	+	+		+		+
Corvidae	*Corvus bennetti*	Little Crow				•								
	Corvus coronoides	Australian Raven				•		+	+	+	+	+		+
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo				•						+		+
	Cacomantis pallidus	Pallid Cuckoo									+			

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	Chrysococcyx lucidus	Shining Bronze Cuckoo									+			
	Cuculus saturatus optatus	Horsfield's Cuckoo										+		+
Monarchidae	*Grallina cyanoleuca*	Magpie-lark				•						+		+
Falconidae	*Falco berigora*	Brown Falcon				•				+				
	Falco cenchroides	Australian Kestrel				•								+
	Falco longipennis	Australian Hobby				•					+			
	Falco peregrinus	Peregrine Falcon		OS		•				+				
Fringillidae	**Carduelis carduelis*	European Goldfinch			•									
Hirundinidae	*Hirundo neoxena*	Welcome Swallow				•				+		+		
	Petrochelidon nigricans	Tree Martin				•		+		+		+		
Locustellidae	*Megalurus gramineus*	Little Grassbird				•								
Maluridae	*Malurus splendens*	Splendid Fairy-wren				•						+		+

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	Malurus lamberti	Variegated Fairy-wren				•								
Megapodiidae	*Leipoa ocellata*	Malleefowl	VU	VU	•									
Meliphagidae	*Anthochaera carunculata*	Red Wattlebird				•		+	+	+	+	+		+
	Anthochaera lunulata	Western Little Wattlebird				•					+			
	Acanthorhynchus superciliosus	Western Spinebill				•						+		+
	Gavicalis virescens	Singing Honeyeater				•		+	+	+	+	+		
	Lichmera indistincta	Brown Honeyeater				•		+	+	+		+		+
	Manorina flavigula	Yellow-throated Miner				•			+					
	Phylidonyris novaehollandiae	New Holland Honeyeater				•				+	+	+		+
	Phylidonyris niger	White-cheeked Honeyeater				•						+		
Meropidae	*Merops ornatus*	Rainbow Bee-eater		IA	•	•		+	+	+		+		+
Motacillidae	*Motacilla cinerea*	Grey Wagtail	M	IA	•									

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Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella				•								+
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush				•								+
	Pachycephala occidentalis	Western Golden Whistler				•						+		
	Pachycephala rufiventris	Rufous Whistler				•		+	+	+		+	+	
Pandionidae	*Pandion haliaetus*	Osprey	M	IA	•	•								
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote				•					+			
	Pardalotus striatus	Striated Pardalote				•		+	+	+		+		+
Passeridae	**Passer domesticus*	House Sparrow			•									
	**Passer montanus*	Eurasian Tree Sparrow			•									
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican				•								
Petroicidae	*Petroica boodang*	Scarlet Robin												+
	Petroica goodenovii	Red-capped Robin				•								+

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Podargidae	*Podargus strigoides*	Tawny Frogmouth				•			+		+			
Podicipedidae	*Podiceps cristatus*	Great Crested Grebe				•								
	Tachybaptus novaehollandiae	Australasian Grebe				•								
	Poliocephalus poliocephalus	Hoary-headed Grebe				•								
Psittacidae	*Platycercus spurius*	Red-capped Parrot				•						+		+
	Platycercus zonarius	Twenty-eight Parrot, Australian Ringneck				•		+	+		+	+		+
	Polytelis swainsonii	Superb Parrot								+				
	**Trichoglossus moluccanus*	Rainbow Lorikeet				•		+	+	+	+	+	+	
Rallidae	*Fulica atra*	Eurasian Coot				•								
	Gallirallus philippensis	Buff-banded Rail				•								
	Gallinula tenebrosa	Dusky Moorhen				•								
	Porphyrio porphyrio	Purple Swamphen				•								

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	Porzana tabuensis	Spotless Crake				•								
Recurvirostridae	*Cladorhynchus leucocephalus*	Banded Stilt				•								
	Himantopus himantopus	Black-winged Stilt				•								
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail				•		+		+	+	+		
	Rhipidura albiscapa	Grey Fantail				•		+			+	+		+
Rostratulidae	*Rostratula australis*	Australian Painted Snipe	EN	EN	•									
	Tringa nebularia	Common Greenshank	M	IA	•	•								
Strigidae	*Ninox novaeseelandiae*	Southern Boobook Owl				•					+			
Sturnidae	**Acridotheres tristis*	Common Myna, Indian Myna			•									
	**Sturnus vulgaris*	Common Starling			•									
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill				•								
	Platalea regia	Royal Spoonbill				•								

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	Plegadis falcinellus	Glossy Ibis	M	IA		•								
	Threskiornis molucca	Australian White Ibis				•			+					
	Threskiornis spinicollis	Straw-necked Ibis				•								
Tytonidae	*Tyto alba*	Barn Owl									+			
Zosteropidae	*Zosterops lateralis*	Grey-breasted White-eye (Silvereye)				•		+	+	+	+	+		+
REPTILES														
Agamidae	*Pogona minor minor*	Western Bearded Dragon				•				+	+			+
Cheluidae	*Chelodina colliei*	Oblong Turtle				•								
Elapidae	*Brachyurophis fasciolatus fasciolatus*	Narrow-banded Shovel-nosed Snake				•								
	Brachyurophis semifasciatus	Southern Shovel-nosed Snake				•				+				
	Neelaps bimaculatus	Black-naped Snake				•								
	Neelaps calonotus	Black-striped Snake		P3		•								

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	Notechis scutatus	Tiger Snake				•								
	Parasuta gouldii	Black-headed Snake				•								
	Pseudonaja affinis	Dugite				•				+				+
	Simoselaps bertholdi	Jan's Banded Snake				•		+		+				
Gekkonidae	*Christinus marmoratus*	Marbled Gecko				•		+		+				
	Diplodactylus polyophthalmus	Speckled Stone Gecko				•				+				
	**Hemidactylus frenatus*	Asian House Gecko			•									
	Strophurus spinigerus	South-western Spiny-tailed Gecko									+			
Pygopodidae	*Aprasia repens*	Sand-plain Worm-lizard				•				+				
	Lialis burtonis	Burtons Legless Lizard				•			+	+				
Boidae	*Morelia spilota imbricata*	South-west Carpet Python				•								
Scincidae	*Acritoscincus trilineatus*	South-western Cool Skink				•								

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	Cryptoblepharus buchananii	Fence Skink				•		+	+	+				
	Cryptoblepharus plagiocephalus	Snake-eyed Skink									+			
	Ctenotus australis	Western Limestone Ctenotus				•				+	+			
	Ctenotus fallens	West Coast Ctenotus				•		+	+					+
	Cyclodomorphus celatus	Western Slender Bluetongue				•		+		+				
	Hemiergis quadrilineata	Two-toed Earless Skink				•			+	+				+
	Lerista elegans	Elegant Burrowing Skink				•		+		+				
	Lerista lineopunctulata	West Coast Line-spotted Lerista				•								
	Lerista praepedita	Worm Lerista				•				+				
	Menetia greyii	Common Dwarf Skink				•		+	+	+	+			+
	Morethia lineoocellata	Western Pale-flecked Morethia				•								+
	Morethia obscura	Southern Pale-flecked Morethia				•		+	+	+	+			+

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	Tiliqua occipitalis	Western Bluetongue				•								
	Tiliqua rugosa rugosa	Bobtail, Shingleback				•		+	+	+	+			+
Typhlopidae	*Ramphotyphlops australis*	Southern Blind Snake				•				+				
	**Indotyphlops braminus*	Brahminy Blind Snake			•									
Varanidae	*Varanus gouldii*	Bungarra, Sand Goanna				•		+		+				
AMPHIBIANS														
Hylidae	*Litoria adelaidensis*	Slender Tree Frog				•								
	Litoria moorei	Motorbike Frog				•								
Limnodynastidae	*Heleioporus eyrei*	Moaning Frog				•								
	Limnodynastes dorsalis	Western Banjo Frog				•				+				
Myobatrachidae	*Crinia insignifera*	Squelching Froglet				•								
	Crinia glauerti	Clicking Frog				•								

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	Myobatrachus gouldii	Turtle Frog				•				+				
INVERTEBRATES														
Acrididae	*Goniaea australasiae*	Gumleaf Grasshopper								+	+			
(Aranae)	Wolf spider sp.1							+						
	Wolf spider sp. 2							+						
	Wolf spider sp. 3							+						
	Spider sp. 3	Jumping spider						+	+					
	Spider sp. 4	Christmas tree spider							+					
	Spider sp. 5	Orb weaver						+	+					
		Black House Spider									+			
		Crevice Huntsman									+			
		Huntsman									+			

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		Trapdoor Spider 1									+			
		Trapdoor Spider 2									+			
		Trapdoor Spider 2									+			
Armadillidiidae	*Buddelundia* TBC sp. TBC	White-dashed Rolling Slater								+				
Blattidae	*Drymaplaneta communis*	Common Shining Cockroach						+						
(Blattodea)	Flat/Trilobite cockroach sp. 1							+						
Bothriembryontidae	*Bothriembryon* sp. TBC	Snail								+				
Buthidae	*Lychas marmorata*	Marbled Scorpion								+				
Castniidae	*Synemon gratiosa*	Graceful Sun-moth		P4		•				+				
Cicadidae	*Pyropsalta melete*	Red Bandit								+				
(Coleoptera)	Beetle sp. 2							+						
	Weevil sp. 1							+						

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	Weevil sp. 2							+						
		Beetle grub						+						
	Jewel Beetle sp. 1							+						
		Bess Beetle						+						
		Common Kangaroo Dung Beetle									+			
		Native Weevil									+			
		Ladybird									+			
Coreidae	*Mictis profana*	Crusader Bug								+				
(Dermaptera)	Earwig sp. 1	Earwig							+					
(Diptera)	Fly sp. 1							+						
	Mosquito sp. 1							+						
Formicidae	*Camponotus terebrans*	Ant								+				

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	Iridomyrmex sp.	Meat Ant								+				
Gryllacrididae	Gen. nov. TBC sp. TBC	Cricket								+				
	Paragryllacris TBC sp.	Cricket								+				
Helicidae	**Theba pisana*	Variable White Mediterranean snail						+		+				
(Hemiptera)	Stink bug sp. 1							+						
	Small white bug sp. 2							+						
Hesperiidae	*Taractrocera papyria*	Western Grass-dart Butterfly						+						
(Hymenoptera)	Meat ant sp. 1							+						
	Bull ant sp. 1							+						
	Native bee sp. 1							+						
		Native Burrowing Bee									+			
	**Apis mellifera*	European Honey Bee						+	+	+			+	

Appendix 9 – Craigie Bushland Fauna Species List

Family (Order)	Scientific name	Common name	Conservation status[1]		Database searches			Source						
								Craigie Bushland (ELA 2016)	Previous surveys / Natural Area Field Assessments					
			EPBC Act	WC Act/DPaW	PMST	NatureMap	DPaW		Shepherds Bush (ELA 2016)	Hepburn Heights (CoJ 2015)	Craigie Bushland (NAC 2011)	Craigie Bushland Birds Australia (PBP 2006)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Ixodidae	*Amblyomma triguttatum*	Kangaroo Tick						+	+	+	+			
(Julida)	Millipede sp. 1	Millipede						+						
Julidae	**Ommatoiulus moreletii*	Portuguese Millipede						+	+	+				
(Lepidoptera)	Butterfly sp. 1							+						
Lepismatidae	*Lepisma saccharina*	Silverfish						+			+			
Lucanidae	*Lucanus capreolus*	Reddish-brown Stag Beetle						+						
Lycosidae	*'Lycosa' australicola*	Black-chevroned spider								+				
	Tasmanicosa leuckartii	Lycosid spider								+				
(Mantodea)	Mantis sp. 1	Praying Mantis							+					
(Mygalomorphae)	Mygalomorph sp. 1							+						
Myrmeleontidae	Gen. sp. TBC	Larval Myrmlacewing								+				
Nephilidae	*Nephila edulis*	Southern Golden Orb spider								+				

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								Craigie Bushland (ELA 2016)	Previous surveys / Natural Area Field Assessments					
			EPBC Act	WC Act/DPaW	PMST	NatureMap	DPaW		Shepherds Bush (ELA 2016)	Hepburn Heights (CoJ 2015)	Craigie Bushland (NAC 2011)	Craigie Bushland Birds Australia (PBP 2006)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
	Nephila sp.	Golden Orb Weaver								+				
(Orthoptera)	Cricket sp. 1							**+**						
	Grasshopper sp. 1							**+**						
Otostigmidae	*Ethmostigmus* sp. TBC	Centipede								+				
Paradoxosommatidae	*Antichiropus* sp. nov	Millipede								+				
Pentatomidae	*Poecilometis apicalis*	Bug								+				
Phasmatidae	*Arphax australis* (imm.)	Australian Arphax Stick-insect								+				
	Gen. sp. TBC	Large Grey Stick-insect								+				
(Phasmatodea)	Stick insect sp. 1							**+**						
		Stick Insect									+			
Pholcidae	*Pholcus phalangioides*	Cellar Spider								+				

Appendix 9 – Craigie Bushland Fauna Species List

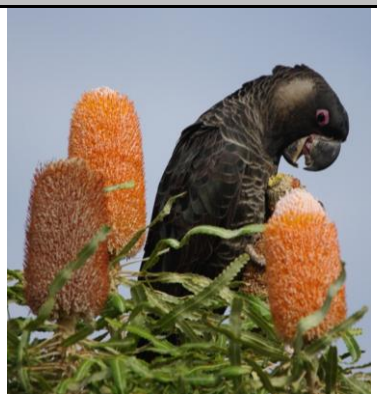
Family (Order)	Scientific name	Common name	Conservation status[1]		Database searches			Source						
									Previous surveys / Natural Area Field Assessments					
			EPBC Act	WC Act/DPaW	PMST	NatureMap	DPaW	**Craigie Bushland (ELA 2016)**	Shepherds Bush (ELA 2016)	Hepburn Heights (CoJ 2015)	Craigie Bushland (NAC 2011)	Craigie Bushland Birds Australia (PBP 2006)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Pieridae	**Pieris rapae*	Cabbage White Butterfly						+						
(Polydesmida)	*Antichiropus* sp.	Millipede							+					
Porcellionidae?	*Porcellio scaber?*	Slater/woodlice								+				
Scarabaeidae	*Colpochila* sp. TBC	Scarab Beetle								+				
	Gen. sp. TBC	Scarab Beetle								+				
	Gen. sp. TBC	Pygmy Brown Scarab Beetle								+				
Scolopendridae	*Cormocephalus* sp. 1	Scolopendrid centipede						+						
(Scolopendromorpha)	Stone centipede sp. 1							+						
		Centipede									+			
(Scorpiones)	Scorpion sp. 1	Marbled scorpion							+					
Sparassidae	*Eodelena lapidicola*	Southern Blackfront Spider								+				
Tenebrionidae	*Helea perforatus*	Beetle								+				

Appendix 9 – Craigie Bushland Fauna Species List

Family (Order)	Scientific name	Common name	Conservation status[1]		Database searches			Source						
								Craigie Bushland (ELA 2016)	Previous surveys / Natural Area Field Assessments					
			EPBC Act	WC Act/DPaW	PMST	NatureMap	DPaW		Shepherds Bush (ELA 2016)	Hepburn Heights (CoJ 2015)	Craigie Bushland (NAC 2011)	Craigie Bushland Birds Australia (PBP 2006)	Craigie Bushland NAIA (2004)	Craigie Bushland Allen et al. (1994)
Tettigoniidae	*Caedicia* sp. TBC	Katydid Grasshopper								+				
	Metaballus sp. TBC (imm.)	Katydid Grasshopper								+				
	Requena verticalis	Katydid Grasshopper								+				
Theridiidae	*Latrodectus hasselti*	Redback spider								+				
Urodacidae	*Urodacus novaehollandiae*	Sand Scorpion								+				

[1] EN = listed as Endangered under the EPBC Act, WC Act and/or the IUCN red list.
VU = listed as Vulnerable under the EPBC Act, WC Act and/or the IUCN red list.
M = listed as Migratory species under the EPBC Act.
IA = listed as Migratory under the WA Act.
P1 = Priority 1: Poorly-known species.
P3 = Priority 3: Poorly-known species.
P4 = Priority 4: Rare, Near Threatened and other species in need of monitoring.
S2 = Schedule 2: Fauna that is rare or likely to become extinct as endangered fauna (EN).
S3 = Schedule 3: Fauna that is rare or likely to become extinct as vulnerable fauna (VU).
S5 = Schedule 5: Migratory birds protected under an international agreement (IA).
S7 = Schedule 7: Other specially protected fauna (OS)

Appendix 10 – Craigie Bushland Key Native Fauna

Name	Common Name	Conservation Code	Image
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Schedule 2 (*Wildlife Conservation Act*), Endangered (IUCN, DBCA and EPBC)	 Photo: Gary Tate, 2012
Merops ornatus	Rainbow Bee-eater	Schedule 5 (*Wildlife Conservation Act*)	 Photo: BirdLife Australia, no date
Isodon obesulus fusciventer	Quenda (Southern Brown Bandicoot)	Priority 4 (Department of Biodiversity, Conservation and Attractions)	 Photo: Gary Tate, 2017
Ninox novaeseelandiae	Southern Boobook Owl	Locally Significant – City of Joondalup	 Photo: Simon Cherriman, 2015

Macropus fuliginosus	Western Grey Kangaroo	Locally Significant – City of Joondalup	 Photo: Gary Tate, 2016
Trichosurus vulpecula	Common Brushtail Possum	Locally Significant – City of Joondalup	 Photo: DBCA, 2017

Note: For further explanations on Conservation Codes, refer to Appendix 4.

Appendix 11 – Craigie Bushland Example of Non-native Fauna

Name	Common Name	Image
Apis mellifera	European Honey Bee	 Photo: Encyclopedia of Life (no date)
Ommatoiulus moreleti	Portuguese Millipede	 Photo: Robert Mesibov (Australian Government no date)
Dacelo novaeguineae	Laughing Kookaburra	 Photo: Chris Kershaw, 2016
Trichoglossus haematodus	Rainbow Lorikeet	 Chris Kershaw, 2016

Mus musculus	House Mouse	 Photo: Roar Solheim (IUCN 2012)
Vulpes vulpes	European Red Fox	 Photo: Centre for Fortean Zoology Australia (2010)

Appendix 12 – Craigie Bushland Fungi Species– 2016 fungi survey

Name	Common name	Image
Amanita sp.		
Coprinopsis ?lagopus	Hairy Ink Cap	
Fomitopsis lilacinogilva	Lilac Shelf Fungus	
Hohenbuehelia ligulata	Tiny Tongue Panellus	

Appendix 12 – Craigie Bushland Fungi Species– 2016 fungi survey

Name	Common name	Image
Laccaria lateritia	Brick Red Laccaria	
?*Lentinellus* sp.		
Pycnoporus coccineus	Scarlet Bracket Fungus	
Scleroderma sp.	Earthballs	

Appendix 12 – Craigie Bushland Fungi Species– 2016 fungi survey

Name	Common name	Image
Tubifera ferruginosa	Strawberry Slime Mould	

City of Joondalup

Community Engagement Plan
Craigie Bushland Management Plan

Purpose of engagement:
To obtain feedback from local environmental organisations, community groups, government stakeholders and the general community on the *draft Craigie Bushland Management Plan*.

Background:
The City's *draft Craigie Bushland Management Plan* has been developed to provide direction for the ongoing management of Craigie Bushland over the next ten years. The draft Plan describes the potential environmental impacts, risks and threats that are likely to affect the biodiversity values of the area and proposes management strategies to be implemented over the life of the Plan in order to minimise potential impacts. Community engagement has previously been conducted with the Friends of Craigie Bushland, the University of Western Australia and the Department of Biodiversity, Conservation and Attractions. A Craigie Bushland Management Plan Focus Group Meeting was held on 30 November 2017 with representatives from the Friends of Craigie Bushland and the University of Western Australia.

Summary of project/proposal:
The objective of the *draft Craigie Bushland 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 aims of the draft Plan are to: • establish a baseline description of the environment to guide future environmental planning and recommended management actions • outline key environmental threats and the impact they have on conservation and recreation values • outline management actions to address key environmental threats including monitoring and reporting.

What do you want to achieve from the community engagement?

☐ Gathering information	☐ Identifying need(s)
☒ Obtaining local knowledge	☐ Validating research/data
☐ Obtaining feedback on activity	☐ Seeking guidance/direction
☒ Obtaining feedback on draft plan/document	☒ Educating community members
☐ Other:	
…….	

Is there a statutory/legal requirement to engage?	
☐ Yes	☒ No

Planned start and end dates:	
Start: 30 April 2018	**End:** 28 May 2018

Budget for engagement:

$ 1,000

This includes the manufacture and installation of a sign at the primary entrance at Craigie Bushland and postage costs informing targeted stakeholders about the opening of the community engagement period.

This cost excludes staff time and resources in analysing the results of the community engagement and developing the Community Engagement Outcomes Report.

Key messages to the community:

- Craigie Bushland is a locally and regionally significant urban bushland remnant containing high environmental values.
- The City is committed to managing this important bushland site into the future.
- There are a number of potential environmental impacts that are likely to affect the site.
- The City has carefully selected appropriated management strategies to address these potential impacts, and these are detailed in the *draft Craigie Bushland Management Plan*.
- The City is keen to hear the views of community members on these proposed management strategies.

Target audience/stakeholders:

☒ General community/residents/ratepayers	☐ Local businesses
☐ Young people	☐ Industry groups/peak bodies
☐ Seniors	☒ Local schools/educational institutions
☐ Community groups/sporting clubs	☒ Media
☐ Faith/religious groups	☐ Other local governments
☒ Environmental/friends' groups	☒ State government(s)
☒ Resident/ratepayer groups	☐ Federal government
☐ Parents' groups	☒ Parliamentarians/politicians
☐ Culturally and linguistically diverse people	☐ City of Joondalup Elected Members
☐ People with disability	☐ City of Joondalup Executive
☐ Aboriginal and Torres Strait Islander people	☐ City of Joondalup staff

Specific stakeholders:

- Department of Biodiversity, Conservation and Attractions (WA)
- Department of Fire and Emergency Services (WA)
- Department of Planning, Lands and Heritage (WA)
- Craigie Resident and Community Association Inc
- Friends of Craigie Bushland
- Friends of Hepburn Heights and Pinnaroo Bushland Inc
- Friends of Shepherds Bush
- Friends of Warwick Bushland
- Craigie Heights Primary School (Department of Education (WA))
- Beldon Primary School (Department of Education (WA))
- Bambara Primary School (Department of Education (WA))
- Springfield Primary School (Department of Education (WA))
- Whitford Catholic Primary School (Catholic Education Commission of WA)
- St Stephen's School (Uniting Church Western Australia)
- Pinnaroo Valley Memorial Park (Metropolitan Cemeteries Board (WA))
- University of Western Australia
- Water Corporation
- Western Australian Local Government Association
- Western Australian Planning Commission

Areas/location are to be targeted as part of the engagement:

- ☐ No area/location targeted (issue–specific)
- ☐ Whole of City
- ☐ Radius around:
  ……
- ☐ Other:
  ……

- ☐ South Ward
  - ☐ Duncraig
  - ☐ Marmion
  - ☐ Warwick
- ☐ South–West Ward
  - ☐ Hillarys
  - ☐ Padbury
  - ☐ Sorrento
- ☐ North Central Ward
  - ☐ Connolly
  - ☐ Edgewater
  - ☐ Heathridge
  - ☐ Mullaloo
  - ☐ Ocean Reef
- ☐ South–East Ward
  - ☐ Greenwood
  - ☐ Kingsley
- ☐ Central Ward
  - ☐ Beldon
  - ☒ Craigie
  - ☐ Kallaroo
  - ☐ Woodvale
- ☐ North Ward
  - ☐ Burns Beach
  - ☐ Currambine
  - ☐ Iluka
  - ☐ Joondalup
  - ☐ Kinross

Expected/desired number of participants?

- ☒ <50
- ☐ 50–100
- ☐ 101–200
- ☐ 201–500
- ☐ 501–1,000
- ☐ >1,000

Engagement methods:

- ☐ Focus group(s)
- ☐ Forum(s)/workshop(s)
- ☒ Hard-copy questionnaire
- ☐ Interview(s)
- ☐ Meeting(s)
- ☒ Online questionnaire
- ☐ Phone questionnaire (CATI)
- ☒ Other:
  Written feedback from stakeholders

Description:

- Online questionnaire preferred with hard-copy questionnaire available on request.
- Long-form written feedback accepted from organisations.

Communication methods:

Direct communication:

- ☒ Email
- ☒ Letter
- ☐ Telephone call

Print communication:

- ☐ Banner
- ☐ Brochure
- ☐ Flyer
- ☐ Frequently Asked Questions
- ☐ Joondalup Voice
- ☒ Media release
- ☐ Newspaper advertisement
- ☒ Poster
- ☐ Public notice
- ☒ Signage

Online communication:

- ☒ eNewsletter
- ☐ Facebook advertisement
- ☒ Facebook post
- ☐ Google advertising
- ☐ Twitter advertisement
- ☒ Twitter post
- ☒ Website (engagement page)
- ☐ Website (hero image)
- ☐ YouTube advertisement
- ☐ YouTube video

Electronic Communication:

- ☒ Electronic display boards
- ☐ Telephone hold message
- ☐ Television advertisement
- ☐ Twin Cities Radio

Miscellaneous:

- ☐ Bench advertising (street)
- ☐ Bin advertising
- ☐ Bus stop advertising
- ☐ On-site meeting/listening post
- ☐ Shopping centre pop-up
- ☐ Special event/launch
- ☐ Other:

……

Description:

- Letter — posted to identified stakeholders advising them of the engagement and directing them to the online questionnaire.
- Email — sent to identified stakeholders advising them of the engagement and directing them to the online questionnaire.
- Email — sent to Community Engagement Network members living in Craigie and those who have expressed interest in environmental issues, advising them of the engagement and directing them to the online questionnaire.
- e-Newsletter (Environmental Events) — sent to recipient database advising of engagement and directing them to the online questionnaire.
- Temporary signage at the main entrance to Craigie Bushland — advising visitors of the engagement and directing them to the online questionnaire.
- Electronic display board at Craigie Leisure Centre — advising customers/user groups of the engagement and directing them to the online questionnaire.
- A2/A3 poster — displayed at Craigie Leisure Centre advising the general community of the engagement and directing them to the online questionnaire.
- Webpage under the “Community Engagement” section of the City’s website — providing details of the engagement and linking users to the online questionnaire.
- Facebook post — advising the general community of the engagement and directing them to the online questionnaire.
- Tweet — advising the general community of the engagement and directing them to the online questionnaire.
- Media release uploaded to the City’s website — advising local media of the engagement.

Valid responses (if relevant):
For a response to be valid, the respondent must: • include their full contact details. The City will not accept anonymous responses.

Multiple/duplicate responses (if relevant):
The City will only accept: • 1 response per household • 1 (formal) response per organisation

Evaluation and reporting of engagement outcomes:
Outcomes from the engagement will be analysed and reported to Elected Members via a Community Engagement Outcomes Report. The report will be presented at a Council Meeting, together with any recommended changes to the *draft Craigie Bushland Management Plan* following engagement.