APPENDIX D

Flora, vegetation and fauna assessment – M291 Ioppolo Road, Chittering

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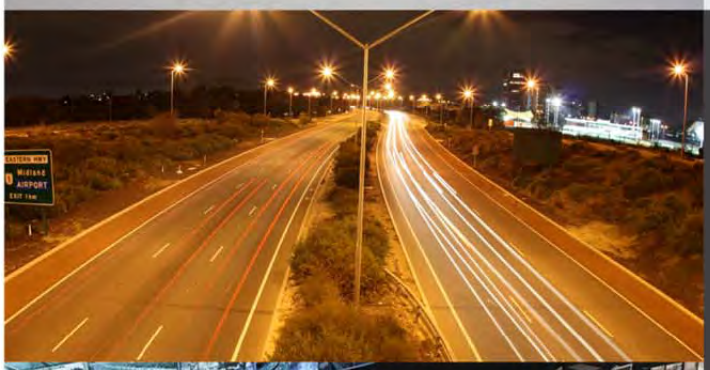
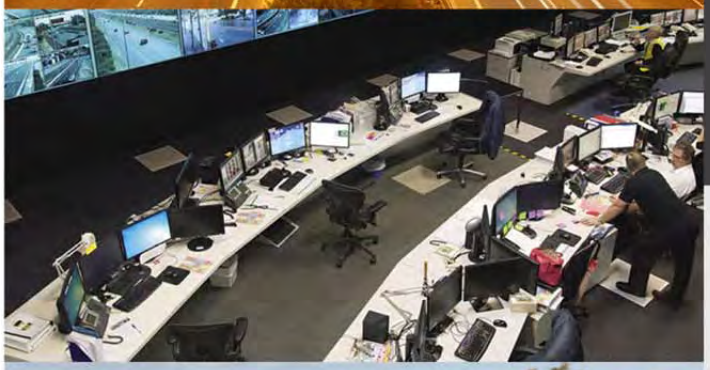
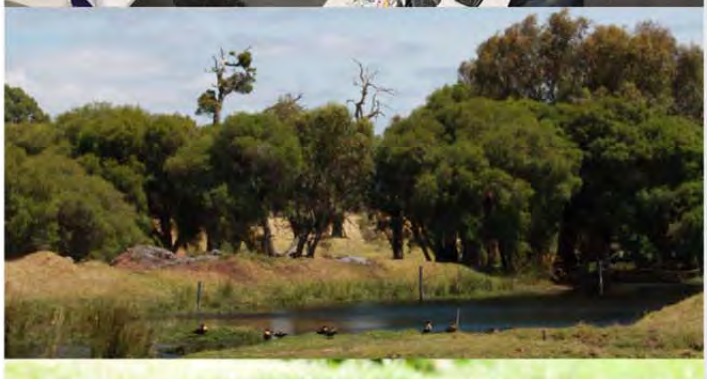
NorthLinkWA

Perth-Darwin National Highway







Flora, Vegetation and Fauna Assessment

Lot M2091 Ioppolo Road, Chittering

DOC NO / NLWA-00-EN-RP-0009

REV / 0

DATE / 15 April 2015

coffey

Australian Government

mainroads WESTERN AUSTRALIA

NorthLinkWA

EXECUTIVE SUMMARY

Main Roads Western Australia (MRWA) commissioned Coffey Environments Australia Pty Ltd (Coffey) to complete a Level 1 flora, vegetation and fauna and Black Cockatoo assessment, at Lot M2019 Ioppolo Road, Chittering (the study area), located approximately 50 kilometres (km) north of Perth in the Swan Coastal Plain bioregion of Western Australia.

The purpose of the study was to undertake an assessment of the ecological values of the study area. The outcome of the assessment will be used to determine the suitability of the land as an offset for values to be impacted by the NorthLink WA project. The study area is 986 hectare (ha) and is adjacent to a C Class Nature Reserve to the west, which is 163 ha.

The survey was conducted over four days 8 to 10 June and 17 June 2014. The key findings of the desktop assessment are:

- Twenty Threatened (Declared Rare-extant) flora listed under the *Wildlife Conservation Act 1950* and the *Environment Protection and Biodiversity Conservation Act 1999* were identified as potentially occurring within close proximity to the study area.
- Thirty four Priority listed flora recognised by the Department of Parks and Wildlife were identified as potentially occurring within close proximity to the study area. Ten taxa are considered Likely to occur; 15 as Possible; and 30 as Unlikely to occur in the study area.
- Seven ecological communities listed as conservation significant, including four Threatened Ecological Communities and three Priority Ecological Communities were identified for the study area.
- 221 fauna species have been previously recorded in the vicinity of the study area; these include 12 amphibians, 47 reptiles, 134 birds and 28 mammals.
- 14 conservation significant fauna species were identified as potentially occurring within close proximity to the study area, of these one species is considered Likely to occur, three as Possible and four species as Unlikely to occur in the study area.

The key findings of the field survey are:

- The vegetation condition of the study area was considered to be Good to Pristine as per Bush Forever (Government of Western Australia, 2000 and Keighery, 1994) vegetation condition scale.
- The areas of vegetation considered to be pristine were generally located within the middle of the study area where introduced taxa and human visitation is low or non-existent.
- Dieback in the study was considered uninfested and presents a low risk of spreading the disease into other areas.
- Dieback risk assessment allocated 87.6 ha as Low risk vegetation, with 12.2 ha as moderate and 19.4 ha as high risk.
- Sixteen vegetation units were described, four are considered to be representative of Priority 2 Ecological Community Banksia Yellow-Orange Sands and two Threatened Ecological Communities.
- A total of 154 vascular taxa were recorded from the study area.
- One Threatened taxa *Chamelaucium* sp. Gingin (N.G. Marchant 6) and One Priority taxa *Hypolaena robusta* (P4) were recorded in the study area.

- Six introduced taxa were recorded from the study area. None of them are considered to be Weeds of National Significance.
- **Zantedeschia aethiopica* is registered as a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* and three species, **Zantedeschia aethiopica, *Lupinus* sp. and **Brassica tournefortii,* have a High rating under the Environmental Weed Strategy for Western Australia.
- Three fauna habitats were recorded in the study area: Banksia Woodland, Eucalypt Woodland and a Dampland.
- The Black Cockatoo Habitat assessed Eucalypt Woodland (315 ha) as high value Black Cockatoo habitat, Banksia Woodland (663 ha) as being moderate and Dampland (3 ha) as low value Black Cockatoo habitat.
- All habitat types contained multiple foraging resources for Black cockatoos which equates to approximately 981 ha of foraging habitat.
- Thirty nine fauna species were recorded during the survey including one species of amphibian, three species of reptile, 32 species of bird and three species of mammal.
- The Western Brush Wallaby (*Macropus irma*) listed as Priority 4 under Department of Parks and Wildlife's Priority listing was the only conservation significant fauna species recorded during the survey.
- Black-eared Cuckoo (*Chrysococcyx osculans*) was recorded during the survey this record is considered to occur just outside of the southerly distribution of this otherwise common species.

The study area is considered to be of high conservation value comprising habitat for a high number of threatened flora and fauna species. The vegetation is representative of a number of Threatened and Priority Ecological Communities, some of these are likely to be impacted by the NorthLink WA Project. The addition of the study area to the conservation estate will substantially increase the estate with the adjacent Class C Reserve and provide protection of an important ecological linkage.

CONTENTS

Tables (in text)

Figures (in text)

Plates (in text)

Figures

Appendices

Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	28/10/2014	Draft to BG&E & Main Roads WA (Coffey – v1)	M. Holliday C. van den Bergh J. Trainer L. Dadour	D. True	D. True
B	28/10/2014	Second draft to BG&E & Main Roads WA (Coffey – v2)	M. Holliday C. van den Bergh J. Trainer L. Dadour	D. True	D. True
C	30/03/2015	Third draft to BG&E & Main Roads WA (Coffey – v3)	M. Holliday C. van den Bergh J. Trainer	D. True	D. True
0	15/04/2015	Final to BG&E & Main Roads WA (Coffey – v4)	C. van den Bergh J. Trainer	D. True	D. True

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ABBREVIATIONS AND UNITS

Term	Definition
°C	decimal degrees
%	percentage
ANZECC	Australian and New Zealand Environment and Conservation Council
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BOM	Bureau of Meteorology
CALM	Conservation and Land Management
CCW	conservation category wetland
Coffey	Coffey Environments Australia Pty Ltd
Cwlth	Commonwealth
DBH	diameter at breast height
DEC	Department of Environment and Conservation
DOTE	Department of the Environment
DOW	Department of Water
DPAW	Department of Parks and Wildlife
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EWSWA	Environmental Weed Strategy for Western Australia
FCT	Floristic Community Type
GPS	global positioning system
ha	hectare
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
km	kilometres
m	metres
mm	millimetres
MNES	Matters of National Environmental Significance
MRWA	Main Roads Western Australia

Term	Definition
MUW	multiple use wetland
NVIS	National Vegetation Information System
PEC	Priority Ecological Community
REW	resource enhancement wetland
SCP	Swan Coastal Plain
TEC	Threatened Ecological Community
UFI	unique feature identifier
WC Act	*Wildlife Conservation Act 1950*
WA	Western Australia
WALGA	Western Australian Local Government Association
WAPC	Western Australian Planning Commission

1 INTRODUCTION

MRWA has purchased an area of land (986 ha) in the Chittering area for the purpose of offsetting impacts of the NorthLink WA Project (including this Perth–Darwin National highway and the Tonkin Grade Separations projects). Both projects have been deemed a 'controlled action' by the Commonwealth Department of the Environment (DOTE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) given their impacts to Matter of National Environmental Significance (MNES), specifically Black Cockatoos. These projects are also being assessed under the *Environmental Protection Act 1986* (EP Act).

To determine the suitability of this land as an offset site for these projects, MRWA commissioned the NorthLink WA Consultancy Services Team to complete an environmental survey of the study area.

1.1 Location and Tenure

The study area is Lot M2091 Ioppolo Road (Certificate of Title 1169-601), Chittering, located approximately 50 kilometres (km) north of Perth within the Swan Coastal Plain bioregion of Western Australia (Figure 1). The study area is approximately 986 ha (Figure 2) in size and is bordered by a C Class Nature Reserve managed by the Department of Parks and Wildlife to the west, private land bordering Ioppolo Road to the north, private land to the southwest, south and east.

The study area is currently zoned "Agriculture Resource" under the Shire of Chittering Town Planning Scheme No. 6. MRWA have purchased the study area for the purpose of conservation management by the Department of Parks and Wildlife. The addition of the study area to the existing C Class Nature Reserve to the west will increase the size of the Nature Reserve from 163 ha to 1146 ha.

1.2 Objective

The objectives of the environmental assessment were to identify the existing environmental values of the study area to determine the suitability of the site as an offset for the project. The environmental assessment included a Level 1 flora and vegetation survey and a Level 1 fauna survey and Black Cockatoo habitat assessment.

The objective of the Level 1 flora and vegetation survey was to:

- Compile an inventory of vascular plants.
- Identify and map the extent of vegetation communities.
- Record the occurrence of introduced plant species.
- Identify and record conservation significant species and ecological communities.
- Locate the presences of wetlands, including rivers, creeks and floodways.

The objective of the Level 1 fauna survey and Black Cockatoo habitat assessment was to:

- Identify the fauna values of the habitats present in the study area.
- Determine the significance of the habitats to support Black Cockatoos.
- Identify conservation significant fauna occurring or likely to occur in the study area.
- Assess the regional and local significance of the study area.

1.3 Scope

The scope of works for the Level 1 flora and vegetation survey included:

- A desktop literature review of databases and previous surveys completed in the vicinity of the study area, including:
  - A search of the Commonwealth's DOTE protected matters search tool for MNES.
  - Department of Parks and Wildlife's (DPAW's) Threatened and Priority flora database.
  - DPAW's Threatened and Priority ecological communities' database.
  - DPAW's combined biological database NatureMap.
  - Environmentally Sensitive Area's listed under the EP Act.
  - Previous flora and vegetation surveys undertaken in close proximity to the study area.
  - A search of DPAW's *Geomorphic Wetlands of the Swan Coastal Plain* dataset.
- A Level 1 flora and vegetation survey, which included:
  - Mapping and description of the plant communities according to a broad floristic formation level and a vegetation association level, using a combination of recent aerial photography and field surveys to ground-truth.
  - Mapping of vegetation condition using the vegetation condition rating scale developed by Keighery (1994) and published in Government of Western Australia (2000).
  - Compiling a list of native and non-native plant species occurring within the study area as recorded from relevé sampling, opportunistic collections and observations.
  - Identifying, locating (GPS point) and mapping any significant plant species or ecological communities recorded on the DPAW Threatened species, Priority species, Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) databases.
  - A targeted search, involving a site walk-over, for conservation-significant species potentially occurring within the study area.

The fauna assessment included:

- A desktop literature review of databases and previous surveys completed in the vicinity, which included:
  - The online DPAW NatureMap database to identify potential vertebrate fauna within the study area based on previous fauna surveys conducted in the region.
  - DPAW's Threatened and priority species database.
  - Commonwealth Government's database of fauna MNES to identify species potentially occurring within the area that are protected under the EPBC Act or international migratory bird agreements.
  - Previous fauna surveys conducted in the area.
- A level 1 fauna survey, to:
  - Identify the major fauna habitats present within the study area.
  - Record opportunistic fauna sightings, including conservation significant fauna.

  - Map the major fauna habitats present surrounding the study area to assess the regional significance of the study area and the importance of ecological linkages.
  - Assess the likely presence of conservation significant fauna.
  - Identify significant features or habitat for conservation significant fauna species.
- A Black Cockatoo habitat assessment, comprising:
  - A site walkover to search for signs of evidence that Black Cockatoo utilise the study area.
  - The determination of the density of Black Cockatoo breeding habitat.
  - The identification of Black Cockatoo feeding habitat.

2 ENVIRONMENTAL LEGISLATION AND POLICY

2.1 Environmental Legislation

The assessment of native vegetation within the study area was undertaken in accordance with the requirements of the following key environmental legislation and regulations:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cwlth).
- *Environmental Protection Act 1986* (EP Act) (WA).
- *Wildlife Conservation Act 1950* (WC Act) (WA).
- *Biosecurity and Agriculture Management Act 2007* (BAM Act) (WA).
- State Planning Policy 2.8 Bushland Policy for the Perth Metropolitan Region.

2.2 Environmental Policies

The EPA has produced a number of policy statements, guidelines and technical guides, which provide guidelines and advice regarding the EPA's position. Position statements, guidelines and technical guides relevant to fauna, flora and vegetation, including:

- Guidance for the Assessment of Environmental Factors No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a).
- Guidance for Assessment of Environmental Factors No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b).
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA/DEC, 2010).
- Guidance for the Assessment of Environmental Factors No. 6 Rehabilitation of Terrestrial Ecosystems (EPA, 2006).
- Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia (EPA, 2000).
- Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002).
- Position Statement No. 7 Principles of Environmental Protection (EPA, 2004c).
- Western Australia Environmental Offset Guidelines (EPA, 2014) and WA Environmental Offsets Policy (EPA, 2011).

3 EXISTING ENVIRONMENT

3.1 Climate

Pearce RAAF Airbase in Bullsbrook is the nearest reliable Bureau of Meteorology (BOM) weather station to the study area approximately 20 km south. The climate of the Chittering region is described typically as Mediterranean with dry summers and wet winters. The average maximum temperature reaches 33.5°C in summer, while in winter the temperature drops to 8.1°C. The region receives an average annual rainfall of 680 mm, with the majority of this falling in the winter months (1937-2014) (BOM, 2014).

The three months prior to the survey commencing (April to June 2014), RAAF Airbase received 234.5 mm, or 7% below the long-term average rainfall of 253.2 mm (1937-2014) for the same period. The 12 months before the survey the rainfall was 683.8 mm (July 2013 to Jun 2014), which is 0.5% above the long term average of 680.0 mm (1939-2014) for the same period (Figure 3).

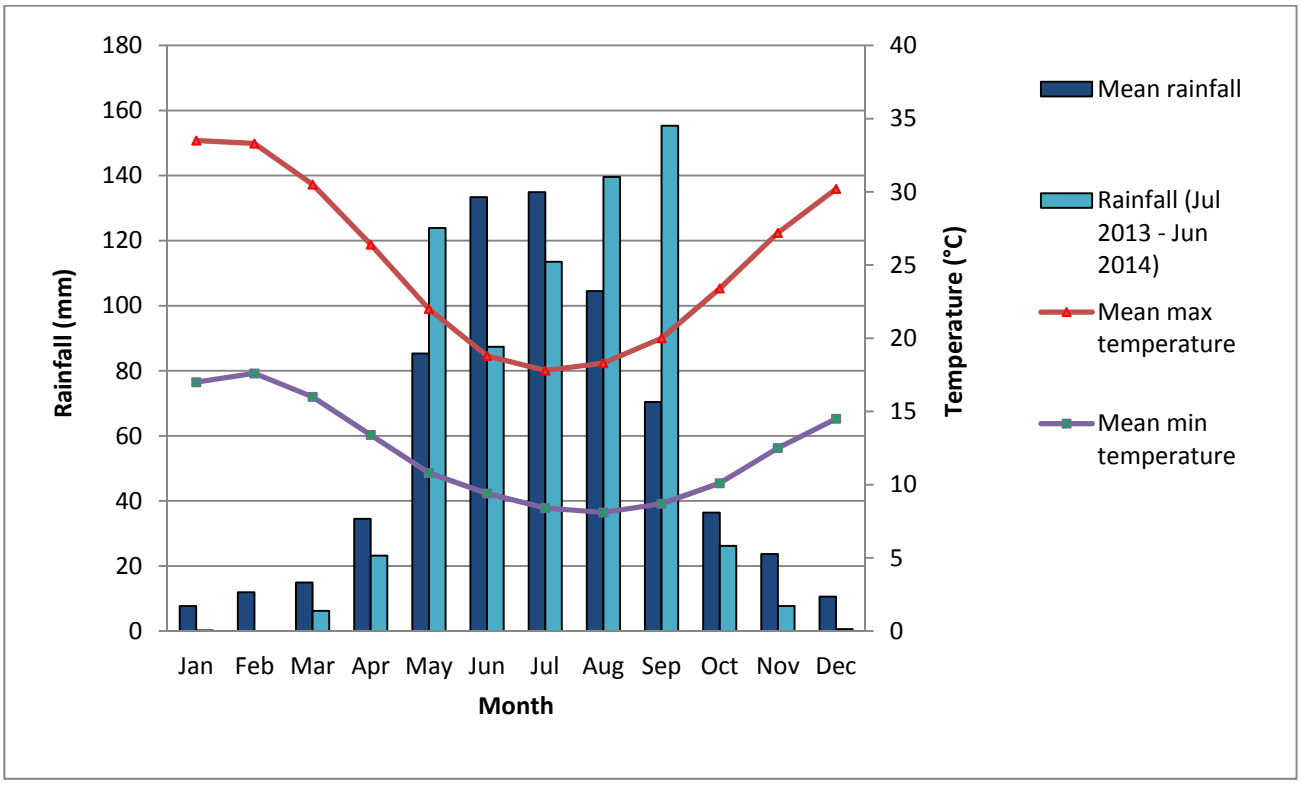


Figure 3 Climate

3.2 Topography and Landforms

The study area is situated on a consolidated sand dune consisting of hill rises, lateritic slopes and plains. A seasonally inundated depression (basin) in the southwest corner of the study area can be associated with Chandala Brook. The soil profile is medium to coarse-grained sand, therefore surface water would infiltrate readily through the porous nature of the soil.

3.3 Geology and Soils

The study area is located on the Swan Coastal Plain bioregion, which in the Perth Region is 34 km wide in the north and 23 km wide in the south and is bounded by the Gingin and Darling Fault Scarps, which rise to over 200 m above sea level (Davidson, 1995). The Swan Coastal Plain consists of a series of distinct landforms (McArthur and Bettenay 1974), roughly parallel to the coast. The distinct landforms, from east to west include the Ridge Hill Shelf, the Pinjarra Plain, the Bassendean Dune system, the Spearwood dune system and the Quindalup dune system (Davidson, 1995).

The study area is located on the Ridge Hill Shelf and the Pinjarra Plain, directly west of the Gingin Scarp and the Dandaragan Plateau. The Ridge Hill Shelf and the Pinjarra Plain are described as:

- Ridge Hill Shelf – comprises the colluvial slopes which form the foothills of the Darling and Dandaragan Plateaus and which represent dissected remnants of a sand covered, wave cut platform.
- Pinjarra Plain – a piedmont and valley-flat alluvial plain consisting predominantly of clayey alluvium that has been transported by rivers and streams from the Darling and Dandaragan Plateaus. The plain is generally about 5 km wide west of the colluvial slopes.

Churchward and McArthur (1978) mapped the soil landforms of the System Six region. According to the mapping by Churchward and McArthur (1978), the study area occurs in association five soil landforms.

- Yanga – Poorly drained plain with grey sandy benches and intervening swamps; also in areas of bog iron ore, marl or solonetzic soils.
- Coonambidgee – Gently sloping fringe to the Dandaragan Plateau; deep grey sands.
- Reagan – Gently sloping scarp dominated by yellow or grey sands; some duricrust and gravels present.
- Mogumber – Gently undulating landscapes; duricrust and gravels on crests and grey sands in broad shallow depressions.
- Moondah – Valleys with deep red and yellow brown sands; occasional swamps.

3.4 Hydrology and Wetlands

According to the Department of Water's (DOWs) Hydrogeological Atlas, there are four aquifers occurring in close proximity to the study area. The four aquifers occur at three levels, with two unconfined aquifers, the Mirrabooka and Surficial, occurring at Level 1 (DOW, 2014). The Leederville-Parmelia confined aquifer occurs at Level 2, while the Perth-Yarragadee North confined aquifer is located at Level 3 and represents the bottom aquifer in relation to the study area (DOW, 2014).

According to drainage and contour mapping viewed on the Shared Land Information Platform, a small drainage line passes through the northwest corner of the study area and an additional drainage line, Chandala Brook, runs in a northeast to southwest direction just outside the southern boundary of the study area. The drainage contour in the northwest of the study area is considered to be minor and is unnamed. It does not have a formal channel, but more a flowline between two small rises.

The surface hydrology of the study area flows into the two drainage contours located in close proximity to the study area before discharging into Chandala Lake and other larger creek systems or floodplains in the vicinity of the study area.

DPAW's Geomorphic Wetlands Swan Coastal Plain dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the Swan Coastal Plain. The

information contained within this dataset was originally digitised from the Wetlands of the Swan Coastal Plain Volume 2B Wetland mapping, Classification and Evaluation: Wetland Atlas, which was captured at a scale of 1:25, 000 (Hill et al., 1996).

Wetlands on the Swan Coastal Plain have been classified using a geomorphic wetland classification system based on the characteristics of landform and water permanence. Table 1 below details the geomorphic classification of wetlands the DPAW (2014a) have adopted for the Swan Coastal Plain, which have been identified by Semeniuk and Semeniuk (1995).

Table 1 Geomorphic wetland classification types

Hydroperiod	Landform				
	Basin	Channel	Flat	Slope	Highland
Permanent inundation	Lake	River	-	-	-
Seasonal inundation	Sumpland	Creek	Floodplain	-	-
Intermittent inundation	Playa	Wadi	Barlkarra	-	-
Seasonal waterlogging	Dampland	Trough	Palusplain	Paluslope	Palusmont

DPAW has assigned wetland management categories based on their ecological, hydrological and geomorphological significance, and took into account the degree of disturbance that had occurred. The three Wetland Management Categories on the Swan Coastal Plain can be summarised as follows:

1. Conservation Category (CCW) – wetlands that support a high level of ecological attributes and functions (generally having intact vegetation and natural hydrological processes), or that have a reasonable level of functionality and are representative of wetland types that are rare or poorly protected.
2. Resource Enhancement (REW) – wetlands that have been modified (degraded) but still support substantial ecological attributes (wetland dependant vegetation covering more than 10%) and functions (hydrological properties that support wetland dependent vegetation and associated fauna), and have some potential to be restored to the Conservation management category. Typically, such wetlands still support some elements of the original native vegetation, and hydrological function.
3. Multiple Use (MUW) – wetlands that are assessed as possessing few remaining ecological attributes and functions. While such wetlands can still play an important role in regional or landscape ecosystem management, including water management, they are considered to have low intrinsic ecological value. Typically, they have very little or no native vegetation remaining (less than 10%).

According to DPAW's *Geomorphic Wetlands Swan Coastal Plain Dataset*, one MUW (UFI 15732; Palusplain) occurs in the extreme southwest of the study area. An additional four CCWs occur in close proximity to the study area. The four CCWs occur approximately 500 m to 1,200 m to the west of the southwest corner and are associated with Chandala Lake within Chandala Nature Reserve.

3.5 Biological Context of Study Area

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 89 bioregions based on major biological and geographical attributes. The bioregions have been further divided into 419 subregions. The study area is located in the Swan Coastal Plain (SCP) bioregion, subregion Dandaragan Plateau (SWA01) and a small portion in the southwest of the study area in the Perth subregion (SWA02).

The Dandaragan Plateau (SWA1) subregion consists of cretaceous marine sediments with sand and lateritic mantle. It is boarded by the Derby and Dandaragan Faults. The vegetation includes scrub-heaths on laterite pavement and gravelly sandplains, Jarrah and Marri woodlands and *Banksia* low woodlands. Dominant land use is mainly dry-land agriculture and areas of conservation.

The Perth (SWA2) subregion is a low lying coastal plain which consists of colluvial and Aeolian sands, alluvial river flats and coastal limestone. In the east it rises to duricrusted Mesozoic sediments while to the south there are widespread outwash plains. A complex series of seasonal wetlands and swamps extend north to south. The vegetation includes heath and/or Tuart woodlands on limestone, Banksia and Jarrah- *Banksia* woodlands on Quaternary marine dunes of various ages, Marri on colluvial and alluvial soils *Casuarina obesa* on out wash plains and paperbark (*Melaleuca* sp.) in wetland areas (Mitchell et al., 2002.)

3.6 Regional Vegetation

Heddle et al. (1980) have described and mapped vegetation complexes of the Darling System at a board floristic scale of 1:250,000 (as recognised by Diels, 1906; and Gardner, 1942). The vegetation complex mapping is based on data collected from the literature, ground surveys, road traverses and aerial photographs and is related to the landforms, soils and climatic conditions.

Based on the mapping undertaken by Heddle et al. (1980) the study area is considered to be representative of five vegetation complexes (Figure 4). The five vegetation complexes have been described as:

- Coonambidgee complex: consists of vegetation ranging from a low open forest and low woodland of Pricklybark (*Eucalyptus todtiana*) and Banksia species (*Banksia attenuata, Banksia menziesii* and *Banksia ilicifolia*) with local admixtures of *Banksia prionotes*, to open woodland of Marri (*Corymbia calophylla*) and Banksias (*Banksia* spp.). The Coonambidgee complex is located on the fluviatile deposits of the Swan Coastal Plain.
- Karamal complex-south: is dominated by an open forest of Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) with a definite second storey of *Banksia grandis* on the gravelly soils and *Banksia attenuata* and *Banksia menziesii* on the sandier soils. The Karamal complex-south is located on the lateritic uplands of the Dandaragan Plateau.
- Mogumber complex-south: dominated by an open woodland of Marri (*Corymbia calophylla*) with a well-defined second storey of Pricklybark (*Eucalyptus todtiana*) and Banksia species (*Banksia attenuata, Banksia menziesii* and *Banksia ilicifolia*). The Mogumber complex-south is located on the lateritic uplands of the Dandaragan Plateau.
- Moondah complex: supports predominantly a low closed to low open forest of *Banksia attenuata, Banksia menziesii, Banksia prionotes* and *Eucalyptus todtiana* on the slopes and an open woodland of Marri (*Corymbia calophylla*) and Banksia (*Banksia* spp.) in the valleys. The Moondah complex is located in the valleys of the Dandaragan Plateau.
- Reagan complex: supports vegetation ranging from low open woodland of *Banksia attenuata, Banksia menziesii* and *Eucalyptus todtiana* to closed heath, depending on the depth of soil. The Reagan complex is located on the scarps of the Dandaragan Plateau.

The extent of each vegetation complex located within the study area is presented in Table 2 below.

Table 2 Vegetation complex extent

Land unit	Extent within the study area (ha)	Extent within the study area (%)
Coonambidgee complex	8.7	0.9
Karamal complex-south	181.3	18.4
Mogumber complex-south	424.9	43.1
Moondah complex	105.2	10.7
Reagan complex	266.3	27.0

4 METHODS

4.1 Flora and Vegetation

4.1.1 Desktop Assessment

In accordance with the EPA's Guidance Statement No. 51 for a Level 1 flora and vegetation survey, a desktop assessment was undertaken prior to the field survey component of the assessment. The desktop assessment involved a review of existing environmental or biological data available for the study area and lands adjacent to the study area. The desktop assessment involved the review of State and Federal databases, regional and local contextual data for the northern Swan Coastal Plain and existing biological surveys undertaken on the Swan Coastal Plain. The results of the desktop assessment are detailed in Section 5.

4.1.1.1 Databases

A request for searches of DPAW's threatened flora and ecological community's database was submitted on 30 May 2014 for a central coordinate (-31.487441°S; 115.985779°E) within the study area with a 5 km buffer for Threatened and Priority listed flora and a 10 km buffer for Threatened and Priority listed ecological communities (Appendix A). The search was undertaken for:

- The Department's Threatened (Declared Rare) and Priority Flora database.
- The Western Australian Herbarium Specimen database for Priority species opportunistically collected in the area of interest.
- The Department's Threatened and Priority Flora List, which contains species that are declared rare (Conservation Code T or X for those presumed to be extinct), poorly known (Conservation Codes 1, 2 or 3), or require monitoring (Conservation Code 4).
- The Department's Threatened and Priority Ecological Communities database.

A search of DOTE (2014a) online publicly available database for MNES was undertaken for the study area. A central point (-31.48843S; 115.98843E) with a 10 km buffer was undertaken for the study area (Appendix B).

4.1.1.2 Regional Perspective

A review of regional and local contextual data, with reference to flora and vegetation, was completed prior to the field survey component of the assessment. The review was undertaken to identify the flora and plant communities considered to be significant from a regional and local context. The review also concentrated on broad scale mapping of plant communities and floristic units. The documents that have been reviewed include:

- Vegetation complexes of the Darling System Western Australia (Heddle et al., 1980).
- Floristic Survey of the Southern Swan Coastal Plain (Gibson et al., 1994).
- The Bush Forever Strategy: Volume 1 (Government of Western Australia, 2000a) and Volume 2 (Government of Western Australia, 2000).
- Plant Life of Western Australia (Beard, 1990).

- Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region (WALGA, 2004).
- The Darling System – System 6, Part I: General Principles and Recommendations (DCE, 1983).
- Native Vegetation in Western Australia: Technical Report 249 (Shepherd et al., 2002).

4.1.1.3 Existing Biological Surveys

Several biological surveys have been undertaken within the study area and in close proximity to the study area. These reports were reviewed to identify the known plant communities occurring within and adjacent to the study area. The review also identified the condition of the vegetation and the location of known conservation significant flora and ecological communities occurring within and adjacent to the study area. The existing biological surveys reviewed, included:

- Perth–Darwin National Highway – Tonkin Highway Link Alignment Definition Study: Environmental Impact Assessment and Biological Survey (GHD, 2013a).
- Swan Valley Bypass, Perth–Darwin National Highway: Level 2 Flora and Vegetation Survey (360 Environmental, 2014).
- A flora and vegetation survey of Lots 46 and 47 Maralla Road and Lexia Avenue, Ellenbrook (M.E. Trudgen & Associates, 1999).
- East Landsdale Flora and Fauna Assessment – Lots 50 and 51 (Ecoscape, 2009a).
- East Landsdale Flora and Fauna Assessment – Lot 154 (Ecoscape, 2009b).
- Level 2 Flora and Vegetation Survey, North Ellenbrook (360 Environmental, 2012).
- Level 1 flora and fauna assessment of Gaston Road, Muchea (GHD, 2009).
- Flora and fauna assessment, Mitchell Freeway Extension (Burns Beach Road to Romeo Road) (GHD, 2013b).
- Level 2 flora and vegetation survey of Lot 5 Mornington Drive, Mariginuiup (Monocot-Dicot Botanical Research, 2010).
- Flora and vegetation assessment, M70/138 Hopkins Road, Nowergup (Coffey Environments, 2010).

4.1.2 Field Survey

A Level 1 flora and vegetation survey, consistent with the EPA's Guidance for the Assessment of Environmental Factors No. 51 (EPA, 2004a), was conducted of the study area. The survey was completed from 8 to 10 June and 17 June 2014.

The field survey component of the assessment was led by Mr Clinton van den Bergh, assisted by Ms Lucy Dadour and Ms Michelle Holliday. Clinton has over 8 years' experience conducting flora and vegetation surveys in Western Australia with relevant experience on the Swan Coastal Plain.

The survey was conducted under a Licence to take flora for scientific or other prescribed purposes (licence number SL010743) and a Permit to take Declared Rare Flora (permit number 73–1314) from DPAW. All flora specimens were collected during the survey under these licences and permits, in accordance with the conditions required under each licence/permit.

4.1.2.1 Flora and Vegetation Assessment

A total of 30 relevés were sampled within the study area. Relevés are unmarked quadrats where a central point is marked with a Global Positioning System (GPS) and an approximate radius is sampled around this

point for the purpose of recording vegetation structure, species composition, dominance and compiling a species inventory. For the purpose of this assessment a radius of approximately 20 m was sampled. Flora sampling quadrats on the Swan Coastal Plain are 100 m^2 in size, therefore the size of the relevé was sufficient to sample the flora and vegetation within the study area.

Information recorded at each relevé included landform features, soil colour and texture, leaf litter cover, rock size and type, vegetation structure, vegetation condition and fire age. Structural information on the dominant species (species with a cover higher than 1%) including height and percentage cover were recorded for each relevé.

Common species that were well known to the survey botanists were identified in the field, while remaining species unknown to the survey botanist were collected during the field survey and assigned a unique number to facilitate tracking. The specimens were pressed during that day, following recommendations provided by the Western Australia Herbarium. The specimens were then sufficiently dried prior to submitting to a consultant taxonomist, Mr Malcolm Trudgen, for identification.

The broad floristic formations and vegetation associations were described based on the floristic data recorded from the relevés and from visual observations while traversing the study area, utilising the standardised terminology for vegetation structural classes detailed in the Australian Vegetation Attribute Manual (ESCAVI, 2003). The vegetation structural terminology of the National Vegetation Information System (NVIS) was adapted from Specht (1970), Specht et al. (1974), and Walker and Hopkins (1990) (ESCAVI, 2003).

The vegetation recorded from the study area has been described to a NVIS hierarchical level III (Broad Floristic Formation) and V (Vegetation Association). Hierarchical level III requires the dominant growth form, cover, height and dominant land cover genus for the upper most or the ecologically or structurally dominant stratum. Hierarchical level V requires the dominant growth form, cover, height and dominant species (three for each stratum) for each of the three traditional strata (i.e. upper, mid and ground). The hierarchical structure and the vegetation structural terminology are described in Table 3 and Table 4, while the NVIS height class definition is provided in Table 5.

Table 3 NVIS hierarchical structure

Hierarchical level	Description	NVIS structural/floristic component required
I	Class	Dominant growth form for the ecologically or structurally dominant stratum.
II	Structural Formation	Dominant growth form, cover and height for the ecologically or structurally dominant stratum.
III	Broad Floristic Formation	Dominant growth form, cover, height and dominant land cover genus for the upper most or the ecologically or structurally dominant stratum.
IV	Sub-formation	Dominant growth form, cover, height and dominant genus for each of the three traditional strata (i.e. Upper, Mid and Ground).
V	Association	Dominant growth form, height, cover and species (3 species) for each of the three traditional strata (i.e. Upper, Mid, Ground).
VI	Sub-Association	Dominant growth form, height, cover and species (5 species) for all layers/sub-strata.

Source: Table 1 from ESCAVI (2003).

Table 4 NVIS structural terminology

Stratum	Growth form	Height ranges (m)[1]	Structural formation classes (% cover)					
			80–100	50–80	20–50	0.25–20	0–0.25	Unknown
U	Tree, palm	<10 = low 10-30 = mid >30 = tall	Closed forest	Open forest	Woodland	Sparse woodland	Isolated trees	Isolated clumps of trees
	Tree mallee	<3 = low <10 = mid 10-30 = tall	Closed mallee forest	Open mallee forest	Mallee woodland	Sparse mallee woodland	Isolated mallee trees	Isolated clumps of tree mallees
M	Shrub, cycad, tree-fern	<1 = low 1-2 = mid >2 = tall	Closed shrubland	Shrubland	Open shrubland	Sparse shrubland	Isolated shrubs	Isolated clumps of shrubs
	Mallee shrub	<3 = low <10 = mid 10-30 = tall	Closed mallee shrubland	Mallee shrubland	Open mallee shrubland	Sparse mallee shrubland	Isolated mallee shrubs	Isolated clumps of mallee shrubs
	Heath shrub	<1 = low 1-2 = mid >2 = tall	Closed heath shrubland	Heath shrubland	Open heath shrubland	Sparse heath shrubland	Isolated heath shrubs	Isolated clumps of heath shrubs
	Chenopod shrub	<1 = low 1-2 = mid >2 = tall	Closed chenopod shrubland	Chenopod shrubland	Open chenopod shrubland	Sparse chenopod shrubland	Isolated chenopod shrubs	Isolated clumps of chenopod shrubs
	Samphire shrub	<0.5 = low >0.5 = mid	Closed samphire shrubland	Samphire shrubland	Open samphire shrubland	Sparse samphire shrubland	Isolated samphire shrubs	Isolated clumps of samphire shrubs
G	Hummock grass	<2 = low >2 = mid	Closed hummock grassland	Hummock grassland	Open hummock grassland	Sparse hummock grassland	Isolated hummock grasses	Isolated clumps of hummock grasses
	Tussock grass	<0.5 = low >0.5 = mid	Closed tussock grassland	Tussock grassland	Open tussock grassland	Sparse tussock grassland	Isolated tussock grasses	Isolated clumps of tussock grasses
	Other grass	<0.5 = low >0.5 = mid	Closed grassland	Grassland	Open grassland	Sparse grassland	Isolated grasses	Isolated clumps of grasses
	Sedge	<0.5 = low >0.5 = mid	Closed sedgeland	Sedgeland	Open sedgeland	Sparse sedgeland	Isolated sedges	Isolated clumps of sedges

Stratum	Growth form	Height ranges (m)[1]	Structural formation classes (% cover)					
			80–100	50–80	20–50	0.25–20	0–0.25	Unknown
	Rush	<0.5 = low >0.5 = mid	Closed rushland	Rushland	Open rushland	Sparse rushland	Isolated rushes	Isolated clumps of rushes
	Vine	<10 = low 10-30 = mid >30 = tall	Closed vineland	Vineland	Open vineland	Sparse vineland	Isolated vines	Isolated clumps of vines
	Herbs	<0.5 = low >0.5 = mid	Closed herbland	Herbland	Open herbland	Sparse herbland	Isolated herbs	Isolated clumps of herbs

Source: ESCAVI (2003). Note growth forms that do not occur or were not sampled within the study area were omitted (i.e. seagrass bed).
1. Refer to Table 5 for height range information.

Table 5 NVIS height class definition

Height class	Height range (m)	Growth forms			
		Tree, palm, vine	Shrub, heath shrub, chenopod, samphire shrub, tree-fern	Tree mallee, mallee shrub	Hummock grass, tussock grass, other grass, sedge, rush, herb
8	>30	Tall			
7	10-30	Mid		Tall	
6	<10	Low		Mid	
5	<3			Low	
4	>2		Tall		Tall
3	1-2		Mid		Tall
2	0.5-1		Low		Mid
1	<0.5		Low		Low

Source: ESCAVI (2003).

The condition of the vegetation recorded within the study area was described based on the condition rating scale developed by Keighery (1994) and published in the Bush Forever Strategy (Government of Western Australia, 2000b) (Table 6).

Table 6 Vegetation condition rating scale

Condition code	Definition
P Pristine	Pristine or nearly so, no obvious signs of disturbance.
Ex Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are nonaggressive species.
VG Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
G Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Deg Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
CD Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often referred to as parkland cleared with the flora composing weed or crop species with isolated native trees or shrubs.

Source: Bush Forever (Government of Western Australia, 2000), originally developed by Keighery (1994).

4.1.2.2 Targeted Searches

Sections of the study area were traversed on foot, with known locations of conservation significant flora or habitat likely to support conservation significant flora targeted during the searches. For populations of potential or known significant flora, a specimen, GPS location, photo, estimated population size and description of vegetation was documented. Further opportunistic collections of taxa not recorded in the relevés and introduced flora were also recorded. The focus of the targeted introduced flora surveys were:

- Weeds of National Significance listed under the EPBC Act.
- Declared Pests under Section 22 of the BAM Act.
- Environmental weed species with a “High” rating as listed by DPAW.

4.1.3 Limitations of Survey

The field survey component of the assessment was not undertaken at the most appropriate time for conducting flora and vegetation surveys on the Swan Coastal Plain. The survey was undertaken in winter, while the optimal time is spring. However, this is not considered to be a major limiting factor, as only a Level 1 flora and vegetation survey was required to identify the dominant vegetation structures.

No numerical analysis of the floristic data collected from the field survey was undertaken. Fungi and non-vascular flora (e.g. bryophytes, mosses etc.) were not collected or recorded during the field survey. The collection of fungi and non-vascular flora was outside the scope of this survey.

Table 7 below details the botanical survey limitations associated with the flora and vegetation assessment of the Study area.

Table 7 Botanical survey limitations

Limitation	Constraint and significance*	Comments
Competency/experience of the scientist conducting the survey	No	The survey and reporting was executed by Senior Botanist Clinton Van Den Bergh and Environmental Ecologist Lucy Dadour. A specialist consultant taxonomist, Malcolm Trudgen, undertook the specimen identifications.
Level of survey	No	A single phase Level 1 flora and vegetation survey was completed in accordance with the EPA's Guidance Statement 51 (EPA, 2004a).
Sources of information	No	The Swan Coastal Plain has been comprehensively surveyed in the past as a result of urban development. The sources of information were reviewed prior to, during and after the survey.
Scope	No	The entire scope was met.
Proportion of: a) Flora collected and identified. b) Task achieved and further work that may be required.	a) Yes; low b) No	a) It is estimated that between 70 and 80% of the potential flora occurring in the study area has been recorded. b) All tasks were achieved.
Completeness	No	The study area was adequately sampled and traversed.
Mapping reliability	No	The study area was traversed on foot and was easily accessible. The upper stratums of the plant communities were fairly homogenous over the entire study area. As a result the mapping reliability from a broad floristic formation is considered to be high. The mapping reliability at the vegetation association level is considered to be moderate to high.
Timing/weather/season/cycle	Yes	The survey was undertaken in winter so does not constitute a comprehensive inventory of annual and ephemeral species.
Disturbances which affected the results of the survey	No	The study area was considered to be in excellent condition with very minor disturbances. In some sections, the Banksia species were dying as a result of the drought or poor rainfall in the years preceding the survey.
Intensity of the survey	No	The survey was undertaken at an intensity which is in accordance with the EPA guidance (EPA, 2004a).
Completeness	No	The study area was adequately traversed on foot or via vehicle.
Resources	No	Adequate resources were assigned to the field surveys, specimen identifications and reporting components of the assessment.
Remoteness and/or access problems	No	Several unmade roads and informal tracks were located across the study area. These were accessed during the field survey component of the assessment.
Availability of contextual information	No	The greater Swan Coastal Plain region has been extensively surveyed, therefore a large amount of contextual information is available for the study area.

* Indicates whether the limitation is a constraint (yes/no) and, if yes, the significance of the constraint (low/moderate/high).

4.2 Fauna

4.2.1 Desktop Assessment

In accordance with the EPA's Guidance Statement No. 56 for a Level 1 fauna survey, a desktop assessment was undertaken prior to the field survey component of the assessment. The desktop assessment involved a review of existing environmental or biological data available for the study area and lands adjacent to the study area. The desktop assessment involved the review of State and Federal databases, regional and local contextual data for the northern Swan Coastal Plain and existing biological surveys undertaken on the Swan Coastal Plain. The results of the desktop assessment are detailed in Section 5.

4.2.1.1 State and Federal Government Databases

State and federal database searches were undertaken using:

- DPAW NatureMap online database (DPAW, 2014a). The search area was a 15 km circle around the coordinates 31°29'12"S 115°59'05"E.
- DPAW list of Threatened and Priority fauna (DPAW, 2014b). The search area was a 15 km circle around the coordinates 31°29'12"S 115°59'05"E.
- The Protected Matters Search Tool maintained by the DOTE bounded by a 10 km buffer area for the coordinates -31.486074°S, 115.989609°E (DOTE, 2014a).

4.2.1.2 Regional and Local Contextual Data

A review of regional and local contextual data, with reference to fauna, was completed prior to the field survey component of the assessment. The documents that have been reviewed include:

- Birds Australia Birdata (Birdata, 2014). The search area was a one degree square containing the point -31.41522 °S, 115.9935 °E.
- General texts to provide supplementary information including Tyler and Doughty (2009) for frogs; Storr et al., (1983, 1990, 1999, 2002), Bush et al. (2010), Bush et al. (2007) and Wilson and Swan (2010) for reptiles; Johnstone and Storr (1998; 2004), Simpson and Day (2010) and Johnstone and Storr (1998; 2004) for birds; and Menkhorst and Knight (2011) and van Dyck and Strahan (2008) for mammals; Churchill (2008) for bats.

4.2.1.3 Existing Biological Surveys

Several biological surveys have been undertaken within the study area and in close proximity to the study area. These reports were reviewed to identify the fauna assemblages occurring within and adjacent to the study area. The review also identified the location of known conservation significant fauna occurring within and adjacent to the study area. The existing biological surveys reviewed, included:

- Egerton Fauna Survey (Tingay and Associates, 1994).
- A Biological Survey of Boonaring Nature Reserve (Burbidge et al., 1996).
- Flora, Vegetation and Vertebrate Fauna Assessment Neerabup Industrial Area (ATA, 2007).
- Neerabup Road Extension Level 2 Fauna Survey (GHD, 2014).

Collectively these sources of information were used to create lists of species expected to utilise the study area. It should be noted that these lists include historic records of species that have since become locally extinct and species that have been recorded in the general region, but are vagrants, and are generally not found in the area because of a lack of suitable habitat. Many previously recorded fauna have specific habitat requirements that may be present in the general area but not located in the study area (e.g. marine

species). As such, erroneous records and species that have habitat specificity to habitats not present in the study area (wetland and marine species) have been omitted from the list of species expected to occur.

4.2.2 Field Survey

The field survey was conducted on 8 to 11 July by John Trainer and Michelle Holliday. The survey included an inspection of the major fauna habitats, Black Cockatoo habitat assessment and opportunistic fauna observations. The site was traversed by foot and a list of fauna recorded during the survey was assembled. The presence or evidence of any conservation significant fauna had its details recorded (GPS location, sex, habitat and picture taken if possible).

4.2.2.1 Fauna Habitat

Fauna habitats were classified according to vegetation and landform types and then mapped using a combination of aerial photography and ground-truthing. Fauna habitat assessments were conducted to record the habitat features and habitat values across the site. Fauna habitats were assessed on the microhabitats they provide to the expected faunal assemblage, habitat/vegetation condition and also the number of conservation significant fauna they potentially support.

4.2.2.2 Black Cockatoo Habitat Assessment

The vegetation of the study area was assessed on its ability to provide habitat to the three threatened species of Black Cockatoo. Based upon the current distribution maps in the EPBC Act referral guidelines for three threatened Black Cockatoo species (herein referred to as the Cockatoo referral guidelines) the study area is located in the known range of two of the three species: the Carnaby's Cockatoo and on the extreme northern range of the Forest Red-tailed Black Cockatoo (DSEWPAC, 2012). The methodology used to conduct the Black Cockatoo habitat assessment is consistent with that specified in the Cockatoo referral guidelines.

Habitats were mapped as High, Moderate or Low value for Black Cockatoos based on the level of suitable habitat they provide. High value habitats provide breeding, foraging and roosting habitat. Moderate value habitats provide quality foraging habitat or quality foraging habitat and roosting habitat. Low value habitats provide limited foraging habitat.

Foraging Assessment

The site was examined for evidence of current and historic foraging by Black Cockatoos, with particular focus upon the species of plant that are known foraging resources of these species (Valentine and Stock, 2008, Johnstone et al., 2008 and Chapman, 2007). Evidence in the form of chewed Marri or Jarrah nuts/fruits, chewed/broken Banksia seed pods and stripped tree bark are usually located on the ground underneath foraging resources. Due to the differing beak morphology of each of the Black Cockatoo species, characteristic chew marks are created upon Marri nuts which can be used to provide species identification (Fleming, 2011). Foraging habitat is mapped according to the presence of foraging resources.

Roosting Assessment

According to the Cockatoo referral guidelines roosting habitat is classified as a group of tall trees that are located close to riparian environments or other permanent water sources, usually close to or within foraging habitat (DSEWPAC, 2012). Trees or stands of trees that match this description were examined for evidence of recent use as a roost site (feathers and droppings) and a database searches was conducted for known roost sites in the vicinity of the site. Any stand of tall trees was classified and mapped as potential roosting habitat due to the study areas close proximity to riparian environments and permanent water sources.

Breeding Assessment

All three species of Black Cockatoo breed in large tree hollows which are found in trees usually more than 200 years old (DSEWPAC, 2012). The size of a tree is measured by its diameter at breast height (DBH) in millimetres (mm) and is used to establish its hollow bearing potential. Trees with a DBH of 500 mm or above (300 mm DBH for Salmon Gum and Wandoo) are classified as providing breeding habitat.

Due to the large size of the study area (988 ha) a tree density survey was deemed the most appropriate method to establish the level of breeding habitat present. Within each large stand of tree in the Eucalypt Woodland, a one hectare quadrat (100 m x 100 m) was conducted in an area of representative tree density. The number of trees with a DBH over 500 mm per quadrat and their details (species, height and presence of hollows) was recorded per site. This information was used to provide breeding tree density for each Eucalypt Woodland stand (number of trees/hectare) and extrapolated based on habitat mapping to give a total estimate of the number of breeding trees in the study area. In the stands of trees where multiple tree density surveys were completed an average of total tree density was used.

Additionally, the details (GPS location, species, height and size of hollows) of trees with suitable breeding hollows were opportunistically recorded while traversing the study area.

4.2.3 Limitations of Survey

As this survey was a level 1 survey with no trapping program, small ground dwelling fauna such as skinks, snakes and small mammals are unlikely to be recorded. However, the lack of conservation significant fauna that fall into this category and the high number of previous surveys completed in the vicinity should not impact upon this assessments ability to identify them as part of the wider fauna assemblage.

Both field participants (Mr John Trainer and Ms Michelle Holliday) are experienced in conducting fauna assessments in the South West.

As numerous terrestrial fauna surveys have been conducted in the region, fauna assemblages are well characterised. As such, there is sufficient quantitative terrestrial fauna data collected from study area to allow for comparison to regional data.

Weather was cold and intermittently wet during the assessment with maximum ambient temperatures between 15.7 and 17.2°C and minimum ambient temperatures down to 2.4°C (BOM, 2014). With 11 mm recorded over the survey period. The survey was conducted out of season (EPA, 2004b and EPA/DEC, 2010), which deem that late spring/early summer is the most appropriate time to conduct fauna surveys in the South West. However, as this was a Level 1 survey with no trapping program, the focus of the survey was on habitat assessments rather than recording the faunal assemblage and is considered a low value constraint. The cold weather experienced during the survey would have impacted the number of opportunistic fauna records obtained during the survey, in particular observations of retiles.

There were no access issues throughout the study area and the entire area was adequately surveyed. A statement of the fauna survey limitations for the project is provided in Table 8.

Table 8 Fauna survey limitations

Limitation	Constraint and significance*	Comments
Competency/experience of the scientist conducting the survey	No	An experienced zoologist undertook the field survey and the reporting.
Level of survey	No	A Level 1 fauna survey was considered appropriate to identify the habitat and conservation significant fauna values of the study area.

Limitation	Constraint and significance*	Comments
Sources of information	No	The Swan Coastal Plain region has been extensively surveyed with several comprehensive fauna surveys undertaken in within comparable habitats to those found in the study area.
Scope	No	The entire scope was met.
Proportion of: a) Fauna identified, recorded and/or collected; and b) Task achieved and further work that may be required	a) Yes; low b) No	a) The lack of pit fall traps reduces the number of small reptiles and mammals identified. However, the lack of conservation significant fauna that fall into this category and the high number of previous surveys completed in the region should not impact upon this assessments ability to identify them as part of the wider fauna assemblage. b) No further work is considered necessary to meet the current objectives and scope.
Completeness	No	The study area was adequately sampled and traversed.
Mapping reliability	No	The mapping reliability is considered to be high due to the homogenous nature of the study area and the quadrat sampling undertaken across the study area.
Timing/weather/season/cycle	Low	The survey was conducted out of season (EPA, 2004b and EPA/DEC, 2010), which deem that late spring/early summer is the most appropriate time to conduct fauna surveys in the South West. However, as this was a Level 1 survey with no trapping program, the focus of the survey was on habitat assessments rather than recording the faunal assemblage and is considered a low value constraint.
Disturbances which affected the results of the survey	No	There were no disturbances that affected the results of the survey.
Intensity of the survey	No	The intensity of the survey is sufficient to identify the presence of conservation significant fauna within the study area and to conduct a Black Cockatoo habitat assessment.
Completeness	No	The study area was adequately traversed on foot or via vehicle.
Resources	No	Adequate resources were assigned to the field survey and the reporting associated with the project.
Remoteness and/or access problems	No	The study area was adequately traversed on foot or via vehicle.
Availability of contextual information	No	The Swan Coastal Plain has been extensively surveyed, with all contextual information accessed prior, during and after the field survey (refer to Section 4.2.1).

* Indicates whether the limitation is a constraint (yes/no) and, if yes, the significance of the constraint (low/moderate/high).

4.3 Dieback

Phytophthora Dieback (Dieback) is a soil borne pathogen. In the southwest of Western Australia there is a number of plant hosts, including the Ericaceae, Fabaceae, Myrtaceae, Proteaceae, and Xanthorrhoeaceae families. While not all plants are susceptible to the disease, the ones that are affected by the pathogen generally results in chlorosis, dieback and often death (Terratree, 2014).

A linear dieback assessment of the main access tracks (approximately 119 ha) was conducted for the study area (Terratree, 2014 Appendix C). The following categorisation for vegetation was applied to determine the risk of dieback:

- High Risk: Areas where *Phytophthora cinnamomi* has been recovered from samples and disease symptoms are consistent with the presence of Dieback.
- Moderate Risk: Areas exhibiting past or current disturbances (logging, grazing, dumping etc.) which has altered vegetation structure and composition and areas downslope of confirmed infestations, or vegetation exhibiting disease symptoms but have not returned positive results for *P. cinnamomi*.
- Low Risk: Areas of protectable uninfested vegetation (as determined by a registered Dieback interpreter), which exhibit multiple healthy indicator species, vegetation in Pristine to Very Good condition, no disease pattern or chronology, and no significant risks from disease vectors or current land use.

5 RESULTS

5.1 Flora and Vegetation

5.1.1 Desktop Assessment

The desktop review and database searches yielded a total of 55 conservation significant taxa occurring or potentially occurring within the proximity of the study area (Appendix D). The 55 conservation significant taxa occurring or potentially occurring in the study area included 20 Threatened (declared rare-extant) taxa, three Priority 1 taxa, eight Priority 2 taxa, seventeen Priority 3 taxa and six Priority 4 taxa.

The desktop review identified one Threatened, *Chamelaucium* sp. Gingin (D. Marchant 6), and six Priority taxa (*Acacia cummingiana* (P3); *Caustis* sp. Gigas (A.S. George 9318) (P2); *Hypolaena robusta* (P4); *Schoenus griffinianus* (P3); *Verticordia rutilastra* (P3); and *Verticordia serrata* var. *linearis* (P3)) as occurring within the study area (Figure 5). The likelihood of the remaining 19 Threatened and 29 Priority listed taxa is detailed in Appendix D and is based on the following criteria:

- **Likely**: suitable habitat present and records within or less than 2 km from the study area.
- **Possible**: suitable habitat present, with records within 2-10 km from the study area.
- **Unlikely**: lacks of suitable habitat present, and/or there are no records closer than 10 km from the study area.

Based on the assessment of likelihood of occurrence, ten conservation significant taxa are known to occur or expected to occur within the study area, and a further 15 conservation significant taxa may potentially occur within the study area based on known locations and habitat preferences. The remaining 30 conservation significant taxa are not expected to occur within the study area based on habitat preferences and the current known locations (Appendix D).

Of the ten conservation significant taxa known to occur or expected to occur within the study area, only *Chamelaucium* sp. Gingin (N.G. Marchant 6) is listed as Threatened taxa under the WC Act and the EPBC Act. The remaining nine conservation significant taxa are listed as Priority taxa by DPAW.

Seven ecological communities listed as conservation significant, including four Threatened Ecological Communities and three Priority Ecological Communities are known to occur. Of the four TECs, three are listed as TECs under the EPBC Act. The list of TECs and PECs known to occur or potentially occur in the study area are presented in Table 9. The TEC SCP20c and the PECs SCP23b and Banksia yellow-orange sands, occur within the study area (see Figure 5), while the buffer for the Wooded waterbird wetlands PEC occurs across the southwest corner of the study area. The remainder of the TECs occur between 7 and 10 km of the study area.

Table 9 Threatened and Priority Ecological Communities occurring within close proximity to the study area

Community name	Community description	Federal listing[1]	State listing[1]
NTHIRON	Perth to Gingin Ironstone Association.	Endangered	Critically Endangered
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain).	Endangered	Critically Endangered
Muchea Limestone	Shrublands and woodlands on Muchea Limestone.	Endangered	Endangered
SCP20c	*Banksia attenuata* woodland over species rich dense shrublands.		Endangered
Banksia yellow-orange sands	*Banksia* woodland of the Gingin area restricted to soils dominated by yellow to orange sands.		Priority 2
Wooded waterbird wetlands	Wooded wetlands which support colonial waterbird nesting areas.		Priority 2
SCP23b	Swan Coastal Plain *Banksia attenuata* – *Banksia menziesii* woodlands.		Priority 3

1. See Appendix E for the definitions of Federal and State listing categories.

5.1.2 Vegetation Condition

The condition of the vegetation recorded within the study area ranged from Good to Pristine (Figure 6) according to the vegetation condition rating scale in Table 6. The majority (84%) of the vegetation was in excellent condition due to the intact vegetation structure, minimal anthropogenic disturbances and minimal signs of disturbance as a result of pathogens, diseases and overgrazing from native and non-native fauna.

The sections of vegetation in good condition were generally located in areas of higher visitation from humans and non-native fauna. These areas were located in the southwest corner, the eastern and northern boundaries of the study area and along the unmade Reserve Road that goes through the centre of the study area. Old car bodies and higher concentrations of introduced taxa were located along the eastern boundary, associated with a gate in the fence that allowed stock to graze within the study area and uncontrolled movement from the paddocks.

In addition to the areas of the study area that were considered to have a lower condition rating, there were several areas that were considered to have a higher condition rating. The areas of vegetation considered to be pristine were generally located within the middle of the study area were introduced taxa and human visitation is low to non-existent.

5.1.3 Dieback

The majority of the study area (87.6 ha) is categorised as Low risk vegetation, with 12.2 ha rated as moderate and 19.4 ha assessed as high risk. Most of the study area is uninfested and presents a low risk of spreading the disease into other areas (Terratree, 2014; Appendix C).

5.1.4 Vegetation Units

The vegetation units recorded from the study area can be broadly categorised into four broad floristic formations. The broad floristic formations have been mapped on Figure 7 and are described below:

- *Corymbia* woodland – The *Corymbia* woodland broad floristic formation occurred as a dominant and as a co-dominant with *Eucalyptus* species along the higher landforms of the study area and generally in association with lateritic soils. The dominant upper stratum species was *Corymbia calophylla*. The extent of *Corymbia* woodland covers 17% of the study area.
- *Eucalyptus* woodland – The *Eucalyptus* woodland broad floristic formation occurred across the study area and occurred as either the dominant upper stratum or as a co-dominant with *Corymbia calophylla*. The *Eucalyptus* woodland occurred on lateritic soils and deep sands higher in the landscape. The dominant species in the upper stratum was *Eucalyptus marginata*. The extent of *Eucalyptus* woodland covers 56% of the study area.
- *Banksia* woodland – The *Banksia* woodland occurred in small isolated patches and has been identified as a separate formation compared to the *Banksia* shrubland due to the height of woodland (over 10 m) and the lack of *Eucalyptus* or *Corymbia* species. The dominant *Banksia* species were *Banksia attenuata* and *Banksia menziesii*. The extent of *Banksia* woodland covers 10% of the study area.
- *Banksia* shrubland – The *Banksia* shrubland is distinct from the *Banksia* woodland due to the isolated or sparse presence of *Eucalyptus todtiana* in the upper stratum. The Banksia species (commonly *Banksia attenuata* and *Banksia menziesii*) were generally lower than 10 m in height. The *Banksia* shrubland broad floristic formation was the dominant formation across the study area. The extent of *Banksia* shrubland covers 17% of the study area.

A total of 16 vegetation units were identified from the study area (Table 10). The vegetation units have been described to a vegetation association level (Hierarchical Level V) and have been divided further from the four broad floristic formations. The vegetation association units have been mapped on Figure 8, while the floristic data collected from the 30 relevés sampled within the study area are provided in Appendix F.

5.1.5 Vegetation Significance

5.1.5.1 Boregional and Subregional Protection

The bioregions and subregions are the reporting unit for assessing the status of native ecosystems and their level of protection in the National Reserve System. In this way, IBRA is used as a dynamic tool for monitoring progress towards building a comprehensive, adequate and representative (CAR) reserve system (DOTE, 2014b). Such information assists governments to decide how to best prioritise funding to meet national protection targets.

The study area is located within the Swan Coastal Plain bioregion and the Perth subregion. According to the National Reserve System, the Swan Coastal Plain bioregion is not considered to be a bioregion with less than 10% protection. Both the Swan Coastal Plain bioregion and the Perth subregion have between 10-15% of their current area protected within International Union for Conservation of Nature (IUCN) Class I-IV Reserves (i.e. National Parks, Nature Reserves).

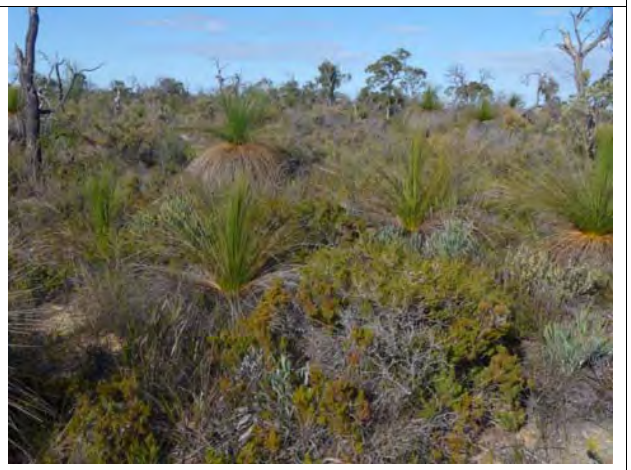
Table 10 Vegetation units recorded

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
EmCc[1]	COR01 & COR09	*Eucalyptus* woodland Lateritic slopes and rises	*Eucalyptus marginata* and occasional *Corymbia calophylla* mid sparse woodland over *Xanthorrhoea preissii* and *Allocasuarina humilis* mid open to mid sparse shrubland over *Hibbertia hypericoides*, *Conostephium pendulum* and occasional *Hakea stenocarpa* low open shrubland over *Lepidosperma pubisquameum* (flat form) and *Mesomelaena tetragona* and *Mesomelaena pseudostygia* low sparse sedgeland on lateritic coarse black, brown sandy loam on lateritic rises and slopes.	1.2% / 11.5 ha	
BaBmNf	COR03, COR11, COR18, COR26 & COR27	*Banksia* shrubland Consolidated dunes and plains	*Banksia attenuata, Banksia menziesii* and *Nuytsia floribunda* tall sparse to tall open shrubland over *Allocasuarina humilis, Xanthorrhoea preissii* and *Daviesia divaricata* subsp. *divaricata* mid sparse to mid open shrubland over *Eremaea pauciflora* var. *pauciflora, Melaleuca systena* and *Leucopogon conostephioides* low open shrubland over *Mesomelaena pseudostygia* and *Schoenus efoliatus* low sparse sedgeland on yellow, grey-brown coarse grained sand on consolidated dunes.	15.0% / 147.9 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
EmCc[2]	COR05	*Eucalyptus* woodland Lateritic slopes	*Eucalyptus marginata* and *Corymbia calophylla* mid woodland over *Xanthorrhoea preissii* mid sparse shrubland over *Hibbertia hypericoides* low open shrubland over *Mesomelaena tetragona* low sparse sedgeland on a lateritic slope with brown coarse grained sandy loam with a laterite subsurface on lateritic slopes.	0.5% / 4.8 ha	
Em[1]	COR06	*Eucalyptus* woodland Consolidated plains	*Eucalyptus m*arginata low sparse woodland over *Banksia attenuata, Banksia menziesii* and *Adenanthos cygnorum* subsp. *cygnorum* tall open shrubland over *Jacksonia floribunda* mid isolated shrubs over *Hibbertia hypericoides* and *Stirlingia latifolia* low open shrubland over *Hypolaena exsulca*, *Lyginia imberbis* and *Alexgeorgea nitens* low sparse rushland on a plain with grey brown coarse grained sand on consolidated plain.	3.6% / 35.9 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
EtNf	COR10 & COR24	*Eucalyptus* woodland Consolidated dunes	*Eucalyptus todtiana* and *Nuytsia floribunda* mid sparse to mid isolated mallee woodland over *Banksia attenuata, Banksia menziesii* and *Adenanthos cygnorum* subsp. *cygnorum* tall open to tall sparse shrubland over *Beaufortia elegans, Xanthorrhoea preissii* and *Jacksonia floribunda* mid sparse shrubland over *Calothamnus sanguineus, Scholtzia involucrata*, and *Eremaea pauciflora* var. *pauciflora* low open to low sparse shrubland over *Mesomelaena pseudostygia* low isolated sedges over *Lyginia imberbis* low isolated rushes on grey coarse-grained sand on consolidated dunes.	25.0% / 246.3 ha	
Cc[1]	COR12 & COR13	*Corymbia* woodland Lateritic slopes and rises	*Corymbia calophylla* with occasional *Eucalyptus marginata* and *Nuytsia floribunda* mid sparse woodland over emergent patches of *Banksia sessilis* var. *sessilis* tall sparse shrubland over *Xanthorrhoea preissii* mid open shrubland over *Hibbertia hypericoides, Acacia celastrifolia* and *Calothamnus sanguineus* low open to low sparse shrubland on black, brown coarse-grained loamy, sand on lateritic rises and slopes.	3.0% / 29.3 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
Ba	COR14	*Banksia* woodland Seasonally waterlogged depressions	*Banksia attenuata* mid sparse woodland over *Kunzea glabrescens* and *Banksia menziesii* tall shrubland over *Macrozamia riedlei* and *Xanthorrhoea preissii* mid sparse shrubland over various sparse herbs with brown grey white coarse grained sand in a seasonally inundated depression.	0.4% / 4.2 ha	
CcEm	COR15 & COR17	*Corymbia* woodland Consolidated dunes with lateritic subsurface	*Corymbia calophylla* and *Eucalyptus marginata* mid sparse woodland over *Banksia attenuata* and *Banksia menziesii* low sparse to isolated woodland over *Xanthorrhoea preissii* and *Daviesia divaricata* subsp. *divaricata* tall sparse shrubland over *Hakea trifurcata* and *Macrozamia riedlei* mid sparse shrubland over *Hibbertia hypericoides, Conostephium pendulum* and *Stirlingia latifolia* low open shrubland over *Mesomelaena pseudostygia* low sparse sedgeland on grey, brown coarse-grained sand on consolidated dunes with lateritic subsurface.	11.0% / 108.6 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
BaBm[1]	COR19	*Banksia* shrubland Consolidated dunes	*Banksia attenuata* and *Banksia menziesii* low sparse woodland over *Adenanthos cygnorum* subsp. *cygnorum* tall open shrubland over *Xanthorrhoea preissii* and *Beaufortia elegans* mid sparse shrubland over *Hibbertia hypericoides, Scholtzia involucrata* and *Calothamnus sanguineus* low sparse shrubland over *Mesomelaena pseudostygia* low sparse sedgeland with grey brown coarse grained sandy loam on consolidated dunes.	2.4% / 23.7 ha	
Cc[2]	COR20	*Corymbia* woodland Consolidated dunes	*Corymbia calophylla* with occasional *Eucalyptus marginata* mid isolated trees over *Banksia attenuata* tall sparse shrubland over *Allocasuarina humilis* and *Xanthorrhoea preissii* mid sparse shrubland over *Eremaea pauciflora* var. *pauciflora, Calothamnus sanguineus* and *Stirlingia latifolia* low open shrubland over *Mesomelaena pseudostygia* low sparse sedgeland with yellow brown coarse grained sand on consolidated dunes.	1.3% / 12.5 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
Em[2]	COR25	*Eucalyptus* woodland Consolidated dunes	*Eucalyptus marginata* mid woodland over *Banksia attenuata* and *Banksia menziesii* tall sparse shrubland over *Eremaea pauciflora* var. *pauciflora*, *Hibbertia hypericoides* and *Daviesia triflora* low open shrubland over *Mesomelaena pseudostygia* low isolated sedges over *Lyginia imberbis* low isolated rushes with grey white coarse grained sand on consolidated dunes.	7.1% / 70.1 ha	
Cc[3]	COR28	*Corymbia* woodland Consolidated dunes	*Corymbia calophylla* mid isolated trees over *Eucalyptus todtiana* mid isolated mallee trees over *Banksia attenuata, Banksia menziesii* and *Daviesia divaricata* subsp. *divaricata* tall sparse shrubland over *Eremaea pauciflora* var. *pauciflora*, *Calothamnus sanguineus* and *Hibbertia hypericoides* low sparse heath shrubland over *Mesomelaena pseudostygia* low sparse sedgeland with yellow brown coarse grained sand on consolidated dunes.	2.0% / 19.2 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
BaBm[2]	COR30	*Banksia* woodland Seasonally waterlogged swale	*Banksia attenuata* and *Banksia menziesii* low woodland over *Melaleuca preissiana* and *Adenanthos cygnorum* subsp. *cygnorum* tall sparse shrubland over *Calytrix angulata* and *Xanthorrhoea preissii* mid sparse shrubland over *Leucopogon conostephioides* and *Hibbertia subvaginata* low sparse shrubland with grey brown coarse grained sand in a swale.	1.0% / 9.7 ha	
Em[3]	COR02, COR07 & COR21	*Eucalyptus* woodland Consolidated dunes	*Eucalyptus marginata* with occasional *Corymbia calophylla* mid sparse woodland over *Xanthorrhoea preissii* mid sparse shrubland over *Hibbertia hypericoides, Calothamnus sanguineus* and *Conostephium pendulum* low heath shrubland over *Mesomelaena pseudostygia* and *Lepidosperma pubisquameum* (flat form) low sparse sedgeland over *Lyginia imberbis* low isolated rushes on grey, yellow, white coarse-grained sand on consolidated dunes.	12.7% / 125.5 ha	

Unit code	Quadrats	Broad floristic formation and site preference	Vegetation description	Area of study area	Photograph
Em[4]	COR04	*Eucalyptus* woodland Consolidated dunes	*Eucalyptus marginata* mid sparse woodland over *Banksia attenuata, Banksia grandis* and *Nuytsia floribunda* tall sparse shrubland over *Jacksonia floribunda* and *Adenanthos cygnorum* subsp. c*ygnorum* mid open shrubland over *Eremaea pauciflora* var. *pauciflora*, *Hibbertia hypericoides* and *Melaleuca systena* low heath shrubland over *Mesomelaena pseudostygia* low sparse sedgeland with white brown coarse grained sand on consolidated dune rises.	5.1% / 50.6 ha	
Et	COR08, COR16, COR22, COR23 & COR29	*Eucalyptus* woodland Consolidated dunes	*Eucalyptus todtiana* mid sparse to mid isolated mallee woodland with occasional *Nuytsia floribunda* low isolated trees over *Banksia attenuata, Banksia menziesii* and *Adenanthos cygnorum* subsp. *cygnorum* tall sparse shrubland over *Allocasuarina humilis, Xanthorrhoea preissii* and *Jacksonia floribunda* mid open shrubland over *Eremaea pauciflora* var. *pauciflora, Hibbertia hypericoides* and *Calothamnus sanguineus* low open to low sparse shrubland over *Mesomelaena pseudostygia* low sparse sedgeland on yellow, brown coarse-grained sand on consolidated dunes.	8.7% / 86.3 ha	

5.1.5.2 Floristic Community Types

The floristic information collected from the 30 relevés was compared against the floristic data from *'A Floristic Survey of the southern Swan Coastal Plain'* (Gibson *et al*., 1994) to determine the nearest match to the Floristic Community Types (FCTs) known to occur on the Swan Coastal Plain.

The results of the presence/absence comparison between the 30 relevés and the floristic data collected by Gibson *et* al. (1994) are presented in Table 11.

Table 11 Inferred floristic community types

Relevé	Nearest matches (FCT)	Landform	Inferred match	Description
COR01	28; 1a; 20a; 20b; & 21a	Ridge Hill/ Pinjarra	20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginate.*
COR02	28; 20a; 21a; 21b; & 23a	Spearwood	28	Spearwood *Banksia attenuata* or *Banksia attenuata-Eucalyptus marginata* woodlands.
COR03	28; 23b; 20a; 20b; & 21a	Spearwood/ Pinjarra	20a	*Banksia attenuata* woodlands over species rich dense shrublands.
COR04	28; 20a; 23a; 23b; & 21a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR05	28; 1a; 20b; 21a; & 3a	Ridge Hill/ Pinjarra	20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginate.*
COR06	28; 21c; 23a; 23b; & 21a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR07	28; 21a; 1a; 21b; & 21c	Bassendean/ Spearwood	21a	Central *Banksia attenuata-Eucalyptus marginata* woodlands.
COR08	28; 20a; 21a; 23a ;& 23b	Spearwood/ Pinjarra	20a	*Banksia attenuata* woodlands over species rich dense shrublands.
COR09	28; 1a; 3b; 3b ;& 1b	Bassendean/ Spearwood	21a	Central *Banksia attenuata-Eucalyptus marginata* woodlands.
COR10	23a; 28; 23b; 21a; & 20a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR11	28; 23b; 20b; 20a; & 21a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR12	28; 1a; 21a; 3b; & 3b	Bassendean/ Spearwood	21a	Central *Banksia attenuata-Eucalyptus marginata* woodlands.
COR13	28; 1a; 21a; 1b; & 21b	Bassendean/ Spearwood	21a	Central *Banksia attenuata-Eucalyptus marginata* woodlands.
COR14	28; 21a; 24; 21c; & 23a	Bassendean	21c	Low lying *Banksia attenuata* woodlands or shrublands.
COR15	28; 21a; 23a; 24; & 26b	Bassendean/ Spearwood	21a	Central *Banksia attenuata-Eucalyptus marginata* woodlands.
COR16	28; 21a; 23a; 23b; & 20a	Bassendean/ Spearwood	21a	Central *Banksia attenuata-Eucalyptus marginata* woodlands.

Relevé	Nearest matches (FCT)	Landform	Inferred match	Description
COR17	28; 20b; 21a; 1a; & 21b	Ridge Hill/ Pinjarra	20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginate.*
COR18	21a; 23b; 28; 23a; & 20a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR19	28; 23b; 23a; 20a; & 21c	Bassendean	23a	Central *Banksia attenuata-Banksia menziesii* woodlands.
COR20	28; 20a; 21b; 23a; & 20b	Spearwood/ Pinjarra	20a	*Banksia attenuata* woodlands over species rich dense shrublands.
COR21	28; 21a; 23a; 26b; & 26b	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR22	28; 23b; 23a; 20a; & 21a	Bassendean	23a	Central *Banksia attenuata-Banksia menziesii* woodlands.
COR23	28; 20a; 23a; 23b; & 20b	Spearwood/ Pinjarra	20a	*Banksia attenuata* woodlands over species rich dense shrublands.
COR24	23b; 23a; 28; 21c; & 20a	Bassendean	23a	Central *Banksia attenuata-Banksia menziesii* woodlands.
COR25	28; 20a; 21a; 23a; & 23b	Spearwood/ Pinjarra	20a	*Banksia attenuata* woodlands over species rich dense shrublands.
COR26	28; 20a; 23b; 21a; & 23a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR27	28; 20a; 23b; 20b; & 21a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR28	28; 20a; 23b; 20b; & 21a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR29	28; 20a; 23b; 21a; & 23a	Bassendean	23b	Northern *Banksia attenuata-Banksia menziesii* woodlands.
COR30	21c; 23a; 23b; 28; & 20c	Bassendean	21c	Low lying *Banksia attenuata* woodlands or shrublands.

It must be noted that the determination of the FCTs from the floristic data collected from the 30 relevés is considered to be an inference. To accurately determine the FCTs, systematic sampling of quadrats located in representative vegetation associations and multivariate analysis against the floristic data collected by Gibson *et al.* (1994), is required.

According to the comparison (Table 11), the following FCTs potentially occur in the study area:

- FCT20a – *Banksia attenuata* woodlands over species rich dense shrublands.
- FCT20b – Eastern *Banksia attenuata* and/or *Eucalyptus marginate.*
- FCT21a – Central *Banksia attenuata-Eucalyptus marginata* woodlands.
- FCT21c – Low lying *Banksia attenuata* woodlands or shrublands.
- FCT23a – Central *Banksia attenuata-Banksia menziesii* woodlands.

- FCT23b – Northern *Banksia attenuata-Banksia menziesii* woodlands.
- FCT28 – Spearwood *Banksia attenuata* or *Banksia attenuata-Eucalyptus marginata* woodlands.

According to DPAW information on ecological communities on the Swan Coastal Plain, FCT20a (also known as SCP20a) and FCT20b (also known as SCP20b) are considered to be Threatened Ecological Communities. FCT21c and FCT23b, also known as SCP21c and SCP23b respectively, are considered to be Priority Ecological Communities.

The locations of the inferred TECs and PECs are provided in Figure 9 and discussed in more detail in Section 5.1.4.3.

5.1.5.3 Threatened and Priority Ecological Communities

The floristic information collected from the 30 relevés was compared against the floristic data collected from the Gibson *et al.* (1994) survey of the Southern Swan Coastal Plain and the descriptions available for the TECs and PECs from DPAW to infer the presence of any additional TECs and PECs.

The majority of the study area is considered to be representative of the P2 PEC Banksia Yellow-Orange Sands and the PEC SCP23b. Both PECs are known to occur extensively within and adjacent to the study area. The description for the PEC Yellow-Orange Sands is:

> Species-rich Banksia woodlands on deep yellow-red sands that appears restricted to the western Dandaragan Plateau. The vegetation is described as scattered *Eucalyptus todtiana* and *Corymbia calophylla* over *Banksia menziesii* and *Banksia attenuata* low open woodland over *Jacksonia sternbergiana* and *Adenanthos cygnorum* high open shrubland over *Allocasuarina humilis* and *Chamelaucium* sp. Gingin (N.G. Marchant 6)(T) open shrubland over *Eremaea pauciflora* and *Astroloma xerophyllum* low shrubland over *Mesomelaena pseudostygia* open sedgeland.

Vegetation associations BaBm[1], BaBmNf, Et and EtNf are considered to be representative of the Priority 2 Banksia Yellow-Orange Sands. The four vegetation associations listed above consist of *Eucalyptus todtiana* over Banksia spp. with an understorey layer dominated by *Allocasuarina humilis* and *Eremaea pauciflora* var. *pauciflora* over a sedge layer consisting of *Mesomelaena pseudostygia* on coarse-grained deep yellow-brown sands. This is considered to be consistent with the description of the PEC.

In addition to the known locations of the TEC and the PECs, based on a comparison between the floristic data collected from the 30 relevés with Gibson *et al.* (1994), an additional two TECs (SCP20a, SCP20b) and one PEC (SCP21c) potentially occur within the study area. The comparison confirmed the presence of the PEC SCP23b, known to occur within the study area. The location of the TECs and the PECs are presented in Figure 9.

The descriptions as provided by DPAW, for the additional TECs and the PECs are detailed below:

- Threatened Ecological Communities:
  - SCP20a – *Banksia attenuata* woodland over species rich dense shrublands. The TEC SCP20a is classified as Endangered. SCP20a corresponded with relevés COR03, COR08, COR20, COR23 and COR25. These relevés correspond with vegetation associations BaBmNf, Et, Cc[2] and Em[2].
  - SCP20b – *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain. The TEC SCP20b is classified as Endangered. The TEC SCP20b corresponded with relevés COR01, COR05 and COR17, which corresponded with vegetation associations EmCc[1], EmCc[2] and CcEm.
  - SCP20c – Shrublands and woodlands of the eastern side of the Swan Coastal Plain. The TEC SCP20c is classified as Critically Endangered. According to DPAW data, the TEC SCP20c occurs

in the southeast of the study area. The exact location is difficult to determine based on the information provided by DPAW. The buffer associated with the TEC is 500 m which indicates that the TEC is located in association with vegetation association Em[3] and relevé COR07. Relevé COR07 was inferred to represent FCT21a, which is not listed as a TEC or a PEC.

- Priority Ecological Communities:
  - SCP21c – Low lying *Banksia attenuata* woodlands or shrublands. This P3 PEC occurs sporadically between Gingin and Bunbury, and is largely restricted to the Bassendean system. The PEC tends to occupy lower lying wetter sites and is variously dominated by *Melaleuca preissiana, Banksia attenuata, Banksia menziesii, Regelia ciliata, Eucalyptus marginata* or *Corymbia calophylla*. Structurally, this community type may be either a woodland or occasionally shrubland. The PEC SCP21c corresponded with relevés COR14 and COR30 and occurred in low lying areas with *Melaleuca preissiana* present. The vegetation associations that correspond with COR14 and COR30 are Ba and BaBm[2].
  - SCP23b – Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands. These woodlands occur in the Bassendean system, from Melaleuca Park to Gingin. The P3 PEC occurs in reasonably extensive Banksia woodlands north of Perth. The PEC SCP23b is represented by relevés COR04, COR06, COR10, COR11, COR18, COR21, COR26, COR27, COR28 and COR29. These relevés corresponded with vegetation associations Em[4], Em, EtNf, BaBmNf, Em[3], Cc[3] and Et.

There is significant overlap between the inferred TECs and PECs and the known TECs and PECs (according to DPAW data). To remove the overlap and accurately confirm the presence of TECs or PECs, a systematic quadrat sampling survey with multivariate analysis needs to be completed across the study area.

In the case of an overlap between the PEC Banksia Yellow-Orange Sands and the inferred TECs and PECs, the PEC Banksia Yellow-Orange Sands has been mapped. This is based on the accurate vegetation description provided by DPAW compared to the data available on the remaining TECs and PECs and the reliance on multivariate analysis.

DPAW also identify Banksia dominated woodlands on the Swan Coastal Plain bioregion as a Priority 3 ecological community. The main feature of these Banksia woodlands is the presence of Banksia attenuata and/or Banksia menziesii occurring on deep sands, with the species commonly co-occurring. The community occurs on the Quindalup, Spearwood and Bassendean dunes and rarely on the Pinjarra Plain landforms, which comprise the dominant landforms of the Swan Coastal Plain.

5.1.5.4 Vegetation Complexes

The study area is located across five vegetation complexes; the Mogumber complex-south, Reagan complex, Karamal complex-south, Coonambidgee complex and Moondah complex. The pre-European extent, extent remaining in 2013 and the pre-European extent remaining in formal protection is provided in Table 12. Formal protection includes native vegetation remaining in conservation estate, Bush Forever sites in conservation estate and Bush Forever sites in Regional Parks.

The National Objectives and Targets for Biodiversity Conservation 2001-2005 recognises that a retention of 30% or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected (ANZECC, 2000). In addition to the Australian and New Zealand Environment and Conservation Council (ANZECC) 30% retention target, the EPA has adopted a 10% level of pre-clearing extent as representing 'endangered' (EPA, 2000).

The pre-European extent remaining on the Swan Coastal Plain for each vegetation complex is greater than 30%; however, only the Coonambidgee (10%) and the Karamal Complex-South (27%) have greater than 10% of the pre-European extent remaining in formal protection.

Table 12 Native vegetation extent by vegetation complexes on the Swan Coastal Plain

Vegetation Complex	Pre-European extent (ha)	2013 extent (ha)	Pre-European extent remaining (%)	Formal protection[1] (ha)	Pre-European extent with formal protection (%)	Extent within the study area	Inclusion of the study area (%)
Coonambidgee	6,272.3	2,859.5	45.6	647.7	10.3	8.7	10.5
Karamal (south)	24,016.7	15,225.9	63.4	6,513.5	27.1	181.3	27.9
Mogumber (south)	13,985.5	5,621.9	40.2	175.3	1.3	424.9	4.3
Moondah	17,858.8	7,279.8	40.8	1,742.8	9.8	105.2	10.4
Reagan	9,080.5	3,052.4	33.6	341.4	3.8	266.3	6.7

Source: Perth Biodiversity Program (WALGA 2013).
1: Formal protection includes DPAW conservation estates, Bush Forever on conservation estate and Bush Forever in Regional Parks.

The vesting of the study area as conservation estate will increase the formal protection of each of the vegetation complexes. However, the increase is not sufficient to increase the pre-European extents above the 30% threshold.

The inclusion of the study area into the conservation estate will not increase the pre-European extent within formal protection above the endangered 10% level for any of the vegetation complexes within the study area. However, the pre-European extent of the Moondah vegetation complex within formal protection will be increased above the 10% endangered level (an increase of 0.6% to 10.4%).

5.1.6 Ecological Corridors

The study area is located within the Perth subregion which has historically been cleared for urban development, industrial development and agriculture. As a result only 42% (or 473,176 ha) of the pre-European extent for the Perth subregion (1,117,757 ha) remains intact (DPAW, 2013a).

The study area is located within an ecological corridor linking Boonanarring Nature Reserve and Leda Nature Reserve. The corridor runs in a north to south alignment and is fragmented in sections and crosses the Great Northern Highway.

The study area is not located within an east-west ecological corridor. The east-west movement of flora and fauna is impeded by the historical clearing of native vegetation along both sides of the Brand Highway.

5.1.7 Taxa Recorded

A total of 154 vascular taxa were recorded from the study area during the site visit. This included 148 native taxa and six introduced taxa from 36 families and 88 genera. Two taxa were not identified to genus level, one was from the Orchidaceae family. The taxon was not identified to genus level because only the basal leaf was present. The remaining taxon that was not identified to genera level had inadequate material to make an accurate identification to genera.

An additional seven taxa, *Austrodanthonia* sp., *Haemodorum* sp., *Anigozanthos* sp., *Pimelea* sp. 1, *Pimelea* sp. 2, *Stylidium* sp. and **Lupinus* sp., were only identified to genus level. The taxa within the field were not flowering and/or fruiting at the time of the survey which is required to ensure a positive identification.

The dominant families recorded from the study area are listed in Table 13, while the dominant genera recorded from the study area is listed in Table 14. The entire list of vascular taxa recorded from the study area is provided in Appendix G.

Table 13 Dominant families recorded from the study area

Family name	Common name	Native taxa	Introduced taxa
Proteaceae	Banksia family	28	0
Fabaceae	Legume or Pea family	24	1
Myrtaceae	Myrtle family	19	0
Ericaceae	Heath family	12	0
Cyperaceae	Sedge family	8	0

Of the 36 families recorded from the study area, 18 families were only represented by one genera, while the vast majority of the taxa were members of four families, the Proteaceae, Fabaceae, Myrtaceae and Ericaceae, which constituted approximately 55% of the total number of taxa recorded.

Table 14 Dominant genera recorded from the study area

Genera	Common name	Native taxa	Introduced taxa
Acacia	Wattle	10	0
Banksia	Banksias	7	0
Hakea	Hakeas	7	0
Daviesia	Daviesias	6	0

Of the 88 genera recorded from the study area, 58 genera were only represented by one taxon. The dominant nine genera (*Acacia, Banksia, Hakea, Daviesia, Calytrix, Hibbertia, Lepidosperma, Lomandra* and *Petrophile*) represented approximately 33% of the total number of taxa recorded.

5.1.8 Taxa of Significance

One Threatened and six Priority listed taxa are known to occur in the study area. The known locations were traversed to locate the conservation significant taxa and to further refine the population size. The Threatened taxa, *Chamelaucium* sp. Gingin (N.G. Marchant 6), was located in the northwest of the study area. *Chamelaucium* sp. Gingin (N.G. Marchant 6) (Plates 1 to 3) is a Threatened taxon under the WC Act with a classification of Vulnerable and it is listed as Endangered under the Commonwealth EPBC Act (see Figure 9).

Chamelaucium sp. Gingin (N.G. Marchant 6) is endemic to Western Australia and is apparently confined to the Gingin/Chittering area where it is known from a range of only 3 km and six populations (Stack and English, 2003). The six known populations contain a total of approximately 4700 adult plants and 1800 juveniles. This species occurs on white/yellow sand supporting open low woodland with *Eucalyptus todtiana, Banksia attenuata* and *Hibbertia* species.

Plate 1 ***Chamelaucium*** **sp. Gingin (N.G. Marchant 6) growing along fence line between offset site and nature reserve**

Plate 2 ***Chamelaucium*** **sp. Gingin (N.G. Marchant 6), close-up of buds before flowering**

Plate 3 **Chamelaucium sp. Gingin (N.G. Marchant 6), close-up of flowers**

Plate 4 ***Hypolaena robusta*** **(Priority 4)***

* Photography by A.D. Crawford. Image used with the permission of the Western Australian Herbarium, Department of Parks and Wildlife (http://florabase.dpaw.wa.gov.au/help/copyright). Accessed on Tuesday, 26 August 2014.

Plate 5 **Arum Lily (**Zantedeschia aethiopica*)**

Chamelaucium sp. Gingin (N.G. Marchant 6) is an open straggly shrub growing to a height of 1 to 2 m tall and has many slender stiff branches that bear numerous long axillary shoots. Its erect, glandular, bright green leaves are 5.4-11.5 mm long by 1.2-1.4 mm wide, and are scattered along the main branches, but are mostly crowded on numerous short axillary shoots. The inflorescence is composed of a small head on short axillary shoots or sometimes a larger flower head at the end of main branches. The flowers occur in groups of two to nine in small heads on axillary shoots. Up to 20 flowers are held in clusters at the end of main branches. The flowers are pale pinkish-white, and the buds are tinged a deeper pink (adapted from Stack and English, 2003).

Critical habitat is defined as habitat that is identified as being critical to the survival of the threatened taxon. The critical habitat for *Chamelaucium* sp. Gingin (N.G. Marchant 6) comprises:

- The area of occupancy of known populations.
- Areas of similar habitat within 200 m of known populations, i.e. white/yellow sand supporting open low woodland over open scrub (these provide potential habitat for natural range extensions).
- Corridors of remnant vegetation that link populations (these are necessary to allow pollinators to move between populations and are usually road and rail verges).
- Additional occurrences of similar habitat that do not currently contain the species but may have done so in the past (these represent possible translocation sites).

The study area represents critical habitat for *Chamelaucium* sp. Gingin (N.G. Marchant 6) for the existing population and areas of similar habitat within 200 m and providing a vegetated corridor linking populations.

Of the six Priority listed taxa recorded from the study area, only one was re-recorded, *Hypolaena robusta* (P4). The remaining five Priority listed taxa were not identified during the July 2014 site visit. No other Priority listed taxa were recorded from the study area.

Hypolaena robusta is listed a Priority 4 taxon and is a member of the Restionaceae or rush family. *Hypolaena robusta* (see Plate 4) is described as a tall stout, dioecious rhizomatous, perennial rush with well-spaced culms on thick rhizomes (Meney and Pate, 1999; DPAW, 2014c). It is known to occur on white sand on the sandplains of the northern Swan Coastal Plain and the Northern Sandplain (DPAW, 2014c). It flowers in early to mid-spring (September and October) (DPAW, 2014c; Meney and Pate, 1999).

The locations of *Chamelaucium* sp. Gingin (N.G. Marchant 6) (T) and *Hypolaena robusta* (P4) recorded from the study area are provided in Table 15. The locations of Threatened and Priority listed flora within the study area is provided in Figure 9.

Table 15 Threatened and Priority listed taxa recorded from the study area

Taxa	Phenology and life form	Individuals	Zone 50J, GDA 94	
			Easting	Northing
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults and seedlings. Buds present on adults.	50+	402225	6517206
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)			402229	6517194
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)			402235	6517193
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)			402222	6517190
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)			402226	6517212
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults with buds.	10+	402227	6517251

Taxa	Phenology and life form	Individuals	Zone 50J, GDA 94	
			Easting	Northing
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults with buds.	20+	402232	6517409
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults with buds.	30+	402298	6517414
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults and seedlings. Adults with buds.	70+	402324	6517417
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults.	3	402365	6516987
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults.	1	402383	6516980
Chamelaucium sp. Gingin (N.G. Marchant 6) (T)	Adults and seedlings. Adults with buds.	10+	402460	6517417
Hypolaena robusta (P4)	Last season's flowers and buds.	Unknown	403976	6514919
Hypolaena robusta (P4)	Last season's flowers and buds.	Unknown	403985	6516766

5.1.9 Introduced Taxa

A total of six introduced taxa were recorded from the study area during the site visit. The six introduced taxa were reviewed to determine if they are WONS, a Declared Pest under the BAM Act or an Environmental Weed with a 'High' rating (Table 16).

Table 16 Introduced taxa recorded from the study area

Species	Common name	Family	WONS (EPBC Act)	Declared pest (BAM Act)	Environmental weed rating (CALM, 1999)	Species-led ranking (DPAW, 2013b)
**Zantedeschia aethiopica*	Arum Lily	Araceae	No	Declared Pest (s22)	High	Medium
**Lupinus* sp.	Lupin	Fabaceae	No	Permitted (s11)	High	High[1]
**Brassica tournefortii*	Wild Turnip	Brassicaceae	No	Permitted (s11)	High	Low
**Briza maxima*	Quaking Grass	Poaceae	No	Permitted (s11)	Moderate	Low
**Hypochaeris glabra*	Smooth Catsear	Asteraceae	No	Permitted (s11)	Moderate	Low
**Gladiolus caryophyllaceus*	Wild Gladiolus	Iridaceae	No	Permitted (s11)	Moderate	Medium

1: The highest ranked Lupin (**Lupinus angustifolia* and **Lupinus cosentinii*) has been chosen to ensure the introduced taxa is appropriately managed at the upper limit.

5.1.9.1 WONS and Declared Pests

None of the six introduced taxa are WONS. Arum Lily (**Zantedeschia aethiopica*) is considered to be a Declared Pest under Section 22 of the BAM Act (see Figure 6). The remaining five introduced taxa are classified as Permitted under Section 11 of the BAM Act.

The BAM Act and regulations were enacted on 1 May 2013. The BAM Act replaces the *Agriculture and Related Resources Protection Act 1976*. The main purposes of the BAM Act that relate to weeds are to:

- Prevent new animal and plant pests (vermin and weeds) and diseases from entering Western Australia.
- Manage the impact and spread of those pests already in Western Australia.

Organisms are grouped into four main classifications:

- Declared pests (under Section 22 of the Act).
- Permitted (under Section 11 of the Act).
- Prohibited (under Section 12 of the Act).
- Permitted requiring a permit (under Section 73 of the BAM Regulations 2013).

Under the BAM Act, all Declared Pests are placed in one of three categories, namely C1 (exclusion), C2 (eradication) or C3 (management). Arum Lily has been placed in the C3 (management) category and it is prohibited to keep in WA. Arum Lily was recorded from one location in the southwest corner of the study area (Table 17; see Plate 5).

Table 17 GPS coordinate (Zone 50J, GDA94) for the known Arum Lily location

	Easting	Northing
Arum Lily (**Zantedeschia aethiopica*)	402409	6514543

5.1.9.2 Environmental Weeds and Weed Prioritisation Process

The Environmental Weed Strategy for Western Australia (EWSWA) (CALM, 1999) has detailed criteria for the assessment and rating of introduced flora based on their impact on biodiversity. The criteria included:

- Invasiveness – ability to invade bushlands in good to excellent condition or ability to invade waterways (score of yes or no).
- Distribution – wide current or potential distribution including consideration of known history of widespread distribution elsewhere in the world (score as a 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 (score as a yes or no).

The EWSWA uses the following scoring system:

- High – an introduced flora species that scores yes to all three criteria. An introduced flora species with a high rating would indicate prioritising this weed for control and/or research.
- Moderate – an introduced flora species that scores yes to tow of the three criteria. Rating an introduced flora species as moderate would indicate that control or research effort should be directed if funds are available, however it should be monitored.

- Mild – an introduced flora species that scores yes to one of the three criteria. A mild rating would indicate that monitoring and control of the introduced flora species is necessary where appropriate.
- Low – an introduced flora species that scores no to all three criteria. A low rating would mean that this species would require a low level of monitoring.

The EWSWA (CALM, 1999) provided a ranking of weed species on a state-wide basis against three criteria – invasiveness, distribution and environmental impacts (as detailed above). A total of 1350 weeds were rated through this process as high, moderate, mild or low, with 34 weed species being rated as high.

The State-wide ratings from the Strategy are now considered to be too broad to be of use from an on-ground operational perspective and are now out of date (DPAW, 2013b). In an effort to address these issues and implement an integrated approach to weed management on DPAW-managed lands in WA, the Weed Prioritisation Process for DPAW was developed in 2008.

DPAW proposed that the Weed Prioritisation Process was to prioritise in each DPAW Region, with the aim being to establish both a species-led and an asset-protection-based approach to weed management (DPAW, 2013b). The species-led process assessed weed species for their invasiveness, ecological impacts, potential and current distribution and feasibility of control. The resulting priorities focus on infestations of species which are considered to be high impact, rapidly invasive and still at a population size which is feasible to eradicate or contain to a manageable size. Hence, weed species which are already widespread did not rank as a high priority through this part of the process.

The rating for each of the six introduced taxa with regards to the EWSWA and the Species-led process is detailed in Table 16.

5.2 Fauna

5.2.1 Fauna Habitats

A total of three fauna habitats were recorded in the study area: Banksia Woodland, Eucalypt Woodland and a Dampland (Figure 10). Tracks comprised 9 ha. Habitat assessments were completed at 26 sites across the study area (Appendix H). Habitats are summarised in Table 18 and detailed in the following sections.

Table 18 Fauna habitat types

Habitat type	Area (ha)	Habitat value	Black Cockatoo value
Banksia Woodland	663	Moderate	Moderate
Eucalypt Woodland	315	High	High
Dampland	3	Moderate	Low

5.2.1.1 Banksia Woodland

The vegetation of this habitat type is typified by *Banksia attenuata, Banksia menziesii, Eucalyptus todtiana* and *Nuytsia floribunda* woodland over *Allocasuarina humilis, Xanthorrhoea preissii* and *Macrozamia riedlei* over various herb and sedge species. The Banksia Woodland habitat is generally located on the geographically flat section of the study area. This habitat type has occasional and sporadic mature Jarrah trees growing with in it and they are usually associated with the buffer zone between the Banksia woodland and Eucalypt Woodland habitats. The sandy soils of this habitat provide ideal substrate for burrowing species such as dragons and goannas. Microhabitats provided by this habitat include leaf litter, exfoliating bark and Banksia flowers which provide a feeding resource to nectivores. Due to the dominance of the Banksia species this habitat type does not contain many tree hollows or hollows logs. The Banksia

Woodland habitat is classified as being in excellent condition with little weed impact, old fire age and some dieback effected areas and it provides moderate habitat value.

5.2.1.2 Eucalypt Woodland

The vegetation of this habitat type is typified by *Eucalyptus marginata*, *Eucalyptus todtiana* and *Corymbia calophylla* over *Banksia attenuata* and *Banksia menziesii* over herbs and sedges. The Eucalypt Woodland habitat is generally dominated by jarrah over most of the study area with Marri becoming increasingly more common along the western border of the site. The sandy soils of this habitat provide ideal substrate for burrowing species such as dragons and goannas. Microhabitats provided by this habitat include sandy soils, leaf litter, exfoliating bark, hollow logs and tree hollows. The dense canopy foliage and presence of tree hollows provides suitable habitat for a range of birds, specifically for the species that nest in tree hollows such as parrots. The abundant leaf litter and fallen logs produce refuge for ground dwelling fauna. The Eucalypt Woodland habitat is classified as being in excellent condition with little weed impact, old fire age and some dieback effected areas and it provides high habitat value.

5.2.1.3 Dampland

The vegetation of this habitat type is typified by *Banksia attenuata* woodland over *Kunzea glabrescens* and *Banksia menziesii* shrubland over *Macrozamia riedlei* and *Xanthorrhoea preissii* over various sparse herbs in a seasonally inundated depression. The Dampland habitat is located in the low lying part, in the southwest of the study area. The Dampland is a small remnant (3 ha) after the rest of the habitat was cleared and used as pastures in the surrounding properties. This habitat type as its name suggests is an area where moisture collects and during the winter months becomes seasonally waterlogged. The damp nature of this habitat provides an ideal environment for amphibians. Microhabitats provided by this habitat include damp soil, leaf litter, exfoliating bark and dense mid-story vegetation which provide habitat for many bird species. The Dampland habitat is classified as being in excellent condition with little weed impact, old fire age and it provides moderate habitat value.

5.2.2 Black Cockatoo Habitat Assessment

The habitat types of the study area were assessed upon the habitat they provide to Black Cockatoos and classified as being high, moderate or low value habitats. The Eucalypt Woodland provides quality foraging, roosting and breeding habitat and is classified as being high value Black Cockatoo habitat. The Banksia Woodland provides quality foraging habitat and is classified as being moderate value Black Cockatoo habitat, due to the lack of breeding habitat. The Dampland provides limited foraging habitat and is classified as being low value Black Cockatoo habitat (Table 18 and Figure 11). A description of the foraging, roosting and breeding habitat is provided in the following sections.

5.2.2.1 Foraging Assessment

The study area contains 17 plant species that are known foraging resources for Black Cockatoos (Valentine and Stock, 2008, and Chapman, 2007) (Table 19). All habitat types contained multiple foraging resources, as such the entire study area can be classified as foraging habitat for Black Cockatoos which equates to approximately 981 ha of foraging habitat. No signs of current and historical foraging evidence were located.

Table 19 Foraging Resources of the study area

Foraging species	Foraging resource
Banksia attenuata	flowers, seeds
Banksia dallanneyi	flowers, seeds
Banksia grandis	flowers, seeds

Foraging species	Foraging resource
Banksia menziesii	flowers, seeds
Banksia sessilis	flowers, seeds
Corymbia calophylla	flowers, seeds, nectar
Eucalyptus marginata	seeds
Eucalyptus todtiana	seeds
Hakea costata	seeds
Hakea lissocarpha	seeds
Hakea prostrata	seeds
Hakea ruscifolia	seeds
Hakea stenocarpa	seeds
Hakea trifurcata	seeds
**Lupinus* sp.	seeds
Mesomelaena tetragona	seeds
Mesomelaena pseudostygia	seeds
Xanthorrhoea preissii	seeds

5.2.2.2 Roosting Assessment

The Eucalypt Woodland habitat contains stands of tall trees that are located close to riparian environments and permanent water sources, which according to the Cockatoo referral guidelines constitutes roosting habitat for Black Cockatoos (DSEWPAC, 2012). Trees or stands of trees that match this description were examined for evidence of recent use as a roost site (feathers and droppings), however none was located.

A database search was completed for known roost locations for Carnaby's Cockatoos with none located in the study area or its immediate surrounds. The closest known roost sites occur in Gingin and Yanchep which are approximately 17 km north and west of the study area respectively (Burnham et al., 2010).

5.2.2.3 Breeding Assessment

As the study area was too large to accurately measure individual trees, a tree dentistry survey was used to give an estimate of the number of potential breeding trees (Appendix I). The study area contains an estimated 6,353 trees that have a DBH over 500 mm. This number is most likely an underestimate as the Banksia Woodland contained some suitable sized trees, however these were omitted from the total tree estimate as their sporadic nature would make the tree density estimates inaccurate. The Cockatoo referral guidelines states "in a woodland stand with trees of suitable diameter at breast height, all trees of all ages and size are potentially important for maintaining breeding in the long term," as such the Eucalypt Woodland is classified as breeding habitat (approximately 315 ha). The tree density survey identified areas of high, moderate and low tree densities within the Eucalypt Woodland. Areas containing a tree density of between 0-9 trees per hectare were classified as low density, areas with densities of 10-19 trees per hectare were classified as moderate density and areas containing 20 or more trees per hectare were classified as being high density (Table 20 and Figure 11).

Table 20 Breeding tree density

Tree density	Area (ha)
Eucalypt Woodland – High Density	193
Eucalypt Woodland – Moderate Density	112
Eucalypt Woodland – Low Density	10

A total of 30 trees with hollows classified as suitable for current breeding (with an opening greater than 20 cm diameter) were opportunistically identified across the site (Appendix I). However, there was no evidence of their use as historic breeding sites (chew marks around hollow openings and droppings). As stated these records were opportunistically recorded while walking around the study area and do not represent the full breeding capability of the site.

The availability of foraging habitat within 6 to 12 km of breeding sites is important in providing the resources necessary for raising chicks (DSEWPAC, 2012). The study area and the surrounding nature reserves (Boonanarring Nature Reserve and Leda Nature Reserve) contain large amounts of quality foraging habitat supporting any potential breeding sites in the vicinity.

5.2.3 Faunal Assemblage

From the desktop assessment a total of 221 species have been previously recorded in the vicinity of the study area (Appendix J). These include 12 amphibians, 47 reptiles, 134 birds and 28 mammals. As stated earlier all marine and aquatic species have been omitted from this list as no suitable habitat is present. Of these 39 species were recorded during the survey including one species of amphibian, three species of reptile, 32 species of bird and three species of mammal. The Black-eared Cuckoo (*Chrysococcyx osculans*) was recorded during the survey but has not been previously recorded form the vicinity. This record is just outside of the southerly distribution of this otherwise common species.

5.2.3.1 Amphibians

From the desktop review a total of 12 species of amphibian were identified as being previously recorded in the vicinity of the study area. One species, the Quacking Frog (*Crinia georgiana*) was recorded in the Eucalypt Woodland habitat type during the survey (Appendix J).

5.2.3.2 Reptiles

From the desktop review a total of 47 species of Reptile were identified as being previously recorded in the vicinity of the study area. Three species, the Buchanan's Snake-eyed Skink (*Cryptoblapherus buchananii*), West Coast *Ctenotus* (*Ctenotus fallens*) and the Southern Shovel-nosed Snake (*Brachyurophus semifasciatus*) were recorded in the Eucalypt Woodland habitat type during the survey (Appendix J).

5.2.3.3 Birds

From the desktop review a total of 134 species of birds were identified as being previously recorded in the vicinity of the study area. A total of 32 species were recorded during the survey. The most speciose families recorded during the survey were Psittacidae (Parrots) with four species, Meliphagidae (Honeyeaters) with four species and Cuculidae (Cuckoos) with three species (Appendix J).

5.2.3.4 Mammals

From the desktop review a total of 28 species of mammals were identified as being previously recorded in the vicinity of the study area. A total of three species of mammal were recorded during the survey, the Western Grey Kangaroo (*Macropus fuliginosus*), Western Brush Wallaby (*Macropus irma*) and the Red Fox (*Vulpes vulpes*) which is an introduced species (Appendix J).

5.2.4 Conservation Significant Fauna

The Western Brush Wallaby (*Macropus irma*) listed as Priority 4 was the only conservation significant fauna species recorded during the survey (Table 21 and Figure 10).

From the desktop assessment a total of 14 conservation significant species have been previously recorded in the study area. Of these one species was recorded, six species are classified as 'Likely' to occur, three species are classified as 'Possible' to occur and four species are classified as 'Unlikely' to occur (Table 22).

Table 21 Location of recorded conservation significant fauna

Species	Conservation status	Habitat type	Easting	Northing
Western Brush Wallaby (*Macropus irma*)	P4	Eucalypt Woodland	50J 404973	6515779

Table 22 Likelihood of occurrence for conservation significant fauna

Species	Conservation status	Habitat relevance	Likelihood[1]
Western Carpet Python (*Morelia spilota imbricata*)	S4	All habitat types within the study area provide habitat for this species. Especially the Eucalypt Woodland which contains Tree hollows and hollow logs used by this species to shelter in. The Western Carpet Python has been previously recorded 20 km southwest of the study area (GHD, 2013a).	Likely
Black-striped Snake (*Neelaps calonotos*)	P3	The Banksia and Eucalypt Woodland of the study area contain the leaf litter and loose soil preferred by this species. The Black-striped Snake has been previously recorded 8 km south of the study area in Muchea (DPAW, 2014b).	Likely
Peregrine Falcon (*Falco peregrinus*)	S4	The study area does not contain the cliff faces this species prefers to nest on. However, due to the vagrant nature of the Peregrine Falcon it may use the study area as part of a wider foraging territory. This species has been previously recorded in the vicinity of the study area (ATA, 2007, DPAW, 2014a and Birdata, 2014).	Possible
Bush Stone-curlew (*Burhinus grallarius*)	P4	Although suitable habitat exists in the study area for this species there have been limited recent records of this species on the Swan Coastal Plain and is thought to be locally extinct due to predation from feral species.	Unlikely
Brush Bronzewing (*Phaps elegans*)	P4	The Eucalypt Woodlands provides marginal habitat for this species, but lacks the dense shrubs and understory this species prefers. This species is thought to be locally extinct on the Swan Coastal Plain (Johnstone and Storr, 1998).	Unlikely
Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)	Vu, S1	The Eucalypt Woodland provides both foraging and breeding habitat for this species and the Banksia Woodland provides foraging habitat for this species. Based upon the distribution map in the referral guidelines the study area is at the northern extent of this species distribution. There have been no records of this species in the vicinity of the study area, the closest occurring approximately 40 km south of the study area (DPAW, 2014b).	Possible
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	En, S1	The Eucalypt Woodland provides both foraging and breeding habitat for this species and the Banksia Woodland provides foraging habitat for this species. There have been numerous records of this species occurring in the vicinity of the study area (Burbidge *et al*, 1996; ATA, 2007; GHD, 2013a; DPAW, 2014a, b).	Likely

Species	Conservation status	Habitat relevance	Likelihood[1]
Baudin's Cockatoo (*Calyptorhynchus baudinii*)	Vu, S1	The Eucalypt Woodland provides both foraging and breeding habitat for this species and the Banksia Woodland provides foraging habitat for this species. The study area is mapped as occurring outside of this species current distribution (DSEWPAC, 2012) and the most recent record of this species in the vicinity is from more than 30 years ago (DPAW, 2014a).	Unlikely
Barking Owl (*Ninox connivens*)	P2	This species prefers the thick vegetation present is the forests of the deep southwest of Western Australia, rather than the open woodlands located in the study area. The closest recent record of this species is from an isolated record approximately 50 km south of the study area.	Unlikely
Fork-tailed Swift (*Apus pacificus*)	Mi, S3	The Fork-tailed Swift is an almost exclusively aerial species, foraging and sleeping on the wing. This species is independent of terrestrial habitats. This species has been previously recorded in the vicinity of the study area (Birdata, 2014).	Possible
Rainbow Bee-eater (*Merops ornatus*)	Mi, S3	The Rainbow Bee-eater is one of the most widespread bird species in Australia (Barrett et al., 2003) occurring in a range of habitats. All habitat types of the study area provide suitable habitat for the Rainbow Bee-eater. This species has been previously recorded in the vicinity of the study area (Tingay, 1994, Burbidge, 1996, ATA, 2007, GHD, 2013a, DPAW, 2014a and DPAW, 2014b)	Likely
Western Quoll (*Dasyurus geoffroii*)	Vu, S1	The Western Quoll occurs in a wide range of habitats including woodlands, dry sclerophyll forests and riparian vegetation, where it creates dens in hollow logs, burrows, tree hollows and cavities. All habitats in the study area provide foraging habitat for this species with the Eucalypt Woodland providing potential den sites with the presence of tree hollows and hollow logs. There are scattered records of this species in the vicinity of the study area, the closest occurring in Bindoon (DPAW, 2014a).	Likely
Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)	P5	The Southern Brown Bandicoot is occurs in areas containing dense ground cover such as forests, woodlands, scrub and heathlands. It is particularly prevalent in areas surrounding wetlands and damplands. The Dampland habitat provides ideal habitat for this species however the conical diggings typical of this species were not identified during the survey. This species has been previously recorded in Bindoon (DPAW, 2014a) and in the vicinity of the study area (Tingay, 1994, GHD, 2013a and DPAW, 2014b).	Likely

Species	Conservation status	Habitat relevance	Likelihood[1]
Western Brush Wallaby (*Macropus irma*)	P4	The Western Brush Wallaby occurs in open forests or woodlands, favouring open seasonally wet flats and thickets (van Dyck and Strahamn, 2008). The Eucalypt Woodland and Banksia Woodland provide ideal habitat for this species and one individual was recorded in the Eucalypt Woodland during the survey. This species has been previously recorded in the vicinity to the study area (Burbidge, 1996).	Recorded

1. Likelihood definitions:
   Recorded – The species was recorded within the study area, historically or during the survey.
   Likely – Suitable habitat is present and records of this species exist close to the study area.
   Possible – Suitable habitat is present however no records exist in the vicinity, or records exist in the vicinity but suitable habitat is nearby but not in the study area.
   Unlikely – Neither suitable habitat nor records exist near the study area.

6 DISCUSSION

6.1 Flora

A detailed Level 1 flora and vegetation assessment, in accordance with the EPA's Guidance Statement No. 51 (EPA, 2004a), was undertaken. The assessment involved a desktop review of available and relevant literature and a site reconnaissance involving the sampling of 30 relevés (simplified floristic sampling points) located throughout the study area.

The site reconnaissance survey involved the identification of vascular plant taxa recorded from the 30 relevés and from site traverses to identify additional vascular plant taxa not identified at each of the relevés. The survey also included an assessment of the presence/absence and population size of the Threatened and Priority listed taxa known to occur in the study area.

6.1.1 Vegetation

A total of four broad floristic formations and 16 vegetation associations were delineated from the study area during the July 2014 site visit. The vegetation associations recorded from the study area were considered to be in excellent condition with isolated patches of very good and good condition vegetation. The areas of vegetation in good and very good condition were located on the outer edges of the study area against the cleared paddocks and along areas of previously disturbed areas (i.e. the power line infrastructure corridor along the western boundary).

The four broad floristic formations included: *Eucalyptus* woodland, *Corymbia* woodland, *Banksia* woodland and *Banksia* shrubland. The dominant formation across the study area was *Eucalyptus* woodland which included vegetation associations with an upper storey dominated by *Eucalyptus todtiana* and *Eucalyptus marginata*. The *Banksia* shrubland and *Banksia* woodland was separated into two separate formations based on the height and dominance of the *Banksia* species. The *Banksia* woodland formation consisted of associations with *Banksia attenuata* and *Banksia menziesii* greater than 10 m high.

The sixteen vegetation associations are not considered to be unique to the study area, however they do represent two Priority Ecological Communities (SCP23b and Banksia Yellow-Orange Sands) and one Threatened Ecological Community (SCP20c) according to data provided by DPAW. The presence of the TEC and two PECs was identified during the desktop review, while the distribution and extent of the PEC Banksia Yellow-Orange Sands is considered to be wider spread throughout the study area based on the vegetation association descriptions and extent.

In addition to the TEC and two PECs identified by DPAW during the desktop review, an additional two TECs, SCP20a and SCP20b, and one PEC, SCP21c, are inferred to occur in the study area. The TECs and PECs are located throughout the study area and in association with the known TEC and PECs locations, the majority of the vegetation within the study area is considered to be significant.

The presence and extent of the TECs and the two PECs cannot be accurately confirmed due to the lack of systematic quadrat sampling of the floristic composition recorded within the study area and a multivariate analysis and comparison of regional and existing datasets (including the dataset from Gibson *et al*., 1994) has not been completed. However, a comparison of the floristic information collected at each of the 30 relevés and the biological and geological information known for each of the TEC and PECs has been completed. An inference on the floristic community type described from Gibson *et al*. (1994) can be made to identify possible TECs and PECs present within the study area.

The retention and vesting of the study area into a DPAW conservation estate will increase the pre-European extent within formal protection (DPAW conservation estates, Bush Forever sites in DPAW managed lands and Bush Forever sites in Regional Parks). The new extent within formal protection will not significantly increase to ensure they are above the 30% threshold however will push the Moondah complexes above the 10% endangered level.

The study area is located within a north-south ecological corridor that connects the Boonanarring Nature Reserve in the north and Leda Nature Reserve in the south. The corridor will allow the continual movement of genetic material (via insect and wind pollination) in a north-south movement to maintain genetic integrity.

6.1.2 Flora

A total of 154 vascular plant taxa from 38 families and 88 genera were recorded from the study area, including 148 native taxa and six introduced taxa. This number is considered to significantly increase if the survey was undertaken at the optimum time in spring for the Swan Coastal Plain.

One Threatened taxon, *Chamelaucium* sp. Gingin (N.G. Marchant 6) and one Priority listed taxon, *Hypolaena robusta* (P4), were recorded from the study area. An additional five Priority listed taxa, *Acacia cummingiana* (P3); *Caustis* sp. Gigas (A.S. George 9318) (P2); *Schoenus griffinianus* (P3); *Verticordia rutilastra* (P3); and *Verticordia serrata* var. *linearis* (P3), have previously been recorded from the study area. These five Priority listed taxa were not recorded at the time of the site reconnaissance.

The five Priority listed taxa not recorded at the time of the survey may still persist in the study area. The timing of the survey was not optimal for identifying the two *Verticordia* species and the *Schoenus* and *Caustis* species. Searches were conducted for *Acacia cummingiana* at the known location along Reserve Road but it was not recorded.

Chamelaucium sp. Gingin (N.G. Marchant 6) was recorded from 12 point locations totalling approximately 200 individuals. This number is considered to only represent a subset of the individuals known to occur in the northwest corner of the study area and the adjacent DPAW managed lands.

The study area is considered to represent critical habitat for *Chamelaucium* sp. Gingin (N.G. Marchant 6) according to the interim recovery plan (Stack and English, 2003). The study area represents current known occupancy, similar within 200 m and a corridor for pollination between populations located adjacent to the study area (Stack and English, 2003).

Hypolaena robusta (P4) was recorded from two locations within the study area and is known from one other location within the study area.

An assessment of the likelihood of the conservation significant flora identified from the desktop review occurring within the study area, concluded that ten conservation significant taxa are likely to occur within the study area. An additional 15 conservation significant taxa may potentially occur within the study area based on known locations and habitat preferences. The remaining 30 conservation significant taxa are not expected to occur within the study area based on habitat preferences and the current known locations of these taxa (Appendix D).

Of the ten conservation significant species likely to occur in the study area, only one, *Chamelaucium* sp. Gingin (N.G. Marchant 6), is listed Threatened (Declared Rare-Extant) under the WC Act and the EPBC Act. The remaining 19 Threatened taxa identified from the desktop review are not expected to occur in the study area based on their known distribution and preferred habitat requirements.

A total of six introduced taxa were recorded from the study area. The six introduced taxa are not considered to be WONS, while the Arum Lily (**Zantedeschia aethiopica*), recorded from the southwest corner in vegetation association Ba, is considered to be a Declared Pest under the BAM Act. The remaining

five introduced taxa are common weed species of disturbed or degraded sites and are present within the study area in low densities. The majority of the weeds are encroaching from the cleared paddocks located to the southwest and east of the study area.

6.2 Fauna

6.2.1 Fauna Habitats

The study area contains approximately 663 ha of Banksia Woodland, 315 ha of Eucalypt Woodland and 3 ha of Dampland habitat. The majority of the study area is classified as excellent condition, with dieback being the only major disturbance.

The fauna habitats present in the study area are considered to be common on a local scale with similar habitat existing in the immediate vicinity. Chandala Nature Reserve, Barracca Nature Reserve, Breera Road Nature Reserve and Yeal Nature Reserve are all located within 10 km of the study area. The close proximity of the study area to these permanent sections of native vegetation increases its local importance and value as an offset site. Habitat connectivity occurs with Breera nature reserve to the north, Chandala Nature Reserve to the east and even Bullsbrook Nature Reserve along a drainage line to the south of the study area. Drainage lines are well known conduits for fauna movement as they provide a well-covered/vegetated habitat to provide safe passage between areas. Due to its position and surrounding habitats the study area has an importance far greater than its 988 ha size suggests.

The large size of the study area and the excellent condition of the habitats indicates the full suite of microhabitats native fauna rely upon is present, e.g.: thick leaf litter, old logs and hollows, fruit/flower bearing trees. As such, the vast majority of the species in Appendix J are expected to occur in the study area. The large area of Banksia Woodland (663 ha) provides a wealth of foraging resource for nectivorous species such as honeyeaters and Honey Possums that are not readily supported by the fragmented landscapes present in urban areas.

The moderate to old age of the trees in the study area means they have become a hollow bearing resource, many species of bird and mammal rely on as integral part of their life cycle e.g.: for breeding and shelter. Galahs and Australian Ringnecks were seen using hollows during the survey. The lack of recent fire in some sections of the study area has meant that tree branches and limbs have fallen but are yet to produce tree hollows or hollow logs, which would increase the habitat value of the study area.

6.2.2 Black Cockatoo Habitat

The study area provides suitable foraging, roosting and breeding habitat for the Carnaby's Cockatoo and to a lesser extent the Forest Red-tailed Cockatoo (due to the study area occurring at the northern extent of its distribution). During the survey no evidence of either species of Black Cockatoo was recorded in the study area however the presence of such species can be difficult to assess due to their seasonal movement patterns and sporadic nature.

The location of the study area is strategic as it supports Carnaby's Cockatoos during their migration to and from breeding sites in the Wheatbelt. Carnaby's Cockatoos that have been breeding in the Dandaragan, Moora and Bindoon regions potentially move through the vicinity of the study area prior to their movement south through the Swan Coastal Plain. Bindoon and the areas around it have been identified as an appropriate location to be recommended as offset site and Chittering has been identified as an area under pressure (Johnstone and Kirkby, 2011).

The study area contains 17 species of known foraging resources for Black Cockatoos and approximately 981 ha classified as foraging habitat. The habitats present are dominated by Jarrah, Marri and *Banksia* species which are all important foraging species. The mature age of the foraging species (predominantly

Jarrah, Marri and *Banksia* species) allows a greater yield of fruiting bodies/seed pods as compared to immature habitats. Given the large area of foraging habitat and the excellent condition of the vegetation the study area provides an important foraging resource for Black Cockatoos in the vicinity.

Roost sites for Black Cockatoos typically have tall, dense canopied trees, are close to water where the birds can drink and close to food trees such as *Banksias* and Marri. The roost trees are usually clumped and at larger roosts, cover an area of at least five hectares (Burnham et al., 2010). The study area provides ideal setting as a potential roost site, as it contains these conditions. The closest known roost sites for Carnaby's Cockatoos occur in Gingin and Yanchep which are approximately 17 km north and west of the study area respectively (Burnham et al., 2010). These sites are known from their inclusion in the Great Cocky Count where potential roost sites are surveyed. As no roost surveys have been conducted in the study area or its direct surrounds an accurate assessment of its use as a roost site cannot be ascertained. The entire Eucalypt Woodland habitat is classified as containing roosting habitat which equates to approximately 315 ha.

The tree age in the study area is sufficient to produce large hollows with potential to yield more with subsequent fires. For hollows to be of use to Carnaby's Cockatoos dimensions must be a minimum of 14 cm entrance size and at least 50 cm deep (Groom, 2011). As such, the study area contains habitat that can be classified as having current breeding potential for Carnaby's Cockatoos in a region known to have breeding records (Johnstone and Kirkby, 2011). The Cockatoo referral guidelines states "in a woodland stand with trees of suitable diameter at breast height, all trees of all ages and size are potentially important for maintaining breeding in the long term," as such the Eucalypt Woodland is classified as breeding habitat (approximately 315 ha). The tree density survey results show that the study area contains large areas (192 ha) with a high tree density, with more than 20 trees with a DBH over 500 mm per hectare. An estimated 6,353 trees with a DBH over 500 mm occur in the study area. As such, the study area contains large areas of high quality breeding habitat for Black Cockatoos.

6.2.3 Conservation Significant Fauna

The only conservation significant fauna recorded in the study area was the Priority 4 listed Western Brush Wallaby (*Macropus irma*). A further six species of conservation significance are considered Likely to occur in the study area.

The Western Brush Wallaby is listed as Priority 4, rare, near threatened and other species in need of monitoring under the DPAW Priority listings. It occurs only in the South West of Western Australia and has undergone a massive decline due to habitat fragmentation in the Wheatbelt and fox predation. Due to foxes some populations have experienced an 80% reduction between the 1970s and 1990s. However, fox control has allowed this species to become more common throughout its range (Van Dyck and Strahan, 2008). Limited records for this species occur for the vicinity of the study area (DPAW, 2014b). One individual was recorded in the Eucalypt Woodland but it is also expected to occur across the Banksia Woodland habitat.

The Western Carpet Python (*Morelia spilota imbricata*) occurs only along the southwestern portions of Western Australia and is listed as Schedule 4 under the WC Act. Threatening processes include habitat destruction and changed fire regimes, with the impact of feral predators being unknown (Pearson et al., 2005 and DEC, 2012). This species requires large areas of undisturbed bushland (Bush et al., 2007) and is expected to occur in all habits types of the study area. The large area of excellent condition habitat and abundance of logs and tree hollows suggest the study area is ideal habitat for this species.

The Black-striped Snake (*Neelaps calonotos*) is listed as Priority 3, poorly-known species under the DPAW Priority listings. It occurs only along the Swan Coastal Plain with the bulk of this species known distribution occurring in the Perth region, however there have been recent records of this species further north near Dongara and Eneabba suggesting it has a broader distribution (Bush et al., 2010). Threatening processes

involve habitat destruction within its small distribution. Both the Banksia Woodland and Eucalypt Woodland provide ideal habitat for this species. There have been records of this species from the vicinity of the study area from Muchea and Gingin (DPAW, 2014b).

The Carnaby's Cockatoo (*Calyptorhynchus latirostris*) is listed as Endangered under the EPBC Act and Schedule 1 under the WC Act. This species is endemic to the southwest of Western Australia, from Kalbarri in the north to Esperance (DSEWPAC, 2012). In the last 45 years the Carnaby's Cockatoo population has dropped to by 50% to an estimated 40,000 individuals (Johnstone et al., 2008 and Cale, 2003). The major threats to this species include clearing of their core breeding habitat in the Wheatbelt and the clearing of foraging resources on the Swan Coastal Plain (Cale, 2003). There are numerous records of this species in the vicinity of the study area (Burbidge et al., 1996, ATA, 2007, GHD, 2013a, b, DPAW, 2014a and DPAW, 2014b), including breeding records form Bindoon and Gingin (Johnstone and Kirkby, 2011). As mentioned previously the Banksia Woodland provides foraging habitat for this species and the Eucalypt Woodland provides foraging, roosting and breeding habitat for this species.

The Rainbow Bee-eater (*Merops ornatus*) is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. The Rainbow Bee-eater is one of the most widespread birds species in Australia distributed across mainland Australia (Barrett et al., 2003). There are no known threats to this common species. All habitat types are expected to be used by this species.

The Western Quoll (*Dasyurus geoffroii*) is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act. Once distributed over 70% of Australian this species distribution is now down to 5% of its former range, restricted to the southwest of Western Australia (Orell and Morris, 1994). The major threats to this species include feral predators, habitat clearing and changed fire regimes (Smith et al., 2004). The Western Quoll has large home range, 400 ha for females and 900 ha for males. Given the connectivity with surrounding areas of bush and the large size of the site the potential exists for this species to reside in the study area or its surrounds. All habitat types would be used as foraging habitat and the hollows logs found in the Eucalypt Woodland provides suitable den site locations. The Western Quoll has been recently recorded In Bindoon.

The Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) is listed as Priority 5, conservation dependent species under the DPAW Priority listing. The West Australian sub species is distributed along the coast from Guilderton to Esperance (DPAW, 2014b). The major threatening processes for this species are fragmentation and loss of habitat, predation by foxes, cats and in residential areas dogs. The Dampland habitat and the surrounding Woodlands provide habitat for this species. This species has been previously recorded in Bindoon and in the vicinity of the study area (Tingay, 1994, GHD, 2013a and DPAW, 2014b).

6.3 Conservation Value

In summary, the study area is considered to be of high conservation value comprising habitat for a significant number of threatened flora and fauna species. Some of these species are likely to be impacted by the NorthLink WA project. The vegetation is representative of a number of Threatened and Priority Ecological Communities, some of which likely to be impacted by the NorthLink WA Project. The addition of the study area to the conservation estate will substantially increase the estate with the adjacent Class C Reserve and provide protection of an important ecological linkage.

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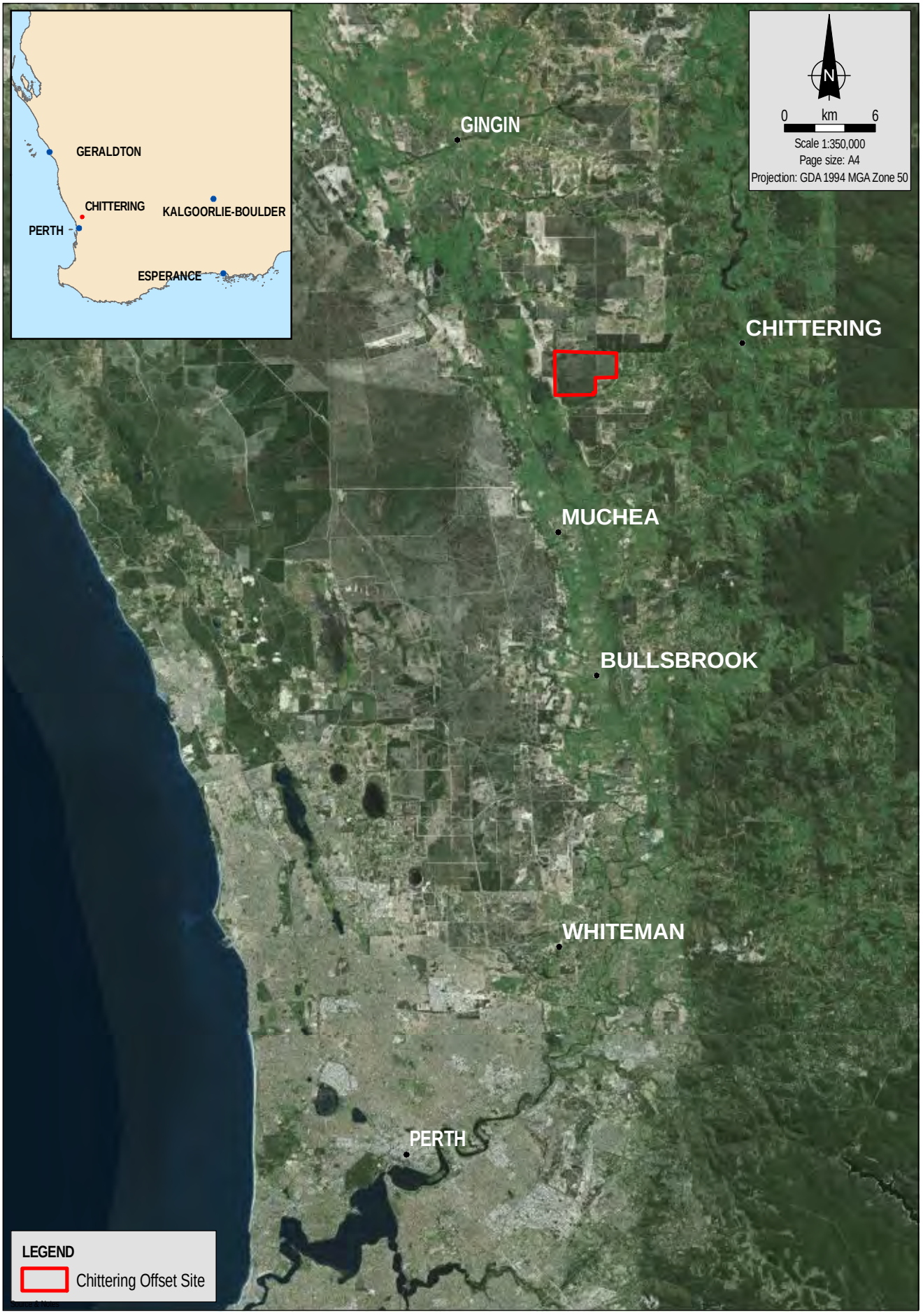
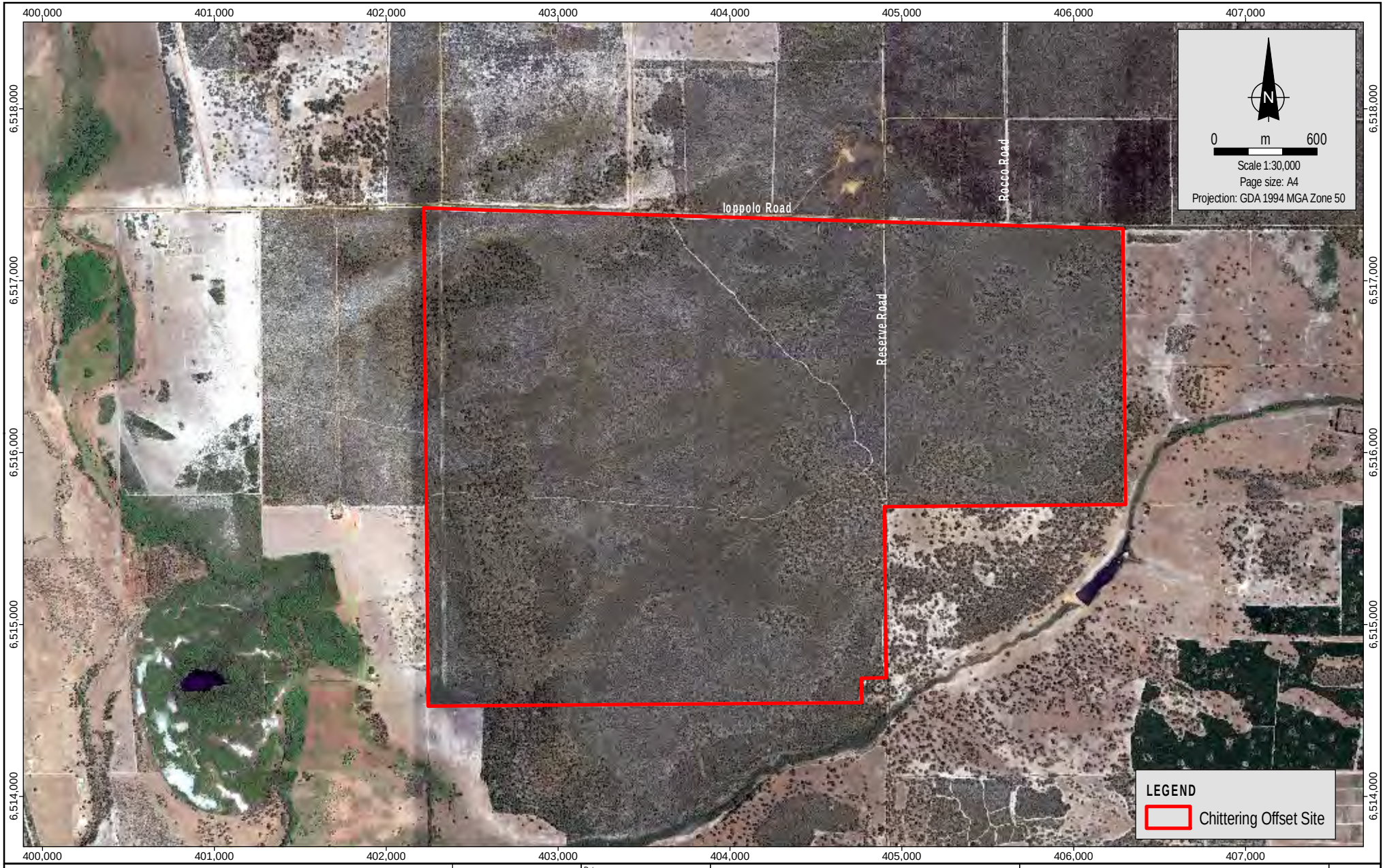
Figures



coffey	Date: 14.04.2015 MXD: 4483AA_06_GIS001_1 File Name: 4483AA_06_F001_GIS	Main Roads WA NorthLinkWA	Regional Location Flora, Vegetation and Fauna Assessment	Figure No: 1



Source & Notes
Aerial Imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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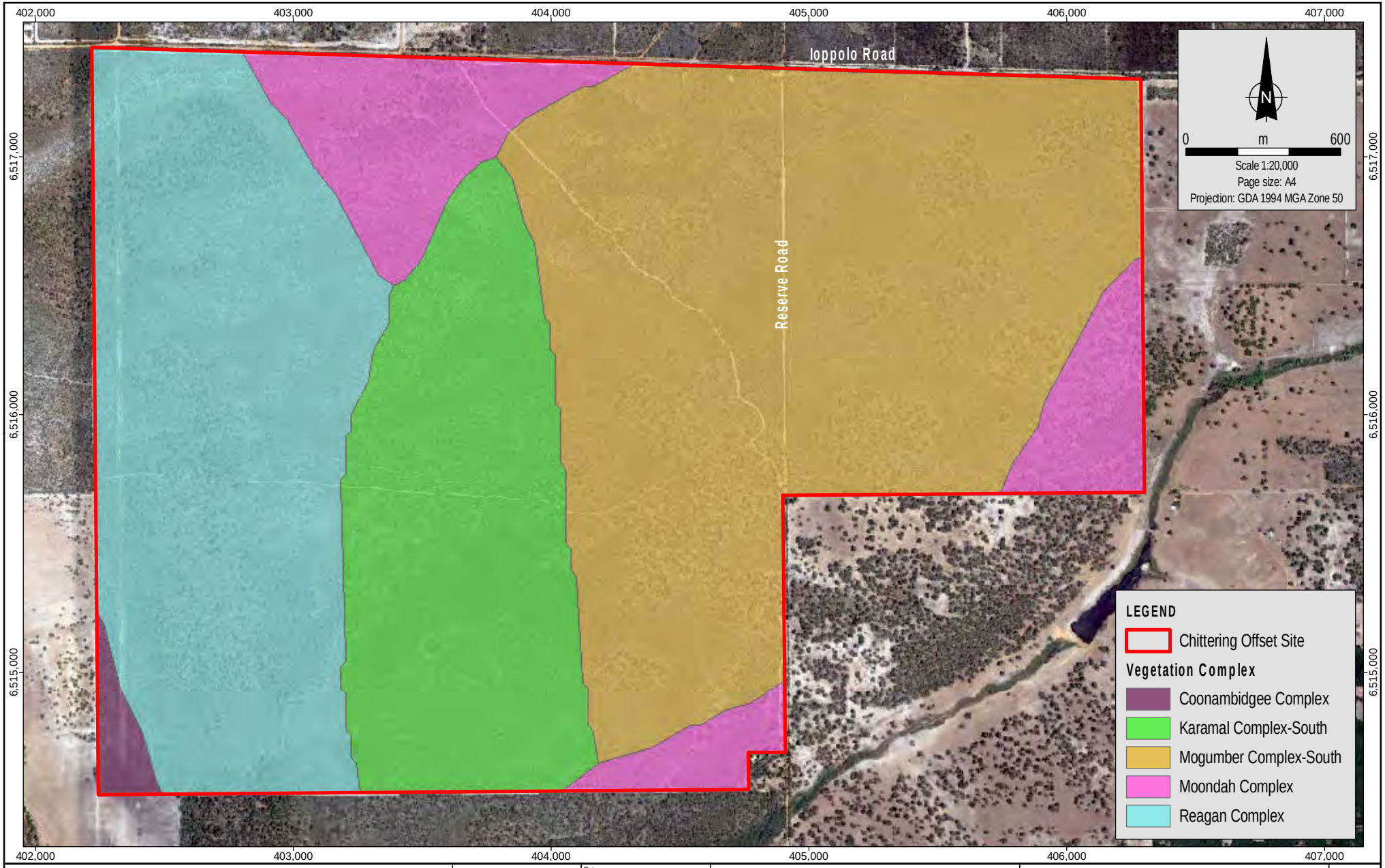
Main Roads WA

NorthLinkWA

Study Area
Flora, Vegetation and Fauna Assessment

Figure No: **2**



Source & Notes
Vegetation complex mapping from DPAW (January 2015).
Aerial Imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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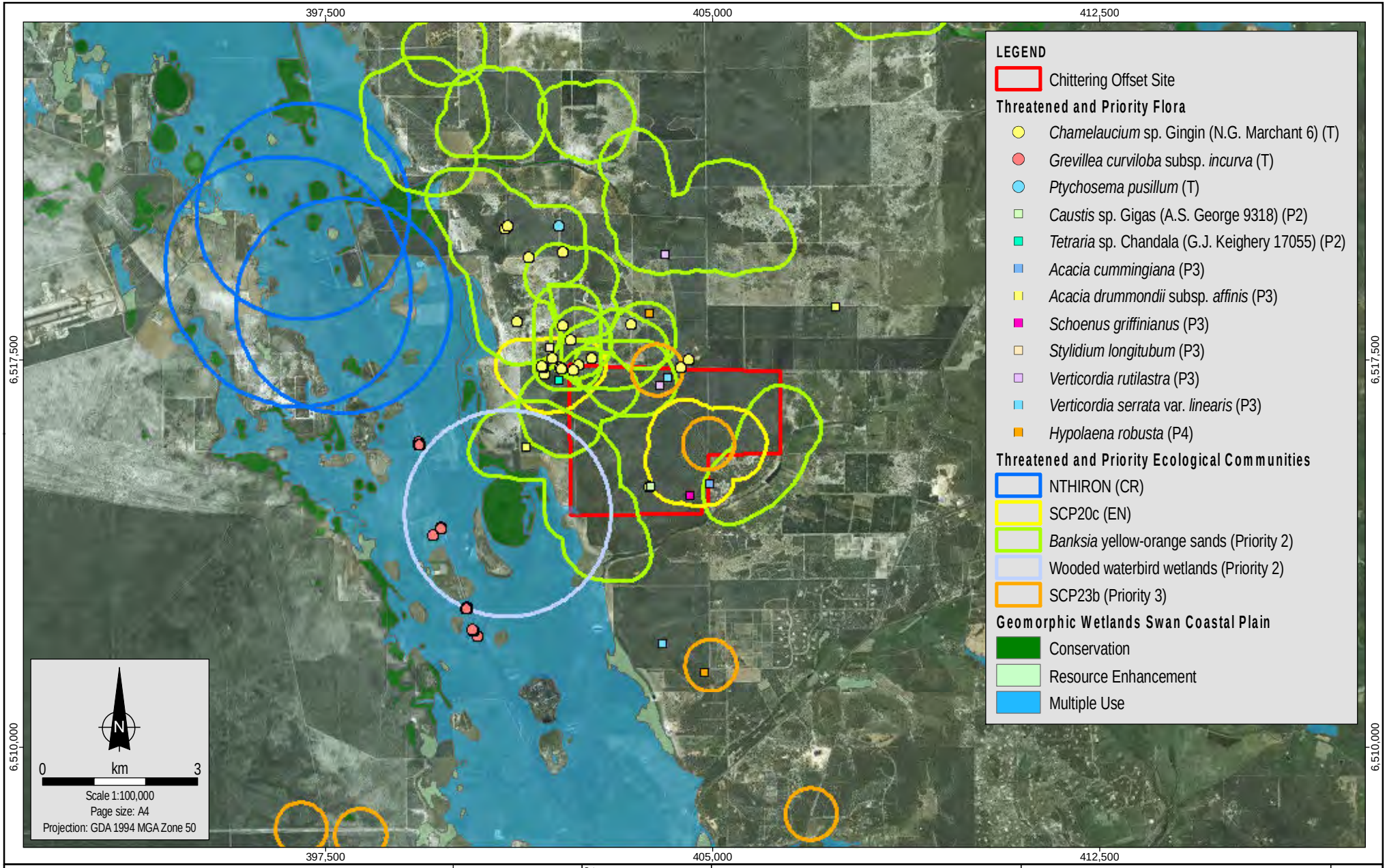
Main Roads WA

NorthLinkWA

Vegetation Complexes
Flora, Vegetation and Fauna Assessment

Figure No: 4



Source & Notes
Conservation significant flora and vegetation mapping from Coffey (August 2014).
Aerial imagery from ArcGIS Online.

coffey

Date: 14.04.2015
MXD: 4483AA_06_GIS023_1
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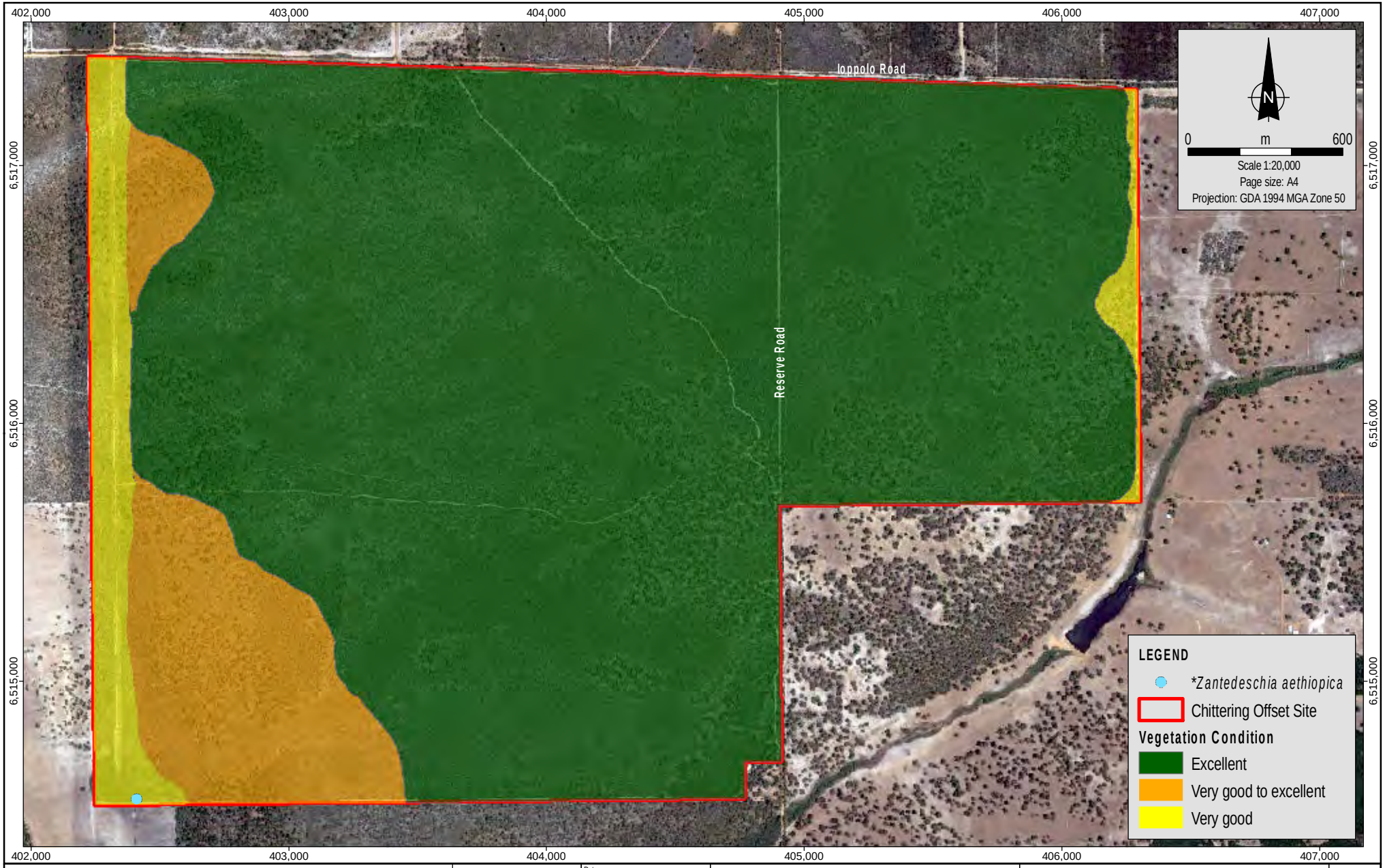
Main Roads WA

NorthLinkWA

Flora and Vegetation Constraints
Flora, Vegetation and Fauna Assessment

Figure No: 5



Source & Notes
*<ita>Zantedeschia aethiopica</ita> location and vegetation condition mapping from Coffey (2014)
Aerial Imagery from Google Earth Pro (10.01.2015).

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Date: 14.04.2015
MXD: 4483AA_06_GIS005_1
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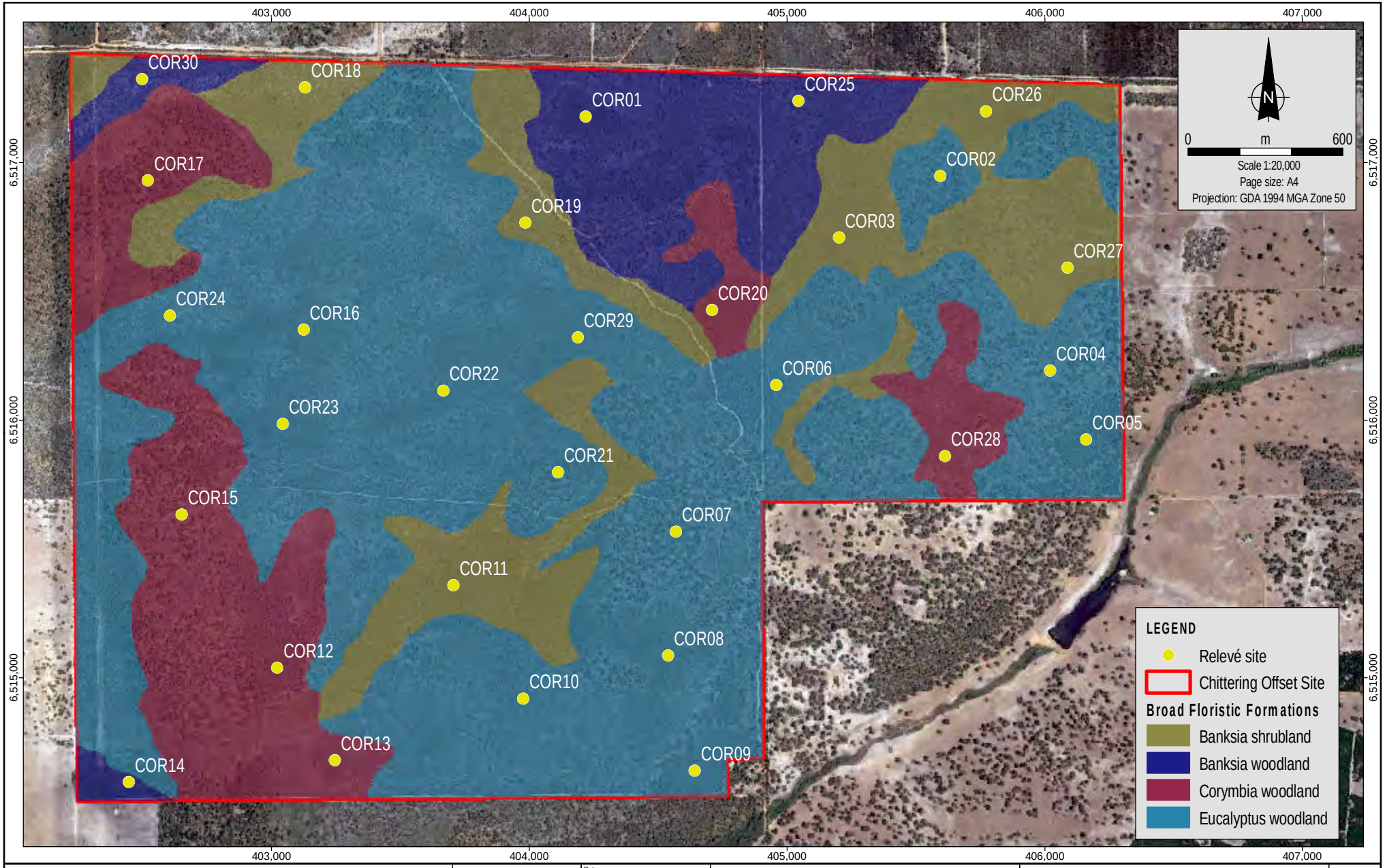
Main Roads WA

NorthLinkWA

Vegetation condition and introduced flora

Flora, Vegetation and Fauna Assessment

Figure No: **6**



Source & Notes
Relevé sites and broad floristic formation mapping from Coffey (2014).
Aerial Imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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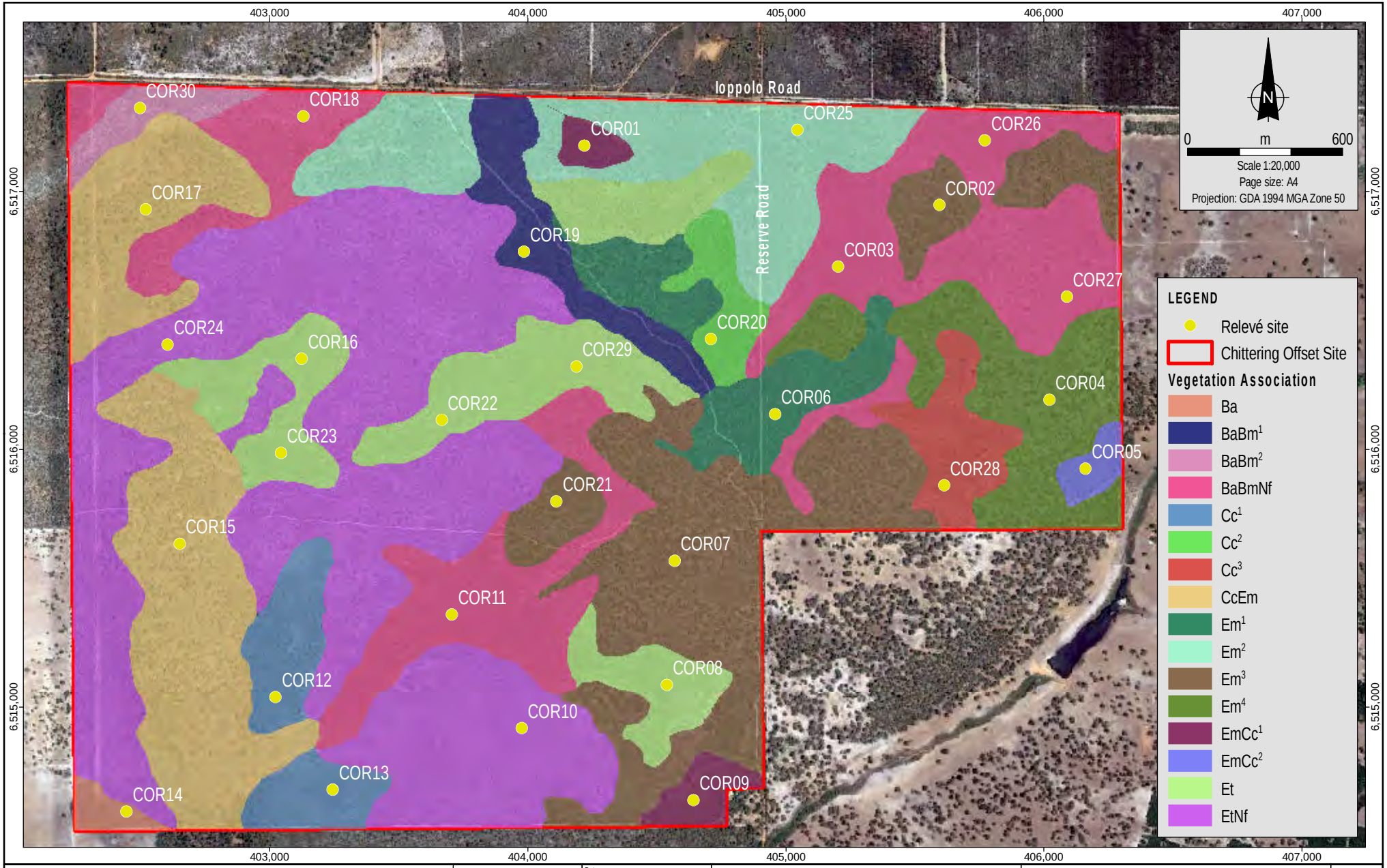
Main Roads WA

NorthLinkWA

Broad Floristic Formations
Flora, Vegetation and Fauna Assessment

Figure No: 7



Source & Notes
Relevé sites and vegetation association mapping from Coffey (August 2014).
Aerial imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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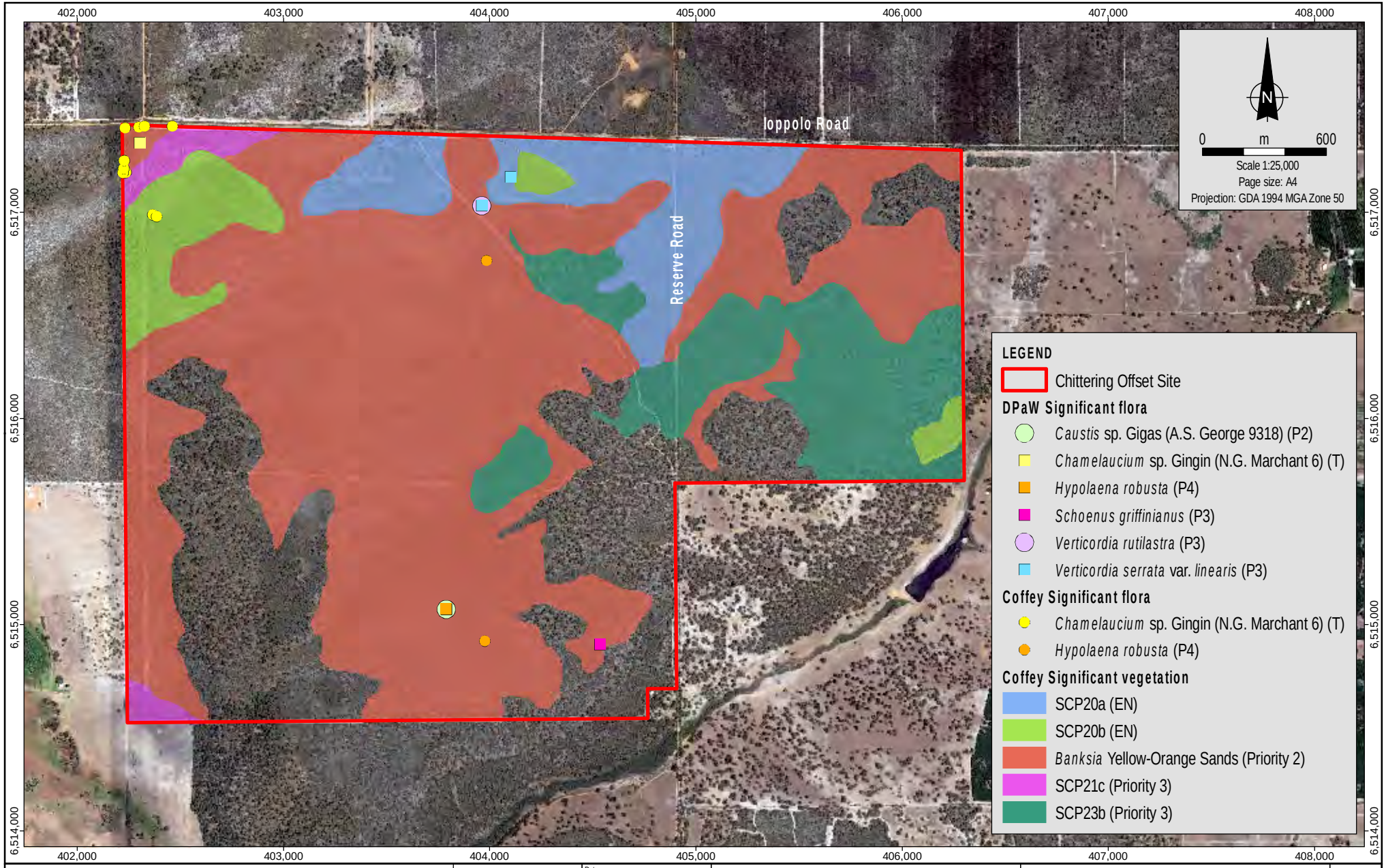
Main Roads WA

NorthLinkWA

Vegetation Associations
Flora, Vegetation and Fauna Assessment

Figure No: 8



Source & Notes
Conservation significant flora and vegetation mapping from Coffey (August 2014).
Aerial imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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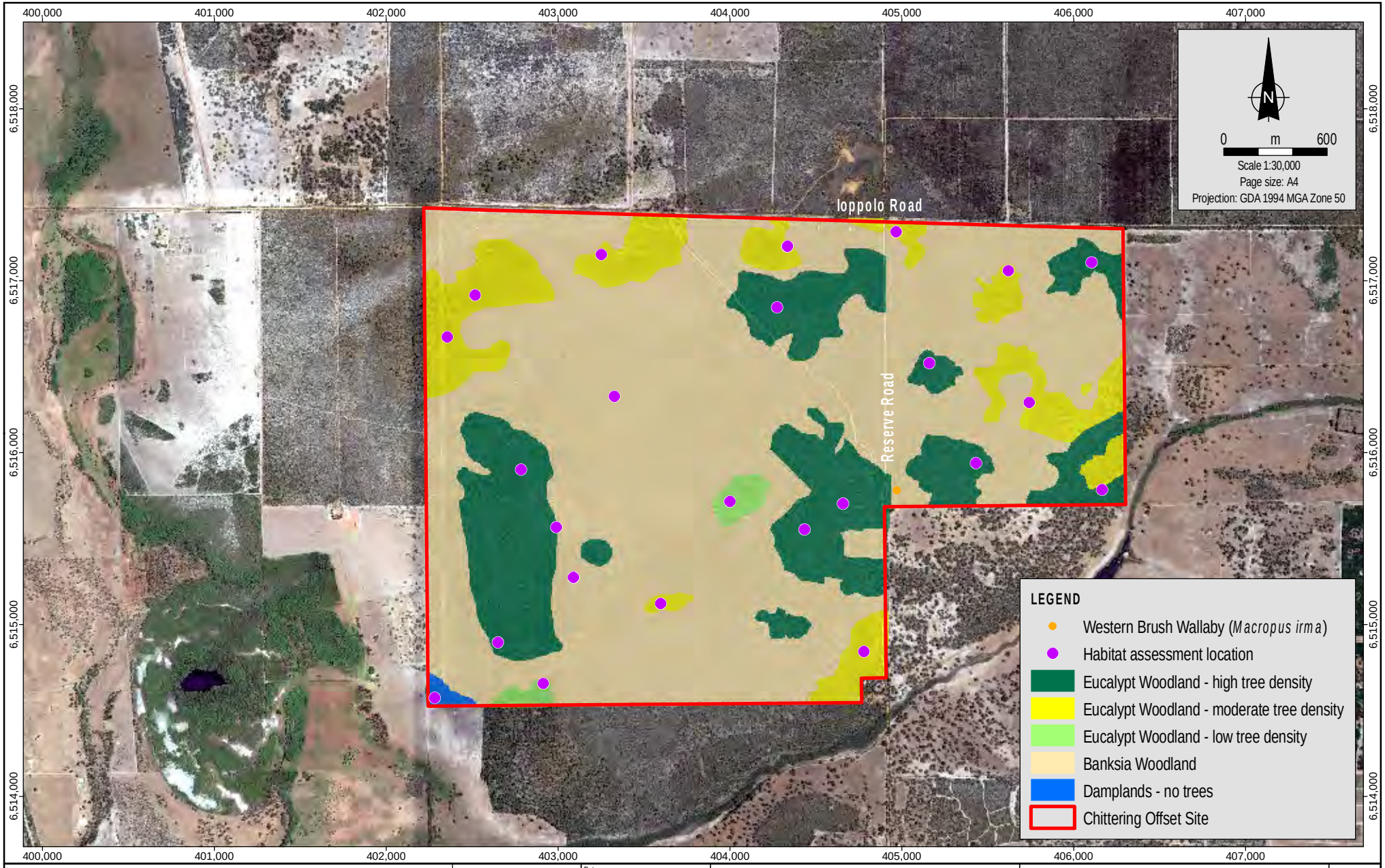
Main Roads WA

NorthLinkWA

Conservation Significant Flora and Vegetation
Flora, Vegetation and Fauna Assessment

Figure No: 9



Source & Notes
Fauna habitat and tree density from Coffey (August 2014).
Aerial Imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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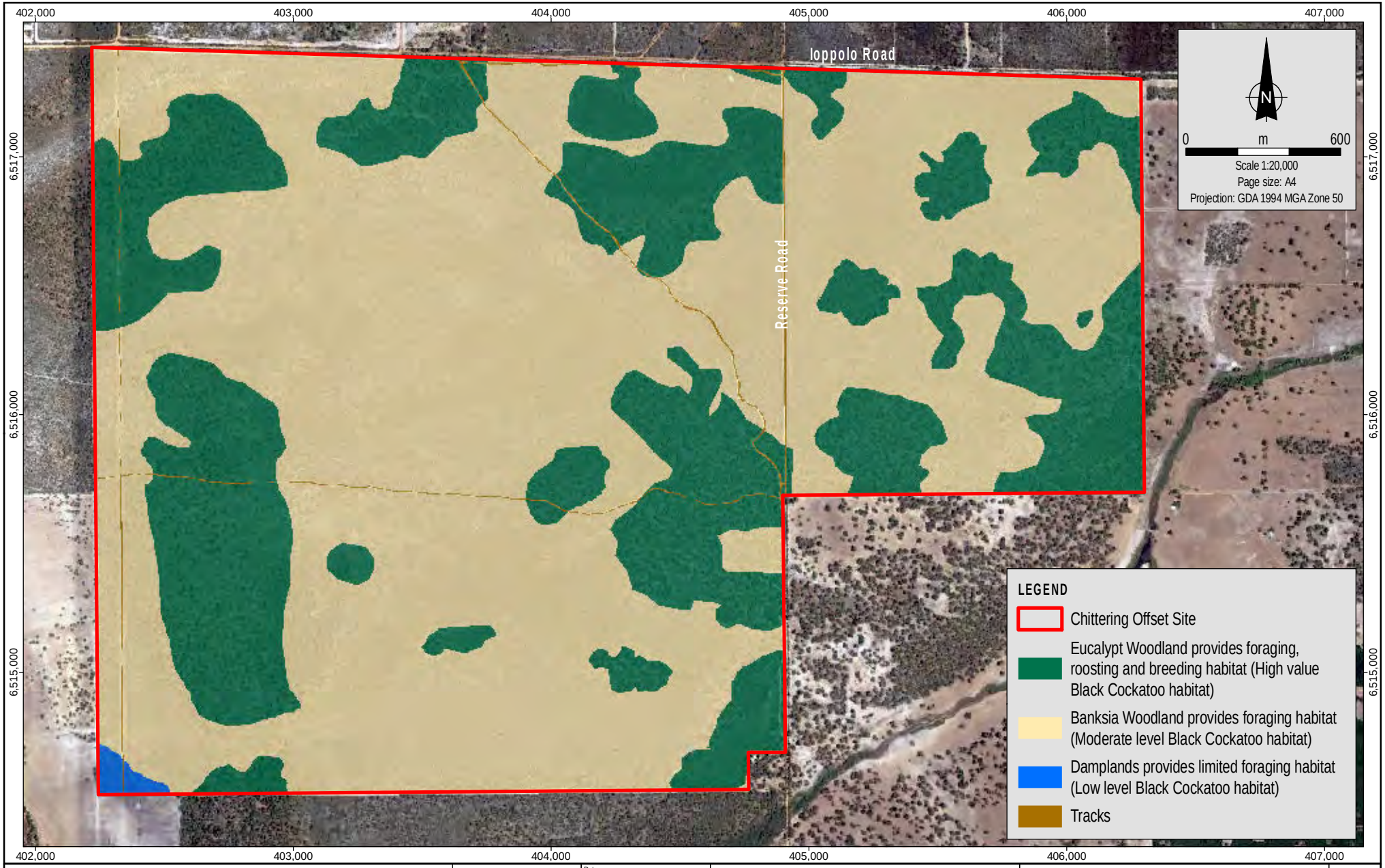
File Name: 4483AA_06_F010_GIS

Main Roads WA

NorthLinkWA

Fauna Habitat and Tree Density
Flora, Vegetation and Fauna Assessment

Figure No: **10**



Source & Notes
Black Cockatoo habitat mapping from Coffey (August 2014).
Aerial Imagery from Google Earth Pro (10.01.2015).

coffey

Date: 14.04.2015
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File Name: 4483AA_06_F011_GIS

Main Roads WA

NorthLinkWA

Black Cockatoo Habitat
Flora, Vegetation and Fauna Assessment

Figure No: **11**

APPENDIX A

Department of Parks and Wildlife Database Searches

Government of **Western Australia**
Department of **Parks and Wildlife**

Your Ref:
Our Ref: **12-0614FL**
Enquiries: Myrto Robert
Phone: (08) 9218 8760
Fax: (08)
Email: flora.data@dpaw.wa.gov.au

Coffey Environments
PO Box 4223
Victoria Park WA 6979

Attention: John Trainer

Dear John Trainer,

REQUEST FOR THREATENED AND PRIORITY FLORA INFORMATION

I refer to your request of 30 May 2014 for Threatened (Declared Rare) and Priority Flora information in the Chittering area. The search was conducted within 5km radial area of the central coordinates you submitted.

A search was undertaken for this area of **(1)** the Department's *Threatened (Declared Rare) and Priority Flora* database (for results, *if any*, see "TPFL" – coordinates are GDA94), **(2)** the *Western Australian Herbarium Specimen* database for priority species opportunistically collected in the area of interest (for results, *if any*, see "WAHERB"- coordinates are GDA94 – see condition number 9 in the attached 'Conditions in Respect of Supply' and **(3)**, the Department's *Threatened and Priority Flora List* [this list is searched using 'place names'. This list, which may also be used as a species target list, contains species that are declared rare (Conservation Code R or X for those presumed to be extinct), poorly known (Conservation Codes 1, 2 or 3), or require monitoring (Conservation Code 4) – for results, *if any*, see "TP List"]. The results are attached electronically to this email.

Attached also are the conditions under which this information has been supplied. Your attention is specifically drawn to the seventh point, which refers to the requirement to undertake field investigations for the accurate determination of Threatened and Priority flora occurrence at a site. *The information supplied should be regarded as an indication only of the Threatened and Priority flora that may be present and may be used as a target list in any surveys undertaken.*

The information provided does not preclude you from obtaining and complying with, where necessary, land clearing approvals from other agencies.

An invoice for $300 (plus GST) to supply this information will be forwarded.

It would be appreciated if any populations of Threatened and Priority flora you encounter in the area could be reported to this Department to ensure their ongoing management.

If you require any further details, or wish to discuss Threatened and Priority flora management, please contact Dr Ken Atkins, Manager, Species and Communities Branch, on (08) 9334 0455.

Yours faithfully

Miss Myrto Robert
.....
A/THREATENED FLORA DATABASE OFFICER
for the Director General

9 June 2014

DEPARTMENT OF PARKS AND WILDLIFE

THREATENED (DECLARED RARE) AND PRIORITY FLORA INFORMATION

CONDITIONS IN RESPECT OF SUPPLY OF INFORMATION

1. All requests for data to be made in writing to the Director General, Department of Parks and Wildlife, Attention: Threatened Flora Database Officer, Species and Communities Branch.

2. The data supplied may not be supplied to other organisations, nor be used for any purpose other than for the project for which they have been provided, without the prior written consent of the Director General, Department of Parks and Wildlife.

3. Specific locality information for Threatened and Priority Flora is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information may not be used in public reports without the written permission of the Director General, Department of Parks and Wildlife. Publicly available reports may only show generalised locations or, where necessary, show specific locations without identifying species. Species and Communities Branch is to be contacted for guidance on the presentation of Threatened and Priority Flora information.

4. Note that the Department of Parks and Wildlife respects the privacy of private landowners who may have Threatened and Priority Flora on their property. Threatened and Priority Flora locations identified in the data as being on private property should be treated in confidence, and contact with property owners made through the Department of Parks and Wildlife.

5. Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data provided, they may be present. The Department of Parks and Wildlife accepts no responsibility for this.

6. Receiving organisations must also recognise that the database is subject to continual updating and amendment, and such considerations should be taken into account by the user.

7. **It should be noted that the supplied data do not necessarily represent a comprehensive listing of the Threatened and Priority Flora of the area in question. Its comprehensiveness is dependant on the amount of survey carried out within the specified area. The receiving organisation should employ a botanist, if required, to undertake a survey of the area under consideration.**

8. Acknowledgment of the Department of Parks and Wildlife as source of the data is to be made in any published material. The unique reference number that is given upon the request for information should be quoted when referencing the data. Copies of all such publications are to be forwarded to the Department of Parks and Wildlife, Attention: The Manager, Species and Communities Branch.

9. The development of the PERTH Herbarium database was not originally intended for electronic mapping (eg. GIS ArcView). The latitude and longitude coordinates for each entry are not verified prior to being databased. It is only in recent times that collections have been submitted with GPS coordinates. Therefore, be aware when using this data in ArcView that some records may not plot to the locality description given with each collection.

Species and Communities Branch
17 Dick Perry Ave, Technology Park, Kensington
Phone: (08) 9334 0455 Fax: (08) 9334 0278
Locked Bag 104, Bentley Delivery Centre, Bentley, Western Australia 6983

www.dpaw.wa.gov.au

DECLARED RARE AND PRIORITY FLORA LIST

CONSERVATION CODES

for Western Australian taxa

T: **Threatened Flora** (Declared Rare Flora - Extant)
Schedule 1 under the *Wildlife Conservation Act 1950* Rare Flora Notice

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. The assessment of the conservation status of these species is based on their national extent.

X: **Presumed Extinct Flora** (Declared Rare Flora – Extinct)
Schedule 2 under the *Wildlife Conservation Act 1950* Rare Flora Notice

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.

Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:

CR: **Critically Endangered** – considered to be facing an extremely high risk of extinction in the wild.

EN: **Endangered** – considered to be facing a very high risk of extinction in the wild.

VU: **Vulnerable** – considered to be facing a high risk of extinction in the wild.

A list of the current rankings can be downloaded from DPAW's Listing of species and ecological communities webpage at
http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities

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17 Dick Perry Ave, Technology Park, Kensington
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Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora and Priority Fauna Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation Dependent species are placed in Priority 5.

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

1: Priority One: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2: Priority Two: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3: Priority Three: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4: Priority 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.

5: 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.

Recommendations for additions, deletions or changes to the Declared Rare and Priority Flora List should be forwarded to the Flora Administration Officer or Senior Botanist Species and Communities Branch, DEC.

Species and Communities Branch
17 Dick Perry Ave, Technology Park, Kensington
Phone: (08) 9334 0455 Fax: (08) 9334 0278
Locked Bag 104, Bentley Delivery Centre, Bentley, Western Australia 6983

www.dpaw.wa.gov.au

ABBREVIATIONS USED IN THREATENED AND PRIORITY FLORA DATABASE

VESTING

AAP	Aboriginal Planning Authority
AGR	Chief Executive, Dep. of Agriculture
ALT	Aboriginal Land Trust
APB	Agricultural Protection Board of WA
BGP	Botanical Gardens & Parks Authority
BSA	Boy Scouts Association
CC	Conservation Commission – NPNCA - LFC
CGT	Crown Grant in Trust
COM	Commonwealth of Australia
CRO	Crown Freehold-Govt Ownership
CRW	Crown
DAG	Dep. of Agriculture
DOW	Dep. of Water
DPI	Dep. of Planning
EXD	Exec Direc CALM
FES	Fire and Emergency Services Aust.
HOW	Dep. of Housing/State Housing Commission
ILD	Industrial Lands Develop. Auth
LAC	LandCorp
LGA	Shire/LGA
MAG	Minister for Agriculture
MCB	Metropolitan Cemeteries Board
MED	Ministry of Education
MHE	Minister for Health
MIN	Minister for Mines
MPL	Ministry for Planning
MPR	Minister for Prisons
MRD	Main Roads WA
MTR	Minister for Transport
MWA	Minister for Water Resources
MWO	Minister for Works
NAT	Natural Trust of Australia WA
NON	Not Vested
PLB	Pastoral Lands Board
PRI	Private/Freehold
RAI	Public Transport Authority
REL	Religious Organisation
SPC	State Planning Commission
SYN	Synergy (ex Western Power)
SWA	State of Western Australia
TEL	Telstra
UNK	Unknown
WAT	Water Corporation
WEL	Minister Community Welfare
WRC	Water & Rivers Commission
XPL	Ex-Pastoral Lease

PURPOSES

ABR	Aboriginal Reserve
ACC	Access Track
AER	Aerodrome
AIR	Airport
ARS	Agricultural Research Station
BAP	Baptist Union of WA
CAM	Camping
CAR	Caravan park
CEM	Cemetery
CFA	Conservation of Fauna
CFF	Conservation Of Flora & Fauna
CFL	Conservation of Flora
CHU	Church
CMN	Communications
COM	Common
CON	Conservation Park
CPK	Car Park
CRM	Conservation & Resource Management
DEF	Defence
DRA	Drain
EDE	Educational Endowment
EDU	Educational purposes UWA
ENE	Enjoyment of Natural Environ.
EPL	Ex-pastoral Lease (Sect 33(2) CALM Act)
EPS	Explosives
EXC	Excepted from sale
EXL	Exploration Lease
EXP	Experimental Farm
FIR	Firing Range
FOR	State Forest
FP	Foreshore Purposes
GE	General Lease
GHA	Grain Handling
GOL	Golf
GRA	Gravel Pit
GVT	Government Requirements
HAR	Harbour Purposes
HEP	Heritage Purposes
HER	Heritage trail
HOS	Hospital
KEN	Kennels
LGA	LGA/Shire Requirements
LPR	Landscape Protection
MIN	Mining lease
MUN	Municipal Purposes
NPK	National Park
NRE	Nature Reserve
OTH	Other
PAR	Parkland (& Recreation)
PAS	Pastoral lease
PCR	Proposed for Conservation
PFF	Protection of Flora & Fauna
PFL	Protection of Flora
PIC	Picnic ground
PLA	Plantation
PMC	Protection of Meteorite Crater
POS	Public Open Space
PPA	Public parkland
PRS	Prison site
PUR	Purchase Lease
PUT	Public Utility
QUA	Quarry
RAC	Racecourse
RAD	Radio Station
REC	Recreation
REH	Rehabilitation/Re-establish Native Plants
RRE	Railway Reserve
RUB	Rubbish
SAL	Saleyards
SAN	Sand
SCH	School-site
SET	Settlers requirements
SHO	Showgrounds
SNN	Sanitary
SOI	Soil Conservation
STO	Stopping place
STK	Stock Route
TIM	Timber
TOU	Tourism
TOW	Town-site
TRA	Training Ground
TRI	Trig station
UCL	Unallocated Crown Land
UNK	Unknown
VER	Road Verge
VPF	Vermin Proof Fence
WAT	Water
WLS	Wildlife Sanctuary
WOO	Firewood

ABBREVIATIONS USED IN THE WESTERN AUSTRALIAN HERBARIUM DATABASE

Geocode Method - The method that was used to record the latitude and longitude.

Auto - Indicates that the coordinate data in the record was created automatically (i.e. by software), usually by creating a coordinate from information provided in the Nearest Named Place or Locality textual description fields.

GAP - Acronym for "Generalised Arbitrary Point" as used in HISPID. GAP indicates that the coordinate data was obtained manually from the Nearest Named Place or Locality textual description fields.

GPS - Acronym for "Global Positioning System". GPS indicates that the coordinate data in the record was obtained from a GPS unit by the collector of the specimen.

MAN - Shorthand for manual. MAN indicates that the coordinate data was created by hand using some method not allowed for by one of the other manual Geocode Method values, in particular, TOPO, GAP, or GPS.

TOPO - Shorthand for topographic map. TOPO indicates that the coordinate data was obtained by plotting textual locality details against a topographic map.

None - Indicates that no coordinate data has been supplied by the collector.

Unknown - Indicates that there is no known method for determining the coordinate data. Should be used if the collector provided no indication of how they sampled the specimen's coordinate data.

PREC (Precision) - precision ratings for coordinates.

Precision 1: Absolutely precise (to nearest 100m or nearest second) and must be GPS determined. For example 35°26'42"S 123°40'26"E

Precision 2: Falling within a diameter of 3km (ca 2 minutes) or if no GPS mentioned in collecting notes. (The location must be able to be pinpointed on a 1:250 000 map, a spot locality. For example 35°26'42"S 123°40'26"E

Precision 3: Falling within a diameter of 10km (ca 7 minutes) or for degrees and minutes, where seconds have not been given. For example 35°26'_"S 123°40'_"E

Precision 4: Falling within a diameter of ca 50km (30 minutes). For example 35°26'_"S 123°40'_"E

Precision 5: Where a location is a prescribed large geographical area within a state or only the state is given. Diameter is greater than 50km. For example 35°_'_"S 123°_'_"E

Precision 6: used when localities are New Holland, Eastern Australia or Not given. Fields will be left blank.

Clinton Van Den Bergh

From: Communities Data <Communities.Data@DPaW.wa.gov.au>
Sent: Tuesday, 10 June 2014 2:56 PM
To: John Trainer; Fauna Data; Flora Data; Communities Data
Cc: Denise True; Clinton Van Den Bergh; Paul Mitrovski; Natassja Raymond
Subject: Results of TEC/PEC Search - Coffey (Bindoon) (Our Ref:08-0614EC) (Your Ref:)
Attachments: TEC-PEC_metadata_26072011.pdf; Conditions of supplying TEC and PEC data.pdf; Bindoon_Coffey_TecPecSearchResults_10062014.dbf; Bindoon_Coffey_TecPecSearchResults_10062014.prj; Bindoon_Coffey_TecPecSearchResults_10062014.sbn; Bindoon_Coffey_TecPecSearchResults_10062014.sbx; Bindoon_Coffey_TecPecSearchResults_10062014.shp; Bindoon_Coffey_TecPecSearchResults_10062014.shp.xml; Bindoon_Coffey_TecPecSearchResults_10062014.shx

Hi,

I refer to your request on the 30 of May 2014 for information on threatened and priority ecological communities occurring within a 10km radius of the co-ordinates provided in the email below.

A search was undertaken on the Department's Threatened Ecological Communities database. Please find attached a buffer shapefile from the database where records were found. If you do not use shapefiles please use the (.dbf file) this can be open in excel as a spreadsheet. Please note that this information is not to be given to any external third parties as it may contain information regarding private property.

Please note not all priority ecological communities are currently recorded on our database. You may like to view the current list in related documents at http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority_ecological_communities_list_Sept2013.pdf

Attached are the conditions under which this information has been supplied. The information supplied should be regarded as an indication only of the threatened and priority ecological communities that may be present.

It would be appreciated if any occurrences of threatened and priority ecological communities encountered by you in the area could be reported to this Department to ensure their ongoing management. An occurrence report form and associated manual can be found at http://www.dpaw.wa.gov.au/plants-and-animals/monitoring/96-standards/140-standard-report-forms?showall=&start=2

Search area response information is only accurate at the time of provision. Over time, new occurrences or modifications to existing occurrences may occur as information becomes available. It is recommended that searches be re-submitted every six months where projects occur over a long period of time.

An invoice for $220 (including GST) for the supply of this information will be forwarded.

Your request for information reference number for this search is: 08-0614EC. Please quote this unique reference number when acknowledging the Department of Parks and Wildlife as a source of the data in any published material.

Kind Regards

Wendy Chow| TEC Ecologist| Species & Communities Branch
Department of Parks and Wildlife | Kensington | Ph. 9334 0554| wendy.chow@dpaw.wa.gov.au

From: John Trainer [mailto:John.Trainer@coffey.com]
Sent: Friday, 30 May 2014 3:23 PM
To: Fauna Data; Flora Data; Communities Data
Cc: Denise True; Clinton Van Den Bergh; Paul Mitrovski; Natassja Raymond
Subject: ecological database search

Hi All,

Could I please request a threatened fauna, flora and ecological communities database searches for the following area with a 10km buffer (or whichever you deem appropriate).
This information will be used for a consultant's report.

Fauna: Species list format
Flora: CSV and DBF format
Ecological Communities: CSV and DBF format

Iopollo Rd muchea

50J 403670 E
6515930 S

Please respond to all parties CC'd into this email as not all members will be in the office.

Thanks

John Trainer
Senior Environmental Consultant/ Zoologist

Suite 2, 53 Burswood Road, Burswood WA 6100
PO Box 4223 Victoria Park WA 6979

t: +61 8 9269 6200

m: +61 400 224 012

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES INFORMATION

CONDITIONS IN RESPECT OF SUPPLY OF INFORMATION

1. All requests for data are to be made in writing to the Director General, Department of Environment and Conservation Attention: Species and Communities Branch

2. The data supplied may not be supplied to other organisations, nor be used for any purpose other than for the project for which they have been provided, without the prior written consent of the data custodian (Val English), Species and Communities Branch.

3. Specific locality information for threatened and priority ecological communities (TECs/PECs) is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information for TECs/PECs may not be used in public reports without the written permission of the Director General, Department of Environment and Conservation. Publicly available reports may only show generalised locations (ie buffer locations). The TEC database manager is to be contacted for guidance on the presentation of TEC/PEC information.

4. Note that the Department of Environment and Conservation respects the privacy of private landowners who may have threatened and priority ecological communities on their property. Locations of TECs/PECs identified in the data as being on private property should be treated in confidence, and contact with property owners made through the Department of Environment and Conservation.

5. Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data provided, they may be present. The Department of Environment and Conservation accepts no responsibility for this.

6. Receiving organisations must also recognise that the Threatened Ecological Communities database is subject to continual updating and amendment, and such considerations should be taken into account by the user.

7. It should be noted that the supplied data do not necessarily represent a comprehensive listing of the threatened and priority ecological communities of the area in question. Its comprehensiveness is dependant on the amount of survey carried out within the specified area. Private property has been relatively little surveyed. The receiving organisation should employ a consultant, if there is any likelihood of the presence of any threatened or priority ecological community, to undertake a survey of the area under consideration.

8. Acknowledgment of the Department of Environment and Conservation as source of the data is to be made in any published material. Copies of all such publications are to be forwarded to the Department of Environment and Conservation, Attention: Manager, Species and Communities Branch.

Threatened and Priority Ecological Community buffers in WA

UNDER NO CIRCUMSTANCES IS THIS DATA TO BE PROVIDED TO ANY THIRD PARTIES, for more details see conditions for the supply of this information.

Citation

Title: Threatened and Priority Ecological Community buffers in WA

Custodian: Department of Environment & Conservation

Description

Abstract: Ecological communities throughout WA that are "Presumed Totally Destroyed", "Critically Endangered", "Endangered", "Vulnerable", "Priority 1-5", "Lower Risk" and "Not evaluated". Communities are based on various life-forms including plants, invertebrates and micro-organisms.

Geographical Bounding Box

North: -14.788854

South: -35.005719

East: 128.870214

West: 113.765525

Data Currency and Status

Beginning Date: 1/1/94

Ending Date: current

Maintenance/Update: As requested

Access

Stored Data Format: ESRI shapefile

Coordinate System: GCS_GDA_1994

Access Constraints:	**Digital data is only available with written permission of the custodian. In addition, some occurrence data eg. location of sites on private land, is password restricted.**

Data Quality

Positional Accuracy:	**Point location data within occurrences usually from GPS fix, usually within 100 metres. Some digitized from hard copy.**
Attribute Accuracy:	**Not documented.**
Logical Consistency:	**Not documented.**
Completeness:	**Information on specific communities was obtained from regional, subregional or specific habitat surveys of floristic communities, invertebrate communities, wetland assemblages and communities of micro-organisms.**

Attributes List:

Name	Description
BDY_ID	Associated boundary polygon unique identifier
OCC_UNIQUE	Unique occurrence identifier
COM_ID	Shortened community name identifier
COM_NAME	Community name
CT_DESC	State listed Category of Threat
S_ID_COUNT	Number of Site IDs within a buffer
FIRST_S_ID	First site identifier
LAST_S_ID	Last site identifier
BUFFER	Buffer radius from site ID or boundary in metres

General Information:

Priority Ecological Communities

- There are 284 known PECs and subtypes , 271 (~95%) of these on the TEC/PEC database
- The location of priority communities is good, but not complete across the state
- There is a formal list of PECs at http://www.dec.wa.gov.au/content/view/849/2017/
- Many PECs are awaiting endorsement as TECs

buffers

- The buffer radius around each occurrence of a TEC or PEC is included to help ensure that developments with potential to impact groundwater or surface water are picked up.
- For wetland TEC or PECs we seek to include an area within the buffer zone that is intended to help protect groundwater and surface water. The area required to protect different types of wetlands from a variety of hydrological impacts will, of course, differ.

- For upland TEC or PECs that are believed not to be groundwater dependent, the buffer area radius encompasses the TEC or PEC site location recorded in the TEC database, and extends at least to the furthest point in the occurrence. This is to ensure that the 'buffer' area encompasses at least the entire TEC or PEC. This means that some linear occurrences may need a larger buffer radius to encompass the entire occurrence.
- Occurrences with a buffer distance of 0 are no longer extant.

Contact Information

Contact Organisation:	**Department of Environment & Conservation**
Contact Position:	**TEC Database Administrator - Species and Communities Branch**
Mail Address:	**Locked Bag 104, Bentley Delivery Centre**
Suburb/Locality:	**Kensington**
Country/State:	**WA**
Postcode:	**6983**
Telephone:	**(08) 9334 0116**
Fax:	**(08) 9334 0300**
Email:	**communities.data@dec.wa.gov.au**

Metadata Information

Metadata Date: **current**

APPENDIX B

EPBC Act Database Search for MNES

Australian Government

Department of the Environment

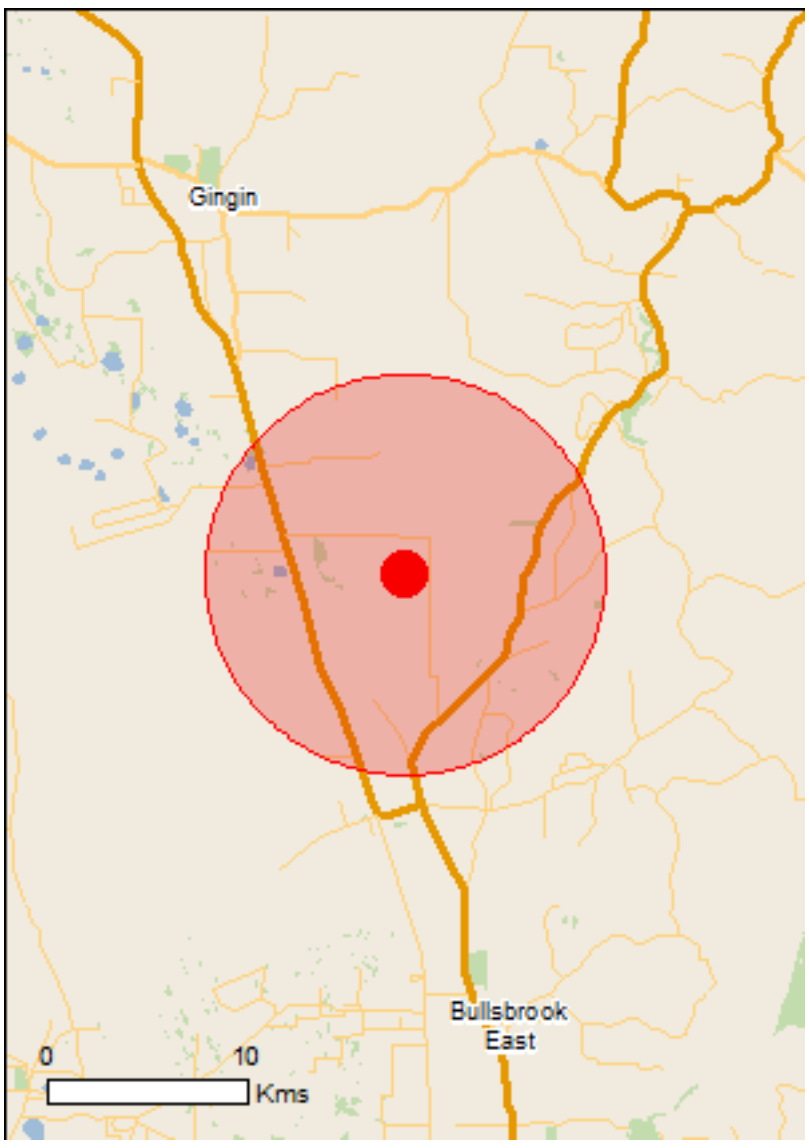
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

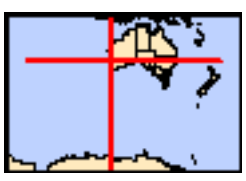
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 04/07/14 11:16:40



Coordinates

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	26
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	1
Listed Marine Species:	7
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	3
State and Territory Reserves:	6
Regional Forest Agreements:	1
Invasive Species:	38
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Shrublands and Woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain	Endangered	Community known to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Breeding likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat likely to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Centrolepis caespitosa [6393]	Endangered	Species or species habitat likely to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [64649]	Endangered	Species or species habitat known to occur within area
Conospermum densiflorum subsp. unicephalatum One-headed Smokebush [64871]	Endangered	Species or species habitat may occur within area
Darwinia foetida Muchea Bell [83190]	Critically Endangered	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat may occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer-orchid, Praying Virgin [16753]	Endangered	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur within area
Epiblema grandiflorum var. cyaneum Baby Blue Orchid, Blue Babe-in-the-cradle Orchid, Blue Babe-in-a-cradle [67182]	Endangered	Species or species habitat may occur within area
Eucalyptus balanites Cadda Road Mallee, Cadda Mallee [24264]	Endangered	Species or species habitat may occur within area
Eucalyptus leprophloia Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat may occur within area
Grevillea corrugata a shrub [65445]	Endangered	Species or species habitat known to occur within area
Grevillea curviloba subsp. curviloba Curved-leaf Grevillea [64908]	Endangered	Species or species habitat known to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat known to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Ptychosema pusillum Dwarf Pea [11268]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra manginii K.Dixon & Batty ms. [67443]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Verticordia plumosa var. pleiobotrya		
Narrow-petalled Featherflower, Mundijong Featherflower [55803]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - MUCHEA ARMAMENT RANGE

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Muchea / Pearce Air Weapons Range	WA	Indicative Place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat likely to occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Muchea / Pearce Air Weapons Range	WA	Indicative Place
Lake Chandala Area	WA	Registered
Yeal - Gnangara Area	WA	Registered

State and Territory Reserves [Resource Information]

Name	State
Barracca	WA
Breera Road	WA
Burroloo Well	WA
Chandala	WA
Timaru	WA
Unnamed WA50678	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Chandala Swamp	WA

Coordinates

-31.48843 115.98843

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

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Please feel free to provide feedback via the Contact Us page.

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