APPENDIX 3

ECOLOGICA ENVIRONMENT: BEENYUP STAGE 1 BIOLOGICAL SURVEY JANUARY 2013

JANUARY 2013

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BEENYUP STAGE 1 BIOLOGICAL SURVEY

Document Status						
Rev	Author	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
1	M d'Auvergne M Campos	K Honczar	30/11/2012	K Honczar	L McGuire, Water Corporation	30/11/2012
2	M d'Auvergne M Campos	M Campos	07/01/2013	K Honczar	L Kaay, Water Corporation	08/01/2013
3	M d'Auvergne M Campos	K Honczar	22/01/2012	K Honczar	L Kaay, Water Corporation	22/01/2013

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND GLOSSARY

ARRP Act	*Agriculture and Related Resources Protection Act 1976*
BOM	Bureau of Meteorology
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DEFL	The DEC's Threatened (Declared Rare) Flora Database
DSEWPC	Department of the Sustainability, Environment, Water, Populations and Communities
DRF	Declared Rare Flora
ESA	Environmentally Sensitive Area
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IBRA	Interim Biogeographic Regionalisation for Australia
NVIS	National Vegetation Information System
PEC	Priority Ecological Community
TEC	Threatened Ecological Community
WAHERB	Western Australian Herbarium
WC Act	*Wildlife Conservation Act 1950*

EXECUTIVE SUMMARY

The Water Corporation is seeking to expand the Groundwater Replenishment (GWR) trial at Beenyup Wastewater Treatment Plant (WWTP). As part of this project the Beenyup WWTP site will need to be expanded with a total area of 25 hectares expected to be cleared in Stage 1. The Project Area is located in the Perth metropolitan area, approximately 20 km north of the city centre and it is located entirely in Perth subregion of the Swan Coastal Plain Bioregion. The Project Area overlaps with Whitfords Avenue Bushland (Bush Forever Site 303), and is also in the vicinity of Bush Forever Sites 299 and 407.

A level 2 Flora and Vegetation Survey and a Level 1 Zoology Survey were undertaken by *ecologia* during October 2012.

The key results of the flora, vegetation and fauna assessment are as follows:

- Three species of Declared Plants (**Echium plantagineum, *Lantana camara* and **Moraea flaccida*) were recorded and require control methods as specified by DAFWA.
- The regional vegetation types of the Project Area are the Karrakatta Complex – Central and South and Cottesloe – Central and South, which Perth Biodiversity Project reports to be represented by 24% and 35% of its pre-European extent. The Karrakatta Complex – Central and South falls below the threshold level of 30%. The proposed clearing may be variance with Principle (e) due to this result.
- Some of the Project Area intersects with a section of Bush Forever site 303, however these areas are zoned for the development of infrastructure for roads/rail and public utilities. The proposed clearing may be, although is unlikely to be at variance with Principle (h) due to this result.
- The occurrence of *Phytophthora multivora* has been confirmed at the site, from one of nine samples collected and tested using laboratory methods.
- One fauna species of conservation significance; Carnaby's Black-Cockatoo, listed as Endangered under the EPBC Act and Endangered (Schedule 1) under the WC Act, was recorded. The proposed clearing is at variance with Principle (b) due to this result.

The following recommendations are suggested:

- Limit clearing of vegetation to that which is absolutely necessary for construction and safe operation of the project, particularly within Bush Forever site 303.
- Undertake obligatory weed control for Declared Plants, in accordance with methodologies prescribed by DAFWA.
- If clearing of intact native remnant vegetation is required, consider offsetting further clearing impacts to the Karrakatta Complex – Central and South by undertaking some rehabilitation at the site, in areas that are currently degraded and that are not required for the development.
- Where possible, avoid clearing of mature trees at the site, in particular the nine trees identified to be significant or potential habitat trees and in particular the tree identified to have hollows suitable for Black-Cockatoo nesting.
- Prepare an appropriate Construction Environmental Management Plan to minimise and manage impacts to ecological values during construction.

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1 INTRODUCTION

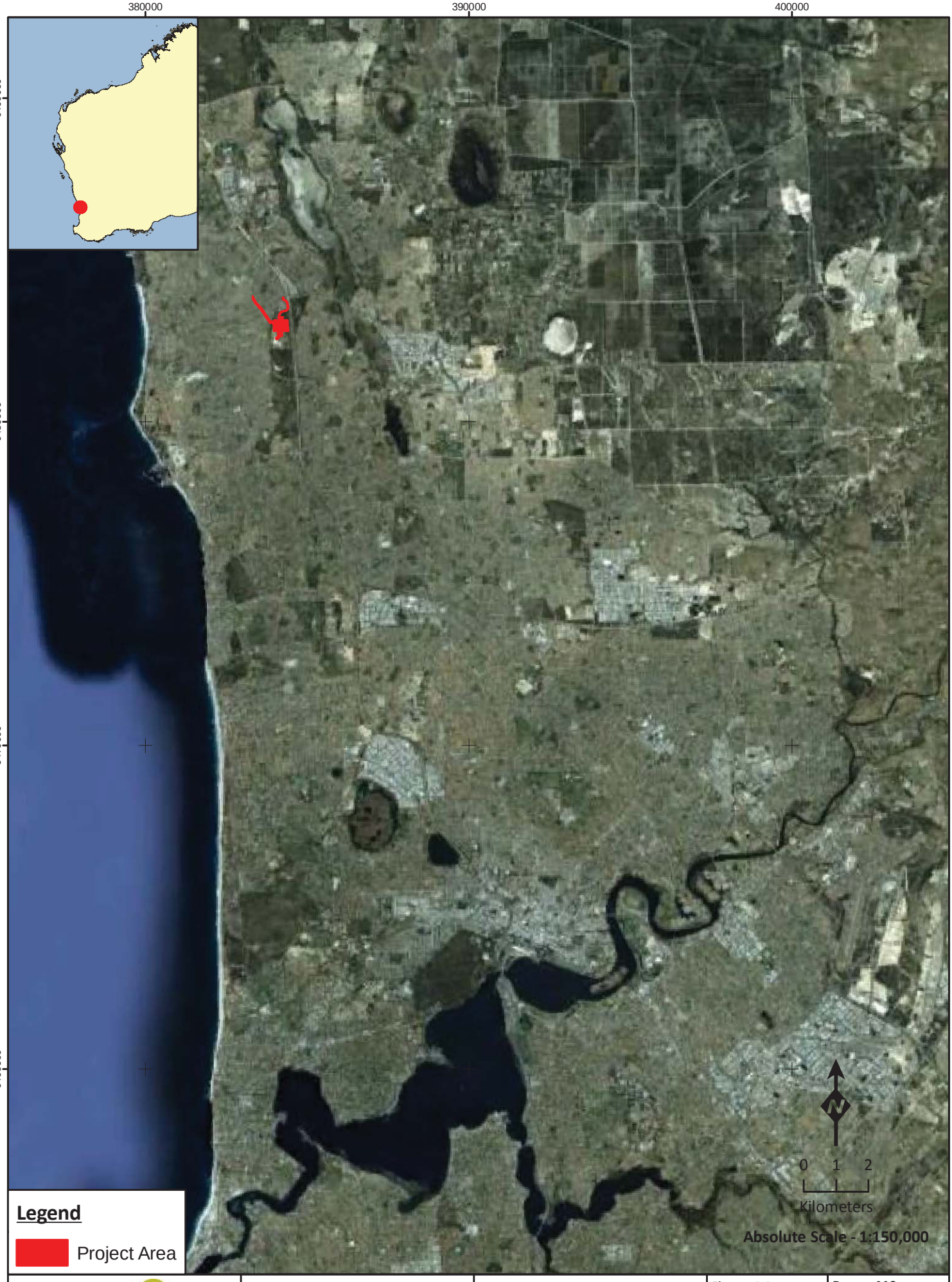
1.1 PROJECT BACKGROUND

The Water Corporation is seeking to expand the Groundwater Replenishment (GWR) trial at Beenyup Waste Water Treatment Plant (WWTP) into a 7 GL/year scheme. The GWR Trial is currently proceeding at Beenyup to demonstrate the technical and social feasibility of this source option. If the trial is successful the 7 GL/year scheme will be subject to regulatory, social and political acceptance. GWR has the potential to form part of the Water Corporation's climate independent water sources to supply a percentage of Perth's water into the future.

As part of this project the Beenyup WWTP site will need to be expanded to allow new infrastructure, such as an Advanced Water Recycling Pant (AWRP), to be constructed. The total area of the clearing boundary for Stage 1 is 25 hectares in size, although this includes large expanses of open or developed space. Some of the assessment area is within Bush Forever site 303.

1.2 LOCATION

The Project Area is located in the Perth metropolitan area, approximately 20 km north of the city centre. The Beenyup WWTP is 4 km inland from the ocean and 2 km west of Lake Joondalup, on the southwest corner of Ocean Reef Road and Mitchell Freeway (Figure 1.1).



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Location of Project Area Beenyup Stage 1

Figure: 1.1	**Drawn: MC**
Project ID: 1469	**Date: 20/11/2012**

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC073

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1.3 LEGISLATIVE FRAMEWORK

Legislation relevant to the protection of biodiversity in Western Australia includes, but is not limited to, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the State *Wildlife Conservation Act 1950* (WC Act) and *Environmental Protection Act 1986* (EP Act).

The Commonwealth EPBC Act was developed to provide protection for matters of national environmental significance. It includes provisions to protect threatened species and communities and the conservation of migratory species.

The State WC Act was developed to provide for the protection of wildlife in Western Australia. Under section 14 of this act, all flora and fauna are protected in Western Australia. In addition, the Minister has published a list of species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listing was published in Western Australian Government Gazette on 17th August 2010.

The State EP Act was developed to ensure that impacts on native flora and fauna are considered in the assessment of development proposals. While the assessment of specific proposals is not within the scope of this report, the surveys undertaken conform to the requirements of the Environmental Protection Authority's (EPA's) *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002a), *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a) and *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

Under the relevant legislation, certain species of flora, fauna and ecological communities are awarded protection in the interest of their conservation.

1.3.1 Threatened and Priority Flora

During April 2011, the Department of Environment and Conservation (DEC) revised the conservation codes for Western Australian flora. DEC assigns conservation codes to endemic plant species that are geographically restricted to few known populations or threatened by local processes. Allocating conservation codes to plant species assists in protecting populations and conserving species from potential threats (DEC, 2011a and 2011b).

The definitions of the categories of Threatened and Priority Flora protected at a State level under the WC Act are presented in Appendix A.

1.3.2 Introduced Flora

1.3.2.1 Declared Plants

Weeds that are, or have the potential to become, pests to agriculture can be declared formally under the *Agriculture and Related Resources Protection Act 1976* (Department of Agriculture and Food 1976) as Declared Plants. Weeds listed under this Act are listed with Standard Control Codes that outline the requirements for their control. Five priority groupings exist (P1, P2, P3, P4 or P5). More than one priority may be assigned to a weed species and different municipal districts may list different priority levels. Landholders are obliged to control Declared Plants that occur on their property and are encouraged to adhere to the standard control recommendations.

1.3.2.2 Environmental Weeds

A second and much more extensive categorisation of weeds has been developed by the DEC, formerly the Department of Conservation and Land Management (CALM) in the Environmental Weed Strategy ((Department of Conservation and Land Management 1999). Species considered to adversely affect the communities they invade are evaluated based on the following criteria:

- Invasiveness; ability to invade bushland in good to excellent condition or ability to invade waterways (scored as yes or no).
- Distribution; wide current or potential distribution including consideration of known history of widespread distribution elsewhere in the world (scored as yes or no).
- Environmental impacts; ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community (scored as yes or no).

Weeds listed as Environmental Weeds are ranked into four categories using the above criteria and the scoring system:

- High; a species which scores yes to all three of the above criteria. A rating of high indicates a species that should be prioritised for control and/or research.
- Moderate; a species which scores yes for two of the above criteria. A rating of moderate indicates a species which should be monitored. Control or research should be directed to it if funds are available.
- Mild; a species which scores yes to one of the criteria. A mild rating indicates monitoring or control if appropriate.
- Low; a species which does not score yes for any of the criteria. A low rating indicates a low requirement for monitoring.

1.3.3 Threatened and Priority Ecological Communities

Ecological communities are naturally occurring biological assemblages located in a particular type of habitat. At a national level, Threatened Ecological Communities (TECs) are protected under the EPBC Act. TECs are listed under this Act as either 'Critically Endangered', 'Endangered' or 'Vulnerable'. A definition of these codes is provided in Appendix A.

The DEC also maintains a list of TECs endorsed by the Minister of Environment (DEC, 2010) that are classified as being either 'Presumed Totally Destroyed', 'Critically Endangered', 'Endangered' or 'Vulnerable'. Definition of these codes is also provided in Appendix A.

The DEC maintains an additional list of Priority Ecological Communities (PECs), for communities that could potentially be classified as TECs, but are not currently adequately defined or surveyed. Communities are placed in this category while consideration can be given to their declaration as a TEC. Five priority codes exist for PECs and these are defined in Appendix A.

1.3.4 Threatened, Priority and Migratory Fauna

Species of fauna are defined as threatened where their populations are under threat, require protection or are protected under an international agreement between federal governments. DEC recognises these threats of extinction and consequently applies regulations towards population and species protection. Schedule 1 Threatened fauna are further ranked by DEC according to their threat using International Union for Conservation of Nature (IUCN) Red List criteria. Threatened fauna species are protected under the WC Act and the categories are defined in Appendix A.

Priority fauna not listed as Threatened (Scheduled) under the WC Act, but that are poorly known or poorly represented in the conservation estate are regarded as priority and attention is given to their conservation by DEC. The five classifications of Priority fauna are listed in Appendix A.

Threats of extinction of fauna species are also recognised at a Commonwealth level and are categorised according to the EPBC Act, administered by DSEWPaC. Categories of threatened species are summarised in Appendix A.

Migratory species are matters of Commonwealth environmental significance under the EPBC Act. Recognised migratory species include any native species identified in an international agreement approved by the Minister and those listed under:

- the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- the China-Australia Migratory Bird Agreement (CAMBA)
- the Japan-Australia Migratory Bird Agreement (JAMBA).

1.3.5 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are areas that require special protection due to aspects such as landscape, wildlife of historical value (Naturenet 2010). ESAs are declared under the *Environmental Protection (Clearing of Native Vegetation) Regulation 2004*.

1.3.6 Conservation Estate

The National Reserve System (NRS) is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia. Areas vested in the Conservation Estate are managed by the Conservation Commission.

1.4 SCOPE AND OBJECTIVES

The EPA's objectives with regards to the management of native flora and vegetation are to:

- Avoid adverse impacts on biological diversity comprising the different plants and animals and the ecosystems they form, at the levels of genetic, species and ecosystem diversity.
- Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.
- Protect Declared Rare Flora (DRF) consistent with the provisions of the WC Act.
- Protect other flora species of conservation significance.

The primary objective of the assessment was to provide sufficient information to the carry out an assessment of the proposed clearing against the Clearing Principles and to assist the Water Corporation in determining whether clearing can proceed under the Statewide Clearing Purpose Permit.

The scope of the assessment was as follows:

Desktop Assessment

- Carry out a desktop assessment of relevant literature, databases and spatial databases to evaluate the environmental values and any potential issues, such as Endangered or Priority flora or fauna species, Bush Forever sites, Threatened Ecological Communities (TEC's) and Priority Ecological Communities (PEC's) that may be present in the area of proposed disturbance or its surrounds; and
- Provide maps presenting the above (GDA 94 datum).

Flora and Vegetation

- Complete a Level 2 floristic survey, compliant with Guidance Statement 51 in terms of survey timing and sampling methodology;
- Complete the site survey, including an inventory of plants and communities; a map and photographs showing the vegetation types/communities observed; and maps and photographs showing vegetation condition;
- Record landforms/landscape features present such as floodplains, ridgelines, side slopes;
- Record drainage features present;
- Record any land management problems such as gully erosion, water logging, salinity, weed invasion, and the extent area of the problem;
- Determine the native vegetation representation (i.e. current extent of native vegetation compared with pre-European extent) of the vegetation associations/complexes and assess the significance of the proposed clearing;
- Undertake a specific targeted search for and map the location of any *Lomandra maritima* and *Lomandra hermaphrodita*, and if found make recommendations in relation to the presence of the Graceful Sun Moth;
- Determine the presence (status) of *Phytophthora* dieback at the Project Area and provide protocols and/or recommendations in relation to hygiene measures accordingly;
- Identify, map and discuss the Bush Forever site vegetation and determine the significance and quality of the Bush Forever vegetation inside the clearing area;

- Document impacts on any flora that may result from the proposed works and provide recommendations to minimise impacts on native vegetation (i.e. minimise clearing, topsoil handling etc.) and endemic or protected fauna;
- Recommend any requirements that the Water Corporation must follow under the EPBC Act, the WC Act and the EP Act;
- Assess the proposed native vegetation clearing against the 10 clearing principles, with regard to the DEC's Guide to Assessment: Clearing of Native Vegetation;
- Report on the outcome of the above assessment; and
- Propose actions consistent with the offset principles if clearing is likely to be at variance to the clearing principles.

Vertebrate Fauna

- Complete a Level 1 fauna survey, compliant with Guidance Statement 56 in terms of survey timing and sampling methodology;
- Provide an inventory of fauna species and habitat/breeding trees for fauna or conservation species from within the Project Area;
- Produce a map showing the location of any conservation significant fauna sighted, or any habitat trees for conservation significant species;
- Discuss the likelihood of conservation significant fauna species presence within the area;
- Document impacts on any conservation significant fauna that may result from the proposed works and provide recommendations to minimise impacts on native vegetation (i.e. minimise clearing, topsoil handling etc.) and endemic or protected fauna; and
- Recommend any requirements that the proponent must follow under the EPBC Act, the WC Act and the EP Act.

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2 METHODOLOGY

The flora, vegetation and fauna assessment was carried out in accordance with EPA Guidance and encompassed both desktop and field assessments. The field survey was conducted by two botanists and one zoologist on the 16 and 17 of October 2012. A survey effort equivalent to six person days was expended.

2.1 FLORA AND VEGETATION ASSESSMENT

A Level 2 flora and vegetation assessment was carried out in accordance with EPA Guidance Statement 51 (Environmental Protection Authority 2004). Two 100 m^2 quadrats (Figure 2.1) were surveyed to characterise the remnant vegetation and the entire Project Area was traversed using a series of transects to produce a species inventory and to search for Priority flora.

2.1.1 Opportunistic Collections

The Project Area was searched using a series of transects, during which opportunistic collections were made, noting the local abundance or canopy cover. Species planted for landscaping purposes were not collected unless outside of the landscaped areas; i.e. with the potential to be invasive.

2.1.2 Floristic Quadrats

Quadrat locations were selected to represent the range of vegetation types present. The following information was recorded at each quadrat and is provided in Appendix B:

- location details, including GPS coordinates;
- photograph of vegetation structure;
- topography, surface soil composition and colour, and surface lithology;
- structural information describing the vegetation community; including the height, foliage canopy cover, form and dominant species;
- height ranges and foliage canopy cover for each species recorded within the quadrat;
- vegetation condition and the nature of any disturbance; and
- estimated time since the last fire.

Plant specimens were collected for later identification and verification by a qualified plant taxonomist. Vegetation type, life-form strata and percentage cover for each stratum were recorded using the National Vegetation Information System (NVIS) level 6 vegetation classifications (Department of Environment and Water Resources 2003), as described in Appendix C. Nomenclature and taxonomy follow the conventions currently adopted by Florabase (Western Australian Herbarium 1998-2012).

Vegetation condition was assessed at each quadrat and throughout the Project Area using the rankings and criteria (Department of Environment and Water Resources 2003), detailed in Table 2.1.

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Location of Flora Quadrats Beenyup Stage 1

Figure: 2.1
Project ID: 1469

Drawn: MC
Date: 19/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC068

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Table 2.1 – Vegetation Condition Assessment

Vegetation Condition	Criteria
Excellent	Pristine or nearly so, no obvious sign of damage caused by European man.
Very good	Some relatively slight signs of damage caused by the activities of European man. E.g. damage to tree trunks by repeated fires, the presence of some relatively non-aggressive weeds or occasional vehicle tracks.
Good	More obvious signs of damage caused by the activities of European man, including some obvious impact to vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of European man such as grazing or partial clearing or very frequent fires. Presence of some more aggressive weeds.
Very poor	Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weeds species including aggressive species.
Completely Degraded	Areas that are completely or almost completely without native vegetation e.g. areas that are cleared or parkland cleared with their flora comprising weed or crop species with isolated native trees or shrubs.

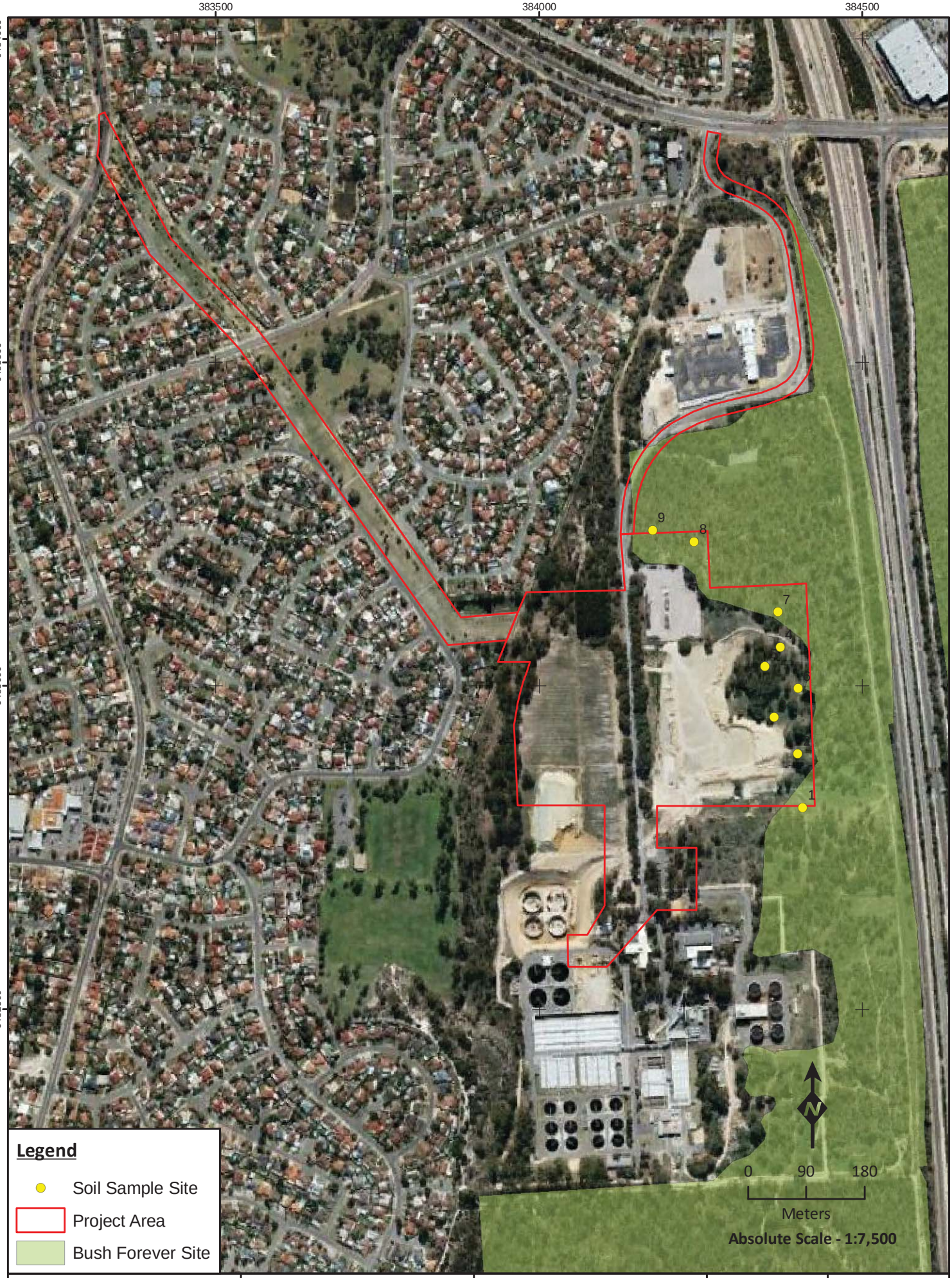
2.2 DIEBACK ASSESSMENT

Vegetation health was visually assessed in the entire Project Area, by means of looking for effects of dieback infestation. These signs include browning or death of the crown of native vegetation, such as *Banksia, Xanthorrhoea* and *Eucalyptus*. Dieback can commonly be visually identified by the banding of the vegetation, with a band of unaffected healthy vegetation, a band of infected vegetation with browning foliage and a band of dead vegetation.

Apart from the visual assessment, soil and root material were sampled from nine locations across the Project Area (Figure 2.2) for laboratory analyses of *Phytophthora cinnamomi*, commonly known as the dieback disease. The soil samples were collected between surface level and 20 cm in depth, adjacent to native flora suspected to be affected by dieback infection. Whenever possible, portions of live root material were included in the soil samples.

To avoid cross-contamination, the trowel used to collect samples was cleaned with 100% ethanol in between collections. Samples of approximately 500 grams were collected from each location and they were sealed in plastic bags and placed in a chilled container.

All collections were made on the 16 of October and sent to the Centre for *Phytophthora* Science and Management on the morning of the 17 of October. The samples were processed and analysed using the most appropriate culture-based isolation techniques for the sample, which involved soil baiting and/or direct plating onto selective agar, according to current methodology at the Centre for *Phytophthora* Science and Management.



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Soil Sample Locations Beenyup Stage 1

Figure: 2.2	**Drawn: MC**
Project ID: 1469	**Date: 19/11/2012**

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC074

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2.3 VERTEBRATE FAUNA ASSESSMENT

Prior to the development of survey methods, a review was undertaken of factors likely to influence survey design and intensity (Table 2.4). Based on this review, it was deemed necessary for a Level 1 survey in accordance with EPA Guidance Statement 56 (EPA, 2004) to be conducted within the Project Area, incorporating a desktop assessment and reconnaissance field survey.

Table 2.2 –Factors likely to influence survey design (EPA 2004b)

Factor	Comment
Bioregion – level of existing survey-knowledge of the region and associated ability to predict accurately	The Swan Coastal Plain bioregion has been well studied and information was readily available.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region	The landforms associated with the Project Area are typical for the region and do not present any rare or special characteristics.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present	Not applicable to a Level 1 survey of this calibre, survey was habitat assessment based.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves)	11 previous terrestrial vertebrate fauna assessments have been conducted within 60 km of the Project Area. Regional and local knowledge for the area is available.
Number of different habitats or degree of similarity between habitats within a Project Area	The survey was undertaken to determine the different habitat types present in the Project Area.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods)	No climatic constraints were experienced.
Sensitivity of the environment to the proposed activities	The environment associated with the Project Area appears to be common with the surrounding region with no specifically environmentally sensitive areas.
Size, shape and location of the proposed activities	The Project Area totals 25 ha, this does not affect survey design.
Scale and impact of the proposal	The scale and impact of the proposal is not known and does not influence the design of this assessment.

The survey methods adopted by *ecologia* are aligned not only with EPA Guidance Statement No. 56, but also Position Statement No. 3 (EPA 2002b), *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010) and *Draft Referral Guidelines for Three Black Cockatoo Species* (DSEWPaC 2011).

Due to the Project Area falling within the known breeding range of conservation significant species Carnaby's Black-Cockatoo, and within the range of Baudin's Black-Cockatoo and Forest Red-tailed Black-Cockatoo, survey methods were aligned with those suggested in guidelines for surveying for these species (DSEWPaC 2011). As per the guidelines, all known species of breeding trees greater than 500 mm in diameter at breast height (DBH) were recorded within the Project Area. All habitats within the Project Area were assessed, with the likelihood of breeding, foraging or roosting habitat determined. Recording of potential breeding trees was restricted to patches of woodland only (DSEWPaC 2011).

An assessment of habitat for all potential conservation significant species was also carried out, to determine the likelihood of occurrence of all potentially occurring significant vertebrate fauna species.

Recording of vertebrate fauna species was achieved by opportunistic sampling methods only, which included direct sightings and records of evidence of activity.

2.3.1 Conservation Significant Fauna Assessment

After the results of the literature review, database searches and survey results were compiled; fauna species were identified that are listed under current legislative frameworks; the Commonwealth (EPBC Act) and State level (WC Act and DEC priority list).

The likelihood of a conservation significant species being present within the project was determined by examining the following:

- fauna habitats known to exist within the Project Area and their condition as assessed during the survey;
- distance of previously recorded conservation significant species from the Project Area;
- frequency of occurrence of conservation significant species records in the region; and
- time passed since conservation significant species were recorded within, or nearby the Project Area.

Each conservation significant or biologically significant species potentially occurring in the Project Area, was assigned a likelihood of occurrence based on the below categories (Table 2.3). The level of available information for each species was also taken into consideration so that species are not allocated a low likelihood of occurrence because of insufficient survey information or cryptic behaviours and ecology, in accordance with the precautionary principle. Conservation significant species likely to occur in the project area are discussed in Section 4.6.

Table 2.3 – Likelihood of Occurrence Categories

RECORDED	Species recorded during current survey
HIGH	Species recorded within, or in proximity to, the Project Area within 20*years; suitable habitat occurs in the Project Area
MEDIUM	Species recorded within, or in proximity to, the Project Area more than 20 years ago. Species recorded outside Project Area, but within 50 km; suitable habitat occurs in the Project Area
LOW	Species rarely, or not recorded, within 50 km, and/or suitable habitat does not occur in the Project Area

**ecologia* chooses to incorporate regional data from the last 20 years to assess a high likelihood of occurrence of species. Species that have previously been recorded from an area within the last 20 years and where high quality, suitable habitat still persists within an area are considered by *ecologia* to still have potential for a high likelihood of occurrence, following the precautionary principle.

2.3.2 Fauna Habitat Mapping

Previous terrestrial vertebrate fauna assessment information, aerial photographs, vegetation and land system maps of the Project Area were reviewed prior to the survey to determine the potential habitat types of the Project Area.

As part of the flora and vegetation assessment carried out by the botanists, a targeted search for *Lomandra maritima* and *L. hermaphrodita* was carried out in order to establish whether suitable habitat for the Graceful Sun Moth is present in the Project Area.

Targeted assessment of Black-Cockatoo habitat was also carried out.

2.3.3 Fauna Taxonomy and Nomenclature

Nomenclature for mammals, reptiles and amphibians within this report is as per *Western Australian Museum Checklist of the Vertebrates of Western Australia*, birds according to Christidis and Boles (2008). References used for fauna identification are listed in Table 2.4.

Table 2.4 – References Used for Identification

Fauna Group	Reference
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2008)
Bats	Churchill (1998), Menkhorst and Knight (2011)
Birds	Simpson and Day (2004)
Reptiles	Cogger (2000), Wilson and Swan (2010)
Geckos	Storr *et al*. (1990), Wilson and Swan (2010)
Skinks	Storr *et al*. (1999), Wilson and Swan (2010)
Dragons	Storr *et al*. (1983), Wilson and Swan (2010)
Varanids	Storr *et al*. (1983), Wilson and Swan (2010)
Legless Lizards	Storr *et al*. (1990), Wilson and Swan (2010)
Snakes	Storr *et al*. (2002), Wilson and Swan (2010)
Amphibians	Tyler and Doughty (2009), Cogger (2000)

2.3.4 Animal Ethics and Licences

Surveying was conducted as per *ecologia*'s Animal Ethics Code of Practice, which conforms to Section 5 of the *Australian code of practice for the care and use of animals for scientific purposes* (NHMRC 2004).

Fauna were identified in the field from non-invasive observation and searching. The survey was conducted under DEC Regulation 17 License SF008907.

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3 EXISTING ENVIRONMENT

3.1 CLIMATE

The Project Area is situated in the Swan Region of Western Australia. and experiences a dry Mediterranean climate with a hot dry summer from December to March and a mild winter from June to August (BOM 2012).

Within the Lower West (data from approximately 16 km southeast of the study site, weather station Perth Metro 9225), the annual mean maximum temperature ranges from 18.2°C in winter to 31.5°C in summer (BOM 2012). The climate experienced throughout the year is usually dry since high temperatures and humidity seldom occur simultaneously (Figure 3.1). The area is characterised by the presence of strong winds, with speeds at or over 70 km h^{-1} more than half the year (BOM 2012). Average annual rainfall at Perth Metro is 739 mm, for the period of 1994 to 2012 (BOM 2012). The wettest period is from June to August, when approximately 54% of the mean annual rain falls.

Rainfall in the six months preceding the vegetation monitoring completed in October 2012 was 471.6 mm, 23% lower than the long-term mean for those months (BOM 2012).

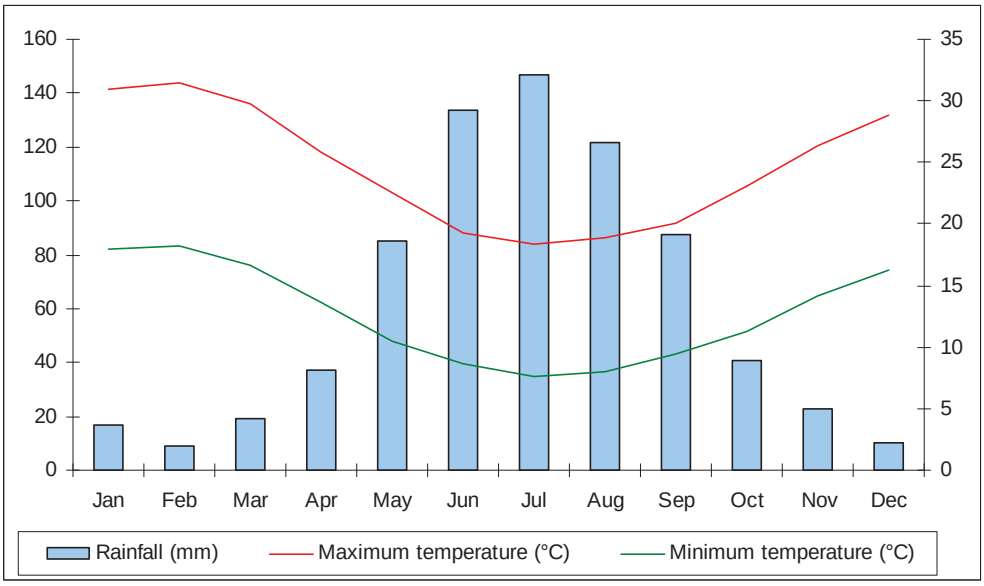


Figure 3.1 – Long-term Climate Data in the Vicinity of the Project Area

Table 3.1 – Rainfall Data for the Project Area

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean from 1993 to 2012	16.5	8.9	18.9	37.0	85.0	133.8	146.8	121.4	87.5	41.0	22.7	10.3
Year 2012*	18.8	23.6	0.2	69.2	49.0	140.8	34.6	87.2	90.8	15.6	58.2	20.2

*Data not quality controlled

3.2 BIOGEOGRAPHIC REGIONS

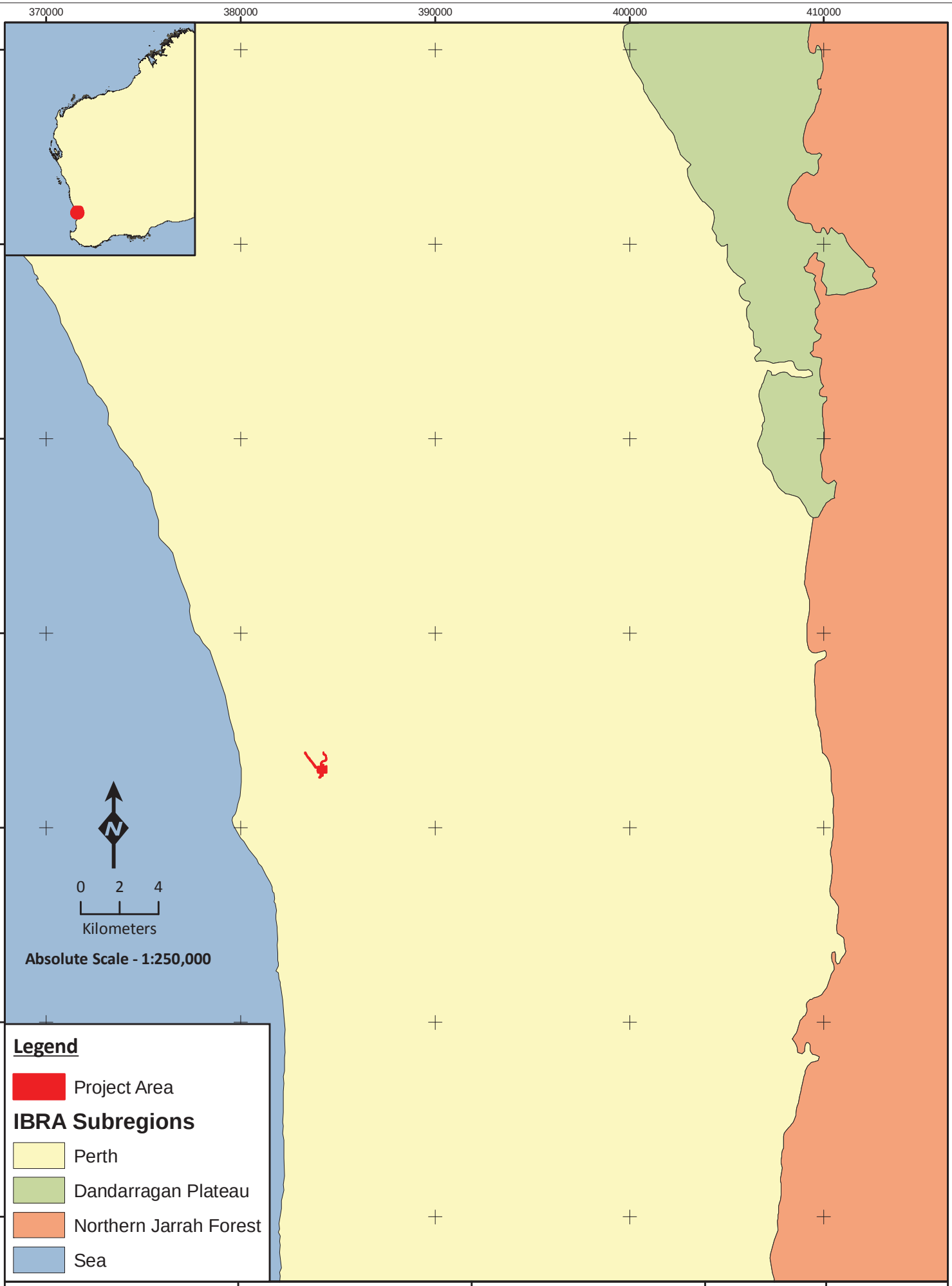
The Interim Biogeographic Regionalisation for Australia (IBRA, Version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (Australian Government Department of Sustainability 2012). The Project Area is located in the Swan Coastal Plain Bioregion, which has an area of 1,525,798 ha. The Swan Coastal Plain Bioregion is further subdivided into two subregions: the Dandaragan Plateau and Perth. The Project Area is located entirely in the Perth subregion (Figure 3.2), which has an area of 1,142,334 ha and represents approximately 75% of the Swan Coastal Plain.

The Perth subregion is a low lying coastal plain composed of colluvial and Aeolian sands, alluvial river flats and coastal limestones (Mitchell *et al*. 2002). The main land use of the Subregion is agriculture; and the Perth Metropolitan Area encompasses about 20% of the Perth Subregion (Mitchell *et al.* 2002).

3.2.1 Regional Vegetation

The vegetation of the Swan Coastal Plain has been mapped at a regional scale by Heddle *et al.* (1980) in correlation to the major geological units of Churchward and McArthur (1980). The Beenyup site occurs predominantly on the Karrakatta Complex – Central and South (Figure 3.4), which is comprised of predominantly open forest of *Eucalyptus gomphocephala, E. marginata* and *Corymbia calophylla* with *Banksia* species (Heddle et al. 1980). A small area of the Project Area is located on the Cottesloe Complex – Central and South, which is comprised of mosaic woodland of *Eucalyptus gomphocephala*; open forest of *E. gomphocephala*, *E. marginata* and *Corymbia calophylla*; and closed heath on the limestone outcrops.

The Study Area lies within Beard's (1975) South-West Botanical Province, part of a series of maps completed by Beard *et al.* from 1974 to 1981 throughout Western Australia. The vegetation mapping was subsequently reinterpreted to reflect the National Vegetation Information System (Department of Environment and Water Resources 2012) standards and revised taxonomy for some species and digitised (Shepherd *et al.* 2001). Three vegetation units are mapped within the Study Area Figure 3.5.



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IBRA Subregions of Project Area Beenyup Stage 1

Figure: 3.2
Project ID: 1469

Drawn: MC
Date: 20/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC073

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Legend

Project Area

Remaining Heddle Vegetation Complexes (Perth Biodiversity Project 2010)

Cottesloe Complex-Central And South

Karrakatta Complex-Central And South

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Heddle Vegetation Complexes Beenyup Stage 1

Figure: 3.3
Project ID: 1469

Drawn: MC
Date: 19/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC121

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Beard Vegetation Associations Beenyup Stage 1

Figure: 3.4
Project ID: 1469

Drawn: MC
Date: 19/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC069

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3.3 RESULTS OF THE DESKTOP ASSESSMENT

3.3.1 Flora

A search of the DEC's flora databases was conducted, applying a buffer of 10 km around the Project Area (Search reference 58-0812). Species protected by the EPBC Act 1999 and the WC Act recorded in the Perth Subregion of the Swan Coastal Plain Bioregion are listed in Table 3.2, and those which have been recorded within 10 km of the Project Area are highlighted in blue.

Table 3.2 – Species Protected by the *EPBC Act* and *WC Act* Recorded in the Perth Subregion

EPBC Act Listing	Family	Taxon
CE	Apiaceae	*Brachyscias verecundus*
CE	Lamiaceae	*Dasymalla axillaris*
CE	Myrtaceae	*Darwinia foetida*
CE	Orchidaceae	*Caladenia procera*
CE	Proteaceae	*Synaphea* sp. Fairbridge Farm (D. Paperifus 696)
CE	Proteaceae	*Synaphea* sp. Pinjarra (R. Davis 6578)
EN	Cyperaceae	*Lepidosperma rostratum*
EN	Ericaceae	*Andersonia gracilis*
EN	Fabaceae	*Chorizema varium*
EN	Fabaceae	*Gastrolobium papilio*
EN	Fabaceae	*Kennedia lateritia*
EN	Hydatellaceae	*Trithuria occidentalis*
EN	Molluginaceae	*Macarthuria keigheryi*
EN	Myrtaceae	*Calytrix breviseta* subsp. *breviseta*
EN	Myrtaceae	*Darwinia acerosa*
EN	Myrtaceae	*Darwinia apiculata*
EN	Myrtaceae	*Darwinia carnea*
EN	Myrtaceae	*Darwinia whicherensis*
EN	Myrtaceae	*Eucalyptus balanites*
EN	Myrtaceae	*Verticordia densiflora* var. *pedunculata*
EN	Myrtaceae	*Verticordia elongata* var. *ananeotes*
EN	Myrtaceae	*Verticordia elongata* var. *pleiobotrya*
EN	Myrtaceae	*Verticordia elongata* var. *vassensis*
EN	Orchidaceae	*Caladenia busseliana*
EN	Orchidaceae	*Caladenia huegelli*
EN	Orchidaceae	*Diuris purdiei*
EN	Orchidaceae	*Drakaea elastica*
EN	Orchidaceae	*Thelymitra stellata*
EN	Proteaceae	*Banksia mimica*
EN	Proteaceae	*Banksia nivea* subsp. *uliginosa*
EN	Proteaceae	*Grevillea calliantha*
EN	Proteaceae	*Grevillea christineae*
EN	Proteaceae	*Grevillea curviloba* subsp. *curviloba*
EN	Proteaceae	*Grevillea curviloba* subsp. *incurva*
EN	Proteaceae	*Grevillea humifusa*
EN	Proteaceae	*Grevillea maccutcheonii*
EN	Proteaceae	*Lambertia echinata* subsp. *occidentalis*
EN	Proteaceae	*Lambertia orbitifolia* subsp. Scott River Plains (L.W. Sage 684)
EN	Proteaceae	*Petrophile latericola*
EN	Proteaceae	*Synaphea stenoloba*
VU	Cyperaceae	*Eleocharis keigheryi*
VU	Cyperaceae	*Tetraria australiensis*
VU	Fabaceae	*Acacia anomala*
VU	Fabaceae	*Acacia aphylla*
VU	Fabaceae	*Daviesia elongata* subsp. *elongata*
VU	Fabaceae	*Ptychosema pusillum*
VU	Haemodoraceae	*Anigozanthos viridis* subsp. *terraspectans*
VU	Myrtaceae	*Chamelaucium* sp. C Coast Plain (R.D. Royce 4872)
VU	Myrtaceae	*Eucalyptus argutifolia*

EPBC Act Listing	Family	Taxon
VU	Myrtaceae	*Eucalyptus crispata*
VU	Orchidaceae	*Diuris drummondii*
VU	Orchidaceae	*Diuris micrantha*
VU	Orchidaceae	*Drakaea micrantha*
VU	Proteaceae	*Banksia squarrosa* subsp. *argillacaea*
VU	Proteaceae	*Conospermum undulatum*
VU	Proteaceae	*Grevillea brachystylis* subsp. *grandis*
VU	Proteaceae	*Grevillea elongata*
VU	Proteaceae	*Hakea megalosperma*

Highlights indicate taxa recorded within 10 km of the Project Area.

The DEC maintains a list of Priority Flora taxa, which are considered poorly known, uncommon or under threat but for which there is insufficient justification, based on known distribution and population sizes, for inclusion on the DRF schedule. One of four priority categories (Atkins 2011) as defined in Appendix A is assigned to these taxa.

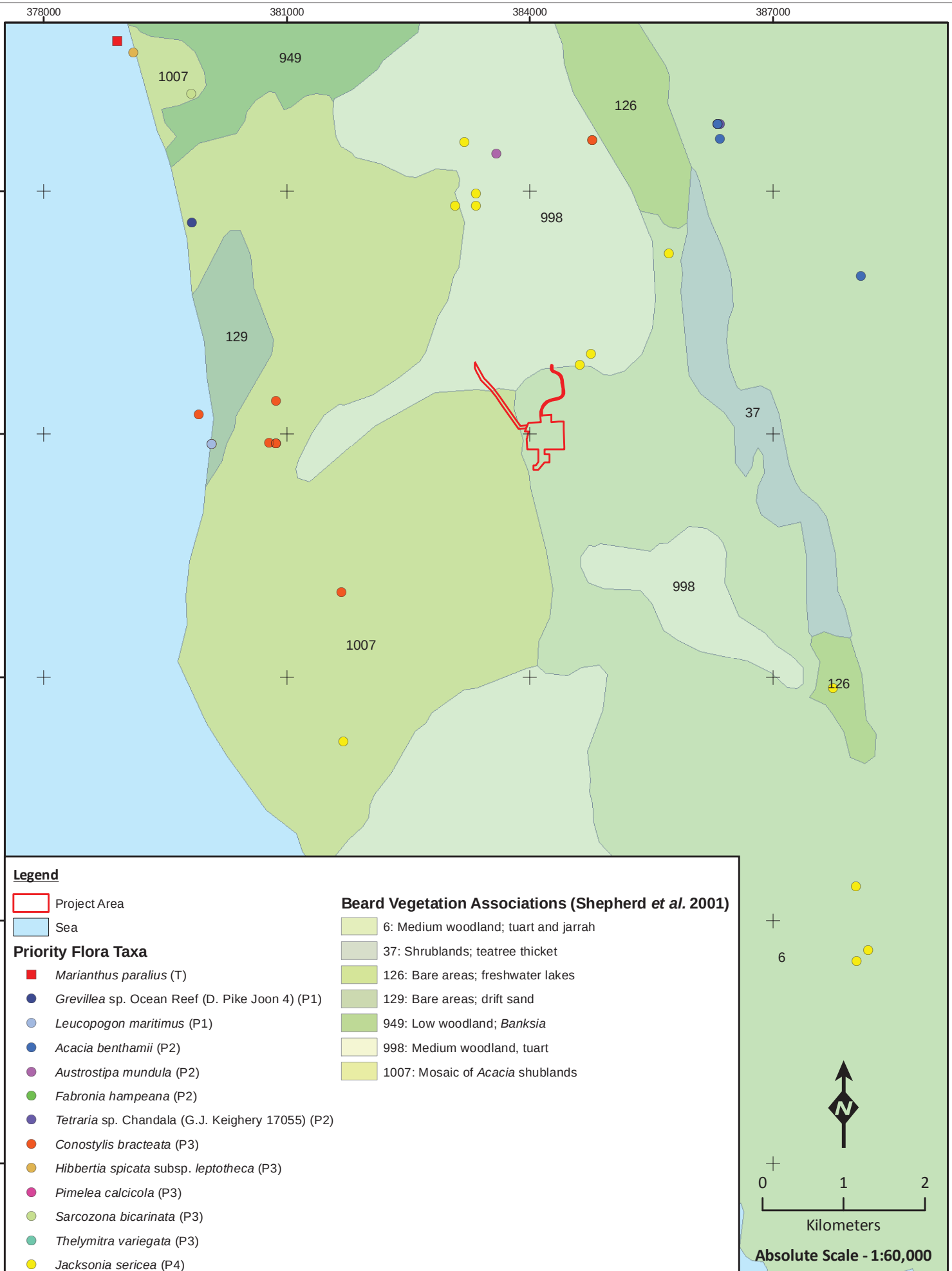
A search of the DEC and the Western Australian Herbarium databases identified 13 priority flora species within the 10 km buffer. The likelihood of their occurrence in the Project Area was assessed using the criteria in Table 3.3. The characteristics and likelihood of occurrence of the 13 priority flora are presented in Table 3.4.

Table 3.3 – Criteria used to Assess Likelihood of Occurrence of Significant Flora

Likelihood of Occurrence	Criteria
Certain	The taxon has been recorded within the Study Area.
Probable	Due to the proximity of previous records (<2 km) and the presence of suitable habitat, the taxon is considered highly likely to occur within the Study Area.
Likely	Given the presence of suitable habitat and moderate proximity (2-5 km) of previous records, the taxon is considered likely to occur within the Study Area.
Possible	The habitat specificity of the taxon is only broadly defined, or is not defined and/or there are no current records within 5 km. However there is insufficient information available to exclude the possibility of occurrence within the Study Area.
Unlikely	The habitat specificity of the taxon is well defined from previous records and the habitat is considered unlikely to be present within the Study Area.

Table 3.4 – Priority Flora Recorded within a 10 km Buffer of the Project Area

Taxon	Status	Preferred habitat based on previous records	Flowering period	Likelihood of Occurrence in the Project Area
Marianthus paralius	T	White sand over limestones. Low coastal cliffs	Sep-Nov	Unlikely
Grevillea sp. Ocean Reef (D. Pike Joon 4)	P1	Bare yellow-brown sand	Nov-Dec	Unlikely
Leucopogon maritimus	P1	On white-yellow sand. Coastal dunes	Mar-Aug	Unlikely
Acacia benthamii	P2	Sand. Typically on limestone breakaways	Aug-Sep	Likely
Austrostipa mundula	P2	Coastal sand or limestone.	Apr, Sep	Unlikely
Fabronia hampeana	P2	Scrubland associated with *Macrozamia*	n/a	Unlikely
Tetraria sp. Chandala (G.J. Keighery 17055)	P2	Humic sand. Along swamps.	Jul-Aug	Unlikely
Conostylis bracteata	P3	Sand, limestone. Consolidated sand dunes	Aug-Sep	Possible
Hibbertia spicata subsp. *leptotheca*	P3	Near-coastal limestone ridges, outcrops and cliffs	Jul-Oct	Unlikely
Pimelea calcicola	P3	Sand. Coastal limestone ridges	Sep-Nov	Unlikely
Sarcozona bicarinata	P3	White sand	Aug	Unlikely
Thelymitra variegata	P3	Sandy clay, sand, laterite	Jun-Sep	Unlikely
Jacksonia sericea	P4	Calcareous and sandy soils	Dec or Jan-Feb	Likely



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Previously Known Priority Flora Beenyup Stage 1

Figure: 3.5
Project ID: 1469

Drawn: MC
Date: 20/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC072

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3.3.2 Vegetation

A search of the DEC's TEC and PEC Database was undertaken as part of the desktop assessment and it was determined that no known TECs occur within the Project Area. The Project Area also lies outside of any PEC buffer zones.

3.3.3 Fauna

Several databases were consulted in the preparation of potential fauna and conservation significant fauna lists (Table 3.5). In addition, publications reporting on 11 terrestrial vertebrate fauna assessments conducted within 60 km of the Project Area were consulted (Table 2.6). The results of all database searches and previous surveys are presented in Appendix D. The online NatureMap database (DEC 2012) encompasses several datasets which include the Western Australian Museum, DEC threatened fauna database and DEC survey return database.

Table 3.5 –Fauna Databases Searched to Determine the Potential Terrestrial Fauna Assemblage

Database	Custodian	Search Details
NatureMap	DEC	Search co-ordinates: 31°46'55"S 115°46'35"E Distance searched (buffer): 40 km Date accessed: 14/9/2012
DEC Threatened Fauna Database	DEC	Records within 10 km of the Project Area (in the vicinity of Craigie)
EPBC Act Protected Matters Search Tool	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	Records within 60 km of the Project Area
Birdata	BirdLife Australia	Records within 100 km of the Project Area

The desktop assessment identified a total of 383 terrestrial vertebrate fauna species with the potential to occur in the Project Area. This includes 19 native and 10 introduced mammal species, 276 bird species, 66 reptile species, and 12 amphibian species (Appendix D).

The literature review for fauna values associated with the Project Area included a number of available assessment reports, some in relatively close proximity to the project area (Table 3.7). The results of these were used to contribute to the consideration of fauna species relevant to the project area.

Table 3.6 –Previous Biological Survey Reports within 60 km of the Project Area

Survey Location and Author(s)	Distance from Project Area (km)	Survey Type
ecologia internal database	7.5-43	Three two-phase Level 2 surveys, one single-phase Level 2 survey and one Level 1 fauna assessment
Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	8	Single-phase Level 2 vertebrate fauna assessment
Hepburn Ave Extension Fauna Assessment (*ecologia* 2000)	12.5	Level 1 fauna assessment
Fauna Survey of the Perth Airport (Tingay and Associates 1994)	27	Single-phase Level 2 vertebrate fauna assessment
Roe Highway Extension (Napier and Associates 1989)	31	Level 1 fauna assessment
Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart 1989)	50	Level 1 fauna assessment

A total of eight mammal species, 65 bird species and five reptile species of conservation significance have been identified as having the potential to occur within the Project Area. Of these, one mammal species and seven bird species have been assessed as having a medium to high likelihood of occurrence based on consideration of habitat availability, quality and relevance of previous records.

The considerably high number of potentially occurring conservation significant bird species is due to the close proximity of the Project Area to the coast (approximately 7 km), as well as the proximity of a number of lakes, commonly utilised by migratory shorebird species (e.g. Lake Joondalup, which is directly adjacent to the Project Area). Although they may occasionally overfly the Project Area, these species are considered to have a low likelihood of occurrence within the Project Area as they will not directly utilise the habitats or the site. For this reason, these 41 migratory and marine species (listed in Table 3.7 and Appendix D) have not been considered further in this assessment.

Table 3.7 – Shorebirds and Waterbirds of Conservation Significance excluded from the assessment

Species	Conservation Status		
	EPBC Act	WC Act	DEC
Australasian Bittern *Botaurus poiciloptilus*	EN	S1	EN
Australian Painted Snipe *Rostratula australis*	VU, M	S1, S3	VU
Lesser Noddy *Anous tenuirostris melanops*	VU	S1	VU
Fairy Tern *Sternula nereis nereis*	VU	S1	VU
Eastern Reef Egret *Egretta sacra*	M	S3	
Eastern Great Egret *Ardea modesta*	M	S3	
Cattle Egret *Ardea ibis*	M	S3	
Glossy Ibis *Plegadis falcinellus*	M	S3	
Pacific Golden Plover *Pluvialis fulva*	M	S3	
Grey Plover *Pluvialis squatarola*	M	S3	
Double-banded Plover	M	S3	

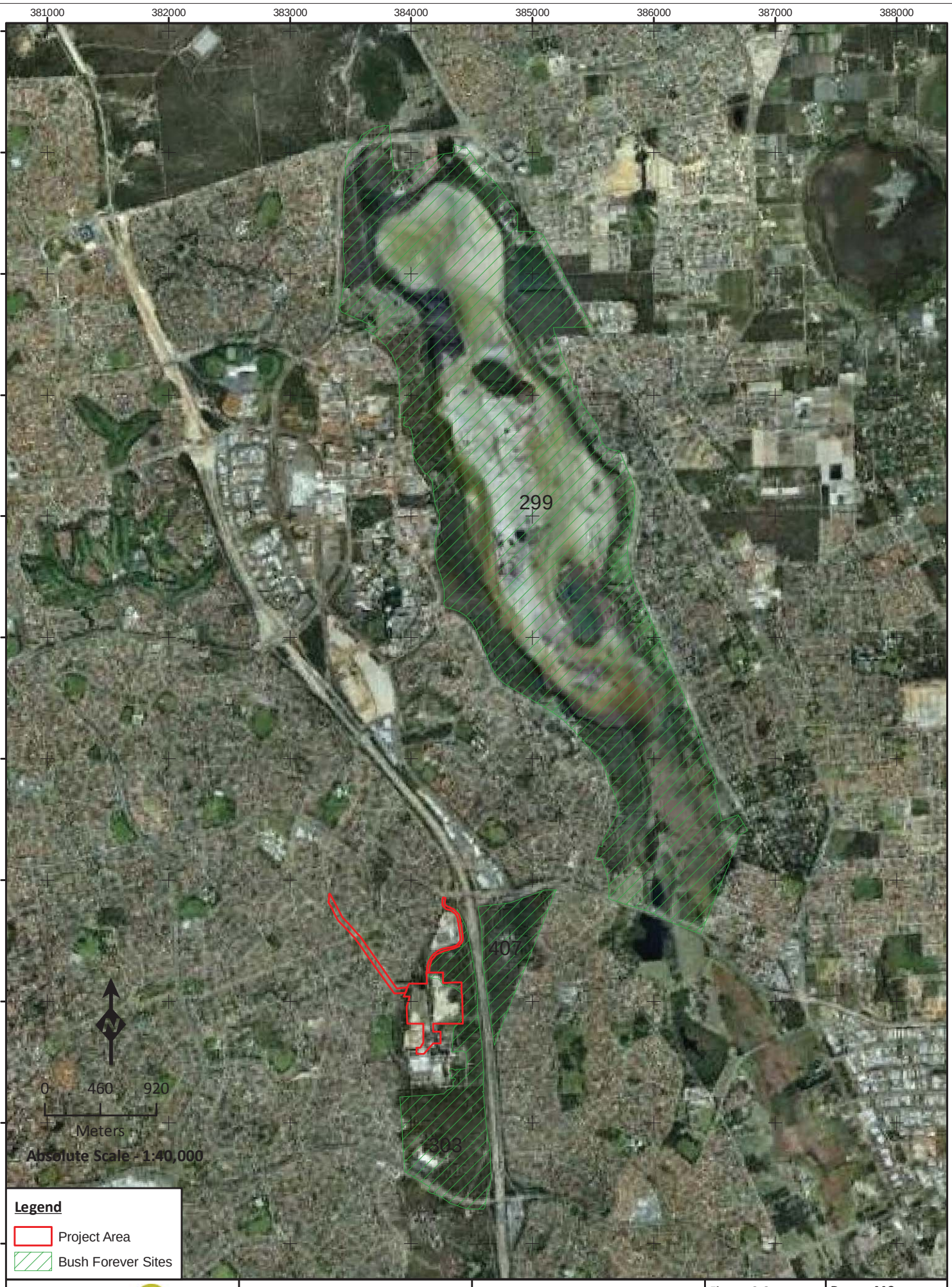
Species	Conservation Status		
	EPBC Act	WC Act	DEC
Charadrius bicinctus			
Lesser Sand Plover *Charadrius mongolus*	M	S3	
Greater Sand Plover *Charadrius leschenaultii*	M	S3	
Oriental Plover *Charadrius veredus*	M	S3	
Black-tailed Godwit *Limosa limosa*	M	S3	
Bar-tailed Godwit *Limosa lapponica*	M	S3	
Little Curlew *Numenius minutus*	M	S3	
Whimbrel *Numenius phaeopus*	M	S3	
Terek Sandpiper *Xenus cinereus*	M	S3	
Common Sandpiper *Actitis hypoleucos*	M	S3	
Grey-tailed Tattler *Tringa brevipes*	M	S3	
Common Greenshank *Tringa nebularia*	M	S3	
Marsh Sandpiper *Tringa stagnatilis*	M	S3	
Wood Sandpiper *Tringa glareola*	M	S3	
Ruddy Turnstone *Arenaria interpres*	M	S3	
Great Knot *Calidris tenuirostris*	M	S3	
Red Knot *Calidris canutus*	M	S3	
Sanderling *Calidris alba*	M	S3	
Red-necked Stint *Calidris ruficollis*	M	S3	
Sharp-tailed Sandpiper *Calidris acuminata*	M	S3	
Curlew Sandpiper *Calidris ferruginea*	M	S3	
Broad-billed Sandpiper *Limicola falcinellus*	M	S3	
Ruff *Philomachus pugnax*	M	S3	
Red-necked Phalarope *Pharalopus lobatus*	M	S3	
Common Noddy *Anous stolidus*	M	S3	
Bridled Tern *Onychoprion anaethetus*	M	S3	
Caspian Tern *Hydroprogne caspia*	M	S3	
Roseate Tern *Sterna dougallii*	M	S3	
Australian Little Bittern *Ixobrychus minutus dubius*			P4

Species	Conservation Status		
	EPBC Act	WC Act	DEC
Hooded Plover *Thinornis rubricollis*			P4
Black Bittern *Ixobrychus flavicollis*			P3

3.3.4 Areas of Conservation Significance

The Project overlaps with Bush Forever site 303: Whitfords Avenue Bushland. This Bush Forever site has an area of 87.3 ha, of which 1.7 ha is within the Project Area (2% of the Bush Forever Site and 7% of the Project Area), as shown in Figure 3.6. The Project Area is also in the vicinity (although it does not overlap with) Bush Forever Sites 299 (Yellagonga Regional Park) and 407 (Woodvale Nature Reserve).

The Project Area does not support any listed Environmentally Sensitive Areas.



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Bush Forever Sites in the Vicinity of Beenyup Stage 1

Figure: 3.6
Project ID: 1469

Drawn: MC
Date: 19/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC075

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4 SURVEY RESULTS

4.1 FLORA

A total of 144 taxa were recorded in the Project Area, including subspecies, varieties and hybrids. Some of these taxa have been planted for the purposes of landscaping, but due to the fact they were not observed in dedicated gardens, they were included in the results.

The total diversity of the flora is summarised in Table 4.1. A complete list of the flora recorded in the Project Area and Proposal Area is included as Appendix E.

Table 4.1 – Diversity of the Flora of the Project Area

Number Taxa Recorded	Number Families	Number Genera	Number Families Represented by a Single Taxon	Number Genera Represented by a Single Taxon
144	52	104	31	83

The families and genera represented by the greatest number of taxa are listed in Table 4.2.

Table 4.2 – Most Represnted Families and Genera in the Project Area

Most Represented Families	Most Represented Genera
Myrtaceae (22 taxa) Fabaceae (18 taxa) Poaceae (15 taxa) Asteraceae (13 taxa) Proteaceae (8 taxa) Asparagaceae (4 taxa)	*Eucalyptus* (12 taxa) *Trifolium* (6 taxa) *Acacia* (4 taxa) *Melaleuca* (4 taxa) *Banksia* (3 taxa)

4.1.1 Flora of Conservation Significance

No *EPBC Act* listed species or Threatened taxa were recorded in the Project Area. No Priority Flora were recorded in the Project Area

4.1.2 Introduced Flora

Three Declared Plants were recorded in the Project Area, all classified as P1 for the region of the Project Area. These species were; **Moraea flaccida*, **Lantana camara* and **Echium plantagineum* (Table 4.3). **Moraea flaccida* (One-leaf Cape Tulip) was common in the northwest portion of the main section of the Project Area (although the coordinates were not recorded in that section) and present in the northeast driveway as well, but not observed to be dominant in any areas. The later two species; **Lantana camara* and **Echium plantagineum* were recorded from only a single individual each.

No Weeds of National Significance were recorded in the Project Area.

The complete list of 79 Environmental Weeds recorded in the Project Area and their relative abundance is presented in Table 4.4. The most frequent and dominant introduced species recorded were **Avena barbata, *Avena fatua, *Brassica tournefortii, *Briza maxina, *Bromus diandrus, *Erharta calycina, *Lagurus ovatus, *Lupinus cosentinii, *Trifolium* spp. Other introduced species, such as **Pinus pinaster* and **Olea europaea* have been intentionally planted as plantation or ornamental plants, and although intentionally introduced, these taxa have been included in the list of introduced flora.

Table 4.3 – Declared Plants Recorded in the Project Area

Taxon	Status	Coordinates of Recorded Individuals^		DEC Invasive Species Attributes for the Swan Region						
		Easting	Northing	Potential Distribution	Current Distribution	Abundance	Ecological Impact	Rate of Dispersal	Feasibility of Control	General Trend
**Echium plantagineum*	P1	384104	6482806	Moderate	Moderate	Common	High	Rapid	High	Potential to increase
**Lantana camara*	P1	384157	6482656	Moderate	Moderate	Common	Moderate	Moderate	High	Established
**Moraea flaccida*	P1	384390	6483700	High	High	Abundant	High	Rapid	Moderate	Established

^Not all individuals present in the Project Area were recorded, as only a voucher specimen was taken from each species.

Table 4.4 – Environmental Weeds Recorded in the Project Area

Taxon	Family	Abundance	Taxon	Family	Abundance
**Acacia iteaphylla*	Fabaceae	occasional	**Lysimachia arvensis*	Primulaceae	occasional
**Agave americana^*	Asparagaceae	occasional	**Medicago polymorpha*	Fabaceae	occasional
**Aira caryophyllea* subsp. *caryophyllea*	Poaceae	occasional	**Melaleuca armillaris*	Myrtaceae	occasional
**Amaryllis belladonna*	Amaryllidaceae	occasional	**Melilotus indicus*	Fabaceae	occasional
**Anethum graveolens*	Apiaceae	occasional	**Monoculus monstrosus*	Asteraceae	occasional
**Arctotheca calendula*	Asteraceae	occasional	**Moraea flaccida*	Iridaceae	common
**Avena barbata*	Poaceae	abundant	**Nerium oleander^*	Apocynaceae	occasional
**Avena fatua*	Poaceae	abundant	**Oenothera drummondii*	Onagraceae	occasional
**Brassica tournefortii*	Brassicaceae	abundant	**Oenothera stricta*	Onagraceae	occasional
**Briza maxima*	Poaceae	abundant	**Olea europaea^*	Oleaceae	common
**Bromus diandrus*	Poaceae	abundant	**Ornithopus pinnatus*	Fabaceae	occasional
**Bromus rubens*	Poaceae	common	**Orobanche minor*	Orobanchaceae	occasional
**Cenchrus clandestinus*	Poaceae	occasional	**Oxalis pes-caprae*	Oxalidaceae	occasional
**Conyza sumatrensis*	Asteraceae	occasional	**Pelargonium capitatum*	Geraniaceae	occasional
**Cotula turbinata*	Asteraceae	occasional	**Petrorhagia dubia*	Caryophyllaceae	occasional
**Cynodon dactylon*	Poaceae	abundant	**Phleum pratense*	Poaceae	occasional
**Dimorphotheca ecklonis*	Asteraceae	occasional	**Pinus pinaster^*	Pinaceae	common
**Echium plantagineum*	Boraginaceae	occasional	**Polycarpon tetraphyllum*	Caryophyllaceae	occasional
**Ehrharta calycina*	Poaceae	abundant	**Prunus cerasifera^*	Rosaceae	occasional
**Ehrharta longifolia*	Poaceae	occasional	**Pyrostegia venusta*	Bignoniaceae	occasional
**Emex australis*	Polygonaceae	occasional	**Ricinus communis*	Euphorbiaceae	occasional
**Eragrostis curvula*	Poaceae	occasional	**Rosmarinus officinalis^*	Lamiaceae	occasional
**Erodium botrys*	Geraniaceae	occasional	**Schinus terebinthifolius^*	Anacardiaceae	occasional

Taxon	Family	Abundance	Taxon	Family	Abundance
**Erodium cicutarium*	Geraniaceae	occasional	**Solanum nigrum*	Solanaceae	occasional
**Euphorbia* sp.	Euphorbiaceae	occasional	**Sonchus oleraceus*	Asteraceae	abundant
**Euphorbia terracina*	Euphorbiaceae	occasional	**Sonchus* sp.	Asteraceae	occasional
**Freesia alba* X *leichtlinii*	Iridaceae	occasional	**Tetragonia decumbens*	Aizoaceae	occasional
**Fumaria capreolata*	Papaveraceae	occasional	**Trachyandra divaricata*	Asphodelaceae	occasional
**Gazania linearis*	Asteraceae	occasional	**Trifolium angustifolium*	Fabaceae	common
**Gomphocarpus fruticosus*	Apocynaceae	occasional	**Trifolium arvense*	Fabaceae	occasional
**Hesperantha falcata*	Iridaceae	occasional	**Trifolium campestre* var. *campestre*	Fabaceae	common
**Hypochaeris glabra*	Asteraceae	occasional	**Trifolium hirtum*	Fabaceae	occasional
**Ipomoea cairica^*	Convolvulaceae	occasional	**Trifolium scabrum*	Fabaceae	occasional
**Lachenalia reflexa*	Asparagaceae	occasional	**Trifolium tomentosum*	Fabaceae	occasional
**Lagurus ovatus*	Poaceae	abundant	**Urospermum picroides*	Asteraceae	occasional
**Lantana camara*	Verbenaceae	occasional	**Ursinia anthemoides subsp. anthemoides*	Asteraceae	abundant
**Lolium rigidum*	Poaceae	occasional	**Vitis vinifera*	Vitaceae	occasional**
**Lupinus angustifolius*	Fabaceae	common	**Vulpia myuros*	Poaceae	occasional
**Lupinus cosentinii*	Fabaceae	abundant	**Wahlenbergia capensis*	Campanulaceae	occasional

^indicates planted specimens or cultivars.

4.1.3 Range Extensions

Thirteen of the collected flora taxa have been collected outside of their range of distribution, according to records on Florabase (Western Australian Herbarium 1998-2012) and the Australian Virtual Herbarium (The Council of Heads of Australasian Herbaria 2012). Of these 13 taxa, ten are cultivars or horticultural species, more than likely planted at the Project Area or garden escapees. These species are therefore not considered to be of significance. Table 4.5 lists the flora species potentially exhibiting range extensions within the Project Area.

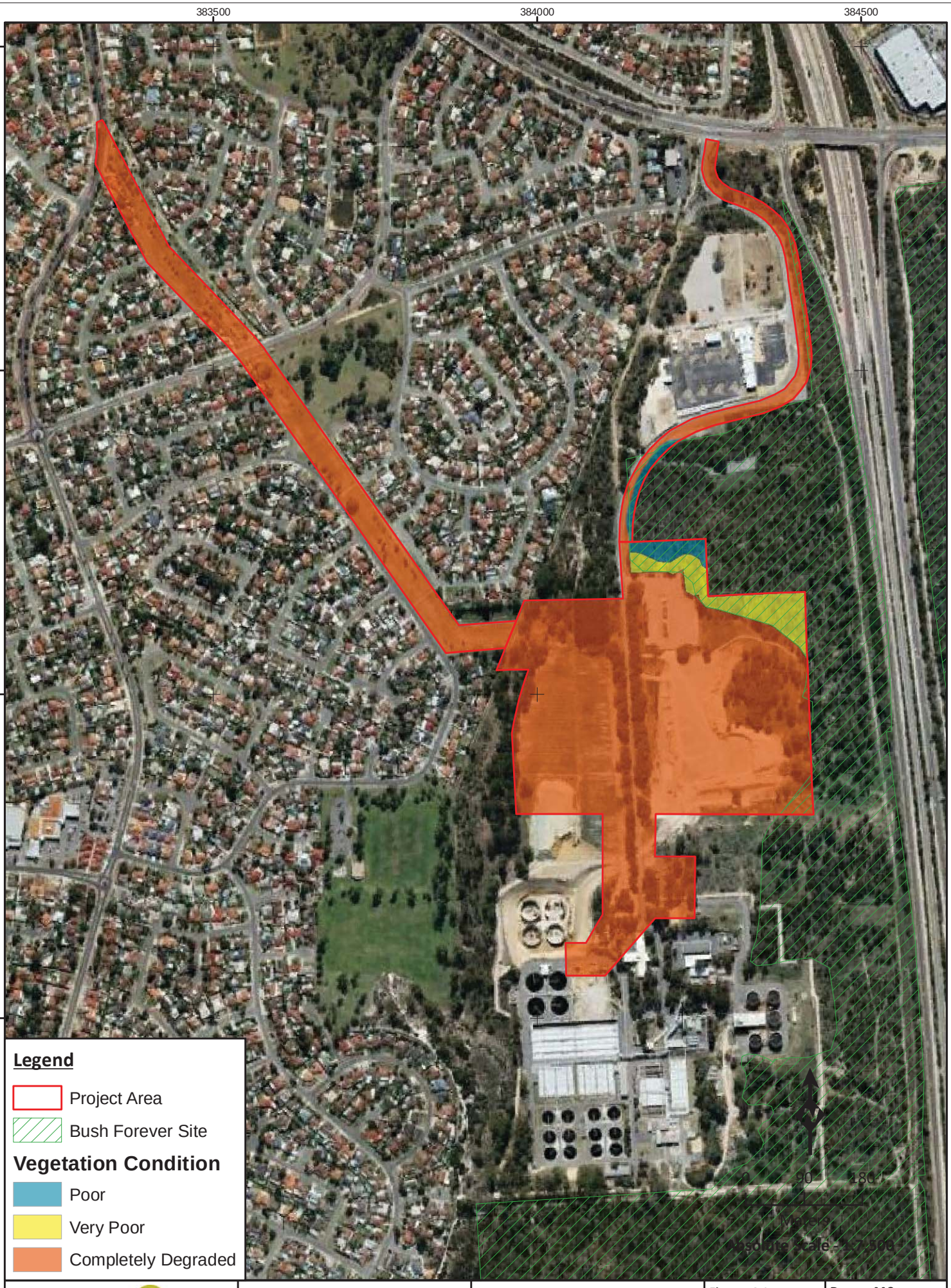
Table 4.5 – Possible Range Extensions in the Project Area

Taxon	Family	Intentionally planted?	Distance
**Aira caryophyllea* subsp. *caryophyllea*	Poaceae	No	304 km northwest of known population
**Anethum graveolens*	Apiaceae	No	2100 km west of known population
Corymbia ficifolia	Myrtaceae	Yes	260 km nor-northwest of known population
Eucalyptus cornuta	Myrtaceae	Yes	160 km north of known population
Eucalyptus polyanthemos	Myrtaceae	Yes	2170 km west of known population
Eucalyptus scoparia	Myrtaceae	Yes	2750 km west of known population
Eucalyptus torquata	Myrtaceae	Yes	500 km west of known population
Eucalyptus tricarpa	Myrtaceae	Yes	2150 km west of known population
Eucalyptus utilis	Myrtaceae	Yes	190 km NW of known population
**Phleum pratense*	Poaceae	No	280 km North of known population
Plumbago auriculata	Plumbaginaceae	Yes	2100 km west of known population
**Pyrostegia venusta*	Bignoniaceae	Yes	3600 km W of known population
Schefflera ?elliptica	Araliaceae	Yes	3400 km SW of known population

4.2 VEGETATION

4.2.1 Vegetation Condition

The Project Area has been largely cleared and the remaining areas of native vegetation are in Poor or Very Poor condition due to the presence of invasive species and lack of understorey. Some areas have been fully cleared for development of roads, buildings and parks; all of which have been classified as “Completely Degraded”. The map of vegetation condition is presented in Figure 4.1. In summary, no areas are in Good condition; 2% of the Project Area is Poor; 4.4% is Very Poor and 93.6% is Completely Degraded.



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WATER CORPORATION

Vegetation Condition Beenyup Stage 1

Figure: 4.1
Project ID: 1469

Drawn: MC
Date: 19/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC071

A4

4.2.2 Vegetation Communities of the Project Area

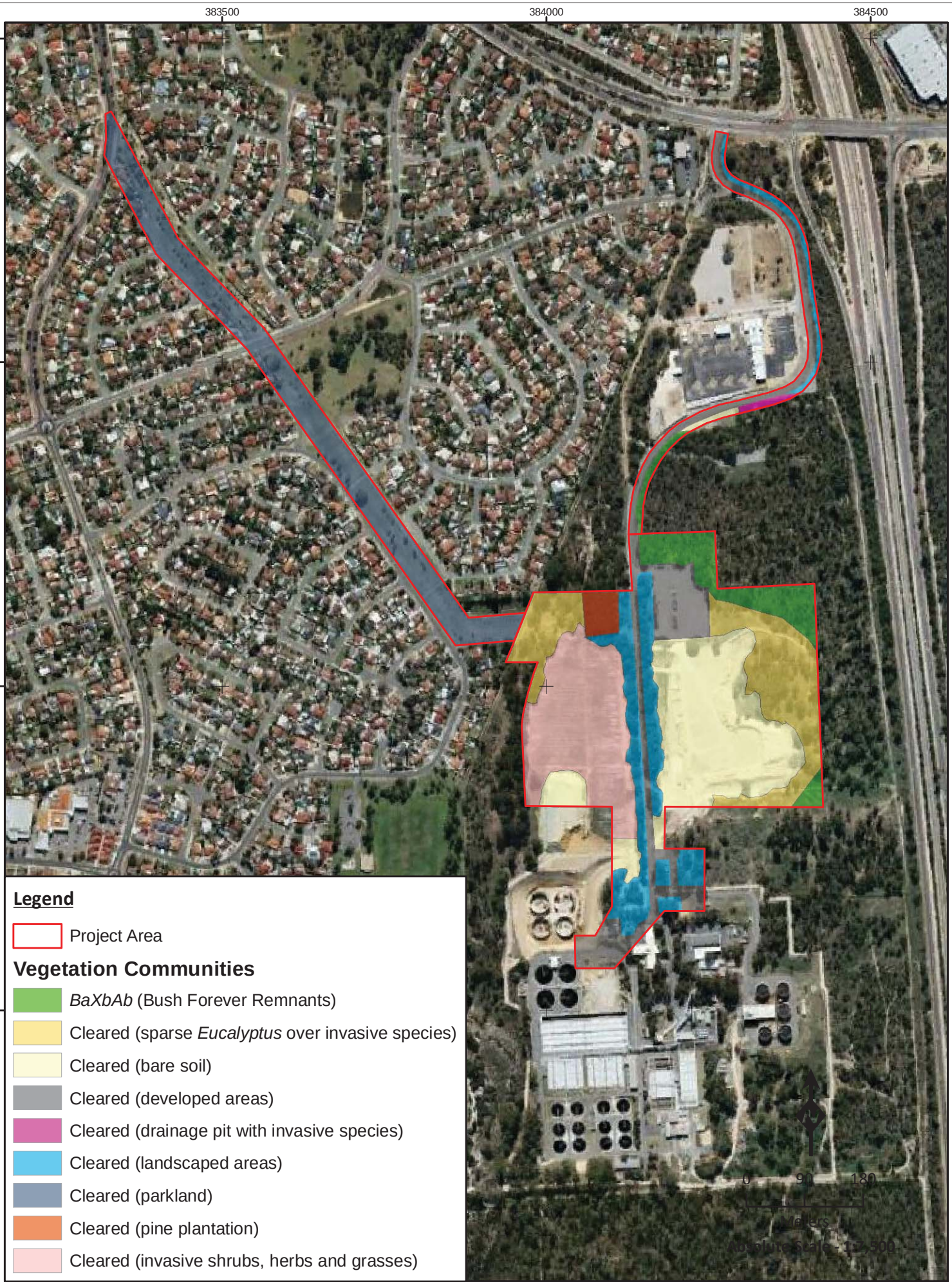
Two 100m^2 quadrats were assessed within the project area. Both quadrats were located inside the Bush Forever site 303. Although these quadrats were recorded in the areas of better condition vegetation, relative to the entire site, both recorded high cover and species richness for weeds.

The qualitative quadrat data is presented in Appendix B.

Only one vegetation community was described within the remnant vegetation (Table 4.6), a *Xanthorrhoea* open shrubland. The Bush Forever remnants of vegetation occupy 7% of the study area and the remaining 93% are either completely degraded or have been cleared (Figure 4.2).

Table 4.6 – Vegetation of the Project Area

Vegetation Community	NVIS Level V Description	NVIS Level VI Description	Associated species
BaXbAf 1.79 ha (7.2% of Project Area)	*Xanthorrhoea* open shrubland	Scattered *Banksia* trees over *Xanthorrhoea* open shrubland over mixed species grassland	*Banksia attenuata* *Xanthorrhoea brunonis* var. *brunonis* **Avena fatua* *Allocasuarina fraseriana* *Desmocladus flexuosus* **Ehrarta calicina* **Euphorbia terracina* *Hakea lasiocarpa* *Hibbertia hypericoides* **Lupinus angustifolius* *Stirlingia latifolia* **Trifolium campestre* var. *campestre* **Ursinia anthemoides* subsp. *anthemoides*
			



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WATER CORPORATION

Vegetation Communities Beenyup Stage 1

Figure: 4.2
Project ID: 1469

Drawn: MC
Date: 19/11/2012

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC070

A4

4.3 DIEBACK ASSESSMENT

Nine samples of soil and root tissue matter were collected and tested for *Phytophthora* Dieback. Eight of these showed no presence of *Phytophthora* and one, collected from sampling point 1 (384408mE 6482812mN), tested positive for the presence of *Phytophthora multivora*. This soil sample was collected from the southeast portion of the Project Area (Figure 4.3), where the vegetation is virtually completely degraded. The sample was collected beneath a Tuart (*Eucalyptus gomphocephala*) tree, with an understorey of introduced grass species. No symptoms of dieback were observed in the plants around the sample point.

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WATER CORPORATION

Location of Positive Result of Dieback

Figure: 4.3
Project ID: 1469

Drawn: MC
Date: 07/01/2013

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MC122

A4

4.4 FAUNA

The field survey recorded a total of 30 fauna species from both direct sighting and indirect evidence such as scats and calls. These species included 4 mammals (1 native, 3 introduced), 23 birds, and 3 reptiles (Table 4.7).

Table 4.7 –Verterbrate Fauna Recorded in the Project Area

Mammals	
Western Grey Kangaroo	*Macropus fuliginosus*
*Dog	**Canis lupus familiaris*
*Cat	**Felis catus*
*European Rabbit	**Oryctolagus cuniculus*
Birds	
Pacific Black Duck	*Anas superciliosa*
*Rock Dove	**Columba livia*
*Laughing Dove	**Streptopelia senegalensis*
Straw-necked Ibis	*Threskiornis spinicollis*
Australian Hobby	*Falco longipennis*
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*
Galah	*Eolophus roseicapillus*
Rainbow Lorikeet	*Trichoglossus haematodus*
Laughing Kookaburra	*Laughing Kookaburra*
Splendid Fairy-wren	*Malurus splendens*
Western Gerygone	*Gerygone fusca*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Red Wattlebird	*Anthochaera carunculata*
Brown Honeyeater	*Lichmera indistincta*
Varied Sittella	*Daphoenositta chrysoptera*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Grey Butcherbird	*Cracticus torquatus*
Australian Magpie	*Cracticus tibicen*
Grey Fantail	*Rhipidura albiscapa*
Willie Wagtail	*Rhipidura leucophrys*
Australian Raven	*Corvus coronoides*
Magpie-lark	*Grallina cyanoleuca*
Silvereye	*Zosterops lateralis*
Reptiles	
Wall Skink / Snake-eyed Skink	*Cryptoblepharus plagiocephalus*
Elegant Slider	*Lerista elegans*
Grey's Dwarf Skink	*Menetia greyii*

4.5 FAUNA HABITATS

The following six fauna habitats were identified in the Project Area:

- Open grassland with scattered *Eucalyptus*/*Melaleuca*/*Acacia* trees and shrubs
- Open grassland
- Mixed *Banksia* and *Xanthorrhoea* heathland (Bush Forever)

- *Eucalyptus* woodland with scattered *Xanthorrhoea*
- Open *Eucalypt* woodland with sparse *Acacia*/*Melaleuca* understorey
- Pine Plantation
- Cleared areas.

These habitats are mapped in Figure 4.4. Apart from the areas that have been cleared, the dominant habitat type supported by the Project Area is the open grassland with scattered *Eucalyptus*/*Melaleuca/Acacia* trees and shrub habitat, which comprises 22% of the total project area and more than 33% of all areas that have not been cleared (Table 4.8). This habitat is found throughout the entire western section and in areas of the central-eastern area of the Project Area.

Table 4.8 –Calculations of Habitat Areas and Impact Area

Habitat Type	Area in Project Area (ha)*	% of Project Area
Open grassland with scattered *Eucalyptus*/*Melaleuca/Acacia* trees and shrubs	5.45	21.8
Open grassland	4.21	16.8
Mixed *Banksia* and *Xanthorrhoea* heathland (Bush Forever)	1.79	7.2
Eucalyptus woodland with scattered *Xanthorrhoea*	2.27	9.1
Open *Eucalyptus* woodland with sparse *Acacia/Melaleuca* understorey	2.72	10.9
Pine Plantation	0.37	1.5
Cleared areas	8.20	32.8
Total	25.01	100

Legend **Absolute Scale - 1:7,500**

- Carnabie's Black Cockatoo sighting
- Potential Black Cockatoo nesting trees (DBH >500mm)
- Potential Black Cockatoo nesting tree (DBH >500mm) with at least one known hollow
- Beenyup Survey Area
- Mixed Banksia and Xanthorrhoea heathland (Bushforever Site 303)
- Eucaypt Woodland with scattered Xathorrhoea
- Open Grassland
- Open Grassland with scattered eucalypt/maleleuca/acacia trees and shrubs
- Pine Plantation
- Open Eucalypt woodland with sparse mixed acacia/maleleuca understory
- Cleared

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WATER CORPORATION

Fauna Habitat Beenyup Stage 1

Figure: 4.4
Project ID: 1469

Drawn: MdA
Date: 23/11/12

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: MXXX

A4

4.5.1 Open grassland with scattered *Eucalyptus/Melaleuca/Acacia* trees and shrubs

The open grassland with scattered *Eucalyptus/Melaleuca/Acacia* trees and shrubs is the most represented habitat type of the Project Area, consisting of 21.8% of the total Project Area. This habitat type typically occurs around built-up residential areas and consists of open grassy ground cover with intermittent *Melaleuca* and *Acacia* shrubs, and some tall remnant Tuart (*Eucalyptus gomphocephala*) and Jarrah (*Eucalyptus marginata*), trees. The soil substrate is typically sandy and ground cover is composed of mainly grasses and weeds (Figure 4.5).

Figure 4.5 – Example of open grassland with scattered *Eucalyptus/Melaleuca/Acacia* trees and shrubs habitat type

4.5.2 Open grassland

The open grassland habitat is typically associated with areas that have previously been cleared. This habitat type makes up to 16.8% of the total Project Area and ranges from heavily weeded grasslands to landscaped verge areas of lawn, and the substrate is typically soft sandy loams (Figure 4.6).

Figure 4.6 – Example of open grassland habitat type

4.5.3 Mixed *Banksia* and *Xanthorrhoea* heathland (Bush Forever)

The mixed *Banksia* and *Xanthorrhoea* heathland makes up the majority of Bush Forever site 303 that occurs along the north-western corner of the central zone of the Project Area. This habitat type comprises 7.2% of the Project Area and typically consists of thick scrub of mixed *Banksia*, *Acacia*, small *Eucalyptus* tress and occasional Sheoaks (*Allocasuarina*) interspersed with *Xanthorrhoea*. The ground cover is thick herb and low-lying shrub vegetation over very soft sand (Figure 4.7).

Figure 4.7 – Example of mixed Banksia and Xanthorrhoea heathland habitat type

4.5.4 *Eucalyptus* woodland with scattered *Xanthorrhoea*

The *Eucalyptus* woodland with scattered *Xanthorrhoea* occurs along the outer eastern and western edges of the Project Area (making up 9.1% of the total site) and consists of large Tuart trees over mixed grass and weed ground cover with scattered *Xanthorrhoea*. Some of the Tuart trees within this habitat have a diameter at breast height (DBH) of over 500mm, rendering them potential suitable breeding trees for Black Cockatoos (indicated on Figure 4.3). The substrate of this habitat type ranges from medium to hard clayey soils to soft sandy loams. Ground cover ranges from medium to high density leaf-litter in some areas, to scarce in other areas where there is thick grass cover (Figure 4.8).

Figure 4.8 – Example of Eucalyptus woodland with scattered Xanthorrhoea habitat type

4.5.5 Open Eucalypt woodland with sparse *Acacia/Melaleuca* understorey

This habitat type consists of planted Eucalypts with landscaped areas of mixed *Acacia* and *Melaleuca*. This habitat type is the third largest habitat type in the Project Area (not including cleared areas), representing 10.9% of the area; and is predominant of the main access roads borders through the centre of the Project Area. The substrate of this habitat type ranges from medium to hard clayey soils to soft sandy loams. Ground cover ranges from medium to high density leaf-litter in some areas (generally in garden beds around office blocks) to scarce in other areas where there are landscaped lawn areas (Figure 4.9).

Figure 4.9 – Example of Eucalypt woodland with sparse *Acacia/Melaleuca* understory habitat type

4.5.6 Pine Plantation

This habitat type is very small and comprises only 1.5% of the total Project Area in a single rectangular-shaped pine plantation of 0.37 ha in area, occurring on the northern edge of the main part of the Project Area (Figure 4.3). Ground cover consists of thick pine needles and grass cover, and the substrate consists of soft sandy loam (Figure 4.10).

Figure 4.10 – Example of Pine Plantation Habitat Type

4.5.7 Black -Cockatoo Habitat

As part of the fauna habitat assessment, recording of suitable Black-Cockatoo habitat, with a focus on foraging and breeding habitat was carried out. The habitat assessment was undertaken in accordance with the EPBC Act draft referral guidelines for three threatened black-cockatoo species (DSEWPaC 2011). The eucalypt woodland with scattered *Xanthorrhoea* habitat, the *Banksia* and *Xanthorrhoea* heathland habitat, the *Eucalyptus* woodland with sparse *Acacia/Melaleuca* understory and the pine plantation represent suitable foraging and potential roost habitat within the Project Area. The foraging habitat covers 7.15 ha, or 28.6% of the Project Area.

A total of nine Tuart trees were recorded with a DBH of 500 mm or greater which represent good foraging and roosting habitat. One tree was observed to contain a hollow suitable for potential nesting for Carnaby Black-Cockatoos which have a potential to breed in the surrounding area and have been recorded frequently in close vicinity to the Project Area. However, no evidence of either foraging or breeding was recorded during this survey. The raw data results are presented in Appendix F and the location of potential breeding tree locations are indicated in Figure 4.4.

4.6 CONSERVATION SIGNIFICANT FAUNA

During the field survey, one conservation significant species was recorded as previously mentioned; Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) (EPBC Endangered, WC Act Schedule 1). Two individuals were observed flying over the project area (Table 4.9).

Table 4.9 – Conservation Significant Fauna Recorded during this Survey

Species	Coordinates		Comments
	Easting	Northing	
Carnaby's Black Cockatoos	384399	6482861	2 individuals recorded flying over Project Area

Zone: 50K
Datum: GDA 94

4.7 GRACEFUL SUN MOTH

The targeted Graceful Sun Moth habitat assessment involved a targeted search for the food-source plants; *Lomandra maritima* and *L. hermaphrodita.* No individuals of either species were recorded in the Project Area and the site is therefore not considered to provide habitat suitable to support the Graceful Sun Moth.

5 DISCUSSION

5.1 FLORA

As previously stated, no flora species of conservation significance, listed as Threatened under the EPBC Act or the WC Act nor any species listed as Priority Flora under the WC Act were recorded from the Project Area.

The small number of taxa collected in the Project Area (144 taxa) is considered low for an area of 25 ha, which reflects the level of disturbance in the Project Area. The higher representation of genera such as *Eucalyptus* (12 taxa), *Acacia* (4 taxa), *Melaleuca* (5 taxa) and *Banksia* (3 taxa each) is an evidence of the remnant vegetation communities that were once supported by the Project Area. On the other hand, the high representation of the families Fabaceae, Poaceae and Asteraceae (18, 15, and 13 taxa each, respectively) indicates the large number of introduced flora species that are now dominant in the understorey. Twelve of 18 taxa of Fabaceae recorded are introduced, as well as 11 of the 13 taxa of Asteraceae and all of the Poaceae taxa. Overall, 54% of the floral taxa recorded in the Project Area are introduced.

As discussed, 78 (54%) of the flora species recorded in the Project Area are introduced. The most significant result in relation to weeds is the occurrence of three species of Declared Plants; **Moraea flaccida*, **Lantana camara* and **Echium plantagineum* (Table 4.3). *Moraea flaccida* (One-leaf Cape Tulip). Obligatory control measures enforced by DAFWA relating to these species therefore apply (Appendix G).

The timing of the survey was considered optimal, during the peak of the spring season. This is supported by the fact that a large proportion of the specimens were collected in their reproductive stage. Only six taxa could be identified only to genus level (*Melaleuca* sp., *Eucalyptus* sp., *Callistemon* sp., *Drosera* sp., *Euphorbia* sp. and *Sonchus* sp.), and an additional two taxa were identified to species level, but without certainty (*Schefflera* ?*elliptica* and *Senecio* ?*candylus*), due to the lack of reproductive material or insufficient material.

5.2 VEGETATION

The condition of the vegetation in the Project Area was found to be poor due to the fact that most of the surveyed area has been cleared or degraded in the past. Most of the Project Area is Completely Degraded (93.6%), and the main factors of disturbance were weeds, vehicle tracks and litter.

A few tracks exist within the Project Area and in close proximity to the site and these appear to be used regularly. The large expanses of exposed sand could enable erosion at the site. No signs of recent fire were observed in the Project Area.

The desktop assessment did not determine that the Project Area supports vegetation previously known to represent a TEC or PEC.

One intact native vegetation community was described and mapped in the remnant portions of the Bush Forever site that intersects with the Project Area (7.2% of the extent of the Project Area). The community is described as; "Scattered *Banksia* trees over *Xanthorrhoea* open shrubland over mixed species grassland" (*BaXbAf*), which as recorded in Poor and Very Poor condition within the Project Area. An analysis against a large floristic database (Gibson *et al.* 1994) resulted in a weak match to Floristic Community Type (FCT) 28; 'Spearwood *B. attenuata* or *B. attenuata* and *Eucalyptus* woodlands'. This FCT is regarded as 'well reserved' and at 'low risk' to the threats of extinction (Gibson *et al.* 1994) and is not listed as a TEC or PEC at either State or Commonwealth levels.

The three Beard vegetation associations of the Project Area are very well represented in Western Australia. Unit 6: Medium woodland, tuart and jarrah has an extent of 563 km^2 in the state (0.21 km2 in the Project Area); unit 998: Medium woodland, tuart has an extent of 510 km^2 in the state (0.02

km^2 in the Project Area); and unit 1007: Mosaic of *Acacia* and *Melaleuca* shrublands has an extent of 304 km^2 in the state (0.02 km2 in the Project Area).

The predominant vegetation type of the Project Area, Karrakatta Complex – Central and South, is a well represented complex that occurs predominately along the Perth wetland chain east of the coastal foredunes and west of the more undulating dunes further east. The typical vegetation of this vegetation complex is forest of *Eucalyptus gomphocephala, E. marginata* and *Corymbia calophylla* with *Banksia* species and is well represented across the Swan Coastal Plain.

More specifically at a local scale, the vegetation typical of FCT 28 is considered well represented within the region, with total of 38 sites across the region representative of this FCT (Gibson *et al.* 1994).

The intact remnant vegetation remaining within the Project Area is not considered to be significant due to poor representation at either a local nor regional scale.

5.3 DIEBACK

No patches of natural vegetation were considered dieback infected in the visual assessment; and none of the samples collected tested positive for *Phytophthora cinammomii*, which is the most commonly found *Phytophthora* species in declining ecosystems. However, in one of nine soil samples, the results of the *Phytophthora* analysis were positive for a different species of the same genus: *Phytophthora multivora*.

In the soil and root sample collected from soil sample point 1 (384408mE 648212mN), the species *Phytophthora multivora* was isolated. It was collected from the base of a Tuart (*Eucalyptus gomphocephala*) tree, but it is not certain that this tree is acting as a host to the pathogen.

Phytophthora multivora has been isolated in WA from natural forest and heath-land stands since the early 1980s from beneath dead and dying plants of 16 species from seven families (Burgess *et al.* 2009; Scott *et al.* 2009). *P. multivora* is very widespread in south-west WA with a distribution similar to that known for *P. cinnamomii*. It has been implicated in the decline of *Eucalyptus gomphocephala* and pathogenicity toward *E. gomphocephala, E. marginata* and *Agonis flexuosa* has been demonstrated. Numerous other hosts including *Banksia attenuata, B. grandis, B. littoralis, B. menziesii, B. prionotes, Bossiaea* sp., *Conospermum* sp., *Gastrolobium spinosum, Leucopogon verticillatus, Xanthorrhoea gracilis, Patersonia* sp., *Podocarpus drouyniana, Quercus petraea* and *Pinus radiata* have been identified.

Based on the precautionary principle, we suggest the area is treated in the same manner as applicable to *Phytophthora cinnamomii*. Soil movement from the area should be avoided or controlled to avoid contamination, as well as using cleaning stations for vehicles, machinery and the cleaning of boots when personnel work in the affected area.

5.4 VERTEBRATE FAUNA

The field survey recorded a total of 30 fauna species from both direct sighting and indirect evidence such as scats and calls. These species included 4 mammals (1 native, 3 introduced), 23 birds, and 3 reptiles. Of these, one species, *Calyptorhynchus latirostris* (Carnaby's Black-Cockatoo) is of conservation significance, listed as Endangered under the Commonwealth EPBC Act and Endangered/Schedule 1 under the State WC Act. Two individuals were observed flying over the site during the field assessment.

With regards to conservation significant vertebrate fauna, a total of one mammal, eight bird species and one invertebrate species have been determined to have a medium to high likelihood of occurrence in the Project Area based on habitat suitability and the relevance and currency of previous records. These are discussed in more detail in the following section.

Table 5.1 –Conservation Significant Vertebrate Fauna Potentially Occurring in the Project Area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Potential Impacts
	EPBC Act	WC Act	DEC				
Mammals							
Red-tailed Phascogale (*Phascogale calura*)	EN	S1	EN	*Allocasuarina* woodland with hollow-containing eucalypts.	Described as "species or species habitat likely to occur within area" (DSEWPaC).	**LOW** Lack of recent records in the region.	**LOW** Species unlikely to occur within the Project Area.
Woylie (*Bettongia penicillata ogilbyi*)	EN	S1	EN	Range from grassland, coastal and inland. *Gastrolobium* thickets provide refuges against predators.	Described as "species or species habitat likely to occur within area" (DSEWPaC).	**LOW** Lack of recent records in the region, suitable habitat not present	**LOW** Species unlikely to occur within the Project Area.
Western Quoll (*Dasyurus geoffroii*)	VU	S1	VU	Sclerophyll forest, dry woodland, heath and mallee shrubland.	Nearest record from 2010, 14 km from Project Area, within Swan Coastal Plain.	**LOW** Recorded close by, but few recent records. Highly unlikely to occur due to isolated nature of habitats within the Project Area and lack of suitable habitat.	**LOW** Species unlikely to occur within the Project Area.
Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)	VU	S1	EN	Dry sclerophyll forest, monsoonal forest and woodland.	Three historical records within 25 km of the Project Area (DEC 2012).	**LOW** Lack of recent records in the region.	**LOW** Species unlikely to occur within the Project Area.
Quokka (*Setonix brachyurus*)	VU	S1	VU	On mainland inhabits dense, wet cover in forest or swampy flats.	Recorded from DEC threatened fauna search only. No close-by recent records.	**LOW** Lack of recent records in the region.	**LOW** Species unlikely to occur within the Project Area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Potential Impacts
	EPBC Act	WC Act	DEC				
Western Brush Wallaby (*Macropus irma*)			P4	Forest and woodland with dense scrub layer, mallee, heathland. Favours open, seasonally wet flats with low grasses and scrubby thickets.	Nearest record from 14 km north of the Project Area from 2003. (NatureMap).	**MEDIUM** Recorded close by, but few recent records. Some suitable habitat may exist within the mixed Banksia and Xanthorrhoea heathland and the eucalypt woodland with scattered Xanthorrhoea	**LOW** Species unlikely to occur within the Project Area due to isolated nature of the areas of potentially suitable habitat. Highly mobile species, able to move away from disturbance.
Water Rat (*Hydromys chrysogaster*			P4	Permanent water bodies with fresh or brackish water.	Two records from 2004 and 2009 from Lake Goollelal (4km south-west of Project Area) (DEC 2012).	**LOW** Suitable habitat not present within Project Area.	**LOW** Species unlikely to occur within the Project Area..
Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)			P5	Sclerophyll forest, dry woodland, heath and mallee shrubland.	Nearest record 21 km north of Project Area, from 2011, numerous records 44 km south of the Project Area (DEC 2012).	**LOW** Suitable habitat not present within Project Area.	**LOW** Species unlikely to occur within the Project Area.
Birds							
Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)	EN	S1	EN	Proteaceous scrubs and heaths, eucalypt and pine forests.	Several recent records from near Project Area (Birds Australia 2010; DEC 2012)	**RECORDED** Recorded during current survey. Several nearby records, recent and historic (Birds Australia 2010; DEC 2012).	**HIGH** 7.15 ha of good quality foraging habitat exists within the Project Area (Bush Forever, Eucalypt woodlands and Pine plantation) and 9 potentially suitable roosting/ nesting trees (Tuart >500mm DBH) were identified from within the Project Area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Potential Impacts
	EPBC Act	WC Act	DEC				
Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)	VU	S1	VU	Eucalypt forests of marri, jarrah, blackbutt or karri. Also feeds on sheoak and snottygobble.	Two records from within 13 km north of Project Area (NatureMap), and recorded from Byford area (*ecologia* internal database). Numerous records from within 20 km south and east of Project Area.	**HIGH** Recently recorded from nearby the Project Area (*ecologia* internal database, 2012) and suitable foraging habitat exists within the Bush Forever habitats and the Eucalypt woodland habitats.	**HIGH** 6.78 ha of good quality foraging habitat exists within the Project Area (Bush Forever and Eucalyptus woodlands) and 9 potentially suitable roosting/nesting trees (Tuart >500mm DBH) were identified from within the Project Area.
Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*)	VU	S1	EN	High-rainfall areas, usually sites that are heavily forested and dominated by marri and eucalypt species, especially karri and jarrah.	Three relatively recent records (2002,2008,2009) from within 10 km north and north-east of Project Area, near Lake Joondalup (Birds Australia 2010; DEC 2012).	**HIGH** Relatively recent nearby records and good quality foraging habitat exists within the Bush Forever habitats and the Eucalypt woodland habitats.	**HIGH** 7.15 ha of good quality foraging habitat exists within the Project Area (Bush Forever, Eucalypt woodlands and Pine plantation) and 9 potentially suitable roosting/ nesting trees (Tuart >500mm DBH) were identified from within the Project Area.
Rainbow Bee-eater (*Merops ornatus*)	M	S3		Varied foraging habitats. Breeds in burrows constructed in sandy soils.	Several recent and historic records from within 10 km of Project Area	**HIGH** Several recent records from Lake Joondalup area and nearby.	**LOW** Species inhabits a variety of habitats and is able to move away from disturbance.
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	M	S3		Coastal and near coastal water bodies.	1 recent (2011) record from Lake Joondalup (4 km north of Project Area), 3 older records (1977, 2000) from same area (DEC 2012)	**MEDIUM** Species may occasionally fly over Project Area, unlikely to utilize habitats.	**LOW** Species is not anticipated to directly utilise the Project Area.
Fork-tailed Swift (*Apus pacificus*)	M	S3		Almost entirely aerial lifestyle. Will not land.	3 relatively recent records within 10 km north of Project Area (DEC 2012).	**MEDIUM** Completely aerial species which may occasionally fly over Project Area.	**LOW** Species is not anticipated to directly utilise the Project Area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Potential Impacts
	EPBC Act	WC Act	DEC				
Eastern Osprey (*Pandion cristatus*)	M			Mangroves, rivers, estuaries, inland seas, coastal islands.	Several recent and historic records.from within 10 km of Project Area (Birds Australia 2010; DEC 2012)	**MEDIUM** Species may occasionally fly over Project Area, unlikely to utilize habitats.	**LOW** Species is not anticipated to directly utilise the Project Area.
Peregrine Falcon (*Falco peregrinus*)		S4		Cliffs, ranges and wooded watercourses	Several recent and historic records.from within 10 km of Project Area (Birds Australia 2010; DEC 2012)	**MEDIUM** Species may occasionally fly over Project Area, unlikely to utilize habitats.	**LOW** Species is not anticipated to directly utilise the Project Area.
Australian Bustard (*Ardeotis australis*)			P4	Open grasslands, chenopod flats and low heathland.	Described as "species or species habitat likely to occur within area" (DSEWPaC). 1 historic records from 25 km of Project Area, no recent records (DEC 2012)	**LOW** No recent nearby records.	**LOW** Unlikely to occur in Project Area.
Bush Stone-curlew (*Burhinus grallarius*)			P4	Woodlands, dry and open grasslands, croplands.	2 records from 1998, one 5 km south of Project Area, two others from near Perth.	**LOW** No recent, nearby records.	**LOW** Unlikely to occur in Project Area.
Crested Shrike-tit (*Falcunculus frontatus sp. Leucogaster)*			P4	Eucalypt forests and woodlands, forested gullies and along rivers in drier areas.	Described as "species or species habitat likely to occur within area" (DSEWPaC). 1 historic record >30 km from Project Area, no recent records (DEC 2012)	**LOW** No recent nearby records, no suitable habitat.	**LOW** Unlikely to occur in Project Area.
Reptiles							
Western Swamp Tortoise (*Pseudemydura umbrinas)*	CR	S1	CR	Lives and feeds in ephemeral winter swamps and spends the other 6 to 9 months of the year in refuges in leaf litter, under fallen branches or in holes in the ground, in contact with the soil.	Described as "species or species habitat likely to occur within area" (DSEWPaC), no recent records (DEC 2012)	**LOW** No recent nearby records, no suitable habitat.	**LOW** Unlikely to occur in Project Area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Potential Impacts
	EPBC Act	WC Act	DEC				
Skink *(Ctenotus gemmula)*				White sandplains of the Swan Coastal Plain, mainly in semiarid and subhumid zones	Described as "species or species habitat likely to occur within area" (DSEWPaC), no recent records (DEC 2012)	**LOW** No recent nearby records, no suitable habitat.	**LOW** Unlikely to occur in Project Area.
Darling Range Heath Ctenotus *(Ctenotus delli)*			P4	Jarrah and Marri woodlands over shrubby understorey on lateritic, sandy and clay soil	Species is restricted to Darling Range. No recent records close by (DEC 2012).	**LOW** No recent nearby records, no suitable habitat.	**LOW** Unlikely to occur in Project Area.
Lined Skink (*Lerista lineata*)			P3	White sands of the Swan Coastal Plain.	Described as "species or species habitat likely to occur within area" (DSEWPaC), no recent records (DEC 2012)	**LOW** No recent nearby records, no suitable habitat.	**LOW** Unlikely to occur in Project Area.
Western Carpet Python (*Morelia spilota imbricata*)		S4	P4	Semi-arid coastal and inland habitats, in *Banksia* and Eucalypt woodlands, grasslands. Needs tree hollows or rock crevices for shelter.	Described as "species or species habitat likely to occur within area" (DSEWPaC). Several historic records from 25 km of Project Area, no recent records (DEC 2012)	**LOW** Recorded close by, but few recent records. Some suitable habitat may exist within the mixed Banksia and Xanthorrhoea heathland and the eucalypt woodland with scattered Xanthorrhoea.	**LOW** Species unlikely to occur within the Project Area due to isolated nature of the areas of potentially suitable habitat. Mobile species, able to move away from disturbance.
Black-striped Snake (*Neelaps calonotos*)			P3	I sandplain on the Swan Coastal Plain.	Described as "species or species habitat likely to occur within area" (DSEWPaC). Several historic records from 25 km of Project Area, no recent records (DEC 2012)	**LOW** Recorded close by, but few recent records. Some suitable habitat may exist within the mixed Banksia and Xanthorrhoea heathland	**LOW** Species unlikely to occur within the Project Area due to isolated nature of the areas of potentially suitable habitat. Mobile species, able to move away from disturbance.
Southern Death Adder (*Acanthophis antarcticus*)			P3	Wet sclerophyll forests, woodland, grasslands, Chenopod dominated shrublands, and coastal heathlands	Species occurs along Darling Range, no records close by (DEC 2012).	**LOW** No recent nearby records, no suitable habitat.	**LOW** Unlikely to occur in Project Area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Potential Impacts
	EPBC Act	WC Act	DEC				
Insects							
Graceful Sun Moth *(Synemon gratiosa)*	EN		P4	*Banksia* woodland/Woolly bush on deep sands and herbland, heathland and shrubland. Breeds on *Lomandra hermaphrodita* and *L. maritima.*	Recorded from numerous locations within 2-10km of the Project Area (DEC 2012).	**MEDIUM** Previously recorded close by but no food source or breeding plants were recorded.	**LOW** No food or breeding plant recorded

5.4.1 Mammals

5.4.1.1 Western Brush Wallaby

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Western Brush Wallaby is restricted to south-western Australia, from north of Kalbarri through to Cape Arid. Its preferred habitat is open forest or woodland, with low grasses and open shrubby thickets.

Ecology: Little is known of the Western Brush Wallaby's food preferences, but it appears to be able to manage without free water. Activity is greatest during the early morning and late afternoon, and the wallabies rest in the shade during the middle of the day.

Likelihood of Occurrence: Medium. Three Western Brush Wallaby records exist within 15 km of the Project Area (NatureMap, two undated records and one from 2002, Figure 4.10). Some potentially suitable habitat may exist within the Bush Forever sites and within the *Eucalyptus* woodland with scattered *Xanthorrhoea* habitat inside the Project Area, although these are constrained habitats with no surrounding areas of suitable habitat and isolated by infrastructure.

Potential Impacts: Low. Western Brush Wallabies are highly mobile and able to disperse away from impact.

5.4.2 Birds

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

Conservation Status: EPBC Act Endangered, WC Act Schedule 1 (Endangered).

Distribution and Habitat: Carnaby's Black-Cockatoo, also known as the Short-billed Black-Cockatoo, is a large, black cockatoo with white tail panels, white cheek patches and a short bill (Threatened Species Network). It is endemic to the south-west of Western Australia, ranging from the lower Murchison River in the north, throughout the south west corner, and east to Cape Arid.

Ecology: They are usually seen in pairs, triples or small flocks. In the non-breeding season, they occur in large flocks of up to 10,000 birds that wander in search of food, particularly in *Banksia* woodland and pine plantations on the northern Swan Coastal Plain (Johnstone *et al.* 2007). The cockatoos breed mainly in the Wheatbelt, in large hollows usually high in eucalypt, karri or marri trees, and then move west following breeding to feed in coastal and near-coastal areas from late December to July (Morcombe 2000; Shah 2006). They forage mainly in shrubland or kwongan heath, eucalypt woodland and pine plantations, feeding on the seeds, nuts and flowers of a large variety of proteaceous species such as *Banksia, Dryandra, Grevillea* and *Hakea*, as well as *Eucalyptus*, *Pinus* and *Allocasuarina* (Johnstone and Storr 1998; Shah 2006). Breeding trees are known to consist of any patch of woodland or forest which contains live or dead trees of Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum, York Gum, Karri or Marri (DSEWPaC 2011). Suitable tree hollows are required for nesting.

The life history of this cockatoo makes it extremely vulnerable to threats resulting from human activities and introduced competitors because pairs bond for life, require large tree hollows for breeding and only produce one chick per year (Shah 2006). The number of Carnaby's Black-Cockatoos remaining in the wild is estimated at 8,000-10,000 individuals (Burnham *et al.* 2010), with an estimated total population decline of over 50% in the past 45 years (Shah 2006).

Factors contributing to their decline include:

- Habitat fragmentation and clearing of semi-arid sandplains, particularly in the northern and eastern areas of the Wheatbelt. Most habitats suitable for breeding and feeding in the Wheatbelt have been cleared entirely.
- Clearing of heathland surrounding breeding sites has reduced the survival rate of fledglings by decreasing the available food sources for the young (Saunders 1986; Cale 2003)
- Poaching of eggs and young by collectors and animal dealers; breeding hollows become unsuitable for future breeding attempts through damage of hollows and trees when young and eggs are taken (Cale 2003).
- The introduction and spread of invasive species such as the Galah (*Eolophus roseicapillus*) on the Swan Coastal Plain, corellas (*Cacatua sanguinea and C. tenuirostris*), and feral bee (*Apis mellifera*). These species compete with and exclude Carnaby's Black-Cockatoos from traditional nest hollows (Saunders 1979; Shah 2006).

Likelihood of Occurrence: Recorded. Two Carnaby's Black-Cockatoos were recorded during this survey, (overflying Project Area) with several records from the Lake Joondalup area and surrounds (Birds Australia 2010; DEC 2012).

DSEWPaC states that "breeding [is] likely to occur within [the] area" in the results of the protected matters database search.

No specific breeding location records in close proximity to the Project Area have been identified from this study.

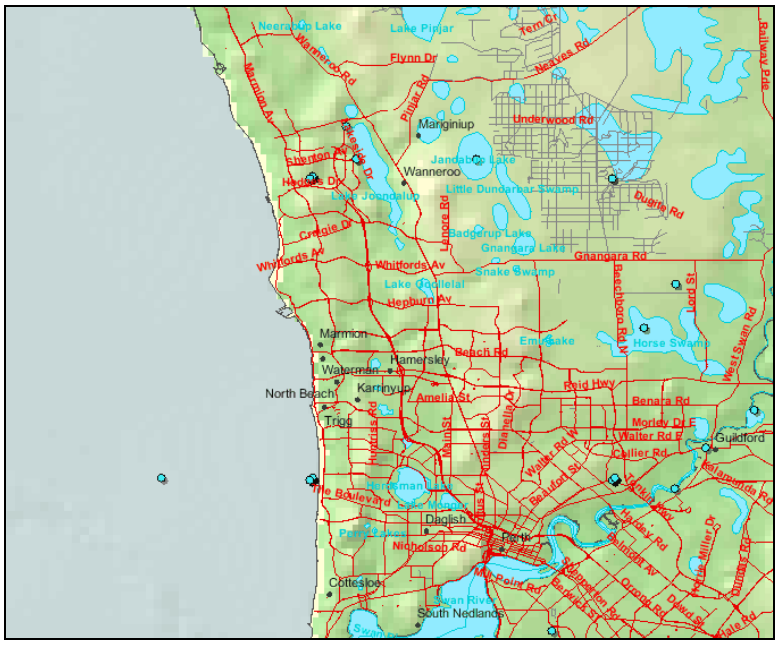
The Great Cocky Count project noted several potential roost sites within 10 km of the Project Area, in a range of tree species including pine (highest frequency of records of roosting), eucalypt (jarrah, marri and tuart) (Burnham *et al.* 2010).

Potential Impacts: High. The EPBC Act draft referral guidelines (DSEWPaC 2011) determine a high risk of significant impacts as clearing of any part of breeding habitat, or clearing of more then 1 ha of quality foraging habitat.

Good quality suitable foraging habitat is present within the mixed *Banksia* and *Xanthorrhoea* heathland habitat (Bush Forever site) (1.79 ha), as well as within the Pine plantation (0.37 ha) and areas of Eucalypt woodland with scattered *Xanthorrhoea* (2.27 ha) and open *Eucalyptus* woodland with sparse *Acacia/Melaleuca* understorey (2.72 ha).

Ten potentially suitable breeding trees (DBH >500mm) were also identified from within the Project Area (Figure 5.1), with one of these Tuart trees observed to contain visible hollows.

Carnaby's Black-Cockatoos have been recorded frequently within, and in close proximity to the Bush Forever site 303 and in close vicinity to the Project Area (Figure 5.1) (DEC 2012).



Source: DEC (2012)

Figure 5.1 – Distribution of Carnaby's Black Cockatoo (*Calyptorhynchus latirostris)* from surrounding region

5.4.2.2 Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*)

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Endangered).

Distribution and Habitat: Baudin's Black-Cockatoo is also known as the Long-billed Black-Cockatoo (Higgins 1999). It is a large, black cockatoo with white tail panels, white ear patches and a bill with a long, fine tip to the upper mandible. In appearance it is very similar to Carnaby's Black-Cockatoo, and was only recognised as separate species in 1974 (Saunders 1974). The species is endemic to the south-west of Western Australia, where it is found in or near forested areas. Being a forest specialist, its range follows the distribution of its main food species, the marri tree (*Corymbia calophylla*), a species of Eucalypt native to the Jarrah and Karri forest.

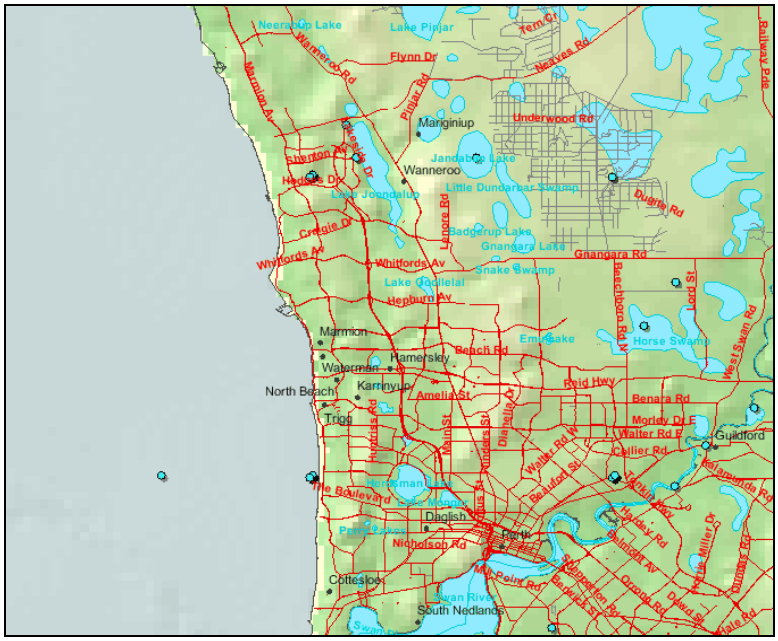
Destruction of habitat due to logging and clearing for agriculture has reduced this species' range by 25% while it has reduced in density over a further 25% (Garnett and Crowley 2000). Baudin's Black Cockatoo only breeds in densely forested areas in the Southern Jarrah Forest bioregion (JF2) (Higgins 1999; McKenzie et al. 2003; Saunders 1974), with the northern-most breeding events recorded near Serpentine, 40 km south of Perth (Johnstone and Kirkby 2008).

Ecology: After breeding, birds congregate in large flocks that move north-east, searching for food (Johnstone and Storr 1998; Saunders 1974). During this time, foraging flocks may enter commercial orchards where they feed on the seeds and juice of apples and pears (Chapman 2007; Chapman and Massam 2005; Saunders 1974; Saunders et al. 1985). Because of this habit, many birds are shot illegally by orchardists, and this process is considered the principal threat to the species (CALM 2006; Chapman 2007). On average, breeding pairs only produce one chick per two years; hence, it is unlikely that sufficient chicks are produced each year to offset the high adult mortality from shooting (Chapman 2007; Johnstone and Storr 1998).

Likelihood of Occurrence: High. This species has been recorded within close proximity to the Project Area (Figure 5.2) (DEC 2012). The Project Area is outside the typical breeding range for this species (DSEWPaC 2011); therefore, habitat usage of the site would be restricted to potential foraging and roosting habitat. No known roost sites within the vicinity of the Project Area have been identified.

Potential Impacts: High. The mixed *Banksia* and *Xanthorrhoea* heathland habitat type (1.79 ha) is assessed as good foraging habitat for this species, as well as areas of the *Eucalyptus* woodland with scattered *Xanthorrhoea* (2.27 ha), open *Eucalyptus* woodland with sparse *Acacia/Maleleuca* understory (2.72 ha), and the Pine plantation (0.37 ha), resulting in a total of 7.15 ha of good foraging habitat is within the Project Area (Table 4.8). DSEWPaC (2011) state clearing of more than 1 ha of quality foraging habitat is a high risk of significant impacts; therefore, this species is assessed as having high potential impacts as a response to the clearing of foraging habitat.

The foraging habitat for Baudin's Black-Cockatoo could also provide suitable roosting habitat, with 7.15 ha of combined suitable habitat type providing roosting habitat within the Project Area. No roost sites are known in close proximity to the Project Area. Due to the Project Area being outside this species breeding range (DSEWPaC 2011), no breeding habitat exists within the Project Area.



Source: DEC (2012)

Figure 5.2 –Distribution of Baudin's Black Cockatoo (*Calyptorhynchus baudinii)* from surrounding region

5.4.2.3 Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Distribution and Habitat: The Forest Red-tailed Black-Cockatoo inhabits the dense Jarrah (*Eucalyptus marginata*), Karri (*E. diversicolor*) and Marri (*Corymbia calophylla*) forests receiving more than 600 mm average rainfall annually (Saunders and Ingram 1995; Saunders et al. 1985). Although most records are in Jarrah-Marri forests, the Forest Red-tailed Black-Cockatoo has been observed in a range of other forest and woodland types, including Blackbutt (*E. patens*), Wandoo (*E. wandoo*), Tuart (*E. gomphocephala*), Albany Blackbutt, Yate (*E. cornuta*), and Flooded Gum (*E. rudis*) (Abbott 1998).

Habitats in which the Forest Red-tailed Black-Cockatoo occurs often have an understorey of *Banksia*, Snottygobble (*Persoonia longifolia*) and Sheoak (*Allocasuarina fraseriana*), with scattered Blackbutt and Wandoo (Johnstone and Kirkby 1999). The Forest Red-tailed Black-Cockatoo occurs within the same habitat as Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*), and as with Baudin's Black-Cockatoo, it nests in large hollows of Marri, Jarrah and Karri (Johnstone and Kirkby 1999). The subspecies has also been sighted nesting in Wandoo and Bullich (*E. megacarpa*).

Ecology: The life span of Forest Red-tailed Black-Cockatoos is predicted to be 25-50 years. The cockatoos are thought to begin breeding when they are 4-6 years old, fledging only one chick at a time

(Johnstone and Storr 1998). It is probable that less than 10% of the population of Forest Red-tailed Black-Cockatoos are be capable of breeding in any one year and birds may only breed every 2-3 years, with low breeding success (Johnstone and Kirkby 2006).

Like all black cockatoos, the Forest Red-tailed Black-Cockatoo is monogamous and pairs probably form a lifetime bond (Higgins 1999; Smith and Saunders 1986). The breeding period spans from September to April, with eggs typically laid in October/November (Johnstone 1997; Johnstone and Storr 1998), or March/April in years with good autumn rains. Nests are made in large tree hollows in Marri, Jarrah, Wandoo and Bullich trees that are at least 500–600 mm in diameter at breast height and may be more than 130 years old (Johnstone and Storr 1998; Whitford 2002; Whitford and Williams 2002). Trees of less than 500 mm in diameter are considered to have the potential to develop hollows and are also important breeding resources for the species.

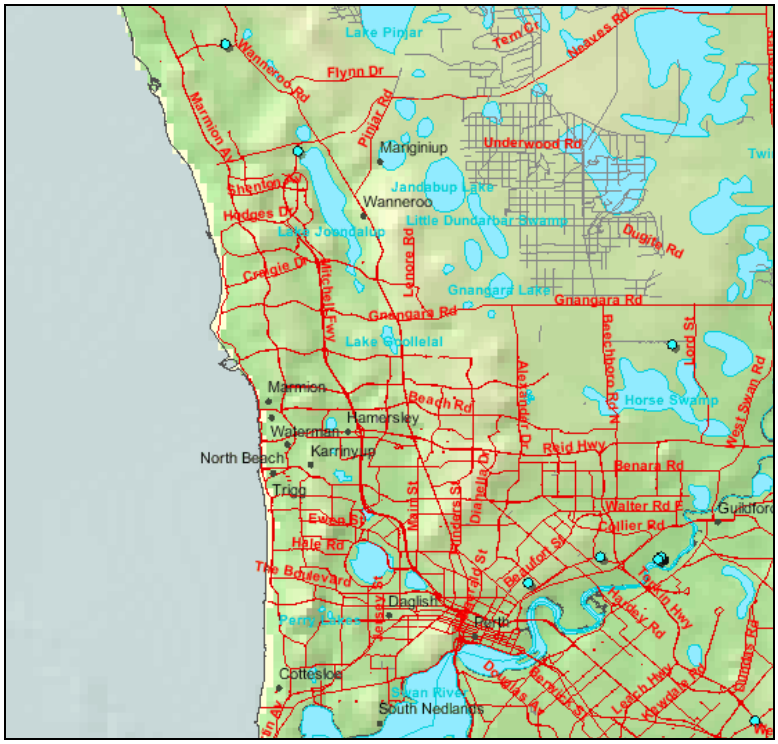
Around 90% of the subspecies' diet is made up of the seeds from Marri and Jarrah fruits (Johnstone and Kirkby 1999). Other species used for feeding include blackbutt, Forest Sheoak, Snottygobble and the non-indigenous native Spotted Gum (*E. maculata*) and Cape Lilac (Johnstone and Kirkby 1999; Johnstone and Storr 1998). Due to the slow and patchy flowering and seeding of Marri trees, Forest red-tailed Black-Cockatoo highlights the need for foraging habitat to consist of a mosaic of tree species and age classes.

Flocks of up to 50 individuals (Abbott 1998) spend the night roosting in trees and leave at sunrise, splitting into smaller family groups, of around 10 birds, and moving into adjacent forest. After a short period of preening and basking in the sunlight they feed for 10–12 hours before moving off to creeks or dams to drink. On dark, they return to their roosts (Johnstone and Kirkby 1999).

Key threats to the Forest Red-tailed Black-Cockatoo are habitat loss, nest hollow shortage and competition for available nest hollows from other species, and injury or death from the European Honeybee (*Apis mellifera*), illegal shooting and fire (CALM 2006). Climate change is an additional threat that is likely to exacerbate other threats as a result of changes to biodiversity and ecosystem function (Chambers et al. 2005).

Likelihood of Occurrence: High. Forest Red-tailed Black-Cockatoos were recorded adjacent to the Project Area during the Phase 2 Beenyup field assessment (*ecologia* unpublished report) from the Lake Joondalup area, and they have previously been recorded south and east of the site, indicating that they are likely to utilise the Project Area on occasion. Habitat requirements are similar to Baudin's Black-Cockatoo, with potential usage of the Project Area likely to be restricted to foraging and potentially roosting. No specific breeding or roosting records close by to the Project Area are known.

Potential Impacts: High. As with Baudin's Black-Cockatoo, the mixed *Banksia* and *Xanthorrhoea* heathland habitat type (1.79 ha) is assessed as good foraging habitat for this species, as well as areas of the *Eucalyptus* woodland with scattered *Xanthorrhoea* (2.27 ha), open *Eucalyptus* woodland with sparse *Acacia/Melaleuca* understorey (2.72 ha), resulting in a total of 6.78 ha of good foraging habitat occurring within the Project Area (Table 4.7). Forest Red-tailed Black Cockatoos are less commonly recorded utilising Pine plantations for foraging. Much of the suitable foraging habitat for Forest Red-tailed Black-Cockatoo is also suitable as roosting habitat, with 6.78 ha of combined suitable habitat type providing roosting habitat within the Project Area. No roost sites are known in close proximity to the Project Area which occurs just within the northern-most known distribution of this species (DSEWPaC 2011)



Source: DEC (2012)

Figure 5.3 –Distribution of Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso)* from surrounding region

5.4.2.4 Rainbow Bee-eater (*Merops ornatus*)

Conservation Status: EPBC Act Migratory

Distribution and Habitat: The Rainbow Bee-eater is scarce to common throughout much of Western Australia, except for the arid interior, preferring lightly wooded, preferably sandy, country near water (Johnstone and Storr 1998).

Ecology: In Western Australia the Rainbow Bee-eater can occur as a resident, breeding visitor, post-nuptial nomad, passage migrant or winter visitor. It nests in burrows usually dug at a slight angle on flat ground, sandy banks or cuttings, and often at the margins of roads or tracks (Simpson and Day 2004). Eggs are laid at the end of the metre long tunnel from August to January (Boland 2004). Bee-eaters are most susceptible to predation.

Likelihood of Occurrence: High. Several previous records have been made throughout the region (DEC 2012).

Potential Impacts: Low. The Rainbow Bea-eater inhabits a variety of habitats which can be found outside the Project Area. Due to the relatively small size of the proposed Project the impact on this species is anticipated to be low.

5.4.2.5 White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

Conservation Status: EPBC Act Migratory, WC Act Schedule 3.

Distribution and Habitat: The White-bellied Sea-Eagle is considered moderately common in the Houtman Abrolhos Islands off Geraldton and in addition to Australia, the species is found in New Guinea, Indonesia, China, south-east Asia and India. White-bellied Sea-eagles occur in coastal and near coastal areas across Australia inhabiting most types of habitats except closed forest.

Ecology: The White-bellied Sea-Eagle feeds mainly on aquatic animals such as fish, turtles and sea snakes, but it takes birds and mammals as well. It breeds almost wholly on islands, building a large stick nest, which is used for many seasons in succession (Johnstone and Storr 1998; RPS 2008). The breeding season ranges from May to September in the north, and in winter and spring in Australia's south (Morcombe 2000).

Likelihood of Occurrence: Medium. The White-bellied Sea-Eagle has previously been recorded from the Lake Joondalup area and thus is likely to possibly overfly the Project Area in search for suitable foraging habitats near Lake Joondalup and along the coast, although no suitable habitat occurs within the site.

Potential Impacts: Low. The White-bellied Sea-Eagle is likely to occasionally overfly the area in the search for these waterbodies, but is not anticipated to land or utilise the Project Area directly.

5.4.2.6 Fork-tailed Swift (*Apus pacificus*)

Conservation Status: EPBC Act Migratory, WC Act Schedule 3.

Distribution and Habitat: The Fork-tailed Swift is a small, insectivorous species with a white throat and rump, and a deeply forked tail (Morcombe 2000). It is distributed from central Siberia and throughout Asia, breeding in north-east and mid-east Asia, and wintering in Australia and south New Guinea. It is a relatively common trans-equatorial migrant from October to April throughout mainland Australia (Simpson and Day 2004). In Western Australia the species begins to arrive in the Kimberley in late September, the Pilbara in November and the South-west by mid-December (Johnstone and Storr 1998). In Western Australia the Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts, common in the Kimberley and rare or scarce elsewhere (Johnstone and Storr 1998).

Ecology: Fork-tailed swifts are nomadic in response to broad-scale weather pattern changes. They are attracted to thunderstorms where they can be seen in flocks, occasionally of up to 2,000 birds. They rarely land, living almost exclusively in the air and feeding entirely on aerial insects, especially nuptial swarms of beetles, ants, termites and native bees (Simpson and Day 2004).

Likelihood of Occurrence: Medium. Birdata states this species as present and recorded within 40 km of the Project Area, but no further observations of this species are publicly available. The Fork-tailed Swift is likely to occasionally overfly the Project Area, but due to its aerial lifestyle it is not expected to directly utilise the site.

Potential Impacts: Low. Due to the entirely aerial lifestyle of the Fork-tailed Swift, the impact on this species on a local or regional scale will be low.

5.4.2.7 Eastern Osprey (*Pandion cristatus*)

Conservation Status: EPBC Act Migratory.

Distribution and Habitat: The Eastern Osprey is a large (50-60 cm), highly visible and water-dependent bird of prey with a world-wide distribution (Henny 1986; Wink *et al*. 2004). It occurs around most of the Australian coastline, inhabiting coastal areas and favouring mangroves, rivers and estuaries, inshore seas as well as coastal islands (Simpson and Day 2004). The species is uncommon to rare or absent from closely settled parts of south-eastern Australia and does not occur in Victoria or Tasmania.

Ecology: The Eastern Osprey feeds mostly on fish, but also on sea snakes, seabirds, turtles, amphibians and large lizards as well as invertebrates such as crustaceans, sea snails and beetles (Henny 1986; Johnstone and Storr 1998). Breeding takes place from autumn to spring, eggs being laid in April in the north and as late as October in the south of Australia. Eastern Osprey nests are large and usually placed at the tops of trees, prominent headlands or communication towers (Henny 1986; Simpson and Day 2004). Some nests are re-used for decades (Morcombe 2000).

Degradation and removal of habitat, and disturbance to nesting sites have been identified as threats to the Eastern Osprey's survival (Henny 1986).

Likelihood of Occurrence: Medium. The Eastern Osprey has numerous recent and historic records from within 10 km of the Project Area. The Project Area comprises little foraging habitat but the species is likely to occasionally overfly the area.

Potential Impacts: Low. The Eastern Osprey is not likely to directly utilise the Project Area, the impact on this species is anticipated to be low.

5.4.2.8 Peregrine Falcon (*Falco peregrinus*)

Conservation Status: WC Act Schedule 4, DEC Specially Protected Fauna.

Distribution and Habitat: This nomadic or sedentary falcon is widespread in many parts of Australia and some of its continental islands, but absent from most deserts and the Nullarbor Plain. The species is considered to be moderately common in the Stirling Range, uncommon in the Kimberley, Hamersley and Darling Ranges, and rare or scarce elsewhere (Johnstone and Storr 1998). The Peregrine Falcon occurs most commonly near cliffs along coasts, rivers and ranges, and around wooded watercourses and lakes.

Ecology: Peregrine Falcons feed almost entirely on birds, especially parrots and pigeons. They nest primarily on ledges on cliffs, granite outcrops and in quarries, but may also nest in tree hollows around wetlands. Eggs are predominantly laid in September (Johnstone and Storr 1998; Olsen et al. 2006).

Likelihood of Occurrence: Medium. The Peregrine Falcon has numerous recent and historic records from within 10 km of the Project Area. The Project Area comprises little foraging habitat but the species is likely to occasionally overfly the area.

Potential Impacts: Low. The Peregrine Falcon is not likely to directly utilise the Project Area, the impact on this species is anticipated to be low.

5.4.3 Graceful Sun Moth

The Graceful Sun Moth (*Synemon gratiosa)* is a small diurnal moth, endemic to the south-west Western Australia, and is currently only known from the Swan Coastal Plain between Quinns Rocks in Perths' northern suburbs, to coastal areas south of Mandurah (Bishop *et al.* 2009).

The Graceful Sun Moth is listed as Endangered under both the EPBC Act and the WC Act (Schedule 1). They have a life cycle that generally takes one to three years to complete, with adult individuals generally only living between two to ten days, with this adult phase spend mating and laying eggs. The eggs are laid at the base of the 'food-plant', and the larvae that hatch from the eggs burrow into the growing tip and down into the underground culms, roots or rhizomes. They live entirely within or alongside the underground parts of the plant, making them very difficult to locate. The larvae look like beetle grubs – they are white or cream in colour, with a small dark brown head (Bishop *et al.* 2009).

The larvae of the Graceful Sun Moth are only known to feed on two species of *Lomandra* mat-rushes - *Lomandra maritima* and *Lomandra hermaphrodita*, both of which are common and have been recently and historically recorded throughout the region and within 5 km if the Project Area (DEC 2012).

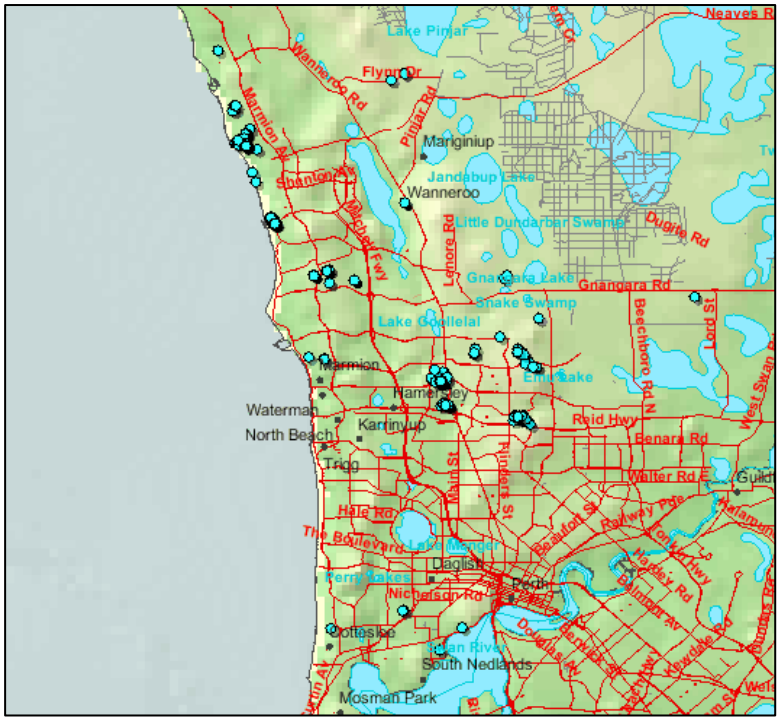
The Graceful Sun Moth is currently only known from two general vegetation types (Bishop *et al.* 2009):

- Banksia woodland/Woolly bush on deep sands, in the northern suburbs of Perth on the Swan Coastal Plain. At these sites the Graceful Sun Moth breeds on *Lomandra hermaphrodita*, which often occurs in low numbers.
- Open areas of herbland, heathland and shrubland in the southern Swan Coastal Plain, close to the coast where it breeds on *Lomandra maritima*, which is often present in reasonable numbers and may even be a dominant understorey herb.

The likelihood of the Graceful Sun Moth occurring in the Project area is considered moderate, based on the proximity of previous records and the provision of suitable habitat at the site and in the region. The species has been recorded both historically (1980's) and recently (2010) from numerous locations within 2 – 10 km of the Project Area (Figure 5.4).

No food source plants were recorded during the current survey, and neither of the above-described vegetation types were recorded from within the Project Area. *Lomandra* could possibly occur within the Project Area, however this is considered unlikely since it was not observed durng the field assessment after targeted searching and also due to the degraded nature of the Project Area.

The potential impacts of the proposed clearing on the Graceful Sun Moth are considered low, as no food-plants were recorded from inside the Project Area. The range of the species is small and it is highly unlikely that adults would to visit the Project Area in search of *Lomandra* to lay their eggs.



Source: DEC (2012)

Figure 5.4 – Distribution of Graceful Sun Moth (*Synemon gratiosa*) from surrounding region

The considerably high number of potentially occurring conservation significant bird species (65) is due to the close proximity of the Project Area to the coast (approximately 4 km), as well as a number of important lakes and wetlands, commonly utilised by migratory shorebird species (i.e. Lake Joondalup which is less than 5 km north of the Project Area). Although they may occasionally overfly the Project Area, all these species are considered to have a low likelihood of occurrence within the site as they do not utilise the habitats present. For this reason, these migratory and marine species (listed in Appendix D) have not been considered in this assessment.

During the current survey, a single conservation significant species was recorded; Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) (EPBC Endangered, WC Act Schedule 1). Two individuals were observed flying over the Project Area in the south-eastern corner of the central part of the Project Area (Figure 4.3).

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6 ASSESSMENT AGAINST THE 10 CLEARING PRINCIPLES

The impacts of the proposed clearing have been assessed against the DEC's 10 clearing principles. The results are summarised in Table 6.1.

Table 6.1 – Assessment against the 10 clearing principles

Principle	Comment
1. Native vegetation should not be cleared if it comprises a high level of biological diversity.	144 taxa were collected in 25 ha, only 46% of which are native. The species richness of native flora in the study area is, therefore, considered very low. There were no species of Priority Flora recorded and the site is not known to, nor was it determined to support vegetation equivalent to PECs. Thirty species of fauna (27 natives) were recorded, however most were birds observed flying overhead. The biodiversity of the site is not considered high and the surrounding region is considered to support more significant biological diversity values, in areas such as nature reserves. **The proposed clearing is not considered at variance with this principle.**
2. Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	A total of 7.15 ha of good quality foraging, and potentially nesting/breeding and roosting habitat for three species of EPBC Act listed Black Cockatoo's was identified inside the Project Area. However, there was no evidence of roosting observed within the Project Area and no known roost sights are supported by the site, or known nearby. Two individuals of Carnaby's Black-Cockatoo were also observed flying overhead during the field assessment. Clearing of this habitat exceeds the Referral Guidelines minimum of 1 ha of clearing of this habitat type. Furthermore, nine potentially suitable habitat trees were recorded, with at least one tree containing potentially suitable hollows for nesting. Referral guidelines recommend that no breeding trees be cleared (DSEWPaC 2011). **The proposed clearing is at variance with this principle.** ***Avoidance recommendation – avoid clearing the ten recorded habitat/significant trees.***
3. Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No taxa of Threatened (rare) Flora were recorded in the Project Area, despite careful (targeted) searching within good quality remnants at the site. One species of Threatened flora; *Marianthus paralius,* resulted from the database search as potentially occurring at the site. Consideration of the habitat suitability for this species (limestone, coastal cliffs) determined that it is highly unlikely to occur within the Project Area. **The proposed clearing is not considered at variance with this principle.**
4. Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	The remnants bushland at the site occurs within Bush Forever site 303. The vegetation in this area was determined to be equivalent to FCT 29 (Gibson *et al.* 1994). This FCT is classified as "well reserved" at "low risk" of extinction and is not classified as a TEC. The desktop assessment did not suggest the possibility of the site supporting TEC equivalent vegetation. **The proposed clearing is not considered at variance with this principle.**

Principle	Comment
5. Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	One of the objectives in EPA's Position Statement No. 2 is to protect at least 30% of the pre-European extent of vegetation. The regional vegetation types of the Project Area are the Karrakatta Complex – Central and South and Cottesloe Complex – Central and South. In 2010, Perth Biodiversity Project reported that the Karrakatta Central and South vegetation complex was at that time represented by 24% of its pre-European extent. This falls below the threshold level of 30%. The Cottesloe Central and South was represented by 35% of the original extent, which does not reach the threshold, but should be considered limited according to the Perth Biodiversity Project (2010), as their calculations are likely to be overestimated. On a finer scale, the intact remnant vegetation at the site was determined to be equivalent to FCT 28 (Gibson *at al.* 1994). This FCT appears to be well represented on the Swan Coastal Plain, represented by 38 sites for the FCT study in 1994. **The proposed clearing may be at variance with this principle.** ***Offset recommendation – rehabilitation of some degraded areas at the site, not required for the development.***
6. Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	The Project Area supports some constructed drainage for surface water management of roads and tracks. There are no natural watercourses or wetlands within the Project Area or in close proximity. **The proposed clearing is not considered at variance with this principle.**
7. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The majority of the Project Area is currently in degraded or completely degraded condition. Provided that the development includes appropriate drainage features, the site is not considered to be at risk of soil erosion or acidification and does not occur within an area of salinity risk. The proposed clearing is not expected to result in appreciable land degradation. **The proposed clearing is not considered at variance with this principle.**
8. Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The proposed clearing appears to include some areas of Bush Forever site 303. However, the areas of Bush Forever site that the proposed clearing intersects with are zoned; "other Government Lands – existing and proposed public utilities" and "Major Road/Rail Reserves". In this regard, consideration was made for development at the site such as that proposed and the areas of Bush Forever site 303 that are intended to be retaining for ongoing conservation should not be affected. **The proposed clearing is considered unlikely to be at variance with this principle.**
9. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	There are no natural surface water features (wetlands, lakes, rivers or streams) supported by the site and therefore no opportunity for the project to impact on surface water quality, provided sediments are controlled during construction via the application of appropriate measures documented in a Construction Environmental Management Plan. The clearing of vegetation will not impact on groundwater, due to a virtual lack of groundwater dependent vegetation proposed to be cleared (clearing a few tress is not expected to have a significant impact). **The proposed clearing is not considered at variance with this principle.**
10. Native vegetation should not be cleared the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	The incidence of flooding in the Project Area should not be increased by clearing of the vegetation due to the fact that the site occurs on free draining sandy soils. The eventual construction of the development will also manage local drainage appropriately. **The proposed clearing is not considered at variance with this principle.**

7 CONCLUSIONS AND RECOMMENDATIONS

The Project Area is largely degraded and from an ecological point of view. The key results of the flora, vegetation and fauna assessment are as follows:

- Three species of Declared Plants (**Echium plantagineum, *Lantana camara* and **Moraea flaccida*) were recorded and require control methods as specified by DAFWA.
- The regional vegetation types of the Project Area are the Karrakatta Complex – Central and South and Cottesloe – Central and South, which Perth Biodiversity Project reports to be represented by 24% and 35% of its pre-European extent. The Karrakatta Complex – Central and South falls below the threshold level of 30%. The proposed clearing may be variance with Principle (e) due to this result.
- Some of the Project Area intersects with a section of Bush Forever site 303, however these areas are zoned for the development of infrastructure for roads/rail and public utilities. The proposed clearing may be, although is unlikely to be at variance with Principle (h) due to this result.
- The occurrence of *Phytophthora multivora* has been confirmed at the site, from one of nine samples collected and tested using laboratory methods.
- One fauna species of conservation significance; Carnaby's Black-Cockatoo, listed as Endangered under the EPBC Act and Endangered (Schedule 1) under the WC Act, was recorded. The proposed clearing is at variance with Principle (b) due to this result.

The following recommendations are suggested:

- Limit clearing of vegetation to that which is absolutely necessary for construction and safe operation of the project, particularly within Bush Forever site 303.
- Undertake obligatory weed control for Declared Plants, in accordance with methodologies prescribed by DAFWA.
- If clearing of intact native remnant vegetation is required, consider offsetting further clearing impacts to the Karrakatta Complex – Central and South by undertaking some rehabilitation at the site, in areas that are currently degraded and that are not required for the development.
- Where possible, avoid clearing of mature trees at the site, in particular the ten trees identified to be significant or potential habitat trees and in particular the tree identified to have hollows suitable for Black-Cockatoo nesting.
- Prepare an appropriate Construction Environmental Management Plan that addresses matters including:
    - measures to avoid accidental over-clearing;
    - site fauna management including avoidance of vehicle and machinery collisions with native vertebrate species;
    - Dieback, pathogen and weed hygiene;
    - erosion and sedimentation control during construction; and
    - appropriate handling of cleared vegetation and topsoil for the purposes of potential rehabilitation activities.

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8 STUDY TEAM

The flora and fauna assessment described in this document was planned, coordinated and executed by:

Project Staff and Qualifications		
Mariana Campos	PhD	Botanist
Udani Sirisena	PhD	Notanist and Taxonomist
Marie-Gabrielle d'Auvergne	BSc (Hons)	Zoologist

Licences - "Licence to Take Flora for Scientific Purposes" and "License to Take Fauna for Scientific Purposes"		
The vegetation and flora assessment, and the Fauna assessment described in this report were conducted under the authorisation of the following licences issued by the DEC:		
	Permit Type	**Permit Number**
Mariana Campos	Flora Licence	SL 009 995
Udani Sirisena	Flora Licence	Pending
Marie-Gabrielle d'Auvergne	Reg 17 Fauna	SF 008 909

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APPENDIX A CONSERVATION CODES FOR THREATENED AND PRIORITY FLORA SPECIES AND ECOLOGICAL COMMUNITIES

Table A.1 – Definition of codes for Threatened and Priority Flora (DEC)

Code	Definition
T	**Threatened Flora – (Declared Rare Flora – Extant)** Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*).
X	**Presumed Extinct Flora (Declared Rare Flora - Extinct)** Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such Schedule 2 under the *Wildlife Conservation Act 1950*).
P1	**Priority One – Poorly Known Species** Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	**Priority Two – Poorly Known Species** Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	**Priority Three – Poorly Known Species** Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities 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 localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	**Priority Four – 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 do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	**Priority Five - Conservation Dependent species** Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table A.2 – Definition of codes for Commonwealth Listed Threatened Flora

Code	Definition
Ex	**Extinct** Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Table A.3 – Definition of codes for Threatened Ecological Communities

Code	Definition
PD: Presumed Totally Destroyed	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant
CR: Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
EN: Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.
VU: Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

Table A.4 – Definition of codes for Priority Ecological Communities

Code	Definition
P1: Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or Pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2: Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3: Priority Three	(i) 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 or: (ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4: Priority Four	Ecological communities that are adequately known, Rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years. P5: Priority Five Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.
P5: Priority Five	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table A.5 – Definition of codes for Threatened Fauna (WC Act)

Code	Definition
T (Schedule 1)	Fauna that is rare or likely to become extinct Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction or otherwise in need of special protection, and have been gazetted as such. Further categorised as: o CR Critically Endangered – considered to be facing an extremely high risk of extinction in the wild o EN Endangered – considered to be facing a very high risk of extinction in the wild o VU Vulnerable – considered to be facing a high risk of extinction in the wild.
X (Schedule 2)	Presumed Extinct Fauna Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
IA (Schedule 3)	Birds protected under an international agreement. Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction are declared to be fauna that is in need of special protection.
S (Schedule 4)	Other specially protected fauna Fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3].]

Table A.6 – Definition of codes for Priority Fauna (WC Act)

Code	Definition
P1	Priority One Taxa with few, poorly known populations on threatened lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
P2	Priority Two Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
P3	Priority Three Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
P4	Priority Four Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
P5	Priority Five Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table A.7 – Definition of codes for Threatened Fauna (EPBC Act)

Code	Definition
Ex	Extinct Taxa not definitely located in the wild during the past 50 years
ExW	Extinct in the Wild Taxa known to survive only in captivity
CE	Critically Endangered Taxa facing an extremely high risk of extinction in the wild in the immediate future
E	Endangered Taxa facing a very high risk of extinction in the wild in the near future
V	Vulnerable Taxa facing a high risk of extinction in the wild in the medium-term
NT	Near Threatened Taxa that risk becoming Vulnerable in the wild
CD	Conservation Dependent Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
DD	Data Deficient (Insufficiently Known) Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

APPENDIX B QUADRAT DESCRIPTIONS

Quadrat 1

Easting	384369
Northing	6483114
Habitat	Plain
Slope	Negligible
Surface Layer	Loose Soil
Soil Colour	White
Soil Texture	Sand
Rocks	No Rocks
Condition	Very Poor
Disturbances	Weeds, Faecal material, Dead trees, Close to clearance
Evidence of Fire	No evidence
Leaf Litter Distribution	Dispersed
Leaf Litter Cover	50%

Stratum	Cover %	Taxon
Trees (<10 m)	5	*Allocasuarina fraseriana*
	5	*Banksia attenuata*
Shrubs (1-2 m)	30	*Xanthorrhoea brunonis* subsp. *brunonis*
	10	*Hakea lissocarpha*
Shrubs (<1 m)	30	**Lupinus angustifolius*
	2	**Fumaria capreolata*
Sedges	2	*Mesomelaena pseudostygia*
Herbs	5	**Euphorbia terracina*
	2	**Trifolium campestre* var. *campestre*
	1	**Trifolium arvense*
	1	**Wahlenbergia capensis*
	1	*Hesperantha falcata*
	1	*Hibbertia racemosa*
	1	*Senecio ?condylus*
	1	*Wahlenbergia gracilenta*
Grasses	30	**Ehrharta longifolia*
	20	**Avena fatua*
	5	**Ehrharta calycina*
	5	**Lagurus ovatus*
	1	**Lolium rigidum*

Quadrat 2

Easting	384211
Northing	6483218
Habitat	Plain
Slope	Negligible
Surface Layer	Loose Soil
Soil Colour	White
Soil Texture	Sand
Rocks	No Rocks
Condition	Poor
Disturbances	Weeds, Litter, Close to clearance
Evidence of Fire	No evidence
Leaf Litter Distribution	Dispersed
Leaf Litter Cover	50%

Stratum	Cover %	Taxon
Trees (<10 m)	10	*Banksia attenuata*
Shrubs (1-2 m)	30	*Xanthorrhoea brunonis* subsp. *brunonis*
	2	*Acacia pulchella*
	1	*Daviesia divaricata*
	1	*Daviesia nudiflora*
Shrubs (<1 m)	20	*Hibbertia hypericoides*
	15	*Stirlingia latifolia*
	2	*Hypocalymma angustifolium*
	1	*Corynotheca micrantha* var. *micrantha*
	1	*Petrophile macrostachya*
	1	*Haemodorum laxum*
	1	*Petrophile linearis*
Sedges	3	*Mesomelaena pseudostygia*
Herbs	30	**Trifolium campestre* var. *campestre*
	30	**Ursinia anthemoides* subsp. *anthemoides*
	3	**Trifolium arvense*
	2	**Lachenalia reflexa*
	1	*Conostylis aculeata* subsp. *cygnorum*
	1	*Scaevola canescens*
Grasses	30	*Desmocladus flexuosus*
	10	**Avena fatua*
	1	**Briza maxima*

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APPENDIX C NATIONAL VEGETATION INFORMATION SYSTEM (NVIS) CLASSIFICATIONS

NVIS Structural Formation Classes Used For Vegetation Classification

Height Range (m)	Tree	Shrub	Mallee	Grass
>30	tall	-	-	-
10-30	mid	-	tall	-
<10	low	-	mid	-
<3	-	-	low	-
>2	-	tall	-	tall
1-2	-	mid	-	tall
0.5-1	-	low	-	mid
<0.5	-	low	-	low

Growth Form	Height (m)	Structural Formation Classes					
Foliage cover % (cover #)		70-100% (5)	30-70% (4)	10-30% (3)	<10% (2)	0-5% (1)	≈0% (N)
Tree	**<10,10-30, >30**	closed forest	open forest	woodland	isolated clumps of trees	isolated trees	isolated clumps of trees
Tree mallee	**<3, <10, 10-30**	closed mallee forest	open mallee forest	mallee woodland	isolated clumps of mallee trees	isolated mallee trees	isolated clumps of mallee trees
Shrub	**<1,1-2,>2**	closed shrubland	shrubland	open shrubland	isolated clumps of shrubs	isolated shrubs	isolated clumps of shrubs
Mallee shrub	**<3, <10, 10-30**	closed mallee shrubland	mallee shrubland	open mallee shrubland	isolated clumps of mallee shrubs	isolated mallee shrubs	isolated clumps of mallee shrubs
Heath shrub	**<1,1-2,>2**	closed heathland	heathland	open heathland	isolated clumps of heath shrubs	isolated heath shrubs	isolated clumps of heath shrubs
Chenopod shrub	**<1,1-2,>2**	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	isolated clumps of chenopod shrubs	isolated chenopod shrubs	isolated clumps of chenopod shrubs
Samphire shrub	**<0.5,>0.5**	closed samphire shrubland	samphire shrubland	open samphire shrubland	isolated clumps of samphire shrubs	isolated samphire shrubs	isolated clumps of samphire shrubs
Hummock grass	**<2,>2**	closed hummock grassland	hummock grassland	open hummock grassland	isolated clumps of hummock grasses	isolated hummock grasses	isolated clumps of hummock grasses
Tussock grass	**<0.5,>0.5**	closed tussock grassland	tussock grassland	open tussock grassland	isolated clumps of tussock grasses	isolated tussock grasses	isolated clumps of tussock grasses
Sedge	**<0.5,>0.5**	closed sedgeland	sedgeland	open sedgeland	isolated clumps of sedges	isolated sedges	isolated clumps of sedges
Rush	**<0.5,>0.5**	closed rushland	rushland	open rushland	isolated clumps of rushes	isolated rushes	isolated clumps of rushes

Source: Department of Environment and Heritage, 2003.

APPENDIX D REGIONAL FAUNA RECORDS AND SPECIES RECORDED DURING THE SURVEY

Mammals

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
TACHYGLOSSIDAE														
Tachyglossus aculeatus	Echidna						✓			✓				
DASYURIDAE														
Antechinus flavipes leucogaster	Yellow-footed Antechinus									✓				
Dasyurus geoffroii	Western Quoll	VU	S1	VU						✓		✓		
Ningaui timealeyi	Pilbara Ningaui									✓				
Phascogale calura	Red-tailed Phascogale	EN	S1	EN								✓		
Phascogale tapoatafa tapoatafa	Brush-tailed Phascogale	VU	S1	VU						✓				
Planigale ingrami	Long-tailed Planigale									✓				
Planigale maculata	Common Planigale									✓				
Sminthopsis crassicaudata	Fat-tailed Dunnart									✓				
Sminthopsis macrourus	Strip-faced Dunnart									✓				
PERAMELIDAE														
Isoodon obesulus fusciventer	Southern Brown Bandicoot (south-western)			P5	✓		✓	✓	✓	✓				
POTOROIDAE														
Bettongia penicillata ogilbyi	Woylie	EN	S1	VU						✓		✓		
Bettongia lesueur graii	Boodie									✓				
MACROPODIDAE														
Macropus fuliginosus	Western Grey Kangaroo				✓	✓				✓				✓
Macropus irma	Western Brush Wallaby			P4	✓	✓		✓		✓				
Setonix brachyurus	Quokka	VU	S1	VU						✓		✓		

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
PHALANGERIDAE														
Trichosurus vulpecula vulpecula	Common Brushtail Possum				✓				✓	✓				
BURRAMYIDAE														
Cercartetus concinnus	Western Pygmy-possum									✓				
TARSIPEDIDAE														
Tarsipes rostratus	Honey Possum				✓	✓				✓				
PTEROPODIDAE														
Pteropus scapulatus	Little Red Flying Fox									✓				
VESPERTILIONIDAE														
Chalinolobus gouldii	Gould's Wattled Bat				✓					✓				
Chalinolobus morio	Chocolate Wattled Bat									✓				
Nyctophilus geoffroyi	Lesser Long-eared Bat				✓					✓				
Nyctophilus gouldi	Gould's Long-eared Bat									✓				
Vespadelus regulus	Southern Forest Bat				✓					✓				
MOLOSSIDAE														
Mormopterus planiceps	South-western Freetail Bat				✓					✓				
Tadarida australis	White-striped Freetail Bat				✓	✓				✓				
MURIDAE														
Hydromys chrysogaster	Water-rat			P4						✓	✓			
Pseudomys albocinereus	Ash-grey Mouse									✓				
Pseudomys delicatulus	Delicate Mouse									✓				
Pseudomys desertor	Desert Mouse									✓				

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Rattus fuscipes	Western Bush Rat									✓				
INTRODUCED MAMMALS														
**Funambulus pennant*	Indian Palm Squirrel									✓				
**Mus musculus*	House Mouse				✓	✓	✓			✓				
**Mustela putorius*	European Polecat									✓				
**Rattus rattus*	Black Rat						✓			✓				
**Canis lupus familiaris*	Dog				✓					✓				✓
**Vulpes vulpes*	Red Fox				✓	✓	✓	✓	✓	✓				
**Felis catus*	Cat				✓	✓		✓		✓				✓
**Oryctolagus cuniculus*	Rabbit				✓	✓		✓	✓	✓				✓
**Equus caballus*	Horse									✓				
**Camelus dromedarius*	Camel									✓				
**Ovis aries*	Sheep									✓				
**Sus scrofa*	Pig									✓				
**Bos taurus*	Cow									✓				

Birds

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
CASUARIIDAE														
Dromaius novaehollandiae	Emu				✓					✓			✓	
PHASIANIDAE														
Coturnix pectoralis	Stubble Quail									✓			✓	
Coturnix ypsilophora	Brown Quail				✓					✓			✓	
**Pavo cristatus*	Indian Peafowl												✓	
**Phasianus colchicus*	Common Pheasant												✓	
ANATIDAE														
Dendrocygna eytoni	Plumed Whistling-Duck									✓			✓	
Biziura lobata	Musk Duck				✓		✓			✓			✓	
Stictonetta naevosa	Freckled Duck												✓	
Cygnus atratus	Black Swan				✓		✓			✓			✓	
**Branta canadensis*	Canada Goose												✓	
Tadorna tadornoides	Australian Shelduck				✓		✓						✓	
Chenonetta jubata	Australian Wood Duck				✓		✓			✓			✓	
Malacorhynchus membranaceus	Pink-eared Duck												✓	
Anas rhynchotis	Australasian Shoveler						✓			✓			✓	
Anas gracilis	Grey Teal				✓		✓			✓			✓	
Anas castanea	Chestnut Teal									✓			✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Anas platyyrhynchos	Mallard									✓			✓	
Anas superciliosa	Pacific Black Duck				✓		✓	✓		✓			✓	
Aythya australis	Hardhead									✓			✓	
Oxyura australis	Blue-billed Duck				✓								✓	
PODICIPEDIDAE														
Tachybaptus novaehollandiae	Australasian Grebe						✓						✓	
Tachybaptus ruficollis	Little Grebe												✓	
Poliocephalus poliocephalus	Hoary-headed Grebe				✓								✓	
Podiceps cristatus	Great Crested Grebe												✓	
COLUMBIDAE														
**Columba livia*	Rock Dove				✓					✓			✓	✓
**Streptopelia senegalensis*	Laughing Dove				✓	✓	✓		✓				✓	✓
**Streptopelia chinensis*	Spotted Dove				✓			✓					✓	
Phaps chalcoptera	Common Bronzewing				✓	✓	✓						✓	
Phaps elegans	Brush Bronzewing												✓	
Ocyphaps lophotes	Crested Pigeon				✓		✓						✓	
Geopelia cuneata	Diamond Dove									✓				
Geopelia striata	Peaceful Dove									✓				
PODARGIDAE														
Podargus strigoides	Tawny Frogmouth				✓								✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
EUROSTOPODIDAE														
Eurostopodus argus	Spotted Nightjar									✓				
AEGOTHELIDAE														
Aegotheles cristatus	Australian Owlet-nightjar									✓				
APODIDAE														
Apus pacificus	Fork-tailed Swift	M	S3							✓	✓	✓	✓	
PHALACROCORACIDAE														
Microcarbo melanoleucos	Little Pied Cormorant				✓		✓						✓	
Phalacrocorax carbo	Great Cormorant				✓		✓						✓	
Phalacrocorax sulcirostris	Little Black Cormorant				✓		✓						✓	
Phalacrocorax varius	Pied Cormorant				✓								✓	
Phalacrocorax fuscescens	Black-faced Cormorant												✓	
PELECANIDAE														
Pelecanus conspicillatus	Australian Pelican				✓		✓						✓	
ARDEIDAE														
Botaurus poiciloptilus	Australasian Bittern	EN	S1	EN						✓	✓	✓		
Ixobrychus dubius	Australian Little Bittern			P4									✓	
Ixobrychus flavicollis	Black Bittern			P3							✓			
Ardea pacifica	White-necked Heron						✓			✓			✓	
Ardea modesta	Eastern Great Egret	M	S3		✓		✓			✓	✓	✓	✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Ardea ibis	Cattle Egret	M	S3							✓	✓	✓	✓	
Egretta novaehollandiae	White-faced Heron				✓		✓	✓	✓	✓			✓	
Egretta garzetta	Little Egret												✓	
Egretta sacra	Eastern Reef Egret	M	S3							✓	✓		✓	
Nycticorax caledonicus	Nankeen Night-Heron												✓	
THRESKIORNITHIDAE														
Plegadis falcinellus	Glossy Ibis	M	S3								✓		✓	
Threskiornis molucca	Australian White Ibis				✓		✓						✓	
Threskiornis spinicollis	Straw-necked Ibis				✓		✓						✓	✓
Platalea regia	Royal Spoonbill												✓	
Platalea flavipes	Yellow-billed Spoonbill						✓						✓	
ACCIPITRIDAE														
Pandion cristatus	Eastern Osprey	M											✓	
Elanus axillaris	Black-shouldered Kite				✓		✓	✓	✓	✓			✓	
Lophoictinia isura	Square-tailed Kite												✓	
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	S3								✓	✓	✓	
Haliastur sphenurus	Whistling Kite				✓								✓	
Accipiter fasciatus	Brown Goshawk				✓		✓	✓		✓			✓	
Accipiter cirrocephalus	Collared Sparrowhawk				✓	✓	✓			✓			✓	
Circus assimilis	Spotted Harrier												✓	
Circus approximans	Swamp Harrier				✓					✓			✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Aquila audax	Wedge-tailed Eagle						✓			✓			✓	
Hieraaetus morphnoides	Little Eagle					✓	✓			✓			✓	
FALCONIDAE														
Falco berigora	Brown Falcon				✓		✓			✓			✓	
Falco longipennis	Australian Hobby									✓			✓	✓
Falco subniger	Black Falcon									✓				
Falco peregrinus	Peregrine Falcon		S4							✓	✓		✓	
RALLIDAE														
Porphyrio porphyrio	Purple Swamphen				✓		✓						✓	✓
Gallirallus philippensis	Buff-banded Rail									✓			✓	
Porzana pusilla	Baillon's Crake												✓	
Porzana fluminea	Australian Spotted Crake				✓								✓	
Porzana tabuensis	Spotless Crake												✓	
Tribonyx ventralis	Black-tailed Native-hen									✓			✓	
Gallinula tenebrosa	Dusky Moorhen				✓		✓			✓			✓	✓
Fulica atra	Eurasian Coot				✓		✓			✓			✓	✓
OTIDIDAE														
Ardeotis australis	Australian Bustard			P4						✓				
BURHINIDAE														
Burhinus grallarius	Bush Stone-curlew			P4						✓				

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
HAEMATOPODIDAE														
Haematopus longirostris	Australian Pied Oystercatcher												✓	
Haematopus fuliginosus	Sooty Oystercatcher												✓	
RECURVIROSTRIDAE														
Himantopus himantopus	Black-winged Stilt				✓		✓						✓	
Recurvirostra novaehollandiae	Red-necked Avocet												✓	
Cladorhynchus leucocephalus	Banded Stilt						✓			✓			✓	
CHARADRIIDAE														
Pluvialis fulva	Pacific Golden Plover	M	S3									✓		
Pluvialis squatarola	Grey Plover	M	S3									✓		
Charadrius dubius	Little Ringed Plover									✓			✓	
Charadrius ruficapillus	Red-capped Plover									✓			✓	
Charadrius bicinctus	Double-banded Plover	M										✓		
Charadrius mongolus	Lesser Sand Plover	M	S1	EN						✓		✓	✓	
Charadrius leschenaultii	Greater Sand Plover	M	S1	VU						✓		✓	✓	
Charadrius veredus	Oriental Plover	M	S3							✓				
Elseyornis melanops	Black-fronted Dotterel				✓		✓	✓		✓			✓	
Thinornis rubricollis	Hooded Plover			P4						✓			✓	
Erythrogonys cinctus	Red-kneed Dotterel									✓			✓	
Vanellus tricolor	Banded Lapwing												✓	
ROSTRATULIDAE														

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Rostratula australis	Australian Painted Snipe	VU, M	S1, S3	VU								✓	✓	
SCOLOPACIDAE														
Limosa limosa	Black-tailed Godwit	M	S3									✓	✓	
Limosa lapponica	Bar-tailed Godwit	M	S1	VU								✓	✓	
Numenius minutus	Little Curlew	M	S3									✓	✓	
Numenius phaeopus	Whimbrel	M	S3									✓	✓	
Xenus cinereus	Terek Sandpiper	M	S3									✓	✓	
Actitis hypoleucos	Common Sandpiper	M	S3							✓	✓	✓	✓	
Tringa brevipes	Grey-tailed Tattler	M	S3									✓	✓	
Tringa nebularia	Common Greenshank	M	S3								✓	✓	✓	
Tringa stagnatilis	Marsh Sandpiper	M	S3									✓	✓	
Tringa glareola	Wood Sandpiper	M	S3								✓	✓	✓	
Arenaria interpres	Ruddy Turnstone	M	S3							✓		✓	✓	
Calidris tenuirostris	Great Knot	M	S1	VU						✓		✓	✓	
Calidris canutus	Red Knot	M	S1	VU						✓		✓		
Calidris alba	Sanderling	M	S3							✓		✓	✓	
Calidris ruficollis	Red-necked Stint	M	S3							✓	✓	✓	✓	
Calidris acuminata	Sharp-tailed Sandpiper	M	S3							✓			✓	
Calidris ferruginea	Curlew Sandpiper	M	S1	VU						✓	✓	✓	✓	
Limicola falcinellus	Broad-billed Sandpiper	M	S3									✓		
Philomachus pugnax	Ruff	M	S3										✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Phalaropus lobatus	Red-necked Phalarope	M	S3										✓	
TURNICIDAE														
Turnix maculosus	Red-backed Button-quail												✓	
Turnix varius	Painted Button-quail				✓									
Turnix velox	Little Button-quail												✓	
LARIDAE														
Anous stolidus	Common Noddy	M	S3							✓			✓	
Anous tenuirostris melanops	Lesser Noddy	VU	S1	VU						✓		✓		
Onychoprion anaethetus	Bridled Tern	M	S3									✓	✓	
Onychoprion fuscata	Sooty Tern												✓	
Sternula nereis nereis	Fairy Tern	VU	S1	VU								✓	✓	
Gelochelidon nilotica	Gull-billed Tern												✓	
Hydroprogne caspia	Caspian Tern	M	S3		✓							✓	✓	
Chlidonias hybrida	Whiskered Tern												✓	
Sterna dougallii	Roseate Tern	M	S3										✓	
Sterna paradisaea	Arctic Tern												✓	
Thalasseus bergii	Crested Tern												✓	
Larus dominicanus	Kelp Gull												✓	
Chroicocephalus novaehollandiae	Silver Gull				✓								✓	
CACATUIDAE														

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Calyptorhynchus banksii	Red-tailed Black-Cockatoo									✓			✓	
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	VU	S1	VU						✓		✓		
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	EN	S1	EN	✓	✓	✓			✓	✓	✓	✓	✓
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	VU	S1	EN						✓	✓	✓	✓	
Eolophus roseicapillus	Galah				✓	✓	✓	✓	✓	✓			✓	✓
Cacatua tenuirostris	Long-billed Corella									✓			✓	
Cacatua pastinator	Western Corella				✓					✓			✓	
Cacatua sanguinea	Little Corella				✓					✓			✓	
Cacatua galerita	Sulphur-crested Cockatoo									✓			✓	
Nymphicus hollandicus	Cockatiel				✓								✓	
Trichoglossus haematodus	Rainbow Lorikeet				✓								✓	✓
Glossopsitta porphyrocephala	Purple-crowned Lorikeet												✓	
Aprosmictus erythropterus	Red-winged Parrot									✓				
Polytelis anthopeplus	Regent Parrot												✓	
Platycercus icterotis	Western Rosella												✓	
Barnardius zonarius	Australian Ringneck				✓	✓	✓	✓	✓				✓	
Purpureicephalus spurius	Red-capped Parrot				✓	✓	✓	✓	✓				✓	
Neophema elegans	Elegant Parrot					✓	✓						✓	
Neophema petrophila	Rock Parrot												✓	
CUCULIDAE														
Chalcites basalis	Horsfield's Bronze-Cuckoo				✓					✓			✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Chalcites lucidus	Shining Bronze-Cuckoo					✓	✓	✓	✓	✓			✓	
Cacomantis pallidus	Pallid Cuckoo				✓		✓			✓			✓	
Cacomantis flabelliformis	Fan-tailed Cuckoo					✓	✓	✓		✓			✓	
STRIGIDAE														
Ninox connivens	Barking Owl												✓	
Ninox novaeseelandiae	Southern Boobook				✓	✓							✓	
TYTONIDAE														
Tyto javanica	Eastern Barn Owl				✓								✓	
HALCYONIDAE														
**Dacelo novaeguineae*	Laughing Kookaburra				✓	✓	✓	✓	✓	✓			✓	✓
Todiramphus sanctus	Sacred Kingfisher				✓	✓	✓	✓					✓	
MEROPIDAE														
Merops ornatus	Rainbow Bee-eater	M	S3		✓	✓	✓	✓			✓	✓	✓	
CORACIIDAE														
Eurystomus orientalis	Dollarbird									✓				
CLIMACTERIDAE														
Climacteris rufa	Rufous Treecreeper									✓			✓	
PTILONORHYNCHIDAE														
Ptilonorhynchus violaceus	Satin Bowerbird												✓	
Ptilonorhynchus muculatus	Spotted Bowerbird												✓	

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
MALURIDAE														
Malurus splendens	Splendid Fairy-wren				✓	✓	✓						✓	✓
Malurus leucopterus	White-winged Fairy-wren				✓								✓	
Malurus lamberti	Variegated Fairy-wren												✓	
Malurus pulcherrimus	Blue-breasted Fairy-wren												✓	
Malurus elegans	Red-winged Fairy-wren												✓	
Stipiturus malachurus	Southern Emu-wren												✓	
ACANTHIZIDAE														
Sericornis frontalis	White-browed Scrubwren				✓	✓							✓	
Calamanthus campestris	Rufous Fieldwren												✓	
Smicrornis brevirostris	Weebill				✓	✓		✓					✓	
Gerygone fusca	Western Gerygone				✓	✓	✓	✓	✓	✓			✓	✓
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				✓	✓	✓	✓	✓	✓	✓		✓	✓
Acanthiza uropygialis	Chestnut-rumped Thornbill									✓	✓			
Acanthiza inornata	Western Thornbill				✓	✓				✓	✓		✓	
Acanthiza apicalis	Inland Thornbill				✓	✓	✓			✓	✓		✓	
PARDALOTIDAE														
Pardalotus punctatus	Spotted Pardalote				✓	✓	✓						✓	
Pardalotus striatus	Striated Pardalote				✓	✓	✓	✓	✓				✓	
MELIPHAGIDAE														

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Acanthorhynchus superciliosus	Western Spinebill				✓	✓	✓			✓	✓		✓	
Lichenostomus virescens	Singing Honeyeater				✓	✓	✓	✓					✓	
Lichenostomus leucotis	White-eared Honeyeater												✓	
Lichenostomus ornatus	Yellow-plumed Honeyeater												✓	
Purnella albifrons	White-fronted Honeyeater												✓	
Manorina flavigula	Yellow-throated Miner				✓								✓	
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				✓					✓	✓		✓	
Anthochaera lunulata	Western Wattlebird				✓		✓		✓	✓			✓	
Anthochaera chrysoptera	Little Wattlebird					✓								
Anthochaera carunculata	Red Wattlebird				✓	✓	✓	✓	✓	✓			✓	✓
Conopophila rufogularis	Rufous-throated Honeyeater									✓				
Epthianura tricolor	Crimson Chat									✓			✓	
Epthianura albifrons	White-fronted Chat						✓			✓			✓	
Glyciphila melanops	Tawny-crowned Honeyeater				✓		✓						✓	
Lichmera indistincta	Brown Honeyeater				✓	✓	✓	✓	✓				✓	✓
Phylidonyris novaehollandiae	New Holland Honeyeater				✓	✓	✓	✓	✓				✓	
Phylidonyris niger	White-cheeked Honeyeater				✓		✓						✓	
Melithreptus lunatus	White-naped Honeyeater												✓	
NEOSITTIDAE														
Daphoenositta chrysoptera	Varied Sittella				✓	✓	✓	✓		✓			✓	✓
CAMPEPHAGIDAE														

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Coracina maxima	Ground Cuckoo-shrike									✓				
Coracina novaehollandiae	Black-faced Cuckoo-shrike				✓	✓	✓	✓	✓	✓			✓	✓
Lalage sueurii	White-winged Triller						✓						✓	
PACHYCEPHALIDAE														
Falcunculus frontatus sp. Leucogaster	Crested Shrike-tit			P4						✓				
Pachycephala pectoralis	Golden Whistler					✓							✓	
Pachycephala rufiventris	Rufous Whistler				✓	✓	✓	✓	✓				✓	
Colluricincla harmonica	Grey Shrike-thrush				✓	✓	✓		✓	✓			✓	
Oreoica gutturalis	Crested Bellbird												✓	
ARTAMIDAE														
Artamus leucorynchus	White-breasted Woodswallow									✓				
Artamus personatus	Masked Woodswallow									✓			✓	
Artamus cinereus	Black-faced Woodswallow				✓		✓	✓	✓	✓			✓	
Artamus cyanopterus	Dusky Woodswallow						✓			✓			✓	
Cracticus torquatus	Grey Butcherbird				✓	✓	✓	✓	✓	✓			✓	✓
Cracticus nigrogularis	Pied Butcherbird									✓			✓	
Cracticus tibicen	Australian Magpie				✓	✓	✓	✓	✓	✓			✓	✓
Strepera versicolor	Grey Currawong												✓	
DICRURIDAE														
Dicrurus bracteatus	Spangled Drongo									✓				

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		EPBC Act	WC Act	DEC										
RHIPIDURIDAE														
Rhipidura albiscapa	Grey Fantail				✓	✓	✓	✓	✓				✓	✓
Rhipidura leucophrys	Willie Wagtail				✓		✓	✓	✓				✓	
CORVIDAE														
Corvus coronoides	Australian Raven				✓	✓	✓	✓	✓	✓			✓	✓
Corvus bennetti	Little Crow									✓			✓	
Corvus orru	Torresian Crow									✓				
MONARCHIDAE														
Myiagra inquieta	Restless Flycatcher												✓	
Grallina cyanoleuca	Magpie-lark				✓		✓	✓	✓				✓	✓
PETROICIDAE														
Microeca fascinans	Jacky Winter												✓	
Petroica boodang	Scarlet Robin				✓	✓			✓				✓	
Petroica goodenovii	Red-capped Robin						✓						✓	
Melanodryas cucullata	Hooded Robin				✓								✓	
Eopsaltria griseogularis	Western Yellow Robin									✓			✓	
Eopsaltria georgiana	White-breasted Robin					✓				✓			✓	
ACROCEPHALIDAE														
Acrocephalus australis	Australian Reed-Warbler						✓			✓			✓	
MEGALURIDAE														

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
Megalurus gramineus	Little Grassbird												✓	
Cincloramphus mathewsi	Rufous Songlark									✓			✓	
Cincloramphus cruralis	Brown Songlark									✓			✓	
TIMALIIDAE														
Zosterops lateralis	Silvereye				✓	✓	✓	✓	✓				✓	✓
HIRUNDINIDAE														
Cheramoeca leucosterna	White-backed Swallow									✓			✓	
Hirundo neoxena	Welcome Swallow				✓	✓	✓	✓	✓				✓	
Petrochelidon ariel	Fairy Martin						✓						✓	
Petrochelidon nigricans	Tree Martin				✓		✓	✓	✓				✓	
NECTARINIIDAE														
Dicaeum hirundinaceum	Mistletoebird				✓		✓	✓		✓			✓	
ESTRILDIDAE														
Stagonopleura oculata	Red-eared Firetail												✓	
Lonchura castaneothorax	Chestnut-breasted Mannikin												✓	
MOTACILLIDAE														
Anthus Australis	Australian Pipit									✓				
Anthus novaeseelandiae	Australasian Pipit				✓		✓	✓					✓	
FRINGILLIDAE														
**Carduelis carduelis*	Goldfinch									✓			✓	

Reptiles

Family and Species	Common name	EPBC Act	WC Act	DEC	*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
CHELUIDAE														
Chelodina oblonga	Oblong Turtle						✓			✓				
Pseudemydura umbrinas	Western Swamp Tortoise	CR	S1	CR								✓		
AGAMIDAE														
Ctenophorus adelaidensis	Western Heath Dragon				✓					✓				
Ctenophorus caudicinctus	Ring-tailed Dragon									✓				
Ctenophorus ornatus	Ornate Crevice Dragon									✓				
Diporiphora valens										✓				
Pogona minor	Dwarf Bearded Dragon				✓	✓	✓				✓			
DIPLODACTYLIDAE														
Crenadactylus ocellatus	Clawless Gecko				✓					✓				
Diplodactylus calcicolus														
Diplodactylus granariensis										✓				
Diplodactylus polyophthalmus										✓				
Diplodactylus pulcher										✓				
Diplodactylus savagei										✓				
Oedura marmorata	Marbled Velvet Gecko				✓									
Strophurus spinigerus					✓									

Family and Species	Common name	EPBC Act	WC Act	DEC	*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
CARPHODACTYLIDAE														
Nephrurus milii	Barking Gecko									✓				
GEKKONIDAE														
Christinus marmoratus	Marbled Gecko				✓					✓				
Gehyra variegata										✓				
PYGOPODIDAE														
Aprasia pulchella										✓				
Aprasia repens					✓	✓				✓				
Delma concinna										✓				
Delma fraseri					✓	✓	✓			✓				
Delma grayii										✓				
Delma pax										✓				
Lialis burtonis					✓	✓								
Pletholax gracilis	Keeled Legless Lizard													
Pygopus lepidopodus	Common Scaly Foot				✓									
SCINCIDAE														
Acritoscincus trilineatus					✓		✓			✓				
Carlia munda										✓				
Cryptoblepharus buchananii										✓				

Family and Species	Common name	EPBC Act	WC Act	DEC	*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
Cryptoblepharus plagiocephalus	Wall Skink/ Snake-eyed Skink				✓	✓	✓	✓	✓	✓				✓
Ctenotus australis	Western limestone ctenotus						✓			✓				
Ctenotus delli	Darling Range Heath Ctenotus			P4						✓				
Ctenotus fallens					✓	✓				✓				
Ctenotus gemmula				P3						✓				
Ctenotus impar							✓			✓				
Ctenotus labillardieri										✓				
Ctenotus saxatilis										✓				
Cyclodomorphus celatus										✓				
Egernia kingii	King's Skink				✓					✓				
Egernia napoleonis					✓	✓				✓				
Hemiergis peronii					✓				✓					
Hemiergis quadrilineata					✓	✓	✓							
Lerista elegans	Elegant Slider				✓	✓	✓	✓						✓
Lerista lineata	Lined Skink			P3	✓									
Lerista macropisthopus					✓									
Lerista praepedita					✓	✓								
Lissolepis luctuosa	Western Swamp Skink									✓				
Menetia greyii	Grey's Dwarf Skink				✓	✓	✓	✓	✓					✓

Family and Species	Common name	EPBC Act	WC Act	DEC	*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
Morethia lineoocellata					✓									
Morethia obscura					✓	✓								
Tiliqua rugosa	Bobtail				✓	✓	✓	✓	✓					
VARANIDAE														
Varanus gouldii	Sand Monitor						✓		✓					
Varanus tristis tristis	Racehorse Monitor				✓	✓	✓							
TYPHLOPIDAE														
Ramphotyphlops australis					✓									
BOIDAE														
Antaresia stimsoni	Stimson's Python									✓				
Morelia spilota imbricata	Western Carpet Python		S4	P4							✓			
ELAPIDAE														
Acanthophis antarcticus	Southern Death Adder			P3						✓				
Brachyurophis fasciolatus										✓				
Brachyurophis semifasciatus										✓				
Demansia psammophis	Yellow-faced Whipsnake									✓				
Echiopsis curta	Bardick				✓					✓				
Elapognathus coronatus	Crowned Snake						✓			✓				
Neelaps bimaculatus	Black-naped Snake				✓									

Family and Species	Common name	EPBC Act	WC Act	DEC	*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
Neelaps calonotos	Black-striped Snake			P3							✓			
Notechis scutatus	Tiger Snake								✓					
Parasuta gouldii					✓				✓					
Pseudonaja affinis	Dugite				✓	✓	✓							
Simoselaps bertholdi	Jan's Banded Snake				✓									

Amphibians

Family and Species	Common name	Conservation Status			*ecologia* internbal database	Fauna Studies in Water Supply Reserve 34537, Adjacent to Neerabup National Park (CALM 1993)	Fauna Survey of the Perth Airport (Tingay & Associates 1994)	Roe Highway Extension (Napier & Associates 1989)	Kwinana Freeway Yangebup Road to Thomas Road Biological Survey (Hart, Simpson & Associates 1989)	NatureMap	DEC Rare Fauna	DSWEPaC Protected Matters Search	Birdata	This Survey
		EPBC Act	WC Act	DEC										
HYLIDAE														
Litoria adelaidensis	Slender Tree Frog						✓							
Litoria coplandi	Rock Frog				✓									
Litoria moorei	Motorbike Frog				✓									
LIMNODYNASTIDAE														
Heleioporus eyrei	Moaning Frog				✓	✓	✓							
Limnodynastes dorsalis	Western Banjo Frog				✓	✓			✓					
MYOBATRACHIDAE														
Crinia georgiana	Quacking Frog									✓				
Crinia glauerti	Clicking Frog						✓			✓				
Crinia insignifera	Squelching Froglet				✓		✓			✓				
Crinia pseudinsignifera	Bleating Froglet									✓				
Geocrinia leai	Ticking Frog									✓				
Myobatrachus gouldii	Turtle Frog				✓									
Pseudophryne guentheri	Crawling Toadlet				✓		✓							

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APPENDIX E FLORA SPECIES LIST RECORDED IN THE PROJECT AREA

Taxon	Family	Status
Acacia cyclops	Fabaceae	
Acacia iteaphylla	Fabaceae	Invasive
Acacia pulchella	Fabaceae	
Acacia saligna	Fabaceae	
Acanthocarpus preissii	Asparagaceae	
Agave americana	Asparagaceae	Invasive
Agonis flexuosa	Myrtaceae	
Aira caryophyllea subsp. caryophyllea	Poaceae	Invasive
Allocasuarina fraseriana	Casuarinaceae	
Allocasuarina humilis	Casuarinaceae	
Amaryllis belladonna	Amaryllidaceae	Invasive
Anethum graveolens	Apiaceae	Invasive
Arctotheca calendula	Asteraceae	Invasive
Avena barbata	Poaceae	Invasive
Avena fatua	Poaceae	Invasive
Banksia attenuata	Proteaceae	
Banksia menziesii	Proteaceae	
Banksia sessilis var. cygnorum	Proteaceae	
Brassica tournefortii	Brassicaceae	Invasive
Briza maxima	Poaceae	Invasive
Bromus diandrus	Poaceae	Invasive
Bromus rubens	Poaceae	Invasive
Callistemon sp.	Myrtaceae	
Carpobrotus edulis	Aizoaceae	
Cenchrus clandestinus	Poaceae	Invasive
Chamelaucium uncinatum	Myrtaceae	
Citrullus lanatus	Cucurbitaceae	
Conostylis aculeata subsp. cygnorum	Haemodoraceae	
Conyza sumatrensis	Asteraceae	Invasive
Corymbia ficifolia	Myrtaceae	
Corynotheca micrantha var. micrantha	Hemerocallidaceae	
Cotula turbinata	Asteraceae	Invasive
Crassula colorata	Crassulaceae	
Cynodon dactylon	Poaceae	Invasive
Daviesia divaricata	Fabaceae	
Daviesia nudiflora	Fabaceae	
Desmocladus flexuosus	Restionaceae	
Dianella revoluta	Hemerocallidaceae	
Dimorphotheca ecklonis	Asteraceae	Invasive
Drosera sp.	Droseraceae	
Echium plantagineum	Boraginaceae	Invasive
Ehrharta calycina	Poaceae	Invasive
Ehrharta longifolia	Poaceae	Invasive
Emex australis	Polygonaceae	Invasive
Eragrostis curvula	Poaceae	Invasive
Eremaea pauciflora	Myrtaceae	

Taxon	Family	Status
Erodium botrys	Geraniaceae	Invasive
Erodium cicutarium	Geraniaceae	Invasive
Eucalyptus cornuta	Myrtaceae	
Eucalyptus gomphocephala	Myrtaceae	
Eucalyptus marginata	Myrtaceae	
Eucalyptus patens	Myrtaceae	
Eucalyptus polyanthemos	Myrtaceae	
Eucalyptus rudis	Myrtaceae	
Eucalyptus scoparia	Myrtaceae	
Eucalyptus sp.	Myrtaceae	
Eucalyptus torquata	Myrtaceae	
Eucalyptus tricarpa	Myrtaceae	
Eucalyptus utilis	Myrtaceae	
Euphorbia sp.	Euphorbiaceae	Invasive
Euphorbia terracina	Euphorbiaceae	Invasive
Freesia alba X leichtlinii	Iridaceae	Invasive
Fumaria capreolata	Papaveraceae	Invasive
Gazania linearis	Asteraceae	Invasive
Gomphocarpus fruticosus	Apocynaceae	Invasive
Grevillea vestita subsp. vestita	Proteaceae	
Haemodorum laxum	Haemodoraceae	
Hakea lissocarpha	Proteaceae	
Hardenbergia comptoniana	Fabaceae	
Hesperantha falcata	Iridaceae	Invasive
Hibbertia hypericoides	Dilleniaceae	
Hibbertia racemosa	Dilleniaceae	
Hybanthus calycinus	Violaceae	
Hypocalymma angustifolium	Myrtaceae	
Hypochaeris glabra	Asteraceae	Invasive
Ipomoea cairica	Convolvulaceae	Invasive
Lachenalia reflexa	Asparagaceae	Invasive
Lagurus ovatus	Poaceae	Invasive
Lantana camara	Verbenaceae	Invasive
Lolium rigidum	Poaceae	Invasive
Lupinus angustifolius	Fabaceae	Invasive
Lupinus cosentinii	Fabaceae	Invasive
Lysimachia arvensis	Primulaceae	Invasive
Macrozamia fraseri	Zamiaceae	
Macrozamia riedlei	Zamiaceae	
Medicago polymorpha	Fabaceae	Invasive
Melaleuca acutifolia	Myrtaceae	
Melaleuca armillaris	Myrtaceae	Invasive
Melaleuca nesophila	Myrtaceae	
Melaleuca sp.	Myrtaceae	
Melia azedarach	Meliaceae	
Melilotus indicus	Fabaceae	Invasive
Mesomelaena pseudostygia	Cyperaceae	

Taxon	Family	Status
Mesomelaena stygia	Cyperaceae	
Monoculus monstrosus	Asteraceae	Invasive
Moraea flaccida	Iridaceae	Invasive
Nerium oleander	Apocynaceae	Invasive
Oenothera drummondii	Onagraceae	Invasive
Oenothera stricta	Onagraceae	Invasive
Olea europaea	Oleaceae	Invasive
Ornithopus pinnatus	Fabaceae	Invasive
Orobanche minor	Orobanchaceae	Invasive
Oxalis pes-caprae	Oxalidaceae	Invasive
Pelargonium capitatum	Geraniaceae	Invasive
Petrophile linearis	Proteaceae	
Petrophile macrostachya	Proteaceae	
Petrorhagia dubia	Caryophyllaceae	Invasive
Philotheca spicata	Rutaceae	
Phleum pratense	Poaceae	Invasive
Pinus pinaster	Pinaceae	Invasive
Plumbago auriculata	Plumbaginaceae	
Podotheca gnaphalioides	Asteraceae	
Polycarpon tetraphyllum	Caryophyllaceae	Invasive
Prunus cerasifera	Rosaceae	Invasive
Ptilotus polystachyus	Amaranthaceae	
Pyrostegia venusta	Bignoniaceae	Invasive
Ricinus communis	Euphorbiaceae	Invasive
Rosmarinus officinalis	Lamiaceae	Invasive
Scaevola canescens	Goodeniaceae	
Schefflera ?elliptica	Araliaceae	
Schinus terebinthifolius	Anacardiaceae	Invasive
Senecio ?condylus	Asteraceae	
Solanum nigrum	Solanaceae	Invasive
Sonchus oleraceus	Asteraceae	Invasive
Sonchus sp.	Asteraceae	Invasive
Stirlingia latifolia	Proteaceae	
Tetragonia decumbens	Aizoaceae	Invasive
Trachyandra divaricata	Asphodelaceae	Invasive
Trifolium angustifolium	Fabaceae	Invasive
Trifolium arvense	Fabaceae	Invasive
Trifolium campestre var. campestre	Fabaceae	Invasive
Trifolium hirtum	Fabaceae	Invasive
Trifolium scabrum	Fabaceae	Invasive
Trifolium tomentosum	Fabaceae	Invasive
Urospermum picroides	Asteraceae	Invasive
Ursinia anthemoides subsp. anthemoides	Asteraceae	Invasive
Vitis vinifera	Vitaceae	Invasive
Vulpia myuros	Poaceae	Invasive
Wahlenbergia capensis	Campanulaceae	Invasive
Wahlenbergia gracilenta	Campanulaceae	
Xanthorrhoea brunonis subsp. brunonis	Xanthorrhoeaceae	

Taxon	Family	Status
Xanthorrhoea preissii	Xanthorrhoeaceae	

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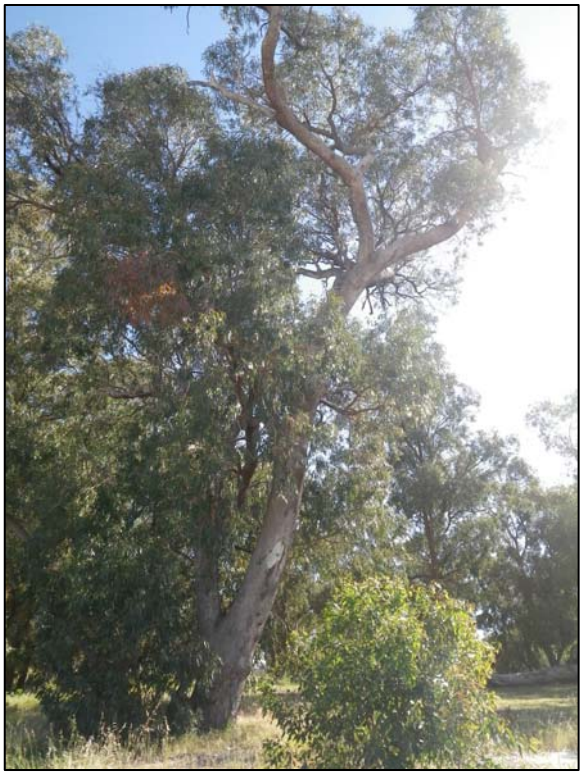
APPENDIX F POTENTIAL NESTING / ROOSTING TREES FOR BLACK COCKATOOS



Tree 1. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: ~1 m

Height: >25 m

Hollows: None

Easting 384105, Northing 6482645

Tree 2. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: >1 m

Height: >30 m

Hollows: Yes, one recorded, bees nesting in hollow

Easting 384413, Northing 6482900

Tree 3. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: >1 m

Height: 20 - 25 m

Hollows: None

Easting 384348, Northing 6483131

Tree 4. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: ~800 mm

Height: >25 m

Hollows: None

Easting 383974, Northing 6482904

Tree 5. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: >1 m

Height: 25 - 30 m

Hollows: None

Easting 384157, Northing 6482809

Tree 6. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: Multi-trunked, largest 500mm

Height: >20 m

Hollows: None

Easting 383921, Northing 6483086

Tree 7. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: ~700 mm

Height: 25 - 30 m

Hollows: None

Easting 383695, Northing 6483299

Tree 8. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: 500 – 600 mm

Height: 25 - 30 m

Hollows: None

Easting 384323, Northing 6483427

Tree 9. Tuart (*Eucalyptus gomphocephala)*.

Diameter at Breast Height: Multi-trunked, largest 800mm

Height: 30 m

Hollows: None

Easting 384291, Northing 6483777

APPENDIX G DAFWA WEED MANAGEMENT CONTROL MEASURES

Paterson's curse

(*Echium plantagineum*)

Family : **Boraginaceae**
Form : **Herbaceous – Annual or biennial**
Status : **Present in WA**

An erect annual (occasionally biennial) herb to 1.5 m high, commonly 30-60 cm, reproducing by seed. Native to southern Europe. Widespread throughout the south-west of Western Australia, and the eastern Goldfields.

Stems : One to several stems arise from base, much branched and covered with stiff white hairs.

Leaves : Alternate, bristly. Rosette leaves to 25 cm long, oval to oblong, stalked and with distinct lateral veins. Stem leaves are smaller and narrower, not stalked and almost clasping the stem.

Flowers : Purple, rarely pink or white, crowded along one side of a curved spike. Five petals joined in a curved trumpet shape, 2-3 cm long. Five stamens, two of which are longer than the others and extend beyond the petals.

Fruit : A group of four nutlets surrounded by a stiffly bristled calyx.

Seeds : Brown to grey, 2-3 mm long, three sided strongly wrinkled and pitted.

Declaration

Category : P1
Location : For the whole of the State

Category : P3
Location : For the municipal districts of Augusta-Margaret River, Broomehill, the City of Bunbury, Busselton, Capel, Chittering, Collie, Cranbrook, Dandaragan, Dalwallinu, Dardanup, Denmark, Donnybrook-Balingup, Harvey, Esperance, Gingin, Kent, Kojonup, Mandurah, Moora, Murray, Ravensthorpe, Serpentine-Jarrahdale, Tambellup, Victoria Plains, Waroona, Wongan – Ballidu, Wagin, West Arthur and Woodanilling.

Category : P4
Location : For the municipal districts of the City of Albany, Boddington, Boyup Brook, Bridgetown-Greenbushes, Gnowangerup, Brookton, Bruce Rock, Corrigin, Cuballing, Dumbleyung, Jerramungup, Katanning, Kondinin, Kulin, Lake Grace, Manjimup, Merredin, Mukinbudin, Nannup, Narembeen, Narrogin, Nungarin, Pingelly, Plantagenet, Wandering, Westonia, Wickepin, Williams, Yilgarn and those portions of the municipal districts of Carnamah and Coorow west of the Midland Road.

Standard Control Codes (these may vary for individual plants)	
P1 REQUIREMENTS Prohibits movement	Introduction of the plant or their seeds into, or movement within the declared area is prohibited.
P3 REQUIREMENTS Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that reduces the extent/distribution and/or density of the declared plant within the infested property. The infested area must be managed to prevent the spread of seeds or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery Treatment must be done prior to seed set each year.
P4 REQUIREMENTS Aims to prevent infestation spreading beyond existing boundaries of infestation.	The infested area must be managed in such a way that contains the declared plant by preventing the spread of seeds or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery to prevent spread beyond existing boundaries on the infested property. Treatment must be done prior to seed set each year.

Control Method

Recommended herbicides	**:**	In cereals • **Chlorsulfuron** • **Metsulfuron methyl** • **Triasulfuron** • **Tigrex** • **Broadstrike** • **Jaguar** • **Bromoxynil + MCPA** In Pasture • Up to 4 leaf stage **Jaguar®** **Tigrex®** **Broadstrike®** **Bromoxynil + MCPA** • At early flowering - seed set control **Chlorsulfuron** **Metsulfuron methyl** **Triasulfuron** **Glyphosate + 2,4-D LV ester**

Herbicide	**:**	**2,4-D amine** (various trade names - APVMA site)
Active ingredient	**:**	a) 500 g/litre 2,4-D amine **(Group I)** b) 625 g/L
Rates of dilution for spot spraying	**:**	Not Recommended
Amount of product per 10 litres water	**:**	Not Recommended
Rate of product per hectare	**:**	• a) 0.75 L for 'Spray Grazing • b) 0.6 L. • a) 1.6 L for rosettes less than 10 leaves. • b) 1.3 L
Time of application	**:**	'Spray Grazing' - Winter - from three weeks after germination.
Remarks	**:**	'Spray-graze' technique for selective control in pastures.
More information and other control methods	**:**	'Spray Grazing' apply low rate (0.75 L) of 2,4-D amine (500 g/L) or MCPA (1L/ha) and heavy graze at 4 - 6 times normal stocking rate from 7 - 10 days after treatment. Best results in small paddocks 10 - 20 ha. Other formulations of 2,4-D amine are available and if using these adjust rates accordingly

Herbicide	**:**	**Chlorsulfuron** (various trade names - APVMA site)
Active ingredient	**:**	750 g/kg chlorsulfuron **(Group B)**
Rates of dilution for spot spraying	**:**	1 g in 50 litres
Amount of product per 10 litres water	**:**	0.2 g
Rate of product per hectare	**:**	15 – 20 g
Wetting agent dilution	**:**	1:400
Time of application	**:**	• In cereals: Wheat pre-sowing. Wheat, barley and oats post-emergence. • In pasture: apply at early flowering to prevent seed formation. The addition of 750 mL - 1 L of 2,4-D amine (500 g/L) will improve the control.
Remarks	**:**	• Ensure chlorsulfuron is thoroughly dissolved when using small quantities prior to adding to tank mix. • May also be used for spot spraying, roadsides etc. Can be used in non-legume pastures. Spot spraying recommendations are based on 20 g/ha. • An application of 1g/L through a blanket wiper can also be effective in pasture where reduced damage to subterranean clover is desired.
More information and other control methods	**:**	Application of 10 – 15 g/ha at flowering prevents seed formation. Addition of 2.4 –D amine at 10 mL/10 L or 1 L/ha will improve control of seed formation.

Herbicide	**:**	**Metsulfuron methyl** (various trade names - APVMA site)
Active ingredient	**:**	600 g/kg metsulfuron-methyl **(Group B)**
Rate of product per hectare	**:**	5 g
Rates of dilution for spot spraying	**:**	0.5 g in 100 L water
Wetting agent dilution	**:**	1:400
Time of application	**:**	In cereals - Pre-sowing in wheat only. Post-emergence in wheat and barley. In pastures - At flowering of Patersons curse for seed control.
Remarks	**:**	More effective on older plants, i.e. August – September.
More information and other control methods	**:**	Addition of 2,4 –D amine @ 1 L/ha of 500 g/L or 0.8 L of 625 g/L will improve control of seed formation.

Herbicide		**Triasulfuron** (various trade names - APVMA site)
Active ingredient		714 g/kg triasulfuron **(Group B)**
Rate of product per hectare		a) 30 g b)15 g
Package size		
Time of application		a) Apply pre-emergence to wheat only. b) At early flowering of Paterson's curse for control of seed formation on plants growing along road sides.
Remarks		For seed set control. Addition of 0.75-1.0 litre 2,4-D amine (500 g/L) or 0.6 – 0.8 L/ha of the 625 g/L 2,4-D amine concentration will give a quicker kill of seeds.
More information and other control methods		• Triasulfuron, metsulfuron or chlorsulfuron @ 1 g/L of water are effective for controlling seed set when used through a 'Blanket wiper' on plants that have run up in pasture. • Resistance has developed to these chemicals so it is important to rotate use. • Results are poorer once green/black seeds of Paterson's curse are present.

Herbicide	**:**	**Glyphosate + 2,4-D LV ester** (various trade names - APVMA site)
Active ingredient	**:**	1) 360 g/litre or 2) 450 g/L glyphosate **(Group M)** + 600 g/litre or 680 g/L 2,4-D LV ester **(Group I)** Other concentrations of glyphosate are available. Adjust rates if using them.
Amount of product per 10 litres water	**:**	1) 5 mL or 2) 4 mL + 5 mL LV ester
Rate of product per hectare	**:**	1) 500 mL 2) or 400 mL + 500 mL of 2,4-D LV ester
Time of application	**:**	At early flowering
Remarks	**:**	Where Paterson's curse is growing in drains or near water courses the herbicide Roundup Biactive® should be used. An APVMA permit is required to apply 2,4-D ester (80%) from 1 September until 1 May. Alternative formulations of 2,4-D are available to substitute the 80% formulation. Rates should be adjusted for the different formulations.
More information and other control methods	**:**	Glyphosate is suitable for spot spraying in non-selective situations. Care should be taken to check for restricted spraying permits when applying 2,4-D ester. This treatment is only suitable in cereal growing areas where there are no commercial vineyards or tomato gardens

Herbicide	**:**	**Jaguar®**
Active ingredient	**:**	250 g/L bromoxynil **(Group C)** + 25 g/L diflufenican **(Group F)**
Rate of product per hectare	**:**	500 - 750 mL/ha
Time of application	**:**	Lower rate for plants with less than 2 leaves, higher rates for plants with up to 4 leaves.
Remarks	**:**	Registered in cereals and pastures, including cover crops in vineyards.
More information and other control methods	**:**	Similar product Barracuda registered @ 600 mL for small Paterson's curse.

Herbicide	**:**	**Tigrex®**
Active ingredient	**:**	250 g/L MCPA **(Group I)** + 25g/L diflufenican **(Group F)**
Rate of product per hectare	**:**	1 L/ha
Time of application	**:**	Up to 4 leaf stage
Remarks	**:**	Clovers should have 3 trifoliate leaves.
More information and other control methods	**:**	Some yellowing of clovers may occur. Check label for tolerance of various clovers.

Herbicide	**:**	**Broadstrike®**
Active ingredient	**:**	800 g/kg flumetsulam **(Group B)**
Rate of product per hectare	**:**	25 g/ha
Wetting agent dilution	**:**	1:400 BS 1000 or Uptake® at 500 mL/100L
Remarks	**:**	Safe on clovers. Appears more effective in the south west. Clovers should have 3 trifoliate leaves. Paterson's curse around metro areas has developed resistance to this herbicide as well as the sulfonyl areas.
More information and other control methods	**:**	Restrictions on grazing or cutting for stockfeed as follows: • medic/clover 3 days, • wheat 8 weeks after treatment • Improved control has been obtained when this product is mixed with terbutryn (Igran) @ 300-500 mL/ha. If using this mixture with Broadstrike, do not use the spraying oil Uptake®. Only use a non ionic wetting agent.

Other relevant information related to this topic:

- Quarantine WA
- Permitted and quarantine species list
- CSIRO biological control
- Paterson's curse (Farmnote 33/2005)
- How to control Paterson's curse (Note 169)
- Off-label permit of a registered agvet chemical product
  (Declared plants: Permit number – per13236)
- Off-label permit (olp) for use of a registered agvet chemical product
  (Environmental weeds: Permit number – per13333)
- For description and distribution http://florabase.dec.wa.gov.au/browse/profile/6681

Common name

(*Lantana camara*)

Family : **Verbenaceae**
Form : **Shrub - Perennial**
Status : **Present in WA**

Lantana is a perennial shrub, usually 1-2m high, but it can reach 4m. It is a Weed of National Significance. In WA, Lantana invades areas along rivers and near wetlands, usually when birds spread the seeds. It has naturalised around Kununurra and at scattered sites from Geraldton to Albany, but is most common around Perth along parts of the Swan and Canning Rivers. It is toxic to livestock.

Stems : Long, often highly branched, square in cross section and hairy when young. The weedy forms usually have small sharp prickles along the angles.

Leaves : The oval leaves can be up to 100mm long and are carried in opposite pairs up the stem. They are rough, due to being covered with small stiff bristles, and give off a strong smell if crushed.

Flowers : The small flowers occur in compact heads with 20-40 flowers in each head. They can be yellow, pink, orange, red, or combinations of these colours.

Seeds : After flowering, lantana produces many small black berries, each 5-7mm in diameter and containing one seed.

Declaration

Category : P1
Location : For the whole of the State.

Standard Control Codes (these may vary for individual plants)	
P1 **REQUIREMENTS** Prohibits movement	Introduction of the plant or their seeds into, or movement within the declared area is prohibited.

Control Method

Recommended herbicides	:	• **Hot Shot ™** • **Triclopyr + picloram** • **2,4-D + picloram** • **Metsulfuron methyl**

Herbicide	**:**	**Hot Shot**
Active ingredient	**:**	Amino pyralid + fluroxypyr **(Group I)**
Amount of product per 10 litres water	**:**	50 mL for seedlings and regrowth 0.5 – 1.2 m 70 mL for regrowth and mature plants 1.2 – 2.0 m
Wetting agent dilution		Addition of a non ionic surfactant may help
Time of application	**:**	While actively growing October to April

Herbicide	**:**	**Picloram + triclopyr** (various trade names - APVMA site)
Active ingredient	**:**	300 g/L triclopyr + 100 g/L picloram **(Group I)**
Amount of product per 10 litres water	**:**	350 mL for plants up to 1 m tall 500 – 750 mL for plants 1 -2 m tall=
Wetting agent dilution		Add 0.5% uptake or Pulse® @ 0.1%
Time of application	**:**	Summer to autumn
Remarks	**:**	Thoroughly wet foliage and soil around plants.

Herbicide	**:**	**2,4-D + picloram** (various trade names - APVMA site)
Active ingredient	**:**	300 g/L 2,4-D amine + 75 g/L picloram **(Group I)**
Amount of product per 10 litres water	**:**	650 mL
Wetting agent dilution		Add 0.5% uptake or Pulse® @ 0.1%
Time of application	**:**	Summer to autumn
Remarks	**:**	Thoroughly wet foliage and soil around plants.

Herbicide	**:**	**Triclopyr** (various trade names - APVMA site)
Active ingredient	**:**	600 g/L triclopyr **(Group I)**
Rates of dilution for spot spraying	**:**	1:60 in distillate
Type of spraying		• Basal bark – Don't treat wet stems. Use low pressure <200 kPa to avoid splashing and drift. Treat stems up to 30 cm from ground level. • Cut stems – Make cut < 15 cm above ground. Immediately apply the mixture • A 755 g/L formulation available

Herbicide	**:**	**Metsulfuron** (various trade names - APVMA site)
Active ingredient	**:**	Metsulfuron methyl 600 g/kg **(Group B)**
Amount of product per 10 litres water	**:**	10 g
Wetting agent dilution		A non ionic such as Bs-1000 at 1 mL/L
Time of application		Bushes up to 2 m
Remarks	**:**	Thoroughly wet foliage. Retreat regrowth as necessary

Other relevant information related to this topic:

- Quarantine WA
- Permitted and quarantine species list
- Weeds of National Significance
- FloraBase information
- Off-label permit of a registered agvet chemical product
  (Declared plants: Permit number – per13236)
- Off-label permit (olp) for use of a registered agvet chemical product
  (Environmental weeds: Permit number – per13333)

One-leaf Cape Tulips

(*Moraea flaccida)*

Family : Iridaceae
Form : Herbaceous - Perennial
Status : Present in WA

One-leaf Cape tulip (*Moraea flaccida,* previously *Homeria flaccida*) is a native of South Africa. Perennial herb to 70 cm high, distinguished by fibrous-sheathed corm at the base of the plant, orange to salmon pink flowers that are yellow in the centre; single leaves and presence of seeds in capsules. Corms 1–4 cm wide, developing new corms each year. Spread by seed and movement of corms. Often found in hay cut from infested paddocks.

Leaves : Leaf folded, ribbed, linear, to 1 m long, extended and drooping above the flowers.

Flowers: Borne on branched stems. Flowers with 6 petal-like perianth segments, each 2.6–4 cm long, not joined to each other; yellow forms have been found occasionally in WA. Flowers in spring when 2 or 3 years old.

Seeds : Angular red brown seeds, about 2 mm long, in narrow-cylindrical capsules 2.5–5 cm long, splitting from the apex into 3 parts.

Originally introduced as a garden plant in the 19th century. Seeds germinate in autumn and plants regrow from corms at the same time. Poisonous to stock but generally avoided by them. Young stock may be affected if there is no alternative grazing available. One-Leaf Cape Tulip is a serious pasture weed in WA, SA and Vic.

Declaration

Category : P1
Location : For the whole of the State.

Category : P3
Location : For the municipal districts of Denmark, Kent and Cranbrook, except that area bordered by Albany Highway, Weir Rd, Boyup-Cranbrook Road, Shamrock & Yeriminup Roads & Frankland-Cranbrook Road..

Category : P4
Location : For the municipal districts of the City of Albany, Augusta-Margaret River, Boddington, Boyup Brook, Bridgetown-Greenbushes, Brookton, Broomehill, the City of Bunbury, Busselton, Capel, Collie, Corrigin, Cuballing, Dardanup, Donnybrook-Balingup, Dumbleyung, Esperance Gnowangerup, Jerramungup, Harvey, Katanning, Kojonup, Mandurah, Manjimup, Murray, Narrogin, Nannup, Pingelly, Plantagenet, Ravensthorpe, Serpentine-Jarrahdale, Tambellup, Wagin, Wandering, West Arthur, Wickepin, Williams, Woodanilling, Waroona and Yilgarn and that area of the Cranbrook Shire bordered by Albany Highway, Weir Rd, Boyup-Cranbrook Road, Shamrock & Yeriminup Roads & Frankland-Cranbrook Road.

Standard Control Codes (these may vary for individual plants)	
P1 REQUIREMENTS Prohibits movement	Introduction of the plant or their seeds into, or movement within the declared area is prohibited.
P3 REQUIREMENTS Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that reduces the extent/distribution and/or density of the declared plant within the infested property. The infested area must be managed to prevent the spread of seeds or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery Treatment must be done prior to seed set each year.
P4 REQUIREMENTS Aims to prevent infestation spreading beyond existing boundaries of infestation.	The infested area must be managed in such a way that contains the declared plant by preventing the spread of seeds or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery to prevent spread beyond existing boundaries on the infested property. Treatment must be done prior to seed set each year.

Control Method

Recommended herbicides	**:**	• (1 leaf) August-September, (2 leaf) July-end August **2,4-D LV ester** (cereals and pasture) **2,4-D amine** (cereals and pasture) **2,4-DB** (cereals and pasture) **Paraquat** (blanket wiper) • Full emergence to early August **2,2-DPA** • Wheat pre-sowing or post-emergence. Barley and oats post-emergence only **Chlorsulfuron** • Wheat - 10 days presowing. Barley post-emergence **Metsulfuron** • At point of corm exhaustion (pasture) **Spinnaker®** (for two leaf only)

Herbicide	**:**	**2,4-D ester** (various trade names - APVMA site)
Active ingredient	**:**	600 or 680 g/litre 2,4-D ester **(Group I)**
Rates of dilution for spot spraying	**:**	1:1500 to 1:1000
Amount of product per 10 litres water	**:**	7 - 10 mL
Rate of product per hectare	**:**	600 g/L formulation • Cereal crops(not oats) 1.3 litre • Pastures 1.8 L – 3.7 L (will damage legumes) 680 g/L formulation • Cereal crops(not oats) 1.15 litre • Pastures 1.7 L – 2.47 L (will damage legumes)
Wetting agent dilution	**:**	1:600
Time of application	**:**	August-September (1 leaf) July-end August (2 leaf)

Remarks	**:**	• Burn paddock in late summer early autumn to increase sprouting of corms cormils. Respraying at lower rates will be necessary for several years to exhaust dormant corms and cormils. Treatment will damage sub-clover. • Not favoured if near crops sensitive to 2,4-D eg. peas, canola, vines and lupins
More information and other control methods	**:**	• Cultivate after a good emergence. Repeat a few weeks later. • Repeat treatment for several years to exhaust dormant corms. Grub individual plants and burn but chemical control is preferable. • Glyphosate or paraquat applied through a blanket wiper is effective on one-leaf. Less satisfactory results are achieved on two-leaf.

Herbicide	**:**	**2,4-D amine** (various trade names - APVMA site)
Active ingredient	**:**	500 g/litre 2,4-D amine **(Group I)**
Rates of dilution for spot spraying	**:**	1:1000 to 1:670
Amount of product per 10 litres water	**:**	10 - 15 mL
Rate of product per hectare	**:**	1 - 1.5 litres
Wetting agent dilution	**:**	1:600
Time of application	**:**	August-September (1 leaf) July-end August (2 leaf)
Remarks	**:**	Burn paddock in late summer early autumn to increase sprouting of cormils and corms. Respraying at lower rates will be necessary for several years to exhaust dormant corms and cormils. Treatment will damage clover.
More information and other control methods	**:**	• Cultivate after a good emergence. Repeat a few weeks later. • Repeat treatment for several years to exhaust dormant corms. • Grub individual plants and burn but chemical control is preferable.

Herbicide	**:**	**2,4-DB** (various trade names - APVMA site)
Active Ingredient	**:**	400 g/litre 2,4-DB **(Group I)**
Rates of dilution for spot spraying	**:**	1:500 to 1:300
Amount of product per 10 litres water	**:**	20 - 30 mL
Rate of product per hectare	**:**	2 - 3 litres
Wetting agent dilution	**:**	1:600
Time of application	**:**	• August-September (1 leaf) • July-end August (2 leaf)
Remarks	**:**	Use where it is important to maintain clover content of pastures
More information and other control methods	**:**	• Cultivate after a good emergence. Repeat a few weeks later. • Repeat treatment for several years to exhaust dormant corms. • Grub individual plants and burn but chemical control is preferable.

Herbicide	**:**	**2,2-DPA**
Active ingredient	**:**	740 g/kg 2,2-DPA **(Group J)**
Rates of dilution for spot spraying	**:**	55 g in 10 litres
Amount of product per 10 litres water	**:**	55 g
Rate of product per hectare	**:**	5.5 kg
Wetting agent dilution	**:**	1:600
Time of application	**:**	Full emergence to early August
Remarks	**:**	This treatment is recommended only for early control. More expensive than 2,4-D. Use in non-arable areas only. Useful for areas that become boggy later in winter. Can also be useful in bushland treatments.
More information and other control methods	**:**	• Cultivate after a good emergence. Repeat a few weeks later. • Repeat treatment for several years to exhaust dormant corms. Grub individual plants and burn but chemical control is preferable. • Applied through a blanket wiper is effective on one-leaf. Less satisfactory results are achieved on two-leaf.

Herbicide	**:**	**Chlorsulfuron** (various trade names - APVMA site)
Active ingredient	**:**	750 g/kg chlorsulfuron **(Group B)**
Rates of dilution for spot spraying	**:**	2 g in 100 litres (**see remarks**)
Amount of product per 10 litres water	**:**	0.2 g
Rate of product per hectare	**:**	15 g
Wetting agent dilution	**:**	1:400
Time of application	**:**	Wheat pre-sowing or post-emergence. Barley and oats post-emergence only. Control can be achieved from early emergence to flowering of the Cape tulip. Less damage occurs to most non-legume components if applied late post-emergence
Remarks	**:**	• Recommended for control of tulip in cereal crops and non legume pastures, particularly if Paterson's curse, soursob or dock are also a problem. Dilution rate for spot spraying is based on 20 g/ha. • Before using chlorsulfuron or other sulfonyl urea herbicides in cereals consider its implications for herbicide resistance strategies.
More information and other control methods	**:**	• Chlorsulfuron and metsulfuron have given promising results when used on pasture through a weed/blanket wiper at rates of 1 g/litre.

Herbicide	**:**	**Metsulfuron** (various trade names - APVMA site)
Active ingredient	**:**	600 g/kg Metsulfuron methyl **(Group B)**
Rates of dilution for spot spraying	**:**	1 g in 100 litres
Amount of product per 10 litres water	**:**	0.1 g
Rate of product per hectare	**:**	5 g
Wetting agent dilution	**:**	1:400 to 1:250
Time of application	**:**	• Wheat: 10 days pre sowing. • Wheat-barley: post-emergence
More information and other control methods	**:**	• Chlorsulfuron and metsulfuron have given promising results when used on pasture through a weed wiper at rates of 1 g/litre.

Herbicide	**:**	**Spinnaker®**
Active ingredient	**:**	700 g/kg imazethapyr **(Group B)**
Rate of product per hectare	**:**	35 - 50 g
Wetting agent dilution	**:**	BS-1000 1:500 or Pulse® at 200 mL/100 L or Hasten 500 mL/ 100 L
Time of application	**:**	At point of corm exhaustion
Remarks	**:**	Use Spinnaker only on two-leaf Cape tulip. Very safe on subterranean clover It may suppress some grasses and erodium.
More information and other control methods	**:**	Chlorsulfuron and metsulfuron have given promising results when used on pasture through a weed wiper at rates of 1 g/litre. A mixture of 20-25 g Spinnaker with 100-150 mL glyphosate in pasture. Re-treatment the following years is essential.

Herbicide	**:**	**Paraquat**
Active ingredient	**:**	250 g/L paraquat **(Group L)**
Rate of product per hectare	**:**	1 - 1.5 L
Wetting agent dilution	**:**	100 mL BS - 1000 per 100 L
Time of application	**:**	• Late August to September or at appearance of first flowers. • For 1 leaf cape tulip only
Remarks	**:**	• Recommended for trained or registered spraying contractor. • Can also be applied using a blanket wiper at 1 L / 10 L of mix
More information and other control methods	**:**	Can be used as a spray in conjunction with spray - topping to prevent grass seed production in pasture.

Other relevant information related to this topic:

- Quarantine WA
- Permitted and quarantine species list
- Cape tulips (Farmnote 100)
- Cape tulip control in pastures
- FloraBase information
- Off-label permit of a registered agvet chemical product
  (Declared plants: Permit number – per13236)
- Off-label permit (olp) for use of a registered agvet chemical product
  (Environmental weeds: Permit number – per13333)