

Legend

- Straight Line Kilometre Marker (1km)
  - Town
  - Hollow with Evidence of Use
  - Suitable Hollow
  - Muchea North Alignment
  - Existing GNH Alignment
  - Freeway / Highway
  - Minor Road
  - NVCP Application Area
  - CBC Breed Rating (Phoenix, 15/02/2017)
  - Foraging Habitat
- Carnaby's Black Cockatoos Potential Breeding Trees (Phoenix, 15/02/2017)
- Data Source: Main Roads WA, Landgate



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Great Northern Highway  
Muchea to Wubin Upgrade Stage 2

Carnaby's Black Cockatoo  
Habitat  
Map 3 of 4

Drawing No  
GNH-CN03-EN01-GIS-0047

Issue  
B

Task No  
GNH-1329

Drawing Status / Other  
Draft

Date	By	Chkd	Appd
11/04/2017	SR	CG	XX





PRELIMINARY PLAN ONLY

**Legend**

- Straight Line Kilometre Marker (1km)
- Town
- Carnaby's Black Cockatoos Potential Breeding Trees (Phoenix, 15/02/2017)
- Hollow with Evidence of Use
- Suitable Hollow
- Mucnea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Minor Road
- Data Source: Main Roads WA, Landgate

- NVCP Application Area
- CBC Breed Rating (Phoenix, 15/02/2017)
- Foraging Habitat
- Cadastral Boundary (05-12-2016)

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**Carnaby's Black Cockatoo**  
**Habitat**  
**Map 4 of 4**

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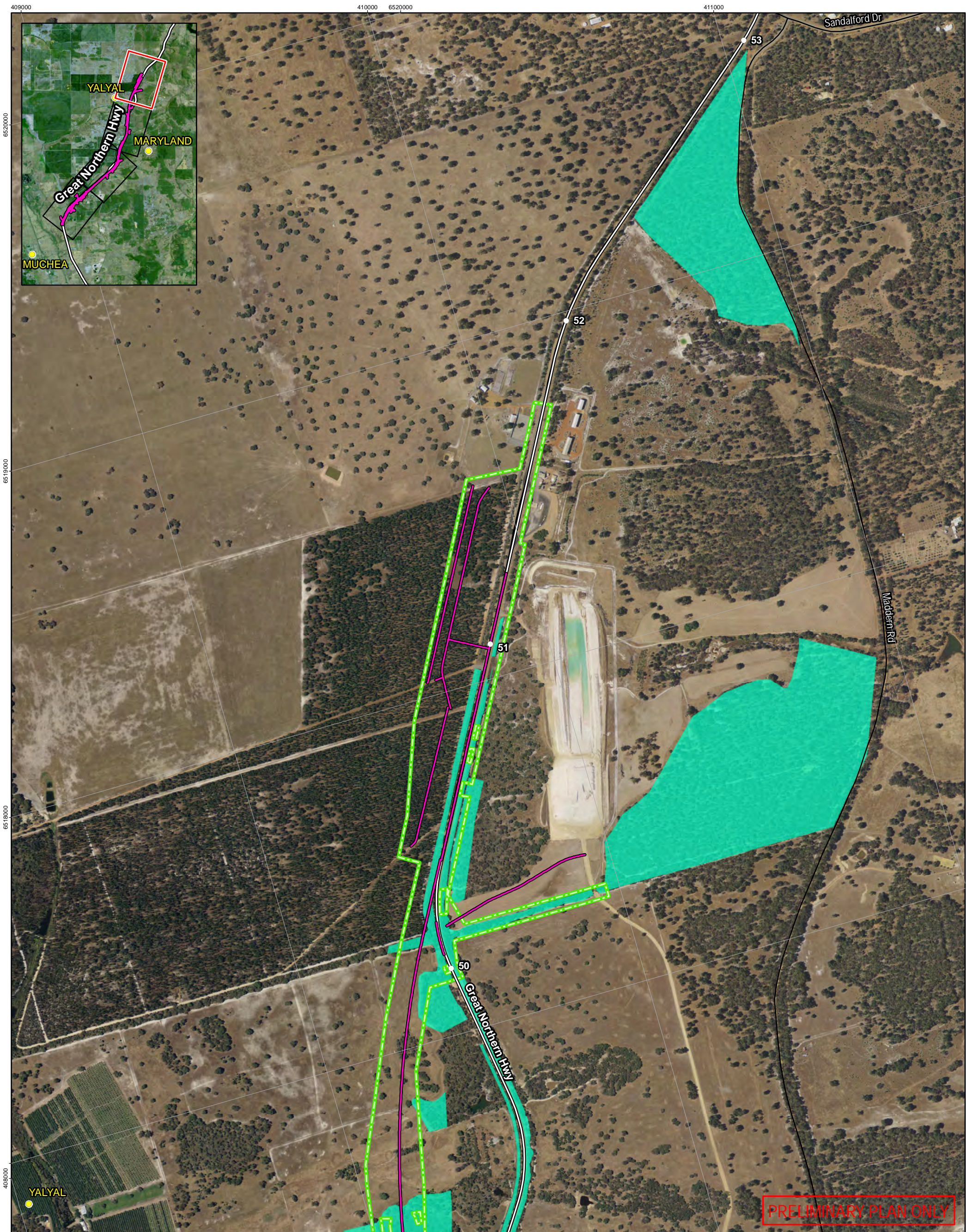


Figure 10 : Forest Red-Tailed Black Cockatoo Potential Foraging Habitat

*[refer to GNH-CN03-EN01-GIS-0068]*

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PRELIMINARY PLAN ONLY

**Legend**

- Town
- Straight Line Kilometre Marker (1km)
- Muchea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Minor Road
- NVCP Application Area
- Potential Forest Red-Tailed Black Cockatoo Foraging Habitat

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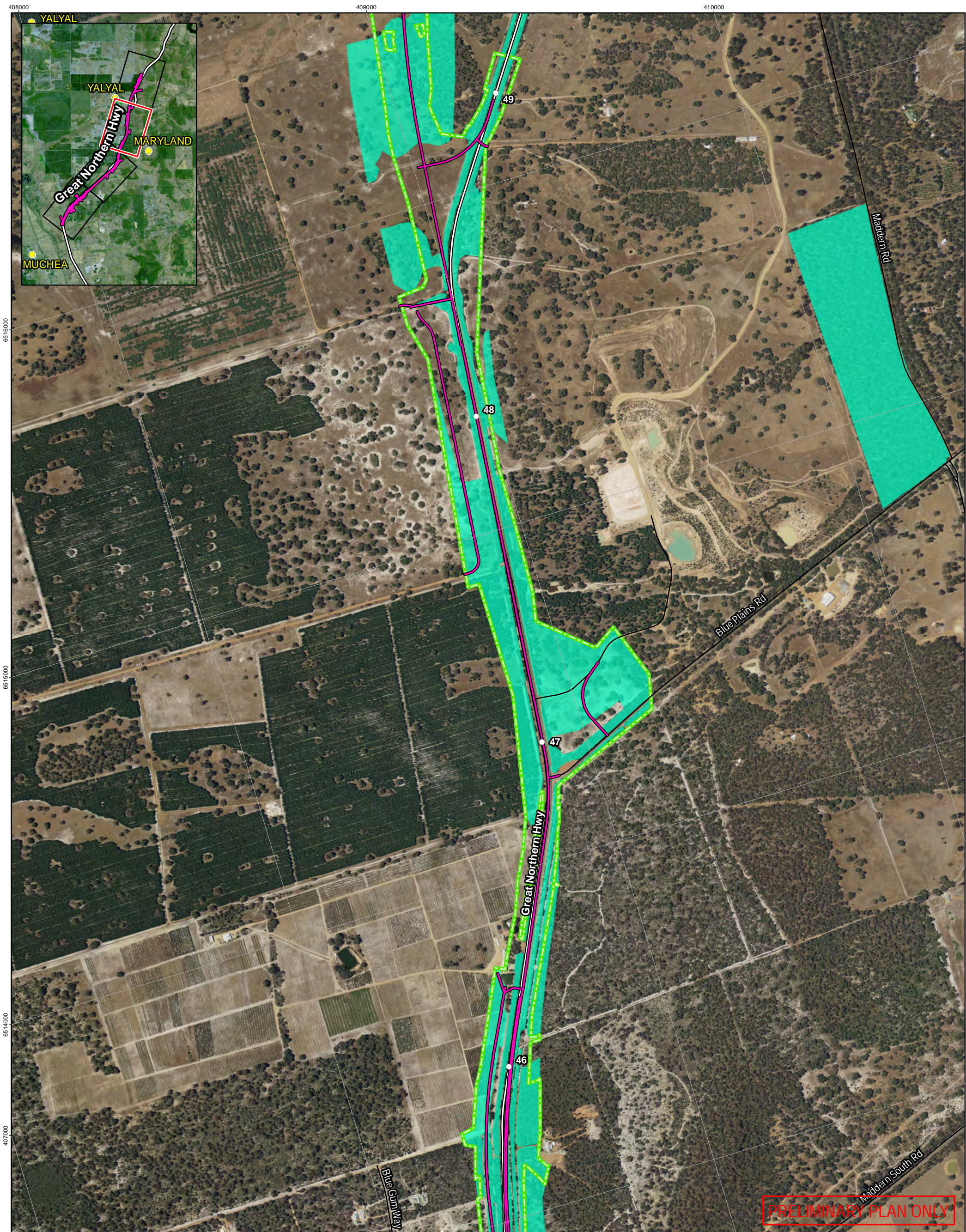
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Drawing No <b>GNH-CN03-EN01-GIS-0068</b>		Issue <b>B</b>	
Task No <b>GNH-1414</b>		Drawing Status / Other <b>Draft</b>	
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PRELIMINARY PLAN ONLY

**Legend**

- Town
- Straight Line Kilometre Marker (1km)
- Muchea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Minor Road
- NVCP Application Area
- Potential Forest Red-Tailed Black Cockatoo Foraging Habitat

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Muchea to Wubin Upgrade Stage 2**

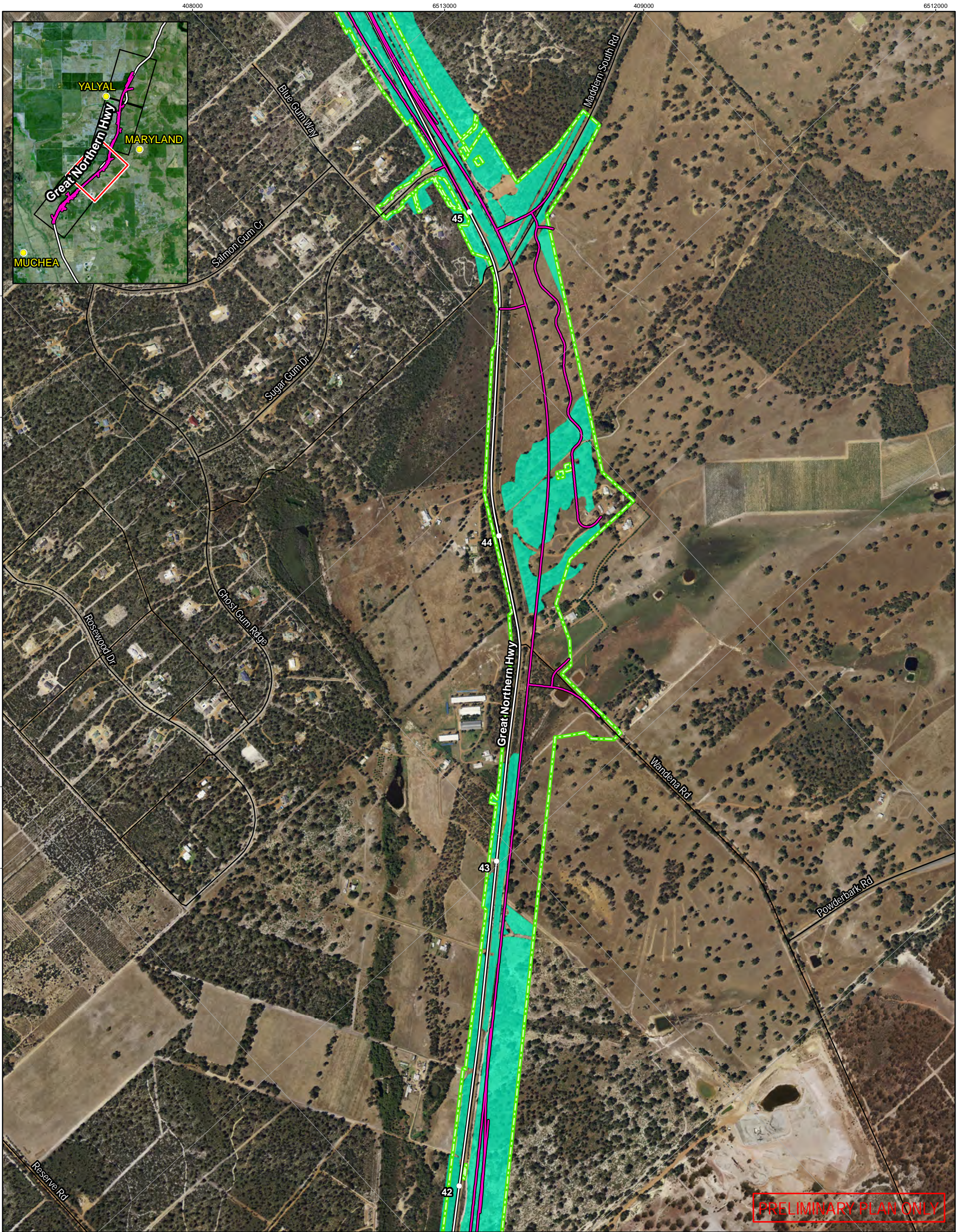
**Forest Red-Tailed Black  
Cockatoo Potential Foraging  
Habitat - Map 2 of 4**

Drawing No <b>GNH-CN03-EN01-GIS-0068</b>	Issue <b>B</b>		
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- Legend**
- Straight Line Kilometre Marker (1km)
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  - Potential Forest Red-Tailed Black Cockatoo Foraging Habitat



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Muchea to Wubin Upgrade Stage 2

**Forest Red-Tailed Black  
Cockatoo Potential Foraging  
Habitat - Map 3 of 4**

Drawing No  
GNH-CN03-EN01-GIS-0068

Issue  
B

Task No  
GNH-1414

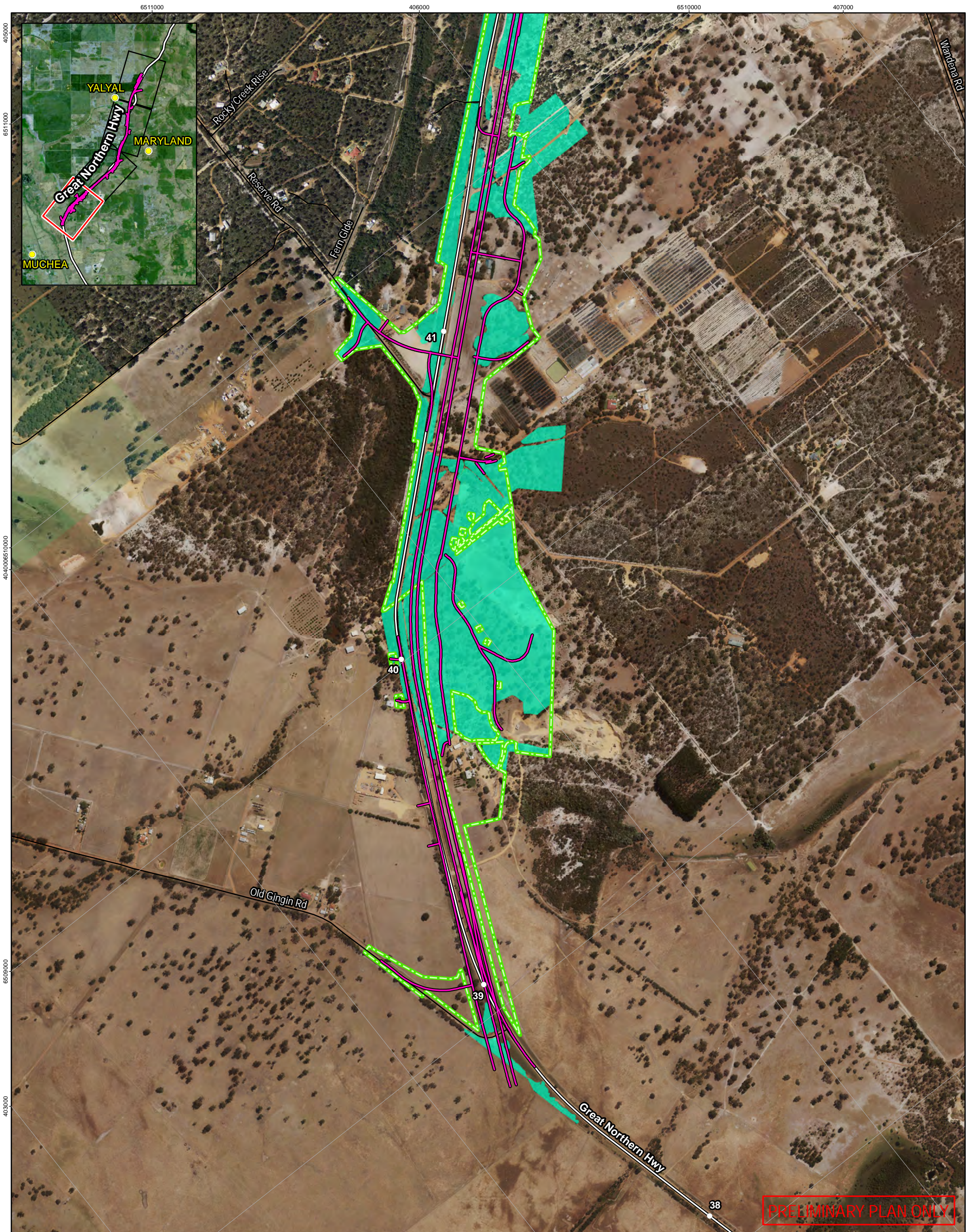
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- Legend**
- Straight Line Kilometre Marker (1km)
  - Muchea North Alignment
  - Existing GNH Alignment
  - Freeway / Highway
  - Minor Road
  - NVCP Application Area
  - Potential Forest Red-Tailed Black Cockatoo Foraging Habitat

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**Forest Red-Tailed Black Cockatoo Potential Foraging Habitat - Map 4 of 4**

Drawing No  
GNH-CN03-EN01-GIS-0068

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Task No  
GNH-1414

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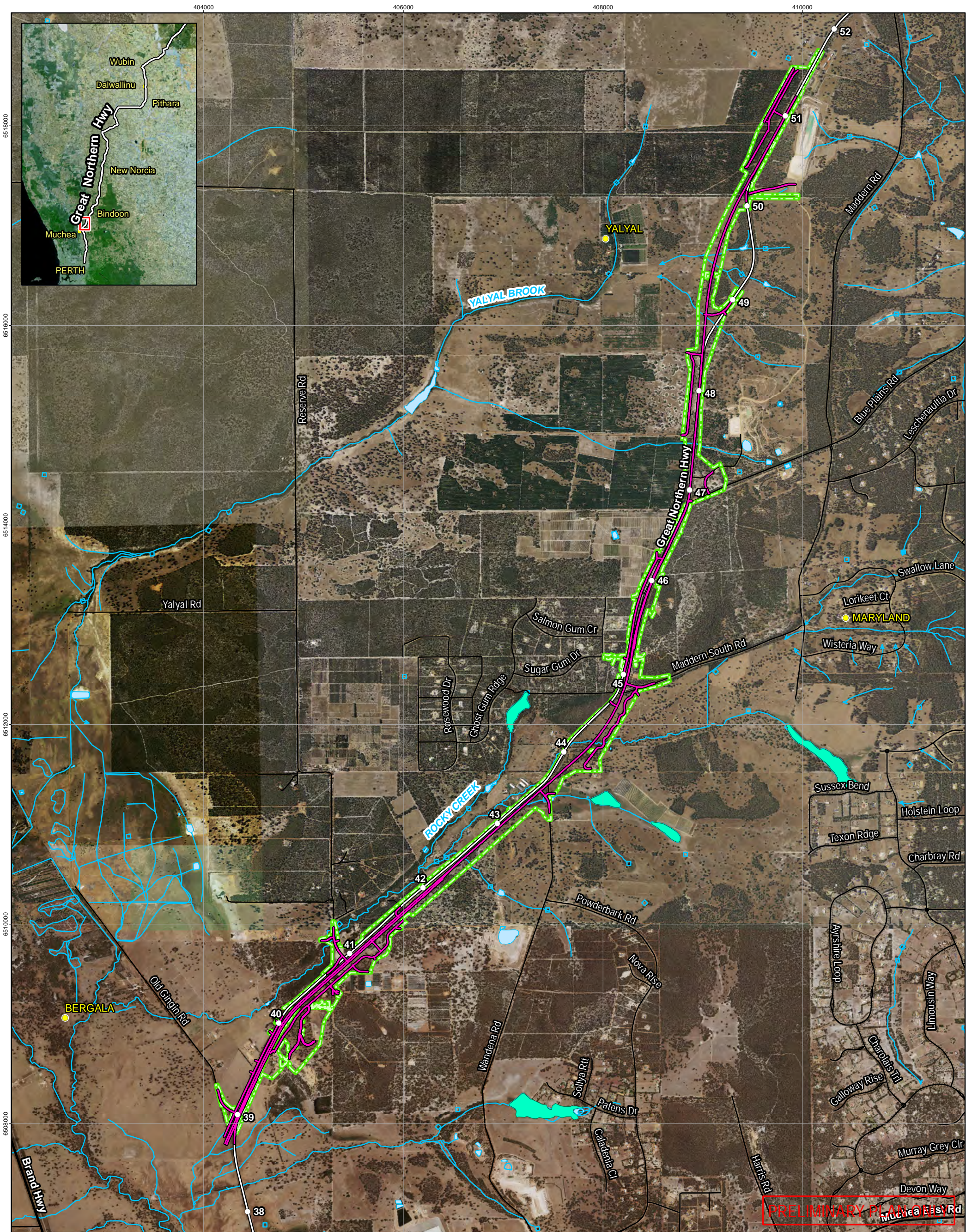
Figure 11 : Hydrology

*[refer to GNH-CN03-EN01-GIS-0049]*



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**Legend**

- Straight Line Kilometre Marker (1km)
- Town
- Muechea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Major Road
- Minor Road
- Watercourse
- NVCP Application Area
- Water Body
- Wetland

Data Source: Main Roads WA, Landgate

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Client Project

**Hydrological Features**

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Task No <b>GNH-1329</b>	Drawing Status / Other <b>Draft</b>		
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## **Appendix A. Flora and Fauna Assessment for Muchea North and Chittering (Phoenix, 2015)**



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# PHOENIX

## ENVIRONMENTAL SCIENCES

Flora and fauna assessment for Muchea North and Chittering study area

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

December 2015

Final Report





Flora and fauna assessment for the Muchea North and Chittering study area.

Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project.

Prepared for Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup)

Final Report

Authors: Anna Leung and Grace Wells

Reviewer: Karen Crews

Date: 21 December 2015

Submitted to: Kerry McCann, Todd Jess

Version history			
Name	Status	Version	Date
A. Leung, G. Wells, K. Crews	Draft issued for client review	A	9 December 2015
K. Crews	Final issued to client	0	21 December 2015

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Project code: 1080-GNH-JA-FAU, 1081-GNH-JA-BOT



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## ABBREVIATIONS

AWC – Australian Weeds Committee  
BoM – Bureau of Meteorology  
CAMBA – China-Australia Migratory Bird Agreement  
CR – Critically Endangered  
D – Depleted  
DBH – diameter at breast height  
DPaW – Department of Parks and Wildlife  
DSEWPaC – Department of Sustainability, Environment, Water, Population and Communities  
EN – Endangered  
EP Act – *Environmental Protection Act 1986*  
EPA – Environmental Protection Authority  
EPBC Act – *Environmental Protection and Biodiversity Act 1999*  
EPP – Environmental Protection Policy  
ESA – Environmentally Sensitive Area  
GNH – Great Northern Highway  
GPS – Global Positioning System  
IBRA – Interim Biogeographic Regionalisation of Australia  
JAMBA – Japan-Australia Migratory Bird Agreement  
LC – least concern  
Mig. – Migratory  
NES – national environmental significance  
NVIS – National Vegetation Information System  
PDA – personal data assistant  
PEC – priority ecological community  
RAAF – Royal Australian Air Force  
ROKAMBA – Republic of Korea on the Protection of Migratory Birds  
SC – special conservation need  
SLK – straight line kilometre  
SP – Specially Protected  
sp. – species (singular)  
spp. – species (plural)  
subsp. – subspecies (singular)  
TEC – threatened ecological community



VU – Vulnerable

WA – Western Australia

WC Act – *Wildlife Conservation Act 1950*

WoNS – Weeds of National Significance



## EXECUTIVE SUMMARY

The Great Northern Highway (GNH) forms part of the National Land Transport Network that links the Perth Metropolitan area and Fremantle Port with the North-West of Australia, along with a link to Darwin and the Northern Territory. Main Roads Western Australia (Main Roads WA) has been undertaking a significant program of works to improve safety and efficiency of the GNH between Muchea and Wubin, north of Perth, to meet National Highway Standards.

In 2014, Main Roads WA established the Muchea to Wubin Integrated Project Team with industry partners Jacobs and Arup to conduct a comprehensive planning review of the full Muchea to Wubin link; Muchea to Wubin Upgrade Stage 2 (the Project).

Phoenix Environmental Sciences Pty Ltd (Phoenix) was engaged by Jacobs to undertake a flora and fauna assessment for a number of proposed work packages, which included work package 1, Muchea North, and work package 2, Chittering (collectively, the study area). This report documents the flora and fauna assessment for the study area which comprised:

- a desktop review to determine potential conservation significant flora, vegetation and fauna in the study area, as well as weeds of significance
- flora and vegetation field survey including delineation and mapping of vegetation associations by quadrat sampling, mapping of vegetation condition boundaries, targeted searches for conservation significant flora and vegetation, and targeted searches for populations of declared plants
- fauna survey including a habitat assessment and habitat mapping, assessment of likelihood of occurrence within the study area for conservation significant fauna, targeted searches for conservation significant fauna, and recording of potential breeding trees, feeding and roosting sites for black cockatoos, particularly Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)
- mapping of breeding and foraging habitat for Carnaby's Black Cockatoo.

The desktop review relied on State and Commonwealth databases and available reports from previous surveys of the GNH road reserve in the vicinity of the study area. Field surveys were undertaken in October 2014, and between May and November 2015. A total of 32 quadrats and 17 relevés were sampled. The targeted flora and fauna searches were conducted in habitats considered likely to contain or support conservation significant species, at locations of previous records and in the vicinity of these.

Descriptions of vegetation undertaken in the field were subsequently matched to regional vegetation mapping undertaken by the Department of Agriculture and Food (WA) in line with previous surveys in the vicinity of the study area. Known foraging associations/genera for black cockatoo species were cross-referenced with the vegetation type mapping from the survey to determine areas with potential feeding value to black cockatoos.

From the desktop review, 18 Protected Flora listed under the *Wildlife Conservation Act 1950* (WC Act) and 15 Priority Flora were identified as potentially occurring in the study area. The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters database identified 17 Threatened Flora where species or species habitat may occur within 1 km of the study area.

Seven declared plants and one species classified as a Weed of National Significance (WoNS) were identified in the desktop review.

No Threatened Ecological Communities (TECs), Priority Ecological Communities (PECs) or Environmentally Sensitive Areas (ESAs) were identified within the study area from the desktop review.



A total of 19 Protected Fauna species listed under the WC Act and eight Priority Fauna were identified as potentially occurring in the study area from the desktop review. The EPBC Act Protected Matters database identified 13 Threatened Fauna and seven Migratory species where species or species habitat may occur within 10 km of the study area.

A total of 273 plant taxa representing 52 families and 153 genera were recorded in the study area during the surveys. The assemblage comprised 223 native species and 51 weeds, including 48 annual and 225 perennial species. The most prominent families were Fabaceae (39), Myrtaceae (29), Poaceae (26), Proteaceae (24), Haemodoraceae (18) and Asteraceae (16).

Specimens collected of six taxa could not be definitively identified to species level. None of the specimens resembled conservation significant species.

A total of seven conservation significant flora represented by 247 individual plants were recorded in the study area:

- *Acacia drummondii* subsp. *affinis* (Priority 3)
- *Darwinia foetida* (Critically Endangered, EPBC Act; Schedule 2, WC Act)
- *Eucalyptus caesia* (Priority 4)
- *Haemodorum loratum* (Priority 3)
- *Stylidium squamellosum* (Priority 2)
- *Verticordia lindleyi* subsp. *lindleyi* (Priority 4)
- *Verticordia serrata* var. *linearis* (Priority 3).

Three of the weed species recorded in the study area are declared plants, *\*Asparagus asparagoides*, *\*Echium plantagineum*, *\*Moraea miniata*. *\*Asparagus asparagoides* is also a WoNS.

Nineteen vegetation associations were defined locally for the study area. Broadly the vegetation associations recorded represent mid forests (Jarrah, Wandoo), low to mid woodlands (Marri, Jarrah, Wandoo, Banksia, paperbark) and shrublands (tea-tree, scrub-heath, mixed heath).

None of the vegetation associations recorded within the study area were considered to represent a Commonwealth or State listed TEC, or any State listed PEC.

Seven of the vegetation associations (23, 27, 37, 48, 49, 949 and 1003) may be considered locally significant as they covered less than 1% of the study area. Additionally, nine of the vegetation associations (48, 946, 965, 968, 975, 992, 999, 1003 and 1019) may be considered to be locally significant as they represent habitat for the conservation significant flora recorded in the study area. The areas of the vegetation recorded to be in pristine or excellent condition may also be considered locally significant as they represent patches of comparatively high native species diversity in otherwise degraded vegetation.

Five vegetation associations (4, 946, 992, 999 and 1008) within the study area may be considered regionally significant as there is less than 30% of their pre-European extent remaining.

Fauna habitats recorded in the study area were described as woodland (Jarrah, Marri, Wandoo and/or banksia), shrubland (low heath/scrub), shrubland (thicket), woodland (paperbark or sheoak) and forest (Jarrah and/or Marri). These represented 38.7% of the study area. The remainder of the study area was comprised of cleared areas, represented by agriculture, roads and other infrastructure; and cleared and revegetated non-native woodlands.

Fauna habitat quality was variable, ranging from completely degraded areas offering little habitat value to good quality habitat, particularly in woodland habitats of Muchea North that were contiguous with larger pockets of native vegetation.



Fauna habitat quality was variable, ranging from completely degraded areas offering little habitat value to good quality habitat, particularly in woodland habitats of Muchea North that were contiguous with larger pockets of native vegetation.

Carnaby's Black Cockatoo was recorded on numerous occasions in the Muchea North study area during the surveys. Extensive evidence of feeding (residues) by the species was recorded at several locations in the study area and evidence of nine likely nesting sites was recorded.

Based on habitats present, known species distributions, and habitat quality and extent, up to 14 conservation significant fauna species may occur in the study area. However, due to the poor condition, presence of introduced species and fragmentation, the fauna habitats in the study area are unlikely to provide core habitat for species of conservation significance identified in the desktop review with the exception of Carnaby's Black Cockatoo.

Potential breeding trees and roosting and foraging habitat were recorded for Carnaby's Black Cockatoo. Within the study area, 1,465 potential black cockatoo breeding trees were recorded during the survey, comprising predominantly *Corymbia calophylla*, *Eucalyptus wandoo*, *E. marginata* and *E. rudis*. Of these, 25 were recorded that contained hollows suitable for breeding and nine of these showed signs of use at the time of the survey. Based on the records, 98.5 ha of remnant vegetation within the study area has been mapped as potential breeding habitat for the species. Based on spatial analysis of quadrat data and the vegetation associations, 87.5 ha of quality foraging habitat for Carnaby's Black Cockatoo was mapped in the study area.

In terms of overall value the northern part of Muchea North was considered to have the highest ecological value in the study area due to the following attributes:

- vegetation was in very good, excellent or pristine condition
- provided suitable habitat for several conservation significant flora
- considered some of the better fauna habitat
- provided broader regional linkage between Barracca Nature Reserve and surrounding larger native remnants.



# **1 INTRODUCTION**

## **1.1 BACKGROUND**

The Great Northern Highway (GNH) forms part of the National Land Transport Network that links the Perth Metropolitan area and Fremantle Port with the North-West of Australia, along with a link to Darwin and the Northern Territory. Main Roads Western Australia (Main Roads WA) has been undertaking a significant program of works to improve safety and efficiency of the 218 km section of the GNH between Muchea and Wubin, north of Perth, to meet National Highway Standards. Stage 1 of the upgrade works were completed between 2000 and 2009 and involved upgrading 76 km of the Muchea to Wubin section of GNH.

In 2014, Main Roads WA established the Muchea to Wubin Integrated Project Team with industry partners Jacobs and Arup to conduct a comprehensive planning review of the full Muchea to Wubin link; Muchea to Wubin Upgrade Stage 2 (the Project). As part of the Project upgrades are proposed for several sections of GNH, including specific work packages for Muchea North (work package 1) and Chittering (work package 2).

In September 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was appointed by the Muchea to Wubin Integrated Project Team (Main Roads WA, Jacobs and Arup) to undertake a flora and fauna assessment for the proposed Muchea North and Chittering work packages.

## **1.2 PURPOSE**

The purpose of this report is to document the biological survey completed for the Muchea North and Chittering work packages to inform an environmental impact assessment for these sections of the Project.

## **1.3 STUDY AREA**

The study area defined for this report (Figure 1-1) includes Muchea North (Muchea North study area) and Chittering (Chittering study area) work packages and is based on the following:

- Phase 1 survey area, an area within which surveys were conducted between October 2014 and June 2015
- Phase 2 survey area, an area within which surveys were conducted between September and October 2015.

Some parts of the Phase 1 survey area fall outside of the current study area (Figure 1-1) and are not directly reported herein. However, they have been used to provide additional context to the study area.

In this report, the Muchea North study area extended for approximately 10.9 km from straight line kilometre (SLK) 37.11, 250 m north of the Brand Highway–GNH junction to SLK 46.44, approximately 520 m south of the Blue Plains Road–GNH junction (Figure 1-1). The Chittering study area in this report extended for approximately 6.3 km from SLK 46.44 to SLK 51.82, approximately 1.5 km south of the Sandalford Drive–GNH intersection (Figure 1-1).

The average width of the study area was approximately 200 m and total area was approximately 302.6 ha.



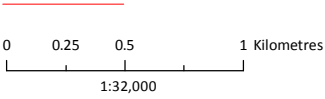
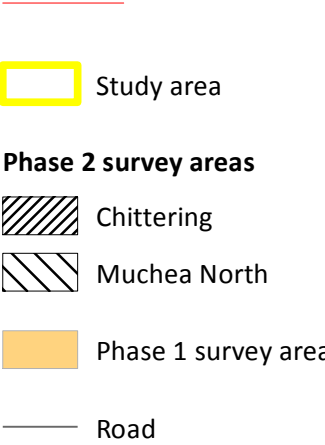
## 1.4 SCOPE OF WORK

The scope of work comprised:

- biological desktop review of the study area
- flora and vegetation field survey entailing
  - delineation and mapping of vegetation types by quadrat sampling
  - mapping of vegetation condition
  - targeted searches for conservation significant flora and vegetation
  - targeted searches for populations of declared plants (weeds).
- fauna survey entailing
  - habitat assessment and mapping
  - assessment of likelihood of occurrence within the study area for conservation significant fauna
  - targeted searches for conservation significant species
  - survey of potential breeding trees, roosting sites and feeding sites for black cockatoo species, particularly Carnaby's Black Cockatoo
  - mapping of breeding and foraging habitat for Carnaby's Black Cockatoo.



Figure 1–1  
Project location and study area



Client: Jacobs  
Project: Great Northern Highway –  
Muchea to Wubin (Stage 2) Upgrades  
Author: A. Leung  
Date: 21/12/2015

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





## 2 LEGISLATIVE CONTEXT

The protection of flora and fauna in Western Australia (WA) is principally governed by three acts:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act).

### 2.1 COMMONWEALTH

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES), require approval from the Australian Government Minister for the Environment. The EPBC Act provides for the listing of threatened native flora, fauna and threatened ecological communities (TECs) as matters of NES.

Conservation categories applicable to Threatened Flora and Threatened Fauna species under the EPBC Act are as follows:

- Extinct (EX)<sup>1</sup> – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent<sup>1</sup> – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.

Ecological communities are defined as ‘naturally occurring biological assemblages that occur in a particular type of habitat’ (English & Blyth 1997). There are three categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

The EPBC Act is also the enabling legislation for protection of migratory species under a number of international agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn)
- Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).

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<sup>1</sup> Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.



## 2.2 STATE

### 2.2.1 Threatened and Priority species and communities

In WA, the WC Act provides for the listing of protected flora (Rare Flora) and fauna (Specially Protected Fauna) species which are under identifiable threat of extinction. Protected flora listed under the WC Act receive statutory protection and, under current classifications (Western Australian Government 2015a), are assigned to one of four categories (schedules):

- Schedule 1 (S1) – flora that are considered likely to become extinct or rare as critically endangered (CR) flora
- Schedule 2 (S2) – flora that are considered likely to become extinct or rare as endangered (EN) flora
- Schedule 3 (S3) – flora that are considered likely to become extinct or rare as vulnerable (VU) flora
- Schedule 4 (S4) – flora presumed to be extinct (EX).

All listed species are in need of special protection and are declared to be rare flora for the purposes of section 23F of the WC Act (Western Australian Government 2015a).

Under current classifications (Western Australian Government 2015a), protected fauna are assigned to one of seven categories under the WC Act (Western Australian Government 2015b):

- Schedule 1 (S1) – fauna that is rare or is likely to become extinct as critically endangered (CR) fauna
- Schedule 2 (S2) – fauna that is rare or is likely to become extinct as endangered (EN) fauna
- Schedule 3 (S3) – fauna that is rare or is likely to become extinct as vulnerable (VU) fauna
- Schedule 4 (S4) – fauna presumed to be extinct (EX)
- Schedule 5 (S5) – Migratory birds protected under an international agreement (Mig.)
- Schedule 6 (S6) – fauna that is of special conservation need (SC) as conservation dependent fauna
- Schedule 7 (S7) – other specially protected (SP) fauna.

Assessments for listing of both flora and fauna are based on the International Union for Conservation of Nature threat categories.

The Department of Parks and Wildlife (DPaW) administers the WC Act and also maintains a non-statutory list of Priority Flora and Priority Fauna species (updated each year). Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the WC Act until there is adequate understanding of their threat levels. Species on the Priority Flora and Fauna lists are assigned to one of five priority (P) categories, P1 (highest) – P5 (lowest), based on level of knowledge/concern.

The Minister for Environment may also list ecological communities which are at risk of becoming destroyed as ‘threatened’. DPaW maintains a list of ministerial-endorsed TECs as well as a non-statutory list of Priority Ecological Communities (PECs) which are also assigned to one of five categories.

Any activities that are deemed to have a significant impact on listed flora or fauna species can trigger referral to the Environmental Protection Authority (EPA) for assessment under the EP Act. The EPA’s



position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment (EPA 2006a).

### **2.2.2 Locally or regionally significant flora and vegetation**

Flora species, sub-species, varieties, hybrids and ecotypes may be significant for a variety of reasons other than being listed as Threatened or Priority Flora, including where they have keystone roles for threatened species, are representative of the range limit of a species, are locally endemic, are poorly reserved or display anomalous features that indicate a potential new discovery (EPA 2004b).

Native vegetation communities may be considered significant for a range of reasons other than a statutory listing as a TEC, including where they have restricted distributions (i.e. to one or two locations or as isolated communities, or are below threshold levels), exhibit unusually high structural and species diversity, are limited to specific landform types, are determined to be uncommon or restricted within the regional context, have a role as key habitat for threatened or priority species or provide refugial habitats (EPA 2004b). The most important factor in consideration of community significance is the degree of representation at a local and regional scale. It may be considered that representation of less than one percent of the total study area defines limited representation within the local context.

### **2.2.3 Clearing of native vegetation**

The clearing of native vegetation in WA is not generally permitted where the biodiversity values, land conservation and water protection roles of native vegetation would be significantly affected. Any clearing of native vegetation in WA requires a permit under Part V Division 2 of the EP Act, except where an exemption applies under the act, or is prescribed by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (the Regulations), and the vegetation is not in an Environmentally Sensitive Area (ESA). Permit applications to clear native vegetation require assessment against the '10 Clearing Principles', as outlined in the regulations.

### **2.2.4 Environmentally Sensitive Areas**

Under section 51B of the EP Act the Minister for Environment may declare by notice either a specified area of the State or a class of areas of the State to be ESAs. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005.

ESAs are generally areas where the vegetation has high conservation value. Several types of areas are declared ESAs including:

- the area covered by vegetation within 50 m of Threatened Flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened Flora is located
- the area covered by a TEC
- a defined wetland (Ramsar wetlands, conservation category wetlands and nationally important wetlands) and the area within 50 m of the wetland
- Bush Forever sites.



## 2.3 INTRODUCED FLORA

Introduced flora (i.e. weeds) pose threats to biodiversity and natural values by successfully out-competing native species for available nutrients, water, space and sunlight; reducing the natural diversity by smothering native plants or preventing them from growing back after clearing, fire or other disturbance; replacing the native plants that animals use for shelter, food and nesting; and altering fire regimes, often making fires hotter and more destructive (AWC 2007). Some weeds are classified as declared under the *Agriculture and Related Resources Protection Act 1976* (declared plant) or Weeds of National Significance (WoNS) and require specific control actions. Specific terms are used in WA to describe weeds (Table 2-1).

**Table 2-1 Terms used to describe weeds (DEC 2012b)**

Term	Definition
Declared plant	A weed that has been "Declared" under the <i>Agriculture and Related Resources Protection Act 1976</i> . The Declared Plants Database lists declared plants within a particular region (shire/city) of WA and contains information on the status of a plant, its declaration, a brief description and control methods.
Environmental weed	An introduced plant that establishes in natural ecosystems and adversely modifies natural processes, resulting in decline of invaded communities (refer to the Environmental Weed Strategy, DEC 1999).
Exotic	A plant occurring in a place to which it is not native.
Invasive plant	One that is introduced and successfully reproduces resulting in the establishment of a population that spreads and threatens ecosystems, habitats or species with economic or environmental harm. Often called weeds when established they can result in harmful impacts to biodiversity, property and life. Not all introduced species are invasive if there are controls on their spread or competitiveness.
Naturalised plant	A plant that is not native to an area but has become established and can reproduce there. Not all naturalised species become weeds or have detrimental environmental or economic effects, but many do.
Weed	A plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity, and can include plants from other countries or other regions in Australia or WA.



## 3 METHODS

### 3.1 DESKTOP REVIEW

Desktop review methods entailed:

- a review of existing environmental information relevant to the biological values of the study area including
  - base environmental datasets to define the physical characteristics of the study area
  - searches of relevant biological databases (Table 3-1)
  - literature reviews of available technical reports from projects adjacent to the study area, or within the area of the desktop review
- assessment and mapping of broad-scale vegetation in the study area.

The desktop review was initially conducted for the entire Project (Muchea North to Chittering) in September 2014 (Phoenix 2015) and has been used as the basis for the review in this report. Where possible, database search results were refined to be more specific to the current study area.

**Table 3-1 Databases searches conducted for the desktop review**

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (Department of the Environment 2014c)	EPBC Act Threatened Flora, TECs and Threatened Fauna	GDA94; Polyline of study area centreline (approximate) with a 1 km buffer
DPaW Threatened and Priority Flora database and WA Herbarium database (DPaW 2014c)	WC Act Threatened and Priority Flora	GDA94; Polyline of study area centreline (approximate) with a 2 km buffer
DPaW Threatened and Priority Ecological Communities database (DPaW 2014c)	TECs and PECs	GDA94; Polyline of study area centreline (approximate) with a 5 km buffer
DPaW NatureMap databases, including Western Australian Herbarium records (DPaW 2014b)	Threatened and Priority Flora, weeds and all potentially occurring fauna	GDA94; Polyline of study area centreline (approximate) with a 1 km buffer for flora and 10 km buffer for fauna
Department of Agriculture and Food, Western Australia Organism List search for Declared Plants under the <i>Biosecurity and Agriculture Management Act 2007</i>	Declared plant species	Species recorded in the Chittering Local Government Area (Local Government Area boundaries)
Department of the Environment weeds database	Weed species	National weeds lists, WoNS
Any sites of significance	Wetlands, conservation estate and ESAs	SLIP Services, Landgate: ESA (updated 22/09/2014) and wetlands (updated 04/06/2015) location maps



Database	Target group/s	Search coordinates and extent
DPaW Threatened Fauna database (DPaW 2014c)	Threatened and Priority Fauna	GDA94; Polyline of GNH centreline from Muchea North to Wubin (approximate) with a 10 km buffer
Birdlife Australia Birddata database (Birdlife Australia 2014)	All potential avian fauna records, including Threatened and Migratory bird species	GDA94; Polyline of study area centreline (approximate) with a 10 km buffer

Base environmental datasets were reviewed to define the physical characteristics of the study area including

- Interim Biogeographic Regionalisation of Australia (IBRA) region (DSEWPaC 2012b; Thackway & Cresswell 1995b)
- climate (BoM 2015)
- land systems – landforms and soils.

**Table 3-2 Previous survey reports included in the review**

Report title	SLK
Biological Survey - Great Northern Highway: Muchea to Walebing (Ninox Wildlife Consulting 1989)	36–150
Great Northern Highway: assessment of flora & vegetation (Ecologia 2004)	36–253
Preliminary environmental impact assessment (KBR 2005)	36–253
Flora survey for extension of proposed disturbances on Great Northern Highway road reserves (Western Botanical 2006)	37–164 (areas within)
Report for Great Northern Highway Upgrade: Muchea to Bindoon Flora and Fauna Assessment (GHD 2011b)	33.13–65.31
Report for Great Northern Highway Upgrade: Muchea to Bindoon Environmental Impact Assessment (GHD 2011a)	33.13–65.31
Flora and fauna assessment for the Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades Project <sup>1</sup> (Phoenix 2015)	37.1–255.0
Great Northern Highway flora and vegetation assessment – SLK 89 to SLK 114 (ENV 2007)	89–114

<sup>1</sup>Phase 1 survey report; desktop review used as basis for desktop review in current report; field survey covered the Phase 1 survey area; field results for Muchea North and Chittering have been incorporated into current report.

## 3.2 FIELD SURVEY

### 3.2.1 Flora and vegetation

Flora and vegetation was assessed for the study area over two seasonal periods and a number of field surveys to accommodate changes to the study area.

An initial spring season flora and vegetation field survey was undertaken in the Phase 1 survey area in October 2014. Field assessment methodology involved description of vegetation types and condition



at locations in remnant and planted vegetation using quadrat, relevé and opportunistic sampling, and included searches for conservation significant and introduced flora. Pastures and completely degraded areas were not surveyed.

The second spring season field survey was undertaken on 17 - 29 September 2015 in the Phase 2 survey area and included additional areas which were not surveyed in spring 2014 (Figure 1-1). Survey methods from the spring 2014 survey were repeated in the new areas. In addition, the boundaries of vegetation associations and vegetation condition classifications defined in the spring 2014 survey were ground-truthed to confirm accuracy. In the targeted searches for conservation significant flora more detailed survey effort was employed in vegetation types that conservation significant flora were recorded during the spring 2014 survey and in surrounding areas outside the study area to identify other locations outside the proposed disturbance area.

Additional targeted searches were also conducted for particular species in May 2015 (section 3.2.1.2).

Prior to the commencement of the field surveys, all known data was loaded onto either a personal data assistant (PDA) unit or a hand-held Global Positioning System (GPS, Garmin Montana 650t), including aerial photography and pre-selected vegetation quadrats. This allowed points of interest and vegetation boundaries to be directly inserted into an electronic format, ensuring all locations were accurately mapped at the time of the survey. In the latter two surveys, previously described vegetation association and vegetation condition boundaries, and locations of previous sites were also loaded onto the devices.

All surveys were conducted in accordance with the EPA's Guidance Statement No. 51: *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* (EPA 2004b) and Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (EPA 2002).

### 3.2.1.1 Quadrat and relevé selection

In total, 32 quadrats and 17 relevés were selected and surveyed across spring 2014 and 2015 (Table 3-3; Figure 3-1). In Muchea North, 23 quadrats and 12 relevés were sampled over the total survey period. Survey effort for Chittering over both seasons comprised nine quadrats and five relevés.

Quadrat sampling sites typically measured 10 m x 10 m. However, due to the nature of the study area quadrat dimensions were modified to fit the road reserve at some sites (e.g. 20 m x 5 m), although the overall quadrat area was maintained.

In addition, GHD (GHD 2011c) sampled 11 quadrats in the Muchea North study area and 14 quadrats in the Chittering study area (Figure 3-1). Where no field surveys were completed in the Chittering study area in spring 2014, the vegetation mapping undertaken by GHD (based on GHD's quadrat data) has been used as the base vegetation type dataset.



**Table 3-3 Survey timing and effort for the flora and vegetation survey in each survey area**

Section	SLKs surveyed <sup>1</sup>	Survey dates	No. person hours	No. quadrats	No. relevés	Work undertaken
Muchea North	37.11 – 46.05	16 October – 4 November 2014	42	13	5	Quadrat survey and targeted searches for conservation significant flora and declared plants.
	37.11 – 46.05	12 May 2015	20	-	-	Targeted searches for specific conservation significant taxa.
	37.5 – 46.44	17 – 18 September 2015 21 September 2015	36	10	7	Quadrat surveys in expanded survey areas. Targeted searches for conservation significant flora. Record locations of declared plants. Record condition of vegetation across Muchea North study area.
Chittering	57.0 – 51.82	16 October – 4 November 2014	6	4		Quadrat survey and targeted searches for conservation significant and declared plants.
	46.44 – 47.01	17 September 2015		1		Quadrat survey and targeted searches for conservation significant flora and declared plants.
	47.82 – 50.61	23 – 25 September 2015	48	4	5	Quadrats completed at a range of locations in the survey area. Targeted searches for significant flora and declared plants across survey area. Condition mapping across Chittering study area.
<b>TOTAL</b>			<b>152</b>	<b>32</b>	<b>17</b>	

<sup>1</sup> SLKs varied slightly between Phase 1 and Phase 2.

Quadrat locations were selected to ensure that an adequate representation of the major vegetation types and flora present within the study area was sampled. This was achieved by pre-selecting locations of sampling quadrats based on apparent changes in the vegetation visible in aerial images (using supplied high quality colour aerial photography) for ground-truthing on foot, selecting additional quadrats in different vegetation types and targeting different landforms during field and relevé surveys.

Vegetation in preselected quadrats that appeared similar to already described vegetation in the field within other quadrats was treated as relevés where only description of dominant vegetation was made, and additional relevés were selected during the field surveys to match vegetation described within other quadrats to facilitate mapping of vegetation type boundaries.



The following information was recorded for each quadrat (Appendix 1):

- location – the coordinates of the quadrat were recorded in GDA 94 projection utilising a PDA unit or hand-held GPS.
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (NVIS) (2003) (Appendix 2)
- habitat – a brief description of landform and habitat
- soil – a broad description of surface soil type and rocks
- disturbance history – a brief description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance and animal grazing
- vegetation condition – the condition of the vegetation was recorded utilising the condition scale of (Keighery 1994) (Table 3-4)
- height and foliage cover – a visual estimate of the canopy cover of each species present was recorded as was the total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover
- photograph – a colour photograph of the vegetation within each quadrat
- species list – the name of every species present in the quadrat; where species were located that were unknown to the botanist conducting the survey, or field identification was not certain, a specimen was collected and pressed for later identification.

**Table 3-4 Vegetation condition rating scale (Keighery 1994)**

<b>Vegetation condition rating</b>	<b>Vegetation condition</b>	<b>Description</b>
<b>1</b>	Pristine	Pristine or nearly so. No obvious signs of disturbance.
<b>2</b>	Excellent	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
<b>3</b>	Very Good	Vegetation structure altered, obvious signs of disturbance.
<b>4</b>	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it.
<b>5</b>	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
<b>6</b>	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost without native species.







### 3.2.1.2 Targeted flora searches

Targeted searches were undertaken simultaneously with the flora and vegetation spring surveys to determine whether any of the conservation significant species identified from the database and literature review occur in the study area. The searches focused on habitats considered likely to contain or support conservation significant flora and previously recorded locations of conservation significant plants or populations within the study area. Vegetation types such as creek lines, gullies, ridges, rocky outcrops and low lying areas were also targeted as these areas typically support a higher level of diversity.

For each population of conservation significant flora recorded, the following information was documented:

- location (as points for individual plants or as polygons for populations)
- description of the floristic community in which the species was located and population size estimate
- voucher collection for lodgement at the WA Herbarium.

For each population of declared plant recorded, the following information was documented:

- location (as points for individual plants or as polygons for populations)
- population size estimate.

As part of the Phase 1 survey, additional targeted searches were conducted in the Muchea North study area in May 2015 for:

- *Trichocline* sp. Treeton (Priority 2) – searches in suitable habitat, i.e. seasonally wet habitats<sup>2</sup>
- *Verticordia lindleyi* subsp. *lindleyi* (Priority 4) – searches for previously recorded populations
- *Darwinia foetida* (Threatened) – more intensive searches of previously recorded populations
- *Daviesia debilior* subsp. *sinuans* (Priority 3) – searches for previous records to confirm identity.

### 3.2.1.3 Vegetation mapping

Review of the previous vegetation surveys conducted for the GNH between Muchea and Wubin identified various methods have been used to delineate vegetation types. Two assessments (ENV 2007; Western Botanical 2006) utilised an approach where descriptions of vegetation undertaken in the field were subsequently matched with those of Shepherd *et al.* (2002). This approach was adopted for the current study because:

- matching the vegetation recorded to the vegetation types of Shepherd *et al.* (2002) facilitated assessment of the significance at a regional level
- the study area traverses areas that are highly impacted by multiple land uses, particularly broad scale clearing for agriculture, which have substantially altered natural community structure and values

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<sup>2</sup> Since the searches were conducted *Trichocline* sp. Treeton has been renamed *Trichocline spathulata* and is no longer listed as conservation significant.



- of the previous vegetation assessments available for review, Western Botanical (2006) and ENV (2007) were the only studies that provided description of the methods undertaken to determine vegetation types facilitating replication of the methodology.

The vegetation descriptions from quadrats and relevés from the current survey were grouped according to similarity of community structure (i.e. canopy levels) and species composition. Vegetation types were matched with the vegetation associations of Shepherd *et al.* (2002) according to the presence of the predominant species (e.g. York Gum (*Eucalyptus loxophleba*), Salmon Gum (*Eucalyptus salmonophloia*)) or combination of species and the prevalent community structure (i.e. woodland, shrubland, etc.). The vegetation boundaries were mapped utilising high quality colour aerial photography (year of capture: 2012) and from vegetation boundaries recorded on GPS during the field survey.

The vegetation classification scale used by Shepherd *et al.* (2002) was of a regional scale (WA) and therefore provided less detail than the current survey, Western Botanical (2006) and ENV (2007) assessments. The locations of some of the vegetation types mapped by Shepherd *et al.* (2002) were supplemented to include additional types within it. For example, riparian vegetation was omitted by Shepherd *et al.* (2002).

### 3.2.2 Fauna and fauna habitat

A fauna assessment was conducted for the study area over five site visits, primarily to accommodate survey area changes (Table 3-5). Initial fauna habitat and significant black cockatoo tree assessments were undertaken concurrently with the flora and vegetation field survey of the Muchea North Phase 1 survey area on 16 October to 4 November 2014. Field work comprised recording fauna habitat attributes at each vegetation quadrat, opportunistic records of conservation significant fauna and recording the location of potential breeding trees for black cockatoos.

This was followed up with a more comprehensive Level 1 fauna survey entailing further habitat assessment, targeted searches for evidence of conservation significant fauna and a complete significant black cockatoo tree survey within the entire road reserve (Phase 1 survey area) for Muchea North and Chittering in March and April 2015.

A final round of field survey was undertaken from 7-8 October 2015 in additional areas of the Phase 2 survey area that were not surveyed previously. Survey methods were consistent with the March–April 2015 survey.

A subsequent site assessment was undertaken 1 and 6 November 2015 with Tony Kirkby, a recognised subject matter expert on black cockatoos, to inspect the recorded potential breeding trees for signs of use.

Total survey effort over all survey periods was 142 person hours.

The surveys were conducted in accordance with Position Statement No. 3: *Terrestrial biological surveys as an element of biodiversity protection* (EPA 2002) and Guidance Statement No. 56: *Terrestrial fauna surveys for environmental impact assessment in Western Australia* (EPA 2004a), and represent a detailed Level 1 assessment with particular emphasis on conservation significant fauna. The survey of potential breeding trees, roosting sites and breeding/ foraging/ roosting habitat for black cockatoo species was also carried out with consideration to the EPBC Act referral guidelines for threatened black cockatoo species (DSEWPaC 2012a).



**Table 3-5 Survey timing and effort for the fauna survey in each survey area**

Section	SLKs surveyed <sup>1</sup>	Survey dates	No. person hours	Activity
Muchea North	37.11 – 46.05	16 October – 04 November 2014	16	Initial habitat assessment; potential black cockatoo breeding tree assessment.
	37.11 – 46.44	31 March – 1 April 2015	32	Fauna habitat assessment; potential black cockatoo breeding tree assessment; review of GHD (2011) findings; searches for conservation significant species.
	37.5 – 46.44	7 October 2015	24	Fauna habitat assessment; potential black cockatoo breeding tree assessment in new parts of study area.
	37.5 – 46.44	1, 6 November 2015	8	Follow up black cockatoo habitat assessment by Tony Kirkby.
Chittering	46.44 – 51.82	17 – 18 March 2015	32	Fauna habitat assessment; potential black cockatoo breeding tree assessment; review of GHD (2011) findings; searches for conservation significant species.
	46.44 – 50.61	8 October 2015	24	Fauna habitat assessment; potential black cockatoo breeding tree assessment in new parts of study area.
	46.86 – 47.01 and 47.82 – 50.61	1, 6 November 2015	6	Follow up black cockatoo habitat assessment by Tony Kirkby.
<b>Total</b>			<b>142</b>	

<sup>1</sup> SLKs varied slightly between Phase 1 and Phase 2.

### 3.2.2.1 Habitat assessment

During the field survey, fauna habitat attributes were assessed and recorded at each flora and vegetation quadrat (Figure 3-1) including habitat type, degree of connectivity, degree of disturbance and presence of rock piles, granite and large logs and debris at ground level. Soil type was also recorded with the quadrats. Habitat suitability and likelihood of occurrence was assessed for conservation significant terrestrial fauna species identified as potentially occurring from the desktop review. Fauna habitat mapping was later undertaken based on vegetation type mapping. Vegetation types with similar fauna habitat attributes were aggregated to generate fauna habitat boundaries.

### 3.2.2.2 Targeted searches for conservation significant species.

Targeted searches for conservation significant fauna species identified as potentially occurring were undertaken in the study area in areas identified with potential habitat value. Searches were conducted for direct observations of fauna and indirect evidence such as burrows, scats, tracks, bones, feathers and calls.



### 3.2.2.3 Survey of potential breeding trees, feeding sites and roosting sites for black cockatoo species

Breeding habitat for black cockatoos is defined in the EPBC referral guidelines (DSEWPaC 2012a) as “trees of species known to support breeding (Table 3-6) within the range of the species which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow. For most tree species, suitable DBH is 500 mm. For salmon gum and wandoo, suitable DBH is 300 mm.” Breeding habitat for Carnaby’s Black Cockatoo generally consists of woodland or forest; however, the species is also known to breed in former woodland or forest which is now isolated trees (DSEWPaC 2012a). Refer to Table 3-6 for known species of breeding trees.

The location of all potential breeding trees for Carnaby’s Black Cockatoo was recorded in the study area during the field survey. Both live and dead tree species known to be suitable for nesting were inspected for presence of hollows and recorded using a GPS. Species identifications were initially conducted in the field and later checked using photos and field samples.

In the follow up site visit on 1 and 6 November 2015, all potential breeding trees recorded with hollows in the previous surveys were inspected by Tony Kirkby from ground level using binoculars to identify any known nesting trees, i.e. any existing trees in which breeding has been recorded or suspected. Trees with hollows suitable for current breeding by Carnaby’s Black Cockatoo were inspected for evidence of use by the species, e.g. wear and chew marks around hollow entrance. Any tree containing a hollow which appeared suitable for Carnaby’s Black Cockatoo was raked with a pole to flush any breeding birds which may be incubating eggs or brooding a chick.

Feeding habitat quality, opportunistic records of feeding residues and evidence of night roosting were also noted during the site visit. Night roost sites are trees or groups of trees where there are records or recent evidence of night roosting. They can be identified from presence of clipped leaves and branches and droppings under suitable trees. Roosting habitat for Carnaby’s Black Cockatoo is generally in or near riparian features or natural and artificial permanent water sources. Known roosting genera include Flat-topped Yate, Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced eucalypts (e.g. Blue Gum) and introduced pines (DSEWPaC 2012a).

**Table 3-6 Known breeding trees for WA black cockatoo species (DSEWPaC 2012a)**

Species <sup>1</sup>	DBH (mm)
<i>Eucalyptus marginata</i> (Jarrah)	500
<i>Corymbia calophylla</i> (Marri)	500
<i>Eucalyptus salmonophloia</i> (Salmon Gum)	300
<i>Eucalyptus wandoo</i> (Wandoo)	300
<i>Eucalyptus rudis</i> (Flooded Gum)	500
<i>Eucalyptus loxophleba</i> subsp. <i>loxophleba</i> (York Gum)	500
<i>Eucalyptus accedens</i> (Powderbark)	500
<i>Eucalyptus camaldulensis</i> <sup>2</sup>	500

<sup>1</sup> list excludes species for which study area is outside the known species distribution, as provided in FloraBase.

<sup>2</sup> not mentioned in DSEWPaC (2012a) referral guidelines; however, is known to be used for breeding (T. Kirkby pers. comm. April 2015).



### 3.2.2.4 Mapping of breeding and foraging habitat for Carnaby's Black Cockatoo

Mapping of potential breeding and foraging habitat within the study area was undertaken utilising field survey results and quadrat data from the flora and vegetation survey.

Foraging habitat for black cockatoos is determined from the presence of plant species that are known food sources for the respective species and evidence of feeding, such as direct observation of birds or feeding residues (chewed nuts or cones). The referral guidelines (DSEWPaC 2012a) define 'quality' habitat by black cockatoo use of the habitat (as opposed to overall quality of the vegetation).

Many plant species have been recognised to be utilised as a food resource by Carnaby's Black Cockatoo (DEC 2011; DSEWPaC 2012a) but relative 'importance' of each species varies considerably. While some plants are known staple food resources for the species (e.g. several *Banksia* species), other plants have been identified from few observations.

In order to account for this variability in mapping quality foraging habitat, a rating was applied to food plant species recorded in the study area based on regional records of foraging activity. Plant species lists from vegetation quadrats of the flora and vegetation survey were initially reviewed to identify species known to be used as food (as well as breeding and roosting) by Carnaby's Black Cockatoo. Species were then rated for importance as a food resource on a scale of 1 to 10 by Tony Kirkby where a rating of 10 is highest importance and a rating of 1 is lowest importance.

The rating took into account:

- records of foraging activity from survey work undertaken by the WA Museum in the general region
- broader knowledge of core food plants for Carnaby's Black Cockatoo
- abundance of food resource, e.g. amount of seed typically produced
- seasonality of food supply, e.g. Carnaby's Black Cockatoo takes nectar from Salmon Gum and Wandoo but only for a limited period.

Vegetation types in quadrats containing known plant species were selected and percentage cover of each plant species over the quadrat was given a rating from 1–3, where:

- 1 = 0.1–19%
- 2 = 20–49%
- 3 = >50%.

The importance rating for each plant in each quadrat was then multiplied by the cover rating and the values for all plants in each quadrat summed to derive an overall quality rating for the quadrat which was assigned to one of three categories:

- 0 = no value
- 1-19 = habitat of low value
- > 20 = 'quality' habitat.

Foraging habitat value for vegetation types in the study area was then extrapolated based on the quadrat values, where vegetation polygons containing a quadrat were assigned the value of the quadrat. If there was more than one quadrat within a single polygon, the highest value was applied to the polygon. Vegetation polygons without a quadrat were extrapolated from adjacent polygons. Polygons with cleared vegetation, pasture or planted vegetation types were ignored.



It is emphasised that the rating assessment was a subjective exercise and relative importance of each species will vary between locations.

To generate an area-based map of breeding habitat, potential breeding trees identified from the field surveys were displayed over vegetation types mapped in the flora and vegetation survey. Polygons of remnant vegetation types that contained potential breeding trees were defined as 'breeding habitat in vegetation types representing remnant native vegetation'. All other potential breeding trees, many occurring as isolated trees within pastures were displayed as points only and labelled 'potential breeding trees in vegetation types not representing remnant native vegetation'.

### **3.3 TAXONOMY AND NOMENCLATURE**

Species that were well known to the survey botanist were identified in the field, while unknown and unconfirmed species were collected and assigned a unique number to facilitate tracking. All plant species collected during the field program were preserved in accordance with the requirements of the WA Herbarium.

Plant species were identified using local and regional flora keys, and comparisons with named species held at the WA Herbarium. Plant taxonomists who are considered to be an authority on a particular plant group were consulted when necessary.

The conservation status of all recorded flora was compared against the current lists available on FloraBase (DPaW 2015a), Protected Matters Database (Department of the Environment 2015) and recent changes introduced in WA Government Gazette number 166 (Western Australian Government 2015a).

Nomenclature for flora and vegetation used in this report follows that used by FloraBase (DPaW 2015a) and the WA Herbarium.

Nomenclature used for each vertebrate fauna group is as follows:

- amphibians (Tyler & Doughty 2009)
- reptiles (Wilson & Swan 2013)
- birds (Christidis & Boles 2008)
- mammals (Menkhorst & Knight 2011).

Some taxonomy and nomenclature for species records from previous surveys used in the review has been updated with the publications above for consistency.



### 3.4 SURVEY PERSONNEL

The personnel involved in the survey are presented below (Table 3-7).

**Table 3-7      Project team**

Name	Qualifications	Role/s
Mrs Karen Crews	BSc (Env. Biol.) (Hons)	Project Manager, report review
Dr Grant Wells	PhD (Botany)	Field surveys, flora taxonomy, data analyses and report writing
Dr Grace Wells	PhD (Plant Conservation)	GIS, vegetation mapping and report writing
Dr Andrew Batty	PhD (Botany)	Field surveys, flora taxonomy, vegetation mapping
Ms Sophie Fox	BSc (Env. Sci.)	Flora taxonomy
Ms Emily Ager	BSc (Nat. Res. Mgmt.) (Hons)	Field surveys and flora taxonomy
Mr Ryan Ellis	Dip (Cons. Land Mgmt.)	Field surveys and fauna taxonomy
Ms Anna Leung	BSc (Env. Sci.) (Hons)	Field surveys, fauna taxonomy and report writing
Mr Tony Kirkby		Field survey (black cockatoo assessment)

## 4 EXISTING ENVIRONMENT

### 4.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) defines 'bioregions' as large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems (Thackway & Cresswell 1995a). They categorise the large-scale geophysical patterns that occur across the Australian continent that are linked to fauna and flora assemblages and processes at the ecosystem scale (Thackway & Cresswell 1995a).

WA contains 26 IBRA bioregions and 53 subregions. The study area falls within the Swan Coastal Plain and Jarrah Forest bioregions (Figure 4-1). The Swan Coastal Plain bioregion covers an area of 1,781,563 km<sup>2</sup> and is divided into two subregions; Perth (SWA2) covering 1,333,901 ha and Dandaragan (SWA1) covering 447,862 ha (Department of the Environment 2014b; Desmond 2001). The Jarrah Forest Bioregion covers an area of 5,416,026 ha and is divided into two subregions; Northern Jarrah Forest (JF1) covering 2,255,904 ha and Southern Jarrah Forest (JF2) covering 3,160,122 ha. The study area spans the Perth, Dandaragan and Northern Jarrah Forest subregions.

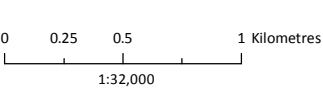
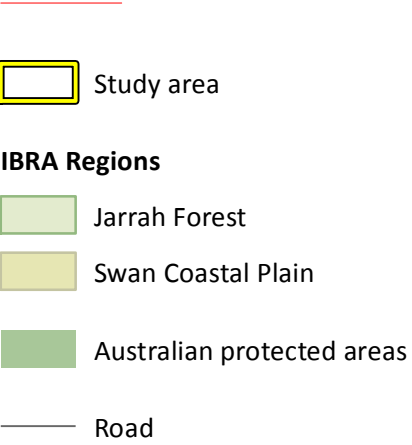
The Dandaragan subregion is a plateau bordered by the Derby and Dandaragan faults with Cretaceous marine sediments mantled by sands and laterites. Vegetation is characterised by *Banksia* low woodland, Jarrah (*Eucalyptus marginata*)-Marri (*Corymbia calophylla*) woodland and scrub-heaths on laterite pavement and gravelly sandplains (Desmond 2001). Special values include rare vertebrate fauna including Peregrine Falcon, Malleefowl, Carnaby's Black Cockatoo, Western Quoll and South-western Carpet Python, a large number of rare flora and a degree of floristic endemism.

The Perth subregion is composed of colluvial and aeolian sands, coastal limestone and alluvial river flats. Limestone supports heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands. *Banksia* and Jarrah-*Banksia* woodlands occur on Quaternary marine dunes and Marri woodlands in alluvial flats (Mitchell *et al.* 2002). Special values of the subregion include rare landscape features such as Holocene dunes and wetlands, TECs (e.g. tumulus springs), refugia for relictual species (e.g. thrombolite communities), high degree of species diversity and a large number of threatened flora.

The Northern Jarrah Forest subregion incorporates the area east of the Darling Scarp, overlying Archaean granite and metamorphic rocks capped by an extensive lateritic duricrust (Williams & Mitchell 2001). Vegetation comprises Jarrah-Marri forest in the west with Bullich (*Eucalyptus megacarpa*) and Blackbutt (*E. patens*) in the valleys grading to Wandoo (*E. Wandoo*) and Marri woodlands in the east with Powderbark (*E. accedens*) on breakaways. Extensive but localised sand sheets support *Banksia* low woodlands. Heath is found on granite rocks and as a common understorey of forests and woodlands in the north and east. Rare features include extensive native forest cover and refugia for threatened bird translocation sites, populations of critical weight range mammals (native species that have been most impacted by introduced predator species; 35–5,500 g (Johnson & Isaac 2009)), granite outcrops and Wandoo or Wandoo-Powderbark woodlands in the eastern zone with associated flora and fauna (Williams & Mitchell 2001).

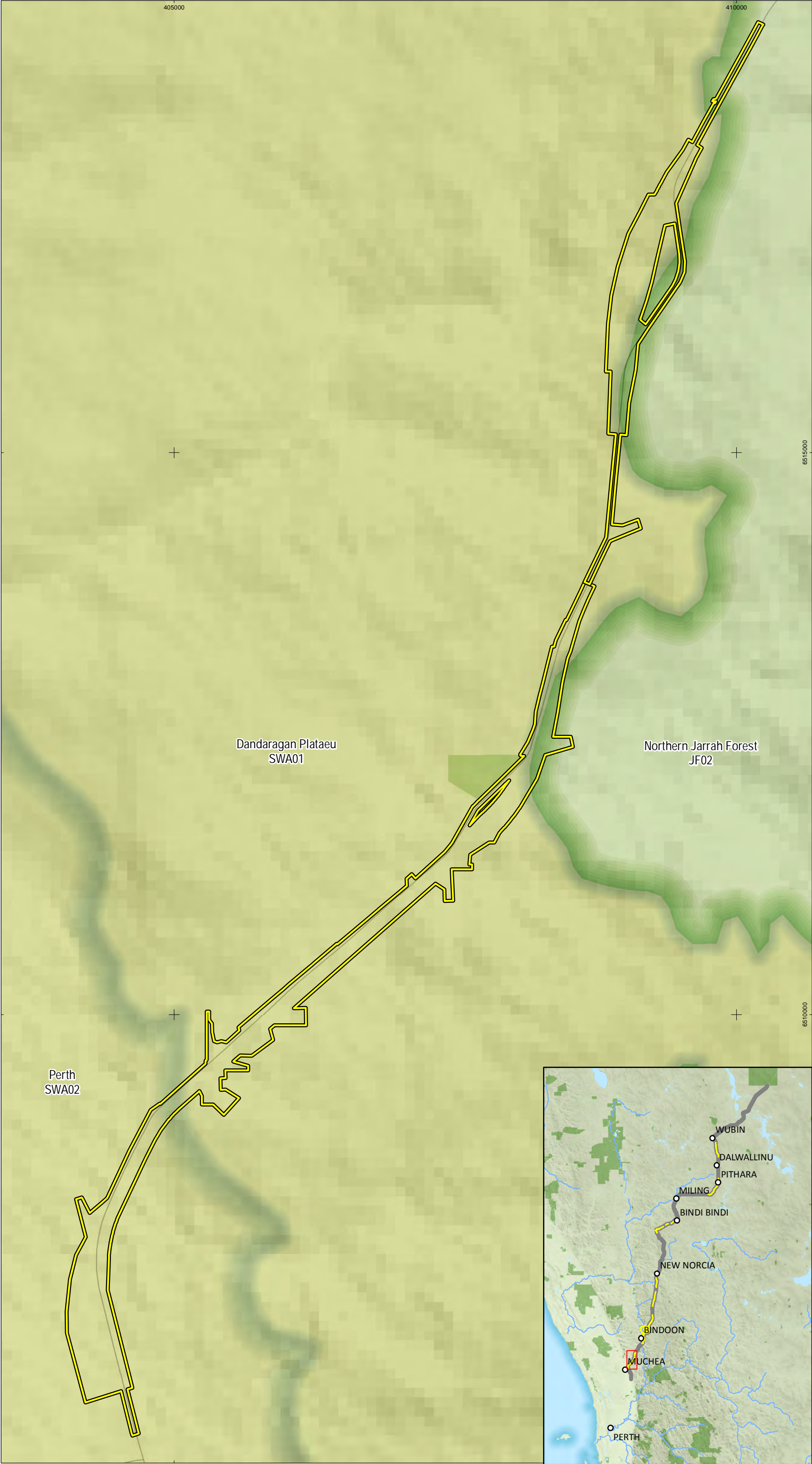


Figure 4–1  
IBRA regions of the study area



Client: Jacobs  
Project: Great Northern Highway –  
Muchea to Wubin (Stage 2) Upgrades  
Author: G. Wells  
Date: 21/12/2015

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

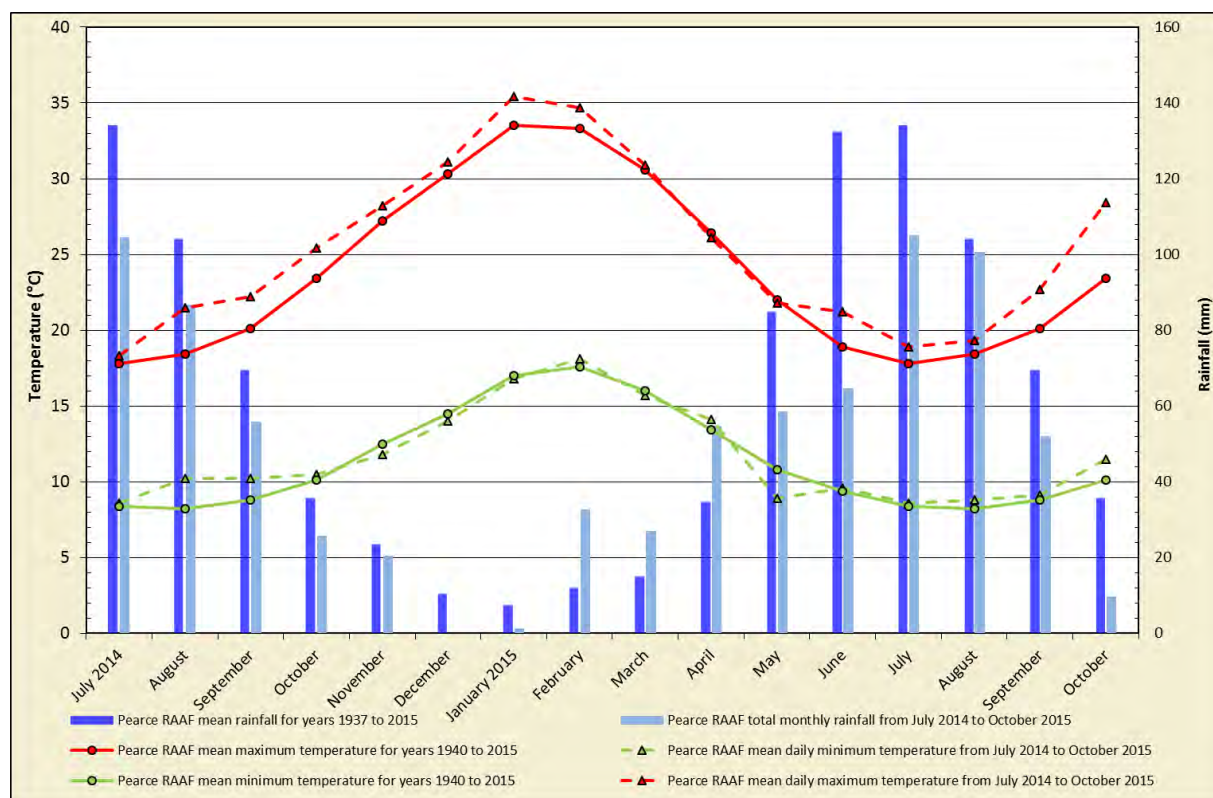


## 4.2 CLIMATE AND WEATHER

The climate of the Swan Coastal Plain and Jarrah Forest bioregions is warm Mediterranean. In general, the study area experiences warm dry summers and cool wet winters.

The nearest BoM weather station to the southern end of the study area is located at Pearce Royal Australian Air Force (RAAF) (Latitude: 31.67°S Longitude: 116.02°E) approximately 10 km south of Muchea. Pearce RAAF records the highest maximum mean monthly temperature (33.5°C) in January and the lowest maximum mean monthly temperature (17.8°C) in July and an average annual rainfall of 680.2 mm, of which most falls within a well defined wet season in winter (BoM 2015) (Figure 4-2).

Daily maximum temperatures in the months leading up to and during the spring 2014 and spring 2015 survey periods were mostly above average with the exception of April and May 2015 where they were close to the average (Figure 4-2). Minimum temperatures fluctuated between above and below the long term average for Pearce. Monthly rainfall at Pearce RAAF was mostly below average leading up to and throughout the survey period, but was above average in February, March and April 2015 (Figure 4-2).



**Figure 4-2** Climate data (average monthly temperatures and rainfall records) and recent observations prior to the field survey for Dalwallinu (BoM 2015)

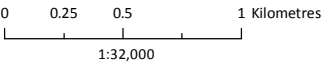
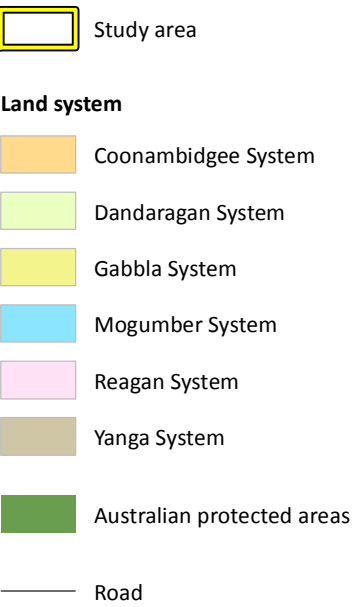


### 4.3 LAND SYSTEMS

The Department of Agriculture and Food WA has mapped the land systems from aerial photography. Land systems are grouped according to a combination of landform, soils, vegetation and drainage patterns. The study area comprises predominantly four land systems (Figure 4-3):

- **Reagan System (140.0 ha; 46% of the study area)** – Gentle slopes from the Dandaragan plateau to the Pinjarra plain. Brown, yellow and pale sands that may be shallow to very deep with clay or duricrust underlying. Variable low woodland and shrubland of *Eucalyptus*, *Banksia* and *Acacia*.
- **Mogumber System (119.7 ha; 40%)** – Gentle to moderate sloping sandplain, varying from pale to yellow clayey sand with gravel and laterised ridges. Low woodland and shrubland of, *Corymbia calophylla*, *Banksia* and *Acacia* spp. Some tall *C. calophylla* and *Eucalyptus marginata*.
- **Yanga System (36.8 ha; 12%)** – Poorly drained plain with pale sands and deep sandy duplex, wet, semi-wet and saline wet soils. *Banksia*-pricklybark-marri-swamp, sheoak-paperbark woodlands.
- **Dandaragan System (6.3 ha; 2%)** – Subdued dissected lateritic plateau, undulating low hills and rises with narrow alluvial plains. Variable deep sands and sandy gravels plus minor earths, duplexes and clays. Marri woodlands and shrublands.

Figure 4–3  
Land systems of the study area



Client: Jacobs  
Project: Great Northern Highway –  
Muchea to Wubin (Stage 2) Upgrades  
Author: G. Wells  
Date: 17/12/2015

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





## 4.4 NATIVE VEGETATION EXTENT AND STATUS

The study area lies within the Avon Botanical District of the South-West Botanical Province that covers 93,520 km<sup>2</sup> and is broadly characterised by scrub-heath on sandplain, *Acacia-Casuarina* thickets on ironstone gravels, woodlands of York gum (*Eucalyptus loxophleba*), Salmon gum (*Eucalyptus salmonophloia*) and Wandoo (*Eucalyptus wandoo*) on loams, halophytes on saline soils (Beard 1990). While within the Avon Botanical District, the Muchea North and Chittering study area borders with the Darling Botanical District and Dale Botanical Subdistrict which are characterised by Jarrah (*Eucalyptus marginata*) forest on ironstone gravels, Marri-Wandoo (*Corymbia calophylla* - *Eucalyptus wandoo*) woodlands on loamy soils, sclerophyll understoreys. Jarrah forest and Marri-Wandoo woodlands are prevalent in the study area rather than woodlands of York Gum and Salmon Gum.

A vegetation type is considered under represented if there is less than 30% of its original distribution remaining. Several key criteria are applied to vegetation clearing from a biodiversity perspective, as follows (EPA 2000):

- the 'threshold level' below which species loss appears to accelerate exponentially within an ecosystem level is regarded as being at a level of 30% (of the pre-European, i.e. pre 1750 extent of the vegetation type)
- a level of 10% of the original extent is regarded as being a level representing Endangered
- clearing which would result in an increase in the threat level such that it changes the assigned remaining status classification (see below) should be avoided.

Shepherd *et al.* (2002) have assigned the status of vegetation remaining (to pre-European extent) into five classes:

- Presumed Extinct – probably no longer present in the bioregion
- Endangered<sup>3</sup> – <10% of pre-European extent remains
- Vulnerable<sup>3</sup> – 10-30% of pre-European extent exists
- Depleted<sup>3</sup> – >30% and up to 50% of pre-European extent exists
- Least Concern – >50% pre-European extent exists and subject to little or no degradation over a majority of this area.

Regional vegetation mapping by Shepherd *et al.* (2002) identifies four vegetation types within the study area (Figure 4-4):

- 3 'Medium forest; Jarrah (*Eucalyptus marginata*) - Marri (*Corymbia calophylla*)' (68% remaining)
- 4 'Medium woodland; Marri (*Corymbia calophylla*) & Wandoo (*Eucalyptus wandoo*)' (28% remaining)
- 1020 'Mosaic: Medium forest; Jarrah (*Eucalyptus marginata*) - Marri (*Corymbia calophylla*) / Medium woodland; Marri (*Corymbia calophylla*) - Wandoo (*Eucalyptus wandoo*)' (28% remaining)
- 1027 'Mosaic Medium open woodland Jarrah (*Eucalyptus marginata*) - Marri (*Corymbia calophylla*) with low woodland Banksia/medium sparse woodland Jarrah (*Eucalyptus marginata*) - Marri (*Corymbia calophylla*)' (59% remaining).

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<sup>3</sup> or a combination of depletion, loss of quality, current threats and rarity gives a comparable status.

Based on Shepherd *et al.* (2002), in terms of extent of vegetation remaining compared to pre-European extents, none of the vegetation types were considered 'Endangered'. Of the four vegetation types mapped in the study area, two are classed as 'Vulnerable' (4 and 1020) and two as 'Least Concern' (3 and 1027).

## 4.5 CONSERVATION RESERVES

Twelve reserves listed in the Collaborative Australian Protected Area Database are located within 10 km of the study area, including 11 nature reserves (Table 4-1). They range in size from 4 ha to 322 ha. The closest reserve, Barracca Nature Reserve (17 ha), borders GNH between SLK 44.22 and 44.79 (Figure 4-4).

**Table 4-1 Protected areas within 10 km of the study area**

Name	Type	Area (ha)	Proximity to study area
Barracca	Nature Reserve	17.79	West adjacent between SLK 44.22 and 44.79
Breera Road	Nature Reserve	107.83	9.5 km NW of SLK 96
Bullsbrook	Nature Reserve	119.57	East adjacent to SLK 30
Burroloo Well	Nature Reserve	10.73	West adjacent to SLK 54 (Chittering study area)
Chandala	Nature Reserve	145.88	6 km NW of SLK 41
Chittering Lakes	Nature Reserve	231.17	East and west adjacent to SLK 51 (Chittering study area, Bindoon survey area)
Neaves Road	Nature Reserve	9.13	7 km W of SLK 28
Unnamed WA02336	Nature Reserve	10.86	2.5 km W of SLK 36
Unnamed WA44622	Nature Reserve	4.05	4 km W of SLK 36
Unnamed WA44713	5(1)(g) Reserve	5.95	1 km W of SLK 61
Unnamed WA46564	Nature Reserve	23.17	4.5 km E of SLK 31
Unnamed WA50678	Nature Reserve	163.58	8.5 km W of SLK 49





## 5 RESULTS

### 5.1 SURVEY LIMITATIONS

The limitations of the surveys have been considered in accordance with the potential survey limitations listed in Guidance Statement 51 (EPA 2004b) and Guidance Statement 56 (EPA 2004a) (Table 5-1).

**Table 5-1 Limitations and constraints associated with the field survey**

Variable	Impact on survey outcomes
Availability of contextual information	<p><b>Slight constraint.</b> Existing information on the vegetation and land systems of the study area has been mapped by Shepherd <i>et al.</i> (2002).</p> <p>Access to online floristic records and information including previous studies undertaken on or in close proximity to the study area provided adequate information on the vegetation of the study area.</p> <p>Few existing systematic fauna surveys were available within close proximity to the study area; however, this is not considered a major constraint due to condition of habitat present.</p>
Access problems	<p><b>Not a constraint.</b> No access problems were encountered during the field survey and the majority of the study area (open paddocks excepted) was traversed by foot.</p>
Experience levels	<p><b>Not a constraint.</b> The survey was undertaken by suitably qualified and experienced botanists and zoologists.</p>
Timing, weather, season	<p><b>Not a constraint.</b> According to EPA Guidance Statement 51 the preferred flora survey time in the bioregion is spring. Two detailed surveys were conducted in spring 2014 and 2015 when the majority of quadrats were surveyed. Some areas were surveyed in other seasons to coincide with individual plant species flowering times.</p> <p>There were no constraints from a fauna survey perspective.</p>
Disturbances	<p><b>Slight constraint.</b> Large sections of the study area were in degraded to completely degraded condition from multiple historical disturbances particularly clearing and weed infestation making it difficult to discern changes in vegetation type in some areas.</p>
Survey intensity	<p><b>Not a constraint.</b> The field program was conducted primarily over two seasonal survey events for a total of 152 flora and 140 fauna person hours. A total of 35 quadrats and 17 relevés were sampled and most patches of remnant and planted vegetation encompassed by the study were traversed by foot in search of conservation significant flora and fauna.</p> <p>Targeted searches for conservation significant flora and fauna were conducted in all areas considered to have potential to provide suitable habitat. Additional flora searches were conducted outside study area in the vicinity of conservation significant flora records to determine the extent of populations.</p> <p>The black cockatoo breeding tree, roosting site and breeding/ foraging/ roosting habitat assessment was conducted for the entire study area.</p>
Completeness	<p><b>Slight constraint.</b> In the areas surveyed in spring 2014 and 2015 some annual species may have been missed (e.g. orchids), Some of the species are very short lived and presence may depend on climatic conditions particularly the amounts of rainfall.</p> <p>The fauna survey was focussed on identifying the potential for presence of conservation significant species in the study area. Systematic censusing of the fauna assemblage was not</p>



Variable	Impact on survey outcomes
	undertaken but this is consistent with other surveys for similar linear infrastructure projects in the region.
Determination	<b>Not a constraint.</b> Determinations regarding taxonomy and conservation status of flora and fauna were made on the basis of current classifications.

## 5.2 DESKTOP REVIEW

### 5.2.1 Flora and vegetation

#### 5.2.1.1 Conservation significant flora

The desktop and literature review identified a total of 33 conservation significant species (Table 5-2). Of these, 17 are listed as Threatened under the EPBC Act, including one Critically Endangered (CR), 14 Endangered and two Vulnerable (VU). Eighteen species are listed as protected flora under the WC Act, including all the EPBC Act-listed species. Under the current State classifications, six species are Critically Endangered (S1), seven are Endangered (S2) and five are Vulnerable (S3) (Table 5-2).

A further 15 species are listed as Priority Flora by DPaW (2015c), one Priority 1, three Priority 2, six Priority 3 and five as Priority 4 (Table 5-2).

From the combined State database searches and literature review, seven conservation significant flora were identified to occur within the study area, five were identified within 1 km and four within 2 km (Table 5-2).

**Table 5-2 Conservation significant flora species identified from the desktop review**

Species name	Common name	Reference	EPBC Act Threatened species	WC Act protected flora	DPaW list	Approximate distance to study area (km)
<i>Acacia anomala</i>	Grass Wattle	DPaW 2014c, NatureMap, Protected Matters	T (EN)	S3 (VU)		Species or species habitat may occur
<i>Acacia drummondii</i> subsp. <i>affinis</i>		DPaW 2014c, NatureMap, Ecologia 2004, GHD 2010, Western Botanical 2006			P3	Within study area
<i>Acacia pulchella</i> var. <i>reflexa</i> (acuminate bracteole variant)		Western Botanical 2006			P3	Within study area
<i>Andersonia gracilis</i>	Slender Andersonia	Protected Matters	T (VU)	S3 (VU)		Species or species habitat may occur
<i>Anigozanthos viridis</i> subsp. <i>terraspectans</i>	Dwarf Green Kangaroo Paw	Protected Matters	T (EN)	S3 (VU)		Species or species habitat may occur
<i>Caladenia huegelii</i>	King Spider-orchid, Grand Spider-orchid	Protected Matters	T (EN)	S1 (CR)		Species or species habitat may occur
<i>Chamaescilla gibsonii</i>		NatureMap			P3	Within 1 km
<i>Chamelaucium</i> sp. Gingin (N.G.Marchant 6)	Gingin Wax	Protected Matters	T (EN)	S3 (VU)		Species or species habitat may occur
<i>Conospermum densiflorum</i> subsp. <i>unicephalum</i>	One-headed Smokebush	Protected Matters	T (EN)	S2 (EN)		Species or species habitat may occur
<i>Cyathochaeta teretifolia</i>		DPaW 2014c			P3	Within 2 km
<i>Darwinia foetida</i>	Muchea Bell	DPaW 2014c, Protected Matters	T (CE)	S2 (EN)		Species or species habitat may occur
<i>Daviesia debilior</i> subsp. <i>sinuans</i>		Western Botanical 2006			P3	Within study area
<i>Diuris micrantha</i>	Dwarf Bee-orchid	Protected Matters	T (VU)	S2 (EN)		Species or species habitat may occur
<i>Diuris purdiei</i>	Purdie's Donkey-orchid	Protected Matters	T (EN)	S2 (EN)		Species or species habitat may occur
<i>Eucalyptus x balanites</i>	Cadda Road Mallee, Cadda Mallee	Protected Matters	T (EN)	S1 (CR)		Species or species habitat may occur
<i>Eucalyptus leprophloia</i>	Scaly Butt Mallee, Scaly-butt Mallee	Protected Matters	T (EN)	S2 (EN)		Species or species habitat may occur



Species name	Common name	Reference	EPBC Act Threatened species	WC Act protected flora	DPaW list	Approximate distance to study area (km)
<i>Grevillea althoferorum</i> subsp. <i>fragilis</i>		DPaW 2014c		S1 (CR)	T	Within 2 km
<i>Grevillea corrugata</i>		Protected Matters	T (EN)	S3 (VU)		Species or species habitat may occur
<i>Grevillea curviloba</i> subsp. <i>curviloba</i>	Curved-leaf Grevillea	DPaW 2014c, Protected Matters	T (EN)	S1 (CR)		Species or species habitat may occur
<i>Grevillea curviloba</i> subsp. <i>incurva</i>	Narrow curved-leaf Grevillea	DPaW 2014c, Protected Matters	T (EN)	S2 (EN)		Species or species habitat may occur
<i>Hibbertia glomerata</i> subsp. <i>ginginensis</i>		DPaW 2014c, NatureMap			P1	Within 1 km
<i>Hypolaena robusta</i>		DPaW 2014c			P4	Within 2 km
<i>Jacksonia pungens</i>	Pungent Jacksonia	Protected Matters	T (EN)	S1 (CR)		Species or species habitat may occur
<i>Leucopogon cymbiformis</i>		NatureMap			P2	Within 1 km
<i>Millotia tenuifolia</i> var. <i>laevis</i>		GHD 2010			P2	Within study area
<i>Persoonia sulcata</i>		GHD 2010			P4	Within study area
<i>Stylidium squamellosum</i>	Maize Trigger Plan	DPaW 2014c, NatureMap			P2	Within study area
<i>Stylidium striatum</i>	Fan-leaved Triggerplant	NatureMap			P4	Within 1 km
<i>Synaphea grandis</i>		DPaW 2014c			P4	Within 2 km
<i>Thelymitra dedmaniarum</i>	Cinnamon Sun Orchid	Protected Matters	T (EN)	S1 (CR)		Species or species habitat may occur
<i>Thelymitra stellata</i>	Star Sun-orchid	DPaW 2014c, NatureMap, Protected Matters, Ecologia 2004	T (EN)	S2 (EN)		Species or species habitat may occur
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>		DPaW 2014c, NatureMap, Ecologia 2004, KBR 2005, Western Botanical 2005			P4	Within study area
<i>Verticordia serrata</i> var. <i>linearis</i>		DPaW 2014c, NatureMap, Ecologia 2004			P3	Within 1 km

### 5.2.1.2 Introduced flora

The search of the NatureMap and DPaW (2015a) databases identified records for four weed species within 1 km of the study area (Table 5-3). One of these, *Chondrilla juncea*, is declared plant and another, *Genista linifolia*, is a Weed of National Significance (WoNS).

Six declared plants and/or a WoNS have been previously recorded in the road reserve of Muchea North (Ninox Wildlife Consulting 1989; Western Botanical 2006) and Chittering (Western Botanical 2006):

- Ninox Wildlife Consulting (1989) noted five declared plants along the GNH road reserve (Muchea North): *\*Moraea flaccida*, *\*Moraea miniata*, *\*Echium plantagineum*, *\*Oxalis pes-caprae* and *\*Carthamus lanatus*
- Western Botanical (2006) recorded one declared plant (Muchea North and Chittering) *\*Tamarix aphylla* between SLK 37.2-45.0.

**Table 5-3 Weed species recorded within 1 km buffer of study area**

Species	Common name	Declared plant	WoNS	Reference
<i>*Arctotheca calendula</i>	Cape Weed	No	No	DPaW (2015a)
<i>*Chondrilla juncea</i>	Skeleton Weed	Yes (C2 Eradication) <sup>1</sup>	No	NatureMap, DPaW (2015a)
<i>*Euphorbia terracina</i>	Geraldton Carnation Weed	No	No	NatureMap, DPaW (2015a)
<i>*Genista linifolia</i>	Flaxleaf Broom	No	Yes	NatureMap, DPaW (2015a)
<i>*Tamarix parviflora</i>		No	No	NatureMap, DPaW (2015a)

<sup>1</sup> Control measures in brackets.

### 5.2.1.3 Vegetation

No Commonwealth or State listed TECs nor any PECs intersect the study area; however, there are five TECs recorded in close proximity to the GNH between Bullsbrook and Bindoon (Table 5-4; Figure 5-1). Four are listed under the EPBC Act and all are listed as TECs under State criteria. Three PECs also occur in close proximity to the study area (Table 5-4; Figure 5-1).



**Table 5-4 Threatened and Priority Ecological Communities recorded in the vicinity of the study area**

Community identification	Community name	TEC (State criteria)	TEC (EPBC Act)	PEC	Nearest location
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	CR	EN		900 m west of Muchea North SLK 36.07
SCP3c	<i>Eucalyptus calophylla</i> - <i>Xanthorrhoea preissii</i> woodlands and shrublands, Swan Coastal Plain	CR	EN		4.5 km south of Muchea North SLK 33.13
Muchea Limestone	Shrublands and woodlands on Muchea Limestone	EN	EN		200 m west of Muchea North SLK 36.53
SCP20a	<i>Banksia attenuata</i> woodland over species rich dense shrublands	EN			3 km west of Chittering SLK 48.46
SCP07	Herb rich saline shrublands in clay pans	VU	CR		1.3 km south of Muchea North SLK 33.13
Banksia yellow-orange sands	<i>Banksia</i> woodland of the Gingin area restricted to soils dominated by yellow to orange sands			P2	2 km west of Chittering SLK 48.46
SCP23b	Swan Coastal Plain <i>Banksia attenuata</i> - <i>Banksia menziesii</i> woodlands			P3	1.2 km east and west of Muchea North SLK 41.67
SCP25	Southern <i>Eucalyptus gomphocephala</i> - <i>Agonis flexuosa</i> woodlands			P3	1.7 km southwest of Muchea North SLK 36.63

There are numerous ESAs within a 10 km radius of the study area, many of which are overlapping (Figure 4-4; Table 5-5). The ESAs encompass primarily wetland values, Threatened Flora and Bush Forever sites (Table 5-5). One nationally important wetland, Chandala Swamp (435 ha), is located 6 km north west of the study area. The section between Bullsbrook and Muchea has a number of areas recognised as ESAs, including Muchea township and the river between Muchea and GNH (approximately 0.6–1.4 km west of GNH):

- Lake Chittering/Needonga is listed as ESA because:
  - it is a Swan Coastal Plain Wetland – the lakes are within the area to which the *Environmental Protection (Swan Coastal Plain Lakes) Policy (EPP) 1992* applies
  - it is an Australian Nature Conservation Agency wetland (Directory of Important Wetlands, 1993, 1996)
- two other ESAs north of Lake Chittering/Needonga are listed because they are Swan Coastal Plain Wetlands under the Swan Coastal Plain Lakes EPP 1992.

**Table 5-5 Values associated with ESAs occurring within 10 km of the study area**

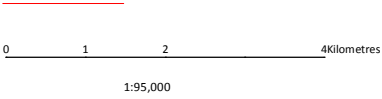
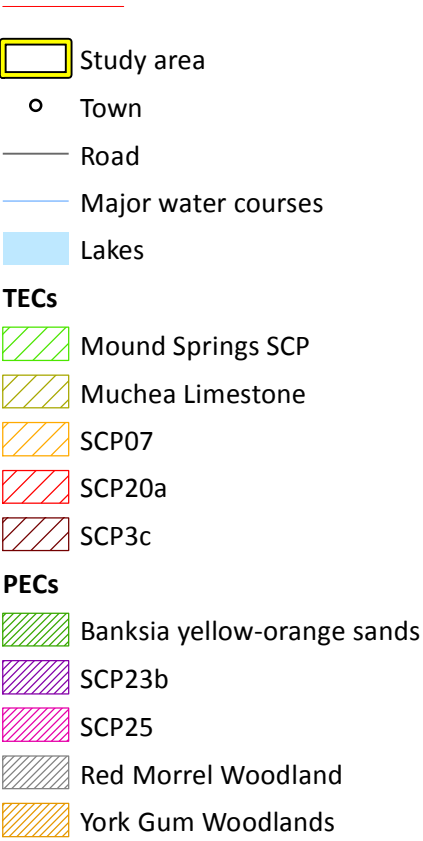
ESA ID	Values								
	SCP Lakes EPP	GM EPP	GW	Bush Forever site	DIW	DRF	RNE	TEC	WST EPP
4093						✓			
4094			✓	✓					
4098				✓					
4101			✓						
4109						✓			
4110						✓			
4116						✓			
4237			✓		✓		✓		
4242			✓						
4254			✓						
4332	✓	✓	✓	✓	✓	✓	✓	✓	✓
4968						✓			
4973						✓			
4989						✓			
5057						✓			
5058						✓			
5419						✓			

SCP Lakes EPP – *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*; GM EPP – *Environmental Protection (Gnangara Mound Crown Land) Policy 2002*; GW – Geomorphic Wetlands; DIW – Directory of Important Wetlands; DRF – Declared Rare (Threatened) Flora; RNE – Register of the National Estate<sup>4</sup>, WST EPP – *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011*.

<sup>4</sup> The Register of the National Estate was closed in 2007 and is no longer a statutory list with all references removed from the EPBC Act in February 2012. The expiration or repeal of parts of the EPBC Act does not diminish the protection of Commonwealth heritage places as these parts have been superseded by stronger ongoing heritage protection provisions under national environment law.



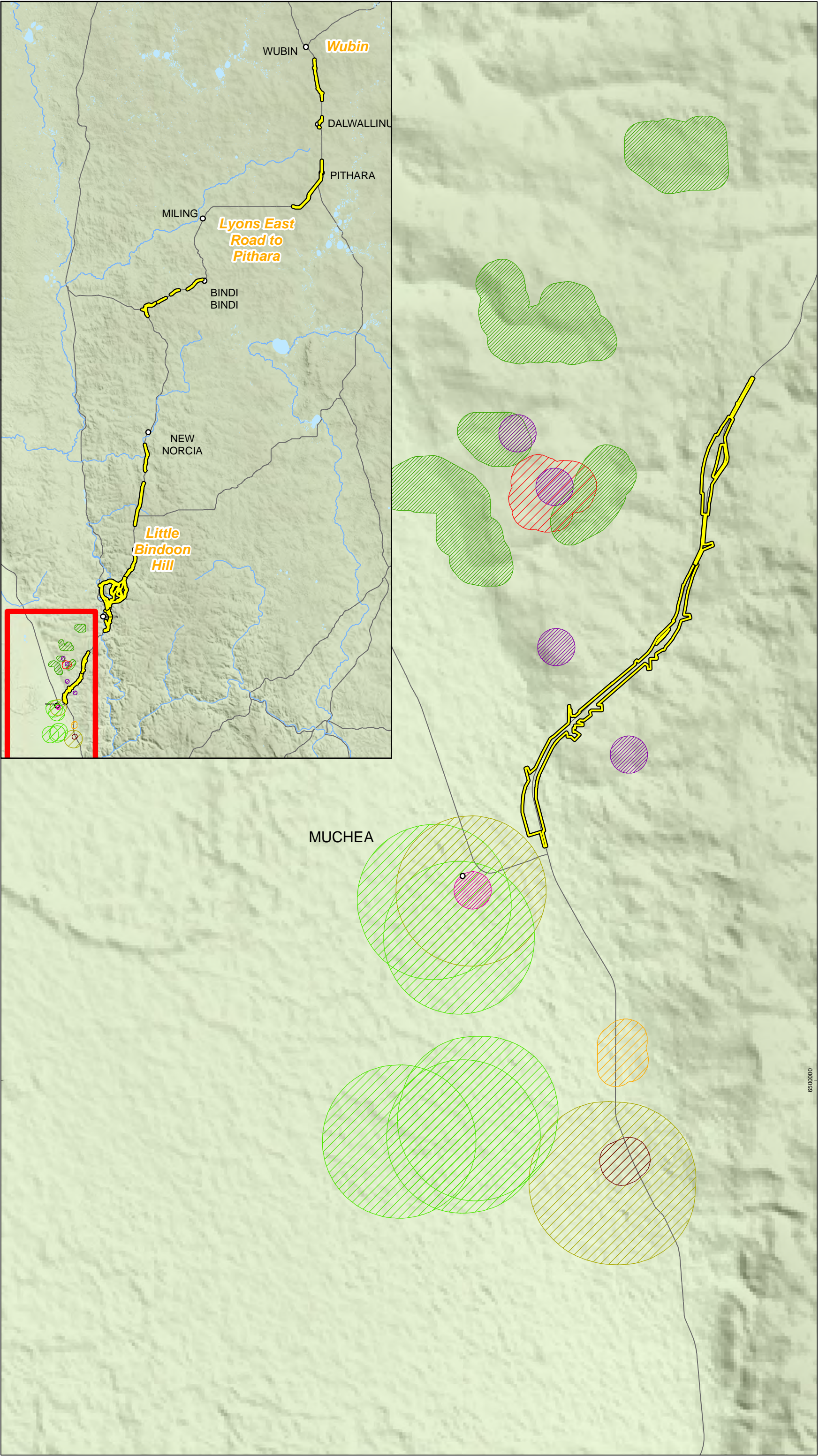
Figure 5-1  
Threatened and Priority  
Ecological Communities  
in the vicinity of the  
study area



Client: Jacobs  
Project: Great Northern Highway Upgrades - Muchea to Wubin

Author: A. Leung  
Date: 17/12/2015

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





## 5.2.2 Fauna and fauna habitat

A total of 231 fauna species, including all terrestrial vertebrate fauna and Threatened or Priority invertebrate species, were identified in database searches and the literature review (Table 5-6; Appendix 3). The review did not consider short-range endemic invertebrate fauna as they were outside the scope of works. Aquatic species have been excluded from this list.

**Table 5-6 Summary of fauna identified in desktop review for the study area**

Class	Number
Invertebrates (includes several classes)	3 <sup>1</sup>
Amphibians	11
Reptiles	35
Birds	157
Mammals	24
<b>Totals</b>	<b>232</b>

<sup>1</sup> only Threatened (EPBC Act), Protected (WC Act) and Priority invertebrate species included.

Twenty eight species from the desktop review are of conservation significance (12%) and protected by Commonwealth and/or State legislation, or listed by DPaW as Priority species (Table 5-7; Table 5-8). Two conservation significant species returned in the Naturemap searches (two Phascogale species) were excluded from the list as the records were not considered relevant to the current study area (i.e. well north of current range and outside species preferred habitat).

**Table 5-7 Summary of relevant conservation significant fauna returned from database searches**

Class	Number of species <sup>1</sup>
EPBC Act Threatened species	13
EPBC Act Migratory species	7
WC Act Protected Fauna species	19
DPaW Priority species	8

<sup>1</sup> Several species are listed under both the EPBC Act and WC Act.



**Table 5-8 Conversation significant fauna returned from database searches of potential relevance to the study area**

Scientific name	Common name	EPBC Act Threatened	EPBC Act Migratory	WC Act	DPaW
<b>Invertebrates</b>					
<i>Leioproctus contrarius</i>	bee				P3
<i>Idiosoma nigrum</i>	Shield-backed Trapdoor Spider	VU		S3 (VU)	
<i>Throscodectes xederoides</i>	Mogumber Bush Cricket				P3
<b>Reptiles</b>					
<i>Pseudemydura umbrina</i>	Western Swamp Tortoise	CR		S1 (CR)	
<i>Egernia stokesii badia</i>	Western Spiny-tailed Skink	EN		S3 (VU)	
<i>Aspidites ramsayi</i>	Woma Python (south-western)				P1
<i>Neelaps calonotos</i>	Black-striped Snake				P3
<b>Birds</b>					
<i>Leipoa ocellata</i>	Malleefowl	VU		S3 (VU)	
<i>Oxyura australis</i>	Blue-billed Duck				P4
<i>Apus pacificus</i>	Fork-tailed Swift		•	S5 (Mig.)	
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN		S2 (EN)	
<i>Ardea modesta</i>	Eastern Great Egret		•	S5 (Mig.)	
<i>Ardea ibis</i>	Cattle Egret		•	S5 (Mig.)	
<i>Plegadis falcinellus</i>	Glossy Ibis		•	S5 (Mig.)	
<i>Falco peregrinus</i>	Peregrine Falcon			S7 (SP)	
<i>Rostratula australis</i>	Australian Painted Snipe	EN	•	S2 (EN)	
<i>Actitis hypoleucos</i>	Common Sandpiper		•	S5 (Mig.)	
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU		S3 (VU)	
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	EN		S2 (EN)	
<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	VU		S2 (EN)	
<i>Ninox connivens connivens</i>	Barking Owl (southern)				P2
<i>Merops ornatus</i>	Rainbow Bee-eater		•	S5 (Mig.)	
<b>Mammals</b>					
<i>Dasyurus geoffroii</i>	Western Quoll	VU		S3 (VU)	
<i>Parantechinus apicalis</i>	Dibbler	EN		S2 (EN)	
<i>Isodon obesulus fusciventer</i>	Southern Brown Bandicoot/ Quenda				P5
<i>Macropus irma</i>	Western Brush Wallaby				P4
<i>Leporillus conditor</i>	Greater Stick-nest Rat	VU		S6 (SC)	

## 5.3 FIELD SURVEY

### 5.3.1 Flora and vegetation

A total of 273 plant taxa (including subspecies and varieties) representing 153 genera and 52 families were recorded in the study area. This total is comprised of 223 (81%) native species and 51 (19%) introduced (weed) species, and included 48 annual and 225 perennial species (Appendix 4). The density of taxa (average number per km) recorded exceeded several previous flora surveys conducted along the GNH (Table 5-9).

**Table 5-9 Comparison of floristic data from the current survey with previous flora surveys of GNH between Muchea and Wubin**

Survey	Road length (km)	Vegetation types (no.)	Taxa (no.)	Av. taxa per km	Families (no.)	Genera (no.)	Weeds (no.)
Current survey	17	20	273	16	52	153	51
ENV (ENV 2007)	25	18	357	14	59	171	44
GHD (2011c)	19	13	277	15	51	160	35
Western Botanical (2006)	68	34	316	5	52	138	26
Ninox Wildlife Consulting (1989)	217	19	300	1	59	108	40

The most prominent families recorded in the study area included the Fabaceae, Myrtaceae, Poaceae, Proteaceae, Haemodoraceae and Asteraceae (Table 5-10). Except for Haemodoraceae, the dominant families recorded were also prominent in previous flora surveys and comprised a similar proportion of the total flora collected.

**Table 5-10 Comparison of total number of species per family from the current survey with previous flora surveys**

Family	Current survey	ENV (2007)	GHD (2011c)	Western Botanical (2006)	Ninox (1989)
Fabaceae	39	50	40	64	60
Myrtaceae	29	29	27	64	40
Poaceae	26	42	14	4	15
Proteaceae	24	38	29	48	43
Haemodoraceae	18	N/A <sup>1</sup>	4	N/A <sup>1</sup>	N/A <sup>1</sup>
Asteraceae	16	22	12	5	7
<b>Taxa recorded (%)</b>	<b>55</b>	<b>51</b>	<b>45</b>	<b>59</b>	<b>55</b>

<sup>1</sup> data not available.

Six specimens (*Grevillea* sp., *Synaphea* sp., Poaceae sp. (x2), *Lepidosperma* sp. and *Haemodorum* sp.) could not be conclusively identified to species level as they lacked adequate reproductive structures. None of these species ressembled conservation significant flora.



### 5.3.1.1 Conservation significant flora

Seven conservation significant flora species (247 individual plants) were recorded in the field surveys, with records from both Muchea North and Chittering (Table 5-11; Figure 5-2). Of 24 populations of conservation significant flora recorded, 20 were located inside the current study area; the other four were located either just outside the study area boundary or in parts of the Phase 1 survey area that fall outside the current study area (Table 5-11).

Five of the taxa were also identified in the desktop review. Detailed results for each species within Muchea North and Chittering are provided in section 5.4.1.1 and 5.5.1.1.

**Table 5-11 Details of conservation significant flora recorded in the study area**

Species	Common name	Conservation status	Study area/s	No. popn's in study area	No. popn's outside study area	Total no. plants
<i>Acacia drummondii</i> subsp. <i>affinis</i>		P3	Muchea North, Chittering	9	1	99
<i>Darwinia foetida</i>	Muchea Bell	T (CE) EPBC Act, S2 (EN) WC Act	Muchea North	1	1	17
<i>Eucalyptus caesia</i>	Caesia	P4	Muchea North	1	-	1
<i>Haemodorum loratum</i>		P3	Chittering	1	-	1
<i>Stylidium squamellosum</i>	Maize Trigger Plant	P2	Muchea North	2	-	2
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>		P4	Muchea North	3	2	133
<i>Verticordia serrata</i> var. <i>linearis</i>		P3	Muchea North	2	-	2