

# NorthLinkWA

Perth-Darwin National Highway



## Level 2 Targeted Fauna Assessment

Perth–Darwin National  
Highway

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## EXECUTIVE SUMMARY

Main Roads Western Australia is proposing to construct the NorthLink WA Project. The project will result in 37 km of new dual carriage highway between Tonkin Highway and Reid Highway interchange in the south and Great Northern Highway and Brand Highway interchange in the north.

NorthLink WA is the southern terminus of the Perth–Darwin National Highway, a key road transport route linking Perth with northern Western Australia and the Northern Territory. The NorthLink WA Project Team has been commissioned by Main Roads Western Australia to complete the design and construction of the Swan Valley Bypass section of the Perth–Darwin National Highway and to obtain the necessary environmental approvals. To identify and assess the ecological values and significance within the study area, the project team commissioned a targeted Level 2 fauna survey, including a fauna movement survey and Black Cockatoo Assessment.

The Perth–Darwin National Highway is approximately 987.1 ha in size and is a mixture of remnant native vegetation, cleared paddocks, rehabilitated land, pine plantations, mine site and linear infrastructure (i.e. roads, railway, and transmission corridor and gas pipeline).


A total of four natural fauna habitats were recorded in the study area: Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland. In addition a further three secondary fauna habitats were recorded in the study area: Modified Vegetation, Paddock and Pine Plantation. The proposed PDNH will impact on approximately 200.7 ha of native vegetation: including 62.6 ha of Eucalypt/Corymbia Woodland, 90.7 ha Banksia Woodland, 27.1 ha of Dampland and 20.2 ha of Wetland. The majority of the impacts will occur in already disturbed areas, with approximately 786.5 ha of the Perth–Darwin National Highway occurring on areas classified as Modified Vegetation, Paddock, Pine Plantation, cleared and infrastructure.

A total of 253.5 ha of quality Black Cockatoo foraging habitat, 76.7 ha of Eucalypt/Corymbia Woodland and Wetland habitat classified as roosting habitat, 162.8 ha of breeding habitat and 1,061 trees with a DBH over 500 mm were recorded in the study area.

The loss/impact upon Black Cockatoo habitat in the study area is expected to be minor at a regional scale. These species are nomadic and are not wholly dependent on the habitats existing in the study area for foraging, roosting or breeding. The loss of suitable foraging and roosting habitat at the local scale is a moderate level impact. However, the study area is not within the current breeding range of both Black Cockatoo species and no significant roost site locations have been recorded in the study area.

A total of 97 species were recorded during the survey including: one fish, six amphibians, 19 reptiles, 62 birds and nine mammals. The number of fauna recorded during the survey is comparable with the other surveys completed in the vicinity. The fauna species recorded during the survey are typical of the habitats present with no new species that had not been previously recorded. The Perth–Darwin National Highway is unlikely to impact the fauna assemblage on a regional level; however, local impacts may include habitat loss, increased risk of road mortalities, habitat fragmentation and habitat degradation such as; rubbish, weeds, feral animals, fire, vehicle tracks and dieback. These impacts are already prevalent in the study area and its surrounds.

A total of three conservation significant fauna were recorded in the study area during the survey: Carnaby's Cockatoo (*Calyptorhynchus latirostris*) listed as Endangered (*Environmental Protection and Biodiversity Conservation Act*) and Schedule 1 (*Wildlife Conservation Act*), the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) listed as Vulnerable (*Environmental Protection and Biodiversity*



*Conservation Act*) and Schedule 1 (*Wildlife Conservation Act*) and the Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) listed as Priority 5 (Department of Parks and Wildlife Priority list). A further seven species of conservation significance are considered Likely to occur in the study area. The ground dwelling fauna in this list are the most likely species to be directly impacted by this development. Due to their limited dispersal ability, they are more likely to be impacted by loss of ecological connectivity and to a lesser degree loss of suitable habitat.

The study area is located approximately 2.6 km west of the Twin Swamps Nature reserve. Due to this proximity a desktop survey was prepared to establish if there is potential for road runoff (and pollutants) to affect this sensitive site. Surface flows from the Perth–Darwin National Highway alignment to the east, split to the south and north of the Twin Swamps Nature Reserve and therefore do not actually flow into Twin Swamps (BG&E, 2014). Preliminary groundwater assessment results suggest that the Twin Swamps site is sufficiently downstream from the Perth–Darwin National Highway site that impacts (if any) are negligible (BG&E, 2014). As such, the PDNH is not expected to impact the Western Swamp Tortoise or its habitat at Twin Swamps Nature Reserve.



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## ABBREVIATIONS AND UNITS

Term	Definition
360	360 Environmental Pty Ltd
ATA	ATA Environmental
BG&E	BG&E Pty Ltd
BOM	Bureau of Meteorology
CALM	Conservation and Land Management
CC	Conservation category
Coffey	Coffey Environments Australia Pty Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBH	Diameter at breast height
DEC	Department of Environment and Conservation
DEWHA	Department of the Environment, Water, Heritage and the Arts
DMP	Department of Mines and Petroleum
DOP	Department of Planning
DOTE	Department of the Environment
DOW	Department of Water
DPAW	Department of Parks and Wildlife
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EPA	Environmental Protection Authority
EPBC Act	<i>Environmental Protection and Biodiversity Conservation Act 1999</i>
EPP	Environmental Protection Policy
ESA	Environmentally Sensitive Area
ESD	Environmental Scoping Document
FPC	forest product commission
GHD	GHD Pty Ltd
ha	hectare
Hwy	highway
IBRA	Interim Biogeographic Regionalisation for Australia
km	kilometres
LIDAR	Light Detection and RADAR



Term	Definition
m	metres
mm	millimetres
MNES	Matters of National Environmental Significance
MRS	Metropolitan Region Scheme
MRWA	Main Roads Western Australia
MU	multiple use
OEPA	Office of the Environmental Protection Authority
PDNH	Perth–Darwin National Highway
PEC	Priority Ecological Community
PER	Public Environmental Review
RE	resource enhancement
SCP	Swan Coastal Plain
SRE	short-range endemic
TEC	Threatened Ecological Community
TGS	Tonkin Grade Separations
WC Act	<i>Wildlife Conservation Act 1950</i>
WSTH	Western Swamp Tortoise Habitat



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# 1 INTRODUCTION

## 1.1 Background

Main Roads Western Australia (MRWA) is proposing to construct the NorthLink WA Project (hereafter referred to as ‘the project’). The project will result in 37 km of new dual carriage highway between Tonkin Highway and Reid Highway interchange in the south and Great Northern Highway and Brand Highway interchange in the north. The project also includes the grade separation of three intersections on Tonkin Highway between Reid Highway and Guildford Road.

NorthLink WA is the culmination of several decades of planning for the southern terminus of the Perth–Darwin National Highway (PDNH), a key road transport route linking Perth with northern Western Australia (WA) and the Northern Territory.

The NorthLink WA Project Team (hereafter referred to as ‘the project team’) has been commissioned by MRWA to complete the design and construction of the Swan Valley Bypass (SVB) section of the PDNH (hereafter referred to as ‘the study area’) and to obtain the necessary environmental approvals.

The PDNH portion of the project was referred to the WA Environmental Protection Authority (EPA) 25 October 2013 to determine the level of assessment that will be required for the project. The EPA determined that the level of assessment would be the Public Environmental Review (PER) level of assessment on 6 January 2014, the highest level under the *WA Environmental Protection Act 1986* (EP Act).

In accordance with the PER level of assessment and at the discretion of the EPA, the EPA determined that the Environmental Scoping Document (ESD) would be prepared and issued by the EPA. The ESD identifies the preliminary key environmental factors that the PER would have regard for and would need to identify the direct, indirect, cumulative and residual impacts as a result of the project.

The EPA, within the ESD, identified that a preliminary key environmental factor would be the potential impacts on native fauna and fauna habitats.


The EPA’s objective is to ‘*maintain representation, diversity, viability and ecological function at the species, population and community level*’. The potential impacts on the fauna include:

- Loss of fauna habitat through clearing and dewatering.
- Fauna mortality as a result of construction activities.
- Fragmentation of fauna habitats.
- Disturbance to waterbirds (including migratory species) from impacts to wetlands.
- Spread of weeds and *Phytophthora* Dieback.

To identify and assess the ecological values and significance within the study area, the project team commissioned a targeted Level 2 fauna survey, including a fauna movement survey and Black Cockatoo Assessment.

## 1.2 Location

The PDNH is located within the City of Swan and the Shire of Chittering and extends from the Reid Highway and Tonkin Highway interchange in the City of Swan north for 37 km to the Great Northern Highway and Brand Highway interchange in the Shire of Chittering (Figures 1 and 2).



The PDNH corridor passes through the suburbs of Malaga, Bennett Springs, Ballajura, Cullacabardee, Whiteman, Ellenbrook, Bullsbrook and Muchea.

The PDNH is approximately 986.3 ha in size and is a mixture of remnant native vegetation, cleared paddocks, rehabilitated land, pine plantations, mine site and linear infrastructure (i.e. roads, railway, and transmission corridor and gas pipeline).

### **1.3 Report Terms**

The following terms have been used within this document:

- The Project – refers to the NorthLink WA project, consisting of the 37 km of new road for the Perth–Darwin National Highway (PDNH).
- Perth–Darwin National Highway (PDNH) – refers to the construction of 37 km of new highway between the Tonkin Highway and Reid Highway interchange in the south and the Great Northern Highway and Brand Highway interchange in the north.
- The Project Team – refers to the NorthLink WA Project Team consisting of seven companies (of engineering and specialty consultancies) that have been commissioned to design and construct the project.
- The Study Area – refers to the Swan Valley Bypass section of the Perth–Darwin National Highway.
- Swan Valley Bypass (SVB) – refers to the new 37 km section of highway for the PDNH.

### **1.4 Objectives**

The objectives of the targeted Level 2 fauna survey are to:

- Complete a targeted Level 2 fauna survey.
- Complete a fauna movement survey, specifically at Maralla Road Bushland, Cullacabardee Bushland and Whiteman Park.
- Complete a Black Cockatoo Habitat Assessment.
- Identify and assess the values and significance of the fauna and fauna habitats within the study area.
- Describe and assess the potential direct and indirect impacts of the project on the fauna and fauna habitats within the study area.
- Summarise the residual impacts of the project and identify management and mitigation measures to meet the EPA's objectives.



## 1.5 Scope of Works

The scope of works completed to address the objectives of the fauna survey of the study area included:

- A Desktop Assessment, which included a review of the following:
  - The State's Department of Parks and Wildlife (DPAW) threatened and priority listed fauna and ecological communities databases;
  - The Commonwealth's Department of the Environment (DOTE) online database search tool for matters of national environmental significance (MNES) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
  - Previous fauna surveys undertaken within and in close proximity to the study area.
- A Level 2 Fauna Survey, including:
  - Identification and mapping of fauna habitats and their value.
  - A targeted trapping program.
  - Opportunistic records of all fauna identified during the survey.
  - Targeted searches for fauna of conservation significance.
  - Assessment of the local and regional significance of habitats and fauna in the study area.
- A Targeted Black Cockatoo Survey, including:
  - Identification of Black Cockatoo foraging resources.
  - Mapping areas of foraging habitat and for Black Cockatoos.
  - Identification of potential roost site locations for Black Cockatoos.
  - Mapping areas of potential breeding habitat for Black Cockatoos.
  - Recording location and details of any potential breeding tree.
  - Recording the presence of any Black Cockatoos including foraging, roosting and breeding evidence.
- A Fauna Movement Survey, including:
  - The identification and assessment of areas of potential ecological linkage, in particular Maralla Road Bushland, Cullacabardee Bushland and Whiteman Park.
  - Sand pad/track survey to identify areas of high fauna traffic.
  - Identification of the most effective fauna underpass/overpass locations.
- The preparation of a concise, technical report, which included:
  - A discussion about the significance of the values identified within the study area.
  - The identification of the direct and indirect impacts of the project on the fauna and fauna habitats within the study area.
  - A discussion on the residual impacts of the project.
  - Recommendations regarding management and mitigation measures to ensure the EPA's objectives for fauna can be met.
  - The figures and appendices discussed within the report.





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## 2 ENVIRONMENTAL POLICY AND LEGISLATION

The assessment of fauna 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).
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (WA).
- *Environmental Protection (Gnangara Mound Crown Land) Policy 1992* (WA).
- *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* (WA).
- *Biosecurity and Agriculture Management Act 2007* (BAM Act) (WA).
- *Conservation and Land Management Act 1984* (CALM Act) (WA).

A short description of the state and federal conservation codes are available in Appendix A.

### 2.1 Commonwealth Legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the key Commonwealth environmental legislation that protects and manages matters of national and international environmental significance. The administering agency for this Act is the Department of the Environment (DOTE).

The nine Matters of National Environmental Significance (MNES) addressed under the EPBC Act are:


- World heritage sites.
- National heritage places.
- Wetlands of international importance (i.e. Ramsar listed wetlands).
- Nationally threatened species and ecological communities.
- Migratory species (protected under international agreements).
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions.
- A water resource, in relation to coal seam gas development and large coal mining development

The key MNES considered relevant to this Level 2 fauna survey are, nationally threatened species and ecological communities, migratory species and wetlands of international importance.

### 2.2 State Legislation

#### 2.2.1 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act) is the primary legislation that governs environmental impact assessment (EIA) and protection in Western Australia. The aim of the Act is:



*“An Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with foregoing”.*

Authorities under this Act include the Department of Parks and Wildlife (DPAW) and the Environmental Protection Authority (EPA).

Part IV of the EP Act relates to the assessment of environmental impacts, and Part V of the EP Act deals with licensing and control of pollution from prescribed premises and permits for land clearing.

### **2.2.2 Wildlife Conservation Act 1950**

The aim of the *Wildlife Conservation Act 1950* (WC Act) is:

*“An Act to provide for Conservation and Protection of Wildlife”.*

Under the Act, all native fauna is protected throughout the whole state at all times. In addition the Minister for the Environment can publish a notice in the Government Gazette, declaring a list of fauna species that are rare, likely to become extinct or otherwise in need of special protection. Fauna that is declared as threatened is protected, and may not be impacted on, unless authorised and carried out in accordance with the terms and conditions of the licences issued under Section 15. The WC Act also protects fauna species that are rare, likely to become extinct or otherwise in need of special protection.

### **2.2.3 Environmental Protection (Clearing of Native Vegetation) Regulations 2004**

In 2004, amendments to the EP Act introduced provisions for regulating the clearing of native vegetation. If native vegetation is intended to be cleared, a permit from the DER or the Department of Mining and Petroleum (DMP) (for mining related activities under a Memorandum of Understanding between the EPA and the DMP) is required, unless an exemption applies. It is an offence to clear native vegetation without the authority of a permit or an exemption.

There are two types of exemptions: Schedule 6 of the EP Act; and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. The exemptions under Regulations do not apply in Environmentally Sensitive Areas (ESAs) declared under Section 51B of the EP Act.

### **2.2.4 Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011**


The purpose of the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* (EPP WSTH) is to protect habitat suitable for the long-term survival of wild populations of the Western Swamp Tortoise.

This policy is related to the potential clearing and modifications of native vegetation that is consistent with wetland communities and the hydrological regimes that influence flows into Twin Swamps Nature Reserve (Class A Reserve No. 27621). Wetland vegetation and the hydrological regimes that may influence Twin Swamps Nature Reserve are located adjacent to the study area.

### **2.2.5 Conservation and Land Management Act 1984**

The *Conservation and Land Management Act 1984* (CALM Act) is managed by DPAW and is:

*“An Act to make better provision for the use, protection and management of certain public lands and waters and the flora and fauna thereof, to establish authorities to be responsible therefor, and for incidental or connected purposes.”*



DPAW manages lands and waters throughout WA to conserve ecosystems and species, and to provide for recreation and appreciation of the natural environment. DPAW manages Crown, freehold and pastoral lease lands jointly with other organisations.

The study area traverses through four DPAW managed properties (Gnangara-Moore River State Forest; R46875; R46919; and R46920) which are managed under the CALM Act.

### **2.3 Environmental Guidance and Policy**

The EPA has produced a number of policy statements, guidelines and technical guides, which provide guidelines and advice regarding the EPA's position on the fauna of Western Australia. Position statements, guidelines and technical guides relevant to terrestrial fauna include:

- Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002).
- Guidance for Assessment of Environmental Factors No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a)
- Guidance for Assessment of Environmental Factors No. 20 – Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA, 2009).
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA/DEC, 2010).
- Position Statement No. 7 Principles of Environmental Protection (EPA, 2004b).
- Guidance statement No. 7 Protection of the Western Swamp Tortoise Habitat, Upper Swan/Bullsbrook (EPA, 2006).



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## 3 EXISTING ENVIRONMENT

### 3.1 Existing and Historical Land Use

The PDNH is located across several existing land uses, including farmland, conservation reserves, transport corridors, rural infrastructure, industrial areas, State Forest, active mining tenement and private land.

The PDNH is located within the Metropolitan Region Scheme (MRS) (DOP, 2014) and the Shire of Chittering Town Planning Scheme No. 6 (TPS6) (DOP, 2012). The current PDNH alignment is zoned:

- MRS zoning – Rural, Primary Regional Roads, Parks and Recreation and State Forest.
- TPS6 zoning – Highway, Agricultural Resource, Parks and Recreation and Railway.

### 3.2 Climate

The city of Perth is described as having a Mediterranean climate with warm to hot summers and cool to mild, wet winters.

The nearest operating Bureau of Meteorology (BOM) weather stations with relevant long term and recent climatic data to the study area are Pearce RAAF Airbase (Station No. 009053) in Bullsbrook (representative of the northern section of the study area), Gingin Aero (Station No. 009178) in Gingin (representative of the northern section of the study area), the Perth Metro station (Station No. 009225) located in Mt Lawley and the Perth Airport (Station No. 009021) (representative of the southern section of the study area) (refer to Figure 3). The following sections detail the climatic conditions of each of the BOM weather stations.

#### **Pearce RAAF Airbase (Station No. 009053)**

The Pearce RAAF Airbase is located in close proximity to the northern section of the study area, approximately 2.8 km in distance. The Pearce RAAF Airbase receives on average 680 mm of rain per annum with the majority of the rain (528 mm or 78%) falling between the months of May and September (BOM, 2014a).

The average summer temperatures range from a maximum of 30°C to 33.5°C to a minimum of 14.5°C to 17.5°C during December and February. The average winter temperatures range from a maximum of 17.8°C to 18.8°C to a minimum of 8.1°C to 9.4°C during June and August (BOM, 2014a). The climatic conditions for Pearce RAAF Airbase are presented in Figure 3.

#### **Gingin Aero (Station No. 009178)**

The Gingin Aero is located approximately 15 km to the north-west of the Brand Hwy and Great Northern Hwy interchange. The Gingin Aero receives on average 655 mm of rain per annum, with the majority of the rain (515 mm or 78%) falling between the months of May and September (BOM, 2014b).

The average summer temperatures range from a maximum of 30.6°C to 33.2°C to a minimum of 14.4°C to 17°C during December and February. The average winter temperatures range from a maximum of 18.3°C to 19.6°C to a minimum of 6.1°C to 7.5°C during June and August (BOM, 2014b). The climatic conditions for Gingin Aero are presented in Figure 3.



### **Perth Metro (Station No. 009225)**

The Perth Metro weather station is located in Mt Lawley, approximately 8 km to the south-west of the Tonkin Hwy and Reid Hwy interchange. The Perth Metro is the main weather station for Perth and on average receives 732 mm of rain per annum (BOM, 2014c). The majority of this rain (578 mm or 79%) is received during the late autumn to early spring months of May to September (BOM, 2014c).

The average summer temperatures range from a maximum of 29°C to 31.6°C to a minimum of 16.4°C to 18.3°C during December and February. The average winter temperatures range from a maximum of 18.4°C to 19.3°C to a minimum of 7.6°C to 8.6°C during June and August (BOM, 2014c). The climatic conditions for Perth Metro are presented in Figure 3.

### **Perth Airport (Station No. 009021)**

The Perth Airport is located approximately 10 km south-east of the Tonkin Hwy and Reid Hwy interchange. The Perth Airport receives on average 772 mm of rain per annum with the majority of the rain (607 mm or 79%) falling between the months of May and September (BOM, 2014d).

The average summer temperatures range from a maximum of 28.9°C to 31.9°C to a minimum of 14.9°C to 17.5°C during December and February. The average winter temperatures range from a maximum of 17.9°C to 18.5°C to a minimum of 8°C to 9°C during June and August (BOM, 2014d). The climatic conditions for the Perth Airport are presented in Figure 3.

## **3.3 Topography and Surface Hydrology**

The study area is located within the Bassendean Dunes and the Pinjarra Plain landforms, which are typically flat with low topographical relief due to the age of the landforms and the weathering period.

The study area is within the Bassendean dune system, this is generally flat low relief with broad swales or moderately flat sand sheets between the dunes. The highest dune of up to 80 metres (m) occurs in the north of the Swan Region, in the area east of Lake Pinjarra, Gnangara, immediately west of the study area (Swan Catchment Council, 2004).

The study area occurs within the sub-catchment boundaries of Bennett Brook catchment (in the south) and Ellen Brook catchment (north) of the Swan Coastal Basin and the Swan Avon (Lower Swan) Catchment.

The PDNH is located within the *Swan River System Rights in Water and Irrigation Act 1914* (RIWI) proclaimed surface water area. No RIWI rivers are located within the study area (DOW, 2014).


## **3.4 Geomorphic Wetlands**

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

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

1. Conservation Category (CC) – 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 (RE) – 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 (MU) – 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 the Geomorphic Wetlands Swan Coastal Plain Dataset, approximately 31 wetlands occur within or immediately adjacent to study area. A further seven CC and RE wetlands occur in close proximity to the study area.

### **3.5 Landforms, Geology and Soils**

The Swan Coastal Plain (SCP) is bounded to the east by the Darling and Gingin Faults, which rise to over 200 m above sea level. The SCP consists of a series of distinct landforms that roughly run parallel to the coast (McArthur and Bettenay, 1960). The landforms, from east to west, comprise the Pinjarra Plain, the Bassendean Dunes, the Spearwood Dunes and the Quindalup Dunes. The study area is located within the Bassendean Dunes and the Pinjarra Plains landforms.

To the west of the colluvial slopes of the Ridge Hill Shelf (a sand covered, wave-cut platform from the Darling and Gingin scarps) lies the 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 in the northern section (Davidson, 1995).


To the west of the Pinjarra Plain, the Bassendean Dune system, the oldest dune system on the SCP, forms a gently undulating Aeolian sand plain about 20 km wide with the dunes to the north of Perth generally having greater topographic relief than those to the south. The dunes probably accumulated as shoreline deposits and coastal dunes during interglacial periods of high sea level and originally consisted of mostly lime (calcareous) sand with quartz sand and minor fine-grained, black, heavy-mineral concentrations. Apart from a small local area to the south of Perth, the carbonate material has been completely leached leaving dunes consisting entirely of quartz sand (Davidson, 1995). The Bassendean Dunes contain little silt or clay, and very low levels of nutrient elements, with any nutrient element content being associated with organic matter (Bolland, 1998).

Churchward and McArthur (1978) have mapped the study area as:

- Bassendean: sand plains with low dunes and occasional swamps; iron or humus podzols; areas of complex steep dunes.
- Southern River: Sandplain with low dunes and many intervening swamps; iron and humus podzols, peats, and clays.
- Yanga: poorly drained plain with grey sandy benches and intervening swamps; also areas of bog iron ore, marl or solonchic soils.
- Coonambidgee: gently sloping fringe to the Dandaragan Plateau; deep grey sands.

### **3.6 Bioregional Context**

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 89 bioregions based on major biological and geographical or geological attributes (Thackway and Cresswell, 1995). The 89 bioregions have been further divided into 419 subregions which are more localised and homogenous



geomorphological units in each bioregion. The study area is located within the Perth subregion (SWA02) of the Swan Coastal Plain bioregion.

The Swan Coastal Plain is a low-lying coastal plain, mainly covered with woodlands. It is dominated by Banksia (*Banksia* spp.) or Tuart (*Eucalyptus gomphocephala*) on sandy soils, *Casuarina obesa* on outwash plains, and paperbark (*Melaleuca* spp.) in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland (Mitchell et al., 2002).

The Perth subregion is composed of colluvial and Aeolian sands, alluvial river flats and coastal limestone. Heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Banksia (*Banksia* spp.) and Jarrah (*Eucalyptus marginata*)-Banksia (*Banksia* spp.) woodlands on Quaternary marine dunes of various ages, and Marri (*Corymbia calophylla*) on colluvials and alluvials. The subregion also includes a complex series of seasonal wetlands. The subregional area is 1,333,901 ha in size (adapted from Mitchell et al., 2002).

### 3.7 Regional Vegetation

Hedde et al. (1980) have described and mapped vegetation complexes of the Darling System at a broad 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.

According to the mapping undertaken by Hedde et al. (1980), seven vegetation complexes occur across the study area. The seven vegetation complexes are described below, while Table 3.1 provides a breakdown of the representation within the study area. The Reagan complex occurs on the Dandaragan Plateau and is not considered to occur on the Swan Coastal Plain. The Reagan Complex covers a small portion (approximately 2 ha) of the study area.

- Bassendean Complex-Central and South: ranges from woodland of Jarrah (*Eucalyptus marginata*)-Sheoak (*Allocasuarina fraseriana*)-Banksia (*Banksia* spp.) on the sand dunes, to a low woodland of *Melaleuca* spp., and sedgelands on the low-lying depressions and swamps.
- Bassendean Complex-North Transition: consists of low open forest and a low woodland of Banksia (*Banksia* spp.)-Prickly Bark (*Eucalyptus tottiana*) and is structurally similar to several other vegetation complexes, but differs in the floristic composition of the understorey.
- Bassendean Complex-North: consists of a range of vegetation from low open forest and low woodland of Banksia (*Banksia* spp.)-Prickly Bark (*Eucalyptus tottiana*) to a low woodland of *Melaleuca* spp., and sedgelands which occupy moister sites.
- Coonambidgee Complex: consists of vegetation ranging from a low open forest and low woodland of Prickly Bark-Banksia (*Eucalyptus tottiana*-*Banksia attenuata*-*Banksia menziesii*-*Banksia ilicifolia*) with local admixtures of *Banksia prionotes*, to an open woodland of Marri (*Corymbia calophylla*)-Banksia (*Banksia* spp.).
- Reagan Complex: supports vegetation ranging from low open woodland of *Banksia attenuata*-*Banksia menziesii*-*Eucalyptus tottiana* to closed heath, depending on the depth of the soil.
- Southern River Complex: consists of open woodland of Marri (*Corymbia calophylla*)-Jarrah (*Eucalyptus marginata*)-Banksia (*Banksia* spp.) on the elevated areas and a fringing woodland of *Eucalyptus rudis*-*Melaleuca raphiophylla* along the streams.

- Yanga Complex: a low open forest of Swamp Sheoak (*Casuarina obesa*) occurs on the low-lying flats, with patches of *Actinostrobus pyramidalis* and *Melaleuca* spp. (including *Melaleuca lateritia* and *Melaleuca hamulosa*).

**Table 3.1 Vegetation complex extent within the study area**

Vegetation complex	Extent within the study area	
	ha	%
Bassendean Complex-Central and South	204	20.6
Bassendean Complex-North Transition	29	2.9
Bassendean Complex-North	184	18.6
Coonambidgee Complex	9	0.9
Reagan Complex	2	0.2
Southern River Complex	200	20.3
Yanga Complex	359	36.4


### 3.8 Bush Forever Strategy

The Bush Forever Strategy is a ten year strategic plan which formally commenced in 2000 to protect approximately 51,200 ha of regionally significant bushland within approximately 290 Bush Forever Sites, representing, where achievable, a target of at least 10% of each of the original 26 vegetation complexes of the Swan Coastal Plain portion of the Perth Metropolitan Region (Government of Western Australia, 2000a).

There are 13 Bush Forever Sites located within or adjacent (within 1 km) to the study area (Table 3.2).

**Table 3.2 Bush Forever sites**

Site no.	Site name	Location (Inside/outside)	Vegetation complexes	Significant fauna
2	North East Ellen Brook Bushland, Bullsbrook	Outside	<ul style="list-style-type: none"> <li>• Beermullah Complex</li> <li>• Yanga Complex</li> </ul>	Not Known
6	Cooper Road Water Reserve and Adjacent Bushland, Bullsbrook	Outside	<ul style="list-style-type: none"> <li>• Yanga Complex</li> <li>• Bassendean Complex-North</li> </ul>	Not Known
13	Sawpit Road Bushland, Bullsbrook	Outside (adjacent)	<ul style="list-style-type: none"> <li>• Yanga Complex</li> </ul>	Not Known
97	Kirby Road Bushland, Bullsbrook	Inside	<ul style="list-style-type: none"> <li>• Yanga Complex</li> <li>• Bassendean Complex-North</li> </ul>	Not Known
100	Neaves Road Creek, Bullsbrook	Inside	<ul style="list-style-type: none"> <li>• Yanga Complex</li> </ul>	Southern Brown Bandicoot
192	Wetherell Road Bushland, Lexia/Ellenbrook	Inside	<ul style="list-style-type: none"> <li>• Bassendean Complex-Central</li> </ul>	Southern Brown Bandicoot



Site no.	Site name	Location (Inside/outside)	Vegetation complexes	Significant fauna
195	Wetherell Road Bushland, Lexia/Ellenbrook	Outside	and South <ul style="list-style-type: none"> <li>Bassendean Complex-North Transition</li> </ul>	
198	Beechboro Road Bushland, Cullacabardee/Ballajura	Inside	<ul style="list-style-type: none"> <li>Bassendean Complex-Central and South</li> <li>Southern River Complex</li> </ul>	Not Known
300	Maralla Road Bushland, Ellenbrook/Upper Swan	Inside	<ul style="list-style-type: none"> <li>Guildford Complex</li> <li>Swan Complex</li> <li>Yanga Complex</li> <li>Bassendean Complex-North</li> <li>Bassendean Complex-North Transition</li> </ul>	Southern Brown Bandicoot Western Brush Wallaby
304	Whiteman Park, Whiteman/West Swan	Inside	<ul style="list-style-type: none"> <li>Bassendean Complex-Central and South</li> <li>Southern River Complex</li> </ul>	Southern Brown Bandicoot Western Brush Wallaby Black-striped Snake Jewelled Sandplain Ctenotus
307	Lightning Swamp and Adjacent Bushland, Noranda	Inside	<ul style="list-style-type: none"> <li>Bassendean Complex-Central and South</li> <li>Southern River Complex</li> </ul>	Not Known
385	Reid Highway Bushland, Mirrabooka/Malaga	Outside	<ul style="list-style-type: none"> <li>Bassendean Complex-Central and South</li> <li>Karrakatta Complex-Central and South</li> </ul>	Not Known
399	Melaleuca Park and Adjacent Bushland, Bullsbrook/Lexia	Inside	<ul style="list-style-type: none"> <li>Yanga Complex</li> <li>Bassendean Complex-North</li> <li>Bassendean Complex-North Transitional</li> </ul>	Black-striped Snake Jewelled Sandplain Ctenotus
480	Victoria Road Bushland, Malaga/Beechboro	Inside	<ul style="list-style-type: none"> <li>Southern River Complex</li> </ul>	Not Known



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## 4 METHODS

### 4.1 Desktop Assessment

In accordance with the EPA's Guidance Statement No. 56 for a 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.

#### 4.1.1 State and Federal Government Databases

A request for a search of the Threatened Fauna database (DPAW, 2014a) was submitted on 3 July 2014 for a shapefile polygon that encompassed the entire alignment of the study area with a 10 km buffer (Appendix B).

A search of NatureMap (DPAW, 2014b) database was submitted on 3 July 2014 for a shapefile polygon that encompassed the entire alignment of the study area with a 10 km buffer (Appendix C).

A search of the online publicly available database for MNES (DOTE, 2014a) was undertaken for the study area. A line search (-31.57526 115.993625 and -31.863796 115.918094) with a 10 km buffer was undertaken for the study area (Appendix D).

#### 4.1.2 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 review was undertaken to identify the fauna species and habitats considered to be significant from a regional and local context. The documents that have been reviewed include:

- A search of Birds Australia's Birddata database (Birddata, 2014) was submitted on 3 July 2014 for a one degree square containing the point 115.91267, -31.79754.
- Whitman Parks register of vertebrate species recorded from staff, researchers and surveys, current as of 2006.
- Ground Vertebrate Fauna of Perth's Vegetation Remnants: Impact of 170 Years of Urbanisation (How and Dell, 2000) only data from sites relevant to the study area were included.
- Biodiversity Values and Threatening Processes of the Gnamptara Groundwater System (DEC, 2009).

#### 4.1.3 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 faunal 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:

- 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).



- Rehabilitation Area Fauna Surveys, Neaves Road, Bullsbrook (Bamford Consulting, 2014).
- Flora and fauna assessment, Mitchell Freeway Extension (Burns Beach Road to Romeo Road) (GHD, 2013b).
- Flora, Vegetation and Vertebrate Fauna Assessment Neerabup Industrial Area (ATA, 2007).
- A Biological Survey of Boonaring Nature Reserve (Burbidge et al., 1996).
- Egerton Fauna Survey (Alan Tingay and Associates, 1994).

## 4.2 Field Survey

The Level 2 fauna assessment was conducted in accordance with *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002); *Guidance for Assessment of Environmental Factors No. 56* (EPA, 2004a), *Guidance for Assessment of Environmental Factors No. 20* (EPA, 2009) and the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC, 2010). A DPAW Regulation 17 Licence (SF010008) and a DPAW Regulation 4 Authority -8(1) Licence (CE004607) were obtained for the trapping regime.

The Level 2 fauna survey, including the Black Cockatoo habitat assessment and the fauna movement survey was undertaken independently from the flora and vegetation survey from 9 to 17 September 2014 by Mr John Trainer (Senior Zoologist) and Mr Glen Murray (Senior Zoologist).

## 4.3 Methods

### 4.3.1 Level 2 Survey

A targeted trapping program was conducted in areas potentially containing significant fauna or their habitats, such as Cullacabardee Bushland and Maralla Road Bushland. These sites were identified by the OEPA as sites where impacts to fauna movement may be impacted. As the fauna assemblage of the Swan Coastal Plain is well known, the trapping program is designed to identify species likely to be impacted in these key areas rather than obtain the fauna assemblage of the area.

Trap sites at these two locations were established in the habitat types within the study area and its immediate surrounds. Two trap sites were established in the Banksia Woodland at the Cullacabardee Bushland site. Four trap sites were established at Maralla Road Bushland, two in Banksia Woodland habitats, one in a Dampland habitat and one in the Eucalypt/Corymbia Woodland habitat.

A total of eight consecutive trapping nights were completed for six trap sites, the minimum requirement is seven consecutive nights (EPA/DEC, 2010). Each trap site contained five pitfall traps (20 litre buckets) spaced approximately 8 m apart, connected by a 50 m drift fence and 6 funnel traps. A total of 10 Elliot traps and 4 cage traps were used per trap site, arranged in two lines running parallel to the drift fence. Each trap line consisted of five Elliot traps with two Cage traps, one at each end. The total trap effort is displayed in Table 4.1 with 1208 trap nights worth of trap effort. The location and results of the trap sites are displayed in Appendix E and Figure 4a–b.

**Table 4.1 Survey trap effort**

Trap type	Total nights	Units used	Total trap nights
Elliot A	8	40	320
Elliot B	8	20	160
Cage	8	24	192
Pit Fall Bucket	8	30	240
Funnel	8	36	288
Camera	4	2	8
<b>Total</b>			<b>1208</b>

The study area was accessed via vehicle and traversed on foot. 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 at locations containing attributes typical to the different fauna habitats present in the study area (Appendix F). Fauna habitats were assessed on the microhabitats they provide to a wide range of faunal assemblages, habitat/vegetation condition and also the number of conservation significant fauna they support. The vegetation condition results from the flora survey were used to assess the fauna habitat condition (Coffey, 2015).


At each of the trap sites a daily 20-minute bird census was conducted within 2 hours of sunrise or dusk. The species and number of individual birds were recorded either by sight or aurally within a 2 ha area surrounding each trap site, which is the methodology used by Birds Australia for the Australia wide Bird Atlas project (Barrett, et al. 2003). To supplement this methodology, opportunistic records of birds throughout the study area were also made.

Nocturnal spotlight surveys were conducted at each trap site in the study area. Nocturnal spotlighting is used to help identify nocturnal species that are unlikely to be recorded through other survey methods. A total of six person hours of nocturnal surveys were completed on the 15 September 2014.

Opportunistic observations of the faunal assemblage were undertaken with specific focus on any conservation significant species. In particular survey effort was invested in searches for ground dwelling species likely to occur in the area, as they are more likely to be impacted by the proposed development. Techniques involved searching for tracks, scat, bones, hair, feathers and burrows. Examples include raking and searching for the Black-striped Snake (*Neelaps calonotos*), searches for Southern Brown Bandicoot (*Isoodon obesulus fusciventer*), including for secondary evidence such as scats and diggings, searches for scats and den sites for the Western Quoll (*Dasyurus geoffroii*). Motion sensitive cameras were not employed along most of the alignment due to a high risk of being stolen. Two motion sensitive cameras were used at trap site six in the Maralla Road Bushland for a total of eight trap nights. The presence or evidence of any conservation significant fauna will have its details recorded (GPS location, sex, habitat and picture taken if possible).

#### **4.3.2 Fauna Movement Survey**

A combination of aerial photographs, ground-truthing, assessment of the Perth regional ecological linkages (Government of Western Australia, 2009) and consultation with the OEPA was used to identify areas of importance in regards to ecological linkages. The main areas of focus include Maralla Road Bushland and Cullacabardee Bushland. These sites were surveyed for their potential to provide ecological linkages and encourage safe fauna movement. The data collected was analysed using ARC GIS Hot Spot analysis to



identify areas of high fauna traffic and importance (Figure 4a–b). This data will be used to recommend the appropriate locations and types of fauna movement corridors (bridges, underpasses etc.) or mechanisms.

Vehicle tracks directly adjacent to the Maralla Road Bushland (approximately 500 m in length) and Cullacabardee Bushland trap sites (approximately 1800 m in length) were used to identify areas of high fauna traffic. Other tracks in the vicinity were not used due to the thick sand and risk of vehicles getting bogged while dragging the tracks. Consultation on the proposed methodology with DPAW occurred prior to the survey initiation (Godfrey, pers.com. 2014). The tracks were dragged each day with a heavy chain rig attached to the back of a car to reveal a fresh layer of sand (Plate 1). A total of 6 nights of fauna movement surveys was conducted at each site. This method was used to identify fresh animal tracks and allow them to be sorted into fauna class and number of movements. The fauna track locations were recorded using Garmin GPSMAP 64s units with an accuracy of +/- 2-8 metres. Only ground dwelling native species were recorded during the fauna movement survey as these are the target species for any potential fauna movement corridors.

#### **4.3.3 Targeted Cockatoo Survey**

A targeted Black Cockatoo survey was undertaken in accordance with the EPBC Act Referral Guidelines for the Three Threatened Black Cockatoo Species (DSEWPAC, 2012), and the Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010). Based upon the distribution maps in the Referral Guidelines two of the three species of Black Cockatoo are expected to occur in the study area: Carnaby's Cockatoo (*Calyptrorhynchus latirostris*) and the Forest Red-tailed Cockatoo (*Calyptrorhynchus banksii naso*). The study area is just outside of the northern distribution for the Baudin's Cockatoo (*Calyptrorhynchus baudinii*).

The study area was assessed on the level of Black Cockatoo habitat it provides in particular foraging, roosting and breeding habitat. Habitats were mapped as High, Moderate or Low value for Black Cockatoos based upon the level 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.

##### **4.3.3.1 Foraging Assessment**

The study area 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, Chapman, 2007 and DSEWPAC, 2012). Evidence in the form of chewed Marri (*Corymbia calophylla*) or Jarrah (*Eucalyptus marginata*) 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 was mapped according to the presence of foraging resources.

##### **4.3.3.2 Breeding Assessment**

Black Cockatoos breed in large tree hollows which are found in trees usually more than 200 years old (DSEWPAC, 2012). The size of the tree measured at 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.

All trees species known to be used by breeding Black Cockatoos were assessed. Trees containing suitable hollows, or with a diameter at breast height (DBH) greater than 500 mm (or 300 mm depending on the species) were identified, and the following information recorded:

- Geographic coordinates.
- Tree species.

- Estimated height of tree (m).
- Number of hollows.
- Estimated diameter of any hollows (i.e. >200 mm or <200 mm).

#### **4.3.3.3 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 desktop search was conducted for known roost sites in the vicinity of the study area.

#### **4.4 Survey Limitations**

The fauna survey was conducted by John Trainer and Glen Murray, both are specialists and are suitably qualified Zoologists with extensive experience conducting fauna surveys on the Swan Coastal Plain. Both participants have been involved in conducting numerous biological surveys including Level 2 surveys and Black Cockatoo assessments (John Trainer six years' and Glen Murray eight years' experience).

The Swan Coastal Plain has been thoroughly studied and the faunal assemblage is well known. The targeted Level 2 assessment and fauna movement survey were specifically designed to record the fauna species that are most likely to be impacted by the proposed development, rather than conducting a baseline survey. As such the survey effort was focused on areas where the maintenance of ecological connectivity was identified as important and recording the species most common in these environments. Based on these considerations the survey design and trapping effort was not considered a limitation.

Weather varied during the survey, with overcast conditions during 9 to 11 September 2014 and fine sunny conditions for the remainder of the survey period. Maximum ambient temperatures were between 19.7 and 27°C and minimum ambient temperatures were between 13.8°C and 4.2°C (Perth Airport Weather station was closest to the trap sites). A total of 5.2 mm of precipitation was recorded at Perth Airport during the survey period, however, very little actually occurred at the trap site locations. A low pressure system and a storm front occurred in the week leading up until the start of the survey period with a total of 22.8 mm of precipitation recorded. The combination of wet conditions and sunshine leading up to and during the survey period provides ideal conditions for identifying both amphibians and reptiles. Considering these conditions are representative of the spring, weather is not considered a limitation. The survey timing was marginally outside of the optimal survey time (October to December) for the South West by the EPA Guidance statement No. 56 (EPA, 2004a) and EPA Technical Guide (EPA/DEC, 2010) for the Level 2 vertebrate fauna assessment and targeted conservation significant survey. However, consultation with the OEPA considered the survey timing to be suitable.

Access to the study area was not considered a limitation as the entire length of it was accessible by either vehicle or by foot.

The EPA Guidance for Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56 (EPA, 2004a) suggested that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 4.2.

**Table 4.2 Survey limitations**

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comments
Competency and experience of the consultant(s) carrying out the survey	No	The scientists who prepared the report and conducted the field assessments are suitably qualified and experienced in conducting ecological surveys on the Swan Coastal Plain
Scope	No	The survey scope was prepared in consultation with the client and the OEPA.
Proportion of fauna identified, recorded and/or collected	Negligible	Based on the habitats present in the study area and the results from the desktop review, it is likely that the majority of the common trappable terrestrial fauna and birds have been recorded.
Sources of information	No	Vertebrate fauna information was available using the DPAW NatureMap online fauna database, surveys conducted at other sites in the region, and published and unpublished reports.
Proportion of the task achieved	No	The survey and assessment fulfils the objectives stated.
Timing/weather/season/cycle	No	The fauna survey was completed 9-17 September 2014, which is considered to be marginally outside the optimal period for sampling reptiles in the south west (i.e. October – December) however was suitable timing for amphibian, bird and mammal sampling. The targeted conservation significant fauna survey was undertaken in August 2012 which was appropriate timing for the conservation significant species targeted.
Disturbances which affected results of the survey	No	No significant disturbances took place during the survey that would affect the results or conclusions.
Intensity of survey effort	No	The intensity of the assessment was sufficient for a trapping survey of this type as comparison with similar sized surveys and results from other surveys in the region. A second season survey was not considered necessary as this was not a baseline fauna survey and due to the availability of regional data.
Completeness	No	Trapping grids were set up in each of the major habitat types.
Resources	No	Adequate resources were available.
Remoteness and/or access problems	No	The entire study area was readily accessible with extensive roads and tracks along the length of the site. The entire study area was also walked on foot.
Availability of contextual information on the region	No	DPAW's online NatureMap database, DPAW's Threatened and Priority species database, surveys conducted at other sites in the region and published and unpublished reports.



## 5 RESULTS

### 5.1 Fauna Habitat

A total of four natural fauna habitats were recorded in the study area: Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland (Table 5.1). In addition a further three secondary fauna habitats were recorded in the study area: Modified Vegetation, Paddock and Pine Plantation. The secondary fauna habitats do not support the full fauna assemblage but provide limited habitat to some species (Figure 5a–m). The fauna habitats present in the study area have been highly impacted upon by rubbish, weeds, feral animals, fire, vehicle tracks and *Phytophthora* sp. (dieback).

**Table 5.1 Fauna habitat types**


Habitat type	Area (ha)	Habitat value
<b>Natural fauna habitats</b>		
Banksia Woodland	90.7	Moderate
Eucalypt/Corymbia Woodland	62.6	High
Dampland	27.1	Moderate
Wetland	20.2	Moderate
<b>Secondary habitats</b>		
Modified Vegetation	295.4	Low
Paddock	311.1	Low
Pine Plantation	68.5	Low
Infrastructure/cleared	106.9	Nil
Total	987.1	

#### 5.1.1 Banksia Woodland

The vegetation of this habitat type is typified by *Banksia attenuata* and *Banksia menziesii* low woodland with occasional *Eucalyptus tottiana* over mixed shrubs dominated by *Eremaea pauciflora*, *Scholtzia involucrata* and *Leucopogon conostephioides* over isolated sedges and rushes. Approximately 90.7 ha of Banksia Woodland occur in the study area, which equates to 9.2% of the total area. 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, with limited niches provided by the Coastal Blackbutt (*Eucalyptus tottiana*). The Banksia Woodland habitat is classified as ranging between degraded to pristine condition with impacts including weeds, feral animals, rubbish, tracks, recent fire damage and dieback. The Banksia Woodland provides moderate habitat value.

#### 5.1.2 Eucalypt/Corymbia Woodland

The vegetation of this habitat type is typified by *Eucalyptus marginata* and/or *Corymbia calophylla* woodland over occasional *Banksia attenuata* and *Banksia menziesii* over *Xanthorrhoea preissii* shrubland



over mixed low shrubs over sedges and rushes. Approximately 62.6 ha of Eucalypt/Corymbia Woodland occur in the study area, which equates to 6.3% of the total area. The Eucalypt/Corymbia Woodland habitat is generally dominated by Marri over most of the study area with sporadic Jarrah and Tuart (*Eucalyptus gomphocephala*) also occurring. 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 the presence of tree hollows provides suitable habitat for a range of birds, specifically for the species that nest in tree hollows such as parrots and pardalotes. The abundant leaf litter and fallen logs produce refuge for ground dwelling fauna. The Eucalypt/Corymbia Woodland habitat is classified as ranging between good to excellent condition with impacts including weeds, feral animals, rubbish, tracks, recent fire damage and dieback. The Eucalypt/Corymbia Woodland provides high habitat value.

#### **5.1.3 Dampland**

The vegetation of this habitat type is characterised by occasional *Eucalyptus rudis* trees over *Melaleuca preissiana* and/or *Melaleuca raphiophylla* low woodland over occasional heath scrub dominated by *Pericalymma* spp., *Astartea* spp. and *Melaleuca* spp. over sedges and rushes. Approximately 27.1 ha of the Dampland habitat occur in the study area, which equates to 2.7% of the total area. This habitat type as its name suggests is an area where moisture collects and during the winter months becomes seasonally waterlogged. The moist 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-storey vegetation which provide habitat for many bird species. The Dampland habitat is classified as ranging between completely degraded to pristine condition with impacts including weeds, feral animals, rubbish, tracks and recent fire damage. The Dampland provides moderate habitat value.


#### **5.1.4 Wetland**

The vegetation of this habitat type is characterised by *Eucalyptus rudis* and *Melaleuca preissiana* woodland over mixed shrubs over sedges and rushes with surface water expression. Approximately 20.2 ha of Eucalypt/Corymbia Woodland occur in the study area, which equates to 2.0% of the total area. Wetlands differ from the Dampland habitat in that they contain surface water for the majority of the year or are a permanent water source. The Wetland habitats provide an important water source for the local fauna and provides habitat for waterfowl, amphibians and other aquatic species such as fish. The Wetlands of the study area are small and do not contain the shallow pools or flats migratory waders typically forage. The Wetland habitat is classified as ranging between completely degraded to very good condition with impacts including weeds, feral animals, rubbish and tracks. The Wetland habitat provides moderate habitat value.

#### **5.1.5 Secondary Fauna Habitats**

The secondary fauna habitats of the study area are classified into Modified Vegetation, Paddock and Pine Plantation. These secondary habitats do not support the full fauna assemblage, although they do provide limited habitat for some species. Secondary fauna habitats often provide conduits between areas of more suitable habitat and act as an ecological linkage.

Areas classified as Modified Vegetation occur where the original vegetation structure of the habitat has been disrupted. Examples include areas where the over-storey and mid-storey has been removed, leaving sporadic cover of lower-storey species; areas where the lower-storey and mid-storey have been cleared leaving an intact over-storey, and areas such as roadside vegetation where rehabilitated vegetation occurs. Approximately 295.4 ha of Modified Vegetation occur in the study area, which equates to 29.9% of the total area. The Modified Vegetation habitat is classified as ranging between good to completely degraded condition with a high level of impact from clearing, weeds, feral animals, rubbish and tracks. The Modified Vegetation habitat provides low habitat value.



The secondary habitat of Paddock is characterised by sporadic Eucalypts/Corymbias such as Flooded Gums (*Eucalyptus rudis*), Jarrah and Marri, over pastures. Approximately 311.1 ha of Paddock occur in the study area, which equates to 31.5% of the total area. The open pastures of the habitat provide grazing resources for species such as Emus, Western Grey Kangaroos and waterfowl. The mature Eucalypts/Corymbias can contain tree hollows that are used as breeding resources for some species of duck, parrots and cockatoos. As the original vegetation structure of this habitat has been disrupted this habitat has been classified as ranging between degraded to completely degraded condition with a high level of impact from clearing, weeds, feral animals, livestock, rubbish and tracks. The Paddock habitat provides low habitat value.

The secondary habitat of Pine Plantations is where the native vegetation has been completely cleared and replaced with planted Pines, mostly Maritime Pine, *Pinus pinaster*. Approximately 68.5 ha of Pine Plantation occur in the study area, which equates to 6.9% of the total area. This habitat provides an important food and roosting resource for Black Cockatoos; however it provides a limited habitat for other fauna. Harvesting of a portion of Pines in the project area has occurred since the survey was undertaken in 2014. The Pine Plantations of the study area are due to be harvested by 2025 at the latest and will not be replanted. The logging of Pines in the study area essentially negates the habitat value of this area for Black Cockatoos. The Pine Plantation contains a high level of impact from clearing, weeds, feral animals, livestock, rubbish and tracks. The Pine Plantation habitat provides low habitat value.

## **5.2 Black Cockatoo Habitat Assessment**

The fauna habitats of the study area were assessed for the level of habitat they provide Black Cockatoos and were classified as being high, moderate or low value habitats (Table 5.1, Table 5.2 and Figure 6a–m). The Eucalypt/Corymbia Woodland is classified as high value as it provides foraging, roosting and breeding habitat. The Banksia Woodland provides only foraging habitat and is classified as being moderate value Black Cockatoo habitat. The Dampland habitat provides limited foraging habitat and is classified as being low value Black Cockatoo habitat. The Wetland habitat provides varied levels of Black Cockatoo habitat; as such each section of habitat was mapped according to the level of habitat it provides. Dampland or Wetland habitats that contained mature Flooded Gums were classified as providing foraging, roosting and potential breeding habitat and were mapped as high value habitat. Dampland or Wetland habitat that did not contain mature Flooded Gums provide limited foraging habitat and is classified as being low value Black Cockatoo habitat.

Some sections of the Modified Vegetation secondary habitat provides foraging, breeding or roosting habitat and are mapped in Figure 6a–m according to the level of habitat they provide. The Pine Plantations provide suitable foraging and roosting habitat however, their harvesting and continued presence is managed by the Forest Product Commission (FPC) and is outside the scope and control of the PDNH development. As such, the 68.5 ha of the Pine Plantation recorded in the study area have not been classified as foraging or roosting habitat as this area will be cleared in the near future.

**Table 5.2 Area of Black Cockatoo habitat within the study area**


Habitat	High (contains breeding, roosting and foraging habitat)	Moderate (contains quality foraging habitat)	Low (contains limited foraging habitat)	Nil (contains no habitat)
Eucalypt/Corymbia woodland	62.6			
Banksia Woodland		90.7		
Dampland			27.1	
Wetland	14.1		6.1	
Modified Vegetation	86		209.3	
Pine Plantation				68.5
Paddock			311.1	
Cleared/infrastructure				111.5
<b>Total</b>	<b>162.8</b>	<b>90.7</b>	<b>553.6</b>	<b>180</b>

### 5.2.1 Foraging assessment

The study area contains 21 species of plant that are known as foraging resources for the Black Cockatoos (Valentine and Stock, 2008, Chapman, 2007 and DSEWPAC, 2012) (Table 5.3). Habitat types that contained quality foraging resources (High and Moderate value) were classified as foraging habitat for Black Cockatoos. As such, approximately 253.5 ha of foraging habitat are located in the study area. Current and historical foraging evidence was located in 10 locations during the survey, the majority of which was on Banksia cones or Marri nuts (Plate 2 and 3).

**Table 5.3 Black Cockatoo foraging resources**

Foraging resources	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
<i>Acacia saligna</i>	X	
<i>Agonis flexuosa</i>	X	
<i>Allocasuarina fraseriana</i>	X	X
<i>Banksia attenuata</i>	X	
<i>Banksia dallanneyi</i>	X	
<i>Banksia ilicifolia</i>	X	
<i>Banksia littoralis</i>	X	
<i>Banksia menziesii</i>	X	
<i>Banksia nivea</i>	X	
<i>Corymbia calophylla</i>	X	X
<i>Erodium botrys</i>	X	
<i>Eucalyptus camaldulensis</i>	X	X
<i>Eucalyptus marginata</i>	X	X



Foraging resources	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
<i>Eucalyptus rudis</i>	X	X
<i>Eucalyptus tottiana</i>	X	
<i>Hakea varia</i>	X	
<i>Jacksonia furcellata</i>	X	
<i>Lupinus</i> sp.	X	
<i>Pinus pinaster</i>	X	
<i>Romulea rosea</i>	X	
<i>Xanthorrhoea preissii</i>	X	

### 5.2.2 Roosting Assessment

Fauna habitats classified as having high value for Black Cockatoos contain 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). Based on this definition the Eucalypt/Corymbia Woodlands and Wetland habitats with stands of tall trees provide potential roosting habitat for Black Cockatoos (76.7 ha). 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. Three major roost site locations have been recorded in the Pine Plantations to the west of the study area in the Gngangara region. All sites are within 10 km of the study area and have between 64 and 542 Carnaby's Cockatoos using these roost locations (Burnham et al., 2010).


### 5.2.3 Breeding Assessment

The study area contains 1,061 trees that have a DBH over 500 mm. The majority of these trees are Marri (804), with the remaining Flooded Gum (138), Jarrah (103) and Tuart (16) (Appendix G). These trees occur across all habitat types (Figure 6a–m). The cockatoo referral guidelines state “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 entire Eucalypt/Corymbia Woodland is classified as breeding habitat (approximately 62.6 ha). In addition, Modified Vegetation or Wetland habitats that contain stands of suitable sized trees are classified as breeding habitat (100.1 ha). As the Paddock and some sections of Modified Vegetation habitats contain sporadic Eucalypt/Corymbia trees rather than stands, the individual suitably sized trees were recorded in the total number of suitable breeding trees rather than the total area of breeding habitat.

For hollows to be of use to Carnaby's Cockatoos they should have dimensions of at least 14 cm entrance size and at least 50 cm deep (Groom, 2011). A total of 18 trees that contained suitable sized hollows were recorded within the study area (Appendix G). However, there was no evidence of their use as current or historic breeding sites (chew marks around hollow openings and droppings). There are no known breeding records for Black Cockatoos in the study area or its vicinity.

## 5.3 Desktop Assessment

The results of the desktop assessment have been separated into two components; the expected faunal assemblages based upon database searches and review of existing fauna surveys (Appendix H) and the



likelihood of occurrence of conservation significant species in the study area based on review of database searches and existing fauna surveys (Appendix I). A summary of the survey effort and results for comparable surveys used in the desktop analysis is displayed in Table 5.4.

The desktop review identified 360 species of fauna that have been previously recorded in the vicinity of the study area (Appendix H). This list includes four invertebrates, five fish, 14 amphibians, 64 reptiles, 232 birds and 41 mammals. It should be noted that this list includes 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). Erroneous records have been omitted from the list of previously recorded fauna.



**Table 5.4** Survey review of existing level 2 fauna surveys completed in proximity to the study area

Source	Area/region of survey	Approx. area of survey site	Trap sites/days	Trapping effort	Amphibians	Reptiles	Birds	Mammals	Total
Alan Tingay and Associates. 1994	Egerton, Shire of Swan (City of Swan)	495 ha	4 sites 5–6 days	605 trap nights	6	9	38	7	60
Burbidge, A. et al. 1996	Boonanarring Nature Reserve, 15 km North of Gingin	9250 ha	7 sites 5 days	600 trap nights	5	20	74	15	104
How, R. and Dell, J. 2000	Perth metropolitan region (Swan Coastal Plain)	1 to 338 ha (Mean 34 ha)	34 sites 50 days	15,300 trap nights	11	43	–	13	67
ATA Environmental. 2007	Neerabup, City of Wanneroo	325 ha	5 Sites 9–10 nights	7,160 trap nights	3	20	42	5	70
GHD. 2013b	Neerabup	Not stated in report	6 sites 8 nights	1,952 trap nights	1	29	70	8	108
Bamford, M. J and A. R., Bamford Consulting Ecologist. 2014	Neaves Road, Bullsbrook	Not stated in report	7 sites 5–6 nights	1,980 trap nights	8	19	63	7	97



## 5.4 Faunal Assemblage

A total of 97 species were recorded during the survey including: one fish, six amphibians, 19 reptiles, 62 birds and nine mammals (Appendix H). All of which were identified as potentially occurring during the desktop assessment.

### 5.4.1 Invertebrates

The objective of the field survey was to sample terrestrial vertebrate fauna; as such a systematic survey for the invertebrates of the study area was not conducted. However, the conservation significant invertebrates recorded in the desktop assessment will be addressed for their likelihood of occurrence in Appendix I.

Short range endemics (SRE) are species of animal (predominantly Invertebrates) that have a restricted distribution, less than 10,000 km squared (EPA, 2009). The desktop did not identify any records of SRE previously recorded in the vicinity of the study area. As such, no SRE specific survey was conducted and Guidance for the Assessment of Environmental Factors – Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia No. 20, was not required.

### 5.4.2 Fish

The objective of the field survey was to sample terrestrial vertebrate fauna; as such a systematic survey for the aquatic vertebrates (fish) in the study area was not conducted. However, five species of fish have been previously recorded in the vicinity of the study area in the desktop assessment. One species of fish the introduced Mosquito Fish (*Gambusia holbrooki*) was opportunistically recorded during the survey.

### 5.4.3 Amphibians

A total of 14 species of amphibian have been previously recorded in the vicinity of the study area. A total of six species of amphibian were recorded during the survey, three species were opportunistically recorded and three species were captured during the trapping survey, the most common of these species was the Moaning Frog (*Heleioporus eyrei*) with 6 individuals captured.

### 5.4.4 Reptiles


A total of 64 species of reptile have previously been recorded in the vicinity of the study area. A total of 19 reptile species were recorded during the survey, seven species were opportunistically recorded and a further 12 species were captured during the trapping survey. These included nine Skinks, one Agamid, one Pygopod and one Elapid. The most common species recorded during the trapping survey was the Bobtail skink (*Tiliqua rugosa*) with 29 individual captures. Of note is that no species of Gecko were recorded opportunistically or during the trapping program.

### 5.4.5 Birds

A total of 232 species of birds have previously been recorded in the vicinity of the study area. A total of 62 bird species were recorded during the survey, 30 species were opportunistically recorded and 32 species were systematically recorded from the trapping sites. The most common families systematically recorded were *Meliphagidae* (Honeyeaters) and *Pardalotidae* (Thornbills) both with four species each. Two introduced birds species were opportunistically recorded during the survey the Domestic Pigeon (*Columba livia*) and the Laughing Turtle-dove (*Streptopelia senegalensis*).

### 5.4.6 Mammals

A total of 41 species of mammal were previously recorded in the vicinity of the study area. A total of nine mammal species were recorded during the survey, five species were opportunistically recorded and four species were captured during the trapping survey. Of these six species were introduced; House mouse (*Mus*



*musculus*), Black rat (*Rattus rattus*), Rabbit (*Oryctolagus cuniculus*), Dog (*Canis lupis*), Red Fox (*Vulpes vulpes*) and Cat (*Felis catus*). Native mammals recorded include the Southern Brown Bandicoot, Common Brushtail Possum (*Trichosurus vulpecula*) and Western Grey kangaroo (*Macropus fuliginosus*).

## 5.5 Conservation Significant Fauna

From the database searches a total of 66 conservation significant fauna species have been recorded in the vicinity of the study area. These include four invertebrates, one fish, four reptiles, 46 birds and 11 mammals. 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). These species were assessed for their likelihood to occur reviewing each species current distribution, habitat requirements/relevance and location and age of previous records in the vicinity of the study area. From this species were classified as to their likelihood of occurrence by the following criteria:

- **Recorded:** This species was recorded during the current survey within the study area.
- **Likely:** Suitable habitat is present and recent records of this species exist close to the study area.
- **Possible:** Suitable habitat is present however no records exist in the vicinity, records exist in the vicinity but suitable habitat is nearby but not present in the study area or isolated records exist close to the study area, however no core habitat is present.
- **Unlikely:** Neither suitable habitat nor recent records exist near the study area.
- **Highly Unlikely:** Study area is outside of species current distribution, is thought to be locally extinct, suitable habitat is not present and no records exist in the vicinity of the study area.


A review of the likelihood of occurrence of these species and subsequent survey has shown that three species were recorded (Figure 5a–m), seven species are classified as ‘likely’ to occur, 22 species as ‘possible’ to occur, 11 species as ‘unlikely’ to occur and 23 species as ‘highly unlikely’ to occur (Appendix I).

The following species of conservation significance were recorded in the study area during the survey:

- Carnaby’s Cockatoo (*Calyptorhynchus latirostris*) – Endangered (EPBC Act) and Schedule 1 (WC Act) (Plate 4).
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable (EPBC Act) and Schedule 1 (WC Act) (Plate 5).
- Southern Brown Bandicoot (*Isodon obesulus fusciventer*) – Priority 5 (DPAW Priority list) (Plate 6).

## 5.6 Fauna Movement

The fauna movement surveys were completed along sandy vehicle tracks that ran adjacent to the study area in two locations: Cullacabardee Bushland and Maralla Road Bushland (Figure 4a–b). The survey was completed for six consecutive nights and only recorded native ground dwelling fauna that crossed the track (Plate 7 and 8). A total of 354 fauna crossings were recorded with the highest proportion of records belonging to Western Grey Kangaroos (82%). Tracks belonging to introduced species such as the Red Fox, Rabbit and Cat were commonly observed along the length of the tracks, however these were not included in the results as they are not the target species for fauna underpass/overpass locations and their inclusion may skew the data. A variety of birds such Australian Ravens, Doves, Australian Ringnecks and passerines were also recorded using the tracks during the survey. These records were omitted from the data as birds



are unlikely to use fauna underpasses and are not impacted by roads to the same extent that ground dwelling fauna are.

The Cullacabardee survey was conducted along an approximately 1,800 m stretch of vehicle track that adjacently ran 60 m to the east of the study area. A total of 255 fauna crossings were recorded during the survey with the vast majority of records belonging to Western Grey Kangaroos (83%) followed by Bobtail Skinks (12%). Smaller skinks (3%), snakes (1.5%) and a Goanna (0.5%) were recorded crossing the track at this location but in much lower numbers. Analysis of the Cullacabardee site has shown a total of nine hotspots (99% confidence interval), two located north of Baal Road and seven concentrated towards the southern section of the track. No hot spots were located near the central Baal Road and its associated fences (Figure 4a–b).

The Maralla Road survey was conducted along an approximately 500 m length of vehicle track running north/south from Maralla Road to the Ellenbrook estate. A total of 99 fauna crossings were recorded during the survey with the vast majority of records belonging to Western Grey Kangaroos (70%) followed by Bobtail Skinks (26%). Smaller skinks (2%), an Emu (1%) and a Goanna (1%) were recorded crossing the track at this location but in much lower numbers. Analysis of the Maralla Road site has shown that two hotspots (99% confidence interval) were recorded along the track. One hotspot was located adjacent to the Dampland habitat and the other half way along the track towards Maralla Road (Figure 4a–b).





**Plate 1** Heavy chain rig designed to clear track



**Plate 2** Black Cockatoo foraging evidence on Banksia cone



**Plate 3** Carnaby's Cockatoo foraging evidence on Marri nut



**Plate 4** Carnaby's Black Cockatoo



**Plate 5** Forest Red-tailed Black Cockatoo



**Plate 6** Southern Brown Bandicoot



**Plate 7** Tracks created by bobtail skink



**Plate 8** Tracks created by a Kangaroo





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## 6 DISCUSSION

### 6.1 Fauna Habitat

A total of four natural fauna habitats were recorded in the study area: Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland. A further three secondary fauna habitats were recorded, namely Modified Vegetation, Paddock and Pine Plantation. The secondary fauna habitats do not support the full fauna assemblage but provide limited habitat to some species.

#### 6.1.1 Banksia Woodland

The Banksia Woodland habitat is the most extensive fauna habitat in the study area with a total of 90.7 ha, equating to 9.2%. This habitat type predominantly occurs south of Maralla Road. The vegetation condition ranged from degraded to pristine with impacts including weeds, feral animals, rubbish, tracks, recent fire damage and dieback. The majority of this habitat type was classified as being in very good to excellent condition in particular the sections associated with Cullacabardee and Maralla Road Bushland. The Banksia Woodland potentially provides habitat for a wide range of fauna including a number of conservation significant species: Jewelled Sandplain Ctenotus (*Ctenotus gemmula*), Western Carpet Python (*Morelia spilota imbricata*), Black Striped-snake, Forest Red-tailed Black Cockatoo and Carnaby's Cockatoo. Based on the fauna supported by this habitat and the vegetation condition the Banksia Woodland was assessed as providing a moderate level of habitat value.

#### 6.1.2 Eucalypt/Corymbia Woodland

The Eucalypt/Corymbia Woodland habitat occurs in 62.6 ha of the study area equating to 6.3%. This habitat type predominantly occurs south of Maralla Road. The vegetation condition ranged from good to excellent with impacts including weeds, feral animals, rubbish, tracks, recent fire damage and dieback. The majority of this habitat type was classified as being in very good to excellent condition in particular the sections associated with Cullacabardee and Maralla Road Bushland. The Eucalypt/Corymbia Woodland habitat potentially provides habitat for a wide range of fauna including a number of conservation significant species: Western Carpet Python, Black Striped-snake, Forest Red-tailed Black Cockatoo and Carnaby's Cockatoo.

This habitat provides a greater level of microhabitats than the Banksia Woodland supporting a wider range of fauna. In particular the tree hollows, hollows logs and dense canopies provide niches, shelter and breeding opportunities for a range of fauna. Based on the fauna supported by this habitat and the vegetation condition the Eucalypt/Corymbia Woodland was assessed as providing a high level of habitat value.

#### 6.1.3 Dampland

Approximately 27.1 ha of Dampland habitat occurs in the study area equating to 2.7%. This habitat type is an area where moisture collects and during the winter months becomes seasonally waterlogged. The vegetation condition ranged from completely degraded to pristine with impacts including weeds, feral animals, rubbish, tracks. The majority of this habitat type was classified as being in very good condition with some degraded sections north of Maralla Road. The moist nature of this habitat provides an ideal environment for amphibians and where present the thick understorey vegetation potentially provides habitat for the conservation significant Southern Brown Bandicoot.

Based on the limited distribution of this habitat, the fauna it supports and the vegetation condition the Dampland was assessed as providing a moderate level of habitat value.



#### 6.1.4 Wetland

Approximately 20.2 ha of this habitat type occurs on the study area equating to 2%. The Wetland habitat is typically small lakes and ephemeral creeks. As such, they provide habitat to some aquatic species but not for fauna that require deep lakes or large wetland habitats such as rivers, swamps and large lakes. The Wetland habitat is classified as ranging between completely degraded to very good condition with impacts including weeds, feral animals, rubbish and tracks. The majority of this habitat type was classified as being in degraded condition (Coffey, 2015).

The Wetland habitats differ from the Dampland habitats in that they contain surface water for the majority of the year or are a permanent water source. Additionally, the Wetland habitat in this section refers to the term “Wetland” in a fauna habitat context and differs from the definition of a wetland referred to in section 3.4. The Wetland habitats provide an important water source for the local fauna and provide habitat for waterfowl, amphibians and other aquatic species. The Wetlands are small and do not contain the shallow pools or flats that migratory waders typically require. The Wetland habitat potentially provides habitat for the conservation significant Great Egret (*Ardea alba*) and Cattle Egret (*Ardea ibis*).

As the Wetland habitat has restricted distribution in the study area and its surrounds its habitat value is elevated, however based on the limited conservation significant fauna this habitat supports and the degraded vegetation condition the Wetland was assessed as providing a moderate level of habitat value.

#### 6.1.5 Secondary Habitats

The secondary fauna habitats of the study area are classified into Modified Vegetation, Paddock and Pine Plantation. These secondary habitats do not support the full fauna assemblage, although they do provide limited habitat for some species. The secondary fauna habitats of the study area provide a conduit between areas of more suitable habitat and act as an ecological linkage. Approximately 675 ha of the secondary habitats occur in the study area equating to 68.4%.

All secondary habitats have had the original vegetation structure disrupted and contain a high level of impact from clearing, weeds, feral animals, rubbish and tracks. Only the Modified Vegetation habitat located directly to the south of Gngangara Road provides habitat for conservation significant fauna: Carnaby’s Cockatoo and the Forest Red-tailed Black Cockatoo. All secondary habitats have been classified as providing low habitat value.

### 6.2 Black Cockatoo Habitat

The Pine Plantations in the study area are part of the Forest Products Commission (FPC) plantation and are currently being harvested and will not be replanted. The Pine Plantations in the study area and its surrounds are of importance to the Carnaby’s Cockatoos that occur on the Swan Coastal Plain; however, the harvesting and occurrence of the plantation is managed by FPC and as such, the occurrence and impacts are outside the scope and control of the PDNH development. Harvesting of a portion of Pines in the study area has occurred since the survey. For the purposes of this study, the 68.5 ha of the Pine Plantation recorded in the study area at the time of survey, are excluded as foraging or roosting habitat.

#### 6.2.1 Foraging Assessment

A total of 253.5 ha of quality foraging habitat were recorded in the study area (mapped as high and moderate value habitat, (Figure 6a–m). Areas adjacent to the study area such as, East Wanneroo, Gngangara and Whiteman Park have been identified as important sites for Carnaby’s Cockatoo on the Swan Coastal Plain (Johnstone and Kirkby, 2011). There were 21 species of foraging resources and 10 records of foraging evidence observed in the study area (upon Marri nuts and Banksia cones), showing that Black Cockatoos actively forage in the area.



### 6.2.2 Roosting Assessment

Roost sites for Black Cockatoos typically have tall, dense canopied trees, are close to water where the birds can drink and close to food resources. The roost trees are usually clumped and at larger roosts, cover an area of at least five hectares (Burnham et al., 2010). Based on this definition the Eucalypt/Corymbia Woodlands and Wetland habitats with stands of tall trees provide potential roosting habitat for Black Cockatoos (76.7 ha).

A desktop search for known roost sites was completed for the study area using data from the Great Cocky Count (Burnham et al., 2010). No known roost sites occur in the study area and none were recorded during the survey. Three major roost site locations have been recorded in the Pine Plantations to the west of the study area in the Gngangara region. All sites are within 10 km of the study area and have between 64 and 542 Carnaby's Cockatoos using these roost locations (Burnham et al., 2010).

### 6.2.3 Breeding Assessment

The study area contains 1,061 trees that have a DBH over 500 mm. The majority of these trees are Marri (804), followed by Flooded Gum (138), Jarrah (103) and then Tuarts (16) (Appendix G). 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/Corymbia Woodland, Modified Vegetation and Wetland habitats with stands of suitable sized trees are classified as breeding habitat and mapped as high value (162.8 ha).

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). A total of 18 trees that contained suitable sized hollows were recorded within the study area (Figure 6a–m, Appendix G). There are no known breeding records for Black Cockatoos in the study area or its vicinity.

## 6.3 Fauna Movement and Ecological Connectivity


### 6.3.1 Cullacabardee Fauna Movement

The Cullacabardee Bushland forms part of an ecological linkage with the greater Whiteman Park Nature Reserve (Government of Western Australia, 2000a), which extends both east and west of the proposed PDNH footprint. A number of priority listed ground dwelling fauna have been previously recorded in the surrounding area: Jewelled Sandplain Ctenotus, Southern Brown Bandicoot and Western Brush Wallaby (*Macropus irma*).

The majority of the records of fauna movement adjacent to the study area were from Western Grey Kangaroos and Bobtail skinks (95%). Analysis of the Cullacabardee site indicated a total of nine hotspots (99% confidence interval), two located north of Baal Road and seven concentrated towards the southern section of the track. No hot spots were located near the central Baal Road and its associated fences (Figure 4a–b). The Cullacabardee site is separated from the rest of the Whiteman Park reserve by a fence that runs either side of North Beechboro Road. Although it does not create an impenetrable barrier for fauna movement it does limit access between the areas. The area to the east of the track was identified as dawn/dusk grazing sites for the resident Western Grey Kangaroos which correlates to the concentration of hotspots recorded to the south of the track.

### 6.3.2 Maralla Road Fauna Movement

The location of the PDNH footprint occurs within an already existing road reserve for the Maralla Road site (Government of Western Australia, 2000b). The Maralla Road Bushland provides an ecological linkage to Bush forever site 300 and 301 in the east and 300, 399 to the west (Government of Western Australia, 2000a). The section of vegetation that exists between the Ellenbrook Estate and Maralla Road is a



bottleneck that restrict access to large areas of native vegetation in both an east and west direction, including Ellenbrook Nature Reserve and Walyunga National Park. A number of priority listed ground dwelling fauna have been previously recorded in the surrounding area: Jewelled Sandplain Ctenotus, Southern Brown Bandicoot and Western Brush Wallaby.

The majority of the records of fauna movement adjacent to the study area were from Western Grey Kangaroos and Bobtail skinks (96%). Analysis of the Maralla Road site indicated two hotspots (99% confidence interval) along the track. One hotspot was located adjacent to the Dampland habitat and the other half way along the track towards Maralla Road (Figure 4a–b).

### **6.3.3 Tonkin/Reid Connectivity**

The Dampland and Eucalypt/Corymbia Woodland at the Tonkin Highway/Reid Highway intersection (Micro Gardens Park) maintain ecological connectivity between Lightning Swamp Bushland, Malaga Regional Space and Koondoola Regional Bushland to the west and Point Reserve to the East. This site has been identified as being part of a “regionally significant, fragmented bushland/wetland linkage.” (Government of Western Australia, 2000a). Diggings attributed to the conservation significant Southern Brown Bandicoot (P5) were recorded in the Micro Gardens Park and the road reserve near the Reid Highway/Altone Road intersection (Figure 5a–m). Although heavily degraded the vegetation of the road reserve provides an ecological linkage between areas of suitable habitat for species such as the Southern Brown Bandicoot.

## **6.4 Fauna Assemblage**

The fauna assemblage of the Swan Coastal Plain is well documented with numerous systematic surveys completed in recent history, however little is known of the fauna assemblage prior to European settlement (Government of Western Australia, 2000a).

A targeted trapping program was conducted in areas potentially containing significant fauna or their habitats, such as Cullacabardee Bushland and Maralla Road Bushland. These sites were identified by the OEPA as sites where impacts to fauna movement may be impacted. As the fauna assemblage of the Swan Coastal Plain is well known, the trapping program was designed to identify species likely to be impacted in these key areas rather than obtain the fauna assemblage of the study area.

A total of 97 species were recorded during the survey including: one fish, six amphibians, 19 reptiles, 62 birds and nine mammals. The number of fauna recorded during the survey is comparable with the other surveys completed in the vicinity (Table 5.4). The fauna species recorded during the survey are typical of the habitats present with no new species that had not been previously recorded.

Of note was the lack of Gecko species recorded either opportunistically or during the trapping program. This could be due to the high level of impacts over the majority of the study area, such as fire, feral animals, clearing and weeds.

## **6.5 Conservation Significant Fauna**

The following species of conservation significance were recorded in the study area during the survey: Carnaby’s Cockatoo listed as Endangered (EPBC Act) and Schedule 1 (WC Act), the Forest Red-tailed Black Cockatoo listed as Vulnerable (EPBC Act) and Schedule 1 (WC Act) and the Southern Brown Bandicoot listed as Priority 5 (DPAW Priority list). A further seven species of conservation significance are considered Likely to occur in the study area.

### 6.5.1 Recorded Conservation Significant Fauna

#### **Carnaby's Cockatoo (*Calyptorhynchus latirostris*)**

The Carnaby's Cockatoo is listed as Endangered under the EPBC Act and Schedule 1 under the WC Act. This species is endemic to the south west 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 (Garnett et al., 2011 and Cale, 2003). The estimated population on the northern Swan Coastal Plain is approximately 8,000 to 10,000 birds (Johnstone and Kirkby, 2011).

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, 1996, ATA, 2007, GHD, 2013b, DPAW, 2014a and DPAW, 2014b). Areas associated with the study area such as, East Wanneroo, Gnangara and Whiteman Park have been identified as important sites for Carnaby's Cockatoo on the Swan Coastal Plain (Johnstone and Kirkby, 2011). This species was recorded in two locations in the study area, in the Banksia Woodland of the Cullacabardee Bushland and in Modified Vegetation of the road reserve on Reid Highway (Figure 5a–m).

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

The Forest Red-tailed Black Cockatoo is listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act. This sub-species occurs in the south west of Western Australia, from Perth in the north to Albany in the south (Johnstone and Storr, 1998). The total estimated population for this species is approximately 10,000 to 15,000 birds, with a breeding population being as low as 10–20% (Johnstone and Kirkby, 2011).

The major threats to this species come from a shortage of suitable nest hollows, habitat clearing, illegal shooting and destruction of habitat from fires (DOTE, 2014b). There are numerous records of this species in the vicinity of the study area (DPAW 2014a, DPAW, 2014b and 360 Environmental, 2013). This species was recorded foraging in the Banksia Woodland habitat of Maralla Road Bushland (Figure 5a–m).

#### **Southern Brown Bandicoot (*Isodon obesulus fusciventer*)**

The Southern Brown Bandicoot 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 Dampland habitat and the surrounding Woodlands provide habitat for this species.

The major threatening processes for this species are fragmentation and loss of habitat, predation by foxes, cats (Woinarski et al., 2014) and in residential areas dogs. This species has been previously recorded in Aveley, Beechboro, Bullsbrook, Whiteman, Caversham and Ellenbrook which are all adjacent to the study area (DPAW, 2014a). Three individuals were captured at trap site 6 (next to the PDNH alignment) during the trapping program and diggings were recorded at Micro Gardens Park and in the road reserve alongside Reid Highway (Figure 5a–m).

### 6.5.2 Conservation Significant Fauna Classified as Likely to Occur

#### **Jewelled Sandplain Ctenotus (*Ctenotus gemmula*)**

Jewelled Sandplain Ctenotus is listed as Priority 3, poorly-known species under the DPAW Priority listings. The Jewelled Ctenotus inhabits banksia woodlands with low vegetation and pale sands (Bush et al., 2010 and Wilson and Swan, 2010). The Banksia Woodland habitat of the study area provides suitable habitat for this species.

Threatening processes are unknown, but due to its limited distribution habitat destruction, changed fire regimes and feral predators are considered likely. There have been recent records of this species occurring in bush associated with the study area such as Whiteman Park and Maralla Road Bushland (Bush et al., 2010).





### **Western Carpet Python (*Morelia spilota imbricata*)**

The Western Carpet Python occurs only along the south western portions of Western Australia and is listed as Schedule 4 under the WC Act. The Western Carpet Python occurs in a variety of habitat types but along the Swan Coastal Plain it typically inhabits Woodlands, forests and dense coastal scrub (Bush et al. 2007). This species requires large areas of undisturbed bushland (Bush et al., 2007); as such the most likely location for this species to occur in the study area is the Maralla Road Bushland.

Threatening processes include habitat destruction and changed fire regimes, with the impact of feral predators being unknown (Pearson, 2005 and DEC, 2012). This species has been previously recorded approximately 15 km west of the study area (GHD, 2013b); however, this is an isolated record with limited additional records in the vicinity of the study area (DPAW, 2014b).

### **Black-striped Snake (*Neelaps calonotos*)**

The Black-striped Snake 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). This species inhabits coastal dunes and Eucalypt/Banksia Woodlands (Bush et al., 2010). Both the Banksia Woodland and Eucalypt/Corymbia Woodland provide suitable habitat for this species.

Threatening processes involve habitat destruction within its small distribution (Bush et al., 2010). The Black-striped Snake has been recently recorded adjacent to the study area in Ellenbrook, Muchea (DPAW, 2014b), and further north at Boonaring Nature Reserve (Burbidge et al. 1996).

### **Great Egret (*Ardea alba*)**

The Great Egret is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. This species occurs over the greater part of the state, but not the arid interior. It also occurs over the rest of eastern Australia, Europe, Asia and New Zealand (Johnstone and Storr, 1998). The Great Egret inhabits mostly shallow fresh lakes, pools in rivers, lagoons, lignum swamps, clay pans and samphire flats, large dams and sewage ponds (Johnstone and Storr, 1998). The Wetlands of the study area provide suitable habitat for this species.

There are no known threats to this common species. The Great Egret has been previously recorded at Lightning Swamp, Whiteman Park, Bennett Brook, Waltham Reserve and Malaga regional Open Space, which are all directly adjacent to the study area (DPAW, 2014a).

### **Cattle Egret (*Ardea ibis*)**

The Cattle Egret is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. This species occurs in the better watered parts of the state. It also occurs in eastern Australia, New Zealand and South-East Asia (Johnstone and Storr, 1998). A Cattle Egret was recorded foraging in pastures adjacent to the study area during the survey period. The Cattle Egret inhabits pastures, garbage tips, crops, wetlands, tidal flats and drains (Pizzey and Knight 2007). The Wetland and Paddock habitat types provide suitable habitat for this species.

There are no known threats to this common species. The Cattle Egret has been previously recorded from the Lake Joondalup area, which is approximately 10 km west of the study area (DPAW, 2014b) and one individual was recorded foraging in similar habitat approximately 3 km from the study area during the survey.





### **Rainbow Bee-eater (*Merops ornatus*)**

The Rainbow Bee-eater 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) occurring in a range of habitats. The Rainbow Bee-eater is expected to forage over all habitat types in the study area.

The only identified threat to the Rainbow Bee-eater is the Cane Toad (DOTE, 2014c), however this is not an issue influenced by the PDNH. This species has been previously recorded on numerous occasions in the vicinity of the study area (DPAW, 2014a and DPAW, 2014b).

### **Western Brush Wallaby (*Macropus irma*)**

The Western Brush Wallaby is listed as Priority 4, rare, near threatened and other species in need of monitoring under the DPAW Priority listings. The Banksia Woodland and the Eucalypt/Corymbia Woodland of the study area provide suitable habitat for this species.

The Western Brush Wallaby 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 1970's and 1990's. However, fox control has allowed this species to become more common throughout its range (van Dyck and Strahan, 2008). The Western Brush Wallaby has been previously recorded in Whiteman Park, Cullacabardee and Ellenbrook which are adjacent to the study area (DPAW, 2014a).

#### **6.5.3 Vagrant Records**

The Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Western Quoll (*Dasyurus geoffroii*) are conservation significant species that have been recently recorded in the vicinity of the study area, however they have been classified as possibly occurring rather than being likely to occur (Appendix I). This is due to that fact that the study area does not contain core habitat for these species and is located on the periphery of their range. As such, no impact to these species from the PDNH is expected and they are not covered in Section 7.4.

The study area is mapped as occurring outside the northern extent of the Baudin's Cockatoos current distribution (DSEWPAC, 2012) however, this species has been recently recorded from Whiteman Park, Ballajura and Morley which are all adjacent to the study area (DPAW, 2014a). The Baudin's Cockatoos is highly mobile and the observations represent isolated records rather than indicating the presence of core supporting habitat.

The Western Quoll has been extinct on the Swan Coastal Plain since the 1930s (Orell and Morris, 1994) as such, the records of this species from areas adjacent to the study area (Lexia, Bullsbrook, Walyunga National Park and Almeria Park) (DPAW, 2014a) are likely to represent individuals transiting through the area rather than a resident population.



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## 7 IMPACT ASSESSMENT

### 7.1 Fauna Habitat

The fauna habitats present in the study area are impacted upon by rubbish, weeds, feral animals, fire, vehicle tracks and dieback. The development of the PDNH corridor will potentially increase the occurrence of these impacts by allowing greater access to remnant vegetation. These impacts cause habitat degradation which potentially reduces the capacity of the surrounding habitats to support fauna populations. The development will create additional impacts including the clearing of native vegetation, habitat fragmentation and the redistribution of surface flows and dewatering. Of these the clearing of native vegetation is the major expected impact as it will reduce the area of habitat available to fauna and create habitat fragmentation.

A total of approximately 200.7 ha of fauna habitats will be impacted by the project including: 62.6 ha of Eucalypt/Corymbia Woodland, 90.7 ha Banksia Woodland, 27.1 ha of Dampland and 20.2 ha of Wetland. The majority of the study area occurs in secondary fauna habitats, which offer limited habitat to selected species. As such, 786.5 ha of secondary fauna habitat (Modified Vegetation, Paddock and Pine Plantation) and infrastructure/cleared areas will be impacted.

The fauna habitats recorded in the study area are typical of those found on the Swan Coastal Plain and the PDNH is unlikely to impact the regional significance of these habitats.

The impact on these habitats at a local scale varies due to the extended linear nature of the project. None of the fauna habitats present are considered more significant than similar habitats in the local vicinity of the study area. The design of the PDNH has predominantly followed existing infrastructure or disturbed areas (79.7% of the entire study area) with narrow sections of natural habitat to be impacted (20.3% of the entire study area). The 200.7 ha of natural vegetation in the study area extends over a large distance thus spreading the expected impacts. The PDNH will result in a loss of habitat at the local scale, but due to its linear nature, similar surrounding habitat will be retained. None of the fauna habitats present are considered more significant than similar habitats in the local vicinity of the study area. The majority of the local impacts to fauna are due to the loss of ecological connectivity (see Section 7.2).

### 7.2 Fauna Movement and Ecological Connectivity

As the PDNH is an extended linear development, the loss of ecological connectivity is a potential impact. The PDNH predominantly runs north/south, limiting the ecological connectivity in the east/west direction. For the majority of the study area, the loss of ecological connectivity is minimal as the design footprint is on already highly impacted area (cleared Paddocks etc.) or abuts existing infrastructure (Ellenbrook or Malaga housing estates). Areas identified as being at risk of loss of ecological connectivity were the Cullacabardee Bushland and the Maralla Road Bushland, both of which have been previously identified as “existing or potential bushland/wetland linkages.” (Government of Western Australia, 2000a). Additionally, Micro Gardens Park and its surrounds were identified during the survey as a location where ecological connectivity will be impacted by the PDNH. This site has been identified as being part of a “regionally significant fragmented bushland/wetland linkage.” (Government of Western Australia, 2000a).

Impacts created by fragmented ecosystems include:

- Loss of genetic diversity: the limiting of gene flow between populations can lead to an increased risk of inbreeding and a higher susceptibility to impacts such as disease, droughts and fires.

- Restricted dispersal: potential loss of territory and inability to find a mate.
- Loss of ecological diversity: which can lead to a reduction in functionality within an ecosystem
- An increased risk of vehicle collisions: the intersection of areas of fauna habitat with a road can lead to a higher level of fauna mortalities.
- Higher susceptibility to impacts: such as fire, disease and feral predation can lead to localised extinction.

A number of priority listed ground dwelling fauna have been previously recorded in the surrounding area of Cullacabardee Bushland and Maralla Road Bushland: Jewelled Sandplain Ctenotus, Southern Brown Bandicoot and Western Brush Wallaby. Fragmentation of the habitat in this area will create greater pressures on the populations of these species.

The clearing of the Dampland and Eucalypt/Corymbia Woodland at the Tonkin Highway/Reid Highway intersection (Micro Gardens Park) will impact the ecological connectivity between Lightning Swamp Bushland, Malaga Regional Space and Koondoola Regional Bushland to the west and Point Reserve to the East. Diggings attributed to the conservation significant Southern Brown Bandicoot (P5) were recorded in the Micro Gardens Park and the road reserve near the Reid Highway/Altone Road intersection (Figure 5a–m). Although heavily degraded the vegetation of the road reserve provides an ecological linkage between areas of suitable habitat for species such as the Southern Brown Bandicoot.

### **7.3 Fauna Assemblage**

The fauna assemblage expected in the study area and those species recorded during the survey are typical of those on the Swan Coastal Plain. The PDNH is unlikely to impact the fauna assemblage on a regional level as the majority of species are commonly recorded and widespread.

Impacts to the fauna assemblage are expected to be localised and low level. Expected impacts include increased risk of road mortalities, habitat fragmentation, and habitat degradation. These impacts are already prevalent in the study area and its surrounds and the faunal assemblage of the study area is expected to remain stable.

### **7.4 Conservation Significant Fauna**


#### **7.4.1 Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo**

The Black Cockatoo habitats in the study area are highly impacted upon by rubbish, weeds, feral animals, fire, vehicle tracks and dieback. The development of the PDNH will potentially increase the occurrence of these impacts and create additional impacts including the clearing of native vegetation, habitat fragmentation and an increased chance of vehicle collision.

The study area is outside of the known breeding range of these species; however, there has been a shift in breeding ranges onto the Swan Coastal Plain (Johnstone and Kirkby, 2011), therefore the study area may provide suitable breeding habitat in the future. As such, the immediate impacts to the Black Cockatoo species are from a loss of foraging and roosting habitat.

The loss/impact on Black Cockatoo habitat in the study area is expected to be minor at a regional scale. These species are nomadic and are not wholly dependent on the habitats existing in the study area for foraging, roosting or breeding.

The loss of suitable foraging and roosting habitat at the local scale is a moderate level impact, especially due to the removal of surrounding foraging and roosting habitat from the Gngara Pine Plantation. The



clearing of foraging resources on the Swan Coastal Plain is a major threat to the Carnaby's Cockatoo (Cale, 2003) and areas associated with the study area such as, East Wanneroo, Gnangara and Whiteman Park have been identified as important sites for Carnaby's Cockatoo on the Swan Coastal Plain (Johnstone and Kirkby, 2011). These impacts will reduce the availability of foraging, roosting and future breeding resources at the local scale. However, the study area is not within the current breeding range of both Black Cockatoo species and no significant roost site locations have been recorded in the study area.

Vegetation clearing will result in the loss of approximately 253.5 ha of foraging habitat, 76.7 ha of roosting habitat and 162.8 ha of breeding habitat, including 1,061 trees of suitable size.

#### **7.4.2 Southern Brown Bandicoot**

The West Australian subspecies is widely distributed with a range that extends along the coast from Guilderton to Esperance (DPAW, 2014b). As such, the impacts to this species at a regional level from the PDNH are not considered significant and are unlikely to alter the conservation significance of this species.

Local populations of this species are likely to be impacted by this development, as they are a ground dwelling species with poor dispersal abilities and are predominantly found in the restricted habitats of the Dampland habitats. In particular, the population recorded at Micro Gardens Park may be affected as there are restricted dispersal opportunities in the area and the majority of the vegetation in this area will be cleared. The population occurring in the Dampland habitat in the Maralla Road Bushland will be affected by the construction of the PDNH with the increased risk of road mortalities, habitat degradation and habitat fragmentation.

A total of 27.1 ha of suitable habitat (classified as Dampland habitat) will be impacted as part of the development of PDNH.

#### **7.4.3 Jewelled Sandplain Ctenotus**

The Jewelled Sandplain Ctenotus is scarce on the Swan Coastal Plain as it is the northern extent of its range (Bush et al., 2010). Populations also occur along the south coast of Western Australia from Rocky Lake to Toolina Cove (Storr et al., 1999). Even though the occurrence of this species is scarce on the Swan Coastal Plain, the development of PDNH is unlikely to impact this species at a regional level due to its extended distribution.

Potential impacts to this species from the development are expected to be low scale and localised. Potential impacts include habitat loss, an increased risk of road mortalities, habitat degradation and habitat fragmentation.

The Jewelled Sandplain Ctenotus is considered Likely to occur in the Banksia Woodland of the study area. A total of 90.7 ha of suitable habitat for this species will be impacted.

#### **7.4.4 Western Carpet Python**

The Western Carpet Python is a widespread sub species which occurs across the southern portion of Western Australia (Bush et al., 2010). As such, the loss/impact upon suitable habitat in the study area from PDNH is expected to be negligible at a regional scale.

Potential impacts to this species from the PDNH are expected to be low scale and localised. Potential impacts include habitat loss, an increased risk of road mortalities, habitat degradation and habitat fragmentation.

The Western Carpet Python is considered Likely to occur in the Banksia Woodland and Eucalypt/Corymbia Woodland of the Maralla Road Bushland. This species requires large areas of undisturbed bushland (Bush et al., 2007), so is not expected to occur in other portions of the PDNH. A total of 153.3 ha of suitable habitat will be impacted by the PDNH.



#### **7.4.5 Black-striped Snake**

The Black-striped Snake 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). The Black-striped Snake inhabits coastal dunes and Eucalypt/Banksia Woodlands (Bush et al., 2010). Even though this species has a limited distribution the loss/impact upon suitable habitat in the study area is expected to be negligible at a regional scale due to the widespread occurrence of suitable habitat.

Potential impacts to this species from the PDNH are expected to be low scale and localised. Potential impacts include habitat loss, an increased risk of road mortalities, habitat degradation and habitat fragmentation.

The Black-striped Snake is considered Likely to occur in the Banksia Woodland and Eucalypt/Corymbia Woodland of the study area. A total of 153.3 ha of suitable habitat for this species will be impacted by the PDNH.

#### **7.4.6 Great Egret and Cattle Egret**

Both the Great Egret and Cattle Egret are cosmopolitan and occur across the majority of the state with populations of each occurring across Australia, New Zealand and Asia (Johnstone and Storr, 1998). The Great Egret is not considered susceptible to fragmentation effects as they are highly mobile (DOTE, 2014d) and there are no significant nesting sites for either species from the Swan Coastal Plain. As such, impacts to this species are likely to be limited to low scale habitat loss.

Both species are considered likely to occur in the study area, the Great Egret in the Wetland habitat and the Cattle Egret in the Wetland and Paddock habitat of the study area. A total of 20.2 ha of suitable Great Egret habitat will be impacted by the PDNH. A total of 331.3 ha of suitable Cattle Egret habitat will be impacted by the PDNH. Given the extended range of each of these species the habitats present are not deemed to be important as they not provide breeding habitat or support an ecologically significant portion of each species population.

#### **7.4.7 Rainbow Bee-eater**

The Rainbow Bee-eater is one of the most widespread bird species in Australia (Barrett et al., 2003) occurring across the country in a range of habitats. As such, the loss/impact upon suitable habitat in the study area is expected to be negligible at a regional scale. Due to the common occurrence, widespread distribution and mobile nature of this species, habitat loss caused by the PDNH is likely to only impact individuals of this species at a local level.

The Rainbow Bee-eater is considered Likely to occur in the study area across all fauna habitat types including the secondary habitat type of Modified Vegetation. A total of 496 ha of suitable habitat for this species will be impacted by the PDNH.

#### **7.4.8 Western Brush Wallaby**

The Western Brush Wallaby occurs in south-western Australia from Kalbarri in the north to Cape Arid (Woinarski et al., 2014). As such, the loss/impact upon suitable habitat in the study area is expected to be negligible at a regional scale.

The Banksia Woodland and the Eucalypt/Corymbia Woodland of the study area around Cullacabardee and Maralla Road Bushlands provide suitable habitat for this species. As such, approximately 153.3 ha of potential habitat will be impacted by the PDNH. Additional potential impacts are expected to be localised and may include an increased risk of road mortalities, increased risk of fox predation and habitat fragmentation.



## 7.5 Western Swamp Tortoise Potential Impacts

The Western Swamp Tortoise (*Pseudemydura umbrina*) is classified as Highly Unlikely to occur in the study area; however, due to the close proximity of the study area to the Twin Swamps Nature Reserve and the conservation significance of this species, an analysis on the potential impact to those habitats was undertaken.

The Western Swamp Tortoise is listed as Critically Endangered under the EPBC Act and Schedule 1 under the WC Act. The current distribution includes three locations Ellen Brook Nature Reserve, Twin Swamps Nature Reserve and Mogumber Nature Reserve. The two latter locations are maintained by translocated individuals (DOTE, 2014e). Current populations at each reserve are as follows: 30 individuals for Ellen Brook Nature Reserve, six individuals at Twin Swamps Nature Reserve and approximately 26 individuals at Mogumber Nature Reserve (based upon 2004 data) (DOTE, 2014e). Threats to this species include slow reproductive cycle and low fecundity, previous habitat clearance, climate change, predation by natural and introduced predators and fire.

The study area is located approximately 2.6 km west of the Twin Swamps Nature reserve. Due to this proximity a desktop survey was prepared to establish if there is potential for road runoff (and pollutants) to affect this sensitive site. By using LIDAR data (1 m contours) the surface hydrology was able to be established. Surface flows from the PDNH alignment to the east, split to the south and north of the Twin Swamps Nature Reserve and therefore do not actually flow into Twin Swamps (BG&E, 2014). In addition, a preliminary groundwater assessment has been completed. The results of which suggest that the Twin Swamps site is sufficiently downstream from the PDNH site that impacts (if any) are negligible (BG&E, 2014). As such, the PDNH is not expected to impact the Western Swamp Tortoise or its habitat at Twin Swamps Nature Reserve.





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## 8 CONCLUSION

A total of four natural fauna habitats were recorded in the study area: Banksia Woodland, Eucalypt/Corymbia Woodland, Dampland and Wetland. In addition a further three secondary fauna habitats were recorded in the study area: Modified Vegetation, Paddock and Pine Plantation. The proposed PDNH will impact on approximately 200.7 ha of native vegetation: including 62.6 ha of Eucalypt/Corymbia Woodland, 90.7 ha Banksia Woodland, 27.1 ha of Dampland and 20.2 ha of Wetland. The majority of the disturbance will occur in already disturbed areas, with approximately 786.5 ha of the PDNH being built on areas classified as Modified Vegetation, Paddock, Pine Plantation, cleared and infrastructure.

A total of 253.5 ha of quality Black Cockatoo foraging habitat, 76.7 ha of Eucalypt/Corymbia Woodlands and Wetland habitat classified as roosting habitat, 162.8 ha of breeding habitat and 1,061 trees with a DBH over 500 mm were recorded in the study area.


The loss/impact upon Black Cockatoo habitat in the study area is expected to be minor at a regional scale. These species are nomadic and are not wholly dependent on the habitats existing in the study area for foraging, roosting or breeding. The loss of suitable foraging and roosting habitat at the local scale is a moderate level impact. However, the study area is not within the current breeding range of both Black Cockatoo species and no significant roost site locations have been recorded in the study area.

The Pine Plantations in the study area and its surrounds are of importance to the Carnaby's Cockatoos that occur on the Swan Coastal Plain; however, the harvesting and occurrence of the plantation is managed by FPC and as such, the occurrence and impacts are outside the scope and control of the PDNH development. Harvesting of a portion of Pines in the project area has occurred since the survey was undertaken in 2014. For the purposes of this study, the 68.5 ha of the Pine Plantation recorded in the study area at the time of survey, are excluded as foraging or roosting habitat.

A total of 97 species were recorded during the survey including: one fish, six amphibians, 19 reptiles, 62 birds and nine mammals. The number of fauna recorded during the survey is comparable with the other surveys completed in the vicinity. The fauna species recorded during the survey are typical of the habitats present with no new species that had not been previously recorded. The PDNH is unlikely to impact the fauna assemblage on a regional level; however, local impacts may include habitat loss, increased risk of road mortalities, habitat fragmentation and habitat degradation such as; rubbish, weeds, feral animals, fire, vehicle tracks and dieback. These impacts are already prevalent in the study area and its surrounds.

A total of three conservation significant fauna were recorded in the study area during the survey: Carnaby's Cockatoo (*Calyptorhynchus latirostris*) listed as Endangered (EPBC Act) and Schedule 1 (WC Act), the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) listed as Vulnerable (EPBC Act) and Schedule 1 (WC Act) and the Southern Brown Bandicoot (*Isodon obesulus fusciventer*) listed as Priority 5 (DPAW Priority list). A further seven species of conservation significance are considered Likely to occur in the study area. The ground dwelling fauna in this list are the most likely species to be directly impacted by this development. Due to their limited dispersal ability, they are more likely to be impacted by loss of ecological connectivity and to a lesser degree loss of suitable habitat.

The study area is located approximately 2.6 km west of the Twin Swamps Nature reserve. Due to this proximity a desktop survey was prepared to establish if there is potential for road runoff (and pollutants) to affect this sensitive site. Surface flows from the PDNH alignment to the east, split to the south and north of the Twin Swamps Nature Reserve and therefore do not actually flow into Twin Swamps (BG&E, 2014). Preliminary groundwater assessment results suggest that the Twin Swamps site is sufficiently downstream



from the PDNH site that impacts (if any) are negligible (BG&E, 2014). As such, the PDNH is not expected to impact the Western Swamp Tortoise or its habitat at Twin Swamps Nature Reserve.




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## 9 RECOMMENDATIONS

Based upon the data recorded during the fauna survey and the desktop assessment the following recommendations should be undertaken:

- Retain as much roadside vegetation as possible, especially along the Reid Highway section of the study area to help facilitate fauna movement between local habitats.
- Try to encompass as many large trees into the landscape design and minimize clearing of the large trees by changing the road design, where possible. Trees to be retained must be more than 5 m away from the side of the road to minimise the risk of vehicle impact to fauna.
- Clearing be kept to a minimum, particularly in areas such as Maralla Road Bushland and Cullacabardee Bushland where ecological connectivity is paramount.
- Try to limit the amount of Banksia and other Black Cockatoo foraging resources in close proximity to the road once rehabilitation is commenced. Having foraging resources close to the road will create a higher chance of vehicle impact on these species.
- Have fauna spotters present during the clearing to help translocate any fauna and minimize any mortality.
- Clearing to occur outside of spring if possible, as to minimize impacts to the breeding cycle of resident fauna e.g., nesting birds. If clearing is conducted during spring fauna spotters must be present.
- Have a fauna friendly design to the road, using fencing to restrict access to the road in key areas where native vegetation is located adjacent to the road (at least 1,800 mm high and dug into the ground).
- Have fauna escape devices fitted to key areas where native vegetation is located adjacent to the road to allow trapped animals safe egress from traffic.
- Limit the amount of night time traffic and reduce the speed limit during the construction period to mitigate against animal strikes.
- Erect fauna warning signs in areas where native vegetation occurs next to the roadside.
- Create a detailed fauna management plan for both the construction aspect and once the road is completed.
- Conduct an appropriate dieback management plan to limit the amount of spread caused during construction.
- Conduct fox baiting in the Cullacabardee and Maralla road Bushland during the construction period and for a minimum of one year after to help the resident fauna relocate themselves away from disturbed areas. Foxes are known to be attracted to disturbance to prey on dislocated fauna.
- Conduct monitoring of the likely locations for fauna underpasses/overpasses and their effectiveness for at least six months prior to construction and a minimum of a year after the development has been completed. This information is important in guiding fauna underpass use in the future.
- Consult fauna underpass/overpass experts to help choose the most appropriate/effective fauna underpass design/locations and the appropriate number to help facilitate ecological connectivity.


- 
- Retain hollow logs for translocation to surrounding habitats. Logs are an important refuge site for many animal species and take a long time to produce.




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## **10.1 Personal Communications**

Godfrey, N. Department of Parks and Wildlife, Kensington, Western Australia. Conversation. August 2014.



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## FIGURES

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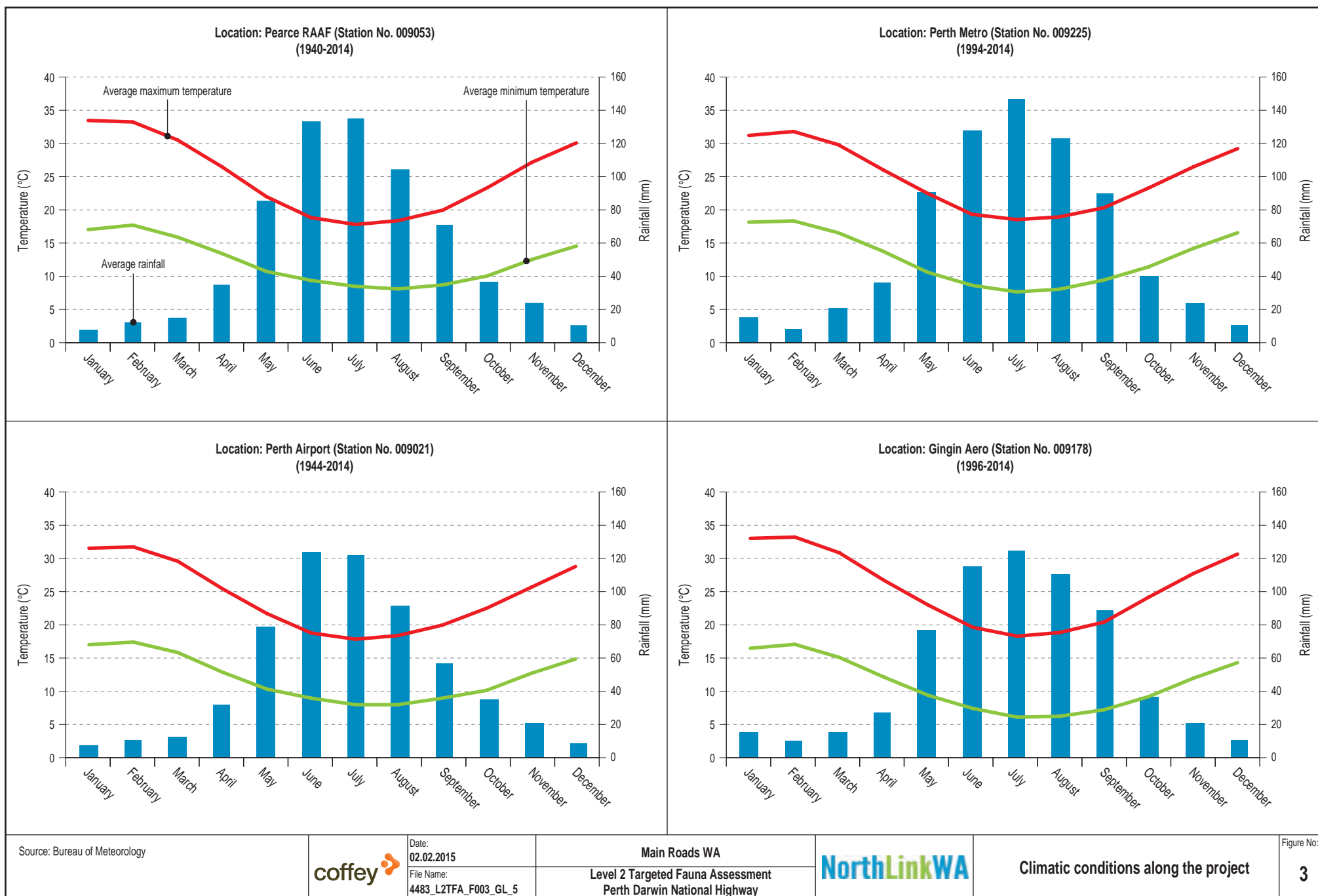












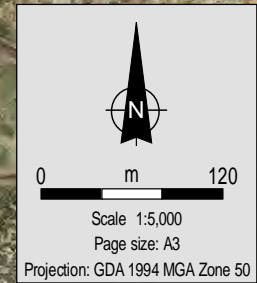






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Maralla Road

Trap Site 3

Trap Site 6

Trap Site 2

Trap Site 1

**LEGEND**

- ▲ Trapping location
- Study area
- Hot Spot Analysis
- Gi\_Bin
- Not Significant
- Hot Spot - 99% Confidence

Source & Notes  
Trapping locations from Coffey.  
Aerial imagery from MRWA WA (September 2013)

NorthLinkWA

coffey

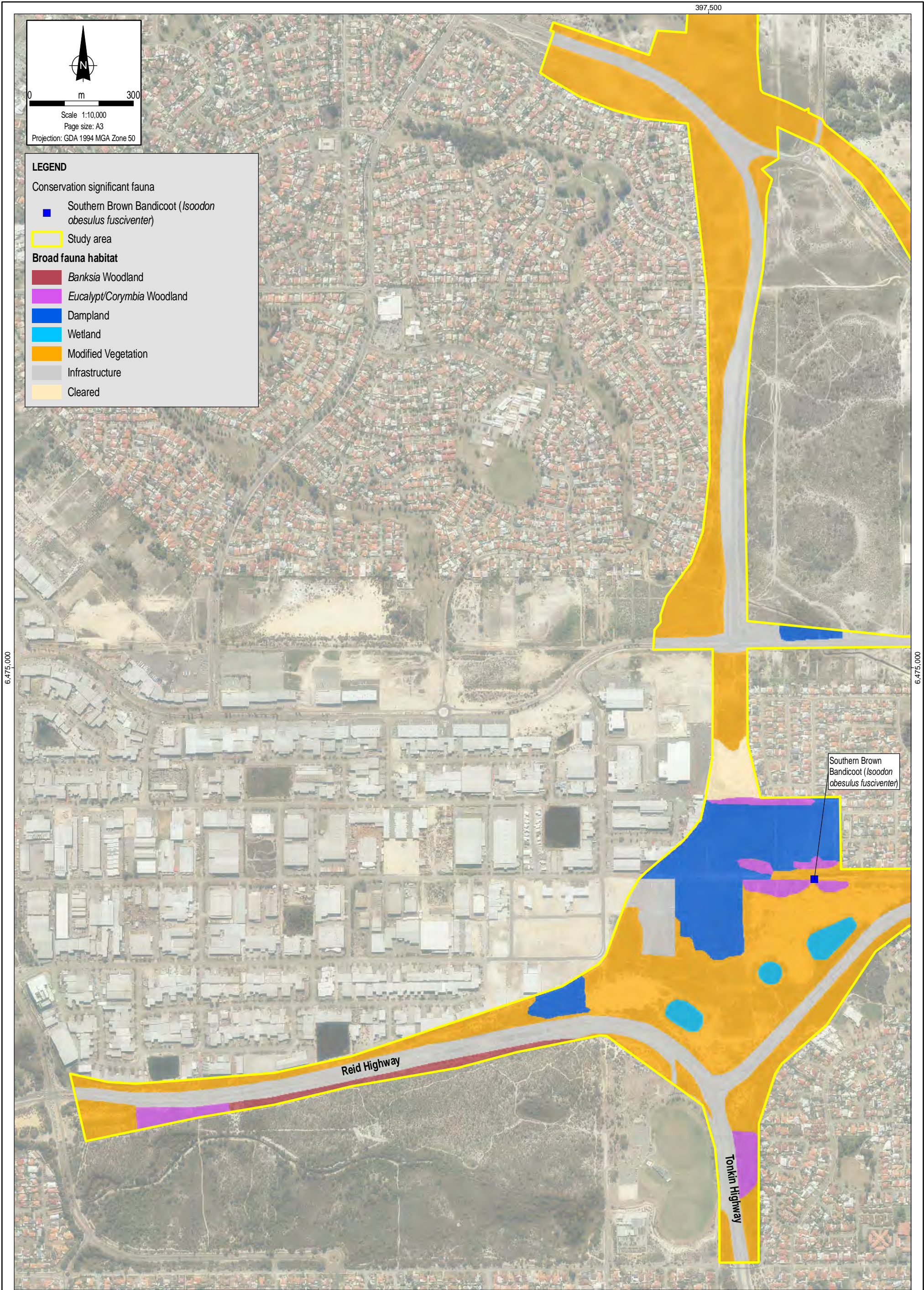
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Main Roads WA  
Perth-Darwin National Highway Fauna Survey

Trap site locations and  
fauna movement results

Figure No:  
**4B**

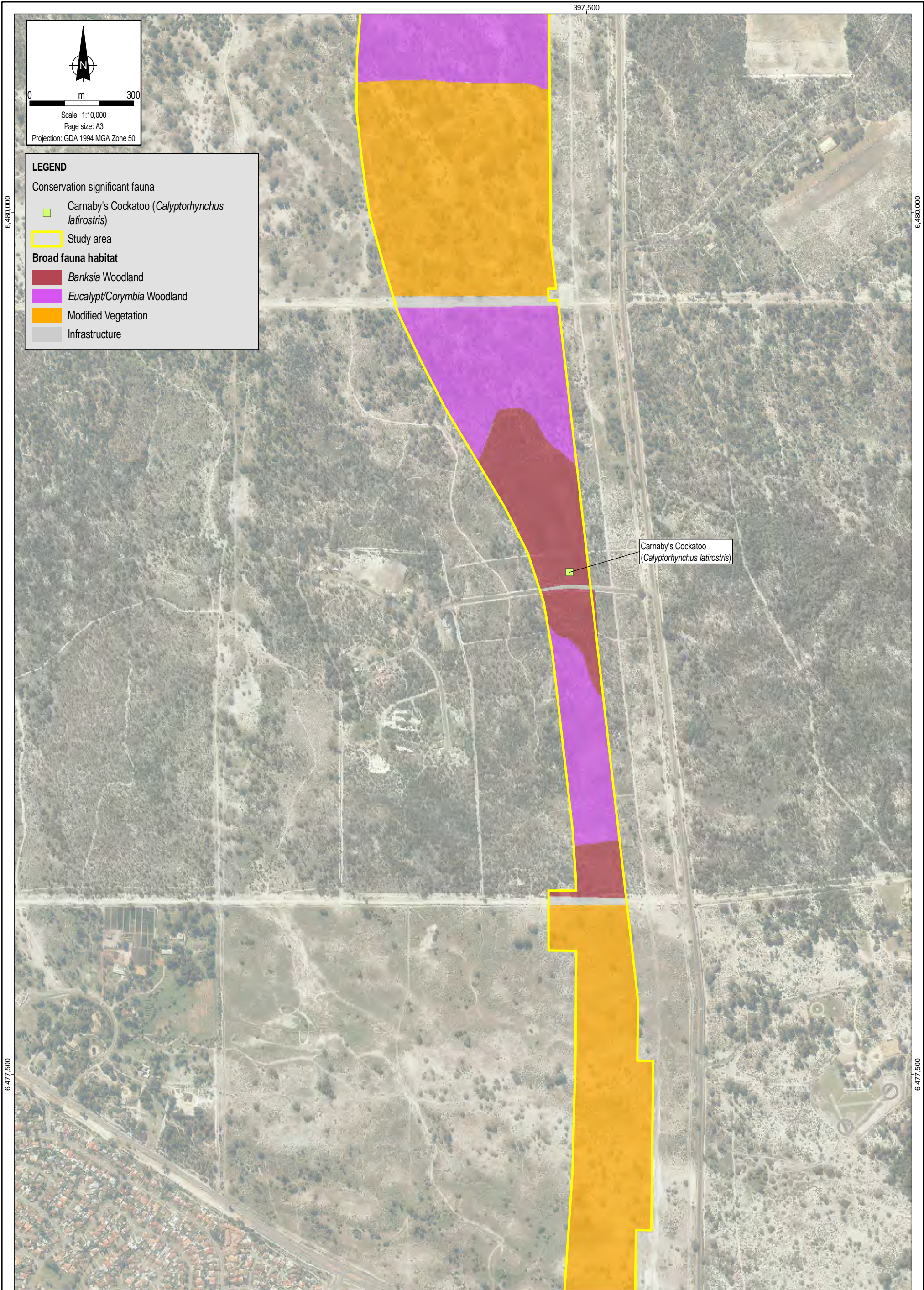












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**LEGEND**

Conservation significant fauna

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*)

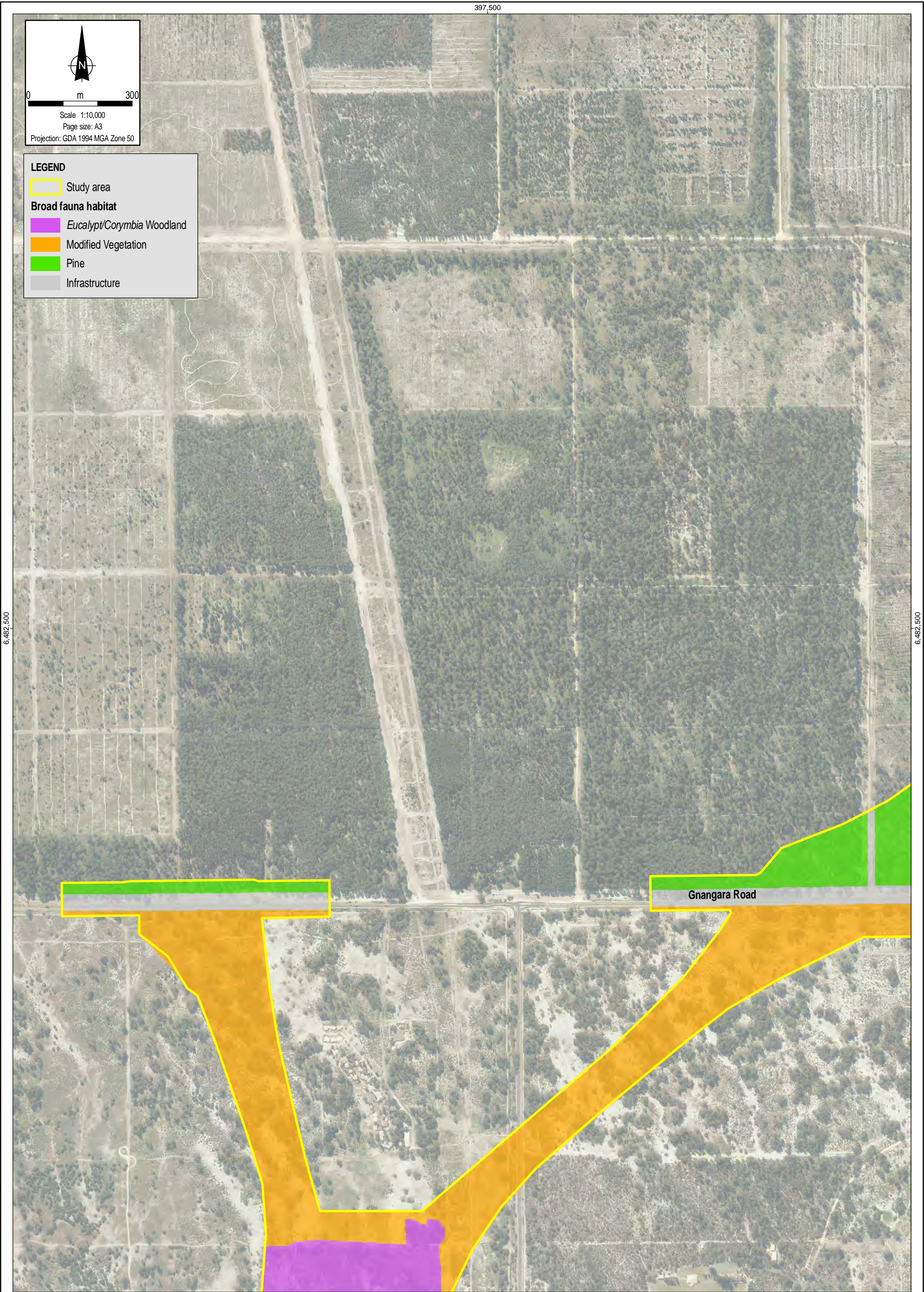
Study area


**Broad fauna habitat**

- Banksia Woodland
- Eucalypt/Corymbia Woodland
- Modified Vegetation
- Infrastructure

Carnaby's Cockatoo  
(*Calyptorhynchus latirostris*)







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LEGEND

Study area

Broad fauna habitat

*Eucalypt/Corymbia* Woodland

Modified Vegetation

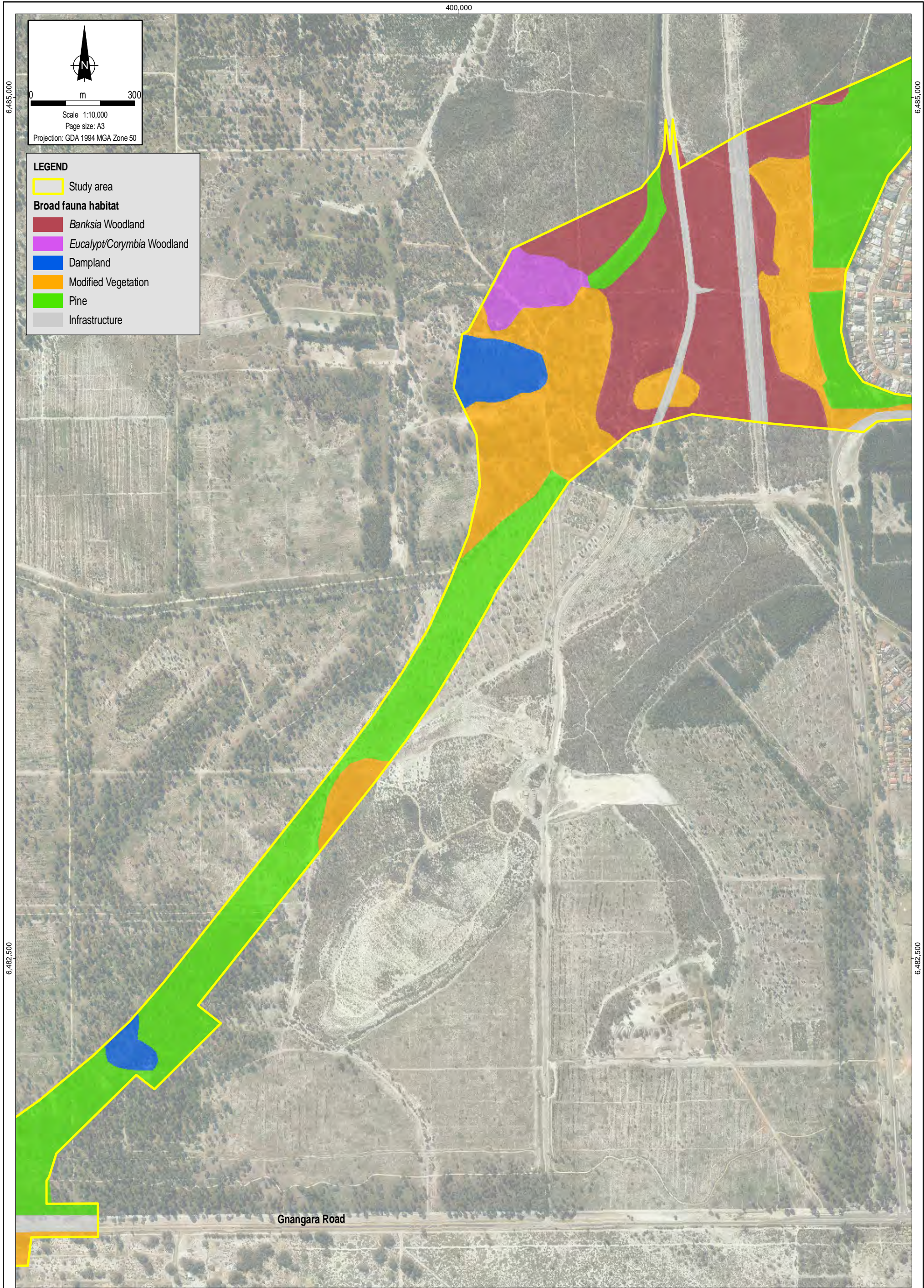
Pine

Infrastructure

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Source & Notes  
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Aerial imagery from Landgate August 2014)

NorthLinkWA



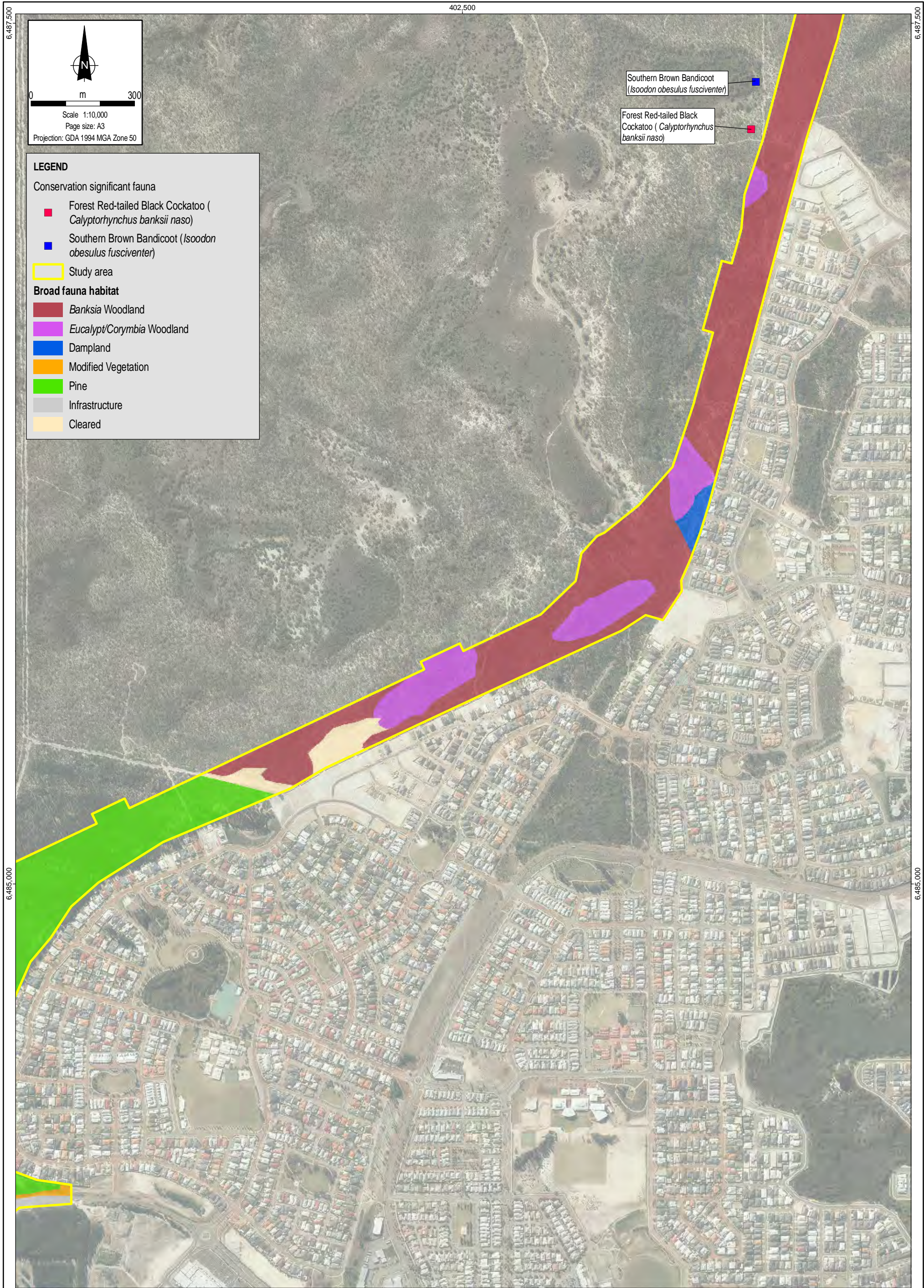
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Main Roads WA  
Perth-Darwin National Highway Fauna Survey

Fauna habitat mapping and  
conservation significant fauna  
Page 5 of 13

Figure No:  
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**LEGEND**

Conservation significant fauna

- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)
- Southern Brown Bandicoot (*Isodon obesulus fusciventer*)

Study area

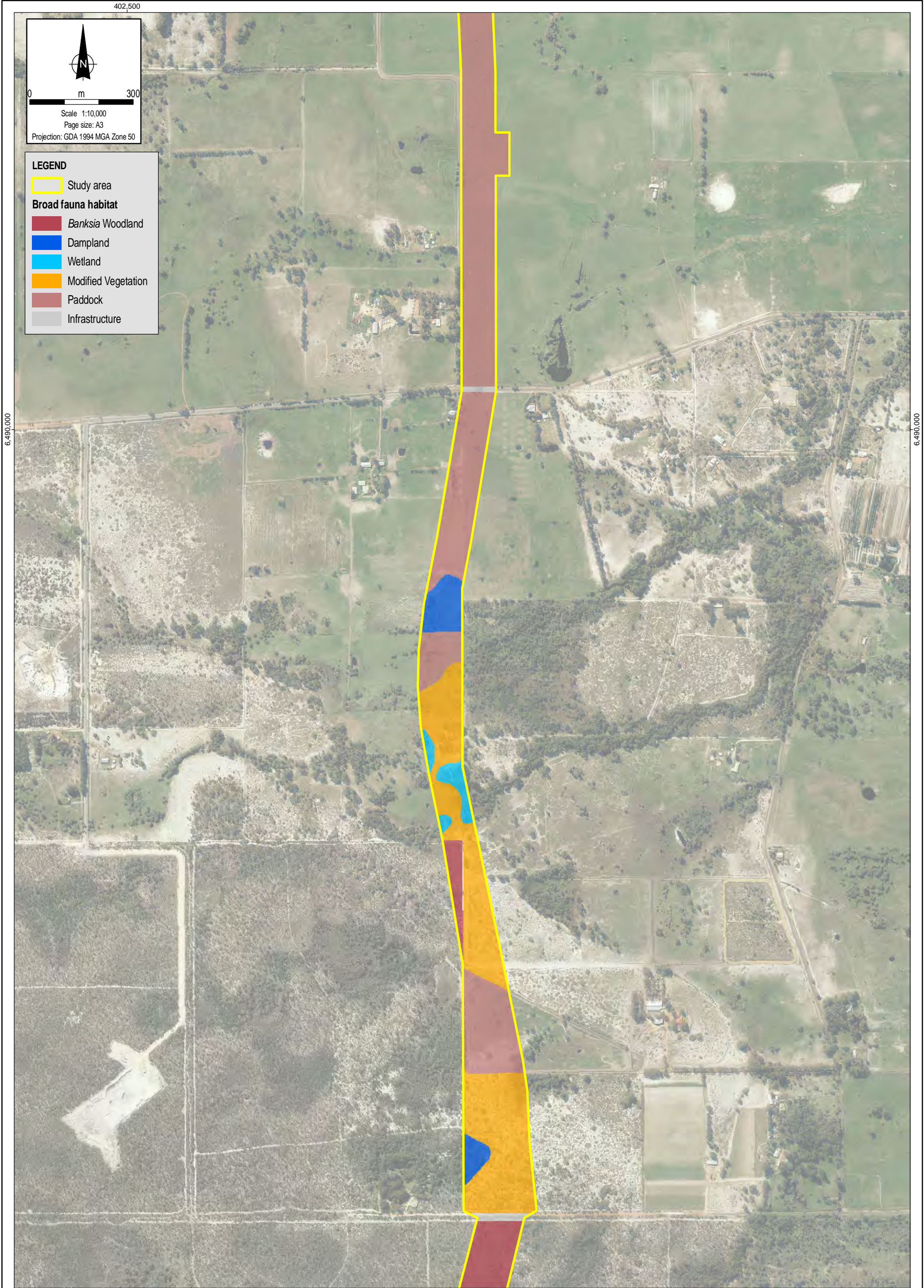
**Broad fauna habitat**

- Banksia Woodland
- Eucalypt/Corymbia Woodland
- Dampland
- Modified Vegetation
- Pine
- Infrastructure
- Cleared

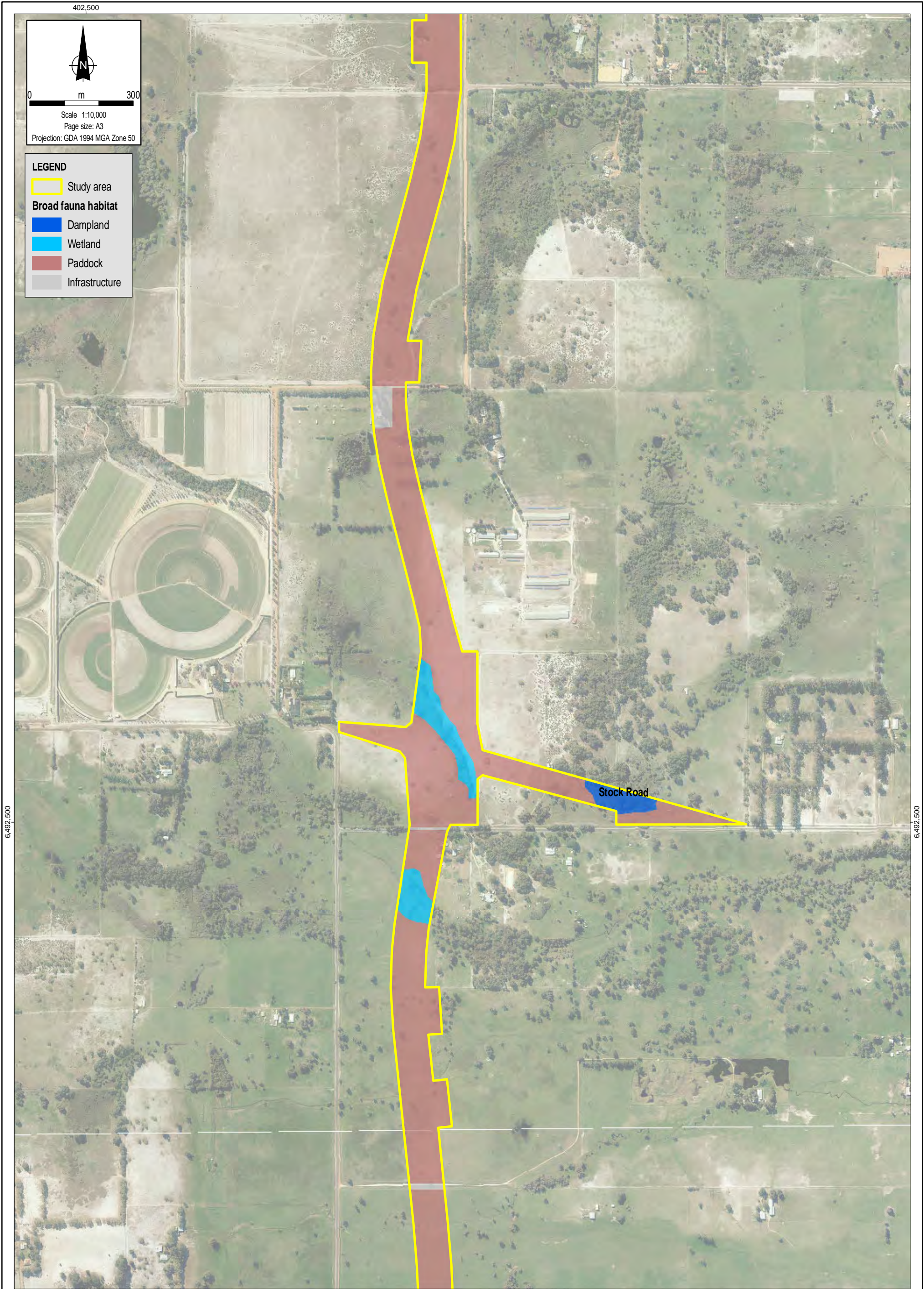
Southern Brown Bandicoot  
(*Isodon obesulus fusciventer*)

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

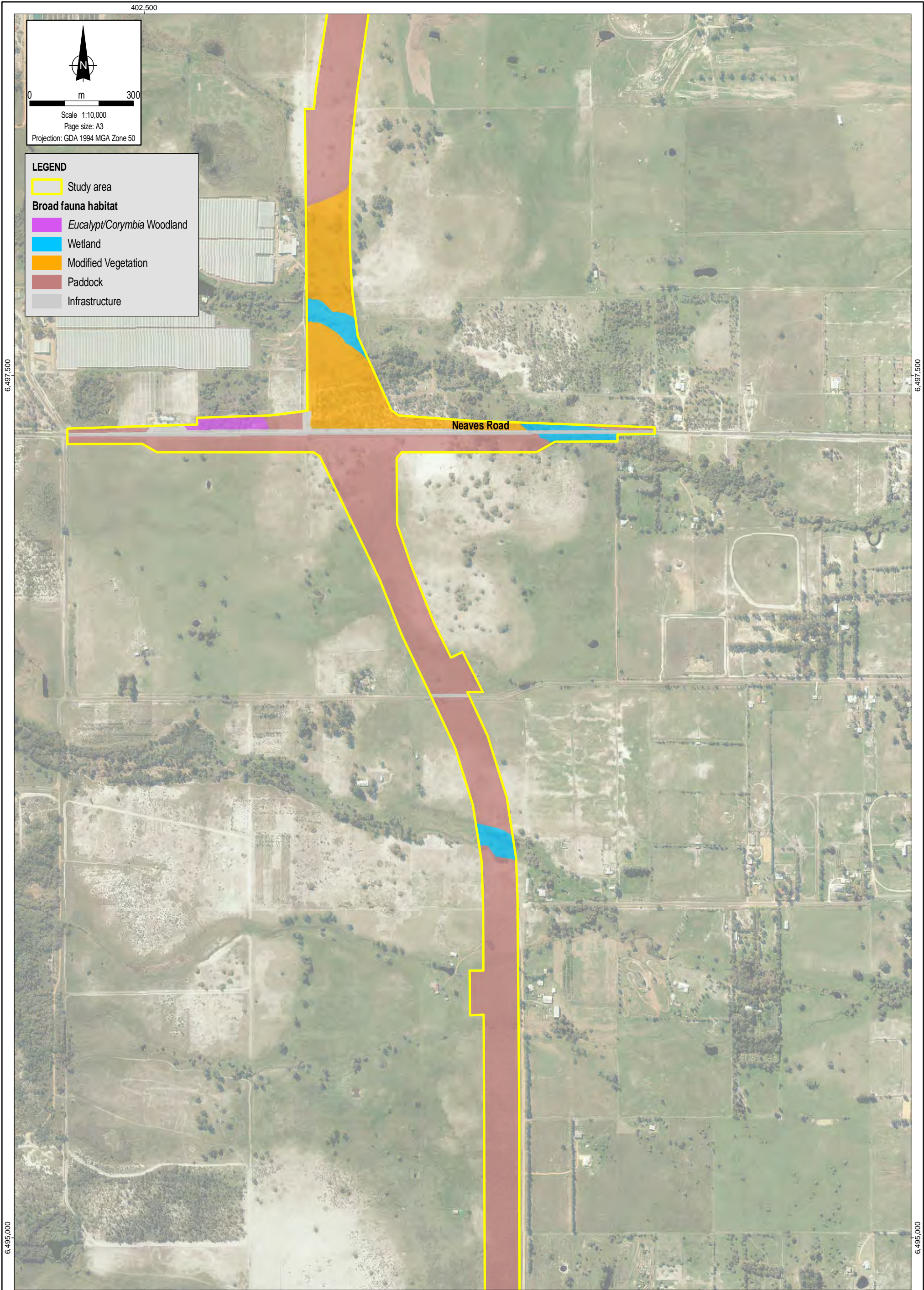















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LEGEND

Study area

**Broad fauna habitat**

*Eucalypt/Corymbia* Woodland

Wetland

Modified Vegetation

Paddock

Infrastructure

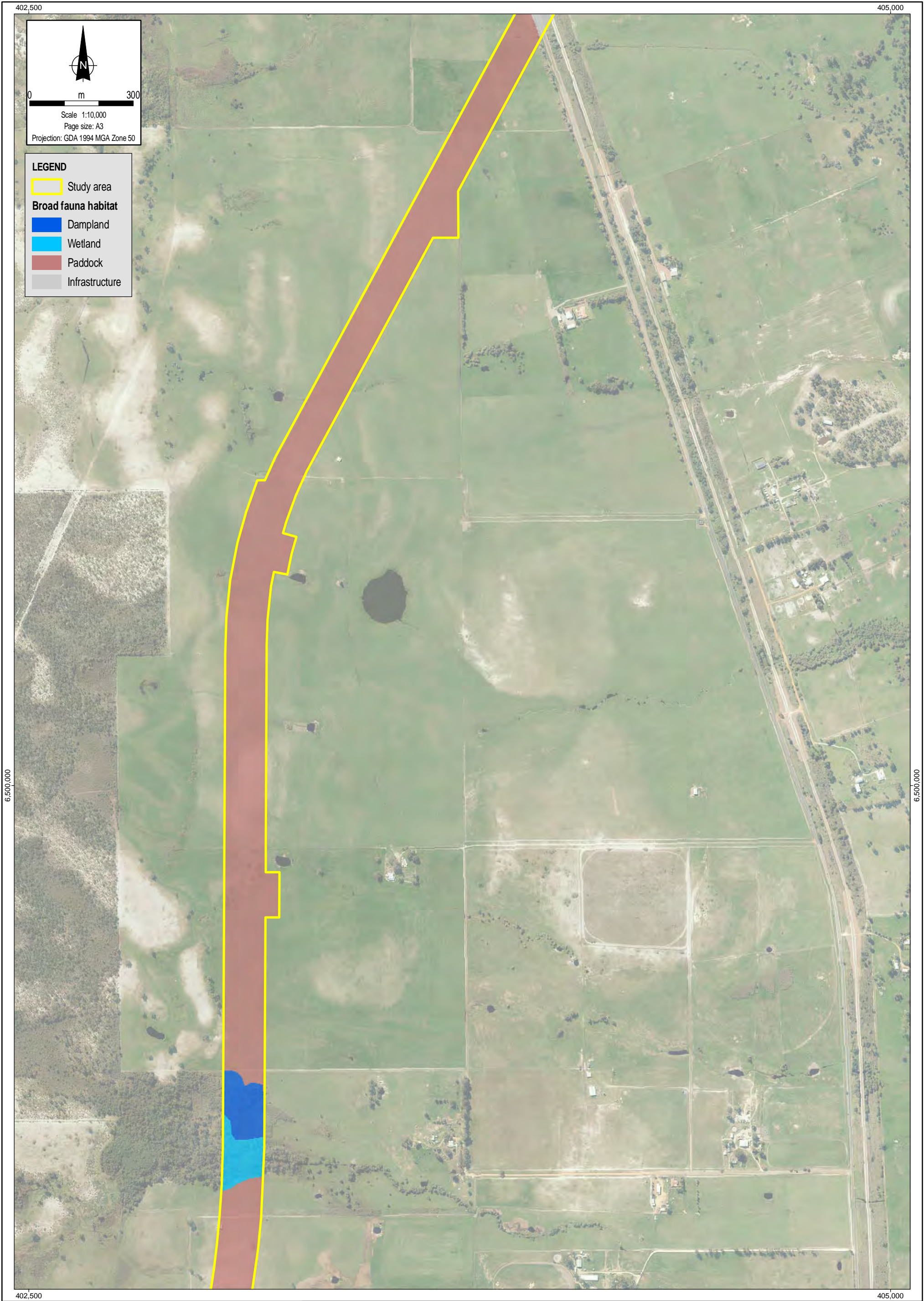
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Source & Notes  
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Aerial imagery from Landgate August 2014)

NorthLinkWA

coffey

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Main Roads WA  
Perth-Darwin National Highway Fauna Survey

Fauna habitat mapping and  
conservation significant fauna  
Page 10 of 13

Figure No:  
5J