Great Northern Highway

MAIN ROADS WESTERN AUSTRALIA

Bindoon Bypass – Northern Section (SLK 94.74 – 112.2)
Purpose Permit to Clear Native Vegetation - Supporting Information

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Issue summary

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3	13-05-2019	Final	PAG Review
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Glossary

Abbreviation	Description
AHA	*Aboriginal Heritage Act 1972*
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ASJV	Arup Jacobs Joint Venture
ASRIS	Australian Soil Resource Information System
BC Act	*Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CN	Contract Number
DBCA	Department of Biodiversity, conservation and Attractions
DWER	Department of Water and Environmental Regulation
DoEE	Department of the Environment and Energy
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Office of the Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GNH	Great Northern Highway
IBRA	Interim Biogeographic Regionalisation of Australia
LISC	Low Impact Screening List (Main Roads)
Main Roads	Main Roads Western Australia
MNES	Matters of National Environmental Significance
NVCP	Native Vegetation Clearing Permit
PAG	Project Advisory Group
SLK	Straight Line Kilometre
WoNS	Weeds of National Significance

1. Introduction

1.1 Great Northern Highway

In 2014 Main Roads Western Australia (Main Roads WA) established an Integrated Project Team (IPT), comprising Main Roads and industry partners Arup and Jacobs (combining to form Arup Jacobs Joint Venture, ASJV) to conduct a comprehensive planning review of the full Muchea to Wubin link along the Great Northern Highway (GNH). Among the improvements considered as part of the planning review were additional passing lanes, flattening crests and easing curves, safer roadsides, more rest stops and additional facilities for heavy vehicles.

The review examined the previous upgrade strategy developed in the 1990s and, having carefully considered current requirements for the safe and efficient movement of people and freight, delivered a revised upgrade strategy. The IPT then used the review to identify and prioritise construction packages to be delivered over the five-year period from 2015/16 to 2019/20.

Additional planning has been undertaken to identify the last remaining impediment to 53.5 m road train movements to Muchea; specifically, a 66 km bypass of Bindoon from Chittering Roadhouse in the south, connected to New Norcia in the north. This bypass comprises two sections: Bindoon Bypass – Southern Section (which is also referred to as the Bindoon Bypass) which forms the main bypass around the town of Bindoon, and Bindoon Bypass – Northern Section that links the bypass to recently completed road upgrades around New Norcia.

Crash history along the Bindoon Bypass – Northern Section of the GNH between 2012 and 2016 recorded five fatalities, seven hospitalisations, four medical treatment incidents, 21 incidents of major property damage, and five incidents of minor property damage. In light of this crash history and with the proposed use of 53.5 m road trains to travel between Muchea and Wubin, it was identified that the current geometry and standard of road condition along the GNH between Hay Flat Road and New Norcia was likely to negatively impact driver safety, and constrain the safe and efficient movement of all vehicles.

Without upgrading the road, safety concerns would prevent use of 53.5 m road trains and crash susceptibility would persist. Both the social imperative to improve road safety and the economic imperative to provide better freight to the State's north mean that the option to not take the action is not practicable.

This application is therefore pursuant to road upgrades in Bindoon Bypass – Northern Section. The proposed upgrade of the highway in this area is discrete and separate to the Bindoon Bypass – Southern Section. Its implementation is not dependent upon approval of the Bindoon Bypass – Southern Section.

1.2 Scope and Purpose of this Document

This document has been prepared in support of an application for a Native Vegetation Clearing Permit (NVCP—Purpose Permit) under Section 51E of Part V of the *Environmental Protection Act 1986* (EP Act), to clear up to 28 ha of native vegetation within an application area of 176 ha. The location of the proposed works and the NVCP application area are shown in **Figure 1**.

This document includes:

- an overview of the works required for the Bindoon Bypass – Northern Section alignment and description of the clearing activities to be undertaken
- an overview of the existing physical and biological environment
- the environmental management measures to be implemented to minimise potential clearing impacts
- an assessment of the proposed clearing against the ten Clearing Principles, as defined in Schedule 5 of the EP Act.

A referral to the Commonwealth Department of the Environment and Energy (DoEE) will be submitted for Bindoon Bypass – Northern Section. Main Roads is not requesting this assessment be undertaken under the provisions of the assessment bilateral agreement.

1.3 Bindoon Bypass – Northern Section

The Bindoon Bypass – Northern Section of the GNH is located approximately 100 km north east of Perth and 28 km north east of Bindoon, in the Jarrah Forest and Avon Wheatbelt bioregions. The proposed design for the Bindoon Bypass – Northern Section upgrade is located between Straight Line Kilometre (SLK) 94.74 and 112.2. South of the Bindoon Bypass – Northern Section is the Bindoon Bypass – Southern Section, the subject of a separate set of approval applications.

The Project comprises a combination of upgrades to existing portions of highway (online) and construction of new road in mostly cleared paddocks adjacent to the existing alignment (offline). The proposed design alignment was determined following several optioneering exercises and iterations aimed at identifying and then avoiding and/or minimising impacts to key environment and heritage constraints, while meeting the key Project objectives for improving the safety and efficiency of the highway.

The proposed alignment for Bindoon Bypass – Northern Section will commence at the northern extent of the Bindoon Bypass – Southern Section alignment, departing from the existing GNH near Calingiri Road, and approximately follow the existing GNH northwards to tie into the southern end of the New Norcia Bypass, 1.6 km south of New Norcia. The project is comprised of the following components:

- The Bindoon Bypass – Northern Section alignment ties into the Bindoon Bypass – Southern Section project at SLK 94.74;
- A new, offline section of road will be constructed to the east of the existing highway in predominantly cleared farmland and some remnant native vegetation between SLK 94.74 and SLK 102.0;
- At SLK 102.0 the alignment re-joins the existing GNH. The existing alignment will be upgraded through to SLK 103.7;
- The alignment then moves offline from SLK 103.7 to SLK 110.6, again to the east of the existing highway and into predominantly cleared farmland; and
- From SLK 110.6 the alignment re-joins the existing GNH until SLK 111.3, where it moves slightly offline to the west, before tying in to the completed New Norcia Bypass at SLK 112.2.

1.4 Location and Land Ownership

The tenure of the proposed application area is majority freehold and road reserve. The Bindoon Bypass – Northern Section alignment traverses a total of 70 land parcels (**Appendix A**). Land required for the Bindoon Bypass – Northern Section will be acquired by Main Roads prior to commencement of construction. Some clearing may be required on private property for ancillary items such as driveways.

Under the *Land Administration Act 1997*, Main Roads has the authority to compulsorily acquire land for works associated with the construction of the Bindoon Bypass – Northern Section of GNH. Land required for the proposed corridor alignment will ultimately be acquired by Main Roads from the individual landowners and transferred from freehold (or other) land to road reserve. As it is expected that the majority of clearing required will be carried out on land that will ultimately be owned by Main Roads at the time of the clearing, authorisation from individual land owners has not been sought at this time. To this end, no clearing will be undertaken for the purposes of this project until an approved purpose permit is in place and either of the following conditions is met:

1. The land in question has been acquired by Main Roads; or
2. Written authorisation to clear the land has been obtained from the relevant landowner(s).

2. Description of Clearing Activities

Vegetation clearing will be required for the following activities:

- construction of approximately 14.7 km of new carriageway with a 10 m wide seal on a 12 m wide formation;
- additional overtaking lanes;
- widening and an overtaking lane extension of approximately 3.4 km of the existing GNH;
- provision of new intersections to link the existing GNH (retained as a local access road) to the new sections of the GNH;
- construction and realignment of private driveways;
- upgrade and installation of culverts;
- installation of signage and line markings and removal of redundant signage;
- installation of safety barriers;
- installation of road reserve fencing; and
- potential installation of road lighting.

Laydown areas, vehicle turnaround bays and other ancillary areas required for construction of the permanent works will be located in previously cleared (paddock) areas, where practicable.

Clearing of native vegetation will be undertaken using standard earthmoving equipment, such as bulldozers, to provide a surface free of vegetative matter, though some roots may remain. Topsoil will be stripped separately to vegetation, stockpiled for later reuse in reinstatement, landscaping and revegetation activities. Where required, topsoil and vegetation stockpiles will be segregated according to their weed and *Phytophthora cinnamoni* (Dieback) status and managed through the Principal's Environmental Management Plan (PEMP) and Contractor's Construction Environmental Management Plan (CEMP).

3. Existing Environment

3.1 Climate

The NVCP application area generally experiences a warm Mediterranean climate with warm dry summers and cool wet winters (Phoenix 2019). The closest Bureau of Meteorology (BoM) weather station that collects climate data and is situated in proximity to the NVCP application area is located at Wongan Hills, about 50 km west of the Bindoon Bypass – Northern Section. The highest average monthly temperature was recorded in January (34.6°C) while the lowest average monthly temperature was recorded in July (6.6°C). The average annual rainfall is 388.2 mm, the vast majority of which falls during winter (**Table 3.1**). The BoM weather station at New Norcia, about 2 km north east of the northern extent of the Bindoon Bypass – Northern Section alignment, collects daily rainfall data. Rainfall data for 2018 and average rainfall statistics are shown on **Table 3.1**. The average annual rainfall recorded at New Norcia is 519.2 mm, significantly higher than that recorded at Wongan Hills.

Table 3.1: Climate Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wongan Hills												
Average maximum temperature (ºC)	34.6	34.1	30.9	26.5	21.6	18.2	17.1	17.9	20.7	25.2	29.2	32.5
Average minimum temperature (ºC)	17.9	18.2	16.4	13.4	9.9	7.7	6.6	6.7	7.6	10.1	13.2	15.8
Average rainfall (mm)	15.5	15.4	20.7	22.4	51.6	69.4	69.5	52.0	29.6	19.8	12.4	10.0
New Norcia												
2018 monthly rainfall (mm)	96.5	21.8	3.2	3.4	42.4	68.0	128.0	132.0	15.2	38.2	5.6	7.8
Average rainfall (mm)	11.7	13.0	21.3	25.1	67.4	97.5	96.7	78.1	47.5	30.4	14.7	11.2

3.2 Land Use

Existing land uses in the application area are agriculture, conservation and transportation (road). No additional land uses are proposed for the application area.

3.3 Soils and Landforms

The following Soil Landscape Systems occur within the project area (Purdie *et. al.*, 2004):

- Glentrome System: stripped, weathered plateau with undulating low hills and rises; loamy earths, loam, loamy gravel and some clay and rock; weathered granite and migmatite
- Julimar System: Moderately dissected areas with gravelly slopes and ridges and minor rock outcrop on the eastern side of the Darling Plateau over weathered granite and granitic gneiss. loamy gravel, shallow duplexes and pale deep sand common.
- Ranfurly System: level to gently undulating plain being a relict flood plain, partially rejuvenated; loamy earths and clay, some duplex; from alluvium;

- Udamong System: Northern Darling Range near New Norcia. Partially stripped lateritic plateau with undulating low hills to gently undulating rises. Loamy gravel, minor pale sand and clay; deep weathered granitic gneiss, gneiss and schist;
- Wannamal System: Alluvial plain and fans, brown and red loamy earths, yellow brown sandy duplexes, loamy duplexes; and
- Yarawindah System: dissected lateritic plateau with rolling to undulating low hills and undulating rises; loamy gravel, loamy earth, loamy duplex, some rock; weathered schist and some gneiss.

3.4 Flora and Vegetation

Flora and vegetation surveys were conducted over seven seasonal periods between Spring 2014 and Autumn 2018. All the survey information was collected and consolidated into a single report titled *Flora and fauna assessment for Calingiri survey area* (Phoenix 2019). Details on the survey method are provided in Section 3 of Phoenix (2019) (**Appendix B**).

The application area lies within the Avon Wheatbelt bioregion and Jarrah Forest bioregion as per the Interim Biogeographic Regionalisation for Australia (IBRA). The most northerly portion of the application area is located in the Katanning subregion of the Avon Wheatbelt bioregion and is comprised of an erosional surface of gently undulating rises to low hills with abrupt breakaways and continuous stream channels (Beecham 2001). Soils support woodlands of Wandoo, York Gum and Salmon Gum with Jam and *Casuarina* species. The remainder of the application area is located within the Northern Jarrah Forest subregion of the Jarrah Forest bioregion, which incorporates an area east of the Darling Scarp and is comprised of Jarrah-Marri forest and Marri woodlands. Sand sheets support local populations of *Banksia* low woodlands and heath.

3.4.1 Vegetation

3.4.1.1 Vegetation Types

Twelve vegetation associations have been mapped within the survey area (a large area including the application area) which exceeds the four that were mapped on the regional scale by Shepherd *et al* (2002). The majority of these vegetation associations comprise of medium woodlands of Wandoo, York Gum, Flooded Gum and/or Marri (Phoenix 2019). Approximately 26% of the survey area consists of native vegetation with approximately 74% of the survey area comprised of roads (existing GNH), cleared areas (townships, driveways, side roads), cleared and planted areas (revegetated areas) and pastures/agricultural areas (Phoenix 2019).Vegetation mapped by Phoenix (2019) comprised the following 12 vegetation associations (**Figure 3**):

- 4: Medium woodland; Marri & Wandoo
- 7: Medium woodland; York Gum (*Eucalyptus loxophleba*) and Wandoo
- 352: Medium woodland; York Gum
- 946: Medium woodland; Wandoo
- 950: Medium woodland; *Casuarina obesa*
- 973: Low forest; paperbark (*Melaleuca rhaphiophylla*)
- 999: Medium woodland; Marri
- 1034: Medium woodland; Marri, Wandoo and Powderbark
- 1132: Medium forest; Marri.
- 1182: Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*

Some of the vegetation recorded in the application area may be considered locally significant as it represents habitat for Threatened and/or Priority Flora. This vegetation was recorded to be in excellent condition and/or to have locally restricted distribution (Phoenix 2019).

The combined extent of all Phoenix surveys in relation to the proposed NVCP application area is provided in **Figure 2**.

3.4.1.2 Eucalypt Woodlands of the Western Australian Wheatbelt

On 4 December 2015 the Eucalypt Woodlands of the Western Australian Wheatbelt (Wheatbelt Woodlands) Threatened Ecological Community (TEC) was listed as a TEC under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Wheatbelt Woodlands TEC is listed as Critically Endangered and is defined in the approved conservation advice as "woodland dominated by a complex mosaic of eucalypt species with a tree or mallet form over an understorey that is highly variable in structure and composition" (Threatened Species Scientific Committee, 2015).

Phoenix assessed the vegetation of the Bindoon Bypass – Northern Section area during the Spring 2018 surveys using tools developed upon review of the diagnostic criteria presented in the conservation advice for this TEC. None of the vegetation assessed within the survey area were determined to meet the diagnostic criteria. Small areas of roadside woodland were assessed as meeting a number of the criteria (width, species composition, vegetation condition and presence of mature trees) but were determined not to be the TEC due to the highly degraded condition of the vegetation, in line with Section 3.3 of the conservation advice (Phoenix 2019).

3.4.1.3 Vegetation Condition

The condition of vegetation within the NVCP application area ranged from Completely Degraded to Excellent (**Figure 4**). A large portion (74%) of the application area passes through cleared areas (paddocks, roads and other infrastructure) classed as Completely Degraded which provides little value to fauna in terms of habitat or as ecological corridors. Of the total area bounded by the NVCP application area:

- 0.37 ha (0.3%) has been recorded as being in Excellent condition
- 4.14 ha (2.9%) as Very Good
- 9.65 ha (6.8%) as Good
- 13.56 ha (9.5%) as Degraded.

3.4.1.4 Vegetation Extent

Six of the vegetation types identified in the application area represent communities that may be considered to have regional conservation significance as they have less than 30% of their pre-European extent remaining in the context of the NVCP application area location (**Table 3.2**). The national objectives and targets for biodiversity conservation in Australia has a target to prevent clearing of ecological communities with a current extent less than 30% of the pre-European extent (Commonwealth of Australia, 2001).

Table 3.2: Vegetation Representation for Vegetation Types within the NVCP Application Area

Vegetation Association	Scale		Pre-European Extent (ha)	Current Extent (ha)	% Pre-European Extent Remaining	% Remaining in DBCA Reserves
No. 4	**Statewide**		1,054,280	287,301	**27**	24
	IBRA Region	Jarrah Forest	1,022,713	280,312	**27**	24
		Avon Wheatbelt	10,333	1,856	**18**	5
		Northern Jarrah Forest	614,201	197,804	32	31
		Katanning	10,333	1,856	**18**	5
	LGA	Shire of Victoria Plains	64,094	14,633	**23**	3
		Shire of Chittering	54,210	13,964	**26**	5
No. 7	**Statewide**		179,725	22,885	**13**	5
	IBRA Bioregion	Jarrah Forest	31,000	6,079	**20**	15
		Avon Wheatbelt	144,189	15,280	**11**	1
		Northern Jarrah Forest	31,000	6,079	**20**	15
		Katanning	144,017	15,274	**11**	1
	LGA	Shire of Victoria Plains	111,345	12,850	**12**	3
		Shire of Chittering	0	0	0	0
No. 352	**Statewide**		724,273	142,019	**20**	9
	IBRA Bioregion	Jarrah Forest	31,607	6467	**20**	23
		Avon Wheatbelt	630,578	108,888	**17**	9
		Northern Jarrah Forest	31,607	6,467	**21**	23
		Katanning	337,872	36,296	**11**	2
	LGA	Shire of Victoria Plains	3581	446	**13**	0
		Shire of Chittering	4,896	826	**17**	0
No. 946	**Statewide**		53,225	14,075	**26**	34
	IBRA Sub-region	Jarrah Forest	6,150	4,139	67	90
		Avon Wheatbelt	43,309	8,372	**19**	14
		Northern Jarrah Forest	5,719	4,030	71	92
		Katanning	37,483	6,793	**18**	16
	LGA	Shire of Victoria Plains	0	0	0	0
		Shire of Chittering	0	0	0	0

Vegetation Association	Scale		Pre-European Extent (ha)	Current Extent (ha)	% Pre-European Extent Remaining	% Remaining in DBCA Reserves
No. 950	**Statewide**		497	287	58	8
	IBRA Bioregion	Jarrah Forest	0	0	0	0
		Avon Wheatbelt	497	287	58	8
		Northern Jarrah Forest	0	0	0	0
		Katanning	359	260	73	0
	LGA	Shire of Victoria Plains	0	0	0	0
		Shire of Chittering	0	0	0	0
No. 973	**Statewide**		5,003	1,896	38	13
	IBRA Bioregion	Jarrah Forest	2,448	1,475	60	5
		Avon Wheatbelt	0	0	0	0
		Northern Jarrah Forest	242	99	41	75
		Katanning	0	0	0	0
	LGA	Shire of Victoria Plains	0	0	0	0
		Shire of Chittering	242	99	41	75
No. 999	**Statewide**		115,707	13,026	**11**	24
	IBRA Bioregion	Jarrah Forest	11,531	2,891	**25**	60
		Avon Wheatbelt	0	0	0	0
		Northern Jarrah Forest	0	0	0	0
		Katanning	0	0	0	0
	LGA	Shire of Victoria Plains	0	0	0	0
		Shire of Chittering	222	39	**17**	0
No. 1034	**Statewide**		1,823	1,129	62	57
	IBRA Bioregion	Jarrah Forest	60	38	63	0
		Avon Wheatbelt	0	0	0	0
		Northern Jarrah Forest	0	0	0	0
		Katanning	0	0	0	0
	LGA	Shire of Victoria Plains	0[1]	0	0	0
		Shire of Chittering	0[1]	0	0	0

Vegetation Association	Scale		Pre-European Extent (ha)	Current Extent (ha)	% Pre-European Extent Remaining	% Remaining in DBCA Reserves
No. 1132	**Statewide**		307	260	84.41	75
	IBRA Bioregion	Jarrah Forest	152	151	99	99
		Avon Wheatbelt	0	0	0	0
		Northern Jarrah Forest	0	0	0	0
		Katanning	0	0	0	0
	LGA	Shire of Victoria Plains	0[1]	0	0	0
		Shire of Chittering	0[1]	0	0	0
No. 1182	**Statewide**		23,437	6,133	**26**	55
	IBRA Bioregion	Jarrah Forest	11,127	4,733	43	70
		Avon Wheatbelt	0	0	0	0
		Northern Jarrah Forest	261	17	**7**	0
		Katanning	0	0	0	0
	LGA	Shire of Victoria Plains	0[1]	0	0	0
		Shire of Chittering	0[1]	0	0	0

[1] Vegetation association occurrence as outlined in this table is based on Department of Biodiversity, Conservation and Attractions datasets that give broad descriptions of occurrence within each region. Although Vegetation Associations 1034, 1132 and 1182 were not included in the Shire of Chittering or the Shire of Victoria Plains in the high-level dataset, the associations were recorded during the detailed, site-specific vegetation surveys.

3.4.2 Flora

A total of 92 conservation significant flora species, including 24 threatened species (listed under the EPBC Act and/or *Biodiversity Conservation Act 2016* [BC Act]) and 68 DBCA listed Priority flora species, were identified in the desktop and literature review undertaken by Phoenix (2019). Of these, 12 were recorded as being present within the survey area and a further three that were not identified in the desktop review, namely *Daviesia debilior* subsp. *sinuans* (P3), *Hakea chromatrope* (P1) and *Leucopogon darlingensis* subsp. *rectus* (P2), were also recorded as being present within the survey area (Phoenix 2019) (**Table 3.3** and **Figure 5**).

Table 3.3: Conservation Significant Flora Recorded (Phoenix 2019)

Scientific name	Conservation Category	Total number of populations	Total number of plants
Acacia anarthros	Priority 3	1	1
Acacia drummondii subsp. *affinis*	Priority 3	2	72
Banksia serratuloides subsp. *serratuloides*	Vulnerable (EPBC Act; BC Act)	1	22
Calothamnus pachystachyus	Priority 4	2	178
Conospermum densiflorum subsp. *unicephalatum*	Endangered (EPBC Act; BC Act)	1	2
Daviesia debilior subsp. *sinuans*	Priority 3	1	1
Grevillea drummondii	Priority 4	2	76
Hakea chromatropa	Priority 1	1	15
Hibbertia miniata	Priority 4	1	15
Hibbertia montana	Priority 4	1	1
Leucopogon darlingensis subsp. *rectus*	Priority 2	1	1
Melaleuca sclerophylla	Priority 3	1	1
Persoonia sulcata	Priority 4	1	1
Synaphea grandis	Priority 4	1	1
Synaphea rangiferops	Priority 2	1	9

One location of One-headed Smokebush (*Conospermum densiflorum* subsp. *unicephalatum*) was observed close to the NVCP application area (**Figure 5**). Proposed clearing activities will be greater than 50 m away from this location, therefore negating the need for the Project to obtain a Threatened Flora Permit to Take. In adddition, regionally important populations of this species as listed in the Conservation Advice (DoEE 2015) will not be affected by proposed clearing activities.

There may be some clearing of habitat within a 200 m radius of the occurrence of *Conospermum densiflorum* subsp. *unicephalatum*. The Interim Recovery Plan for *C. densiflorum* subsp. *unicephalatum* (Patten, J. and G. Broun, 2004) identifies that vegetation within 200 m of known occurrences may be considered critical habitat. However, clearing that will occur within 200m of one of the occurrences will be occurring on the eastern side of the road, and the occurrence is on the western side of the road. With the critical habitat area already truncated by the current route of the Great Northern Highway, additional clearing within 200 m of the occurrence, but separated by the road, is not expected to have any significant impact on *C. densiflorum* subsp. *unicephalatum*.

Table 3.4: *Conospermum densiflorum* subsp. *unicephalatum* Impact Assessment to Critical Habitat

Habitat critical to the survival of the species (Patten, J. and G. Broun, 2004)	Impact Assessment
The area of occupancy of known populations	The closest location of this species is approximately 130 m north, outside of the NVCP application area.
Areas of similar habitat within 200 m of known populations, i.e. gravel or clay soils that support heathland consisting of *Dryandra* spp. and *Allocasuarina campestris* (these provide habitat for natural range extension)	Vegetation association 1034 that supports *Conospermum densiflorum* subsp. *unicephalatum* is bisected by the existing GNH and access tracks. Clearing of this vegetation association will be conducted on the roadside opposite to, and approximately 130 m south of, the existing location of this species.
Remnant vegetation that surrounds or links several populations (this is necessary to allow pollinators to move between populations)	There are no known linkages between populations. Only one location of this species was observed within the NVCP application area.
Additional occurrences of similar habitat that do not currently contain the taxon but may have done so in the past (these represent possible translocation sites)	Vegetation association 1034 extends south along the existing GNH. There is approximately 1.88 ha likely to be cleared, with the majority of this on the eastern side of the existing GNH. There are no historic records of the species identified from government records within this area (Phoenix 2019). A total of 51.3 ha of vegetation association 1035 was recorded in the survey area by Phoenix (2019).
Any potential translocated populations	No translocation sites are known to occur within either the application area or the broader survey area.

Based on the outcomes of **Table 3.4**, it is expected that the project will not impact on *Conospermum densiflorum* subsp. *unicephalatum* or habitat critical to the survival of the species.

3.4.3 Weeds

A total of 52 weed species were recorded for the Bindoon Bypass – Northern Section area, one of which is declared plant and Weed of National Significance (WoNS) **Asparagus asparagoides*. This was recorded in the southern portion of the survey area (**Figure 5**). No other declared plant species or WoNS were observed during the survey.

3.5 *Phytophthora* Dieback

Phytophthora cinnamomi (Dieback) is an introduced plant pathogen targeting the roots of susceptible plants, common in the south west of WA where the mean annual rainfall exceeds 400 mm (Department of the Environment, 2014). It is considered that Dieback may pose a risk to the native vegetation within the NVCP application area, which experiences a mean annual rainfall of 519.2 mm.

A dieback survey was conducted within the NVCP application area by TerraTree in 2016. The dieback survey results indicated that the majority of the Bindoon Bypass – Northern Section assessment area is categorised as Excluded as it is predominantly cleared agricultural land with sparse remnant native vegetation that is in Degraded or Completely Degraded condition. There is a Protectable Uninfested (dieback-free) area located at the southern extent of the Bindoon Bypass – Northern Section assessment area. Another Uninfested area in Bindoon Bypass – Northern Section is Unprotectable due to its size being less than 4 ha.

3.6 Fauna and Habitat

Fauna assessments were conducted between October 2014 and March 2018 to accommodate changes to the survey area. Fauna habitat and black cockatoo tree assessments were conducted in 2015, with subsequent

surveys conducted with Tony Kirby to provide details with respect to breeding habitat for black cockatoos in January 2016 and again in November/December 2017 and March 2018. Details on the survey method are provided in Section 3.2.2 of Phoenix (2019) (Appendix B). Surveys were conducted in accordance with EPA Technical Guidance *Terrestrial Fauna Surveys* (EPA 2016) and EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Black Cockatoo, Baudin's Black Cockatoo and Forest Red-Tailed Black Cockatoo (Department of Sustainability Environment Water Populations and Communities (DSEWPaC, now DoEE) 2012).

3.6.1 Conservation Significant Fauna

The desktop review identified 26 conservation significant fauna species that may occur in the vicinity of the fauna survey area. **Table 3.5** lists those species that may occur with an assessment of their actual likelihood of occurrence.

Table 3.5: Conservation Significant Fauna Likelihood of Occurrence

Scientific Name (Common Name)	Conservation Category	Likelihood of occurrence
Birds		
Leipoa ocellata (Malleefowl)	Vulnerable (EPBC Act & BC Act)	**Unlikely** – habitat unsuitable (too degraded and fragmented)
Rostratula australis (Australian Painted Snipe)	Endangered (EPBC Act & BC Act)	**Unlikely** – no suitable habitat (shallow wetlands)
Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo)	Vulnerable (EPBC Act & BC Act)	**Likely** – may forage and roost but unlikely to breed in the application area. The application area is north of the species current modelled distribution. Not recorded by Phoenix (2019).
Calyptorhynchus latirostris (Carnaby's Black Cockatoo)	Endangered (EPBC Act & BC Act)	**Recorded** - Recorded in survey area and secondary evidence of foraging recorded in woodland habitats. Phoenix (2019) recorded a number of individuals within the application area.
Apus pacificus (Fork-tailed Swift)	Migratory (EPBC Act & BC Act)	**Likely** – May frequent the application area for foraging, however unlikely to land or nest.
Calyptorhynchus baudinii (Baudin's Black Cockatoo)	Vulnerable (EPBC Act) Endangered (BC Act)	**Possible** – survey area north of modelled distribution but a few (potentially unreliable) NatureMap records as far north as New Norcia - may forage but unlikely to breed or roost in the NVCP application area. Not recorded by Phoenix (2019).
Thinornis rubicollis (Hooded Plover)	Priority 4	**Unlikely** – no suitable habitat present (shallow wetlands or salt lakes)
Oxyura australis (Blue-billed Duck)	Priority 4	**Unlikely** – preferred habitat not present in survey area
Falco peregrinus (Peregrine Falcon)	Other Specially Protected Fauna (BC Act)	**Likely** – may forage and breed in woodland habitats where suitable large eucalypts present. Not recorded by Phoenix (2019).
Mammals		
Dasyurus geoffroii (Western Quoll)	Vulnerable (EPBC Act & BC Act)	**Possible** – suitable habitat present within the survey area, however it is fragmented and degraded. Recent records exist approximately 9 km south of survey area. Survey area unlikely to provide core habitat.
Isoodon obesulus fusciventer (Southern Brown Bandicoot/ Quenda)	Priority 5	**Unlikely –** Habitat within survey area is degraded and fragmented, and unsuitable for this species.

Scientific Name (Common Name)	Conservation Category	Likelihood of occurrence
Invertebrates		
Idiosoma mcclemenstorum (Julimar Shield-backed Trapdoor Spider) formally known as *Idiosoma* sp. 'MYG474'	Priority 2	**Previously recorded in survey area** – species known distribution falls within survey area.
Throscodectes xederoides (Mogumber Bush Cricket)	Priority 3	**Possible** – may occur in areas where suitable substrate (white sand) is present/

Previous records of the threatened Trapdoor spider species *Idiosoma nigrum* place this species as occurring within the NVCP application area; however, due to recent revision of the *Idiosoma* genus, this species is now classified as the Julimar Shield-backed Trapdoor Spider *I. mcclemenstorum*. *I. mcclementsorum* is listed as a Priority 2 species on the DBCA Priority Fauna List (2018).

Surveys conducted by Phoenix targeted vegetation considered as potential habitat for *Idiosoma mcclementsorum* and located 12 confirmed burrows, six of which will be impacted by clearing activities. Consultation with the DBCA will be undertaken regarding the management of active *I. mcclementsorum* burrows.

3.6.2 Fauna Habitats

A total of seven fauna habitats were defined in the NVCP application area (**Figure 6**):

- Cleared (agriculture, road, infrastructure) – 108.75 ha
- Woodland (Jarrah, Marri, Wandoo and/or Banksia) – 13.01 ha
- Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet) – 8.98 ha
- Woodland (Paperbark or Sheoak) – 5.70 ha
- Cleared and revegetated non-native woodland mosaic – 1.92 ha
- Forest (Jarrah and/or Marri) – 0.04 ha

3.6.2.1 Carnaby's Black Cockatoo Habitat

Surveys undertaken by Phoenix (2019) recorded approximately 98 ha of quality foraging habitat and 212 ha of low value foraging habitat for Carnaby's Black Cockatoo present within the survey area (**Figure 6**).

A total of 4,146 trees were recorded within the survey area as suitable DBH trees (diameter at breast height greater than 300/500 mm), with *Eucalyptus wandoo* (DBH 300) being the dominant tree species present. Of these, 83 trees were considered by Tony Kirby (2018) to contain hollows suitable for breeding, including 44 which showed signs of use by Black Cockatoos.

Within 12 km of the application area, there are approximately 20,692 ha of remnant vegetation likely to be suitable for foraging and/or breeding by Carnaby's Black Cockatoo. The survey area represents less than 1.5% of the habitat available in the 12 km local area.

3.7 Conservation Areas

There is one conservation reserve in the immediate vicinity of the application area known as Seven Mile Well Nature Reserve (No. R7615), located adjacent to and immediately west of the application area between SLK 103.02 and 103.52.

3.8 Hydrology

The application area lies within the Brockman River sub-catchment within the Swan Avon (Main Avon) Catchment area, and the Moore River East Branch sub-catchment within the Moore River Catchment area. A number of streams cross, or are in proximity to, the NVCP application area, including Moore River East major watercourse and Yarawindah Brook minor watercourse (**Figure 7**). The application area is not within any surface water areas proclaimed under the *Rights in Water and Irrigation Act 1914*.

4. Potential Impacts

4.1 Impact Avoidance through Design

Information from biological surveys has influenced the alignment and design of the Bindoon Bypass – Northern Section upgrade. Where practicable, the road design and alignment avoids areas of high environmental significance such as Black Cockatoo nesting trees, trees with hollows suitable for Black Cockatoos and locations of Threatened and Priority flora. It is not feasible to avoid all environmentally significant areas due to other project constraints such as links to existing and proposed roads, road geometry, safety, and the locations of locally-significant heritage sites, existing houses and other structures.

Design options included:

- Online – works to be completed in the same alignment to the existing route of the Great Northern Highway, and
- Offline – works to be completed in an alignment which does not match the existing route of the Great Northern highway.

Several alignment design variations were examined in the development of the final design, including: a full online upgrade option; staged online upgrades option; and offline options. The final design is a combination of online and offline options.

The final concept alignment design was developed following several optioneering exercises and modifications to the proposed alignment to avoid and minimise environmental and heritage impacts, as well as meet the key Project objectives for improving the safety and efficiency of the highway.

In October 2017, a multi-criteria analysis was undertaken to determine the most suitable design for the Bindoon Bypass – Northern Section upgrade. The multi-criteria analysis involved the creation of a constraints map to show environmental, social, geological, hydrological, existing/proposed planning developments to determine the likely impacts of each option. Several heritage areas and environmental constraints in relation to the road alignment were identified. These included Threatened and Priority flora species and habitat, Threatened fauna species and habitat (most notably Carnaby's Black Cockatoo) and conservation estate, namely Seven Mile Well Nature Reserve.

Assessment of the online options determined that the upgrades required to the existing GNH to improve the safety and efficiency of the road would result in significant impacts to environmental and heritage values. The installation of barriers to protect vehicles from roadside hazards, including trees known to be used for breeding by Carnaby's Black Cockatoo, was not considered a suitable option due to major road geometry flaws which compromised the overall safety of the road. There was limited benefit in improved safety for the substantial cost of installing barriers. As a result, the full online upgrade option was deemed unsuitable, given that safety and efficiency of the road could not be improved by way of geometric alignment and application of suitable clear zones without significantly affecting the environmental constraints identified. In particular, this option would have resulted in the clearing of 21 known nesting trees for Carnaby's Black Cockatoo—an impact that was considered significant and should be avoided if practicable.

Accordingly, offline options were assessed as part of the design analysis. A combination of online and offline areas was assessed and ultimately progressed as the preferred option (this NVCP application). By moving the alignment to the east of the existing carriageway, Main Roads was able to improve the vertical and horizontal geometry, include wider shoulders, introduce a suitable clear zone, and improve the overall safety and efficiency of the road while avoiding significant impacts to the environmental and heritage values of the area. Approximately 15.7 km of the 17.8 km length of this stage (88%) is proposed to be within cleared farmland.

4.2 Potential Impacts to Vegetation and Flora

Up to 28 ha of native vegetation will be cleared for construction of the proposed upgrades to the Bindoon Bypass – Northern Section of the GNH, of which approximately 4.5 ha was considered to be in Very Good to Excellent condition. **Table 4.1** details the clearing requirements per vegetation type and vegetation condition. These numbers are based on current alignment designs and are subject to minor changes during the detailed design phase. Clearing will not exceed the maximum of 28 ha.

Table 4.1: Clearing Requirements for Bindoon Bypass – Northern Section: Native Vegetation

Vegetation Association	Total (ha)				Total (ha)
	Degraded	Good	Very Good	Excellent	
4	1.21	0.89	1.15	0.00	3.25
7	4.62	0.58	0.00	0.00	5.20
352	1.01	1.80	0.66	0.00	3.47
946	2.88	3.47	0.87	0.00	7.22
950	0.90	1.87	0.00	0.00	2.77
973	0.00	0.07	0.66	0.23	0.96
999	0.47	0.14	0.32	0.03	0.96
1034	0.53	0.76	0.48	0.11	1.88
1132	0.00	0.04	0.00	0.00	0.04
1182	1.94	0.03	0.00	0.00	1.97
Total (ha)	**13.56**	**9.65**	**4.14**	**0.37**	**27.72**

Table 4.2 details the Priority Flora likely to be cleared. Areas of Priority Flora in close proximity to the NVCP application area that are not to be cleared will be marked on construction drawings as ‘no-go’ or ‘avoidance areas’.

Table 4.2: Priority Flora Likely to be cleared

Flora species	Conservation Category	Individuals within the survey area	Individuals in the application area
Grevillea drummondii	Priority 4	76	11
Synaphea rangiferops	Priority 2	9	0
Acacia drummondii subsp. *affinis*	Priority 3	72	12
Calothamnus pachystachyus	Priority 4	178	0
Hibbertia miniata	Priority 4	15	0

4.3 Potential Impacts to Fauna and Fauna Habitat

Table 4-3 details the clearing requirements by fauna habitat. These numbers are based on current alignment designs and are subject to minor changes during the detailed design phase.

Table 4.3: Preliminary Clearing Requirements for Bindoon Bypass – Northern Section: Fauna Habitat

Habitat type	Area within NVCP Application Area (ha)	Clearing Amount (ha)	Clearing percentage
Woodland (Jarrah, Marri, Wandoo and/or Banksia)	16.76	13.01	77.6%
Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)	11.54	8.98	77.8%
Woodland (paperbark or sheoak)	6.47	5.70	88.1%
Forest (Jarrah and/or Marri)	0.04	0.04	100.0%
Total	**34.81**	**27.73**	**79.7%**

Fauna habitat is variable, ranging from completely degraded (low value) areas to good quality habitat. Good quality habitat was recorded in woodlands that are contiguous with larger pockets of native vegetation (Phoenix, 2015). Low value fauna habitat was associated with areas of degraded vegetation which was narrow and fragmented.

An assessment of the likelihood of occurrence of all potential conservation significant fauna species identified in the desktop review was undertaken based on known distribution, desktop records, habitat preferences and the habitats present within the NVCP application area (Phoenix, 2019). Many of the species are unlikely to occur within the NVCP application area mainly due to lack of suitable habitat (degradation, fragmentation and habitat too small in size). The habitats likely to support conservation significant fauna species are the larger areas of forest, woodland and shrubland nearby. The narrow habitat corridors are unlikely to support most of the conservation significant fauna species as core habitat but may provide some linkage value to some species. The areas of native vegetation where Carnaby's Black Cockatoo were recorded are of value for this species, especially in regard to food resources.

The existing GNH alignment would currently present a barrier to some fauna movements, particularly ground dwelling fauna. The upgraded GNH is unlikely to significantly worsen this barrier to fauna movement.

The conservation significant fauna species most likely to be impacted by the upgrades proposed for the Bindoon Bypass – Northern Section are Carnaby's Black Cockatoo. The species has been recorded in the application area and suitable foraging and roosting habitat has been identified. **Table 4-4** details the clearing requirements of the proposal with relation to foraging habitat and breeding trees. As discusses in Section 4.1, the initial stages of the design of the Bindoon Bypass – Northern Section alignment took into account the location of potential Black Cockatoo breeding trees and sought to minimise the clearing of these trees where practicable. The proposed alignment will result in a far lesser impact to Carnaby's Black Cockatoo habitat than if current (online) GNH alignment was upgraded to meet Main Roads safety and fright efficiency requirements (**Table 4-4**).

Breeding sites and the associated foraging habitat are critical habitat for the species. All known nesting trees will be avoided by the proposed action. One tree with an unused potentially suitable hollow for Carnaby's Black Cockatoo will be cleared. All other trees containing suitable hollows will be contained within delineated no-go areas established during construction. These areas will be established to prevent unauthorised access and accidental damage.

The landscape design for the project includes revegetating cleared areas with flora species identified as known foraging and/or breeding habitat species. This will reduce the final amount of permanent loss of habitat. In addition, redundant carriageway within the road reserve will be revegetated in line with the landscape design. As landscape designs are progressed, consideration will also be given to improving the condition of existing degraded patches of habitat adjacent to the alignment. Foraging habitat revegetation will be undertaken following a risk assessment of the potential for bird-vehicle collisions.

Table 4-4 : Carnaby's Black Cockatoo Habitat

Factor	Online Option Impact	Proposed Option Impact	Impact Avoidance
Quality Carnaby's Black Cockatoo foraging habitat	16.4 ha	4.5 ha	11.9 ha
Low value Carnaby's Black Cockatoo foraging habitat	19.1 ha	15.5 ha	3.6 ha
Carnaby's Black Cockatoo hollows showing signs of use	21	0	21
Carnaby's Black Cockatoo hollows suitable for breeding but with no signs of use	18	1	17

4.4 Potential Impacts to Conservation Reserves

No works will be undertaken within existing conservations reserves for the Bindoon Bypass – Northern Section project. There is a minor potential for indirect impacts to Seven Mile Well Nature Reserve as works to widen the existing road will be undertaken in the adjacent road reserve. Indirect impacts include the spread of weeds and *Phytophthora* dieback from the adjacent road reserve as a result of road construction activities. Given effective weed and disease hygiene controls will be implemented to manage this risk, it is considered that the potential risk of the Project indirectly impacting the adjacent conservation area is low.

4.5 Land Degradation, Water Quality and Flooding

Given the linear nature and the amount of clearing required (28 ha of native vegetation), there is unlikely to be any increase in land degradation such as soil acidity or salinity, or flood risk as a result of these works. Additionally, given the gentle slopes present throughout the majority of the project area, it is unlikely that clearing will result in increased erosion, particularly water erosion.

5. Environmental Management Framework

The mitigation hierarchy has been applied during the design phase for Bindoon Bypass – Northern Section as follows:

- **Avoid**: realignment of the GNH has allowed for avoidance of a significant amount of native vegetation, conservation significant flora and habitat for Carnaby's Black Cockatoo. The proposed realignment involves both online and offline construction. Although at a considerable cost compared to online construction. offline construction has been adopted where there are significant environmental and safety benefits. Impacts to native vegetation, conservation significant flora and habitat for Carnaby's Black Cockatoo have been minimised through the areas of offline works and avoided where possible.
- **Minimise**: the alignment has been designed to avoid clearing of trees with hollows suitable for use, or showing signs of previous use, by Carnaby's Black Cockatoo. Only one tree with an unused potentially suitable hollow is to be cleared (this tree does not present any evidence of having been used for nesting).
- **Rehabilitate**: cleared areas beyond the final road formation will be revegetated and landscaped, in line with the landscape design for Bindoon Bypass – Northern Section. This will likely result in areas of wider vegetated corridors than currently exists in this predominantly agricultural area.

A Principal's Environmental Management Plan (PEMP) will be developed to manage potential environmental impacts for the proposed works. The PEMP will address both preventative and management measures to be applied during the construction phase to minimise environmental impacts and have been developed to capture regulatory and Infrastructure Sustainability Rating requirements and guide the development of the Contractor's Construction Environmental Management Plan (CEMP). The PEMP will consist of several sub-plans. Those sub-plans relevant to the management and mitigation of impacts related to the clearing of native vegetation will include (but not be limited to):

- Vegetation Clearing Management Plan:
  - Demarcation of site boundaries, areas to be cleared
  - Establishment and communication of No-Go Zones around significant flora or vegetation
  - Establishment of weed and disease management areas as required
- Fauna Management Plan:
  - Assessment of the single potential Carnaby's Black Cockatoo breeding tree within seven days prior to clearing to determine if the one suitable hollow is being used for nesting. If it is being used, it will be clearly identified, and left in-situ until no longer in use
  - Implementation and enforcement of speed limits for construction traffic
  - Transfer of any injured fauna found on site to an appropriate fauna rescue organisation or individual. A list of local fauna rescue organisations and individuals will be maintained on site.
- Other management measures:
  - Management measures for the Declared Plant *Asparagus asparagoides* will be included in the PEMP
  - Main Roads will implement standard dust control measures, which will be included in the PEMP

6. Assessment Against the 10 Clearing Principles

Schedule 5 of the EP Act defines 10 Clearing Principles for native vegetation. These principles aim to ensure that all potential impacts resulting from removal of native vegetation can be assessed in an integrated way. Clearing required for construction of Bindoon Bypass – Northern Section has been assessed against the ten Clearing Principles, with each principle being assessed in accordance with the DWER's A Guide to the Assessment of Applications to Clear Native Vegetation (Department of Environment Regulation, 2014) to determine whether the application is at variance to the principles. The assessment indicates that clearing may be at variance with Principle (a) and is at variance with Principles (b), (e) and (f).

Principle		Assessment	Outcome
A	Native vegetation should not be cleared if it comprises a high level of biological diversity.	**Vegetation** A maximum of 28 ha of native vegetation will be cleared. Most of the native vegetation required to be cleared is in a degraded state, however despite avoiding most of the native vegetation in the survey area by selecting the offline highway alignment, and rehabilitating some of the cleared areas, the Project will clear approximately 4.5 ha of vegetation in Very Good to Excellent condition. Table 4.1 shows that of the approximately 28 ha of native vegetation: · 13.56 ha is Degraded · 9.65 ha is in Very Good condition · 4.14 is in Very Good condition · 0.37 ha is in Excellent condition. **Flora** No flora species listed as threatened under the BC Act or EPBC Act are likely to be impacted by the Project. Removal of eleven (11) individuals of Drummond's Grevillea (*Grevillea drummondii* - Priority 4), and twelve (12) individuals of *Acacia drummondii* subsp. *affinis* (Priority 3) will be required. Areas of conservation significant flora near Project activities that will not be cleared will be marked on construction drawings as 'No-Go Zones'. **Fauna** Project activities will require the removal of six (6) Western Shield-backed Trapdoor Spider (*Idiosoma mcclementsorum*) burrows. *I. mcclementsorum* is currently State-listed under former WA Museum identification code MYG474 as Priority 2. Consultation will be undertaken with DBCA to identify suitable measures to reduce clearing impacts on this trapdoor spider. Project clearing will also impact conservation significant Black cockatoo habitat through removal of one (1) tree with a potentially suitable breeding hollow (but with no evidence of use), and up to 20 ha of foraging habitat, including 4.5 ha of quality foraging habitat.	**Proposed clearing may be at variance with this Principle**

Principle		Assessment	Outcome
B	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia	The application area is within the known breeding range of Carnaby's Black Cockatoo and suitable breeding and foraging habitat has been identified as occurring within the proposed clearing area. The Recovery Plan for Carnaby's Black Cockatoo states that breeding habitat, in particular known nesting trees, are critical habitat for this species (DPAW, 2013). Success in breeding is dependent on the quality and proximity of feeding habitat within 6 km of nesting sites (DPAW, 2013). Along with the trees that provide nest hollows, the protection, management, and increase of the available foraging habitat that supports the breeding of Carnaby's Black Cockatoo is a critical requirement for the conservation of the species (DPAW, 2013). The availability of foraging and breeding habitat within 12 km of the Project is very high, comprising 'Eucalyptus Woodlands' and 'Other Shrublands' (DAFWA, 2016). There is approximately 20,692 ha of remnant vegetation within 12 km of the Project. A high proportion of this is likely to be potential breeding habitat and/or foraging habitat. Proportionally, clearing of 20 ha of Black Cockatoo habitat is not considered significant to the recovery and survival of this species, however given that this foraging habitat likely supports breeding trees it is likely to be considered critical habitat for the species. Up to 20 ha of suitable foraging habitat is proposed to be cleared, including 15.5 ha of low value habitat, and 4.5 ha of quality habitat. No known nesting trees and one (1) tree with a hollow suitable for use by Carnaby's Black Cockatoo will be cleared. Revegetation of cleared areas at the end of construction will include local provenance foraging species. This will assist in mitigating habitat loss over time from the initial clearing. Foraging species will be planted at least 10 m from the edge of the GNH, as measured from the lane line markings. Project activities will also require the removal of six (6) Western Shield-backed Trapdoor Spider (*Idiosoma mcclementsorum*) burrows. *I. mcclementsorum* is currently State-listed under former WA Museum identification code MYG474 as Priority 2. Expert advice on potential translocation of these burrows prior to clearing is currently being sought from a PhD candidate who has had previous success in translocating burrows of other members of the genus *Idiosoma*.	**Proposed clearing is at variance with this Principle**
C	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No flora species listed as Threatened under the BC Act or EPBC Act will be impacted by the Project.	**Proposed clearing is not at variance with this Principle**

Principle		Assessment	Outcome
D	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for, the maintenance of a threatened ecological community.	An assessment of quadrats surveyed by Phoenix (2019) against the Wheatbelt Woodlands TEC diagnostic criteria has been undertaken to determine if the vegetation present is consistent with the TEC. None of the quadrats assessed by Phoenix (2019) were determined to be representative of the Wheatbelt Woodlands TEC.	**Proposed clearing is not at variance with this Principle**
E	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	The Project area is located within the Jarrah Forest and Avon Wheatbelt bioregions of Western Australia. This area is recognised as a highly cleared landscape with remaining native vegetation generally considered to be under represented. As detailed in Table 4.1, all the vegetation associations that occur within the proposed clearing area are under-represented.	**Proposed clearing is at variance with this Principle**
F	Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	The existing GNH abuts the Moore River East at one location. Vegetation clearing will be required to complete earthworks associated with the new road alignment, including watercourse embankment protection. Vegetation clearing will also be required at various other minor watercourses within the Project area, including Yarawinda Brook, to construct the Bindoon Bypass – Northern Section upgrade.	**Proposed clearing is at variance with this Principle**
G	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The locations of clearing required for the project are in different sections along the length of this stage of the GNH upgrade, in a landscape primarily cleared for agricultural use. The additional small areas of clearing required to undertake road upgrade works are considered unlikely to result in appreciable land degradation. Rehabilitation of selected areas at the end of construction may mitigate localised adverse effects from clearing. Due to the linear nature and relatively small scale of the required clearing, clearing of native vegetation is not expected to increase soil acidity or salinity. Given the gentle slopes present along the preferred alignment, it is also unlikely that clearing will result in increased erosion, particularly water erosion. Clearing activities are unlikely to increase the percentage coverage of weeds within the application area. Management controls will reduce the risk of the spread or introduction of weeds and disease in the application area. It is considered unlikely that the required clearing will cause appreciable land degradation.	**Proposed clearing is not at variance with this Principle**

Principle		Assessment	Outcome
H	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The existing GNH road reserve abuts the south eastern corner of the Seven Mile Well Nature Reserve. The scope of the GNH upgrade works is confined to the existing road reserve adjacent to the nature reserve. There will be no direct encroachment into the nature reserve. The nature reserve is surrounded by a highly cleared landscape, with fragmented vegetation scattered through surrounding cleared farmland. The existing GNH road reserve running north and south from the nature reserve contains significant remnant flora, vegetation and fauna habitat values and represents an important corridor linkage. A key advantage of the offline highway upgrade option is the retention of these important values in the existing road reserve, which provide connection within the fragmented landscape. Clearing within the vicinity of this area will be managed in accordance with the PEMP and/or CEMP.	**Proposed clearing is unlikely to be at variance with this Principle**
I	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	Clearing for the Bindoon Bypass – Northern Section will involve a range of earthwork and construction activities. Most of the application area is in the Extremely Low risk category of acid sulfate soils. The northern 4.5 km from chainage 107900 is in the Low risk category. Temporary drainage structures will be installed during the construction phase to manage sediment in runoff. It is therefore, considered unlikely that the required clearing will result in the deterioration of the quality of surface or underground water.	**Proposed clearing is not at variance with this Principle**
J	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	The extent of localised clearing associated with the Bindoon Bypass – Northern Section upgrade is not anticipated to have any impact at a catchment scale. It is unlikely that the clearing will cause, exacerbate, or increase the incidence of flooding in the Project area or surrounds.	**Proposed clearing is not at variance with this Principle**

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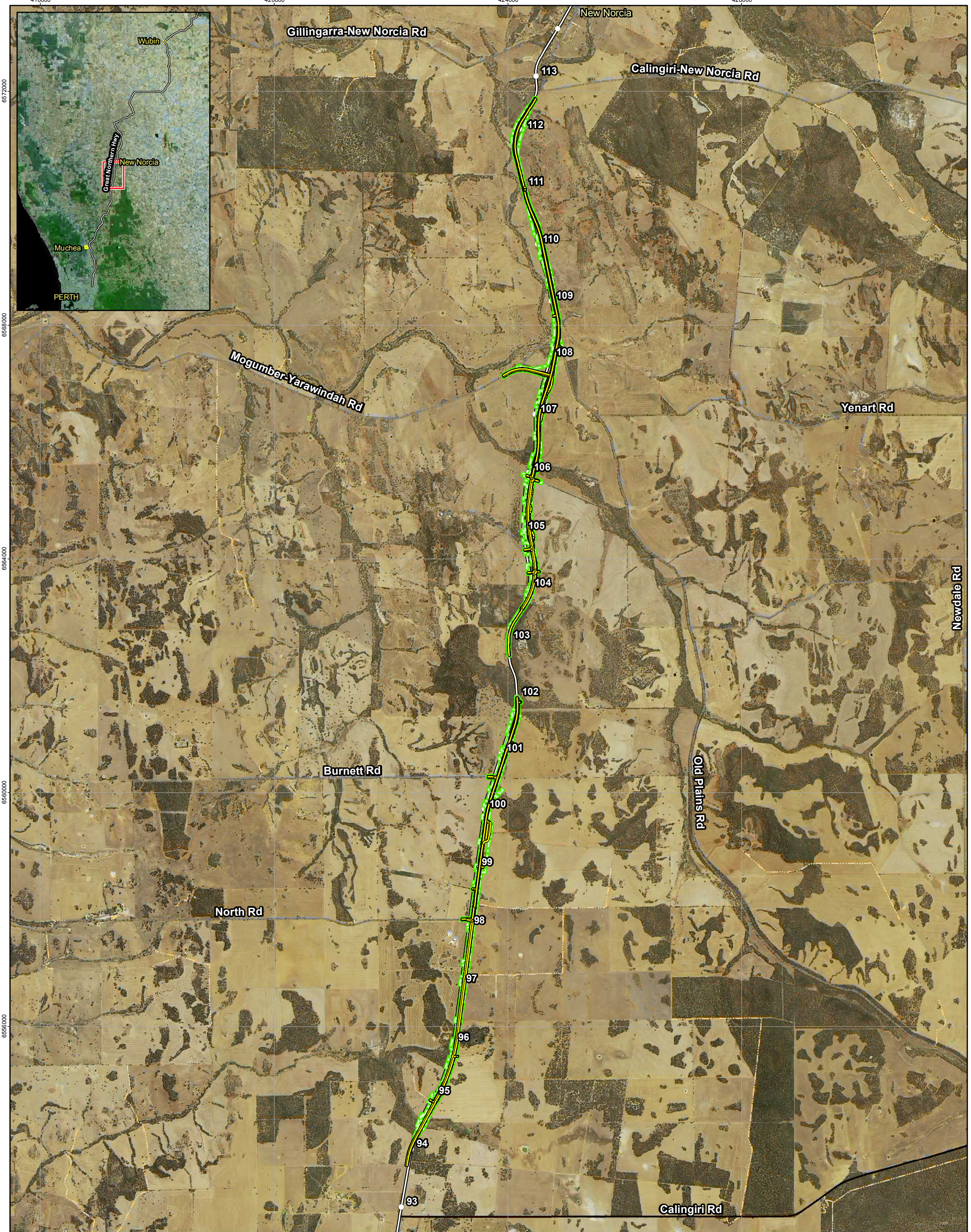
Figures



Legend

- Straight Line Kilometre Marker (1km)
- Existing GNH Alignment
- Main Road
- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
1:60,000

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Client

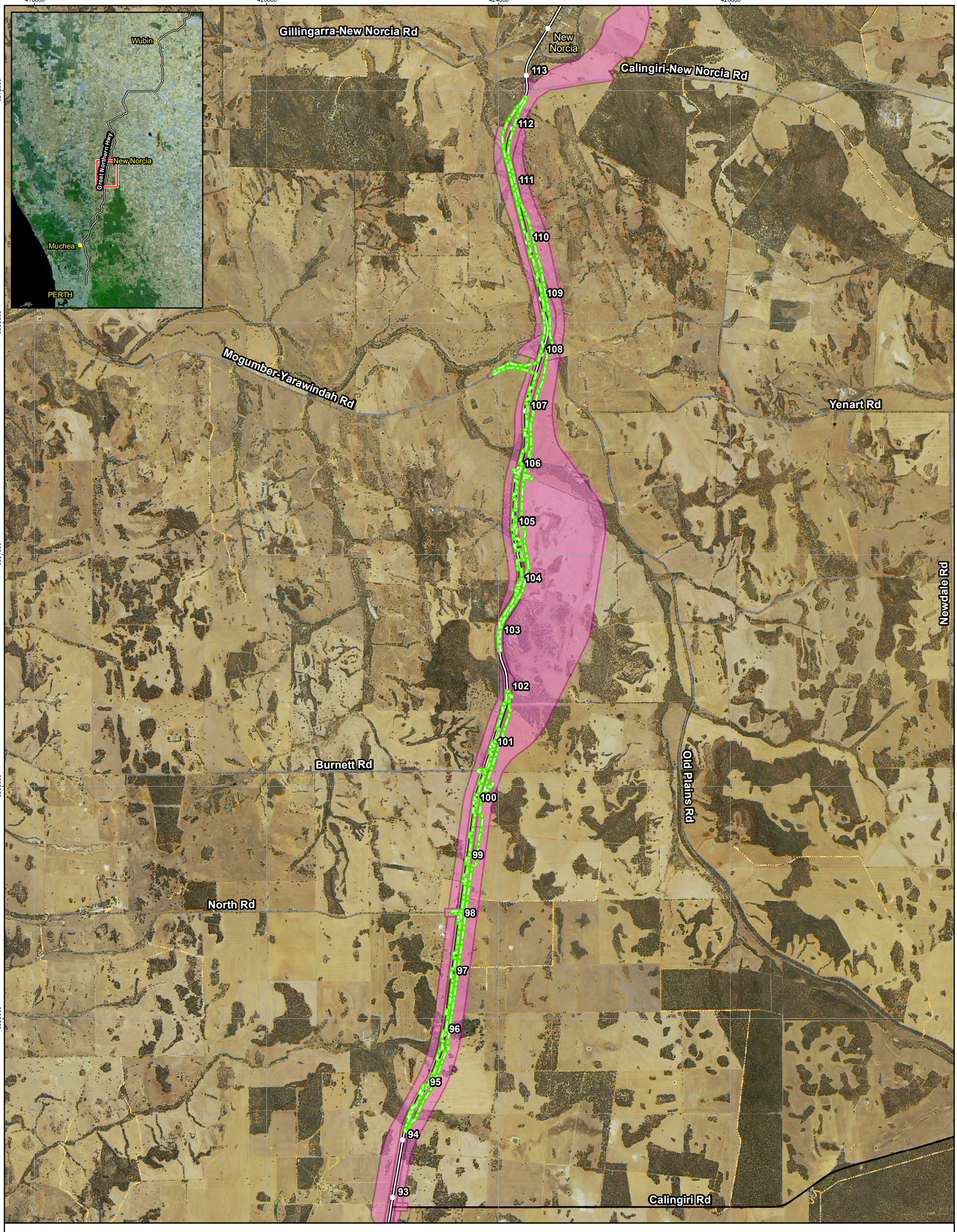
Location of Bindoon Bypass – Northern Section

Drawing No	Issue
GNH-WP05-E-EA-GD-0010	B

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0010-C.mxd



Legend

- Straight Line Kilometre Marker (1km)
- Existing GNH Alignment
- Main Road
- Minor Road
- Track
- Application Area
- Study Area

Data Source: Main Roads WA, Landgate

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Kilometres

Scale at A3
1:60,000

Coordinate System: GDA 1994 MGA Zone 50

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Flora, Vegetation and Fauna Survey Area

Drawing No	Issue
GNH-WP05-E-EA-GD-0014	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0018-B.mxd

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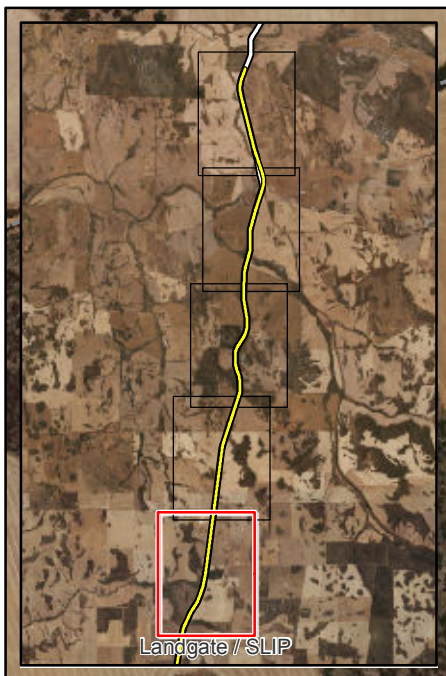

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Landgate / SLIP

Vegetation Association (Phoenix 2019)

- 4 - Medium woodland; Marri and Wandoo
- 946 - Medium woodland, wandoo
- 946 - Medium woodland; Wandoo
- 973 - Low forest; paperbark (Melaleuca rhaphiophylla)
- 1132 - Medium forest; Marri
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present

Legend

- Highway
- Main Road
- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
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Map 1 of 5: Mapped Vegetation Types

Drawing No	Issue
GNH-WP05-E-EA-GD-0012	B

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
24/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0012-C.mxd

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Landgate / SLIP

Burnett Rd

101

100

99

98

North Rd

Landgate / SLIP

Vegetation Association (Phoenix 2019)

- 4 - Medium woodland; Marri and Wandoo
- 946 - Medium woodland; Wandoo
- 999 - Medium woodland; Marri
- 1034 - Medium woodland; Marri, Wandoo and Powderbark
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present

Legend

- Highway
- Main Road
- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Coordinate System: GDA 1994 MGA Zone 50

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Map 2 of 5: Mapped Vegetation Types

Drawing No	Issue
GNH-WP05-E-EA-GD-0012	B

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
24/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PIB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0012-C.mxd

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Landgate / SLIP

Landgate / SLIP

Vegetation Association (Phoenix 2019)

- 4 - Medium woodland; Marri and Wandoo
- 946 - Medium woodland, wandoo
- 1034 - Medium woodland; Marri, Wandoo and Powderbark
- 7 - Medium woodland; York Gum (Eucalyptus loxophleba) and Wandoo
- 352 - Medium woodland; York Gum
- 946 - Medium woodland; Wandoo
- 950 - Medium woodland; Casuarina obesa
- 1034 - Medium woodland; Marri, Wandoo and Powderbark
- 1182 - Medium woodland; Eucalyptus rudis and Melaleuca rhaphiophylla
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present
- Pasture and Cleared - Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses

Legend

- Highway
- Main Road
- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Coordinate System: GDA 1994 MGA Zone 50

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Main Roads Western Australia

Client

Map 3 of 5: Mapped Vegetation Types

Drawing No	Issue
GNH-WP05-E-EA-GD-0012	B

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
24/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0012-C.mxd

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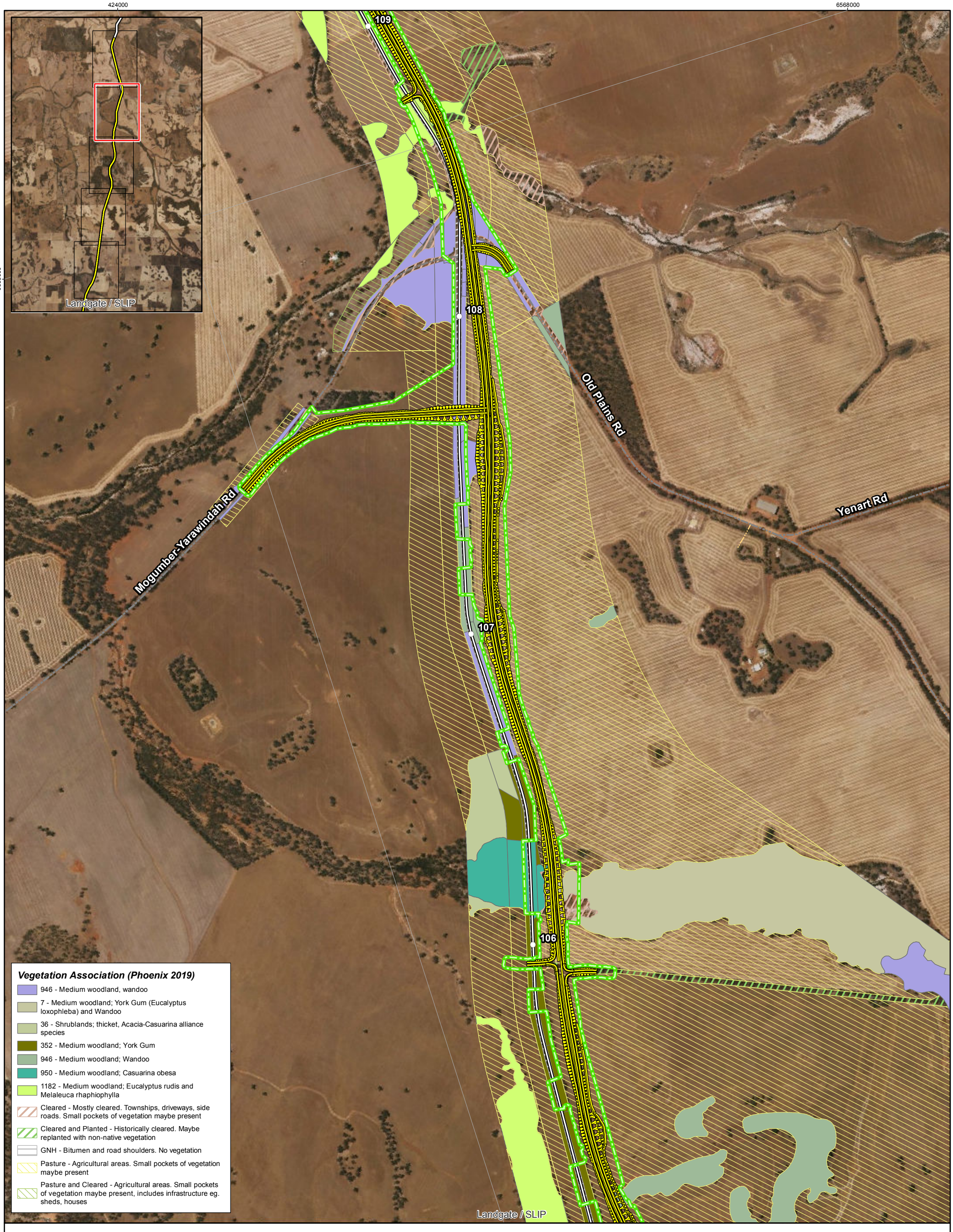

Vegetation Association (Phoenix 2019)

- 946 - Medium woodland, wandoo
- 7 - Medium woodland; York Gum (Eucalyptus loxophleba) and Wandoo
- 36 - Shrublands; thicket, Acacia-Casuarina alliance species
- 352 - Medium woodland; York Gum
- 946 - Medium woodland; Wandoo
- 950 - Medium woodland; Casuarina obesa
- 1182 - Medium woodland; Eucalyptus rudis and Melaleuca rhaphiophylla
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present
- Pasture and Cleared - Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses

Legend

- Highway
- Main Road
- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Scale at A3
1:11,000

Coordinate System: GDA 1994 MGA Zone 50

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Main Roads Western Australia
Client

Map 4 of 5: Mapped Vegetation Types

Drawing No	Issue
GNH-WP05-E-EA-GD-0012	B

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
24/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0012-C.mxd

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Landgate / SLIP

Landgate / SLIP

Vegetation Association (Phoenix 2019)

- 7 - Medium woodland; York Gum (Eucalyptus loxophleba) and Wandoo
- 7/1182 - Medium woodland; York Gum (Eucalyptus loxophleba) and Wandoo,Medium woodland; Eucalyptus rudis and Melaleuca rhaphiophylla
- 352 - Medium woodland; York Gum
- 946 - Medium woodland; Wandoo
- 1182 - Medium woodland; Eucalyptus rudis and Melaleuca rhaphiophylla
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present
- Pasture and Cleared - Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses

Legend

- Highway
- Main Road
- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres

Scale at A3
1:11,000

Coordinate System: GDA 1994 MGA Zone 50

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Map 5 of 5: Mapped Vegetation Types

Drawing No	Issue
GNH-WP05-E-EA-GD-0012	B

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
24/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIFI\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0012-C.mxd

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Landgate / SLIP

Landgate / SLIP

Legend

- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Vegetation Condition

- Completely Degraded
- Degraded
- Good
- Very Good
- Excellent

Data Source: Main Roads WA, Landgate

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Kilometres

Coordinate System: GDA 1994 MGA Zone 50

Scale at A3

1:11,000

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Client

Map 1 of 5: Vegetation Condition

Drawing No	Issue
GNH-WP05-E-EA-GD-0017	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0017-B.mxd

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Landgate / SLIP

Burnett Rd

101

100

99

North Rd

98

Landgate / SLIP

Legend

- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Vegetation Condition

- Completely Degraded
- Degraded
- Good
- Very Good
- Excellent

Data Source: Main Roads WA, Landgate

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Scale at A3
1:11,000

Coordinate System: GDA 1994 MGA Zone 50

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Main Roads Western Australia
Client

Map 2 of 5: Vegetation Condition

Drawing No	Issue
GNH-WP05-E-EA-GD-0017	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0017-B.mxd

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104

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Landgate / SLIP

Landgate / SLIP

Legend

- Minor Road
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Vegetation Condition

- Completely Degraded
- Degraded
- Good
- Very Good
- Excellent

Data Source: Main Roads WA, Landgate

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Coordinate System: GDA 1994 MGA Zone 50

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Main Roads Western Australia
Client

Map 3 of 5: Vegetation Condition

Drawing No	Issue
GNH-WP05-E-EA-GD-0017	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0017-B.mxd

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Mogumber-Yarawindah Rd

Yenart Rd

Old Plains Rd

Landgate / SLIP

Landgate / SLIP

Legend

- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Vegetation Condition

- Completely Degraded
- Degraded
- Good
- Very Good
- Excellent

Data Source: Main Roads WA, Landgate

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Coordinate System: GDA 1994 MGA Zone 50

Scale at A3

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Client

Map 4 of 5: Vegetation Condition

Drawing No	Issue
GNH-WP05-E-EA-GD-0017	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0017-B.mxd

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111

110

109

Landgate / SLIP

Landgate / SLIP

Legend

- Minor Road
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Vegetation Condition

- Completely Degraded
- Degraded
- Good

Data Source: Main Roads WA, Landgate

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Kilometres

Coordinate System: GDA 1994 MGA Zone 50

Scale at A3

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Main Roads Western Australia

Client

Map 5 of 5: Vegetation Condition

Drawing No	Issue
GNH-WP05-E-EA-GD-0017	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0017-B.mxd

Legend

- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Weed

- Asparagus asparagoides

Priority Flora

- Acacia anarthros (P3)
- Daviesia debilior subsp. sinuans (P3)
- Hibbertia miniata (P4)
- Leucopogon darlingensis subsp. rectus (P2)

Data Source: Main Roads WA, Landgate

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Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
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Main Roads Western Australia
Client

Map 1 of 5: Conservation-significant Flora and Weeds

Drawing No	Issue
GNH-WP05-E-EA-GD-0016	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0016-B.mxd

Legend

- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Weed

- Asparagus asparagoides

Data Source: Main Roads WA, Landgate

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Scale at A3
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Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere

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Client

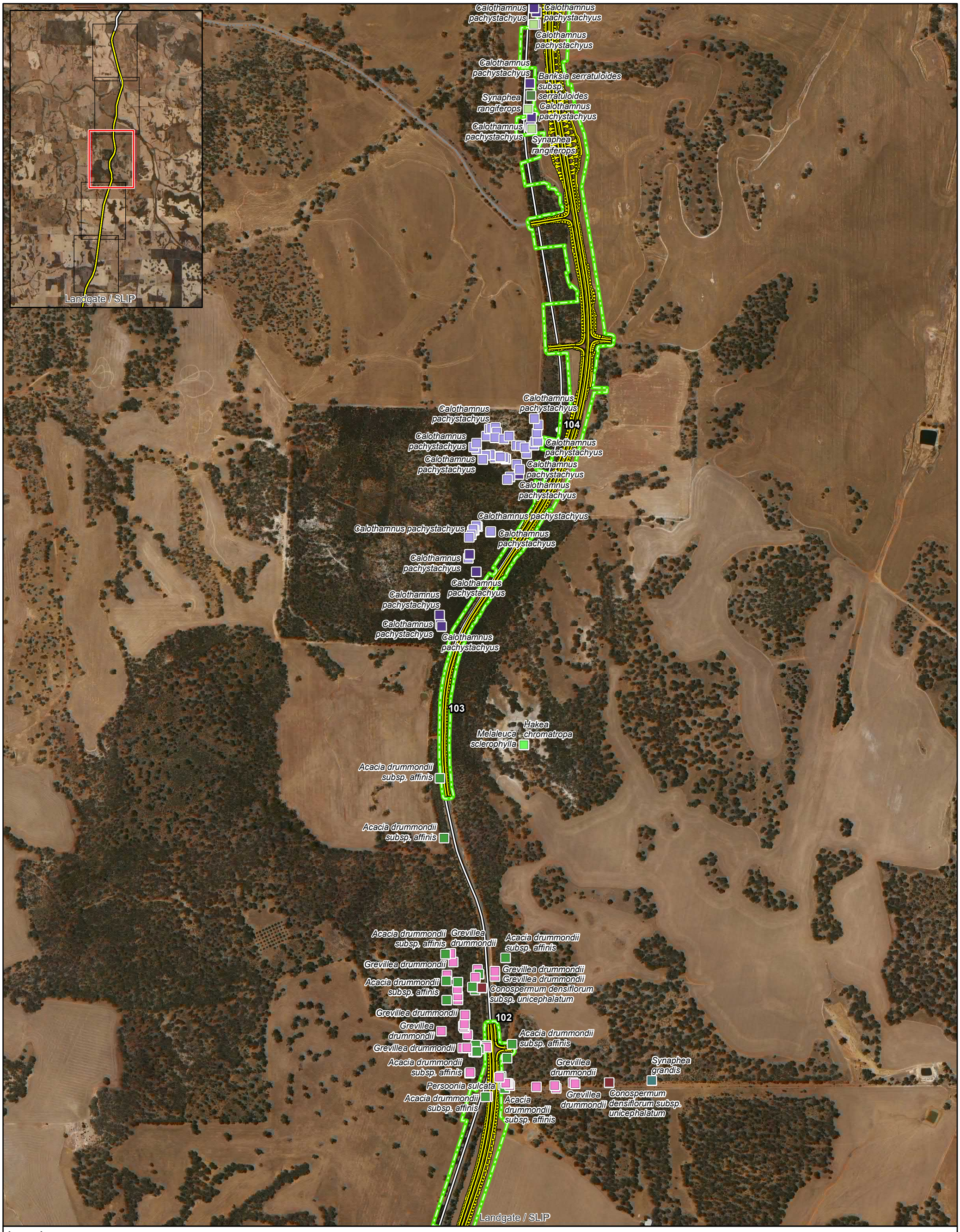
Map 2 of 5: Conservation-significant Flora and Weeds

Drawing No	Issue
GNH-WP05-E-EA-GD-0016	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0016-B.mxd



Legend

- Minor Road
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Priority Flora

- Acacia drummondii subsp. affinis (P3)
- Banksia serratuloides subsp. serratuloides (VU)
- Calothamnus pachystachyus (P1)
- Calothamnus pachystachyus (P4)
- Conospermum densiflorum subsp. unicephalatum (EN)
- Grevillea drummondii (P4)
- Hakea chromatropa (P1)
- Melaleuca sclerophylla (P3)
- Persoonia sulcata (P4)
- Synaphea grandis (P4)
- Synaphea rangiferops (P2)

Data Source: Main Roads WA, Landgate

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Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
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Main Roads Western Australia
Client

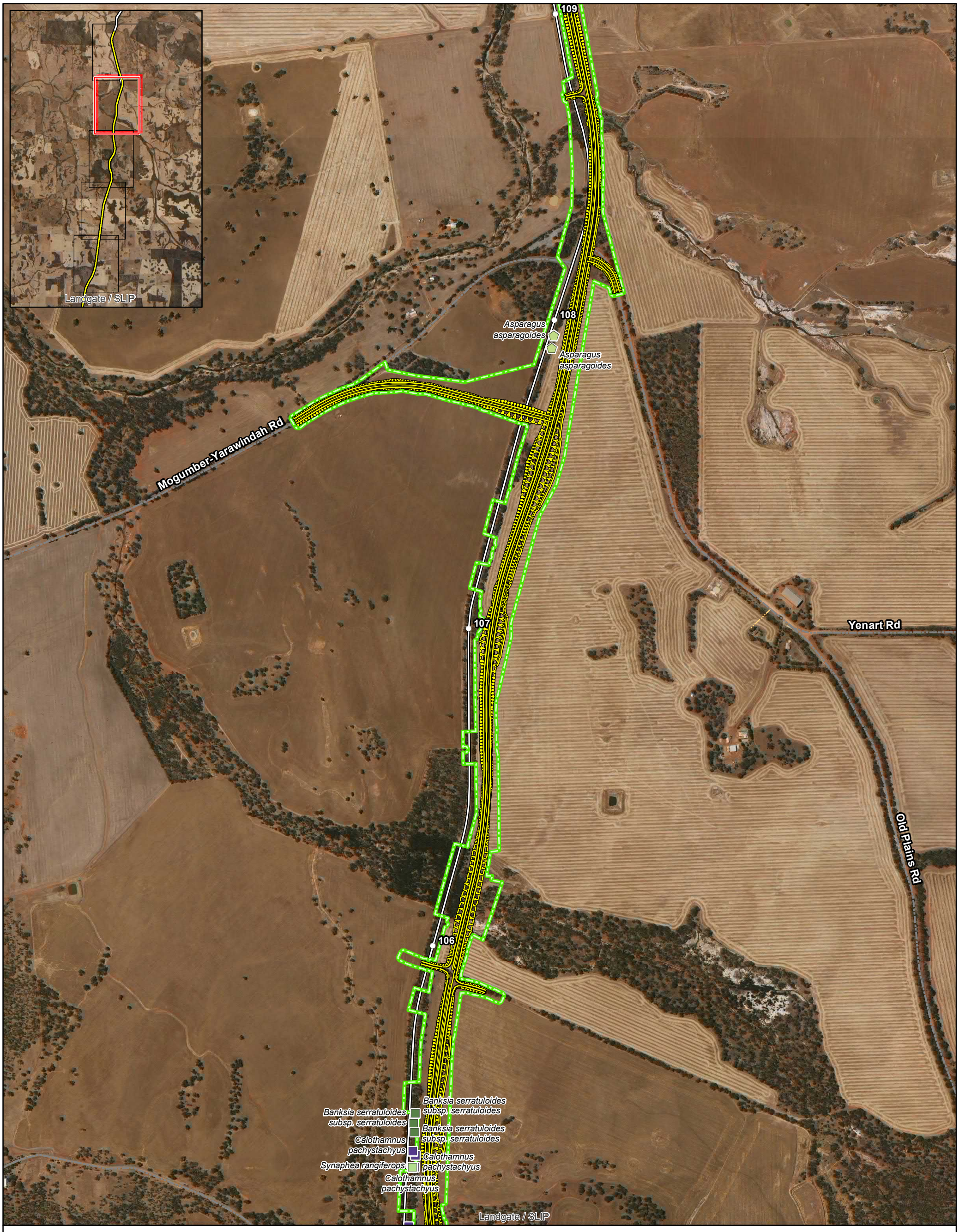
Map 3 of 5: Conservation-significant Flora and Weeds

Drawing No	Issue
GNH-WP05-E-EA-GD-0016	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0016-B.mxd



Legend

- Minor Road
- Track
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Weed

- Asparagus asparagoides

Priority Flora

- Banksia serratuloides subsp. serratuloides (VU)
- Calothamnus pachystachyus (P4)
- Synaphea rangiferops (P2)

Data Source: Main Roads WA, Landgate

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Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
1:11,000

IN PARTNERSHIP WITH
JACOBS ARUP

Main Roads Western Australia
Client

Map 4 of 5: Conservation-significant Flora and Weeds

Drawing No	Issue
GNH-WP05-E-EA-GD-0016	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0016-B.mxd

Legend

- Minor Road
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

Joint Venture Partners:

Arup Pty Ltd
Level 7 Wellington Central
836 Wellington Street
West Perth WA 6005
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www.arup.com

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Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 0.1 0.2
Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
1:11,000

IN PARTNERSHIP WITH

JACOBS ARUP

Main Roads Western Australia
Client

Map 5 of 5: Conservation-significant Flora and Weeds

Drawing No	Issue
GNH-WP05-E-EA-GD-0016	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
21/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0016-B.mxd

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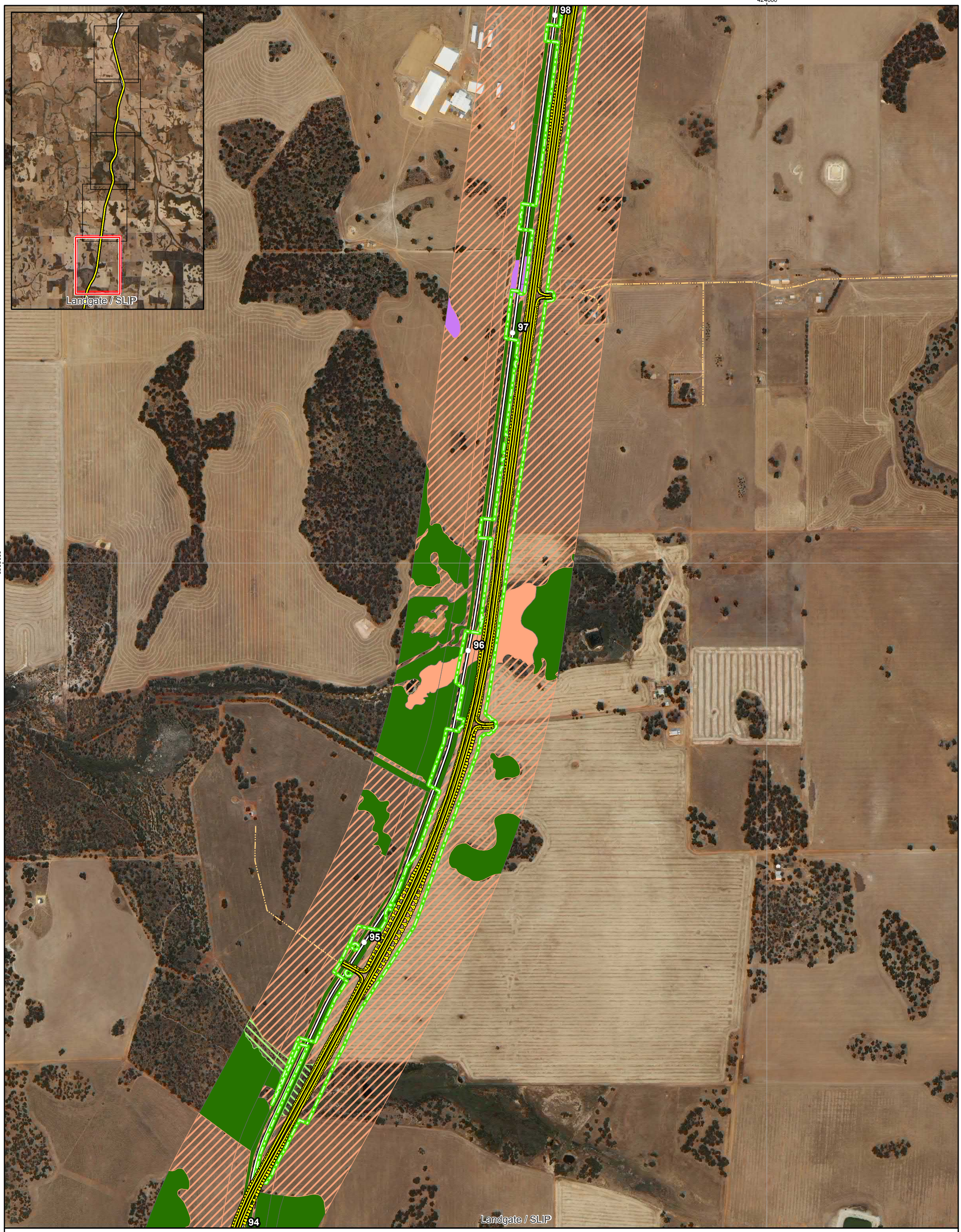

Legend

- 1 - Forest (Jarrah and/or Marri)
- 4 - Woodland (Jarrah, Marri, Wandoo and/or banksia)
- 5 - Woodland (paperbark or sheoak)
- 7 - Cleared and revegetated non-native woodland mosaic
- 8 - Cleared (agriculture, road, infrastructure)
- Track
- Existing GNH Alignment
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres

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1:11,000

Coordinate System: GDA 1994 MGA Zone 50

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Client

Map 1 of 5: Fauna Habitats

Drawing No	Issue
GNH-WP05-E-EA-GD-0015	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0015-B.mxd

424000

6560000

Landgate / SLIP

Burnett Rd

101

100

99

North Rd

98

Landgate / SLIP

Legend

- 4 - Woodland (Jarrah, Marri, Wandoo and/or banksia)
- 7 - Cleared and revegetated non-native woodland mosaic
- 8 - Cleared (agriculture, road, infrastructure)
- Minor Road
- Track
- Existing GNH Alignment
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres

Scale at A3
1:11,000

Coordinate System: GDA 1994 MGA Zone 50

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JACOBS ARUP

Main Roads Western Australia
Client

Map 2 of 5: Fauna Habitats

Drawing No	Issue
GNH-WP05-E-EA-GD-0015	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0015-B.mxd

424000

6564000

105

104

103

102

Landgate / SLIP

Landgate / SLIP

Legend

- 4 - Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)
- 4 - Woodland (Jarrah, Marri, Wandoo and/or banksia)
- 5 - Woodland (paperbark or sheoak)
- 6 - Woodland (paperbark or sheoak)
- 6 - Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)
- 7 - Cleared and revegetated non-native woodland mosaic
- 8 - Cleared (agriculture, road, infrastructure)
- Minor Road
- Existing GNH Alignment
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
1:11,000

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JACOBS ARUP

Main Roads Western Australia
Client

Map 3 of 5: Fauna Habitats

Drawing No	Issue
GNH-WP05-E-EA-GD-0015	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0015-B.mxd

424000

6568000

109

108

107

106

Mogumber-Yarawindah Rd

Yenart Rd

Old Plains Rd

Landgate / SLIP

Landgate / SLIP

Legend

- 3 - Shrubland (thicket)
- 4 - Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)
- 4 - Woodland (Jarrah, Marri, Wandoo and/or banksia)
- 5 - Woodland (paperbark or sheoak)
- 6 - Woodland (paperbark or sheoak)
- 6 - Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)
- 7 - Cleared and revegetated non-native woodland mosaic
- 8 - Cleared (agriculture, road, infrastructure)
- Minor Road
- Track
- Existing GNH Alignment
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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www.jacobs.com

0 0.1 0.2

Kilometres

Coordinate System: GDA 1994 MGA Zone 50

Scale at A3 **1:11,000**

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Main Roads Western Australia

Client

Map 4 of 5: Fauna Habitats

Drawing No	Issue
GNH-WP05-E-EA-GD-0015	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	SP	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0015-B.mxd

424000

6572000

112

111

110

109

Landgate / SLIP

Legend

- 4 - Woodland (Jarrah, Marri, Wandoo and/or banksia)
- 5 - Woodland (paperbark or sheoak)
- 6 - Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)
- 7 - Cleared and revegetated non-native woodland mosaic
- 8 - Cleared (agriculture, road, infrastructure)
- Minor Road
- Existing GNH Alignment
- Bindoon Bypass – Northern Section Concept Alignment
- Application Area

Data Source: Main Roads WA, Landgate

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Kilometres

Scale at A3
1:11,000

Coordinate System: GDA 1994 MGA Zone 50

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JACOBS ARUP

Main Roads Western Australia
Client

Map 5 of 5: Fauna Habitats

Drawing No	Issue
GNH-WP05-E-EA-GD-0015	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	SP	JD	JD

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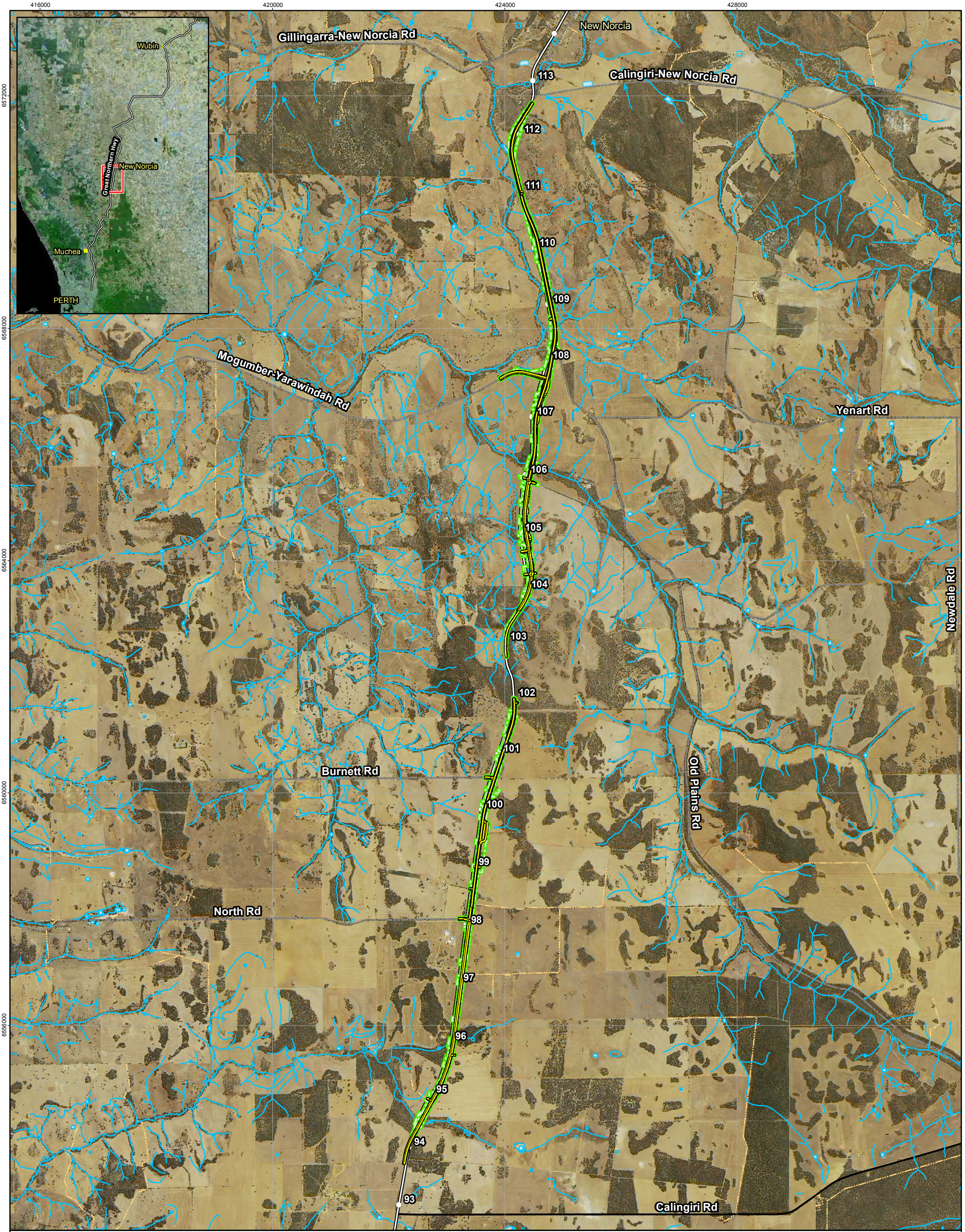

Legend

- Straight Line Kilometre Marker (1km)
- Bindoon Bypass – Northern Section Concept
- Existing GNH
- Main Road
- Minor Road
- Track
- Watercourse
- Application Area
- Water Body

Data Source: Main Roads WA, Landgate

Joint Venture Partners:

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0 0.65 1.3
Kilometres
Coordinate System: GDA 1994 MGA Zone 50

Scale at A3
1:60,000

IN PARTNERSHIP WITH
JACOBS ARUP

Main Roads Western Australia
Client

Hydrological Features near the Bindoon Bypass – Northern Section

Drawing No	Issue
GNH-WP05-E-EA-GD-0014	A

Job No	Drawing Status / Other
NA	Final

Date	By	Chkd	Appd
19/06/2019	FK	JD	JD

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\WP05\GNH-WP05-E-EA-GD-0014-B.mxd

Project

Appendix A. Land Parcels that Intersect with Bindoon Bypass – Northern Section

Certificate of Title Property Name / Number
· FHOLD, LOT 4 Plan P006398, GREAT NORTHERN HWY, WANNAMAL, 6505 · FHOLD, LOT 21 Plan P022601, GREAT NORTHERN HWY, WANNAMAL, 6505 · CROWN, LOT 3234 Plan P152709, GREAT NORTHERN HWY, WANNAMAL, 6505 · FHOLD, LOT 401 Plan P041111, GREAT NORTHERN HWY, NEW NORCIA, 6509 · FHOLD, LOT 82 Plan P074123, GREAT NORTHERN HWY, WANNAMAL, 6505 · FHOLD, LOT 50 Plan D004980, GREAT NORTHERN HWY, NEW NORCIA, 6509 · FHOLD, LOT 2 Plan P006399, GREAT NORTHERN HWY, WANNAMAL, 6505 · FHOLD, LOT M1991 Plan D014747 GREAT NORTHERN HWY, YARAWINDAH, 6509 · CROWN, LOT 102 Plan P156300 · CROWN, LOT 77 Plan P162731 · CROWN, LOT 3509 Plan P207394, MOGUMBER-YARAWINDAH RD, YARAWINDAH, 6509 · FHOLD, LOT 624 Plan P063644 MOGUMBER-YARAWINDAH RD, YARAWINDAH, 6509 · CROWN, LOT 4131 Plan P190016 · FHOLD, LOT 621 Plan P063642 GREAT NORTHERN HWY, YARAWINDAH, 6509 · CROWN, LOT 464 Plan P246379 · CROWN, LOT 365 Plan P245118 · FHOLD, LOT 1 Plan P013508 · CROWN, LOT 354 Plan P245110 · CROWN, LOT 3246 Plan P152749 GREAT NORTHERN HWY, WANNAMAL, 6505 · FHOLD, LOT 81 Plan P074123 · FHOLD, LOT 622 Plan P063643 YENART RD, YARAWINDAH, 6509 · CROWN, LOT 539 Plan P246476 · FHOLD, LOT 400 Plan P041111 · FHOLD, LOT M1903 Plan P005926, OLD PLAINS RD, YARAWINDAH, 6509 · FHOLD, LOT 623 Plan P062546, GREAT NORTHERN HWY, YARAWINDAH, 6509 · FHOLD, LOT 8 Plan P009755 · FHOLD, LOT 3 Plan P006398, GREAT NORTHERN HWY, WANNAMAL, 6505 · FHOLD, LOT 11 Plan P024201, GREAT NORTHERN HWY, YARAWINDAH, 6509 · LandID: 3361820 / Road · LandID: 3367821 / ROAD · LandID: 3367817 / ROAD · LandID: 3367819 / ROAD · LandID: 3536236 / Road · LandID: 3536371 / Road · LandID: 3367823 / ROAD · LandID: 3367824 / ROAD · LandID: 3367818 / ROAD · LandID: 3536234 / Road · LandID: 3361819 / Road · LandID: 3058749 / R 7615 · LandID: 3536317 / Road · LandID: 3536318 / Road · LandID: 3536373 / Road · LandID: 3700058 / MOGUMBER-YARAWINDAH ROAD · LandID: 3367826 / ROAD · LandID: 3361824 / Road

Certificate of Title Property Name / Number
· LandID: 3536372 / Road · LandID: 3367827 / ROAD · LandID: 3191439 / Road · LandID: 3355420 / Easement 7/27A (401) · LandID: 3536235 / Road · LandID: 3367822 / ROAD · LandID: 3367825 / ROAD · LandID: 3702947 / BURNETT ROAD · LandID: 3536237 / Road · LandID: 3700059 / ROAD · LandID: 3536238 / Road · LandID: 3536233 / Road · LandID: 3536370 / Road · LandID: 3699998 / NORTH ROAD · LandID: 3536294 / Road · LandID: 3361821 / Road · LandID: 3536316 / Road · LandID: 3367820 / ROAD · LandID: 3536232 / Road · LandID: 3845473 / LOT 323 · LandID: 3845361 / LOT 321 · LandID: 3845239 / LOT 324 · LandID: 3845401 / LOT 322

Appendix B. Flora and Fauna Assessment for Calingiri Survey area (Phoenix, 2019)

PHOENIX
ENVIRONMENTAL SCIENCES

Flora and fauna assessment for Calingiri 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)

April 2019

Final Report

Flora and fauna assessment for Calingiri 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: Dr Grace Wells, Anna Leung

Reviewer: Karen Crews

Date: 10 April 2019

Submitted to: Jonathan Davies

Version history			
Name	**Status**	**Version**	**Date**
K. Crews	Draft issued for client review	A	16/05/2018
A. Leung	Client comments addressed	B	05/07/2018
Dr Grace Wells	Update to TEC assessment within Calingiri study area	C	05/12/2018
K. Crews	Update to vegetation asociations	D	15/02/2019
K.Crews	Update to TEC assessment	E	10/04/2019

Phoenix Environmental Sciences Pty Ltd

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E: admin@phoenixenv.com.au

Project code: 1170-GNH-JA-ECO

Contents

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ABBREVIATIONS

AWC – Australian Weeds Committee

BAM Act – *Biosecurity and Agriculture Management Act 2007*

BC Act – *Biodiversity Conservation Act 2016*

BoM – Bureau of Meteorology

CAMBA – China-Australia Migratory Bird Agreement

CR – Critically Endangered

D – Depleted

DBCA – Department of Biodiversity, Conservation and Attractions

DBH – diameter at breast height

DoE - Department of the Environment

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

ROKAMBA – Republic of Korea Migratory Bird Agreement

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 flora and fauna assessments for a number of proposed work packages, including Calingiri (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, vegetation and significant weeds
- fauna survey including a habitat assessment and mapping, targeted searches and assessment of likelihood of occurrence 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 and foraging habitat for Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*).

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 over four survey phases between October 2014 and March 2018 to accommodate changes to the study area. A total of 42 quadrats and five relevés were sampled during the survey period. Targeted flora and fauna searches were conducted in habitats considered likely to contain or support conservation significant species, and in the vicinity of previous records.

No Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) were identified within the study area from the initial desktop review; however, subsequent database searches in 2016 identified the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Critically Endangered Eucalypt Woodlands of the Western Australian Wheatbelt TEC within the study area. Subsequently, site assessments were undertaken at 99 sites to determine presence and extent of the TEC in the study area.

Descriptions of vegetation undertaken in the field were matched to broadscale vegetation associations in line with previous surveys in the vicinity. Known foraging vegetation associations/genera for black cockatoo species were cross-referenced with the vegetation association mapping from the survey to determine areas with potential feeding value to black cockatoos.

From the desktop review, 24 Threatened Flora species listed under the EPBC Act and *Wildlife Conservation Act 1950* (WC Act) and a further 68 Priority Flora listed by the Department of Biodiversity, Conservation and Attractions (DBCA) were identified as potentially occurring within the study area. Records of 12 significant flora occurred within the study area.

A total of 296 plant taxa including subspecies and varieties representing 55 families and 154 genera were recorded in the study area during the field surveys. The assemblage comprised 244 native species and 52 weed species. The most prominent families were Poaceae, Fabaceae, Proteaceae and Myrtaceae.

Fifteen conservation significant flora represented by 398 individual plants were recorded in the study area:

- *Acacia anarthros* (P3)
- *Acacia drummondii* subsp. *affinis* (P3)
- *Banksia serratuloides* subsp. *serratuloides* (VU; EPBC Act, WC Act)
- *Calothamnus pachystachyus* (P4)
- *Conospermum densiflorum* subsp. *Unicephalatum* (EN; EPBC Act, WC Act)
- *Daviesia debilior* subsp*. sinuans* (P3)
- *Grevillea drummondii* (P4)
- *Hakea chromatropa* (P1)
- *Hibbertia miniata* (P4)
- *Hibbertia montana* (P4)
- *Leucopogon darlingensis* subsp*. rectus* (P2)
- *Melaleuca sclerophylla* (P3)
- *Persoonia sulcata* (P4)
- *Synaphea grandis* (P4)
- *Synaphea rangiferops* (P2).

A single *Banksia serratuloides* subsp. *serratuloides* population of 22 plants was recorded at a known DBCA population. A single *Conospermum densiflorum* subsp*. unicephalatum* population comprising four plants at two locations was recorded; this is not a known DBCA population.

One declared pest and weed of national significance (WoNS), **Asparagus asparagoides*, was recorded at several locations in the study area. The desktop review also identified previous records in the study area for five other declared pests and WoNS: **Moraea flaccida, *Moraea miniata*, **Echium plantagineum,* **Oxalis pes-caprae* and **Carthamus lanatus*.

Eleven vegetation associations were defined locally which collectively occupy 380.5 ha (26%) of the study area, with the remaining 74% consisting of cleared areas. The vegetation associations recorded represented mostly medium woodlands comprising of Wandoo, York Gum, Flooded Gum and/or Marri. The condition of native vegetation within the study area ranged from degraded to excellent with excellent vegetation condition comprising 32.4 ha.

None of the remnant vegetation in the study area was determined to represent any TECs or PECs.

All but one of the vegetation associations identified in the study area may be considered locally significant as they represent habitat for Threatened and/or Priority flora, were recorded to be in excellent condition and/or may be locally restricted. Eight vegetation associations (4, 7, 36, 352, 946, 999, 1034 and 1182), may be considered regionally conservation significant as less than 30% of their pre-European extent remains at the Statewide and/or bioregional scale. These eight vegetation associations occupy 339.6 ha (23%) of the study area.

Five fauna habitat types were mapped within remnant native vegetation of the study area based on aggregations of the mapped vegetation associations. These were classified into three woodland habitats, one shrubland and one forest habitat type. Three areas were noted to be of potential value: Seven Mile Well Nature Reserve, a remnant ~800 m south of this which links to the reserve, and areas of remnant vegetation approximately 3–4 km north of Udumung Nature Reserve where a larger area of remnant native vegetation extends west of the study area. These woodlands provide potential habitat for some conservation significant species, largely due to their intact understory and connectivity to remnant vegetation outside the study area.

The desktop review identified 13 conservation significant species considered to be of potential relevance to the study area. This included seven Threatened or Protected Fauna under the EPBC Act and/or WC Act, one Migratory species and five Priority species.

One of these was recorded in the surveys, Carnaby's Black Cockatoo *Calyptorhynchus latirostris* (EN; EPBC Act, WC Act) with numerous records of direct observation and extensive foraging evidence observed. The study area is an important breeding and foraging area for Carnaby's Cockatoo. A total of 44 confirmed nesting trees from the 83 trees with hollows suitable for breeding were recorded, as well as a high density of potential breeding trees (4,146 in total) indicating its short- and long-term value as breeding habitat for the species.

An incorrect NatureMap record in the study area for the Threatened species *Idiosoma nigrum* is now classified as the Julimar shield-backed Trapdoor Spider *I. mcclementsorum* (P2) due to a recent revision of the *Idiosoma* genus. There is very limited habitat information for *I. mcclementsorum*; based on a brief review, habitat may include open woodland and forest on laterite or sandy sou. As this is present in the study area, it is possible additional populations exist.

A further six conservation significant species were considered to have potential to occur in the study area: Western Quoll (VU; EPBC Act, WC Act), Mogumber Bush Cricket (P3 - DBCA), Fork-tailed Swift (Mig.; EPBC Act, WC Act), Peregrine Falcon (OS; WC Act), Forest Red-tailed Black Cockatoo (VU; EPBC Act, WC Act) and Baudin's Cockatoo (EN; EPBC Act; WC Act).

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 (Main Roads WA, Jacobs and Arup) to conduct a comprehensive planning review of the full Muchea to Wubin link; Muchea to Wubin Upgrade Stage 2 (the Project; Figure 1-1). As part of the Project, upgrades are proposed for several sections (work packages) of GNH, including Calingiri work package.

In September 2014, Phoenix Environmental Sciences Pty Ltd (Phoenix) was appointed by the Muchea to Wubin Integrated Project Team to undertake flora and fauna assessments for the proposed work packages. A series of biological surveys were subsequently undertaken for the Calingiri work package between October 2014 and March 2018.

1.2 PURPOSE

The purpose of this report is to document and consolidate the results of the suite of biological surveys completed by Phoenix for the Calingiri work package to inform an environmental impact assessment of this section of the Project. It therefore consolidated survey results presented in previous technical reports that cover the Calingiri work package (Phoenix 2015, (Phoenix 2016b, 2017) and those of more recently conducted surveys.

1.3 STUDY AREA

The study area for the surveys of the Calingiri work package was located between straight line kilometre (SLK) 92.67 and SLK 112.42 and is a consolidation of results from from the Spring 2017/Autumn 2018 field survey and study areas reported in earlier survey reports prepared by Phoenix for the Muchea to Wubin Upgrade Stage 2 Project (Figure 3-1):

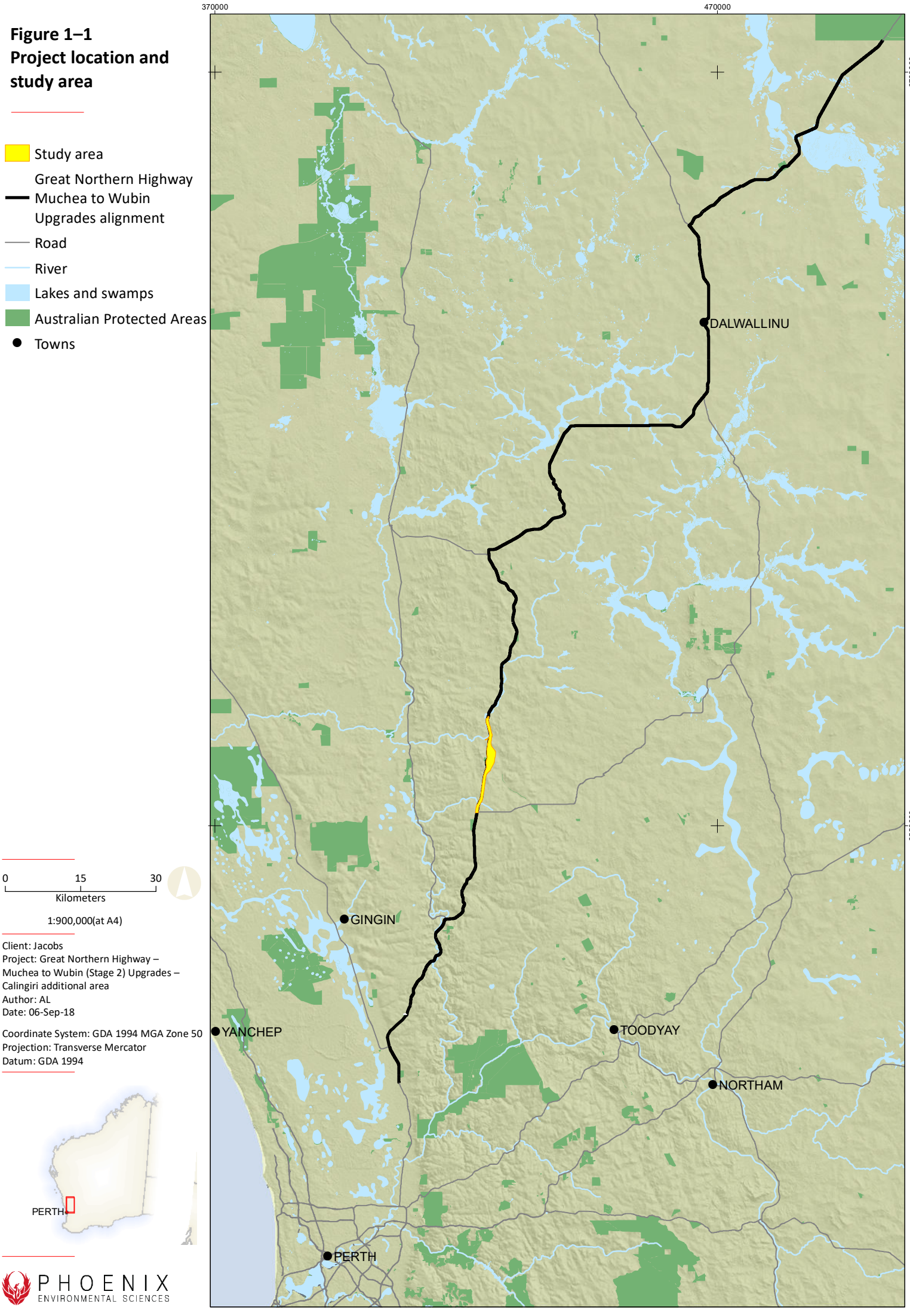
- Phase 1 study area, surveyed spring 2014 (Phoenix 2015)
- Phase 2 study area, surveyed autumn 2015, spring 2015 and autumn 2016 (Phoenix 2016b)
- Phase 3 study area, surveyed spring 2016 (Phoenix 2017)
- Phase 4 study area, surveyed spring 2017 and autumn 2018 (Phoenix 2018b)

The total area was approximately 1,470 ha.

Note that the study area defined in this report does not cover all areas surveyed as the Calinigiri work package in earlier surveys; specifically,the Calingiri section historically extended further south approximately 14 km to SLK 80.6. This southern portion was subsequently removed due to the confirmation of the Bindoon Bypass Project, which will tie in to the Calingiri work package at the southern end of the study area.

The extrapolation survey area in Figure 3-1 is the area within which native vegetation mapping was extrapolated based on vegetation mapping conducted in the study area. This extended approximately 500 m outside the phase 1 – phase 3 study areas.

Figure 1–1
Project location and study area



1.4 SCOPE OF WORK

The scope of work comprised:

- biological desktop review
- flora and vegetation field survey entailing
    - delineation and mapping of vegetation associations by quadrat sampling
    - mapping of vegetation condition
    - targeted searches for conservation significant flora and vegetation, and significant weeds
- extrapolation of remnant native vegetation associations in the extrapolation survey area.
- fauna survey entailing
    - habitat assessment and mapping
    - likelihood of occurrence assessment and targeted searches for conservation significant fauna
    - survey of potential breeding trees, roosting sites/habitat and feeding sites/habitat for black cockatoo species, particularly Carnaby's Cockatoo.

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)
- Western Australian *Wildlife Conservation Act 1950* (WC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act).

The WA *Biodiversity Conservation Act 2016* (BC Act) in its full effect will replace the WC Act on 1 January 2019.

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 and fauna and threatened ecological communities (TECs) as matters of NES.

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

- Extinct (EX)[1] – 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[1] – 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' (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).

[1] 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

In WA, the WC Act provides for the listing of flora and fauna species which are under identifiable threat of extinction as specially protected (Rare or Threatened Flora and Threatened Fauna; T)[2]. Under current classifications (Western Australian Government 2017a), Threatened Flora are assigned to one of four categories (schedules; Appendix 1):

- 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).

Under current classifications, protected fauna are assigned to one of seven categories under the WC Act (Western Australian Government 2017b) (Appendix 1):

- 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 (OS) fauna.

Threatened fauna species are listed under schedules 1–4. Assessments for listing of both flora and fauna are based on the International Union for Conservation of Nature threat categories.

The Department of Biodiversity Conservation and Attractions (DBCA) 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 threat levels imposed on them. Species on the Priority Flora and Fauna lists are assigned to one of five priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern (Appendix 1).

[2] This function of the WC Act will be replaced by the BC Act when the relevant BC Act regulations come into effect on 1 January 2019.

2.2.1 Threatened and Priority communities

The Minister for Environment may list ecological communities, which are at risk of becoming destroyed as 'Threatened'[3]. DBCA maintains a list of ministerial-endorsed Threatened Ecological Communities (TECs) which fall into three categories:

- Critically endangered (CR)
- Endangered (EN)
- Vulnerable (VU).

There is an additional category, Presumed Totally Destroyed, where all records of the ecological community within the last 50 years have been destroyed or presumed to be destroyed.

The DBCA also maintains a non-statutory list of Priority Ecological Communities (PECs), which may become Threatened Ecological Communities in the future, however currently that do not meet survey criteria or that are not adequately defined. PECs are assigned to one of five categories depending on their priority for survey or definition, with Priority 1 of highest concern and Priority 5 of lowest concern (Appendix 1).

2.2.2 Significant flora and vegetation

Flora and vegetation may be considered significant for a range of reasons, including, but not limited to the following (EPA 2016a):

- flora
    - being identified as threatened or priority species
    - locally endemic or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
    - new species or anomalous features that indicate a potential new species representative of the range of a species (particularly, at the extremes of range recently discovered range extensions, or isolated outliers of the main range)
    - unusual species, including restricted subspecies, varieties or naturally occurring hybrids
    - relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape
- vegetation
    - being identified as threatened or priority ecological communities
    - restricted distribution
    - degree of historical impact from threatening processes
    - a role as a refuge
    - providing an important function required to maintain ecological integrity of a significant ecosystem.

[3] The BC Act will allow for the listing of TECs when the relevant BC Act regulations come into effect on 1 January 2019.

A vegetation association is considered under represented if there is less than 30% of its original distribution remaining. 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[4] – <10% of pre-European extent remains
- Vulnerable[4] – 10-30% of pre-European extent exists
- Depleted[4] – >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.

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 Environmentally Sensitive Areas (ESAs). ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (DMP 2008).

ESAs are 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 structural and biological 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).

[4] or a combination of depletion, loss of quality, current threats and rarity gives a comparable status.

Management of some weed species is required under State or Federal frameworks. Key weed classifications for significant weeds that are relevant to this report are:

- Declared pest – the *Biosecurity and Agriculture Management Act 2007* (BAM Act), Section 22 makes provision for a plant taxon to be listed as a declared pest organism in parts of, or the entire State. Under the *Biosecurity and Agriculture Management Regulations 2013* declared pests are assigned to one of three control categories that dictate level of management required (Table 2-1).
- Weed of National Significance (WoNS) – high impact, established weeds causing major economic, environmental, social and/or cultural impacts in a number of states/territories, and which have strong potential for further spread (Australian Weeds Committee 2012). Management is required in accordance with Department of Agriculture and Food guidelines for particular WoNS.

Throughout this report, introduced flora species are indicated with an asterisk (*).

Table 2-1 Description of control categories for declared pests (Government of Western Australia 2013)

Control Category	Description
C1 Exclusion	If in the opinion of the Minister introduction of the declared pest into an area or part of an area for which it is declared should be prevented
C2 Eradication	If in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is feasible
C3 Management	If in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is not feasible but that it is necessary to — (i) alleviate the harmful impact of the declared pest in the area; or (ii) reduce the number or distribution of the declared pest in the area; or (iii) prevent or contain the spread of the declared pest in the area.

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
    - available 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 (Table 3-2)
- assessment and mapping of broad-scale vegetation in the study area.

The desktop review was initially conducted for the entire Project (Muchea North to Wubin) in September 2014 (Phoenix 2015) and this 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 or new database searches were undertaken for subsequent surveys. Species and community conservation listings under the EPBC Act and at the State level were updated in April 2018 to reflect current conservation status.

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 1995)
- climate (BoM 2016)
- land systems – landforms and soils.

Table 3-1 Databases searches conducted for the desktop review

Database	Target group/s	Search coordinates and extent
Protected Matters database via the online Search Tool in 2014 and 2017/ and 2018 (Department of the Environment 2016b; DoEE 2017a, 2018b)	EPBC Act Threatened Flora, TECs, Threatened Fauna and Migratory species	GDA94; Polyline of study area SLK (approximate) with a 1 km buffer.
DBCA Threatened and Priority Flora database and WA Herbarium database in 2014, 2016 and 2017 (DBCA 2017; DPaW 2014c, 2016b)	WC Act Threatened and Priority Flora	GDA94; Polyline of study area SLK (approximate) with a 2 km buffer.
DBCA/DPaW Threatened and Priority Ecological Communities database in 2014 and 2016 (DPaW 2014d, 2016b)	TECs and PECs	GDA94: 30 km radius of the GNH polyline coordinates from 31° 36' 14.7" S 116° 00' 33.9" E to 30° 05' 11.3" S 116° 39' 26.9" E in 2014. Additional search of SLK 80 to 257 specifically for EPBC Act listed TEC, Eucalypt Woodlands of the Western Australian Wheatbelt in April 2016.

Database	Target group/s	Search coordinates and extent
DBCA/DPaW Threatened Fauna database in 2014 and 2016 (DPaW 2014d, 2016b)	WC Act Threatened and Priority Fauna	GDA94: 10 km buffer of the GNH polyline from Muchea to Wubin (search extent set by DPaW).
DBCA/DPaW NatureMap databases, including Western Australian Herbarium records in 2014, 2016 and 2018 (DBCA 2018c; DPaW 2014b, 2016a)	Threatened and Priority Flora, weeds and all potentially occurring fauna	GDA94; Polyline of study area SLK (approximate) with a 1 km buffer for flora and 10 km buffer for fauna.
Department of Agriculture and Food, Western Australian Organism List (WAOL) (DPIRD 2018)	Declared pests	All introduced species returned from database searches were checked against the WAOL for declared pests.
DoEE WoNS list (DoEE 2018a; DotE 2015)	WoNS	All introduced species returned from database searches were checked against the DoEE WoNS list.
Western Australian Land Information System in 2015 and 2017 (WALIS)	ESAs	Shared Land Information Platform (SLIP), Landgate location maps (updated 01/12/2015).
Birdlife Australia Birdata database in 2015 and 2016 (Birdlife Australia 2014, 2016)	All potential avian fauna records, including Threatened and Migratory bird species	GDA94; Polyline of study area SLK (approximate) with a 10 km buffer.

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)
Great Northern Highway flora and vegetation assessment – SLK 89 to SLK 114 (ENV 2007)	89–114
Declared Rare Flora survey. *Banksia serratuloides* subsp. *serratuloides* (Maunsell AECOM 2008)	104.8

3.2 FIELD SURVEY

3.2.1 Flora and vegetation

Flora and vegetation was assessed over seven seasonal periods between spring 2014 and autumn 2018 with a number of field surveys conducted to accommodate several changes to the study area.

An initial spring season flora and vegetation field survey was undertaken in October–November 2014 (Phase 1 survey area; Figure 3-1; Table 3-3). Field assessment methodology involved description of vegetation associations and condition, and all species present (including weeds) at locations in remnant and planted vegetation using quadrat, relevé and opportunistic sampling, and included searches for conservation significant flora, declared pests and WoNS. Pastures and completely degraded areas were not surveyed.

In March 2015, a follow up assessment was conducted in the Phase 1 survey area to ground-truth the accuracy of previous vegetation mapping and conduct additional searches for conservation significant flora. A preliminary flora and vegetation survey was undertaken in the phase 2 survey area. Broad vegetation descriptions in new areas were compared with adjacent areas already assessed to determine if communities aligned. These were also compared with habitat of conservation significant flora in the vicinity to assess potential for occurrence. Quadrat locations were also selected for a follow up spring survey.

A second spring field survey was conducted in October–November 2015 in the Phase 2 survey area (Figure 3-1; Table 3-3) in areas which were not surveyed in spring 2014. Survey methods from the spring 2014 survey were replicated in the new areas. Further ground-truthing of boundaries of previously mapped vegetation associations condition was also conducted. In the targeted searches for conservation significant flora more detailed survey effort was employed in vegetation associations that records were previously made during the spring 2014 survey.

In April 2016, a follow up field survey, including targeted conservation significant flora searches, was conducted in areas previously sampled only once (spring 2015) to meet Level 2 survey effort (EPA 2004b) across the entire Phase 2 survey area. Vegetation association and condition mapping was refined following groundtruthing of mapping undertaken in spring 2015.

Additional areas were surveyed in September and November 2016 (Phase 3 survey area; Figure 3-1; Table 3-3), and in October – November 2017 and March 2018 (Phase 4 survey area; Figure 3-1; Table 3-3). Survey methods were consistent with those of the previous surveys. Taking into account all survey work completed, all remnant vegetation in the study area has been sampled to the level of detailed flora and vegetation survey in accordance with EPA technical guidance (EPA 2016a).

Total survey effort over the series of field surveys was approximately 395 person hours (Table 3-3). The surveys were conducted in accordance with EPA guidance that was current at the time of each survey, i.e.:

- EPA *Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment* (EPA 2016a) – for surveys conducted in 2017 and 2018
- EPA Guidance Statement No. 51: *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* (EPA 2004b) and Technical Guide: *Flora and vegetation surveys for environmental impact assessment* (DPaW and EPA 2015) – for surveys conducted in 2016 or earlier.

Figure 3–1
Survey areas for each survey phase

- Study area
- Phase 3 survey area - "Gaps study area" (Surveyed spring 2016 (Phoenix 2017))
- Phase 1 survey area (Surveyed spring 2014 (Phoenix 2015))
- Phase 2 survey area (Surveyed autumn 2015-autumn 2016 (Phoenix 2016))
- Phase 4 survey area - additional areas (Surveyed spring 2017-autumn 2018)

0 1 2
Kilometers

1:70,000 (at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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Table 3-3 Survey timing and effort for the flora and vegetation survey

Survey area	Survey dates	No. person hours (approx.)[1]	Work undertaken
Phase 1 survey area (107.35 ha)	16 Oct – 4 Nov 2014	10	Quadrats, relevés, targeted search for conservation significant flora and declared pests/WoNS, vegetation description and vegetation condition assessment
Phase 1 and 2 survey areas (263.54 ha)	17 – 20 March 2015	40	Preliminary quadrats in the phase 2 survey area, targeted search for conservation significant flora, description and delineation of vegetation association and condition in the phase 1 and 2 study areas
Phase 2 survey area (242.69 ha)	2 & 6 – 9 Oct, & 11 Nov 2015	148	First (spring) season of detailed flora and vegetation survey. Quadrats, targeted search for conservation significant flora and declared pests, description and delineation of vegetation association and condition
Phase 2 survey area (242.69 ha)	6 – 7 April 2016	48	Second (autumn) season of detailed flora and vegetation survey Quadrats, delineation of vegetation associations and condition
Phase 3 survey area (50.17 ha)	5 September – 24 November 2016	41[2]	Quadrats, targeted search for conservation significant flora and declared pests, description and delineation of vegetation association and condition
Phase 4 survey area (1154.7 ha)	20 October 2017, 1–3 November 2017, 14 November 2017	60	First (spring) season of detailed flora and vegetation survey (quadrat, transect, relevé and opportunistic sampling in remnant and planted vegetation), targeted significant flora searches, transect searches for threatened orchids and Eucalypt Woodlands of the Western Australian Wheatbelt TEC assessment
Phase 4 survey area (1154.7 ha)	6–7 March 2018	48	Second (autumn) season of detailed flora and vegetation survey to re-sample quadrats, ground-truth the accuracy of vegetation association and vegetation condition boundaries and conduct additional searches for significant flora, and further Eucalypt Woodlands of the Western Australian Wheatbelt TEC assessment

[1] Includes travel time. [2] Estimated time due to the time spent in other areas of the survey area were not delineated, a total of 576 hours were spent in the phase 3 Calingiri to Wubin survey area.

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 subsequent field surveys, previous survey data was also loaded onto the devices. In the field, the location of all quadrats, relevés, conservation significant flora and declared pests and WoNS were recorded on GPS or PDA devices.

3.2.1.1 Quadrat and relevé selection

In total, 42 quadrats and 5 relevés were selected and sampled over the survey period (Appendix 2; Figure 3-2). All quadrats were sampled twice, including at least one spring sampling event. 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.

Quadrat locations were selected to ensure that an adequate representation of the major vegetation associations and flora present within the study area was sampled. This was achieved by pre-selecting locations for 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 associations 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. Additional relevés were selected during the field surveys to match vegetation described within other quadrats to facilitate mapping of vegetation association boundaries.

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

- location – the coordinates of the quadrat were recorded in GDA 94 projection
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (NVIS) (2003) (Appendix 4)
- 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 using appropriate condition scale for the South-West Botanical Province (EPA 2016a)[5] (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

[5] Survey phases conducted prior to the release of this guidance applied Keighery (1994) which is consistent with EPA (2016).Keighery, B. 1994. *Bushland plant survey: a guide to plant community survey for the community*. Wildflower Society of WA (Inc.), Nedlands, WA.

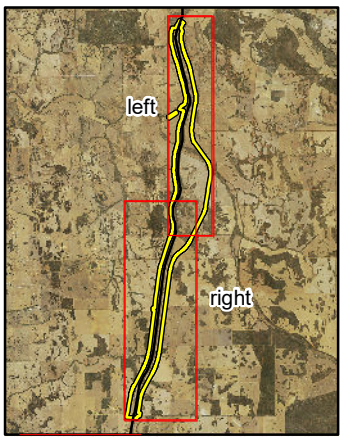
- species list – the name of every species present in the quadrat; where species were located that were unknown to the botanist conducting the survey, or field identification was not certain, a specimen was collected and pressed for later identification.

Table 3-4 Vegetation condition rating scale (EPA 2016a)

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

Figure 3–2
Survey sites

Study area
Quadrat
Relevé
TEC sites



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Kilometers

1:37,000 (at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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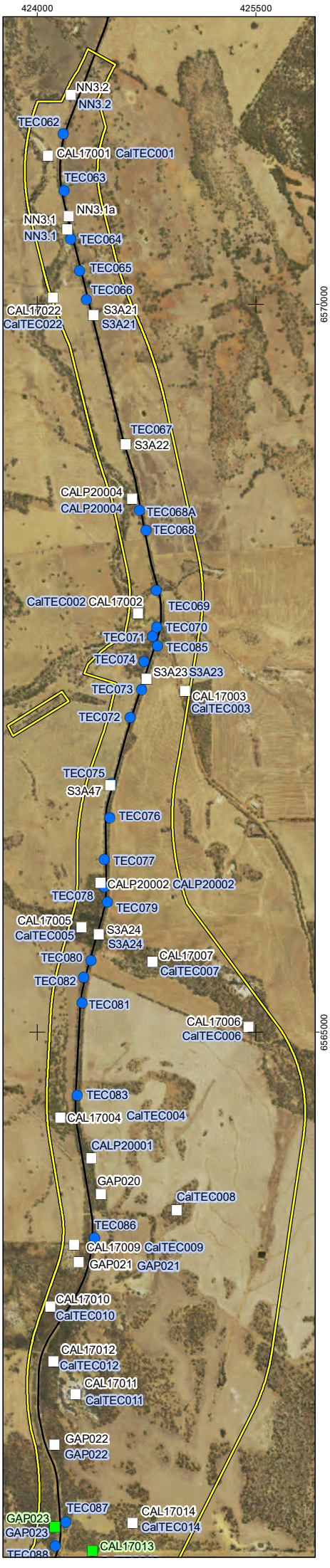

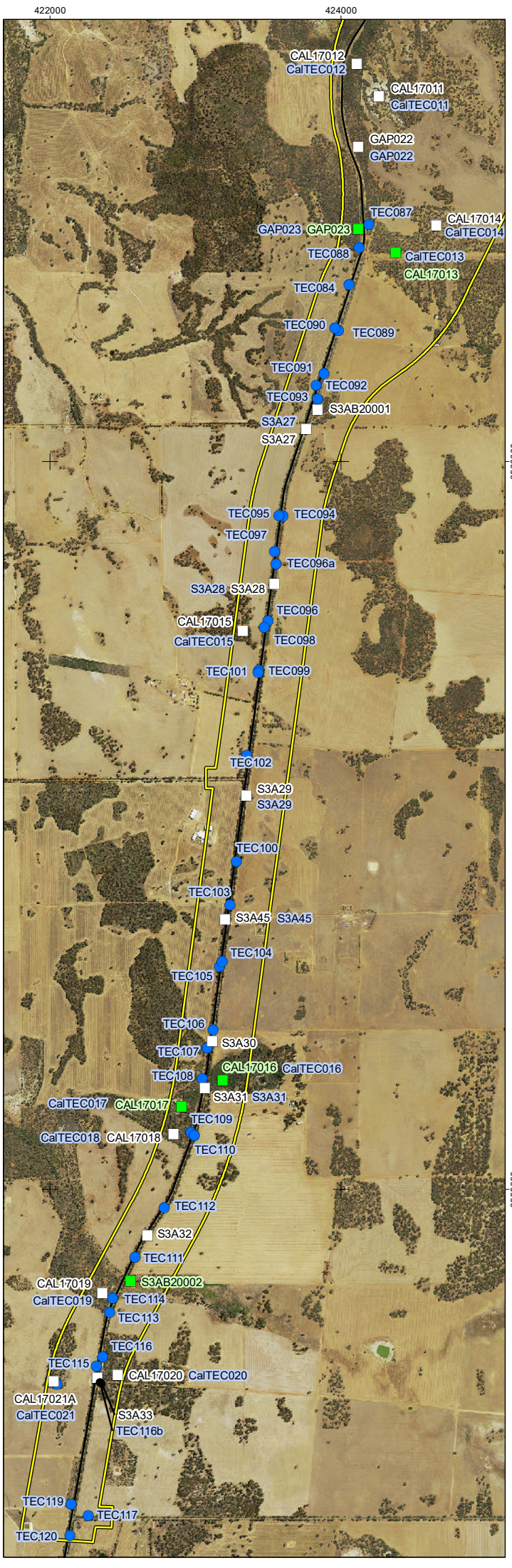

3.2.1.2 Targeted flora searches

Targeted searches were undertaken in the study area for conservation significant species identified from the desktop review. 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. Most remnant vegetation patches were traversed by foot.

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 pest and WoNS recorded, the following information was documented:

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

A detailed desktop assessment in 2016 was conducted for three EPBC Act listed orchids that have previously been recorded within 40 km of the study area Table 3-5:

- *Drakaea elastica* Lindl. (glossy-leaved hammer-orchid; EN)
- *Diuris drummondii* Lindl. (tall donkey orchid; VU)
- *Thelymitra stellata* Lindl. (star sun-orchid; EN).

A detailed habitat assessment and mapping was undertaken for each species by an orchid specialist, Dr Andrew Batty in 2016. This included identification of suitable habitat based on existing vegetation mapping and field reconnaissance to further refine suitable habitat extent.

No suitable habitat was identified for *Drakaea elastica* (*Banksia* and white sand) or *Diuris drummondii* (heavy soil/peat along seasonal creek lines), therefore these species were considered unlikely to occur in the study area and transect searches were not conducted for these species.

Suitable habitat was identified for *Thelymitra stellata* in the very south of the study area (and further south along the GNH alignment). A quadrat survey and transect foot searches were undertaken at known locations of the species to characterise the local habitat in spring 2016. A single plant of *T. stellata* south of the study area was monitored to determine the optimal flowering time to undertake transect searches

Parallel transect foot searches were subsequently undertaken for *Thelymitra stellata* at 5-10 m spacing in all suitable habitat for the species, consistent with the methodology of the Survey Guidelines for Threatened Orchids (Department of the Environment 2014).

Table 3-5 Orchid detectability information (Department of the Environment 2014c)

Species	EPBC Act status	Landscape-scale habitat	Peak detectability	Similar species	Nearest record
Drakaea elastica Lindl. (glossy-leaved hammer-orchid)	EN	In sandy soil adjacent to winter-wet depressions, swamps and water courses, growing in mixed woodlands, often under *Kunzea* species	Peak flowering period: late September to early November Dormant between December and late April *Drakaea elastica* likes open sites and is often found on old, disused tracks and firebreaks	Similar species: *Drakaea concolor* (Kneeling hammer orchid) T VU	Approx. 20 km southwest of study area
Diuris drummondii Lindl. (tall donkey orchid)	VU	Low-lying depressions in peaty and sandy, clay swamps	Peak flowering period: late October to mid January. Note: flowers earlier in the north and later in the south Dormant between late January and late April Summer fires stimulate flowering in most populations	Has often been confused with *Diuris emarginata* Common (tall donkey orchid South of Perth) and *D. heberlei* P2 (Albany region)	Approx. 24 km southwest of study area
Thelymitra stellata Lindl. (star sun-orchid)	EN	Lateritic soil, growing amongst low heath and scrub in jarrah (*Eucalyptus marginata*) woodland, on ridges, slopes, and breakaways	Peak flowering period: late October in northern populations and early November near Perth. Flowers remain closed during cool overcast weather	Similar species: *Thelymitra magnifica*	Approx. 36 km south of study area

3.2.1.3 Vegetation mapping

A review of previous vegetation surveys conducted for the GNH between Muchea and Wubin identified that various methods have been used to delineate vegetation associations. 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 flora and vegetation assessments undertaken for the Project (Phoenix 2015, 2016b, 2017), including current study, because:

- matching the vegetation recorded to the vegetation associations 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

- of the previous vegetation assessments available for review, Western Botanical (2006) and ENV (2007) were the only studies that provided a 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. These were matched with the vegetation associations of Shepherd *et al.* (2002) according to the presence of the predominant overstorey 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: December 2010 – February 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, or the Western Botanical (2006) and ENV (2007) assessments. The locations of some of the vegetation associations mapped by Shepherd *et al.* (2002) were supplemented to include additional associations within it. For example, riparian vegetation was omitted by Shepherd *et al.* (2002).

3.2.1.4 Eucalypt Woodlands of the Western Australian Wheatbelt TEC assessment

Assessment and mapping of the extent of the Eucalypt Woodlands of the Western Australian Wheatbelt TEC was undertaken using a key and customised data collection template derived from the conservation advice for the TEC (Threatened Species Scientific Committee 2015a). An update to the methodology included a review of the assessment to only include vegetation that is not within the geology that defines the Darling Scarp, and therefore is likely to be protected under the EPBC Act (for more information refer section 5.2.1.3).

A total of 99 TEC sites were assessed throughout the study area (Figure 3-2). Many of these align with quadrat or relevé sites, but others were in additional woodland patches to increase the coverage and accuracy of the assessment.

In determining the presence of the TEC, features of the remnant woodland patch including vegetation condition, patch size (or in the case of roadside patches, patch width) and the density of mature trees (an average of five mature trees per 0.5 ha) were considered. This necessitated establishing the area of the patch in the field. Subsequently, prior to undertaking the field assessment, maps of the remnant woodland patches throughout the study area that potentially represented the TEC were uploaded to digital tablets.

During the field assessment, the area of each of patch was identified by highlighting it on the tablet and reading the associated attributes table. Where required (i.e. where vegetation was in good or degraded condition) the area of the patch was reviewed. If found to be of suitable area, the patch was foot-searched and the number of mature trees counted to determine if density was sufficient for the patch to be considered representative of the TEC. All areas of eucalypt woodland that were assessed to be in degraded condition were excluded from being classified as the TEC, in accordance with section 3.3 of the conservation advice (Threatened Species Scientific Committee 2015a).

3.2.1.5 Extrapolation of remnant native vegetation associations

Remnant native vegetation was extrapolated in accordance with methodology outlined in EPA and DPaW (2015). Vegetation associations mapped in the phase 1 – 3 survey areas were assigned to native vegetation present within 500 m on both sides of the survey corridor. This was done by matching

similar features visible on high quality colour aerial photography (supplied), native vegetation extent shapefile and contour lines utilising ArcGIS software. Vegetation mapping in the phase 4 survey area was later refined based on field surveys.

3.2.2 Fauna and fauna habitat

A fauna assessment was conducted over several field trips between October 2014 and March 2018, primarily to accommodate changes to the study area (Table 3-6). Initial fauna habitat and significant black cockatoo tree assessments were undertaken in the Phase 1 survey area in October–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 Level 1 fauna survey in February and September to November 2015 entailing further habitat assessment, targeted searches for evidence of conservation significant fauna and a significant black cockatoo tree assessment in new areas covered by the Phase 2 survey area.

Subsequent black cockatoo habitat assessments were undertaken in January 2016 with Tony Kirkby, a recognised subject matter expert on black cockatoos, to inspect the recorded potential breeding trees for signs of use and record them using DGPS.

The Phase 3 survey area was surveyed between September to November 2017 with fauna habitat assessment, targeted searches for evidence of conservation significant fauna and a significant black cockatoo tree assessment.

Phase 4 fauna and black cockatoo surveys using the same methods as the previous phases were undertaken in November and December 2017 and March 2018. Confirmation of used breeding trees by black cockatoos in the study area took place on 19 March 2018 by Tony Kirkby.

The surveys were conducted in accordance with EPA Guidance Statement No. 56: *Terrestrial fauna surveys for environmental impact assessment in Western Australia* (EPA 2004a), now EPA *Technical Guidance: Terrestrial fauna surveys* (EPA 2016b) 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 3-6 Survey timing and effort for the fauna survey

Survey area	Survey dates	No. person hours (approx.)[1]	Work undertaken
Phase 1 survey area (107.35 ha)	16 October – 04 November 2014	24	Initial habitat assessment and potential black cockatoo breeding tree assessment
Phase 2 survey area (242.69 ha)	20 February 2015 25 – 27 February 2015	64	Fauna habitat assessment, potential black cockatoo breeding tree assessment and searches for conservation significant species in Phase 2 survey area
Phase 2 survey area (242.69 ha)	4 September and 18 – 19 November 2015	72	Fauna habitat assessment, potential black cockatoo breeding tree assessment and searches for conservation significant species
Phase 2 survey area (242.69 ha)	20 and 23 January 2016	12	Follow up black cockatoo habitat assessment by Tony Kirkby

Survey area	Survey dates	No. person hours (approx.)[1]	Work undertaken
Phase 3 survey area (50.17 ha)	5 September – 24 November 2017	30[2]	Fauna habitat assessment, potential black cockatoo breeding tree assessment and searches for conservation significant species
Phase 4 survey area (1154.7 ha)	1 November, 18-20 December 2017, 1-2 March 2018	144	Fauna habitat assessment, potential black cockatoo breeding tree assessment and searches for conservation significant species
Phase 4 survey area (1154.7 ha)	19 March 2018	12	Follow up black cockatoo habitat assessment by Tony Kirkby

[1]Includes travel time. [2] Estimated time due to the time spent in other areas of the survey area were not delineated, a total of 152 hours were spent in the phase 3 survey area.

3.2.2.1 Habitat assessment

During the field survey, fauna habitat attributes were assessed and recorded at some flora and vegetation quadrats where the flora survey preceded the fauna survey (Appendix 2). Where the fauna field survey preceded the flora survey, habitat attributes were assessed at a broad scale and a more detailed habitat assessment was incorporated into flora and vegetation quadrat data when completed. Habitat attributes assessed included 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 association mapping. Vegetation associations 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 in the desktop review as potentially occurring were undertaken in the study area in areas identified as suitable habitat to support the species. Targeted searches primarily focused on black cockatoo (*Calyptorhynchus* spp.) species; however, included other conservation significant species in areas where habitat was considered suitable to support the species (see section 5.2.2 for species identified in desktop review). Targeted searches focused on detecting conservation significant species from direct observations and calls in addition to secondary evidence including diggings, evidence of foraging activity, tracks, scats, feathers and remains. Survey approach and methodology for black cockatoo species is provided in more detail below.

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 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 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 3-7 for known species of breeding trees.

The location of all potential breeding trees for Carnaby's 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 where identification was uncertain.

In the follow up site visits, all potential breeding trees recorded with hollows in the previous surveys were inspected by Tony Kirkby from ground level using binoculars to identify if any were suitable for current breeding by Carnaby's Cockatoo. Trees and their hollows were inspected for evidence of use by the species indicating recent or past use, e.g. wear and chew marks around hollow entrance.

Feeding habitat quality, opportunistic records of feeding residues and evidence of night roosting were also noted during the site visits. 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 Cockatoo is generally in or near riparian features or natural and artificial permanent water sources. Known roosting tree species include Flat-topped Yate, Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced eucalypts (e.g. Blue Gum) and introduced pines (DSEWPaC 2012a).

Table 3-7 Known breeding trees for WA black cockatoo species (DSEWPaC 2012a)

Species[1]	DBH (mm) for hollow formation
Eucalyptus marginata (Jarrah)	500
Corymbia calophylla (Marri)	500
Eucalyptus salmonophloia (Salmon Gum)	300
Eucalyptus wandoo (Wandoo)	300
Eucalyptus rudis (Flooded Gum)	500
Eucalyptus loxophleba subsp. *loxophleba* (York Gum)	500
Eucalyptus accedens (Powderbark)	300
Eucalyptus camaldulensis (River Red Gum)[2]	500

[1] list excludes species for which study area is outside the known species distribution, as provided in FloraBase.
[2] 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 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 Carnaby's Cockatoo is determined from the presence of plant species that are known food sources 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 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 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 Cockatoo
- abundance of food resource, e.g. amount of seed typically produced
- seasonality of food supply, e.g. Carnaby's 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 species 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 of the same vegetation association. Polygons with cleared vegetation, pasture or planted vegetation types have no foraging value and so 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 associations 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 remnant trees within pastures were displayed as points only and labelled 'potential breeding trees in vegetation types not representing remnant native vegetation'.

3.2.2.5 Mapping of foraging habitat for Forest Red-tailed Black Cockatoo

Mapping of potential foraging habitat within the study area for Forest Red-tailed Black Cockatoo was undertaken utilising field survey results and quadrat data from the flora and vegetation survey. Suitable foraging habitat was identified from the presence of plant species that are known food sources and from evidence of feeding, such as direct observation of birds or feeding residues (chewed nuts or cones).

Many plant species have been recognised to be utilised as a food resource by Forest Red-tailed Black Cockatoo (DSEWPaC 2012a) but relative 'importance' of each species varies considerably. The main food sources (~90%) of the Forest Red-tailed Black Cockatoo are *Corymbia calophylla* (Marri) and *Eucalyptus marginata* (Jarrah) seeds. Other forage species include *E. caesia*, *E. erythrocorys*, some introduced eucalypts (*E. camaldulensis*, *E. grandis*), *Allocasuarina* spp. cones, *Persoonia longifolia*, *Corymbia haematoxylon, E. lehmannii*, *E. patens*, *E. steari*, *E. maculata*, *Callitris preissii*, *Melia azedarach* and *Hakea undulata* (Department of the Environment 2016c; Finn 2012).

Where a quadrat contained a known forage species, it was designated as having 'potential' as forage habitat. Foraging habitat value for vegetation types in the study area was then extrapolated based on the quadrat values, and where vegetation polygons containing a quadrat they 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 of the same vegetation association. Polygons with cleared vegetation, pasture or planted vegetation types were ignored.

3.3 TAXONOMY AND NOMENCLATURE

Species that were well known to the survey botanists 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 taxonomic keys, and comparisons with named species held at the WA Herbarium. Plant taxonomists who are considered to be authorities on particular plant groups were consulted when necessary.

The conservation status of flora and fauna identified from the desktop review and field surveys was compared against the current lists available on FloraBase (DBCA 2018b) Protected Matters Database (DoEE 2018b), *Wildlife Conservation (Specially Protected Flora) Notice*, (Western Australian Government 2018a) *Wildlife Conservation (Specially Protected Fauna) Notice* (Western Australian Government 2018b) and DBCA Threatened and Priority and Fauna list (DBCA 2018d, e)

Nomenclature for flora and vegetation used in this report follows that used by FloraBase (DBCA 2018b) 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 3-8).

Table 3-8 Project team

Name	Qualifications	Role/s
Mrs Karen Crews	BSc (Env. Biol.) (Hons)	Project Manager and 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 and vegetation mapping
Ms Emily Ager	BSc (Nat. Res. Mgmt.) (Hons)	Field surveys and flora taxonomy
Ms Alice Watt	BSc (Cons. Bio. And Botany) (Hons)	Field surveys, flora taxonomy and reporting
Ms Catherine Krenns	Bsc (Env. Sci.) Pos. Dip. (EIA)	Field surveys
Ms Gabriela Martinez	BSc (Env. Sci.)	Field surveys
Mr Conrad Slee	BSc (Env. Mgt.) (Hons)	Field survey
Ms Kathryn Wyatt	B Information Technology	GIS, data analysis
Ms Anna Leung	BSc (Env. Sci.) (Hons)	Field surveys, GIS, fauna taxonomy and report writing
Mr Jarrad Clark	BSc (Env. Mgt.)	Field surveys, data management
Mr Ryan Ellis	Dip (Cons. Land Mgmt.)	Field surveys, fauna taxonomy and report writing
Mr Mike Brown	BSc (App. Sci.)	Field surveys
Mr Tony Kirkby		Field survey (black cockatoo assessment)
Mr Frank Obbens	BSc (Biology) (Hons)	Taxonomy

4 EXISTING ENVIRONMENT

4.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The study area falls within two Interim Biogeographic Regionalisation of Australia (IBRA) bioregions, Avon Wheatbelt and Jarrah Forest, predominantly the Northern Jarrah Forest (JAF01) subregion of the latter (Figure 4-1). JAF01 incorporates the area east of the Darling Scarp, overlying Archaean granite and metamorphic rocks capped by 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. Extensive but localised sand sheets support *Banksia* low woodlands and heath is found on granite rocks and as a common understorey of forests and woodlands. Rare features include extensive native forest cover and refugia for threatened bird translocation sites, populations of critical weight range mammals (native species most impacted by introduced predator species; 35–5,500 g) (DPaW 2014a; Johnson & Isaac 2009), granite outcrops and Wandoo or Wandoo-Powderbark woodlands in the eastern zone with associated flora and fauna (Williams & Mitchell 2001).

The most northerly section of the study area is located in the Katanning subregion (AVW02) of the Avon Wheatbelt bioregion. AVW02 comprises the erosional surface of gently undulating rises to low hills with abrupt breakaways and continuous stream channels (Beecham 2001). Soil formed in colluvium or within weathered rocks supports woodlands of Wandoo, York Gum and Salmon Gum (*E. salmonophloia*) with Jam and *Casuarina* spp. Special values include Toolibin Lake (principal breeding ground for waterbirds in SW Australia), Pingelly (Boyagin-Tutanning Reserves) with high density of rare and geographically restricted flora, Dryandra woodland and the South West Botanical Province with high flora diversity and *Eucalyptus* woodlands with high floristic diversity (Yates *et al.* 2000) and a high proportion of Protected Flora (around 25%) (Hopper *et al.* 1990; Yates *et al.* 2000).

Avon Wheatbelt bioregion contains critical weight range mammals (DPaW 2014a; Johnson & Isaac 2009). Two species are now extinct (the Pig-footed Bandicoot and Crescent Nailtail Wallaby) and several species are locally extinct (e.g. Dibbler).

Figure 4–1
IBRA regions of the study area

Study area

IBRA region and subregion

Region: Avon Wheatbelt, Subregion: Katanning (AVW02)

Region: Jarrah Forest, Subregion: Northern Jarrah Forest (JAF01)

0 1 2
Kilometers

1:70,000 (at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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4.2 CLIMATE AND WEATHER

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

The Bureau of Meteorology (BoM) weather station most central to the study area is located at Wongan Hills (Latitude: 30.89°S Longitude: 116.72°E). Wongan Hills records the highest maximum mean monthly temperature (34.6°C) in January and the lowest minimum mean monthly temperature (8.4°C) in August and an average annual rainfall of 388.4 mm, of which the majority falls within a well-defined wet season in winter (BoM 2018) (Figure 4-2).

In Phase 1, daily maximum and minimum temperatures were warmer than average and rainfall was lower in the spring of 2014 (BoM 2015).

In Phase 2, autumn 2015 was average for both temperature and rainfall. The winter leading up to and the spring 2015 survey was wetter than usual however the spring season itself was dryer than average, with temperatures in both the winter and spring both above the long term average (BoM 2016).

Weather leading up to the Phase 3 survey was optimal with sufficient rainfall and normal temperatures in the preceding winter. Dalwallinu weather station (~ 100 km north of the study area), recorded above average rainfall and cooler temperatures in the six months preceding the survey and the Gingin weather station (~40 soutwest of the study area) recorded variable rainfall month to month equalling slightly below average rainfall in the six months preceding the survey and generally lower temperatures (BoM 2017).

Daily maximum temperatures in the months leading up to the Phase 4 survey were generally above or equal the long term average. Rainfall in Wongan Hills was highly variable compared to the local long term averages but overall Wongan Hills received mostly above average rainfall in the months during and leading up to the surveys. An unusually high amount of rain fell in January and February 2017 (BoM 2018).

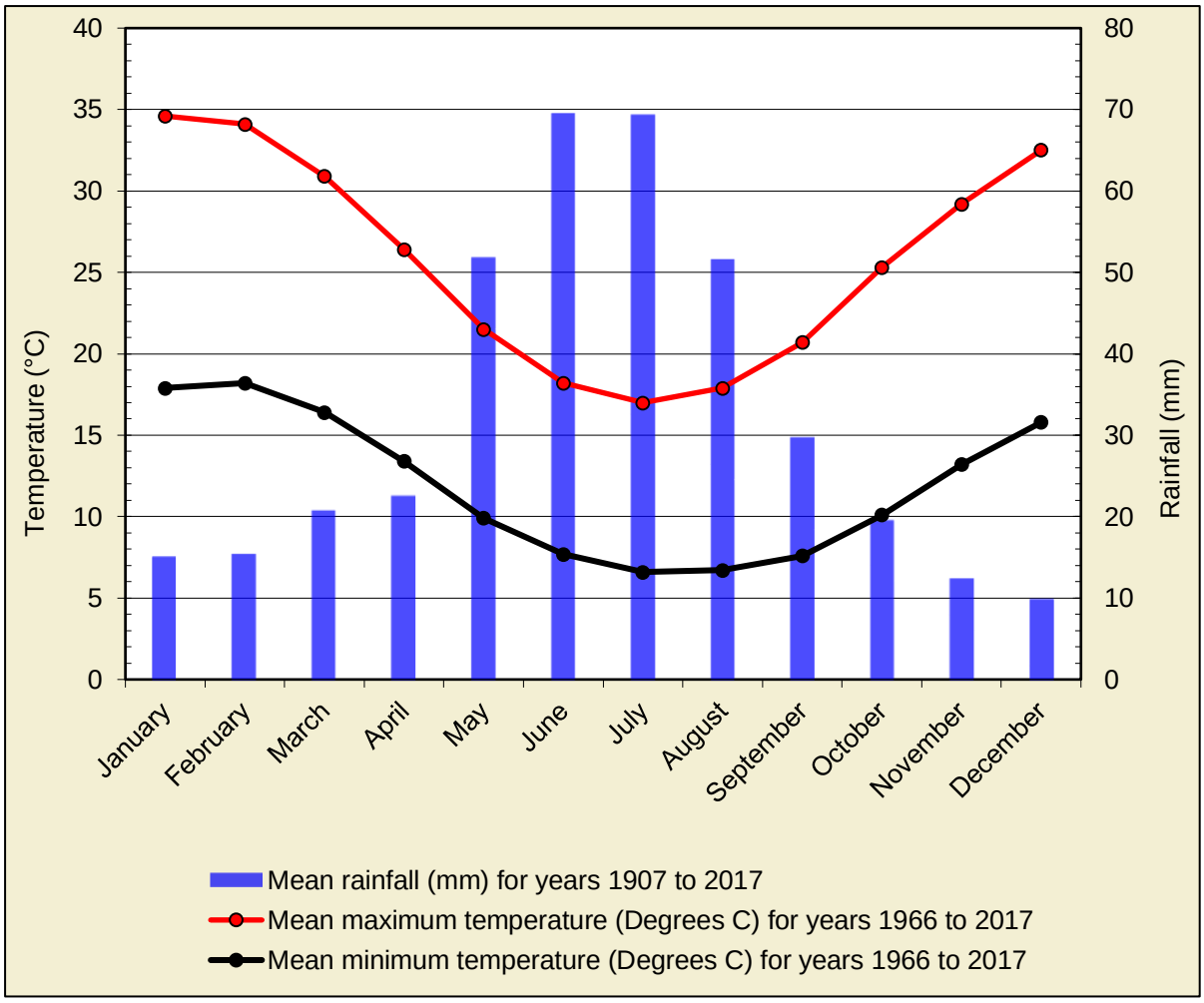


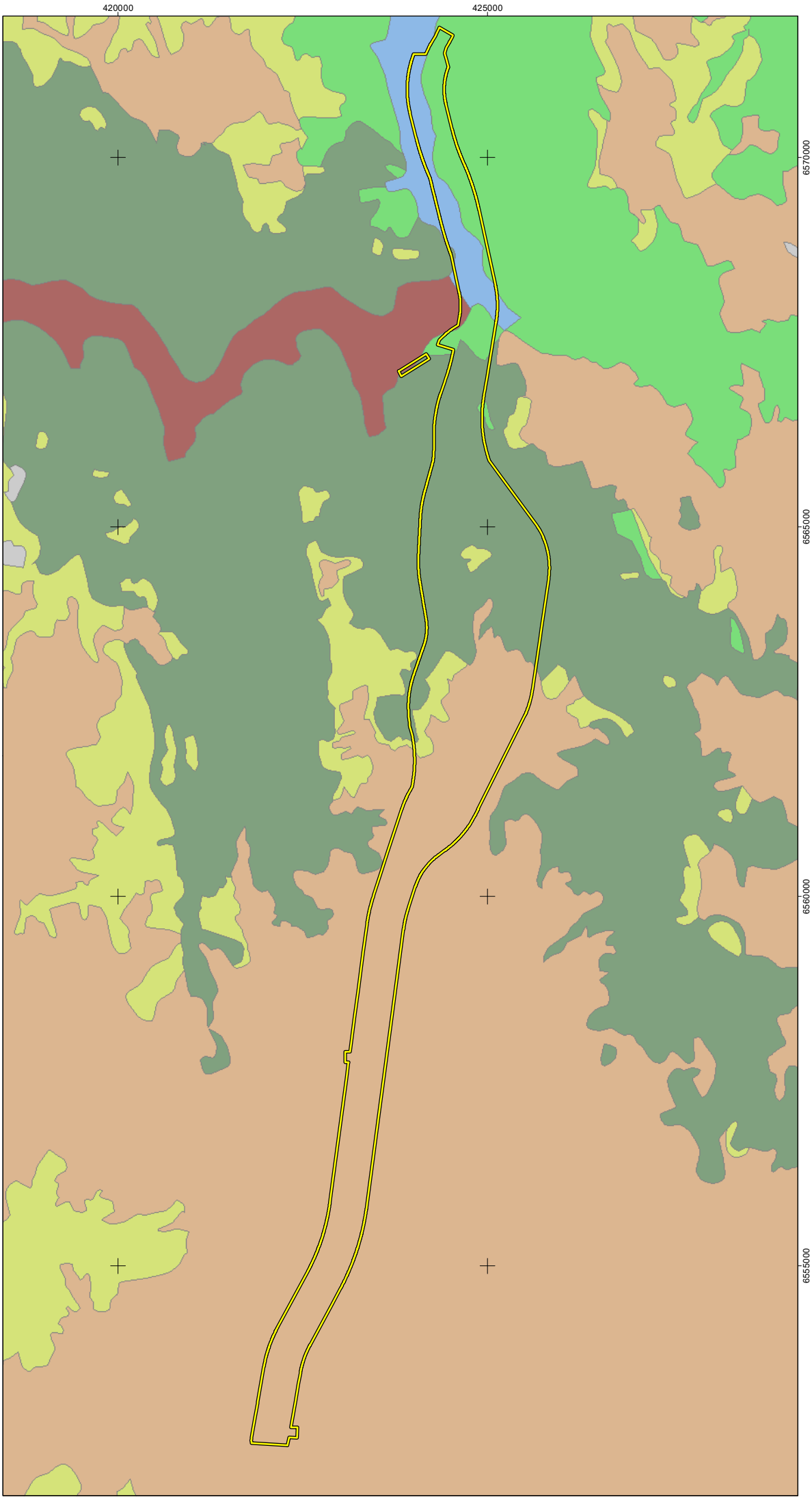
Figure 4-2 **Climate data (average monthly temperatures and rainfall records) for Wongan Hills (BoM 2018)**

4.3 LAND SYSTEMS

The Department of Agriculture and Food WA has mapped broad land systems from aerial photography. Land systems are grouped according to a combination of landform, soils, vegetation and drainage patterns (Payne & Leighton 2004). The study area comprises six land systems (Figure 4-3):

- **Glentrome System (120.76 ha, 8.22%)** – stripped, weathered plateau with undulating low hills and rises; loamy earths, loams, loamy gravel and some clay and rock; weathered granite and migmatite.
- **Julimar System (46.79 ha, 3.18%)** – moderately dissected areas with gravelly slopes and ridges and minor rock outcrop on the eastern side of the Darling Plateau over weathered granite and granitic gneiss. Loamy gravel, shallow duplexes and pale deep sand common. Wandoo woodlands.
- **Ranfurly System (96.74 ha, 6.59%)** – level to gently undulating plain being a relict flood plain, partially rejuvenated; loamy earths and clay, some duplex; from alluvium.
- **Udamong System (720.84 ha, 49.07%)** – northern Darling Range near New Norcia. Partially stripped lateritic plateau with undulating low hills to gently undulating rises. Loamy gravel, minor pale sand and clay; deep weathered granitic gneiss, gneiss and schist.
- **Wannamal Systems (3.50 ha, 0.24%)** – Alluvial plain and fans, brown and red loamy earths, yellow brown sandy duplexes, loamy duplexes
- **Yarawindah System (480.43 ha, 32.70%)** – dissected lateritic plateau with rolling to undulating low hills and undulating rises; loamy gravel, loamy earth, loamy duplex, some rock; weathered schist.

Figure 4–3
Land systems of the study area



Study area

Land system

- Glentrome System
- Julimar System
- Ranfurly System
- Udamong System
- Wannamal System
- Yarawindah System
- other land systems

0 1 2
Kilometers

1:70,000 (at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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4.4 NATIVE VEGETATION EXTENT AND STATUS

Regional vegetation mapping by Shepherd *et al.* (2002) identifies four vegetation associations within the study area (Figure 4-4; Table 4-1).

Based on Shepherd *et al.* (2002), in terms of extent of statewide vegetation remaining compared to pre-European extents, all of the vegetation associations are classed as 'Vulnerable' (Table 4-1).

Table 4-1 Regional vegetation association, extent and status

Code[1]	Description[1]	% remaining[2]	Classification	Extent in study area (ha)
4	Medium woodland; Marri & Wandoo	27.3	Vulnerable	1238.2
7	Medium woodland; York gum (*Eucalyptus loxophleba*) & wandoo	12.7	Vulnerable	57.8
352	Medium woodland; York Gum	19.6	Vulnerable	167.0
1043	Mosaic: medium open woodland; Wandoo & Powderbark Wandoo / Shrublands; dryandra heath	27.8	Vulnerable	6.1

[1]Shepherd *et al.* (2002). [2]Percentage of pre-European extent remaining (DBCA 2018a).

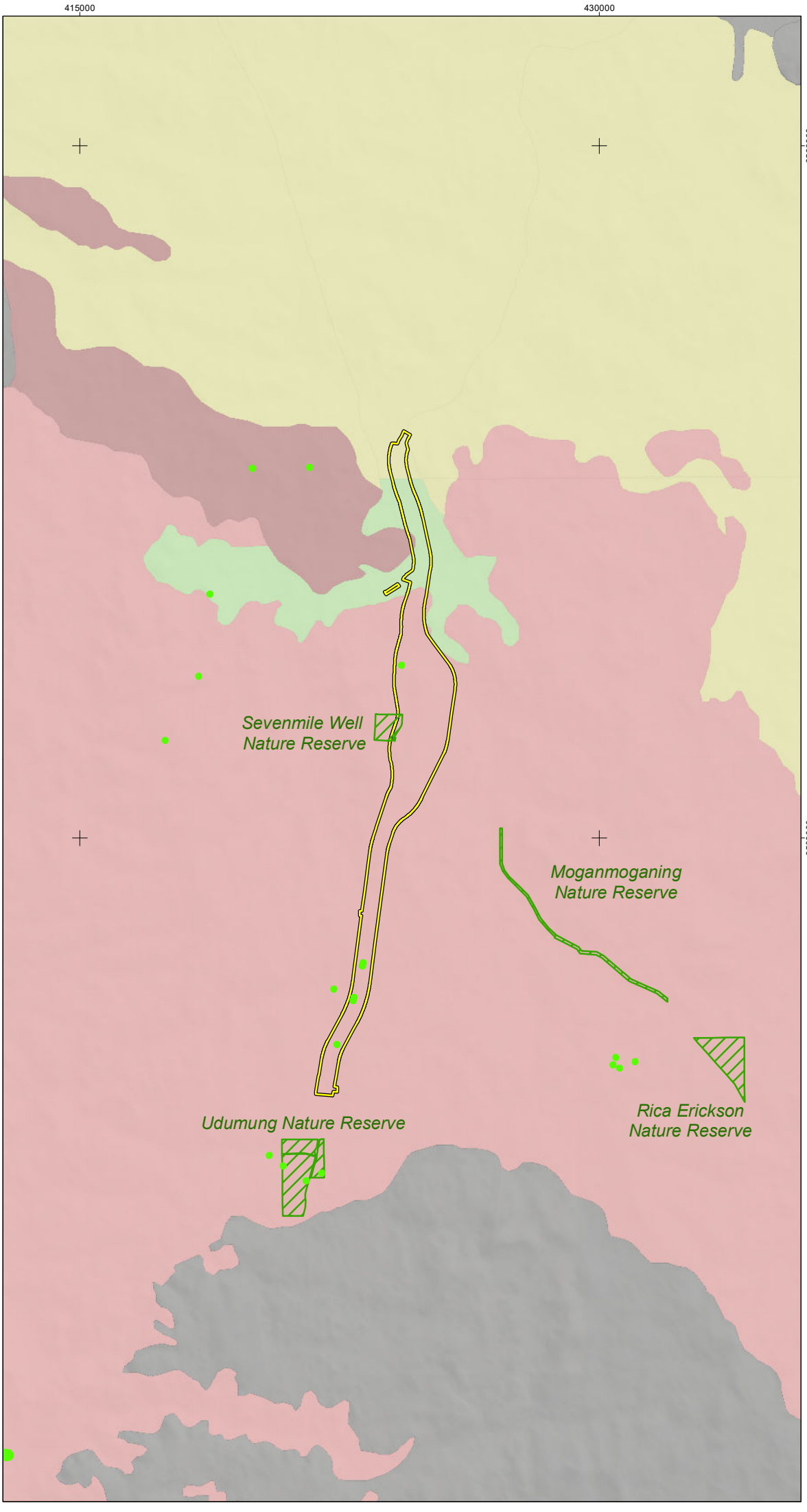
4.5 CONSERVATION RESERVES

Four reserves listed in the Collaborative Australian Protected Area Database and DBCA managed land and waters spatial data are located within 10 km of the study area, all are nature reserves (Figure 4-4). They range in size from just over 50 ha (Sevenmile Well) to 125 ha (Rica Erickson) (Table 4-2).

Table 4-2 Protected areas within 10 km of the study area

Name	Type	Area (ha)	Proximity to study area
Rica Erickson	Nature Reserve	125.5	9.8 km east of the study area
Sevenmile Well	Nature Reserve	52.6	West adjacent to the study area
Udumung	Nature Reserve	202.7	1.2 south of the study area
Moganmoganing	Nature Reserve	53.2	3 km east of the study area

Figure 4–4
Regional vegetation associations, conservation reserves and environmentally sensitive areas



Study area

Environmentally Sensitive Areas

Nature Reserves

Vegetation associations

4: Medium woodland; Marri and Wandoo

7: Medium woodland; York gum and Wandoo

352: Medium woodland; York gum

1043: Mosaic: Medium open woodland; Wandoo and Powderbark wandoo/shrublands; dryandra heath

other vegetation associations

0 2.5 5
Kilometers

1:150,000(at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

PHOENIX ENVIRONMENTAL SCIENCES

5 RESULTS

5.1 SURVEY LIMITATIONS

The limitations of the surveys have been considered in accordance with the potential survey limitations listed in (EPA 2016a) (Table 5-1).

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

Variable	Impact on survey outcomes
Availability of contextual information	**Not a constraint for flora surveys.** Existing information on the vegetation and land systems of the study area has been mapped by Shepherd *et al.* (2002). 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. **Slight constraint for fauna surveys.** Few existing systematic fauna surveys were available in close proximity to the study area. The fauna assessment relied primarily on database records, information about conservation significant species habitat preferences and distributions, and the field habitat assessment.
Access problems	**Not a constraint.** No access problems were encountered during the field survey and the majority of the study area (open paddocks excepted) was traversed by foot. Where required, property owners were notified and entry was gained.
Experience levels	**Not a constraint**. The survey was undertaken by suitably qualified and experienced botanists and zoologists.
Timing, weather, season	**Not a constraint.** Flora and fauna surveys were undertaken in the study area during the appropriate seasons according the relevant EPA guidelines.
Disturbances	**Slight constraint**. 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 association in some areas**.**
Survey intensity	**Not a constraint.** The field program was conducted over four seasonal survey events with a total of 42 quadrats and 5 relevés sampled. All sites were sampled twice, including at least one spring seasons. TEC was also survyered at 100 sites. Most patches of remnant and planted vegetation were traversed by foot in search of conservation significant flora and fauna. Some areas were surveyed more than once to account for different flowering times that aid in flora identification. The black cockatoo breeding tree, roosting site and breeding/ foraging/ roosting habitat assessment was conducted for the entire study area.
Completeness	**Slight constraint.** 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 amount of rainfall. The fauna survey was focussed on identifying the potential for presence of conservation significant species. Systematic censusing of the fauna assemblage was not undertaken but this is consistent with other surveys for similar linear infrastructure projects in the region.
Determination	**Not a constraint.** Determinations regarding the extent of Eucalypt Woodlands of the Western Australian Wheatbelt TEC were completed with strict regard to Threatened Species Scientific Committee (2015a). Determinations regarding taxonomy and conservation status of flora and fauna were made on the basis of current classifications and no limitations were encountered in this regard.

5.2 DESKTOP REVIEW

5.2.1 Flora and vegetation

5.2.1.1 Conservation significant flora

A total of 92 conservation significant flora species were identified from the desktop review as previously recorded within 2 km of the study area (Figure 5-1; Table 5-2). This included 24 Threatened species listed under the EPBC Act and/or WC Act, and 68 Priority species.

Records of 12 significant flora occurred within the study area (Figure 5-1; Table 5-2), including three Threatened species.

Several of the significant species were recorded in some of the previous surveys. Ecologia (2004) recorded a number of conservation species within/in the vicinity of the study area, including:

- three Threatened species, *Asterolasia nivea* (VU, S3) at SLK 96.68, 96.59, and 90.54, *Banksia serratuloides* subsp. *serratuloides* (VU, S3) at SLK 105.5 and *Spirogardnera rubescens* (EN, S3) at SLK 96.03, 95.88, 95.57 and 94.15
- *Acacia anarthros* (P3) at four locations SLK 94.7, 94.2, 92.79 and 90.9
- *Acacia drummondii* subsp. *affinis* (P3) at SLK 90.54
- *Grevillea florida* (P3) at four locations, four within the study area SLK 97.37, 95.65, 95.08, and one 600 m east of SLK 98.14
- *Stylidium cymiferum* (P3) 160 m east of SLK 92.45.

Asterolasia nivea has since been renamed *Asterolasia grandiflora* and the conservation status has changed to P4.

Maunsell/AECOM (2008) recorded a single population of *Banksia serratuloides* subsp. *serratuloides* (VU, S3) comprising 49 plants in an approximately 125 m stretch of road reserve in the study area (SLK 104.8). The population is of high conservation significance as it is one of only three known populations of the species.

Ninox (1989) recorded *Grevillea drummondii* (P4) in the road reserve of the study area between SLK 96.6 and SLK 97.2 and Western Botanical (2006) recorded *Acacia browniana* var. *glaucescens* (P2), also in the road reserve of the study area.

ENV (2007) identified six Priority Flora in the road reserve of the study area or close to it:

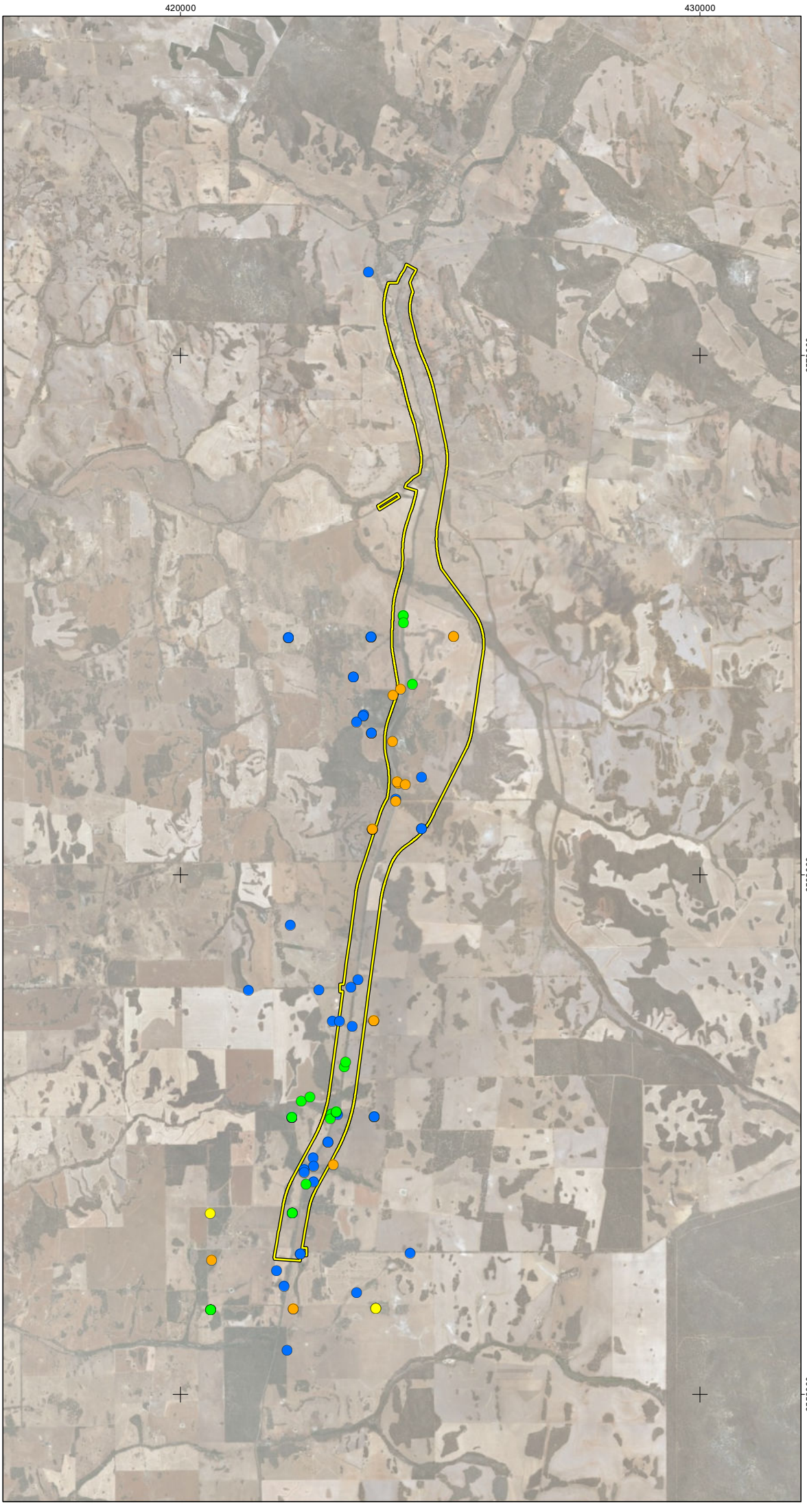
- *Acacia anarthros* (P3) at SLK 94.32
- *Grevillea florida* (P3) at SLK 95.81
- *Hemigenia curvifolia* (P2) at SLK 93.17
- *Persoonia rudis* (P3) at SLK 91.92
- *Synaphea rangiferops* (P2) at SLK 107.91 and 108.14.

Figure 5–1
DBCA records of conservation significant flora

Study area

Significant flora

- Priority 2
- Priority 3
- Priority 4
- Threatened



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Kilometers

1:100,000(at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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Table 5-2 Conservation significant flora species identified from the desktop review[1]

Species name	Common name	EPBC Act	WC Act	DBCA Priority list
Acacia alata var. *platyptera*				P4
Acacia anarthros				P3
Acacia browniana var. *glaucescens*				P2
Acacia cochlocarpa subsp. *cochlocarpa*	Spiral-fruited Wattle	EN	CR	
Acacia cummingiana				P3
Acacia drummondii subsp. *affinis*				P3
Acacia latipes subsp. *licina*				P3
Acacia oncinophylla subsp. *oncinophylla*				P3
Acacia pulchella var. *reflexa* acuminate bracteole variant (R.J. Cumming 882)				P3
Acacia ridleyana				P3
Acacia splendens		CR	EN	
Allocasuarina ramosissima				P3
Anigozanthos humilis subsp. *chrysanthus*	Golden Catspaw			P4
Asterolasia grandiflora				P4
Banksia dallanneyi subsp. *pollosta*				P3
Banksia scabrella	Burma Road Banksia			P4
Banksia serratuloides subsp. *serratuloides*	Southern Serrate Dryandra	VU	VU	
Baeckea sp. Youndegin Hill (A.S. George 15772)				P1
Beaufortia eriocephala	Wooly Bottlebrush			P3
Beaufortia purpurea				P3
Boronia tenuis				P4
Calothamnus accedens				P4
Calothamnus pachystachyus				P4
Chorizema humile		CR	EN	
Conospermum densiflorum subsp. *unicephalatum*	One-headed Smokebush	EN	EN	
Darwinia acerosa	Fine-leaved Darwinia	EN	EN	
Darwinia carnea	Mogumber Bell	EN	CR	
Daviesia localis				P1
Dielsiodoxa leucantha subsp. *leucantha*				P3
Diuris recurva				P4
Eremophila scaberula	Rough Emu Bush	EN	CR	
Eucalyptus pruiniramis	Midlands Gum	EN	EN	
Eucalyptus recta	Silver Mallet	EN	VU	
Frankenia bracteata				P1
Gastrolobium hamulosum	Hook-point Poison	EN	CR	

Species name	Common name	EPBC Act	WC Act	DBCA Priority list
Gastrolobium rotundifolium	Gilbernine Poison			P3
Goodenia arthrotricha			EN	
Grevillea bipinnatifida subsp. *pagna*				P1
Grevillea bracteosa subsp. *bracteosa*			EN	
Grevillea drummondii				P4
Grevillea florida				P3
Grevillea pythara	Pythara Grevillea	EN	CR	
Guichenotia tuberculata				P3
Hemigenia curvifolia				P2
Hemigenia microphylla				P3
Hemiandra gardneri	Red Snakebush	EN	CR	
Hibbertia miniata	Orange Hibbertia			P4
Hibbertia montana				P4
Lasiopetalum caroliae				P3
Lasiopetalum cenobium				P1
Lasiopetalum rotundifolium	Round-leaf Lasiopetalum	EN	EN	
Lechenaultia galactites				P3
Lechenaultia magnifica				P1
Melaleuca barlowii				P3
Melaleuca sciotostyla	Wongan Melaleuca	EN	EN	
Melaleuca sclerophylla				P3
Persoonia rudis				P3
Persoonia sulcata				P4
Petrophile biternata				P3
Petrophile globifera				P3
Petrophile plumosa				P3
Petrophile trifurcata				P2
Podotheca pritzelii				P3
Podotheca uniseta				P3
Rhagodia acicularis	Wongan Rhagodia	VU	VU	
Scholtzia sp. Gunyidi (J.D. Briggs 1721)				P2
Spirogardnera rubescens	Spiral Bush	EN	VU	
Stylidium cymiferum				P3
Stylidium glabrifolium				P2
Stylidium periscelianthum	Pantaloon Triggerplant			P3
Stylidium sacculatum				P3
Stylidium scabridum	Moth Triggerplant			P4
Stylidium semaphorum		CR	CR	

Species name	Common name	EPBC Act	WC Act	DBCA Priority list
Synaphea rangiferops				P2
Synaphea grandis				P4
Synaphea panhesya				P1
Synaphea rangiferops				P2
Tetratheca harperi	Jackson Tetratheca	VU	VU	
Tetratheca plumosa				P1
Thelymitra stellata	Star Orchid, Star Sun-orchid	EN	EN	
Thomasia sp. Green Hill (S.Paust 1322		EN	CR	
Thryptomene shirleyae				P2
Urodon capitatus				P3
Verticordia dasystylis subsp. *oestopoia*				P1
Verticordia insignis subsp. *eomagis*				P3
Verticordia lindleyi subsp. *lindleyi*				P4
Verticordia muelleriana subsp. *muelleriana*				P3
Verticordia roei subsp. *meiogona*				P1
Verticordia rutilastra				P3
Verticordia serrata var. Udumung (D. Hunter & B. Yarran 941006)				P2
Verticordia staminosa subsp. *staminosa*	Wongan Featherflower	EN	CR	
Verticordia venusta				P3

[1]Species shaded grey include records within study area.

5.2.1.2 Introduced flora

The search of the NatureMap database identified records of 36 weed species within 1 km of the study area (Appendix 5). None are declared pests or WoNS.

Several other weed species listed as declared pests and WoNS were previously recorded in the GNH road reserve and may be relevant to the study area as the exact locations of these were not available:

- Ninox Wildlife Consulting (1989) noted that five declared pests are known to occur along the GNH road reserve between Muchea North and Walebing (SLK 36-150): **Moraea flaccida, *Moraea miniata*, *Echium plantagineum, *Oxalis pes-caprae* and **Carthamus lanatus*.
- ENV (2007) recorded two declared pests in the road reserve **Echium plantagineum* and **Asparagus asparagoides* (also a WoNS) between Muchea and Walebing.

5.2.1.3 Significant vegetation

The desktop review identified the EPBC Act listed Eucalypt Woodlands of the Western Australian Wheatbelt TEC within the study area (Figure 5-2). Three other EPBC Act or State listed TECs were identified 20–30 km south of the study area (Table 5-3; Figure 5-2).

The initial Protected Matters database search in 2014 did not return any EPBC Act listed TECs; however, the database was re-checked in May 2016 in light of the subsequent listing (in 2015) of the Eucalypt Woodlands of the Western Australian Wheatbelt TEC under the EPBC Act (Table 5-3). This community is listed as a Priority 3 PEC at the State level. The DBCA dataset shows small portions of the TEC overlapping with the study area (Figure 5-2).

The Eucalypt Woodlands of the Western Australian Wheatbelt community is defined as eucalypt woodlands dominated by a complex mosaic of eucalypt species with a single tree or mallet form over an understorey that is highly variable in structure and composition (Department of the Environment 2015, 2016a). The community occupies a transitional zone between the wetter forests associated with the Darling Range and the southwest coast, and the low woodlands and shrublands of the semi-arid to arid interior. The TEC potentially corresponds to 45 vegetation associations (i.e Shepherd *et al.* 2002) with the most likely equivalents being 37 associations that are dominant or unique within the Wheatbelt regions (Department of the Environment 2015). A more detailed description of the TEC is provided in Appendix 6 which also provides a key incorporating five main diagnostic characteristics that indicate its presence; this was derived from DoEE conservation advice for the TEC (Department of the Environment 2015).

The EPBC Act listing for the TEC focusses on patches mostly confined to the Avon Wheatbelt and Mallee bioregions, that remain in relatively good condition, and retain their natural composition and ecological function to a large degree (Threatened Species Scientific Committee 2015a). Under the EPBC Act, some outlying patches may extend into adjacent areas south and east of the primary wheatbelt bioregions, in the easternmost parts of the Jarrah Forest bioregion. These outlier patches generally occur south of Northam, extending around the vicinity of localities such as Wandering, Williams, Kojonup and Mount Barker (all locations south of Perth), and are limited to areas that are not on the Darling Range, receive less than 600 mm mean annual rainfall and overlie the Yilgarn Craton geology. As these outliers occur under similar patterns of rainfall, landscape and species distribution to the main Wheatbelt subregions, they are therefore included as part of the ecological community, where they meet the other definitional characteristics.

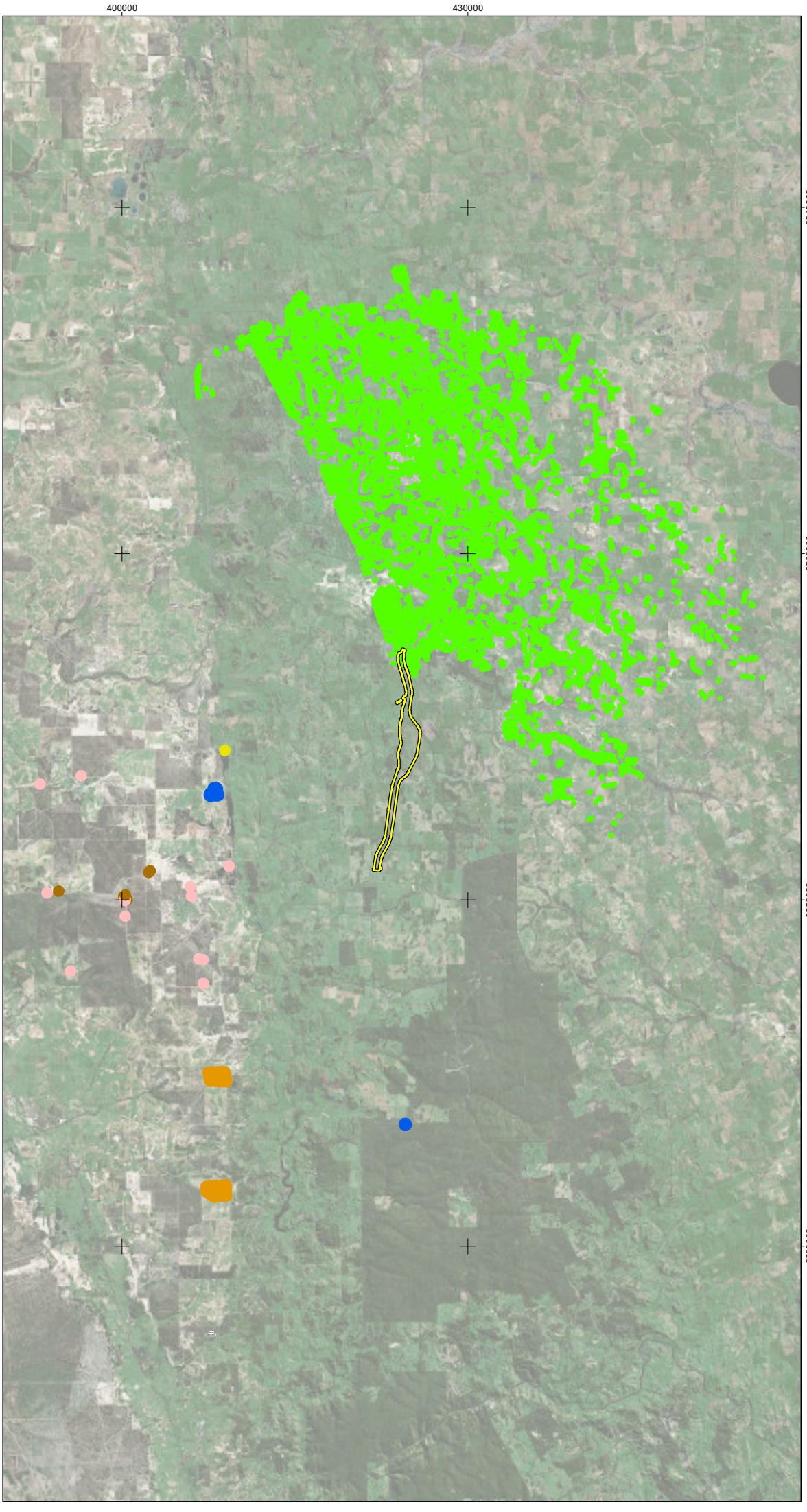
Even though some patches of vegetation that retain their natural composition and ecological function can be found that are similar in composition to the Eucalypt Woodlands of the Western Australian Wheatbelt TEC (e.g. Wandoo woodland) elsewhere in the Jarrah Forest bioregion (e.g. north of Perth), they may not be considered part of the listed TEC due to the underlying geology and soils. This is particularly the case where lateritic and gravely soils underlie these patches, indicating that these are within the geology of the Darling Range and therefore do not meet the location and geology criteria of the TEC. It is recognised that some patches can still retain some important natural values that may be crucial for certain species or habitats. Such sites may be protected through State and local laws or schemes (Threatened Species Scientific Committee 2015a).

Table 5-3 Threatened and priority ecological communities recorded in the vicinity of the study area

Community identification	Community name and description	Federal status	WA status	Nearest location to study area
SCP22	*Banksia ilicifolia* woodlands, southern Swan Coastal Plain PEC ('community type 22'). A component of the Endangered Banksia Woodlands of the Swan Coastal Plain EPBC Act listed TEC.	EN	P3	18 km west

Community identification	Community name and description	Federal status	WA status	Nearest location to study area
	Low lying sites generally consisting of *Banksia ilicifolia – B. attenuata* woodlands, but *Melaleuca preissiana* woodlands and scrubs are also recorded. Occurs on Bassendean and Spearwood systems in the central Swan Coastal Plain north of Rockingham. Typically has very open understorey, and sites are likely to be seasonally waterlogged.			
Claypans over shrubs with herbs	Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs. A component of the Critically Endangered Clayans of the Swan Coastal Plain EPBC Act listed TEC. Claypans (predominantly basins) usually dominated by a shrubland of *Melaleuca lateritia* occurring both on the coastal plain and the adjacent plateau. These claypans are characterized by aquatic (*Hydrocotyle lemnoides* – Priority 4) and amphibious taxa (e.g. *Glossostigma diandrum*, *Villarsia capitata* and *Eleocharis keigheryi* - DRF).	CR	P1	15 km west
SCP07	Herb rich saline shrublands in clay pans. A component of the Critically Endangered Clayans of the Swan Coastal Plain EPBC Act listed TEC.	CR	VU	15 km west
SCP23b	Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands ('community type 23b'). A component of the Endangered Banksia Woodlands of the Swan Coastal Plain EPBC Act listed TEC.	EN	P3	13 km west
Wheatbelt Woodlands	Eucalypt Woodlands of the Western Australian Wheatbelt. Eucalypt-dominated woodlands in the Western Australian Wheatbelt region as defined by the IBRA Avon Wheatbelt 1 and 2 and Western Mallee subregions with the specific exceptions (refer above and to Appendix 6 for more detail).	CR	P3	Occurs within the study area
Banksia yellow-orange sands	Banksia woodland of the Gingin area restricted to soils dominated by yellow to orange sands. A component of the Endangered Banksia Woodlands of the Swan Coastal Plain EPBC Act listed TEC. Species-rich Banksia woodlands on deep yellow-red sands that appear restricted to the western Dandaragan Plateau. The vegetation is described as scattered *Eucalyptus todtiana* and *Eucalyptus calophylla* over *Banksia menziesii* and *Banksia attenuata* low open woodland over *Jacksonia sternbergiana* and *Adenanthos cygnorum* high open shrubland over *Allocasuarina humilis* and *Chamelaucium lullfitzii* (DRF) open shrubland over *Eremaea pauciflora* and *Astroloma xerophyllum* low shrubland over *Mesomelaena pseudostygia* open sedgeland.	EN	P2	21 km south-west

Figure 5–2
Threatened and Priority Ecological Communities in the vicinity of the study area



Study area

TEC and PEC

- *Banksia ilicifolia* woodlands (SCP22), (P3-DBCA; EN-EPBC)
- Banksia woodland of the Gingin area restricted to soils dominated by yellow to orange sands (Banksia yellow-orange sands), (P2-DBCA; EN-EPBC)
- Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs (Claypans over shrubs with herbs), (P1-WC Act; CR-EPBC)
- Eucalypt woodlands of the Western Australian Wheatbelt (Wheatbelt Woodlands), P3-DBCA; CR-EPBC)
- Herb rich saline shrublands in clay pans (SCP07), (VU-DBCA; CR-EPBC)
- Swan Coastal Plain *Banksia attenuata - Banksia menziesii* woodlands (SCP23b), (P3-DBCA; EN-EPBC)

0 5 10
Kilometers

1:450,000(at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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Eighteen ESAs were identified within a 10 km radius of the study area (Figure 4-4). All the ESAs are confined polygons (0.78 ha to 1.75 ha) that are likely to encompass Threatened Flora sites.

Western Botanical (2006) considered all native vegetation in the road reserve to be of high conservation significance due to:

- "the excellent quality of much of the road verge (where the verge is wide, has low weed invasion, high biodiversity and large numbers of trees)
- the high number of Priority Flora species present
- the large amount of clearing that has occurred within the agricultural landscape".

5.2.2 Fauna and fauna habitat

A total of 205 terrestrial fauna species were identified in the desktop review (Table 5-4; Appendix 7). The review did not consider invertebrate fauna apart from those with a conservation listing as they were outside the scope of works. Aquatic species have been excluded from this list.

Table 5-4 Summary of fauna identified in desktop review for the study area

Class	Native species	Introduced species	Total
Invertebrates (includes several classes)	2		2[1]
Amphibians	2		2
Reptiles	16		16
Birds	162	5	167
Mammals	12	6	18
Totals			**205**

[1] only Threatened and Priority invertebrate species included.

Twenty-six species from the desktop review are of conservation significance and protected by Federal and/or State legislation or listed by DBCA as Priority species (Table 5-5; Appendix 7).

Table 5-5 Summary of relevant conservation significant fauna returned from desktop review

Class	Number of species [1]
EPBC Act Threatened species	11
WC Act Protected Fauna species	12
Migratory species (EPBC Act and WC Act)	12
DBCA Priority species	4

[1] Some species are listed as both Threatened/Protected and Migratory.

Four of the species – Grey Wagtail, Dibbler, Red-tailed Phascogale and Shield-back Trapdoor Spider *Idiosoma nigrum* – were not considered relevant to the current study area (i.e. outside current range, or species considered regionally extinct).

The *Idiosoma* genus has recently been subject to a taxonomic revision (Rix *et al.* 2018b) and *I. nigrum* (EN WC Act; VU EPBC Act) is restricted to the central Avon Wheatbelt and eastern Jarrah Forest bioregions. Its habitat preference is *Acacia* (mulga) and eucalypt woodlands on heavy clay or granitic soils, often in or near southern-exposed drainage lines (Main 2003; Minister for the Environment

2013). The study area is approximately 25 km west of the current distribution for the species as defined in Rix *et al.* (2018b)

Migratory shorebirds and aquatic species were also not considered relevant to the study area due to habitat not being present in the study area. Two species identified in the desktop review (Long-tailed Hopping-mouse and Big-eared Hopping-mouse) are considered extinct under the EPBC Act and WC Act and are also not discussed further.

Taking the above into account, 13 conservation significant species identified in the desktop review were considered to be of potential relevance to the study area (Table 5-6).

Idiosoma mcclementsorum (WAM ref. T139832) was collected within the study area in 2015, approximately 170 m south of Sevenmile Well Nature Reserve in a survey conducted for Access Alliance. The record was initially identified as *I. nigrum* and later determined to be the non-significant *I. sigillatum* by Phoenix' arachnologist Volker Framenau after collecting and examining the specimen. It has recently been reclassified as *I. mcclementsorum*[6] as part of a comprehensive review of the *Idiosoma* genus (Rix *et al.* 2018b).

A very old NatureMap record (from 1967) was identified within the study area for Western Quoll. Mogumber Bush Cricket has been recorded adjacent to the study area in SevenmileMile Well Nature Reserve.

Table 5-6 Conservation significant fauna from desktop review of potential relevance to the study area

Scientific name	Common name	EPBC Act	WC Act	DBCA
Invertebrates				
Idiosoma mcclementsorum formerly known as *Idiosoma* sp. 'MYG474'	Julimar shield-backed Trapdoor Spider			P2
Throscodectes xederoides	Mogumber Bush Cricket			P3
Birds				
Leipoa ocellata	Malleefowl	VU	VU	
Oxyura australis	Blue-billed duck			P4
Apus pacificus	Fork-tailed Swift	Mig	Mig.	
Falco peregrinus	Peregrine Falcon		OS	
Thinornis rubricollis	Hooded Plover			P4
Rostratula australis	Australian Painted Snipe	EN	EN	
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	VU	
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	EN	
Calyptorhynchus baudinii	Baudin's Cockatoo	EN	EN	
Mammals				
Dasyurus geoffroii	Western Quoll	VU	VU	
Isoodon obesulus fusciventer	Quenda			P4

[6]At the time of preparing this report, NatureMap still lists this record as *Idiosoma nigrum*.

5.3 FIELD SURVEY

5.3.1 Flora and vegetation

A total of 296 plant taxa (including subspecies and varieties) representing 154 genera and 55 families were recorded in the study area. This total is comprised of 244 (82.4%) native species and 52 (17.6%) introduced (weed) species, and included 60 annual, 223 perennial species, one species that is known to be either annual or perennial and 12 unknown life cycles (Appendix 8). The current survey recorded a similar number of species to previous flora surveys conducted along GNH and higher average diversity (average number of taxa per km) (Table 5-7).

Table 5-7 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	**19**	**25**	**296**	**16**	**55**	**154**	**52**
Worley Parsons (2013)	21	12	197	9	48	114	29
ENV (ENV 2007)	25	18	357	14	59	171	44
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 were Poaceae, Fabaceae, Proteaceae, Myrtaceae, Asteraceae and Iridaceae (Table 5-8). The dominant families recorded were also prominent in at least some of the previous flora surveys.

Table 5-8 Comparison of total number of species per family from the current survey with previous flora surveys

Family	Current survey	Worley Parsons (2013)	ENV (2007)	Western Botanical (2006)	Ninox Wildlife Consulting (1989)
Poaceae	40	N/A[1]	42	4	15
Fabaceae	36	31	50	64	60
Proteaceae	30	N/A[1]	38	48	43
Myrtaceae	23	30	29	64	40
Asteraceae	19	N/A[1]	22	5	7
Iridaceae	14	N/A[1]	6	3	-

[1] data not available.

Twenty six specimens could not be definitively identified to species level as the specimens were either seedlings or sterile (i.e. lacked reproductive structures) at the time of collection and/or reproductive structures present were incomplete, dry and the material was inadequate for full identification (Table 5-9). Majority of the specimens have low or no possibility of risk, but three taxa could represent Threatened flora. One *Acacia* sp. could be a Threatened WC Act and EPBC Act listed species either *Acacia splendens* or *Acacia cochlocarpa* subsp. *cochlocarpa,* one *Rhagodia* sp. could be *Rhagodia acicularis,* and one *Goodenia* sp. could be WC Act listed Threatened species *Goodenia arthrotricha*.

While more that 50 records of *Acacia splendens* occur west of GNH, *Acacia cochlocarpa* subsp. *cochlocarpa* is known from 37 records along the GNH. *Rhagodia acicularis* is known from 19 records surrounding Calingiri. *Goodenia arthrotricha* is known from more than 30 records along the GNH. Four specimens can be Priority flora identified in the desktop review (Table 5-9).

Table 5-9 Details of taxa not identified definitively to species level

Taxon	Comments	Possibility of Risk
**Freesia* sp.	Sterile	None, common weed in the area
?*Beyeria lechenaultii* (sterile)	Sterile	Low, no *Beyeria* species found on the list of possible significant flora in the area
Acacia sp. seedling	Immature Site: CAL17007	Possible, two Priority *Acacia* species found in the study area, two WC and EPBC Acts Threatened and several Priority flora found on the list of possible significant flora in the area
Allocasuarina ?*campestris*	Sterile	Low, *Allocasuarina campestris* is a common species. *Allocasuarina ramosissima* found in the list of possible flora is a P3
Drosera ?*macrantha*	Sterile	None. Very common species found in the area
Drosera sp.	Sterile	Low, no *Drosera* species found on the list of possible significant flora in the area
**Freesia* sp. sterile	Sterile	None, common weed in the area. No native *Freesia* species in WA
**Gladiolus* sp. sterile	Sterile	None, common weed in the area. No native *Gladiolus* species in WA
Goodenia sp. sterile	Sterile Site: CAL170207	Possible, WC Act listed Threatened species of *Goodenia* is listed as possible significant flora in the area
Hydrocotyle ?*callicarpa*	Sterile	Low, no *Hydrocotyle* species found on the list of possible significant flora in the area
Isopogon sp.	Sterile	Low, no *Isopogon* species found on the list of possible significant flora in the area
Lepidosperma sp.	Reproductive structures dry, insufficient material	Low, no *Lepidosperma* species found on the list of possible significant flora in the area
Lomandra ?*preissii*	Reproductive structures dry, insufficient material	Low, no *Lomandra* species found on the list of possible significant flora in the area
Lomandra sp.	Sterile	Low, no *Lomandra* species found on the list of possible significant flora in the area
Lomandra sp. sterile	Sterile	Low, no *Lomandra* species found on the list of possible significant flora in the area
Patersonia ?*occidentalis*	Sterile	Low, no *Patersonia* species found on the list of possible significant flora in the area
Patersonia ?*occidentalis* var. *occidentalis*	Sterile	Low, no *Patersonia* species found on the list of possible significant flora in the area
Poaceae sp.	Plant dry, insufficient material	Low, No species from Poaceae family found on the list of possible significant flora in the area.

Taxon	Comments	Possibility of Risk
		Could be one of the 23 weeds or one of the 17 common species reported in the field tudy
Poaceae sp. seedling	Immature	Low, No species from Poaceae family found on the list of possible significant flora in the area. Could be one of the 23 weeds or one of the 17 common species reported in the field tudy
Rhagodia ?*drummondii*	Sterile Site: CAL17005	Possible, WC Act and EPBC listed Threatened species of *Rhagodia* is listed as possible significant flora in the area
Solanum sp.	Sterile	Low, no *Solanum* species found on the list of possible significant flora in the area
Stylidium sp. sterile	Sterile	Low, no *Solanum* species found on the list of possible significant flora in the area
Synaphea sp.	Sterile Opportunistic record	Possible, four Priority species of *Synaphea* are listed as possible significant flora in the area. One of them is P1. *Synaphea grandis* P4 and *Synaphea rangiferops* P2 were found in the field survey
Synaphea sp. GNH	Sterile Opportunistic record	Possible, four Priority species of *Synaphea* are listed as possible significant flora in the area. One of them is P1 *Synaphea grandis* P4 and *Synaphea rangiferops* P2 were found in the field survey
Tecticornia sp. sterile 1	Sterile	Low, no *Tecticornia* species found on the list of possible significant flora in the area.
Trifolium ?*hirtum*	Sterile	Low, no *Trifolium* species found on the list of possible significant flora in the area

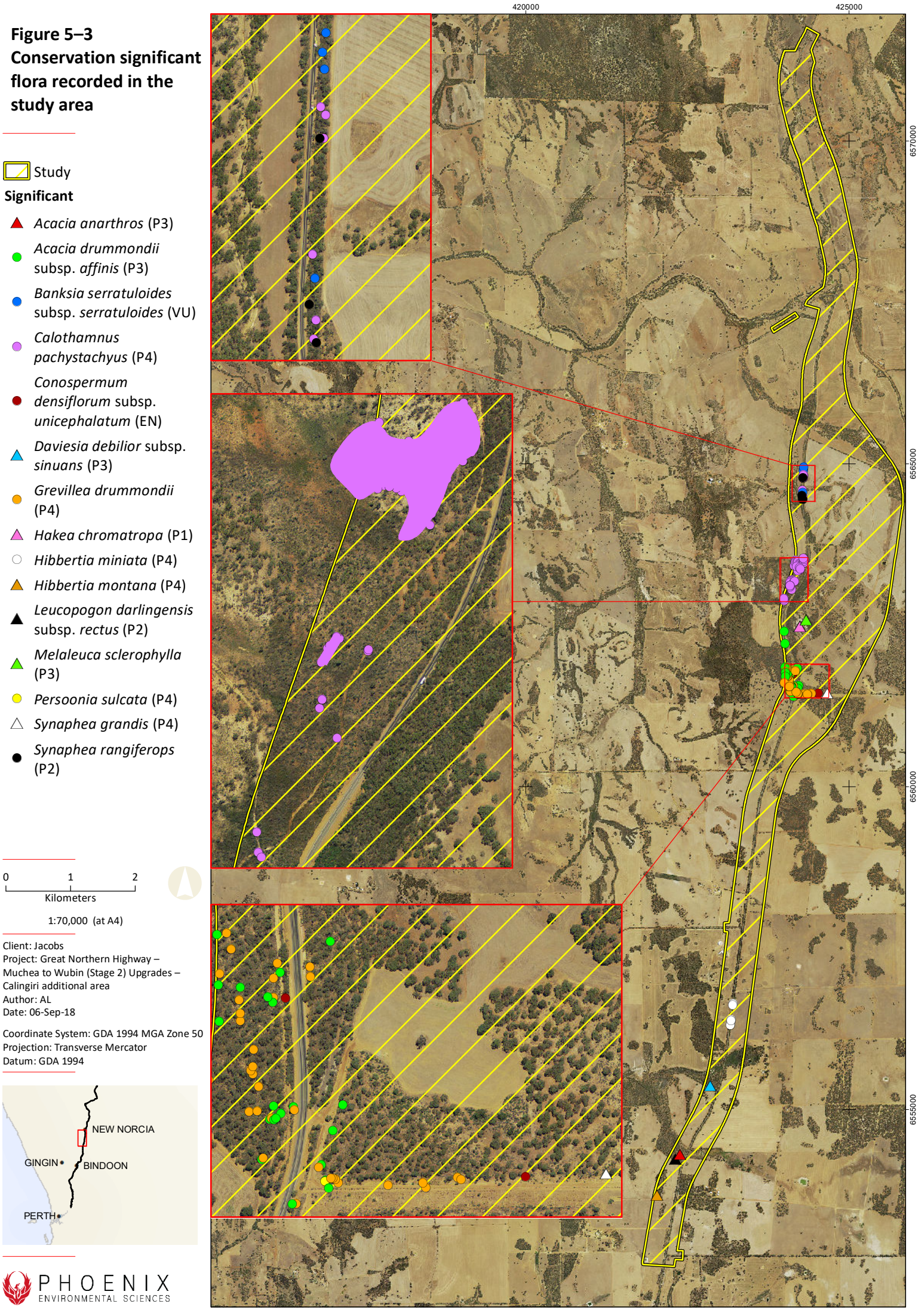
5.3.1.1 Conservation significant flora

Fifteen conservation significant flora species (398 individual plants) were recorded in the field surveys (Table 5-10; Figure 5-3). Twelve of the taxa 12 were identified in the desktop review as present or potentially present. Three species, *Daviesia debilior* subsp. *sinuans* (P3), *Hakea chromatropa* (P1) and *Leucopogon darlingensis* subsp. *rectus* (P2), were not identified in the desktop review. Verification of the identity of all conservation significant taxa has been confirmed with the WA Herbarium.

Table 5-10 Details of conservation significant flora recorded in the study area

Species	Conservation status	No. popns	Total no. plants
Acacia anarthros	P3	1	1
Acacia drummondii subsp. *affinis*	P3	2	72
Banksia serratuloides subsp. *serratuloides*	VU (EPBC Act; WC Act)	1	22
Calothamnus pachystachyus	P4	2	178
Conospermum densiflorum subsp. *unicephalatum*	EN (EPBC Act; WC Act)	1	4
Daviesia debilior subsp. *sinuans*	P3	1	1
Grevillea drummondii	P4	2	76
Hakea chromatropa	P1	1	15
Hibbertia miniata	P4	1	15
Hibbertia montana	P4	1	1
Leucopogon darlingensis subsp. *rectus*	P2	1	1
Melaleuca sclerophylla	P3	1	1
Persoonia sulcata	P4	1	1
Synaphea grandis	P4	1	1
Synaphea rangiferops	P2	1	9

Figure 5–3
Conservation significant flora recorded in the study area



***Acacia anarthros* Priority 3**

Acacia anarthros is an erect or prostrate, spinose shrub that grows to 0.5 m high with yellow flowers in June to September (DBCA 2018b). This taxon is known from 30 records in the Katanning and Northern Jarrah Forest subregions. A single plant of *Acacia anarthros* was recorded in the study area (Figure 5-3).

***Acacia drummondii* subsp. *affinis* Priority 3**

Acacia drummondii subsp. *affinis* is an erect shrub that grows to a height of 1 m with yellow flowers from July to August (DBCA 2018b). The taxon is known from 65 records (ALA 2017) and occurs from New Norcia to Bullsbrook East in WA and grows in laterite or sand over laterite, in Jarrah (*Eucalyptus marginata*), Jarrah- Marri (*E. marginata - Corymbia calophylla*) and sometimes Wandoo (*E. Wandoo*) forest and woodland. The taxon is distinguished from other subspecies by the presence of recurved to revolute green phyllodes (leaflets).

Two populations of *Acacia drummondii* subsp. *affinis* containing 72 plants were recorded along a short stretch of road reserve in the study area (Figure 5-3).

The species has also been recorded at several locations south of the study area between Muchea North and Little Bindoon Hill (Phoenix 2015, 2016a; Western Botanical 2006). The previous record from Ecologia (2004) in the study area was not located in the surveys.

***Banksia serratuloides* subsp. *serratuloides* Threatened (VU) EPBC Act, Schedule 3 (VU) WC Act**

Banksia serratuloides subsp. *serratuloides* is a low bushy lignotuberous shrub that grows up to 1 m high. It has pink-yellow flowers between July and September and grows in loam over laterite and clayey sand (DBCA 2018b). It is only known from several populations close to where the borders of the Avon Wheatbelt, Jarrah Forest and Swan Coastal Plain bioregions meet.

The current survey recorded 22 plants from one known population (DPaW 2014c) that occurs in the study area.

***Calothamnus pachystachyus* Priority 4**

Calothamnus pachystachyus is an erect straggly shrub that grows to 1.7 m high. Flowers are red-brown-black and come out from August to October. It grows in lateritic soils along ridges and road verges (DBCA 2018b). It is known from 31 records in the Chittering, Gingin, Moora, Toodyay and Victoria Plain areas.

Two populations of 178 plants were recorded in the study area (Figure 5-3).

***Conospermum densiflorum* subsp. *unicephalatum* Threatened (EN) EPBC Act, WC Act**

Conospermum densiflorum subsp. *unicephalatum* is an erect, much branched shrub that grows up to 0.6 m high with cream, white and blue flowers in September to November (DBCA 2018b). It grows in clay soils in low lying areas. This species is known from 15 records in the Katanning, Dandaragan Plateau and Northern Jarrah Forest subregions.

Conospermum densiflorum subsp. *unicephalatum* was recorded in the study area from two records of two plants each (Figure 5-3). The records are just under 500 m apart and therefore have been treated as a single population.

***Daviesia debilior subsp. sinuans* Priority 3**

Daviesia debilior subsp. sinuans is a straggling shrub that grows to 0.8 m high with yellow and red to purple flowers in May to July (DBCA 2018b). It grows in gravelly lateritic clay. This taxon is known from 11 records in the Merredin, Katanning and the Northern Jarrah Forest subregions. *Daviesia debilior*

subsp. sinuans was recorded in the current survey in the study area from one population containing one plant (Figure 5-3).

***Grevillea drummondii* Priority 4**

Grevillea drummondii is a spreading to erect shrub that grows to 2.5 m high with cream, yellow and red flowers in June to September (DBCA 2018b). It grows in sandy clay, gravel, loam or sandy lateritic soils or in sand over granite, it is found on rocky hillsides on boulders and granite outcrops, This taxon is known from 25 records in the Avon Wheatbelt, Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain bioregions.

Two populations containing 76 plants were recorded in the study area (Figure 5-3).

***Hakea chromatropa* Priority 1**

Hakea chromatropa is bushy shrub that grows to 2.5 m high with cream or pink flowers in August or September (DBCA 2018b). It grows in gravelly loam in an open shrubland. It is known from six populations in the Katanning and Northern Jarrah Forest subregions.

Hakea chromatropa was recorded in the current survey in the study area from one population containing one plant (Figure 5-3).

***Hibbertia miniata* Priority 4**

Hibbertia miniata is a decumbent or erect shrub that grows up to 1 m high in gravelly lateritic soils in the Avon Wheatbelt, Jarrah Forest and Swan Coastal Plain bioregions. It has orange to orange-red coloured flowers which flower between August and November (DBCA 2018b).

Fifteen plants were recorded from one population in the study area (Figure 5-3).

***Hibbertia montana* Priority 4**

Hibbertia montana is an erect, straggling or sprawling shrub that grows up to 0.7 m high with yellow flowers in July to October (DBCA 2018b). It grows in loam over granite, lateritic soils and gravel on granite rocks, lateritic ridges, boulders and hills. This taxon is known from 93 records in the Katanning, Northern Jarrah Forest and Perth subregions.

A single plant of *Hibbertia montana* was recorded in the study area (Figure 5-3).

***Leucopogon darlingensis subsp. rectus* Priority 2**

Leucopogon darlingensis subsp. rectus is an erect shrub that grows to 0.8 m high with white flowers in August (DBCA 2018b). This taxon is known from 22 populations in the Katanning and Northern Jarrah Forest subregions.

A single plant of *Leucopogon darlingensis* subsp. *rectus* was recorded in the study area (Figure 5-3).

***Melaleuca sclerophylla* Priority 3**

Melaleuca sclerophylla is a erect spreading to prostrate shrub that grows to 0.9 m high with purple to pink flowers in June to September (DBCA 2018b). It grows in gravelly or clayey sand on granite outcrops on rises. This taxon is known from 45 records in the Avon Wheatbelt, Geraldton Sandplains and Jarrah forest bioregions.

A single plant of *Melaleuca sclerophylla* was recorded in the study area (Figure 5-3).

***Persoonia sulcata* Priority 4**

Persoonia sulcata is an erect shrub that grows up to 1 m high in lateritic or granitic soils in the Avon Wheatbelt, Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain bioregions. It has yellow coloured flowers between September and November (DBCA 2018b).

A single plant of *Persoonia sulcata* was recorded in the study area (Figure 5-3).

***Synaphea grandis* Priority 4**

Synaphea grandis is a tufted shrub that grows to 0.3 m high with yellow flowers in October to November (DBCA 2018b). It grows in laterite. The species is known from 45 records in the Avon Wheatbelt, Geraldton Sandplains and Jarrah Forest bioregions.

A single plant of *Synaphea grandis* was recorded in the study area (Figure 5-3).

***Synaphea rangiferops* Priority 2**

Synaphea rangiferops is a shrub that grows up to 0.3 m high in sandy loam and gravel soils. It occurs in the Avon Wheatbelt, Jarrah Forest and Swan Coastal Plain bioregions and has yellow coloured flowers between July and September (DBCA 2018b).

Nine plants were recorded from one population in the study area (Figure 5-3).

Despite visits to records of locations of significant flora and thorough targeted searches, six significant species previously recorded in the study area were not recorded in the current survey; *Lasiopetalum rotundifolium* (EN), *Spirogardnera rubescens* (EN/VU), *Acacia pulchella* var. *reflexa* acuminate bracteole variant (P3), *Grevillea florida* (P3), *Stylidium sacculatum* (P3) and *Asterolasia grandiflora* (P4). It is noted that many of the records provided by the DBCA database are quite old and species may no longer exist in the area.

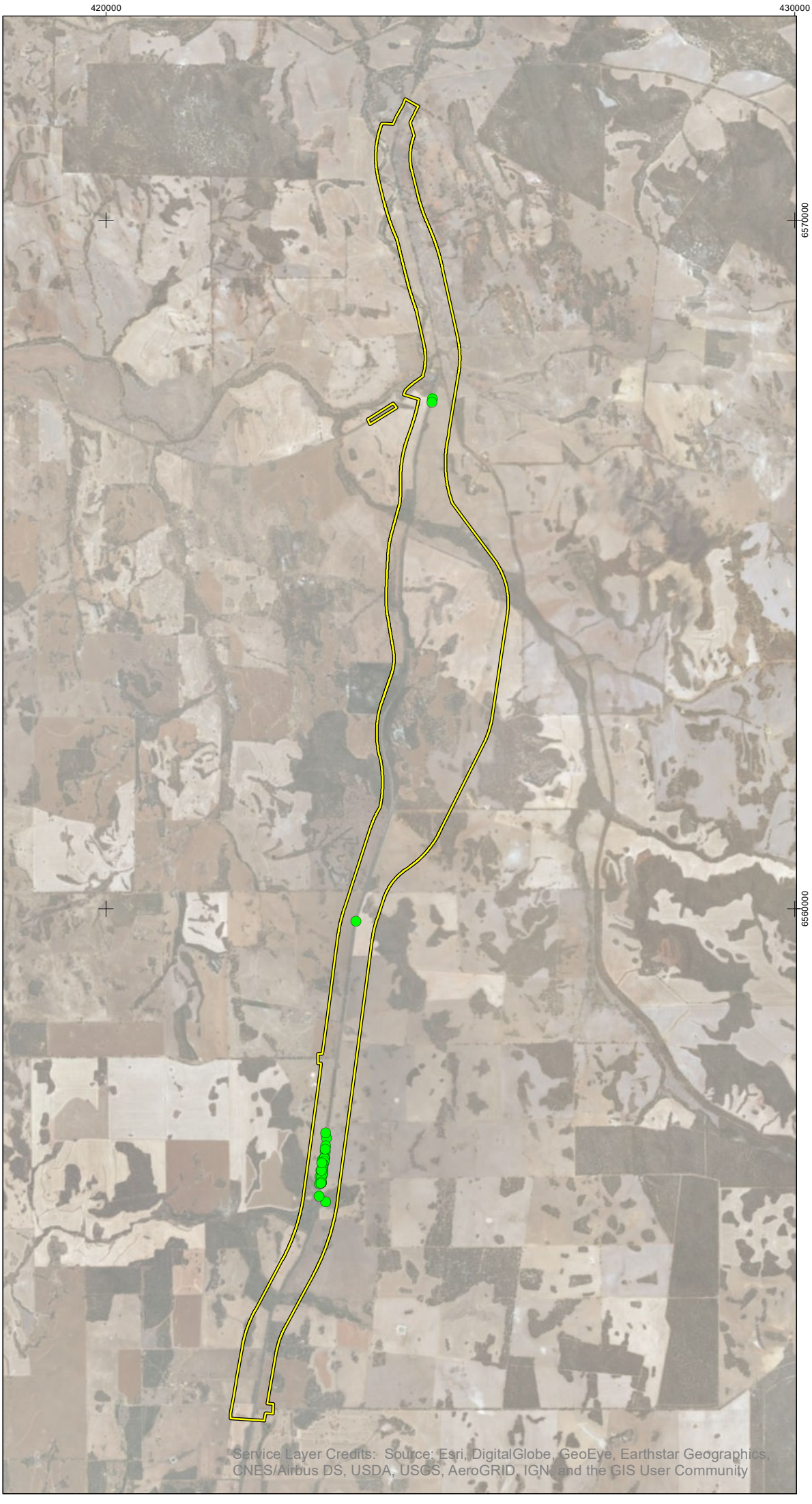
5.3.1.2 Introduced flora

A total of 52 introduced flora species were recorded in the study area (Appendix 8). All species recorded have wide distributions in WA. One of the introduced species, **Asparagus asparagoides*, is a declared pest and WoNS. It was recorded at several locations in the study area (Figure 5-4).

5.3.1.3 Range extensions

No range extensions were identified for any of the native flora species.

Figure 5–4
Declared pests recorded in the study area



Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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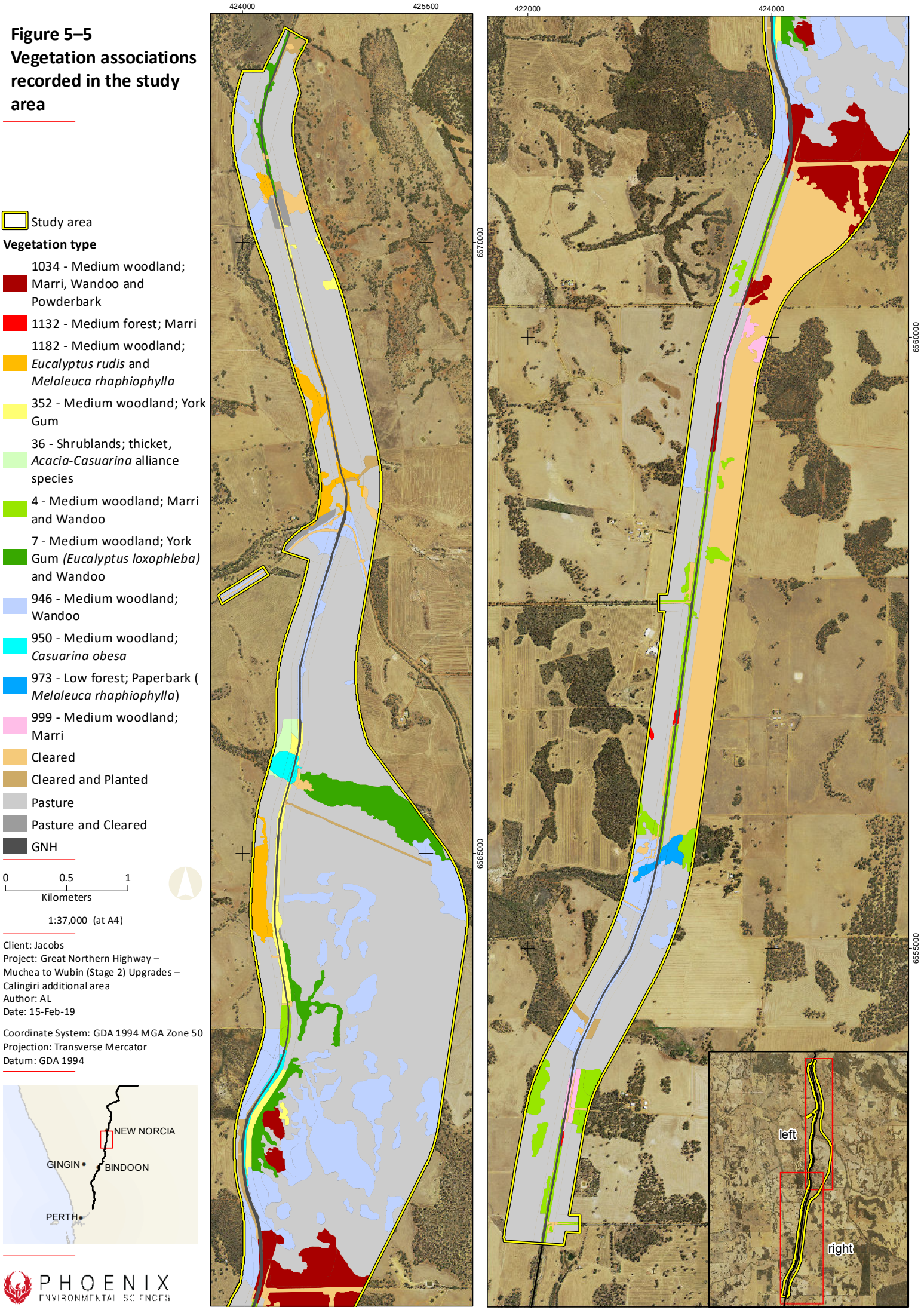
5.3.1.4 Vegetation associations

A total of 11 vegetation associations were defined in the study area (Figure 5-5; Table 5-11). The number of vegetation associations exceeds the four mapped by Shepherd *et al.* (2002) on the regional scale (Figure 4-4). Current mapping on a local scale (Figure 5-5) has resulted in the delineation of a greater number of vegetation associations for the study area and is to be expected. In some instances, vegetation was described that did not align with vegetation associations mapped by Shepherd *et al.* (2002) within the subregion or bioregion. Where this occurred, the vegetation was assigned to corresponding vegetation associations mapped elsewhere by Shepherd *et al.* (2002).

The majority of vegetation associations represented medium woodlands comprising of Wandoo, York Gum, Flooded Gum and/or Marri. These covered approximately 25% of the study area. Areas described as the road (GNH), cleared (e.g. townships, driveways, side roads), cleared and planted (re-vegetated), pasture (agricultural areas), pasture and cleared (mosaic of agricultural areas and cleared areas for other agricultural purposes) accounted for approximately 74% of the study area (Table 5-12). The remaining vegetation associations, Low paperbark forest, Medium Marri forest and Acacia/Casuarina Shrublands, occupied less than 1% of the study area (Table 5-12).

Figure 5–5
Vegetation associations recorded in the study area



Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 15-Feb-19

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

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Table 5-11 Vegetation associations recorded in the study area

Code	Vegetation Description as per Shepherd *et al.* 2002	Quadrat/s	Vegetation description (current survey)
4	Medium woodland; marri & wandoo	S3A29	Mid *Corymbia calophylla* and *Eucalyptus wandoo* woodland over tall sparse *Banksia sessilis* and *Casuarina obesa* shrubland over low sparse *Xanthorrhoea preissii*, *Melaleuca trichophylla* and B*ossiaea eriocarpa* shrubland over isolated mid *Neurachne alopecuroidea, *Avena barbata* and **Bromus diandrus* tussock grasses.
		CAL17020	Low *Corymbia calophylla* woodland over *Banksia sessilis* var. *sessilis* tall shrubland over *Hibbertia hypericoides*, *Xanthorrhoea preissii* and *Acacia huegelii* low sparse shrubland.
		CAL17021A	Low *Eucalyptus wandoo* subsp. *wandoo* and *Corymbia calophylla* woodland over *Banksia sessilis* tall open shrubland over isolated *Amphipogon turbinatus*, *Enteropogon ramosus* and *Rytidosperma caespitosum* grasses.
		S3A30	Mid open *Corymbia calophylla* and *Eucalyptus wandoo* forest over low sparse *Hibbertia hypericoides* and *Phyllanthus calycinus* shrubland over isolated low *Lepidosperma calcicola* and *Lepidosperma* sp. sedges, isolated low *Austrostipa elegantissima* and **Briza maxima* tussock grasses and isolated **Asparagus asparagoides* vines.
7	Medium woodland; York gum (*Eucalyptus loxophleba*) & Wandoo	CALP20001	Low *Eucalyptus loxophleba* forest over isolated low **Lolium rigidum* and **Avena barbata* tussock grasses and isolated low *Dianella revoluta* forbs.
		CAL17007	Low *Eucalyptus loxophleba* subsp. *loxophleba* and *Casuarina obesa* woodland over low **Hordeum marinum*, **Ehrharta longiflora* and **Bromus arenarius* grassland.
		GAP020	Mid open *Eucalyptus loxophleba* subsp. *loxophleba*, *E. rudis* and *E. wandoo* woodland over low **Avena barbata*, **Ehrharta longiflora* and **Lolium rigidum* tussock grassland and low closed **Oxalis purpurea* forbland.
		CAL17012	Low *Eucalyptus loxophleba* woodland over *Casuarina obesa* tall open shrubland over mid *Spyridium globulosum* closed shrubland.
		NN3.1a	Mid open *Eucalyptus wandoo* and *Eucalyptus loxophleba* forest over low **Avena barbata*, **Ehrharta longiflora* and **Bromus diandrus* tussock grassland.
		NN3.2	Mid open *Eucalyptus loxophleba* forest over low **Avena barbata*, **Bromus diandrus* and *Austrostipa variabilis* tussock grassland.
36	Shrublands; thicket, *Acacia-Casuarina* alliance species	CALP20002	Low open *Eucalyptus loxophleba* woodland over tall open *Acacia acuminata* shrubland over low isolated G*ompholobium aristatum*, *Gastrolobium calycinum* and **Lupinus cosentinii* shrubs over low open **Avena barbata* tussock grassland and isolated low *Opercularia vaginata*, *Podolepis aristata* subsp*. aristata* and *P. lessonii* forbs.
352	Medium woodland; York Gum	S3A21	Mid open *Eucalyptus loxophleba* forest over isolated low **Avena barbata*, **Ehrharta calycina* and **Lolium rigidum* tussock grasses.
946		CAL17001	Mid *Eucalyptus rudis* woodland over mid open *Avena sativa*, *Hordeum glaucum* and *Bromus rubens* grassland.

Code	Vegetation Description as per Shepherd *et al.* 2002	Quadrat/s	Vegetation description (current survey)
	Medium woodland, Wandoo	S3A23	Mid *Eucalyptus wandoo* open forest over isolated *low Hibbertia polystachya* and *Lechenaultia biloba* shrubs over isolated low *Austrostipa campylachne*, *A. elegantissima* and **Avena barbata* tussock grasses and isolated low *Arthropodium dyeri* forbs.
		S3A32	Mid open *Eucalyptus wandoo* forest low sparse *Hibbertia hypericoides*, *Bossiaea eriocarpa* and *Hibbertia lasiopus* shrubland over low sparse *Lepidosperma* sp. and *Tetraria octandra* sedgeland, isolated mid *Austrostipa elegantissima* tussock grasses and low open *Opercularia vaginata* forbland.
		CAL17003	Mid *Eucalyptus wandoo* subsp. *wandoo* woodland over low *Acacia lasiocarpa* var. *sedifolia*, *Astroloma compactum* and *Gastrolobium polystachyum* low shrubland over low isolated *Amphipogon turbinatus* and *Austrostipa elegentissima* tussock grasses.
		GAP021	Low *Eucalyptus wandoo* subsp. *wandoo* woodland over low *Acacia lasiocarpa* var. *sedifolia* and *Gastrolobium spathulatum* shrubland.
		GAP022	Mid *Eucalyptus wandoo* subsp. *wandoo* woodland over low open *Acacia lasiocarpa* var. *sedifolia* and *Gastrolobium* spathulatum shrubland.
		S3A47	Mid *Eucalyptus wandoo* woodland over isolated low *Gastrolobium polystachyum, Hibbertia hypericoides* and *Lechenaultia floribunda* shrubs over mid open A*ustrostipa semibarbata, A. elegantissima* and **Avena barbata* tussock grassland.
		CAL17006	Mid *Eucalyptus loxophleba* subsp. *loxophleba* and *Eucalyptus wandoo* woodland over low **Avena sativa*, **Ehrharta longiflora* and **Hordeum glaucum* tussock grassland.
		CAL17008	Mid *Eucalyptus wandoo* subsp. *wandoo* woodland over low open **Ehrharta longiflora*, **Bromus rubens* and **Avena sativa* grassland.
		CAL17009	Mid *Eucalyptus wandoo* woodland over isolated mid *Banksia armata* var. *armata* shrubs over low *Acacia lasiocarpus* var. *sedifolia* and *Glischocaryon aureum* shrubland.
		CAL17010	Low *Eucalyptus wandoo* and *Allocasuarina campestris* low woodland over mid *Trymalium odoratissimum* subsp. *odoratissimum* and *Acacia acuminta* shrubland over *Cheilanthes austrotenuifolia* open forbland.
		CAL17015	Mid *Eucalyptus wandoo* subsp. wandoo over low open **Avena sativa*, **Hordeum glaucum* and **Ehrharta longiflora* grassland.
		CAL17018	Low *Eucalyptus wandoo* subsp. *wandoo* open woodland over *Allocasuarina humilis* and *Xanthorrhoea preissii* mid shrubland over *Mesomelana psuedostygia* and Lepidosperma tenue sedgeland.
		CAL17019	Low *Eucalyptus wandoo* subsp. *wandoo* woodland over *Banksia sessilis* tall isolated shrubs over *Bossiaea eriocarpa*, *Hibbertia hibbertioides* var. *hibbertioides* and *Acacia tetragonophylla* low sparse shrubland.
		CAL17022	Mid *Eucalyptus wandoo* open forest over low open *Avena sativa*, *Ehrharta longiflora* and *Lolium perenne* open tussock grassland.
950	Medium woodland, *Casuarina obesa*	CAL17005	Low *Casuarina obesa* woodland over *Tecticornia* sp. sterile 1 low open shrubland over low open **Parapholis incurva*, **Lolium rigidum* and **Hordeum leporinum* tussock grassland.

Code	Vegetation Description as per Shepherd *et al.* 2002	Quadrat/s	Vegetation description (current survey)
		S3A24	Low open *Casuarina obesa* forest over isolated low *Austrostipa elegantissima*, **Avena barbata* and **Ehrharta calycina* tussock grasses.
973	Low forest; paperbark (*Melaleuca rhaphiophylla*)	S3A31	Low *Melaleuca rhaphiophylla* forest over tall open *Lepidosperma pubisquameum*, **Typha orientalis* and **Juncus acutus* subsp. *acutus* sedges over low **Cynodon dactylon* open grassland and isolated low **Sonchus oleraceus* forbs.
999	Medium woodland; marri	S3A27	Mid *Corymbia calophylla* open forest over isolated mid *Allocasuarina*? *campestris* and *Adenanthos cygnorum* shrubs over isolated low **Avena barbata*, **Briza minor* and **Bromus diandrus* tussock grasses and isolated low *Burchardia congesta*, *Podolepis aristata* subsp. *aristata* and *Ptilotus manglesii* forbs.
		S3A33	Mid open *Corymbia calophylla* woodland over tall open *Banksia sessilis* shrubland over low sparse *Bossiaea eriocarpa, Hibbertia hypericoides* and *Phyllanthus calycinus* shrubland over isolated low *Austrostipa semibarbata*, **Briza maxima* and **Ehrharta calycina* tussock grasses and isolated low *Opercularia vaginata*, *Arthropodium dyeri* and *Lomandra maritima* forbs.
1034	Medium woodland; marri, wandoo & powderbark	S3A28	Mid open *Corymbia calophylla* and *Eucalyptus accedens* forest over isolated mid *Allocasuarina humilis* shrubs over isolated low *Macrozamia riedlei* and *Phyllanthus calycinus* shrubs over mid open **Avena barbata*, **Bromus diandrus* and **Ehrharta calycina* tussock grassland over isolated low *Kennedia prostrata* vines.
		CAL17011	Mid *Eucalyptus loxophleba* subsp. *loxophleba* and *Eucalyptus wandoo* woodland over low **Avena sativa*, **Ehrharta longiflora* and **Hordeum glaucum* tussock grassland.
		CAL17014	Mid *Eucalyptus accedens*, *Corymbia calophylla* and *Eucalyptus wandoo* woodland over *Banksia armata* var. *armata* and *Gastrolobium spinosum* mid open shrubland over *Hibbertia hibbertioides* var. *hibbertioides*, *Acacia lasiocarpa* var. *lasiocarpa* and *Hibbertia hypericoides* low open shrubland.
		S3AB2001	Mid open *Corymbia calophylla* and *Eucalyptus wandoo* forest over isolated mid *Gastrolobium spinosum* shrubs over isolated low A*cacia pulchella* and *Hibbertia* spp. shrubs over isolated low *Neurachne alopecuroidea* and **Bromus diandrus* tussock grasses and isolated low *Desmocladus asper* sedges.
1132	Medium forest; marri	S3A45	Mid *Corymbia calophylla* woodland over isolated mid *Adenanthos cygnorum* shrubs over isolated low *Hibbertia hypericoides*, *Phyllanthus calycinus* and *Daviesia decurrens* shrubs over isolated mid **Briza maxima*, **Ehrharta calycina* and **Avena barbata* tussock grasses.
1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	CALP20004	Low open *Eucalyptus loxophleba* and *E. rudis* woodland over tall closed *Melaleuca rhaphiophylla* shrubland.
		CAL17004	*Eucalyptus loxophleba* subsp. *loxophleba* woodland over low **Ehrharta longiflora*, **Avena barbata* and *Austrostipa elegantissima* tussock grassland
		NN3.1	Tall open *Eucalyptus rudis* forest over a low open *Melaleuca rhaphiophylla* woodland over low **Avena barbata*, **Bromus diandrus* and **Ehrharta calycina* tussock grassland and isolated low **Sonchus oleraceus* forbs.

Code	Vegetation Description as per Shepherd *et al.* 2002	Quadrat/s	Vegetation description (current survey)
		S3A22	Mid *Eucalyptus rudis* and *E. loxophleba* woodland over mid open **Avena barbata*, **Cynodon dactylon* and **Ehrharta calycina* tussock grassland and isolated low **Sonchus oleraceus* forbs.
		CAL17002	Mid *Eucalyptus loxophleba* subsp. *loxophleba* woodland over low open *Hordeum glaucum*, *Bromus rubens* and *Erharta longiflora* grassland

Table 5-12 Extent of each vegetation association in the study area

Code	Vegetation association description as per Shepherd *et al.* (2002)	Area (ha)	% of study area
4	Medium woodland; marri & wandoo	41.9	2.9%
7	Medium woodland; York Gum (*Eucalyptus loxophleba*) and Wandoo	47.2	3.2%
36	Shrublands; thicket, *Acacia-Casuarina* alliance species	3.9	0.3%
352	Medium woodland; York Gum	17.4	1.2%
946	Medium woodland; Wandoo	172.5	11.8%
950	Medium woodland; Casuarina obesa	6.8	0.5%
973	Low forest; paperbark (*Melaleuca rhaphiophylla*)	4.6	0.3%
999	Medium woodland; Marri	8.9	0.6%
1034	Medium woodland; Marri, Wandoo and Powderbark	51.3	3.5%
1132	Medium forest; Marri	0.9	0.1%
1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	25.1	1.7%
Cleared	Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present	153.8	10.5%
Cleared and Planted	Historically cleared. Maybe replanted with non-native vegetation	11.6	0.8%
GNH	Bitumen and road shoulders. No vegetation	28.6	1.9%
Pasture	Agricultural areas. Small pockets of vegetation maybe present	888.9	60.5%
Pasture and Cleared	Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses	5.6	0.4%

5.3.1.5 Vegetation condition

The condition of vegetation within the study area ranged from degraded to excellent condition, with excellent vegetation condition comprising 34.2 ha (Table 5-13; Figure 5-6). The parts of the study area described as GNH, cleared, planted and pasture (collectively 74.1%) were mapped as completely degraded (Figure 5-6).

Table 5-13 Vegetation condition

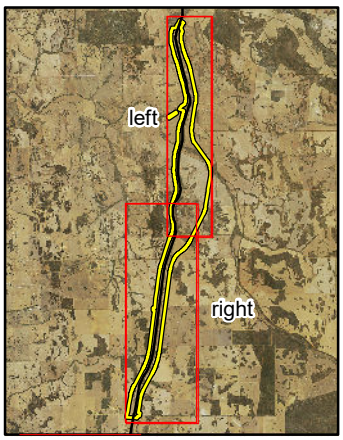
Condition rating	Area (ha)	Percentage
Completely Degraded	1,088.4	74.1%
Degraded	139.0	9.5%
Good	92.8	6.3%
Very Good	116.6	7.9%
Excellent	34.2	2.2%
Total	1,469.1	100%

Figure 5–6
Vegetation condition

Study area

Vegetation condition

- Pristine
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded



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Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 06-Sep-18

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

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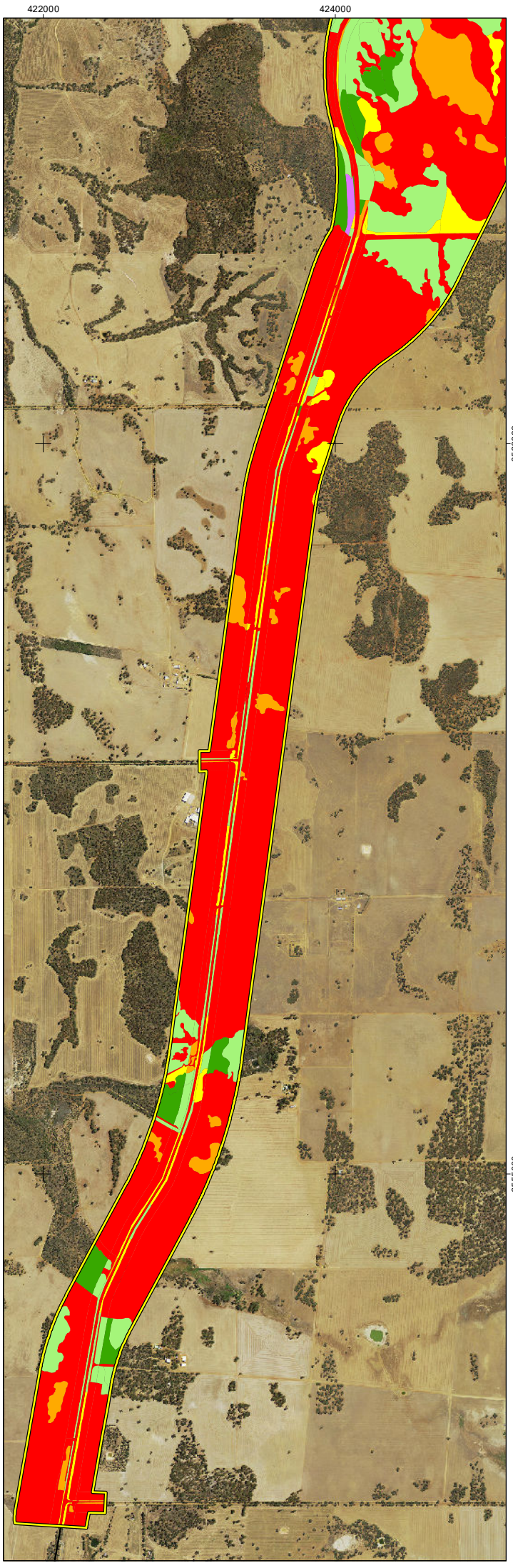


5.3.1.6 Threatened and priority ecological communities

None of the remnant vegetation in the study area was determined to align with any TEC or PEC.

Several TEC assessment sites and patches of eucalypt woodlands met the diagnostic characteristics for the Eucalypt Woodlands of the Western Australian Wheatbelt TEC (Appendix 9). However, all patches were assessed to be in degraded condition in both the TEC site assessments and the vegetation condition mapping; these were therefore were discounted from representing the ecological community in accordance with section 3.3 of the conservation advice for the TEC (Threatened Species Scientific Committee 2015a).

5.3.1.7 Local and regional significance of vegetation

All of the vegetation associations mapped in the study area may be considered locally significant as they represent habitat for Threatened and/or Priority Flora, contain one or more quadrats that align with a TEC, were recorded to be in excellent condition and therefore are considered to represent patches of comparatively high native species diversity surrounded by highly impacted vegetation, and/or have locally restricted distribution (Table 5-14). The percentage of representation of these within the study area varied from 0.06% to 0.60%.

Table 5-14 Vegetation associations considered locally significant

Vegetation code	Reason for local significance
4	Provides habitat for *Calothamnus pachystachyus* (P4), *Hibbertia miniata* (P4), *Hibbertia montana* (P4). Contains vegetation in excellent condition
7	Contains three quadrats that align with the Eucalypt Woodlands of the Western Australian Wheatbelt TEC
36	Locally restricted (<1% of the study area; 0.3%)
352	Provides habitat for *Banksia serratuloides* subsp. *serratuloides* (T), *Calothamnus pachystachyus* (P4) and *Synaphea rangiferops* (P2). Contains three quadrats that align with the Eucalypt Woodlands of the Western Australian Wheatbelt TEC.
946	Provides habitat for *Acacia anarthros* (P3), *Acacia drummondii* subsp. *affinis* (P3), *Calothamnus pachystachyus* (P4), *Conospermum densiflorum* subsp. *unicephalatum* (EN), *Davesia debilior* subsp. *sinuans* (P3), *Grevillea drummondii* (P4) and *Leucopogon darlingensis* subsp. *rectus* (P2). Contains one quadrat that aligns with the Eucalypt Woodlands of the Western Australian Wheatbelt TEC. Contains vegetation in excellent condition.
950	Locally restricted (<1% of the study area; 0.5%).
973	Locally restricted (<1% of the study area; 0.3%). Contains vegetation in excellent condition.
999	Contains vegetation in excellent condition. Locally restricted (<1% of the study area; 0.6%)
1034	Provides habitat for *Acacia drummondii* subsp. *affinis* (P3), *Conospermum densiflorum* subsp. *unicephalatum* (EN), *Hakea chromatoma* (P1), *Grevillea drummondii* (P4), *Melaleuca sclerophylla* (P3), *Persoonia sulcata* (P4) and *Synaphea grandis* (P4). Contains vegetation in excellent condition.
1132	Locally restricted (<1% of the study area; 0.06%).

Vegetation code	Reason for local significance
1182	Contains one quadrat that aligns with the Eucalypt Woodlands of the Western Australian Wheatbelt TEC.

Based on a review of the proportion of pre-European extent in remaining in WA, eight vegetation associations from the study area are considered regionally significant as less than 30% of their pre-European extent remains at the Statewide and/or bioregional scale (status of VU in Table 5-15). Of the pre-European extent remaining in the whole of WA, six of these are vulnerable (Table 5-15). At the bioregional scale, four of the associations are Vulnerable within the Jarrah Forest bioregion and six are Vulnerable within the Avon Wheatbelt bioregion.

Table 5-15 Extent and status of vegetation associations recorded in the study area

Code	Pre-European extent (ha)[1]	Current total (ha)[1]	% remaining[1]	Status[2]	Extent in study area (ha)	% of current extent within study area[3]
WA scale						
4	1,054,280	287,301	27%	VU	41.94	0.0146%
7	179,725	22,885	13%	VU	47.16	0.2061%
36	495,431	226,242	46%	D	3.95	0.0017%
352	724,273	142,019	20%	VU	17.41	0.0123%
946	53,225	14,075	26%	VU	143.881	1.0222%
950	497	287	58%	LC	6.84	2.3833%
973	5,003	1,896	38%	D	4.65	0.2453%
999	115,707	13,026	11%	VU	8.884	0.0682%
1034	1,823	1,129	62%	LC	51.28	4.5421%
1132	307	259	84%	LC	0.94	0.3629%
1182	23,437	6,133	26%	VU	25.13	0.4098%
Jarrah Forest bioregion						
4	1,022,713	280,312	27%	VU	41.94	0.0150%
7	31,000	6,079	20%	VU	43.22	0.7110%
36	0	0	0	na	3.95	*
352	31,607	6,467	20%	VU	15.30	0.2366%
946	6,150	4,139	67%	LC	135.85	3.2822%
950	0	0	0	n/a	6.84	*
973	2,448	1,475	60%	LC	4.65	0.3153%
999	11,531	2,891	25%	VU	8.88	0.3072%
1034	60	38	63%	LC	51.28	134.9474%
1132	152	151	99%	LC	0.94	0.6225%
1182	11,127	4,733	43%	D	23.43	0.4950%
Avon Wheatbelt bioregion						
4	10,333	1855	18%	VU	0	0.0000%
7	144,189	15,280	11%	VU	3.94	0.0258%
36	300,997	72,745	24%	VU	0	
352	630,578	108,888	17%	VU	2.10	0.0019%
946	43,309	8,372	19%	VU	8.03	0.0959%
950	497	287	58%	LC	0	

Code	Pre-European extent (ha)[1]	Current total (ha)[1]	% remaining[1]	Status[2]	Extent in study area (ha)	% of current extent within study area[3]
973	0	0	0	na	0	
999	0	0	0	na	0	
1024	738,927	84,602	11%	VU	0	
1132	0	0	0	na	0	
1182	0	0	0	na	1.69	*

[1]Source – DBCA (2018a). [2]Shepherd *et al.* (2002)Shepherd *et al.* (2002)Shepherd *et al.* (2002)Shepherd *et al.* (2002)Shepherd *et al.* (2002)Shepherd *et al.* (2002)Shepherd *et al.* (2002): VU – vulnerable; D – depleted; LC – least concern (see section 2.2.2). [3]Inaccuracies in broadscale vegetation mapping may cause the % of current extent within study area to be absent (*) or become inflated or deflated.

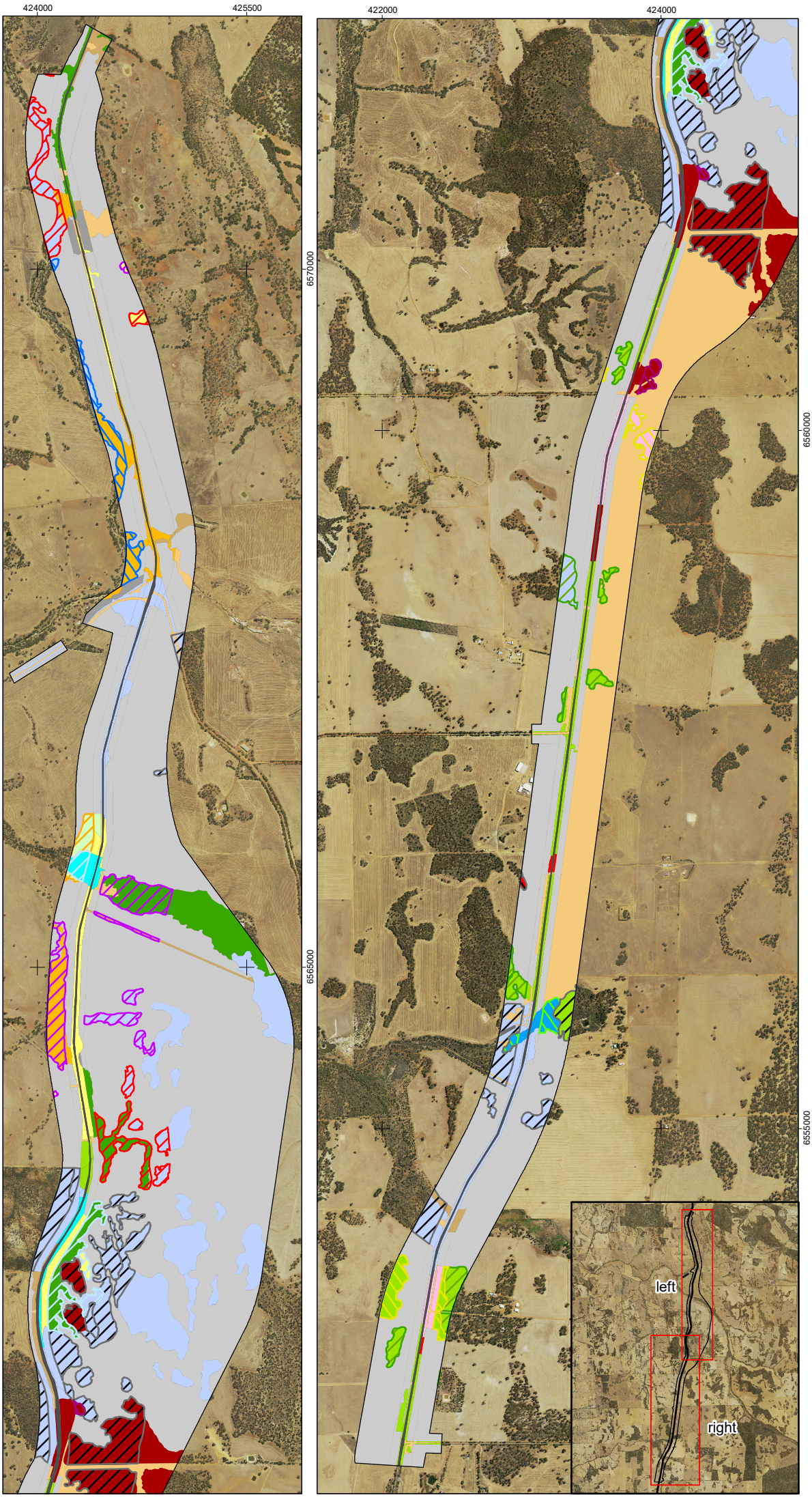
5.3.1.8 Extrapolation of remnant native vegetation

Extrapolation of the vegetation mapping identified 12 vegetation associations covering an area of 195.0 ha (Figure 5-7). The most prominent associations mapped in the extrapolation survey area were 946 (44.9%) and 352 (13.7%) (Table 5-16).

Table 5-16 Extent of vegetation associations extrapolated in extrapolation survey area

Vegetation association	Extent (ha)
4	17.0
7	20.9
36	3.2
352	26.6
946	87.5
950	13.3
973	3.3
999	10.7
1034	2.5
1132	0.4
1182	9.6
Total	**195.0**

Figure 5–7
Vegetation extrapolated to 500 m



Study area

Vegetation type extrapolated

- 4 - Medium woodland; Marri and Wandoo
- 7 - Medium woodland; York Gum *(Eucalyptus loxophleba)* and Wandoo
- 36 - Shrublands; thicket, *Acacia-Casuarina* alliance species
- 352 - Medium woodland; York Gum
- 946 - Medium woodland; Wandoo
- 950 - Medium woodland; *Casuarina obesa*
- 973 - Low forest; Paperbark (*Melaleuca rhaphiophylla*)
- 999 - Medium woodland; Marri
- 1034 - Medium woodland; Marri, Wandoo and Powderbark
- 1132 - Medium forest; Marri
- 1182 - Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*

Vegetation type mapped

- 1034 - Medium woodland; Marri, Wandoo and Powderbark
- 1132 - Medium forest; Marri
- 1182 - Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*
- 352 - Medium woodland; York Gum
- 36 - Shrublands; thicket, *Acacia-Casuarina* alliance species
- 4 - Medium woodland; Marri and Wandoo
- 7 - Medium woodland; York Gum *(Eucalyptus loxophleba)* and Wandoo
- 946 - Medium woodland; Wandoo
- 950 - Medium woodland; *Casuarina obesa*
- 973 - Low forest; Paperbark (*Melaleuca rhaphiophylla*)
- 999 - Medium woodland; Marri
- Cleared
- Cleared and Planted
- Pasture
- Pasture and Cleared
- GNH

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Kilometers

1:37,000 (at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 10/04/2019

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

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5.3.2 Fauna and fauna habitat

5.3.2.1 Fauna habitats

Seven fauna habitat types were defined for the study area, including five comprising remnant native vegetation (Figure 5-8):

- cleared (agriculture, road, infrastructure) (1076.9 ha, 73.3%)
- woodland (Jarrah, Marri, Wandoo and/or banksia) (271.0 ha, 18.4%)
- woodland (York Gum, Wandoo, Salmon Gum, and/or Gimlet) (68.2 ha, 4.6%)
- woodland (paperbark or sheoak) (36.6 ha, 2.5%)
- cleared and revegetated non-native woodland mosaic (11.6 ha, 0.8%)
- shrubland (thicket) (4.0 ha, 0.3%)
- forest (Jarrah and/or Marri) (1.0 ha, 0.1%).

Combined, the fauna habitats representing remnant native vegetation comprised 380.6 ha (25.9%).

The cleared areas, pasture, and non-native revegetation woodlands offer little habitat value to fauna due to their lack of suitable coverage and food sources. The native vegetation habitats offer higher value for fauna habitat where quality was good; this was variable throughout the study area.

Many of the native vegetation remnants are of low value as fauna habitat due to a poor or absent native understory, presence of weeds and feral animals (including livestock), narrowness of habitat (i.e. very narrow roadside remnants), and/or fragmentation from other areas of native vegetation by cleared or highly degraded areas.

However, better quality habitat was observed at a few locations where there was a good mix and density of understory species and mature trees, with little evidence of disturbance and continuity of habitat. These areas may be of value for several species of fauna including birds, mammals and reptiles. Three areas were identified as potentially being of value for fauna:

- Seven Mile Well Nature Reserve
- privately-owned area of native remnant vegetation to the south of this which is linked to Seven Mile Well Nature Reserve, is fenced, and extends outside the study area to the west
- privately-owned areas of native remnant vegetation approximately 3–4 km north of Udumung Nature Reserve where a larger area of remnant native vegetation extends west of the study area.

5.3.2.2 Conservation significant fauna

One conservation significant species, Carnaby's Cockatoo *Calyptorhynchus latirostris* (EN), was recorded in the study area during the surveys many times from direct observation and secondary evidence (Figure 5-8). Direct observations consisted of between 1 and 12 individuals, mostly foraging. Foraging evidence (feeding residues) was noted extensively throughout the study area and hollows were observed with signs of recent use (see section 5.3.2.3).

Three species previously reported as either recorded (Rainbow Bee-eater) or potentially occurring in Calingiri work package (Eastern Great Egret and Cattle Egret) (Phoenix 2016b, 2017), have been de-listed from the EPBC Act and WC Act.

An assessment of the likelihood of occurrence of all potential conservation significant species identified in the desktop review was undertaken based on known distribution, habitat preferences, desktop records and habitats present (Table 5-17).

The record of *Idiosoma mcclementsorum* within the study area (Figure 5-8) was re-visited during the survey in 2015. At the time, the record was being treated as *I. sigillatum* and therefore was not considered significant. The purpose of the trip was to re-inspect burrows at the site to confirm it was not the Threatened species *I. nigrum* (see section 5.2.2). Several burrows were observed at the location of the record, approximately 170 m south of Sevenmile Well Nature Reserve. A wider foot search was conducted in the vicinity within an approximate 1 ha area, but no other burrows were noted.

Many of the species are unlikely to occur within the study area mainly due to lack of suitable habitat (degradation, fragmentation, isolation and habitat too small in size); however, some may occur in the larger areas of remnant vegetation, particularly where connectivity to larger areas of native vegetation is available, or where species have ability to migrate across larger areas of sub-optimal habitat.

Table 5-17 Conservation significant fauna likelihood of occurrence assessment in the study area

Species	Distribution and habitat preferences	Liklihood of occurrence
Invertebrates		
Idiosoma mcclementsorum (Julimar shield-backed Trapdoor Spider) formerly known as *Idiosoma* sp. 'MYG474' P2 (DBCA)	Highly restricted distribution in the northern Jarrah Forest bioregion, from Chittering Lakes, Julimar, and Toodyay north to Gillingarra. Burrows are adorned with a 'moustache- like' arrangement of twig-lines and have been found on sandy substrates overlaying laterite.	Previously recorded in study area in the GNH road reserve near SLK 102.95[7] (Figure 5-3). Study area is within species known distribution. Limited suitable substrate in study area based on site descrptions. Quadrat site CAL17020 potentially suitable.
Throscodectes xederoides (Mogumber Bush Cricket) P3 (DBCA)	*Banksia* and *Dryandra* dominated coastal heath vegetation on white sands. Species has a limited known distribution, with records from Mogumber (Rentz 2010; Rentz 1985) and Sevenmile Well Nature Reserve.	Possible – may occur in areas where suitable substrate present (white sands).
Birds		
Leipoa ocellata (Malleefowl) VU (EPBC Act; WC Act)	Found across the southern half of the Australian continent. In WA, mostly occurs south of a line from Shark Bay to the Nullarbor Plain (Benshemesh *et al.* 2008; Parsons 2008; Parsons *et al.* 2008). Typically found in mallee woodlands on sandy soils with accumulations of litter present, but also in eucalypt woodlands and shrublands.	Unlikely – habitat unsuitable (too degraded and fragmented).
Oxyura australis (Blue-billed duck) P4	Endemic to south-eastern and south-western Australia. Prefers the deep water (fresh or saline) of large, permanent wetlands (including reservoirs, sewerage ponds, rivers salt lakes and saltpans) and swamps, generally with dense aquatic vegetation (Pizzey & Knight 2012).	Unlikely – preferred habitat is not present in study area.

[7] At the time of preparing this report, NatureMap still lists this record as *Idiosoma nigrum*.

Species	Distribution and habitat preferences	Liklihood of occurrence
Apus pacificus (Fork-tailed Swift) Mig. (EPBC Act; WC Act)	Widespread migratory species that overwinters in Australia; occurs across most of WA. Mostly found over inland plains, and also above foothills, in coastal areas and over settlements. Occurs in a wide range of dry or open habitats, including riparian woodlands, tea-tree swamps, low scrub, heathland, saltmarsh, grassland and spinifex sandplains, open farmland and inland and coastal sand-dunes (Department of the Environment 2014a).	Likely – may frequent the study area on occasion above most habitats to forage, unlikely to land or nest within the study area.
Falco peregrinus (Peregrine Falcon) OS (WC Act)	A widespread species occurring across Australia and with a large foraging range. In WA, it can be rare or scarce to moderately common. Preferred habitat includes cliffs and wooded watercourses. Nesting occurs mainly on cliff ledges, granite outcrops, quarries and in trees with old raven or Wedge-tailed Eagle nests (Johnstone & Storr 1998).	Likely – may forage in all habitats and nest in woodland habitats where suitable large eucalypts present throughout the gaps study area.
Thinornis rubricollis (Hooded Plover) P4 (DBCA)	A small shorebird most commonly found along the coastline and lakes near the coast in the southern parts of Australia but also occurs in inland salt lakes. Vulnerable to human disturbance and predators this species is not usually found in populated areas (Pizzey & Knight 2012).	Unlikely – no suitable habitat (shallow wetlands or salt lakes) present.
Rostratula australis (Australian Painted Snipe) EN (EPBC Act; WC Act)	Endemic to Australia, occurs in the southern and northern coastal areas of WA but is generally more common in eastern Australia. Favours the margins and shallow waters of well vegetated wetlands including man made wetlands, such as dams and pastures (Pizzey & Knight 2012).	Unlikely – no suitable habitat (shallow wetlands) present.
Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo) VU (EPBC Act; WC Act)	Endemic to the south-west of WA with its range extending from the Northern Jarrah Forest and Perth subregions in the north to te western part of the Fitzgerald subregion in the south (DoEE 2017b). A shift in range has been observed in recent years to feeding and roosting on the Swan Coastal Plain (T. Kirkby, pers. comm., 29 March 2010). Breeds in parts of the Wheatbelt and Jarrah Forest (DoEE 2017b).	Possible but marginal – may forage and roost but unlikely to breed in study area as it is too far north. The study area is north of the species current modelled distribution (DoEE 2017b). Desktop records are rare in the vicinity of the study area.
Calyptorhynchus latirostris (Carnaby's Cockatoo) EN (EPBC Act; WC Act)	Endemic to south-western Australia, from Kalbarri to east of Esperance (DoEE 2017b). Has undergone a significant decline across its distribution range. Breeding range extends from Dongara to Ravensthorpe. Breeds in woodland or forest, including partially cleared woodland and isolated trees (DoEE 2017b).	Recorded – recorded from multiple direct observations and secondary evidence records within study area. Study area is within species distribution and breeding range (DoEE 2017b).

Species	Distribution and habitat preferences	Liklihood of occurrence
Calyptorhynchus baudinii (Baudin's Cockatoo) EN (EPBC Act; WC Act)	Endemic to a 2000 km^2 area in south-west WA, bounded by the 750 isohyet (Department of the Environment 2014b). Mostly feed on Marri and large fruits with diet changes over the year, depending on the food availability. Modelled breeding range extends from just north of Bunbury and Collie in the north to Albany in the south, with an outlier confirmed breeding area located further inland (DoEE 2017b).	Possible but marginal – study area north of modelled distribution (DoEE 2017b); however, a few (potentially unreliable) NatureMap records occur as far north as New Norcia (DPaW 2016b). May occasionally forage but unlikely to breed or roost in the study area.
Mammals		
Dasyurus geoffroii (Western Quoll) VU (EPBC Act; WC Act)	Prior to European settlement the species occupied approximately 70% of continental Australia (Smith *et al.* 2004; Van Dyck & Strahan 2008). Massive decline in range has occurred and it currently occupies only 5% of its former range. Mostly found in woodland, heath and mallee habitats, often in areas providing suitable denning and shelter habitat that contains large woody debris such as fallen hollowed trees.	Possible – within known distribution, suitable habitat present; however, degraded and fragmented in most areas. There is one old NatureMap record within study area from 1967 and more recent (2000–02) records exist approximately 9 km south. Study area unlikely to provide core habitat for species.
Isoodon obesulus fusciventer (Quenda) P4 (DBCA)	Subspecies is endemic to south-western Australia. Mostly found in sandy soil habitats with dense ealthy understorey vegetation (Van Dyck & Strahan 2008).	Unlikely – habitat unsuitable as it is too degraded and fragmented.

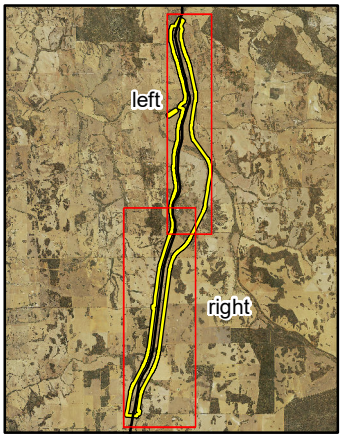
Figure 5–8
Fauna habitats and conservation significant fauna records

Conservation significant fauna

- Carnaby's Cockatoo (EN) - Direct sighting
- Carnaby's Cockatoo (EN) - Forage evidence
- *Idiosoma mcclementsorum* (P2) - Burrow excavation. (Previously known as *I.* 'MYG474', *I. sigillatum* and *I. nigrum*)
- Study area

Fauna habitat

- Cleared (agriculture, road, infrastructure)
- Cleared and revegetated non-native woodland mosaic
- Forest (Jarrah and/or Marri)
- Shrubland (thicket)
- Woodland (Jarrah, Marri, Wandoo and/or banksia)
- Woodland (York Gum, Wandoo, Salmon Gum and/or Gimlet)
- Woodland (paperbark or sheoak)



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Kilometers

1:37,000 (at A4)

Client: Jacobs
Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 10/04/2019

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

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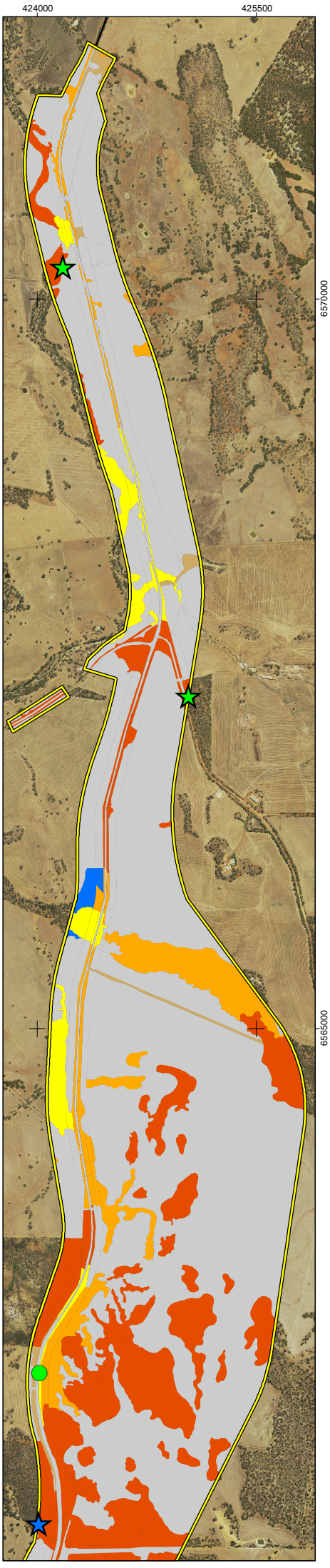


5.3.2.3 Black cockatoo habitat

A total of 4,146 potential Carnaby's Cockatoo breeding trees were recorded in the study area (Table 5-18). *Eucalyptus wandoo* was the dominant tree species in the study area with 2,827 potential breeding trees recorded, representing 68% of all trees recorded. Of these, 357 had visible hollows, and 83 of these were confirmed by Tony Kirkby as having hollows suitable for current breeding by Carnaby's Cockatoo, including 44 which showed signed of use by the species (Figure 5-9). Most of these were in Wandoo (Table 5-18).

Breeding and roosting tree species were recorded in some of the sampled vegetation quadrats in the study area. Based on analysis of remnant vegetation polygons that contained potential breeding trees (section 3.2.2.4), 309.7 ha of breeding habitat is present within remnant native vegetation of the study area. Approximately 91% of the potential breeding trees were present within these mapped areas with the remainder recorded in cleared pastures and revegetated areas.

Known food species for Carnaby's Cockatoo were recorded in many of sampled vegetation quadrats, particularly towards the southern study areas (Table 5-19). Extensive foraging evidence from Marri, and a high abundance of foraging species was recorded in study area.

This finding was supported by the spatial analysis of foraging habitat (section 3.2.2.4) which classified 97.7 ha as quality foraging habitat for Carnaby's Cockatoo.

Table 5-18 Summary of potential Carnaby's Cockatoo breeding trees recorded in the study area

Species	No. trees	With hollows	Suitable hollows	Evidence of breeding	Bees present
Corymbia calophylla	616	34	8	5	0
Eucalyptus accedens	221	32	7	2	0
Eucalyptus camaldulensis	47	8	0	0	0
Eucalyptus loxophleba	202	15	1	0	2
Eucalyptus rudis	179	2	1	1	0
Eucalyptus salmonophloia	1	1	1	1	0
Eucalyptus wandoo	2,827	248	63	35	15
Eucalyptus sp. (dead, introduced or unknown)	53	17	2	0	2
Total	4,146	357	83	44	21

Forest Red-tailed Black Cockatoos are seldom recorded in the vicinity of the study area; however, as there are occasional desktop records in the vicinity, potential foraging habitat was noted in the survey, mainly where their main food preference (seeds of Marri) was present in the existing remnant vegetation.

5.3.2.4 Introduced species

Foxes, dogs and rabbits were present throughout the study area. Direct sightings and evidence (scats, burrows) of these introduced species were common in these areas during the surveys. Long-billed Corellas, a species from eastern Australia similar to the Western Australian native corella species, have also been sighted in the study area.

Table 5-19 Plant species of relevance to Carnaby's Cockatoo recorded in the study area (based on DEC 2011)

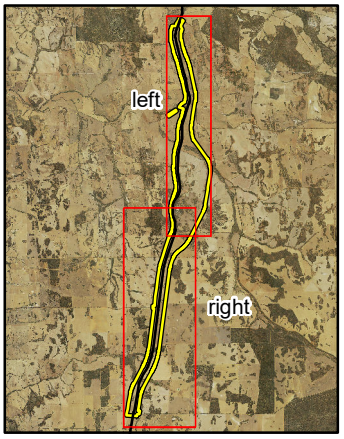
Taxon	Food plant	Nesting	Roosting
Banksia armata	●		
Banksia fraseri var. *fraseri*	●		
Banksia kippistiana var. *kippistiana*	●		
Banksia nobilis subsp. *nobilis*	●		
Banksia sessilis	●		
Banksia sphaerocarpa var. *sphaerocarpa*	●		
Banksia squarrosa	●		
Corymbia calophylla	●	●	●
Eucalyptus accedens	●	●	●
Eucalyptus loxophleba		●	
Eucalyptus marginata	●	●	●
Eucalyptus rudis	●	●	●
Eucalyptus salmonophloia	●	●	
Eucalyptus wandoo	●	●	●
Grevillea bipinnatifida subsp. *bipinnatifida*	●		
Grevillea synapheae subsp. *synapheae*	●		
Hakea chromatropa	●		
Hakea erinacea	●		
Hakea incrassata	●		
Hakea lissocarpha	●		
Xanthorrhoea preissii	●		
Total	**20**	**7**	**5**

Figure 5–9
Carnaby's Cockatoo breeding trees

Study area

Carnaby's Black Cockatoo potential breeding trees

- Potential breeding tree with no hollows
- Potential breeding tree with hollows but not suitable for breeding
- Potential breeding tree with suitable hollows but no signs of use
- Potential breeding tree with suitable hollows with evidence of use for breeding



0 0.5 1
Kilometers

1:37,000 (at A4)

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Project: Great Northern Highway – Muchea to Wubin (Stage 2) Upgrades – Calingiri additional area
Author: AL
Date: 10/04/2019

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

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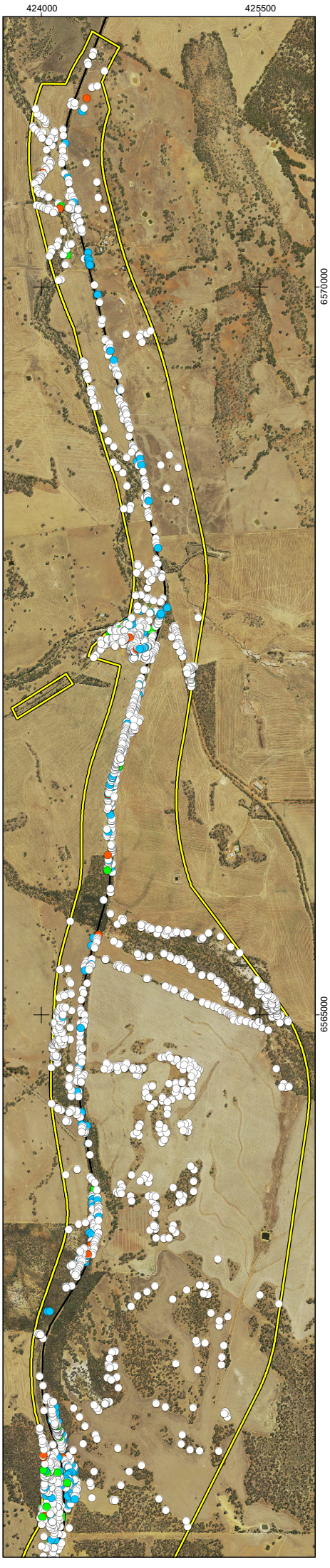


6 DISCUSSION

6.1 FLORA AND VEGETATION

The remnant vegetation in the study area may be considered overall to have moderate to high conservation value as it comprises a small proportion of the study area (i.e. the majority of the area is cleared and completely degraded) yet contains several conservation significant flora and the majority of vegetation associations have regional and/or local conservation significance.

The surveys identified the presence of 15 conservation significant flora species comprised of single populations of the Threatened species *Banksia serratuloides* subsp. *serratuloides* (VU; EPBC Act, WC Act) and *Conospermum densiflorum* subsp*. unicephalatum* (EN; EPBC Act, WC Act), and 1–2 populations of the Priority species *Acacia anarthros* (P3), *Acacia drummondii* subsp. *affinis* (P3), *Daviesia debilior* subsp. *sinuans* (P3), *Calothamnus pachystachyus* (P4), *Grevillea drummondii* (P4), *Hakea chromatropa* (P1), *Hibbertia miniata* (P4), *Hibbertia montana* (P4), *Leucopogon darlingensis* subsp. *rectus* (P2), *Melaleuca sclerophylla* (P3), *Persoonia sulcata* (P4), *Synaphea grandis* (P4) and *Synaphea rangiferops* (P2).

The *Banksia serratuloides* subsp. *serratuloides* population in the study area is a known DBCA population. The current survey recorded 22 plants between SLK 105.36 and 105.47. DBCA point locations for the population are at 105.36 and 105.51. The conservation advice for the species (DSEWPaC 2008) does not provide guidance on what constitutes an important population; however, given the small number of known populations for the species, the population from the study area is highly likely to represent an important population.

The *Conospermum densiflorum* subsp*. unicephalatum* population recorded in the survey is not a known DBCA population. The two records (Figure 5-3) of two plants each were both from vegetation mapped as Medium woodland; Marri, Wandoo and Powderbark (association 1034). The conservation advice for the species (Threatened Species Scientific Committee 2015b) notes that all populations and subpopulations are considered important given the species' restricted range and low population numbers. All known habitat is considered habitat critical to its survival and this includes (Threatened Species Scientific Committee 2015b):

- the area of occupancy of known populations
- areas of similar habitat within 200 m of known populations (these provide potential habitat for natural range extension)
- remnant vegetation that surrounds or links several populations
- additional occurrences of similar habitat that do not currently contain the taxon but may have done so in the past (these represent possible translocation sites).

It is possible that additional *Conospermum densiflorum* subsp*. unicephalatum* plants occur in the vegetation remmant on the eastern side of the GNH between the two records and therefore as a precautionary measure this remnant should be treated as important habitat for the species (Figure 6-1).

Of 26 un-identified specimens, two could be the Threatened WC Act and EPBC Act listed species, *Acacia splendens* or *Acacia cochlocarpa* subsp. *cochlocarpa,* and *Rhagodia acicularis,* and one WC Act listed Threatened species, *Goodenia arthrotricha*. The locations of the records may need to be re-visited to ensure no Threatened species occur in the area.

No TECs or PECs were confirmed to be present in the study area.

The extrapolated remnant vegetation to 500 m either side of the study area indicates that many of the environmental values recorded in the study area are also likely to be present in the extrapolation study area, including habitat for the recorded conservation significant flora, nesting and foraging habitat for Carnaby's Cockatoo and the Eucalypt Woodlands of the Western Australian Wheatbelt TEC. However, the extrapolated vegetation mapping should be treated as a broad indication of vegetation extent and patterning only. Field survey would be required to confirm the accuracy of the extrapolated vegetation mapping.

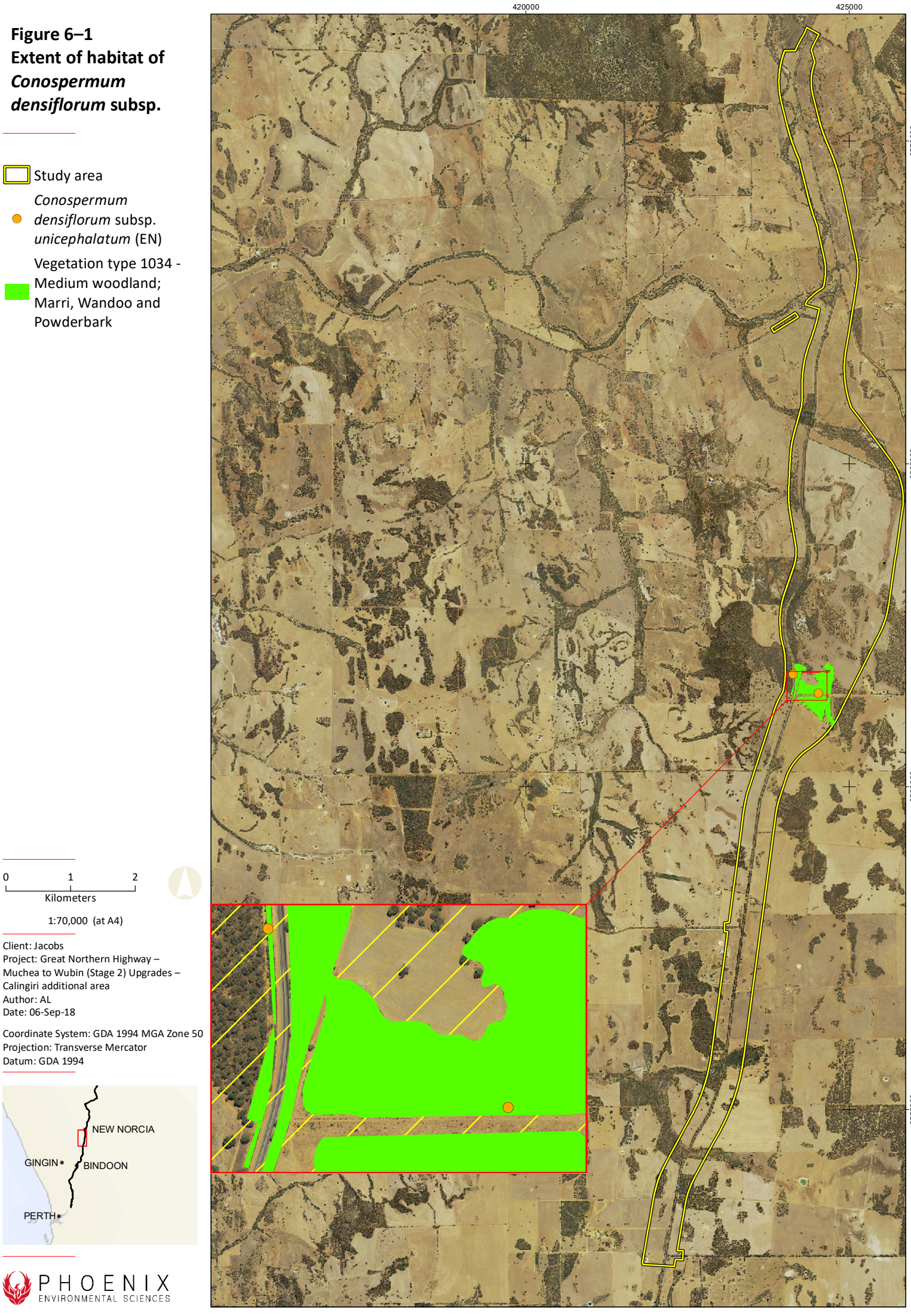
The remnant vegetation within the study area occurs within an area that has been extensively cleared. Nearly 74% of the study area comprised cleared and planted areas, pasture and the extant road reserve. This scale of clearing is also evident more broadly in the extrapolation study area and beyond (Figure 5-7).

The condition of the remnant vegetation in the remaining areas ranged from degraded to excellent with the majority of the vegetation (57.9%) showing clear evidence of significant disturbance (degraded to good condition) and typically very low native biological diversity.

Vegetation in very good to excellent condition was recorded in remnants located just south of Sevenmile Well Nature Reserve (Figure 5-6). Three other small remnants located between 3.0 and 5.5 km north of Udumung Nature Reserve also contained vegetation in very good to excellent condition. Vegetation recorded to be in very good to excellent condition typically comprised a greater level of biological diversity than the surrounding more disturbed remnants.

The declared pest recorded, **Asparagus asparagoides* (C3), will require appropriate management to reduce the numbers or distribution and/ or prevent or contain the spread of the species from any population during road construction.

Figure 6–1
Extent of habitat of *Conospermum densiflorum* subsp.



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Author: AL
Date: 06-Sep-18

Coordinate System: GDA 1994 MGA Zone 50
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Datum: GDA 1994

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6.2 FAUNA AND FAUNA HABITAT

The fauna survey undertaken for the study area identified variable habitat quality ranging from completely degraded areas offering no habitat value to good quality habitat. A number of fauna habitat values were identified in the Calingiri study area:

- good quality woodland habitat
- potential linkage value
- breeding and roosting habitat for Carnaby's Cockatoo
- quality foraging habitat for Carnaby's Cockatoo.

The three areas noted to be of potential value were Seven Mile Well Nature Reserve, the remnant ~800 m south of this which links to the reserve, and areas of remnant vegetation approximately 3–4 km north of Udumung Nature Reserve where a larger area of remnant native vegetation extends west of the study area. These woodlands provide potential habitat for some conservation significant species, largely due to their intact understory and connectivity to remnant vegetation outside the study area.

The narrowness of the habitat within most of the remainder of the study area limits its fauna habitat value beyond that for birds which can disperse in and out of the study area easily, and as a potential linkage for some species. Although narrow, the vegetation within the road reserve provides continuous habitat for much of the study area length and it may act as an ecological linkage between vegetation remnants for some fauna species, especially between Udumung Nature Reserve and Seven Mile Well Nature Reserve. There is potential to improve the linkage value of habitat within the road reserve between these two reserves.

Of the 13 conservation significant species identified in the desktop review as of potential relevance to the study area, one species (Carnaby's Cockatoo) was recorded during the survey. Previous records of two other species (Julimar shield-backed Trapdoor Spider and Western Quoll) were identified in the study area from the desktop review. A further five species were assessed as having potential to occur (Mogumber Bush Cricket, Fork-tailed Swift, Peregrine Falcon, Forest Red-tailed Black Cockatoo and Baudin's Cockatoo) and five species were considered unlikely to occur. Those recorded and potentially occurring are discussed below.

The study area is an important breeding and foraging area for Carnaby's Cockatoo (EN; EPBC Act, WC Act). The presence of 44 confirmed nesting trees from the 83 trees with hollows suitable for breeding indicates the area is actively being used for breeding, and the high density of potential breeding trees (4,146 in total) indicates its long-term value as potential breeding habitat. *Eucalyptus wandoo* is clearly a critical resource for the species in the Calingiri area with 80% of the confirmed nesting trees being this species. The importance of the woodlands in the study area as foraging habitat was illustrated by the extensive records of feeding residues (Marri fruits) and flora species known to be utilised as food plants throughout the native vegetation in the study area resulting in 97.7 ha being mapped as quality foraging habitat. The numerous direct records of Carnaby's Cockatoo during the surveys also indicate the study area is important to the species.

Julimar shield-backed Trapdoor Spider (P2; DBCA) is a rare species with a highly restricted distribution (~1,300 km^2) in the northern Jarrah Forest bioregion. The area of occupancy within that range is difficult to estimate but is unlikely to be larger than 100 km^2 (Rix *et al.* 2018b). The species therefore falls well within the nominate range for short range endemic fauna of 10,000 km^2 (EPA 2016a, after Harvey 2002). While currently listed as Priority 2, Rix *et al.* (2018b) consider it Endangered based on its geographic range, extent of regional sampling effort, its occurrence at <10 severely fragmented sites and the continuing decline in the area, extent and/or quality of habitat. Its status is therefore

likely to be upgraded in the future. Based on what is known of the habitat preferences of this species from the two recent records of this species, it occurs in Casuarina woodland and open eucalypt forest habitats on lateritic to sandy soils (Phoenix (own data); M. Rix, pers. comm. May 2018; Rix *et al*. (2018a)). Potential habitat is present in the study area and it is therefore possible that additional populations exist.

The study area is located within the current distribution of the Western Quoll (VU; EPBC Act, WC Act); and while the NatureMap record from within the study area is very old (1967), more recent (2000–02) NatureMap records exist approximately 20 km south. Most of the remnants in the study area are considered unsuitable for the species due to their degraded and fragmented condition but it is possible the species occasionally forages in remnant vegetation of the study area that is adjacent to/contiguous with larger remnants. Potential for denning was considered less likely as suitable refuge and denning habitat, such as large woody debris including hollowed fallen trees was generally lacking.

The Mogumber Bush Cricket (P3 - DBCA) may occur in areas where suitable substrate is present (white sands). Records of the species are from only a few localities, including Mogumber and SevenmileMile Well Nature Reserve. If the alignment is proposed to go through Sevenmile Well Nature Reserve, loss of habitat for this species will need to be considered in the impact assessment.

The Fork-tailed Swift (Mig.; EPBC Act, WC Act) was not identified in the desktop results within 40 km of the study area (DPaW 2016a)(DPaW 2016a)(DPaW 2016a)(DPaW 2016a)(DPaW 2016a)(DPaW 2016a)(DPaW 2016a)(DPaW 2016a); however, this widely distributed species may forage occasionally above all habitats in the study area.

The Peregrine Falcon (OS; WC Act) is likely to occasionally forage and possibly nest in the study area, which contains suitable nesting trees. Due to the species large foraging range is it likely to be only an occasional visitor unless nesting occurs.

Potential foraging habitat (*Corymbia calophylla* and *Eucalyptus marginate*) is present in the study area for Forest Red-tailed Black Cockatoo (VU; EPBC Act, WC Act); however, the importance of this habitat to the species is uncertain but most likely marginal. There are few desktop records of Forest Red-tailed Black Cockatoo in the vicinity of the study area, which also lies north of the species' modelled distribution (DoEE 2017b), and it is not likely to breed in the vicinity. Foraging habitat quality is also likely to be variable within the mapped extent.

The study area is located outside of Baudin's Cockatoo (EN; EPBC Act; WC Act) modelled distribution (DoEE 2017b); however, the desktop review identified records of the species in proximity to the study area and as far north as New Norcia. It is possible these records are erroneous and actually represent records of Carnaby's Cockatoo; however, this cannot be verified due to the limited information available for the historic records. If the species does occur in the study area it is likely to be only for occasional foraging in the woodlands containing Marri.

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Appendix 1 Western Australian Flora and Fauna Conservation Codes (DPaW 2017)

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

Categories of specially protected fauna and flora are:

T Threatened species

Published as Specially Protected under the Wildlife Conservation Act 1950, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN Endangered species

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU Vulnerable species

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX Presumed extinct species

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA Migratory birds protected under an international agreement

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

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

P Priority species

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

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

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

1 Priority 1: Poorly-known species

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

2 Priority 2: Poorly-known species

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

3 Priority 3: Poorly-known species

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

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix 2 Survey site locations

Quadrat	Relevé	TEC	Latitude	Longitude
CAL17001		CalTEC001	-30.9919	116.2047
CAL17002		CalTEC002	-31.0204	116.211
CAL17003		CalTEC003	-31.0252	116.2143
CAL17004		CalTEC004	-31.0516	116.2051
CAL17005		CalTEC005	-31.0398	116.2067
CAL17006		CalTEC006	-31.046	116.2187
CAL17007		CalTEC007	-31.0419	116.2119
CAL17008		CalTEC008	-31.0573	116.2135
CAL17009		CalTEC009	-31.0595	116.2061
CAL17010		CalTEC010	-31.0633	116.2043
CAL17011		CalTEC011	-31.0687	116.2061
CAL17012		CalTEC012	-31.0667	116.2045
na	CAL17013	CalTEC013	-31.0784	116.2072
CAL17014		CalTEC014	-31.0768	116.2101
CAL17015		CalTEC015	-31.1018	116.196
na	CAL17016	CalTEC016	-31.1297	116.1943
na	CAL17017	CalTEC017	-31.1313	116.1914
CAL17018		CalTEC018	-31.133	116.1907
CAL17019		CalTEC019	-31.1428	116.1855
CAL17020		CalTEC020	-31.1479	116.1866
CAL17021A		CalTEC021	-31.1488	116.1821
CAL17022		CalTEC022	-31.0007	116.2051
CALP20001		CALP20001	-31.0541	116.2074
CALP20002		CALP20002	-31.037	116.2082
CALP20004		CALP20004	-31.0132	116.2106
GAP020		na	-31.0563	116.2078
GAP021		na	-31.0605	116.2064
GAP022		na	-31.0719	116.2046
GAP023	GAP023	na	-31.0769	116.2045
na		TEC062	-30.9941	116.2072
na		TEC063	-30.9941	116.2059
na		TEC065	-30.9991	116.207
na		TEC066	-31.0008	116.2075
na		TEC068	-31.0152	116.2116
na		TEC068A	-31.0139	116.2111
na		TEC069	-31.0204	116.2127

Quadrat	Relevé	TEC	Latitude	Longitude
na		TEC070	-31.0212	116.2123
na		TEC071	-31.0217	116.212
na		TEC072	-31.0292	116.2097
na		TEC073	-31.0247	116.2112
na		TEC074	-31.023	116.2118
na		TEC076	-31.033	116.2089
na		TEC077	-31.0352	116.2084
na		TEC078	-31.0382	116.2084
na		TEC079	-31.0382	116.2086
na		TEC080	-31.0418	116.2074
na		TEC081	-31.0445	116.2068
na		TEC082	-31.0429	116.2069
na		TEC083	-31.0502	116.2064
na		TEC084	-31.0804	116.2038
na		TEC085	-31.0224	116.2124
na		TEC086	-31.059	116.2075
na		TEC087	-31.0766	116.2053
na		TEC088	-31.0781	116.2046
na		TEC089	-31.0832	116.2031
na		TEC090	-31.0831	116.2028
na		TEC091	-31.0859	116.202
na		TEC092	-31.0866	116.2014
na		TEC094	-31.0947	116.199
na		TEC095	-31.0947	116.1987
na		TEC096	-31.1012	116.1978
na		TEC096a	-31.0977	116.1984
na		TEC097	-31.096	116.1985
na		TEC098	-31.1016	116.1949
na		TEC099	-31.1042	116.1972
na		TEC100	-31.1161	116.1954
na		TEC101	-31.1044	116.1971
na		TEC102	-31.1095	116.1962
na		TEC103	-31.1188	116.1949
na		TEC104	-31.1226	116.1941
na		TEC105	-31.1223	116.1944
na		TEC107	-31.1277	116.1932
na		TEC108	-31.1295	116.1929

Quadrat	Relevé	TEC	Latitude	Longitude
na		TEC109	-31.1329	116.192
na		TEC110	-31.1331	116.1922
na		TEC112	-31.1376	116.1901
na		TEC113	-31.144	116.1861
na		TEC114	-31.1431	116.1863
na		TEC115	-31.1473	116.1851
na		TEC116	-31.1468	116.1855
na		TEC117	-30.6864	116.2112
na		TEC119	-31.1559	116.1832
na		TEC120	-31.1578	116.1831
NN3.1		na	-30.9965	116.2061
NN3.1a		TEC064	-30.9971	116.2063
NN3.2		na	-30.9882	116.2064
S3A21		na	-31.0018	116.2079
S3A22		TEC067	-31.0092	116.21
S3A23		na	-31.0244	116.2116
S3A24		na	-31.0402	116.208
S3A27		na	-31.0893	116.2007
S3A28		na	-31.0989	116.1983
S3A29		na	-31.112	116.1962
S3A30		TEC106	-31.1265	116.1936
S3A31		na	-31.1301	116.1931
S3A32		TEC111	-31.1406	116.1879
S3A33		TEC116b	-31.1481	116.1851
S3A45		na	-31.1197	116.1946
S3A47		TEC075	-31.0308	116.209
S3AB20001		TEC093	-31.0875	116.2015
na	S3AB20002	na	-31.1421	116.1876

Appendix 3 Quadrat descriptions

Site:	CAL17001	**Type:**	Quadrat (unbounded)
Date(s):	01 November 2017	**Position:**	-30.991926, 116.204748
Total vegetation cover (%):	60	**Topography:**	river
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown,
Shrub cover <2 m (%):	0.1	**Soil:**	sandy clay,
Grass cover (%):	35	**Rock type:**	none
Herb cover (%):	2	**Fire age:**	not evident
Disturbance details:	erosion channels, vehicle tracks, weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus rudis* woodland over mid open *Avena sativa*, *Hordeum glaucum* and *Bromus rubens* grassland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus rudis	30.0	12.00		
Avena sativa	15.0	00.80	*	
Hordeum glaucum	07.0	00.30	*	
Ehrharta longiflora	05.0	00.60	*	
Bromus rubens	05.0	00.50	*	
Salicornia quinqueflora subsp. *quinqueflora*	02.0	00.10		
Pentameris airoides subsp. *airoides*	00.5	00.05	*	
Neurachne alopecuroidea	00.1	00.50		
Chloris truncata	00.1	00.50		
Lolium perenne	00.1	00.30	*	
Solanum nigrum	00.1	00.20	*	
Solanum sp.	00.1	00.10		
Hypochaeris radicata	00.1	00.10	*	
Maireana marginata	00.1	00.10		
Cotula bipinnata	00.1	00.10	*	
Romulea rosea var. *australis*	00.1	00.10	*	
Sonchus asper	00.1	00.10	*	
Heliotropium curassavicum	00.1	00.05		
Arctotheca calendula	00.1	00.05	*	
Atriplex semilunaris	00.1	00.05		

Site:	CAL17001	**Type:**	Quadrat (unbounded)
Date(s):	01 November 2017	**Position:**	-30.991926, 116.204748
Total vegetation cover (%):	60	**Topography:**	river
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown,
Shrub cover <2 m (%):	0.1	**Soil:**	sandy clay,
Grass cover (%):	35	**Rock type:**	none
Herb cover (%):	2	**Fire age:**	not evident
Disturbance details:	erosion channels, vehicle tracks, weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus rudis* woodland over mid open *Avena sativa*, *Hordeum glaucum* and *Bromus rubens* grassland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus rudis	30.0	12.00		
Avena sativa	15.0	00.80	*	
Hordeum glaucum	07.0	00.30	*	
Ehrharta longiflora	05.0	00.60	*	
Bromus rubens	05.0	00.50	*	
Salicornia quinqueflora subsp. *quinqueflora*	02.0	00.10		
Pentameris airoides subsp. *airoides*	00.5	00.05	*	
Neurachne alopecuroidea	00.1	00.50		
Chloris truncata	00.1	00.50		
Lolium perenne	00.1	00.30	*	
Solanum nigrum	00.1	00.20	*	
Solanum sp.	00.1	00.10		
Hypochaeris radicata	00.1	00.10	*	
Maireana marginata	00.1	00.10		
Cotula bipinnata	00.1	00.10	*	
Romulea rosea var. *australis*	00.1	00.10	*	
Sonchus asper	00.1	00.10	*	
Heliotropium curassavicum	00.1	00.05		
Arctotheca calendula	00.1	00.05	*	
Atriplex semilunaris	00.1	00.05		

Tecticornia lepidosperma

Site:	CAL17002	**Type:**	Quadrat (10 m x 10 m)
Date(s):	14 November 2017	**Position:**	-31.02035, 116.210991
Total vegetation cover (%):	41	**Topography:**	creek
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown,
Shrub cover <2 m (%):	0	**Soil:**	clay loam,
Grass cover (%):	41	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	grazing – high, weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus loxophleba* subsp. *loxophleba* woodland over low open *Hordeum glaucum*, *Bromus rubens* and *Erharta longiflora* grassland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus loxophleba subsp. *loxophleba*	30.0	12.00		
Hordeum glaucum	16.0	00.10	*	
Bromus rubens	10.0	00.20	*	
Ehrharta longiflora	07.0	00.30	*	
Avena barbata	05.0	00.40	*	
Lolium perenne	03.0	00.20	*	
Austrostipa elegantissima	00.1	00.30		
Arctotheca calendula	00.1	00.10	*	

Site:	CAL17003	**Type:**	Quadrat (10 m x 10 m)
Date(s):	01 November 2017	**Position:**	-31.025164, 116.214318
Total vegetation cover (%):	45	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	30	**Soil colour:**	red-brown,
Shrub cover <2 m (%):	16	**Soil:**	laterite,
Grass cover (%):	1	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Good, EPA (2016)		
Vegetation description:	Mid *Eucalyptus wandoo* subsp. *wandoo* woodland over low *Acacia lasiocarpa* var. *sedifolia*, *Astroloma compactum* and *Gastrolobium polystachyum* low shrubland over low isolated *Amphipogon turbinatus* and *Austrostipa elegentissima* tussock grasses		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo subsp. *wandoo*	30.0	12.00		
Acacia lasiocarpa var. *sedifolia*	10.0	00.40		
Astroloma compactum	03.0	00.40		
Gastrolobium polystachyum	03.0	00.40		
Austrostipa elegantissima	01.0	00.50		
Desmocladus asper	01.0	00.10		
Amphipogon turbinatus	00.3	00.20		
Gladiolus caryophyllaceus	00.1	00.70	*	
Dianella revoluta	00.1	00.50		
Hakea erinacea	00.1	00.50		
Banksia fraseri var. *fraseri*	00.1	00.30		
Burchardia congesta	00.1	00.30		
Stypandra glauca	00.1	00.20		
Orthrosanthus laxus var. *laxus*	00.1	00.20		
?*Beyeria lechenaultii* (sterile)	00.1	00.10		
Lomandra rupestris	00.1	00.10		
Ptilotus drummondii	00.1	00.10		
Desmocladus lateriticus	00.1	00.10		

Enchylaena lanata	00.1	00.10
Opercularia vaginata	00.1	00.10
Conostylis setigera subsp. *setigera*	00.1	00.05
Rhodanthe citrina	00.1	00.05
Stylidium sp. sterile	00.1	00.05

Site:	CAL17004	**Type:**	Quadrat (10 m x 10 m)
Date(s):	14 November 2017	**Position:**	-31.051568, 116.205143
Total vegetation cover (%):	70	**Topography:**	plain
Tree/shrub cover >2 m (%):	50	**Soil colour:**	brown,
Shrub cover <2 m (%):	0	**Soil:**	clay loam,
Grass cover (%):	43	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	grazing – high, weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	*Eucalyptus loxophleba* subsp. *loxophleba* woodland over low **Ehrharta longiflora*, **Avena barbata* and *Austrostipa elegantissima* tussock grassland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus loxophleba subsp. *loxophleba*	50.0	12.00		
Ehrharta longiflora	35.0	00.20	*	
Avena barbata	05.0	00.40	*	
Austrostipa elegantissima	02.0	00.20		
Lolium perenne	01.0	00.20	*	
Ursinia anthemoides	00.1	00.20	*	
Sonchus oleraceus	00.1	00.10	*	
Hordeum glaucum	00.1	00.10	*	
Lysimachia arvensis	00.1	00.05	*	

Site:	CAL17005	**Type:**	Quadrat (10 m x 10 m)
Date(s):	14 November 2017	**Position:**	-31.039754, 116.206747
Total vegetation cover (%):	50	**Topography:**	drainage line
Tree/shrub cover >2 m (%):	35	**Soil colour:**	brown,
Shrub cover <2 m (%):	5	**Soil:**	clay loam,
Grass cover (%):	33	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	weed infestation,		
Vegetation condition:	Good, EPA (2016)		
Vegetation description:	Low *Casuarina obesa* woodland over *Tecticornia* sp. sterile 1 low open shrubland over low open **Parapholis incurva*, **Lolium rigidum* and **Hordeum leporinum* tussock grassland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Casuarina obesa	35.0	10.00		
Parapholis incurva	20.0	00.05	*	
Lolium rigidum	07.0	00.40	*	
Tecticornia sp. sterile 1	05.0	00.40		
Ehrharta longiflora	03.0	00.30	*	
Hordeum leporinum	03.0	00.10	*	
Rhagodia ? *drummondii*	00.1	00.10		
Sonchus oleraceus	00.1	00.10	*	
Enchylaena lanata	00.1	00.05		
Salicornia quinqueflora subsp. *quinqueflora*				

Site:	CAL17006	**Type:**	Quadrat (10 m x 10 m)
Date(s):	01 November 2017	**Position:**	-31.046014, 116.21872
Total vegetation cover (%):	45	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown,
Shrub cover <2 m (%):	0	**Soil:**	sandy clay,
Grass cover (%):	33	**Rock type:**	none
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus loxophleba* subsp. *loxophleba* and *Eucalyptus wandoo* woodland over low **Avena sativa*, **Ehrharta longiflora* and **Hordeum glaucum* tussock grassland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Avena sativa	30.0	00.50	*	
Eucalyptus loxophleba subsp. *loxophleba*	20.0	15.00		
Eucalyptus wandoo	10.0	12.00		
Ehrharta longiflora	03.0	00.50	*	
Austrostipa elegantissima	00.5	00.60		
Hordeum glaucum	00.5	00.30	*	
Enteropogon ramosus	00.5	00.10		
Lolium perenne x *rigidum*	00.1	00.80	*	
Austrostipa campylachne	00.1	00.70		
Amphipogon turbinatus	00.1	00.40		
Lolium perenne	00.1	00.20	*	
Briza maxima	00.1	00.10	*	
Freesia alba x *leichtlinii*	00.1	00.10	*	
Centaurium tenuiflorum	00.1	00.10	*	
Ursinia anthemoides subsp. *anthemoides*	00.1	00.10	*	
Pentameris airoides subsp. *airoides*	00.1	00.05	*	
Lysimachia arvensis	00.1	00.05	*	

Site:	CAL17007	**Type:**	Quadrat (10 m x 10 m)
Date(s):	02 November 2017	**Position:**	-31.041944, 116.211865
Total vegetation cover (%):	70	**Topography:**	plain
Tree/shrub cover >2 m (%):	35	**Soil colour:**	red-brown,
Shrub cover <2 m (%):	1	**Soil:**	clay,
Grass cover (%):	60	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	
Disturbance details:	historic clearing, weed infestation,		
Vegetation condition:	Good, EPA (2016)		
Vegetation description:	Low *Eucalyptus loxophleba* subsp. *loxophleba* and *Casuarina obesa* woodland over low **Hordeum marinum*, **Ehrharta longiflora* and **Bromus arenarius* grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Hordeum marinum	40.0	00.20	*	
Casuarina obesa	30.0	04.00		
Eucalyptus loxophleba subsp. *loxophleba*	20.0	10.00		
Ehrharta longiflora	15.0	00.40	*	
Bromus arenarius	02.0	00.20		
Pentameris airoides subsp. *airoides*	01.0	00.50	*	
Ursinia anthemoides	01.0	00.10	*	
Lysimachia arvensis	00.5	00.05	*	
Poaceae sp. seedling	00.1	00.20		
Briza maxima	00.1	00.20	*	
Lolium perenne x *rigidum*	00.1	00.10	*	
Acacia sp. seedling	00.1	00.05		
Centaurium tenuiflorum	00.1	00.05	*	
Angianthus preissianus	00.1	00.05		

Site:	CAL17008	**Type:**	Quadrat (10 m x 10 m)
Date(s):	02 November 2017	**Position:**	-31.057348, 116.213473
Total vegetation cover (%):	40	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	40	**Soil colour:**	brown,
Shrub cover <2 m (%):	0	**Soil:**	sandy clay,
Grass cover (%):	30	**Rock type:**	granite rocks
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus wandoo* subsp. *wandoo* woodland over low open **Ehrharta longiflora*, **Bromus rubens* and **Avena sativa* grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo subsp. *wandoo*	40.0	12.00		
Ehrharta longiflora	20.0	00.40	*	
Avena sativa	05.0	00.30	*	
Bromus rubens	05.0	00.20	*	
Trifolium campestre	00.1	00.10	*	
Trifolium hirtum	00.1	00.10	*	
Lolium perenne	00.1	00.10	*	
Romulea rosea var. *australis*	00.1	00.10	*	

Site:	CAL17009	**Type:**	Quadrat (10 m x 10 m)
Date(s):	20 October 2017	**Position:**	-31.059456, 116.206072
Total vegetation cover (%):	80	**Topography:**	hill top
Tree/shrub cover >2 m (%):	15	**Soil colour:**	brown, whitish,
Shrub cover <2 m (%):	71	**Soil:**	clay loam,
Grass cover (%):	0	**Rock type:**	quartz
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Mid *Eucalyptus wandoo* woodland over isolated mid *Banksia armata* var. *armata* shrubs over low *Acacia lasiocarpus* var. *sedifolia* and *Glischocaryon aureum* shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Acacia lasiocarpa var. *sedifolia*	70.0	00.50		
Eucalyptus wandoo	15.0	12.00		
Glischrocaryon aureum	01.0	00.50		
Gastrolobium spathulatum	01.0	00.40		
Banksia armata var. *armata*	00.5	01.20		
Melaleuca scalena	00.1	00.40		
Cassytha pomiformis	00.1	00.40		
Ursinia anthemoides	00.1	00.15	*	
Drosera sp.	00.1	00.15		
Austrostipa macalpinei	00.1	00.15		
Romulea rosea	00.1	00.15	*	
Opercularia vaginata	00.1	00.10		
Neurachne alopecuroidea	00.1	00.10		
Stylidium leptophyllum	00.1	00.10		
Stylidium caricifolium	00.1	00.10		
Trachymene cyanopetala	00.1	00.02		

Site:	CAL17010	**Type:**	Quadrat (10 m x 10 m)
Date(s):	20 October 2017	**Position:**	-31.063303, 116.204332
Total vegetation cover (%):	90	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	25	**Soil colour:**	red-brown,
Shrub cover <2 m (%):	60	**Soil:**	clay,
Grass cover (%):	10	**Rock type:**	granite rocks
Herb cover (%):	2	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Low *Eucalyptus wandoo* and *Allocasuarina campestris* low woodland over mid *Trymalium odoratissimum* subsp. *odoratissimum* and *Acacia acuminta* shrubland over *Cheilanthes austrotenuifolia* open forbland		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Trymalium odoratissimum subsp. *odoratissimum*	60.0	01.70		
Allocasuarina campestris	10.0	05.00		
Dioscorea hastifolia	05.0	00.50		
Eucalyptus wandoo	03.0	08.00		
Acacia acuminata	03.0	02.50		
Cheilanthes austrotenuifolia	03.0	00.10		
Calothamnus pachystachyus	00.1	01.20		P4 (WC Act)
Freesia sp. sterile	00.1	00.40		
Cassytha pomiformis	00.1	00.30		
Ehrharta longiflora	00.1	00.20	*	
Hordeum leporinum	00.1	00.20	*	
Briza maxima	00.1	00.10	*	
Lysimachia arvensis	00.1	00.05	*	
Parietaria cardiostegia	00.1	00.05		
Aira caryophyllea	00.1	00.05	*	
Romulea rosea	00.1	00.05	*	

Site:	CAL17011	**Type:**	Quadrat (10 m x 10 m)
Date(s):	20 October 2017	**Position:**	-31.068725, 116.206082
Total vegetation cover (%):	25	**Topography:**	hill top
Tree/shrub cover >2 m (%):	12	**Soil colour:**	brown, whitish,
Shrub cover <2 m (%):	20	**Soil:**	clay loam,
Grass cover (%):	0.1	**Rock type:**	granite rocks
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Low *Eucalyptus accedens* woodland over tall *Melaleuca marginata* open shrubland over mid *Melaleuca scalena* shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Melaleuca marginata	15.0	00.80		
Eucalyptus accedens	12.0	08.00		
Melaleuca scalena	03.0	02.00		
Dodonaea divaricata	02.0	00.30		
Gastrolobium spinosum	01.0	01.70		
Hypocalymma angustifolium	01.0	01.00		
Banksia armata var. *armata*	01.0	01.00		
Melaleuca parviceps	00.1	00.50		
Austrostipa elegantissima	00.1	00.50		
Patersonia ?*occidentalis*	00.1	00.40		
Glischrocaryon aureum	00.1	00.30		
Melaleuca sclerophylla	00.1	00.20		P3 (WC Act)
Hakea chromatropa	00.1	00.20		P1 (WC Act)
Neurachne alopecuroidea	00.1	00.10		

Site:	CAL17012	**Type:**	Quadrat (10 m x 10 m)
Date(s):	20 October 2017	**Position:**	-31.066692, 116.204513
Total vegetation cover (%):	80	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	15	**Soil colour:**	red-brown,
Shrub cover <2 m (%):	70	**Soil:**	clay,
Grass cover (%):	0.5	**Rock type:**	granite rocks
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	weed infestation, historic clearing		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Low *Eucalyptus loxophleba* woodland over *Casuarina obesa* tall open shrubland over mid *Spyridium globulosum* closed shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Spyridium globulosum	65.0	01.50		
Eucalyptus loxophleba	10.0	08.00		
Casuarina obesa	03.0	04.50		
Dioscorea hastifolia	02.0	00.40		
Acacia acuminata	01.0	03.50		
Freesia sp. sterile	01.0	00.30		
Dianella revoluta	00.1	00.50		
Austrostipa elegantissima	00.1	00.50		
Lepidosperma leptostachyum	00.1	00.50		
Hordeum leporinum	00.1	00.15	*	
Neurachne alopecuroidea	00.1	00.10		
Cheilanthes austrotenuifolia	00.1	00.10		
Parietaria cardiostegia	00.1	00.10		
Tricoryne elatior	00.1	00.05		
Seringia velutina				

Site:	CAL17014	**Type:**	Quadrat (10 m x 10 m)
Date(s):	02 November 2017	**Position:**	-31.076769, 116.210126
Total vegetation cover (%):	35	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	15	**Soil colour:**	red-brown,
Shrub cover <2 m (%):	15	**Soil:**	laterite,
Grass cover (%):	0.1	**Rock type:**	granite rocks
Herb cover (%):	0.1	**Fire age:**	>5 years
Disturbance details:	none		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Mid *Eucalyptus accedens*, *Corymbia calophylla* and *Eucalyptus wandoo* woodland over *Banksia armata* var. *armata* and *Gastrolobium spinosum* mid open shrubland over *Hibbertia hibbertioides* var. *hibbertioides*, *Acacia lasiocarpa var. lasiocarpa* and *Hibbertia hypericoides* low open shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus accedens	10.0	10.00		
Corymbia calophylla	05.0	12.00		
Banksia armata var. *armata*	05.0	01.20		
Hibbertia hibbertioides var. *hibbertioides*	05.0	00.20		
Acacia lasiocarpa var. *lasiocarpa*	02.0	00.30		
Gastrolobium spinosum	01.0	01.80		
Banksia nobilis subsp. *nobilis*	00.5	02.20		
Hibbertia hypericoides	00.5	00.30		
Austrostipa elegantissima	00.1	00.30		
Lepidosperma pubisquameum	00.1	00.20		
Stackhousia pubescens	00.1	00.20		
Lepidobolus preissianus	00.1	00.20		
Amphipogon turbinatus	00.1	00.20		
Ursinia anthemoides	00.1	00.10	*	
Ptilotus manglesii	00.1	00.10		
Podolepis gracilis	00.1	00.10		
Opercularia vaginata	00.1	00.10		
Laxmannia squarrosa	00.1	00.05		

Tricoryne humilis	00.1	00.05
Conostylis setigera subsp. *setigera*	00.1	00.05
Schoenus clandestinus	00.1	00.05
Eucalyptus wandoo		
Synaphea spinulosa subsp. *major*		

Site:	CAL17015	**Type:**	Quadrat (10 m x 10 m)
Date(s):	03 November 2017	**Position:**	-31.101807, 116.19601
Total vegetation cover (%):	40	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	40	**Soil colour:**	brown,
Shrub cover <2 m (%):	0	**Soil:**	sandy clay,
Grass cover (%):	28	**Rock type:**	granite rocks
Herb cover (%):	0	**Fire age:**	>5 years
Disturbance details:	grazing – high, weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus wandoo* subsp. *wandoo* over low open **Avena sativa*, **Hordeum glaucum* and **Ehrharta longiflora* grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo subsp. *wandoo*	40.0	12.00		
Avena sativa	15.0	00.30	*	
Hordeum glaucum	07.0	00.10	*	
Ehrharta longiflora	05.0	00.30	*	
Bromus rubens	00.5	00.20	*	
Lolium perenne	00.1	00.10	*	
Trifolium ?hirtum	00.1	00.03		

Site:	CAL17018	**Type:**	Quadrat (10 m x 10 m)
Date(s):	03 November 2017	**Position:**	-31.132973, 116.190738
Total vegetation cover (%):	40	**Topography:**	plain
Tree/shrub cover >2 m (%):	10	**Soil colour:**	red-brown,
Shrub cover <2 m (%):	30	**Soil:**	laterite,
Grass cover (%):	5	**Rock type:**	none
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	none		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	*Low Eucalyptus wandoo* subsp. *wandoo* open woodland over *Allocasuarina humilis* and *Xanthorrhoea preisii* mid shrubland over *Mesomelana psuedostygia* and *Lepidosperma tenue* sedgeland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo	10.0	10.00		
Allocasuarina humilis	10.0	01.00		
Acacia willdenowiana	07.0	00.30		
Mesomelaena pseudostygia	05.0	00.50		
Hibbertia hypericoides	05.0	00.40		
Hakea incrassata	03.0	00.50		
Xanthorrhoea preissii	02.0	01.20		
Hakea erinacea	01.0	00.40		
Lepidosperma tenue	00.5	00.40		
Daviesia debilior subsp. *sinuans*	00.5	00.40		P3 (WC Act)
Opercularia vaginata	00.5	00.10		
Austrostipa elegantissima	00.1	00.70		
Grevillea synapheae subsp. *synapheae*	00.1	00.50		
Banksia armata	00.1	00.40		
Lepidobolus preissianus	00.1	00.30		
Lepidosperma pubisquameum	00.1	00.30		
Tetratheca confertifolia	00.1	00.30		
Amphipogon turbinatus	00.1	00.30		
Hibbertia hibbertioides var. *hibbertioides*	00.1	00.20		

Amphipogon caricinus	00.1	00.20
Cassytha racemosa forma *racemosa*	00.1	00.20
Xanthosia ciliata	00.1	00.20
Bossiaea eriocarpa	00.1	00.20
Burchardia congesta	00.1	00.20
Goodenia trichophylla	00.1	00.20
Stylidium pubigerum	00.1	00.10
Conostylis setigera subsp. *setigera*	00.1	00.10
Schoenus clandestinus	00.1	00.05
Borya sphaerocephala	00.1	00.05
Conostylis androstemma	00.1	00.05
Laxmannia squarrosa	00.1	00.05
Pterochaeta paniculata	00.1	00.03
Glischrocaryon aureum		00.70
Boronia ovata		00.20

Site:	CAL17019	**Type:**	Quadrat (10 m x 10 m)
Date(s):	03 November 2017	**Position:**	-31.142807, 116.185541
Total vegetation cover (%):	50	**Topography:**	plain
Tree/shrub cover >2 m (%):	20	**Soil colour:**	brown,
Shrub cover <2 m (%):	10	**Soil:**	laterite,
Grass cover (%):	2	**Rock type:**	granite rocks
Herb cover (%):	3	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Low *Eucalyptus wandoo* subsp. *wandoo* woodland over *Banksia sessilis* tall isolated shrubs over *Bossiaea eriocarpa*, *Hibbertia hibbertioides* var. *hibbertioides* and *Acacia tetragonophylla* low sparse shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo subsp. *wandoo*	20.0	10.00		
Hibbertia hypericoides	03.0	00.30		
Opercularia vaginata	03.0	00.10		
Banksia sessilis	02.0	03.00		
Bossiaea eriocarpa	02.0	00.40		
Amphipogon turbinatus	02.0	00.40		
Hibbertia hibbertioides var. *hibbertioides*	02.0	00.20		
Acacia tetragonophylla	01.0	00.50		
Banksia fraseri var. *fraseri*	01.0	00.40		
Johnsonia pubescens	00.5	00.30		
Hemigenia incana	00.5	00.30		
Isopogon sp.	00.1	00.70		
Banksia kippistiana var. *kippistiana*	00.1	00.70		
Austrostipa elegantissima	00.1	00.60		
Gladiolus sp. sterile	00.1	00.50		
Hakea prostrata	00.1	00.50		
Leucopogon darlingensis subsp. *rectus*	00.1	00.40		P2 (WC Act)
Banksia sphaerocarpa var. *sphaerocarpa*	00.1	00.40		
Grevillea bipinnatifida subsp. *bipinnatifida*	00.1	00.40		

Lepidosperma tenue	00.1	00.30		
Lepidosperma pubisquameum	00.1	00.30		
Acacia anarthros	00.1	00.30		P3 (WC Act)
Stackhousia pubescens	00.1	00.20		
Lomandra sp. sterile	00.1	00.20		
Drosera ?*macrantha*	00.1	00.20		
Rytidosperma caespitosum	00.1	00.20		
Romulea rosea var. *australis*	00.1	00.10	*	
Platysace cirrosa	00.1	00.10		
Ptilotus manglesii	00.1	00.10		
Conostylis setigera subsp. *setigera*	00.1	00.10		
Dianella revoluta	00.1	00.10		
Goodenia pulchella	00.1	00.10		
Laxmannia squarrosa	00.1	00.05		
Daucus glochidiatus	00.1	00.05		
Hyalosperma cotula	00.1	00.05		

Site:	CAL17020	**Type:**	Quadrat (10 m x 10 m)
Date(s):	02 November 2017	**Position:**	-31.147903, 116.186599
Total vegetation cover (%):	45	**Topography:**	plain
Tree/shrub cover >2 m (%):	40	**Soil colour:**	brown,
Shrub cover <2 m (%):	10	**Soil:**	sand,
Grass cover (%):	1	**Rock type:**	granite rocks
Herb cover (%):	0.5	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Excellent, EPA (2016)		
Vegetation description:	Low *Corymbia calophylla* woodland over *Banksia sessilis* var. *sessilis* tall shrubland over *Hibbertia hypericoides*, *Xanthorrhoea preissii* and *Acacia huegelii* low sparse shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Corymbia calophylla	30.0	10.00		
Banksia sessilis var. *sessilis*	15.0	03.50		
Hibbertia hypericoides	05.0	00.30		
Xanthorrhoea preissii	02.0	00.70		
Acacia huegelii	02.0	00.40		
Amphipogon turbinatus	01.0	00.30		
Tetraria octandra	00.5	00.40		
Hibbertia commutata	00.5	00.20		
Hibbertia lasiopus	00.5	00.20		
Grevillea synapheae subsp. *synapheae*	00.3	00.50		
Daviesia angulata	00.1	00.70		
Hakea erinacea	00.1	00.60		
Calothamnus sanguineus	00.1	00.50		
Lepidosperma squamatum	00.1	00.40		
Patersonia rudis subsp. *rudis*	00.1	00.30		
Hemiandra pungens	00.1	00.30		
Tricoryne humilis	00.1	00.30		
Bossiaea eriocarpa	00.1	00.30		
Briza maxima	00.1	00.30	*	

Rytidosperma caespitosum	00.1	00.30	
Acacia pulchella var. *pulchella*	00.1	00.30	
Acacia applanata	00.1	00.20	
Goodenia sp. sterile	00.1	00.20	
Chamaescilla corymbosa	00.1	00.10	
Drosera ?*macrantha*	00.1	00.10	
Opercularia vaginata	00.1	00.10	
Anigozanthos humilis subsp. *humilis*	00.1	00.10	
Stylidium zeicolor	00.1	00.10	
Ursinia anthemoides	00.1	00.10	*
Rhodanthe citrina	00.1	00.10	
Hordeum glaucum	00.1	00.10	*
Kennedia coccinea	00.1	00.10	
Daucus glochidiatus	00.1	00.05	
Hyalosperma cotula	00.1	00.05	
Levenhookia stipitata	00.1	00.05	
Desmocladus asper	00.1	00.05	
Pentameris airoides subsp. *airoides*	00.1	00.05	*
Wahlenbergia gracilenta	00.1	00.05	
Poranthera microphylla	00.1	00.02	

Site:	CAL17021A	**Type:**	Quadrat (10 m x 10 m)
Date(s):	14 November 2017	**Position:**	-31.148266, 116.181982
Total vegetation cover (%):	30	**Topography:**	plain
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown,
Shrub cover <2 m (%):	1	**Soil:**	clay loam, laterite,
Grass cover (%):	2	**Rock type:**	granite rocks
Herb cover (%):	0.5	**Fire age:**	not evident
Disturbance details:	grazing – high, livestock tracks,		
Vegetation condition:	Very Good, EPA (2016)		
Vegetation description:	Low *Eucalyptus wandoo* subsp. *wandoo* and *Corymbia calophylla* woodland over *Banksia sessilis* tall open shrubland over isolated *Amphipogon turbinatus*, *Enteropogon ramosus* and *Rytidosperma caespitosum* grasses.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Banksia sessilis	20.0	02.50		
Eucalyptus wandoo subsp. *wandoo*	10.0	10.00		
Corymbia calophylla	05.0	08.00		
Amphipogon turbinatus	01.5	00.20		
Xanthorrhoea preissii	00.5	01.00		
Enteropogon ramosus	00.5	00.30		
Patersonia ?*occidentalis* var. *occidentalis*	00.5	00.30		
Hibbertia montana	00.5	00.30		P4 (WC Act)
Hibbertia hibbertioides var. *hibbertioides*	00.5	00.20		
Rytidosperma caespitosum	00.5	00.20		
Austrostipa elegantissima	00.1	00.30		
Austrostipa exilis	00.1	00.30		
Lomandra sp. sterile	00.1	00.20		
Hibbertia hypericoides	00.1	00.20		
Ursinia anthemoides	00.1	00.10	*	
Ptilotus manglesii	00.1	00.10		
Hyalosperma cotula	00.1	00.05		
Aira cupaniana	00.1	00.05	*	
Borya sphaerocephala	00.1	00.05		

Site:	CAL17022	**Type:**	Quadrat (10 m x 10 m)
Date(s):	01 November 2017	**Position:**	-31.000708, 116.205058
Total vegetation cover (%):	60	**Topography:**	drainage line
Tree/shrub cover >2 m (%):	60	**Soil colour:**	brown,
Shrub cover <2 m (%):	0.1	**Soil:**	sandy clay,
Grass cover (%):	14	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	weed infestation,		
Vegetation condition:	Degraded, EPA (2016)		
Vegetation description:	Mid *Eucalyptus wandoo* open forest over low open *Avena sativa*, *Ehrharta longiflora* and *Lolium perenne* open tussock grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo	60.0	20.00		
Avena sativa	10.0	00.40	*	
Ehrharta longiflora	03.0	00.30	*	
Lolium perenne	00.5	00.20	*	
Bromus rubens	00.1	00.30	*	
Hordeum glaucum	00.1	00.20	*	
Solanum nigrum	00.1	00.20	*	
Sonchus asper	00.1	00.10	*	
Hypochaeris radicata	00.1	00.10	*	
Atriplex semilunaris	00.1	00.10		
Tricoryne humilis	00.1	00.05		
Arctotheca calendula	00.1	00.05	*	

Site:	CALP20001	**Type:**	Quadrat (10 m x 10m)
Date(s):	07 October 2015, 06 April 2016	**Position:**	-31.054107, 116.207351
Total vegetation cover (%):	90	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	85	**Soil colour:**	red-brown
Shrub cover <2 m (%):	0	**Soil:**	sandy loam
Grass cover (%):	5	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	evidence of feral animals, grazing – medium, historic clearing, weed infestation,		
Vegetation condition:	Very Good, Keighery (1994)		
Vegetation description:	Low Eucalyptus loxophleba and E. wandoo forest over isolated low *Lolium rigidum and *Avena barbata tussock grasses and isolated low Dianella revoluta forbs.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus loxophleba	70.0	09.00		
Eucalyptus wandoo	15.0	10.00		
Avena barbata	02.0	00.20	*	
Lolium rigidum	02.0	00.10	*	
Dianella revoluta	00.1	00.40		
Briza maxima	00.1	00.20	*	
Hordeum leporinum	00.1	00.10	*	

Site:	CALP20002	**Type:**	Quadrat (10 m x 10m)
Date(s):	07 October 2015, 06 April 2016	**Position:**	-31.037024, 116.208161
Total vegetation cover (%):	35	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	20	**Soil colour:**	red-brown
Shrub cover <2 m (%):	5	**Soil:**	sandy loam
Grass cover (%):	10	**Rock type:**	none
Herb cover (%):	5	**Fire age:**	not evident
Disturbance details:	grazing – medium, historic clearing, litter, weed infestation		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Low open *Eucalyptus loxophleba* woodland over tall open *Acacia acuminata* shrubland over low isolated *Gompholobium aristatum*, *Gastrolobium calycinum* and **Lupinus cosentinii* shrubs over low open **Avena barbata* tussock grassland and isolated low *Opercularia vaginata*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Acacia acuminata	25.0	04.00		
Eucalyptus loxophleba	05.0	08.00		
Podolepis aristata subsp. *aristata*	02.0	00.20		
Gastrolobium calycinum	01.0	00.80		
Gompholobium aristatum	01.0	00.60		
Avena barbata	01.0	00.30	*	
Lupinus cosentinii	01.0	00.30	*	
Opercularia vaginata	01.0	00.20		
Podolepis lessonii	01.0	00.20		
Dianella revoluta	00.1	00.60		
Acacia lasiocarpa var. *sedifolia*	00.1	00.50		
Dampiera lavandulacea	00.1	00.30		
Astroloma serratifolium	00.1	00.30		
Austrostipa elegantissima	00.1	00.30		
Burchardia congesta	00.1	00.30		
Neurachne alopecuroidea	00.1	00.30		
Bromus diandrus	00.1	00.20	*	
Briza maxima	00.1	00.20	*	

Site:	CALP20004	**Type:**	Quadrat (10 m x 10m)
Date(s):	07 October 2015	**Position:**	-31.013213, 116.210602
Total vegetation cover (%):	80	**Topography:**	creek
Tree/shrub cover >2 m (%):	80	**Soil colour:**	brown, grey
Shrub cover <2 m (%):	0	**Soil:**	sandy clay
Grass cover (%):	0	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	erosion channels, grazing – medium, livestock tracks		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Low open *Eucalyptus loxophleba* and *E. rudis* woodland over tall closed *Melaleuca rhaphiophylla* shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Melaleuca rhaphiophylla	70.0	04.00		
Eucalyptus rudis	05.0	10.00		
Eucalyptus loxophleba	05.0	10.00		

Site:	GAP020	**Type:**	Quadrat (10 m x 10 m)
Date(s):	09 September 2016	**Position:**	-31.056309, 116.207778
Total vegetation cover (%):	100	**Topography:**	drainage line
Tree/shrub cover >2 m (%):	45	**Soil colour:**	brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam
Grass cover (%):	55	**Rock type:**	Nil rock
Herb cover (%):	50	**Fire age:**	not evident
Disturbance details:	grazing – high, weed infestation,		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid open *Eucalyptus loxophleba* subsp. *loxophleba*, *E. rudis* and *E. wandoo* woodland over low **Avena barbata*, **Ehrharta longiflora* and **Lolium rigidum* tussock grassland and low closed **Oxalis purpurea* forbland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Oxalis purpurea	50.0	00.05	*	
Ehrharta longiflora	40.0	00.40	*	
Eucalyptus wandoo	25.0	12.00		
Eucalyptus loxophleba subsp. *loxophleba*	12.0	15.00		
Eucalyptus rudis	10.0	12.00		
Avena barbata	05.0	00.35	*	
Lolium rigidum	05.0	00.25	*	
Romulea rosea var. *communis*	01.0	00.25	*	
Triticum aestivum	00.1	00.40	*	
Monoculus monstrosus	00.1	00.40	*	
Raphanus raphanistrum	00.1	00.25	*	
Hypochaeris glabra	00.1	00.20	*	
Trifolium hirtum	00.1	00.20	*	
Lysimachia arvensis	00.1	00.15	*	
Arctotheca calendula	00.1	00.15	*	
Sonchus oleraceus	00.1	00.10	*	

Site:	GAP021	**Type:**	Quadrat (10 m x 10 m)
Date(s):	13 September 2016	**Position:**	-31.060541, 116.20638
Total vegetation cover (%):	60	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	35	**Soil colour:**	red-brown
Shrub cover <2 m (%):	40	**Soil:**	gravel / alluvial, clay loam
Grass cover (%):	2	**Rock type:**	laterite
Herb cover (%):	0.2	**Fire age:**	not evident
Disturbance details:	historic operations, weed infestation,		
Vegetation condition:	Excellent, Keighery (1994)		
Vegetation description:	Low *Eucalyptus wandoo* subsp. *wandoo* woodland over low *Acacia lasiocarpa* var. *sedifolia* and *Gastrolobium spathulatum* shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo subsp. *wandoo*	35.0	08.00		
Gastrolobium spathulatum	20.0	00.40		
Acacia lasiocarpa var. *sedifolia*	15.0	00.40		
Hibbertia hypericoides	02.0	00.30		
Desmocladus asper	01.5	00.15		
Bossiaea spinescens	01.0	00.60		
Austrostipa elegantissima	01.0	00.50		
Bossiaea spinescens	01.0	00.50		
Comesperma volubile	01.0	00.50		
Orthrosanthus laxus var. *gramineus*	00.1	00.30		
Melaleuca radula	00.1	00.30		
Ursinia anthemoides	00.1	00.25	*	
Hovea pungens	00.1	00.20		
Lomandra micrantha subsp. *micrantha*	00.1	00.20		
Eriochilus dilatatus subsp. *multiflorus*	00.1	00.20		
Freesia sp.	00.1	00.15	*	
Cheilanthes austrotenuifolia	00.1	00.15		
Ericksonella saccharata	00.1	00.10		
Lysimachia arvensis	00.1	00.08	*	
Lagenophora huegelii	00.1	00.01		

Site:	GAP022	**Type:**	Quadrat (10 m x 10 m)
Date(s):	13 September 2016	**Position:**	-31.071853, 116.204567
Total vegetation cover (%):	40	**Topography:**	hill top
Tree/shrub cover >2 m (%):	30	**Soil colour:**	red-brown
Shrub cover <2 m (%):	15	**Soil:**	clay loam
Grass cover (%):	0.1	**Rock type:**	laterite
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	weed infestation		
Vegetation condition:	Excellent, Keighery (1994)		
Vegetation description:	Mid *Eucalyptus wandoo* subsp. *wandoo* woodland over low open *Acacia lasiocarpa* var. *sedifolia* and *Gastrolobium spathulatum* shrubland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo subsp. *wandoo*	30.0	12.00		
Acacia lasiocarpa var. *sedifolia*	10.0	00.50		
Gastrolobium spathulatum	04.0	00.25		
Loxocarya cinerea	00.1	02.00		
Acacia microbotrya	00.1	01.00		
Comesperma volubile	00.1	00.70		
Austrostipa elegantissima	00.1	00.40		
Freesia sp.	00.1	00.20	*	
Ursinia anthemoides	00.1	00.20	*	
Comesperma integerrimum	00.1	00.20		
Romulea rosea	00.1	00.20	*	
Oxalis pes-caprae	00.1	00.20	*	
Olearia rudis	00.1	00.20		
Bossiaea spinescens	00.1	00.20		
Pauridia glabella var. *leptantha*	00.1	00.15		
Daucus glochidiatus	00.1	00.10		
Lysimachia arvensis	00.1	00.10	*	
Hydrocotyle ? *callicarpa*	00.1	00.10		
Petrorhagia dubia	00.1	00.10	*	
Lagenophora huegelii	00.1	00.01		

Site:	NN3.01	**Type:**	Quadrat (10 m x 10 m)
Date(s):	04 November 2014, 15 June 2015	**Position:**	-30.996487, 116.206084
Total vegetation cover (%):	95	**Topography:**	riparian vegetation of small creek
Tree/shrub cover >2 m (%):	50	**Soil colour:**	black
Shrub cover <2 m (%):	0	**Soil:**	loamy sand
Grass cover (%):	70	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	>10 years
Disturbance details:	clearing, firebreak, fenceline, lack of understorey, intense weeds		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Tall open *Eucalyptus rudis* forest over a low open *Melaleuca rhaphiophylla* woodland over low **Avena barbata*, **Bromus diandrus* and **Ehrharta calycina* tussock grassland and isolated low **Sonchus oleraceus* forbs.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus rudis	40.0	25.00		
Avena barbata	30.0	00.50	*	
Ehrharta calycina	30.0	00.40	*	
Melaleuca rhaphiophylla	10.0	06.00		
Bromus diandrus	10.0	00.20	*	
Sonchus oleraceus	00.1	00.30	*	

Site:	NN3.01a	**Type:**	Quadrat (10 m x 10 m)
Date(s):	04 November 2014, 15 June 2015	**Position:**	-30.995648, 116.206218
Total vegetation cover (%):	95	**Topography:**	slope of low rise undulating plain
Tree/shrub cover >2 m (%):	50	**Soil colour:**	brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam
Grass cover (%):	80	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	>10 years
Disturbance details:	clearing, no native understorey, intense weeds		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid open *Eucalyptus wandoo* and *Eucalyptus loxophleba* forest over low **Avena barbata*, **Ehrharta longiflora* and **Bromus diandrus* tussock grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Ehrharta longiflora	50.0	00.30	*	
Eucalyptus loxophleba	30.0	15.00		
Eucalyptus wandoo	20.0	20.00		
Avena barbata	15.0	00.30	*	
Bromus diandrus	15.0	00.20	*	

Site:	NN3.02	**Type:**	Quadrat (10 m x 10 m)
Date(s):	04 November 2014, 15 June 2015	**Position:**	-30.988152, 116.206425
Total vegetation cover (%):	90	**Topography:**	slope of low rise undulating plain
Tree/shrub cover >2 m (%):	50	**Soil colour:**	brown
Shrub cover <2 m (%):	0	**Soil:**	clay loam
Grass cover (%):	90	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	>10 years
Disturbance details:	cleared, no understorey, dense weeds		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid open *Eucalyptus loxophleba* forest over low **Avena barbata*, **Bromus diandrus* and *Austrostipa variabilis* tussock grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus loxophleba	50.0	15.00		
Avena barbata	40.0	00.30	*	
Austrostipa variabilis	30.0	00.20		
Bromus diandrus	20.0	00.20	*	

Site:	S3A21	**Type:**	Quadrat (5 m x 20 m)
Date(s):	25 November 2015	**Position:**	-31.001806, 116.207945
Total vegetation cover (%):	40	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	39	**Soil colour:**	brown
Shrub cover <2 m (%):	0	**Soil:**	sandy loam: clay loam
Grass cover (%):	1	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	historic operations, litter, weed infestation		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid open *Eucalyptus loxophleba* forest over isolated low **Avena barbata*, **Ehrharta calycina* and **Lolium rigidum* tussock grasses.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus loxophleba	39.0	13.00		
Ehrharta calycina	00.1	00.50	*	
Avena barbata	00.1	00.50	*	
Lolium rigidum	00.1	00.30	*	

Site:	S3A22	**Type:**	Quadrat (2.5 m x 40 m)
Date(s):	25 November 2015, 06 April 2016	**Position:**	-31.009856, 116.210185
Total vegetation cover (%):	50	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown
Shrub cover <2 m (%):	0	**Soil:**	sandy loam
Grass cover (%):	20	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	historic operations, litter, vehicle tracks, weed infestation		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid *Eucalyptus rudis* and *E. loxophleba* woodland over mid open **Avena barbata*, **Cynodon dactylon* and **Ehrharta calycina* tussock grassland and isolated low **Sonchus oleraceus* forbs.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus rudis	24.0	13.00		
Avena barbata	08.0	00.90	*	
Eucalyptus loxophleba	06.0	13.00		
Eragrostis curvula	06.0	01.00	*	
Cynodon dactylon	05.0	00.20	*	
Ehrharta calycina	01.0	00.80	*	
Sonchus oleraceus	00.1	00.30	*	
Bromus diandrus	00.1	00.20	*	

Site:	S3A23	**Type:**	Quadrat (10 m x 10m)
Date(s):	07 October 2015, 06 April 2016	**Position:**	-31.024384, 116.211572
Total vegetation cover (%):	65	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	60	**Soil colour:**	red-brown
Shrub cover <2 m (%):	1	**Soil:**	sandy loam
Grass cover (%):	4	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	historic clearing, litter, weed infestation		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Mid *Eucalyptus wandoo* open forest over isolated mid *Allocasurina huegeliana* and *Melaleuca lateriflora* shrubs over isolated low *Hakea incrassata*, *Hibbertia polystachya* and *Lechenaultia biloba* shrubs over isolated low *Austrostipa campylachne*, *A. elegantissima*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo	60.0	15.00		
Austrostipa campylachne	02.0	00.30		
Melaleuca lateriflora	01.0	02.00		
Hakea incrassata	01.0	01.00		
Austrostipa elegantissima	01.0	00.30		
Hibbertia polystachya	01.0	00.10		
Allocasuarina huegeliana	00.5	01.20		
Xanthorrhoea preissii	00.5	00.50		
Dianella revoluta	00.1	00.40		
Avena barbata	00.1	00.30	*	
Lechenaultia biloba	00.1	00.30		
Acacia applanata	00.1	00.20		
Arthropodium dyeri	00.1	00.20		
Lolium rigidum	00.1	00.20	*	
Briza maxima	00.1	00.20	*	

Site:	S3A24	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015, 06 April 2016	**Position:**	-31.040222, 116.208012
Total vegetation cover (%):	35	**Topography:**	creek
Tree/shrub cover >2 m (%):	35	**Soil colour:**	red-orange
Shrub cover <2 m (%):	0	**Soil:**	laterite
Grass cover (%):	0.1	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	litter, weed infestation		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Low open *Casuarina obesa* forest over isolated low *Austrostipa elegantissima*, **Avena barbata* and **Ehrharta calycina* tussock grasses.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Casuarina obesa	35.0	09.00		
Eucalyptus rudis	00.1	14.00		
Eucalyptus loxophleba	00.1	12.00		
Acacia acuminata	00.1	06.00		
Austrostipa elegantissima	00.1	00.50		
Avena barbata	00.1	00.40	*	
Briza maxima	00.1	00.30	*	
Ehrharta calycina	00.1	00.30	*	

Site:	S3A27	**Type:**	Quadrat (10 m x 10m)
Date(s):	07 October 2015	**Position:**	-31.089326, 116.200661
Total vegetation cover (%):	40	**Topography:**	Plain
Tree/shrub cover >2 m (%):	40	**Soil colour:**	brown
Shrub cover <2 m (%):	2	**Soil:**	clay loam
Grass cover (%):	0.5	**Rock type:**	none
Herb cover (%):	0.2	**Fire age:**	not evident
Disturbance details:	weeds		
Vegetation condition:	Excellent, Keighery (1994)		
Vegetation description:	Mid *Corymbia calophylla* open forest over isolated mid *Allocasuarina* ? *campestris* and *Adenanthos cygnorum* shrubs over isolated low **Avena barbata*, **Briza minor* and **Bromus diandrus* tussock grasses and isolated low *Burchardia congesta*, *Podolepis aristata* subsp. *aristata* and *Ptilotus manglesii* forbs		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Corymbia calophylla	40.0	18.00		
Allocasuarina ? *campestris*	01.0	01.80		
Adenanthos cygnorum	01.0	01.50		
Bromus diandrus	00.1	00.30	*	
Burchardia congesta	00.1	00.20		
Briza maxima	00.1	00.20	*	
Avena barbata	00.1	00.20	*	
Briza minor	00.1	00.10	*	
Podolepis aristata subsp. *aristata*	00.1	00.10		
Ptilotus manglesii	00.1	00.10		

Site:	S3A28	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015, 06 April 2016	**Position:**	-31.098915, 116.198281
Total vegetation cover (%):	40	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	35	**Soil colour:**	brown
Shrub cover <2 m (%):	1	**Soil:**	clay loam, laterite
Grass cover (%):	15	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	historic clearing, litter, weed infestation		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid open *Corymbia calophylla* and *Eucalyptus wandoo* forest over isolated mid *Allocasuarina humilis* shrubs over isolated low *Macrozamia riedlei* and *Phyllanthus calycinus* shrubs over mid open **Avena barbata*, **Bromus diandrus* and **Ehrharta longiflora* tussock		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Corymbia calophylla	18.0	22.00		
Eucalyptus wandoo	16.0	20.00		
Avena barbata	05.0	00.80	*	
Ehrharta longiflora	05.0	00.70	*	
Bromus diandrus	05.0	00.70	*	
Allocasuarina humilis	01.0	01.30		
Macrozamia riedlei	01.0	00.70		
Gastrolobium spinosum	00.5	01.20		
Phyllanthus calycinus	00.1	00.30		
Euphorbia drummondii	00.1	00.10		
Kennedia prostrata	00.1	00.10		

Site:	S3A29	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015	**Position:**	-31.112005, 116.196177
Total vegetation cover (%):	30	**Topography:**	plain
Tree/shrub cover >2 m (%):	25	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	6	**Soil:**	laterite
Grass cover (%):	2	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	litter, weed infestation		
Vegetation condition:	Very Good, Keighery (1994)		
Vegetation description:	Mid *Corymbia calophylla* and *Eucalyptus wandoo* woodland over tall sparse *Banksia sessilis* and *Casuarina obesa* shrubland over low sparse *Xanthorrhoea preissii*, *Melaleuca trichophylla* and *Bossiaea eriocarpa* shrubland over isolated mid *Neurachne alopecuroidea*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Corymbia calophylla	20.0	24.00		
Eucalyptus wandoo	05.0	22.00		
Banksia sessilis	05.0	03.50		
Xanthorrhoea preissii	02.0	00.90		
Casuarina obesa	01.0	06.00		
Leucopogon planifolius	01.0	01.10		
Hibbertia hypericoides	01.0	00.50		
Bossiaea eriocarpa	01.0	00.50		
Melaleuca trichophylla	01.0	00.40		
Neurachne alopecuroidea	01.0	00.40		
Daviesia decurrens	00.1	01.00		
Lepidosperma sp.	00.1	00.80		
Bromus diandrus	00.1	00.80	*	
Hakea lissocarpha	00.1	00.80		
Austrostipa elegantissima	00.1	00.70		
Austrostipa semibarbata	00.1	00.60		
Avena barbata	00.1	00.60	*	
Dianella revoluta	00.1	00.50		

Hakea stenocarpa	00.1	00.40	
Tetraria octandra	00.1	00.40	
Acacia shuttleworthii	00.1	00.30	
Dampiera alata	00.1	00.30	
Adenanthos cygnorum	00.1	00.30	
Briza minor	00.1	00.30	*
Gonocarpus cordiger	00.1	00.30	
Grevillea synapheae subsp. *synapheae*	00.1	00.30	
Lepidosperma calcicola	00.1	00.30	
Lomandra ? *preissii*	00.1	00.30	
Conostylis candicans	00.1	00.30	
Briza maxima	00.1	00.20	*
Opercularia vaginata	00.1	00.20	

Site:	S3A30	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015, 06 April 2016	**Position:**	-31.127231, 116.193595
Total vegetation cover (%):	50	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	45	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	8	**Soil:**	laterite
Grass cover (%):	5	**Rock type:**	none
Herb cover (%):	0	**Fire age:**	not evident
Disturbance details:	historic clearing, litter, weed infestation		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Mid open *Corymbia calophylla* and *Eucalyptus wandoo* forest over low sparse *Hibbertia hypericoides* and *Phyllanthus calycinus* shrubland over isolated low *Lepidosperma calcicola* and *Lepidosperma* sp. sedges, isolated low *Austrostipa elegantissima* , **Briza maxima* and *Stypandra glauca*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Corymbia calophylla	25.0	25.00		
Eucalyptus wandoo	20.0	25.00		
Hibbertia hypericoides	04.0	00.40		
Lepidosperma calcicola	04.0	00.30		
Phyllanthus calycinus	02.0	00.40		
Opercularia vaginata	01.0	00.30		
Persoonia coriacea	00.1	01.00		
Avena barbata	00.1	00.80	*	
Dianella revoluta	00.1	00.80		
Lepidosperma sp.	00.1	00.60		
Briza maxima	00.1	00.30	*	
Stypandra glauca	00.1	00.30		
Austrostipa elegantissima	00.1	00.30		
Asparagus asparagoides	00.1	00.30	*	
Dampiera lavandulacea	00.1	00.30		

Site:	S3A31	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015, 06 April 2016	**Position:**	-31.130136, 116.193051
Total vegetation cover (%):	80	**Topography:**	drainage line
Tree/shrub cover >2 m (%):	75	**Soil colour:**	brown
Shrub cover <2 m (%):	0.1	**Soil:**	clay
Grass cover (%):	35	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	historic clearing, litter, weed infestation		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Mid *Eucalyptus wandoo* woodland over low *Melaleuca rhaphiophylla* forest over tall open *Lepidosperma pubisquameum*, **Typha orientalis* and **Juncus acutus* subsp. *acutus* sedges over low **Cynodon dactylon* open grassland and isolated low **Sonchus oleraceus* forbs.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Melaleuca rhaphiophylla	75.0	06.00		
Eucalyptus wandoo	25.0	12.00		
Cynodon dactylon	20.0	00.50	*	
Lepidosperma pubisquameum	15.0	01.10		
Typha orientalis	01.0	01.80		
Melaleuca lateritia	00.1	01.50		
Juncus acutus subsp. *acutus*	00.1	01.00	*	
Sonchus oleraceus	00.1	00.80	*	
Austrostipa elegantissima	00.1	00.50		

Site:	S3A32	**Type:**	Quadrat (10 m x 10 m)
Date(s):	26 November 2015, 07 April 2016	**Position:**	-31.139287, 116.18883
Total vegetation cover (%):	60	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	40	**Soil colour:**	brown
Shrub cover <2 m (%):	5	**Soil:**	sandy loam
Grass cover (%):	6	**Rock type:**	none
Herb cover (%):	12	**Fire age:**	not evident
Disturbance details:	litter, weed infestation		
Vegetation condition:	Very Good, Keighery (1994)		
Vegetation description:	Mid open *Eucalyptus wandoo* forest low sparse *Hibbertia hypericoides*, *Bossiaea eriocarpa* and *Hibbertia lasiopus* shrubland over low sparse *Lepidosperma* sp. and *Tetraria octandra* sedgeland, isolated mid *Austrostipa elegantissima* tussock grasses		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus wandoo	40.0	15.00		
Opercularia vaginata	10.0	00.30		
Hibbertia hypericoides	04.0	00.50		
Lepidosperma squamatum	03.0	00.40		
Tetraria octandra	02.0	00.30		
Bossiaea eriocarpa	01.0	00.40		
Lomandra sp.	01.0	00.40		
Cassytha glabella forma *casuarinae*	01.0	00.00		
Austrostipa semibarbata	00.1	00.50		
Dianella revoluta	00.1	00.50		
Arthropodium dyeri	00.1	00.40		
Lechenaultia floribunda	00.1	00.40		
Austrostipa elegantissima	00.1	00.40		
Patersonia rudis subsp. *rudis*	00.1	00.30		
Hibbertia lasiopus	00.1	00.30		
Bromus diandrus	00.1	00.30	*	
Kennedia prostrata	00.1	00.20		
Austrostipa hemipogon	00.1	00.20		

Xanthosia candida	00.1	00.20	
Romulea rosea	00.1	00.20	*
Patersonia occidentalis	00.1	00.20	
Banksia bipinnatifida subsp. *multifida*	00.1	00.20	
Ptilotus manglesii	00.1	00.10	

Site:	S3A33	**Type:**	Quadrat (10 m x 10 m)
Date(s):	26 November 2015, 07 April 2016	**Position:**	-31.148066, 116.185137
Total vegetation cover (%):	40	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	30	**Soil colour:**	brown, grey
Shrub cover <2 m (%):	10	**Soil:**	sand
Grass cover (%):	1	**Rock type:**	none
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	weed infestation		
Vegetation condition:	Very Good, Keighery (1994)		
Vegetation description:	Mid open *Corymbia calophylla* woodland over tall open *Banksia sessilis* shrubland over low sparse *Bossiaea eriocarpa*, *Hibbertia hypericoides* and *Phyllanthus calycinus* shrubland over isolated low *Austrostipa semibarbata*, **Briza maxima* and **Ehrharta calycina*		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Banksia sessilis	20.0	03.50		
Corymbia calophylla	10.0	15.00		
Hibbertia hypericoides	05.0	00.40		
Bossiaea eriocarpa	01.5	00.50		
Tetraria octandra	01.0	00.20		
Phyllanthus calycinus	01.0	00.10		
Gompholobium tomentosum	00.5	00.50		
Leptospermum erubescens	00.1	01.50		
Daviesia angulata	00.1	00.70		
Austrostipa semibarbata	00.1	00.60		
Dianella revoluta	00.1	00.50		
Verreauxia reinwardtii	00.1	00.50		
Ehrharta calycina	00.1	00.50	*	
Arthropodium dyeri	00.1	00.50		
Acacia pulchella	00.1	00.50		
Tripterococcus brunonis	00.1	00.40		
Grevillea synapheae subsp. *synapheae*	00.1	00.40		
Lomandra maritima	00.1	00.40		

Acacia huegelii	00.1	00.40	
Acacia willdenowiana	00.1	00.40	
Anigozanthos humilis subsp. *humilis*	00.1	00.40	
Gonocarpus cordiger	00.1	00.30	
Romulea rosea	00.1	00.20	*
Briza maxima	00.1	00.20	*
Ursinia anthemoides subsp. *anthemoides*	00.1	00.20	*
Gastrolobium capitatum	00.1	00.20	

Site:	S3A45	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015, 06 April 2016	**Position:**	-31.11969, 116.19457
Total vegetation cover (%):	35	**Topography:**	plain
Tree/shrub cover >2 m (%):	28	**Soil colour:**	red-orange, brown
Shrub cover <2 m (%):	3	**Soil:**	laterite
Grass cover (%):	6	**Rock type:**	none
Herb cover (%):	1	**Fire age:**	not evident
Disturbance details:	historic clearing, litter, weed infestation		
Vegetation condition:	Good, Keighery (1994)		
Vegetation description:	Mid *Corymbia calophylla* woodland over isolated mid *Adenanthos cygnorum* shrubs over isolated low *Hibbertia hypericoides*, *Phyllanthus calycinus* and *Daviesia decurrens* shrubs over isolated mid **Briza maxima*, **Ehrharta calycina* and **Avena barbata* tussock grass		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Corymbia calophylla	28.0	25.00		
Tetraria octandra	02.0	00.90		
Briza maxima	02.0	00.50	*	
Adenanthos cygnorum	01.0	01.20		
Lepidosperma costale	01.0	00.80		
Ehrharta calycina	01.0	00.70	*	
Hibbertia hypericoides	01.0	00.50		
Stypandra glauca	00.5	00.80		
Phyllanthus calycinus	00.5	00.40		
Xanthorrhoea preissii	00.1	02.00		
Sonchus oleraceus	00.1	00.80	*	
Macrozamia riedlei	00.1	00.80		
Ehrharta longiflora	00.1	00.70	*	
Briza minor	00.1	00.60	*	
Lepidosperma leptostachyum	00.1	00.50		
Daviesia decurrens	00.1	00.50		
Avena barbata	00.1	00.50	*	
Bromus diandrus	00.1	00.20	*	

Solanum nigrum	00.1	00.20	*

Site:	S3A47	**Type:**	Quadrat (10 m x 10 m)
Date(s):	25 November 2015, 14 April 2016	**Position:**	-31.030988, 116.208895
Total vegetation cover (%):	30	**Topography:**	hill slope
Tree/shrub cover >2 m (%):	11	**Soil colour:**	brown
Shrub cover <2 m (%):	4	**Soil:**	clay loam: laterite
Grass cover (%):	25	**Rock type:**	none
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	historic clearing, historic operations, litter, weed infestation		
Vegetation condition:	Degraded, Keighery (1994)		
Vegetation description:	Mid *Eucalyptus wandoo* woodland over isolated low *Gastrolobium polystachyum*, *Hibbertia hypericoides* and *Lechenaultia floribunda* shrubs over mid open *Austrostipa semibarbata*, *A. elegantissima* and **Avena barbata* tussock grassland.		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Austrostipa semibarbata	20.0	00.60		
Eucalyptus wandoo	11.0	15.00		
Poaceae sp.	05.0	00.20		
Gastrolobium polystachyum	01.0	00.40		
Hibbertia hypericoides	01.0	00.40		
Lepidosperma tenue	01.0	00.40		
Lechenaultia floribunda	00.5	00.30		
Banksia bipinnatifida subsp. *multifida*	00.5	00.20		
Allocasuarina humilis	00.1	01.20		
Olea europaea subsp. *europaea*	00.1	00.70	*	
Dichopogon capillipes	00.1	00.60		
Avena barbata	00.1	00.60	*	
Austrostipa elegantissima	00.1	00.50		
Ehrharta calycina	00.1	00.50	*	
Daviesia hakeoides	00.1	00.50		
Acacia pulchella var. *goadbyi*	00.1	00.50		
Lepidosperma sp.	00.1	00.40		
Dampiera alata	00.1	00.40		

Mesomelaena preissii	00.1	00.30	
Pentameris airoides	00.1	00.30	*
Briza maxima	00.1	00.30	*
Lepidobolus preissianus	00.1	00.30	
Burchardia congesta	00.1	00.30	
Astroloma serratifolium	00.1	00.30	
Dianella revoluta	00.1	00.30	
Lomandra maritima	00.1	00.20	

Site:	S3AB20001	**Type:**	Quadrat (10 m x 10m)
Date(s):	07 October 2015, 06 April 2016	**Position:**	-31.088127, 116.201499
Total vegetation cover (%):	35	**Topography:**	undulating plain
Tree/shrub cover >2 m (%):	35	**Soil colour:**	red-orange
Shrub cover <2 m (%):	3	**Soil:**	clay loam
Grass cover (%):	0.5	**Rock type:**	calcrete
Herb cover (%):	0.1	**Fire age:**	not evident
Disturbance details:	grazing – medium, historic clearing, litter, weed infestation		
Vegetation condition:	Very Good, Keighery (1994)		
Vegetation description:	Mid open *Corymbia calophylla* and *Eucalyptus accedens* forest over isolated mid *Gastrolobium spinosum* shrubs over isolated low *Acacia pulchella* and *Hibbertia* spp. shrubs over isolated low *Neurachne alopecuroidea* and **Bromus diandrus* tussock grasses		

Species	Cover (%)	Height (m)	Weeds	Conservation status
Eucalyptus accedens	30.0	15.00		
Corymbia calophylla	05.0	15.00		
Gastrolobium spinosum	01.0	01.80		
Acacia pulchella	01.0	00.30		
Dianella revoluta	00.1	00.50		
Bromus diandrus	00.1	00.30	*	
Desmocladus asper	00.1	00.30		
Neurachne alopecuroidea	00.1	00.20		
Burchardia congesta	00.1	00.20		
Hibbertia commutata	00.1	00.20		
Hibbertia hibbertioides var. *hibbertioides*	00.1	00.20		
Hibbertia lasiopus	00.1	00.10		

Appendix 4 Vegetation structural classes (NVIS 2003)

Height Classes

Height	Growth form					
Height class	Height range (m)	Tree, vine (Mid & Upper), palm (single-stemmed)	Shrub, heath shrub, chenopod shrub, ferns, Samphire shrub, cycad, tree-fern, Grass-tree, palm (multi-stemmed)	Tree mallee, Mallee Shrub	Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (Ground)	Bryophyte, lichen, seagrass, aquatic
8	>30	tall	N/A	N/A	N/A	N/A
7	10-30	mid	N/A	tall	N/A	N/A
6	<10	low	N/A	mid	N/A	N/A
5	<3	N/A	N/A	low	N/A	N/A
4	>2	N/A	tall	N/A	tall	N/A
3	1-2	N/A	mid	N/A	tall	N/A
2	0.5-1	N/A	low	N/A	mid	tall
1	<0.5	N/A	low	N/A	low	low

Structural Formation Classes

Growth form	Height ranges (m)	Structural formation classes					
Foliage cover % (cover #)		70-100% (5)	30-70% (4)	10-30% (3)	<10% (2)	0-5% (1)	≈0% (N)
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs

Growth form	Height ranges (m)	Structural formation classes					
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns
bryophyte	<0.5	closed bryophytelan-d	bryophytela-nd	open bryophytel-and	sparse bryophytela-nd	isolated bryophytes	isolated clumps of bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines
aquatic	0-0.5, <1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics
seagrass	0-0.5, <1	closed seagrass bed	seagrass bed	open seagrass bed	sparse seagrass bed	isolated seagrasses	isolated clumps of seagrasses

Appendix 5 Weeds identified in desktop review

Species	Common name	Declared pest
**Arctotheca calendula*	Cape Weed	
**Avena barbata*	Bearded Oat	
**Avena strigosa*	Sand Oat	
**Babiana angustifolia*		
**Brassica barrelieri subsp. oxyrrhina*	Smooth-stem Turnip	
**Briza maxima*	Blowfly Grass	
**Campylopus introflexus*		
**Chasmanthe floribunda*	African Cornflag	
**Chrysanthemum segetum*	Corn Marigold	
**Cotula bipinnata*	Ferny Cotula	
**Cotula coronopifolia*	Waterbuttons	
**Disa bracteata*		
**Ehrharta calycina*	Perennial Veldt Grass	
**Ehrharta longiflora*	Annual Veldt Grass	
**Eragrostis cilianensis*	Stinkgrass	
**Glebionis segetum*		
**Gorteria personata*	Gorteria	
**Hesperantha falcata*		
**Hypochaeris glabra*	Smooth Catsear	
**Kickxia elatine* subsp. *crinita*		
**Lactuca serriola* forma *serriola*		
**Lysimachia arvensis*	Pimpernel	
**Misopates orontium*	Lesser Snapdragon	
**Monoculus monstrosus*		
**Moraea setifolia*		
**Parentucellia latifolia*	Common Bartsia	
**Pentameris airoides*	False Hairgrass	
**Polygonum aviculare*	Wireweed	
**Secale cereale*	Rye	
**Sonchus asper*	Rough Sowthistle	
**Sonchus oleraceus*	Common Sowthistle	
**Tamarix parviflora*		
**Trifolium angustifolium*	Narrowleaf Clover	
**Ursinia anthemoides* subsp. *anthemoides*		
**Vachellia farnesiana*	Mimosa Bush	
**Wahlenbergia capensis*	Cape Bluebell	

Appendix 6 Key to determining presence of the EPBC Act listed TEC Eucalypt woodlands of the Western Australian Wheatbelt (based on *Approved Conservation Advice (including listing advice) for the Eucalypt Woodlands of the Western Australian Wheatbelt*)

Description

The Eucalypt woodlands of the Western Australian Wheatbelt TEC is composed of eucalypt woodlands dominated by a complex mosaic of eucalypt species with a single tree or mallet form over an understorey that is highly variable in structure and composition. A mallet habit refers to a eucalypt with a single, slender trunk and steep-angled branches that give rise to a dense crown. Many eucalypt species are considered iconic within the Wheatbelt landscape, for example, *Eucalyptus salmonophloia* (salmon gum), *E. loxophleba* subsp. *loxophleba* (York gum), *Eucalyptus rudis* subsp. *rudis*, *E. salubris* (gimlet), *E. wandoo* (wandoo) and the mallet group of species. Associated species may include *Acacia acuminata* (jam), *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah). The understorey structures are often bare to sparse, herbaceous, shrub of heath, chenopod-dominated, thickets (*Melaleuca* spp.) and saline areas with *Tecticornia* spp. The main diagnostic features include location, minimum crown cover of the tree canopy of 10% in a mature woodland, presence of key species and a minimum condition according to scale of Keighery (1994) that depends on size of a patch, weed cover and presence of mature trees. A patch is defined as a discrete and mostly continuous area of the ecological community and may include small-scale variations and disturbances, such as tracks or breaks, watercourses/drainage lines or localised changes in vegetation that do not act as a permanent barrier or significantly alter its overall functionality. Each patch of the community includes a buffer zone, an area that lies immediately outside the edge of a patch but is not part of the ecological community. The buffer zone is designed to minimise this risk to the ecological community.

Woodland vegetation with a very sparse eucalypt tree canopy and woodlands dominated by mallee forms characterised by multiple stems of similar size arising at or near ground level are not part of the ecological community. The ecological community is not likely to be present if it is dominated by non-eucalypt species in the tree canopy, for instance A*cacia acuminata* (jam) or *Allocasuarina huegeliana* (rock sheoak) even though these species may be present as an understorey or minor canopy component.

The community occupies a transitional zone between the wetter forests associated with the Darling Range and the southwest coast, and the low woodlands and shrublands of the semi-arid to arid interior. The Wheatbelt region where the ecological community occurs mostly encompasses two IBRA2 subregions: Avon Wheatbelt subregion AVW01 Merredin and Avon Wheatbelt subregion AVW02 Katanning. Patches of the ecological community may extend into adjacent areas of the primary Wheatbelt bioregions, such as the easternmost parts of the Jarrah Forest bioregion forming an extension of the Avon Wheatbelt landscape in that they comprise areas subject to similar climate, landscape and threats. These outlier patches generally occur south of Northam, extending around the vicinity of localities such as Wandering, Williams, Kojonup and Mount Barker (All locations south of Perth), and are limited to areas that are not on the Darling range, receive less than 600 mm mean annual rainfall and overlie the Yilgarn Craton geology. A third IBRA2 subregion includes Mallee subregion MAL02 Western Mallee and is located south of Perth. The ecological community is generally associated with the flatter, undulating relief, including drainage lines and saline areas.

The WA Wheatbelt woodlands ecological community potentially corresponds to 45 Beard (Shepherd *et al.* 2002) vegetation associations. The most likely equivalents are with the 37 associations that are dominant or unique within the Wheatbelt regions.

Key diagnostics

The key diagnostic characteristics summarise the main features that characterise the WA Wheatbelt Woodlands (refer below). For EPBC Act referral, assessment and compliance purposes, the national ecological community is limited to patches that meet the key diagnostic characteristics (1-4 below) plus the condition thresholds (diagnostic 5 below).

Condition thresholds

It is intended that the condition thresholds will exclude degraded patches from any requirement for protection, for instance:

- isolated paddock trees on farms;
- small or narrow stands of trees that serve as windbreaks or shelterbelts on farms and other properties; or
- roadside and other woodland remnants that are too small and narrow, or where the tree canopy has become too patchy and discontinuous (effectively <10% cover), or the understorey has lost considerable elements of its native structure and diversity.

Diagnostic 1 Location

Survey location occurs within one of the following three regions:

- Avon Wheatbelt bioregion - subregions AVW01 Merredin and AVW02 Katanning
- Mallee bioregion - MAL02 Western Mallee only
- Jarrah Forest bioregion – outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt, and are effectively an extension of the Avon Wheatbelt landscape. Within the Jarrah Forest bioregion, the ecological community occurs on landscapes that fall below 600 mm mean annual rainfall (Figure 1), are off the Darling Range, associated with the Yilgarn Craton geology and are generally heavily cleared. This covers the eastern to southeastern-most parts of the bioregion. The ecological community generally falls within the 300 to 600 mm average annual rainfall isohyets. The isohyets based on the latest 30-year average between 1976 to 2005 (BoM 2016) are most applicable to the current climatic regime.

……2

Survey location occurs within region:

- Jarrah Forest bioregion – outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt. Within the Jarrah Forest bioregion, the ecological community occurs on landscapes that ARE ABOVE the 600 mm isohyet, are ON the Darling Range, NOT associated with the Yilgarn Craton geology and are NOT generally heavily cleared. This covers the eastern to southeastern-most parts of the bioregion. It generally DOES NOT fall within the 300 to 600 mm average annual rainfall isohyets. The isohyets based on the latest 30-year average between 1976 to 2005 (BoM 2016) are most applicable to the current climatic regime.

……**NOT** TEC

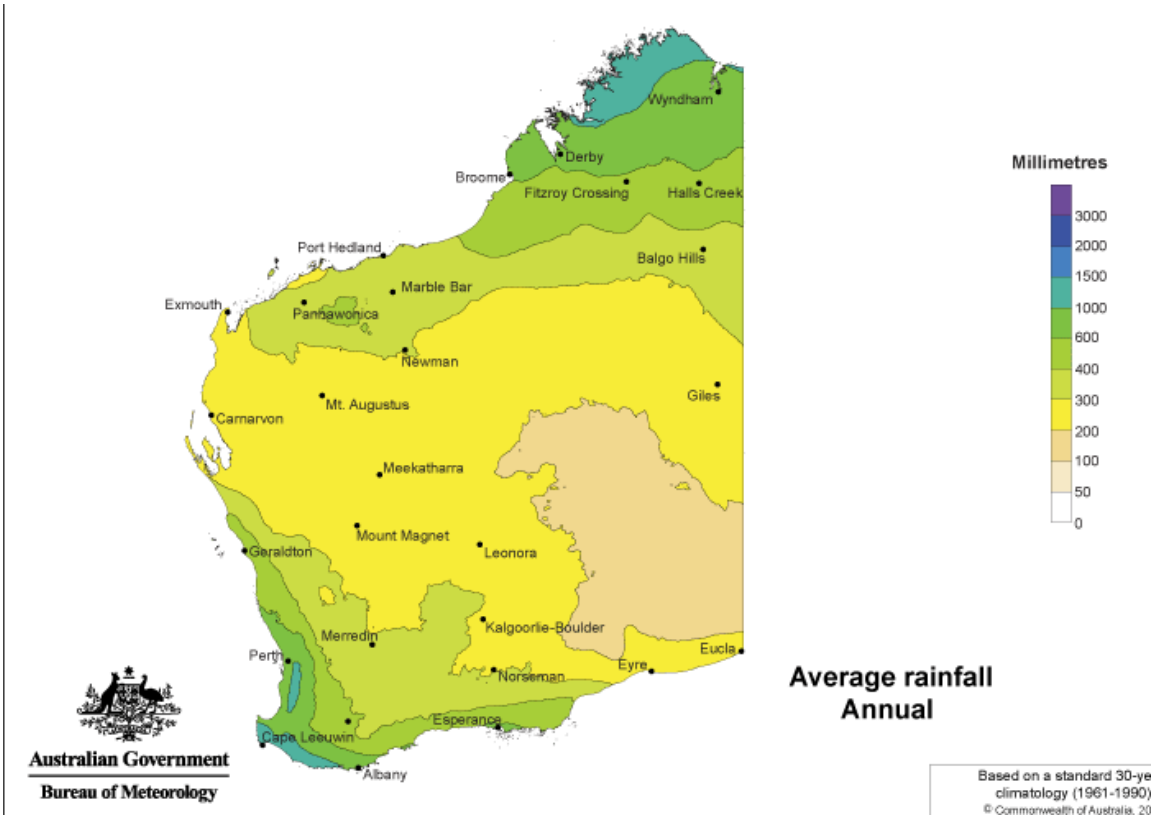

Figure 1 Isohyets of Western Australia (BoM 2016)

Diagnostic 2 Minimum crown canopy

The structure of the ecological community is a woodland in which the minimum crown cover of the tree canopy in a mature eucalypt woodland is 10% (crowns measured as if they are opaque). The maximum tree canopy cover usually is up to 40%. It may be higher in certain circumstances, for instance trees with a mallet growth form (multi-stemmed upper canopy) may be more densely spaced, or disturbances such as fire may result in an increased cover of canopy species during regeneration.

……3

Crown cover of trees less than 10% but area recently disturbed (e.g. fire), presence of seedlings and/or saplings.

……3

Crown cover of trees less than 10%, no evidence of recent disturbance, no presence of seedlings or saplings.

……**NOT** TEC

Diagnostic 3 Dominant *Eucalyptus* tree canopy

One or more of the key tree species in Table 1 are dominant or co-dominant, the trees are predominantly single trunked, not mallee (multi-stemmed).

……4

Other species are present in the tree canopy (e.g. species in Table 2 or other taxa) but these collectively do not occur as dominants in the tree canopy.

……4

Dominant woodlands with a mallee subcanopy (lower tree layer of mallee or non-eucalypt tree species). Upper eucalypt tree canopy must be present dominated by key woodland species in Table 2 and have cover of 10% or more.

……4

Other species are present in the tree canopy (e.g. species in Table 2 or other taxa) and these collectively do occur as dominants in the tree canopy.

……**NOT** TEC

Table 1 Key eucalypt species. One or more of these species are dominant or co-dominant within a given patch of the ecological community

Scientific name	**Common name/s**
Eucalyptus accedens	powder-bark; powder-bark wandoo
Eucalyptus aequioperta	Welcome Hill gum
Eucalyptus alipes	Hyden mallet
Eucalyptus astringens subsp. *astringens*	brown mallet
Eucalyptus capillosa	wheatbelt wandoo
Eucalyptus densa subsp. *densa*	narrow-leaved blue mallet
Eucalyptus extensa	yellow mallet
Eucalyptus falcata	silver mallet
Eucalyptus gardneri subsp. *gardneri*	blue mallet
Eucalyptus goniocarpa	Lake King mallet
Eucalyptus kondininensis	Kondinin blackbutt
Eucalyptus longicornis	red morrel
Eucalyptus loxophleba subsp. *loxophleba*	York gum
Eucalyptus melanoxylon	black morrel
Eucalyptus mimica subsp. *continens*	hooded mallet
Eucalyptus mimica subsp. *mimica*	Newdegate mallet
Eucalyptus myriadena	small-fruited gum; blackbutt
Eucalyptus occidentalis	flat-topped yate
Eucalyptus ornata	ornamental silver mallet; ornate mallet
Eucalyptus recta	Mt Yule silver mallet; Cadoux mallet
Eucalyptus rudis subsp. *rudis*	flooded gum
Eucalyptus salicola	salt gum; salt salmon gum
Eucalyptus salmonophloia	salmon gum
Eucalyptus salubris	gimlet
Eucalyptus sargentii subsp. *sargentii*	salt river gum
Eucalyptus singularis	ridge-top mallet
Eucalyptus spathulata subsp. *spathulata*	swamp mallet
Eucalyptus spathulata subsp. *salina*	Salt River mallet
Eucalyptus urna	merrit
Eucalyptus wandoo subsp. *pulverea*	wandoo
Eucalyptus wandoo subsp. *wandoo*	wandoo

Table 2 Associated canopy species that may be present within the ecological community but are not dominant or co-dominant[1]

Scientific name	Common name/s
Acacia acuminata	jam
Allocasuarina huegeliana	rock sheoak
Corymbia calophylla	marri
Eucalyptus annulata	prickly-fruited mallee
Eucalyptus arachnaea subsp. *arachnaea*	black-stemmed mallee
Eucalyptus arachnaea subsp. *arrecta*	black-stemmed mallet
Eucalyptus armillata	flanged mallee
Eucalyptus calycogona subsp. *calycogona*	square-fruited mallee
Eucalyptus camaldulensis subsp. *arida*	river red gum
Eucalyptus celastroides subsp. *virella*	wheatbelt mallee
Eucalyptus cylindriflora	Goldfields white mallee
Eucalyptus decipiens	redheart; moit
Eucalyptus drummondii	Drummond's mallee
Eucalyptus eremophila	sand mallee
Eucalyptus erythronema subsp. *erythronema*	red-flowered mallee
Eucalyptus erythronema subsp. *inornata*	yellow-flowered mallee
Eucalyptus eudesmioides	Kalbarri mallee
Eucalyptus flocktoniae subsp. *flocktoniae*	Flockton's mallee
Eucalyptus gittinsii subsp. *illucida*	northern sandplain mallee
Eucalyptus incrassata	ridge-fruited mallee
Eucalyptus kochii subsp. *plenissima*	Trayning mallee
Eucalyptus leptopoda subsp. *leptopoda*	Merredin mallee; Tammin mallee
Eucalyptus loxophleba subsp. *gratiae*	Lake Grace mallee
Eucalyptus loxophleba subsp. *lissophloia*	smooth-barked York gum
Eucalyptus loxophleba subsp. *supralaevis*	blackbutt York gum
Eucalyptus macrocarpa	mottlecah
Eucalyptus marginata	jarrah
Eucalyptus moderata	redwood mallee
Eucalyptus obtusiflora	Dongara mallee
Eucalyptus olivina	olive-leaved mallee
Eucalyptus orthostemon	diverse mallee
Eucalyptus perangusta	fine-leaved mallee
Eucalyptus phaenophylla	common southern mallee
Eucalyptus phenax subsp. *phenax*	white mallee
Eucalyptus pileata	capped mallee
Eucalyptus platypus subsp. *platypus*	moort
Eucalyptus polita	Parker Range mallet
Eucalyptus sheathiana	ribbon-barked mallee
Eucalyptus sporadica	Burngup mallee

Eucalyptus subangusta subsp. *subangusta*	grey mallee

The list is not comprehensive and presents the more common taxa encountered.

Diagnostic 4 Native understorey

A native understorey is present but is of variable composition, being a combination of grasses, other herbs and shrubs. A list of key species is summarised in Table 3. Any one of the structural understorey categories may or may not be present.

Bare to sparse understorey (e.g. under some mallet woodlands).

……5

Herbaceous understorey – a ground layer of forbs and/or graminoids though a few, scattered shrubs may be present.

……5

Scrub or heath understorey – comprises a mixture of diverse shrubs of variable height and cover. A ground layer of herbs and grasses is present to variable extent.

……5

Chenopod-dominated understorey – a subset of the scrub category in which the prominent species present are saltbushes, bluebushes and related taxa (e.g. *Atriplex, Enchylaena*, *Maireana, Rhagodia* and *Sclerolaena*).

……5

Thickets of taller shrub species understorey (e.g. *Melaleuca pauperiflora, M. acuminata, M. uncinata, M. lanceolata, M. sheathiana, M. adnata, M. cucullata* and/or *M. lateriflora, Allocasuarina campestris* with *Melaleuca hamata* or *M. scalena*). A range of other shrub and ground layer species may occur among or below the thickets.

……5

Salt tolerant species understorey (e.g. samphire, *Tecticornia* spp.).

……5

Shrublands or herblands in which the tree canopy layer is very sparse to absent, either naturally or maintained so through long-term disturbance. Native vegetation where a tree canopy was formerly present is often referred to as ‘derived’ or ‘secondary’ vegetation. These sites would fall below the 10 per cent minimum canopy cover threshold for a woodland.

……**NOT** TEC

Table 3 Understorey species

Scientific name	Common name/s
Shrubs	
Acacia acuaria	
Acacia colletioides	wait-a-while
Acacia erinacea	
Acacia hemiteles	
Acacia lasiocalyx	silver wattle
Acacia lasiocarpa	panjang
Acacia leptospermoides	
Acacia mackeyana	
Acacia merrallii	

Acacia microbotrya.	manna wattle
Acacia pulchella	prickly moses
Allocasuarina acutivalvis	
Allocasuarina campestris	
Allocasuarina humilis	dwarf sheoak
Allocasuarina lehmanniana	dune sheoak
Allocasuarina microstachya	
Argyroglottis turbinata	
Astroloma epacridis	
Banksia armata	prickly dryandra
Banksia sessilis	parrot bush
Beyeria brevifolia	
Bossiaea divaricata	
Bossiaea eriocarpa	common brown pea
Bossiaea halophila	
Callistemon phoeniceus	lesser bottlebrush
Calothamnus quadrifidus	one-sided bottlebrush
Calothamnus quadrifidus subsp. *asper*	one-sided bottlebrush
Comesperma integerrimum	
Conostylis setigera	
Dampiera lavandulacea	
Darwinia sp. Karonie	
Daviesia nematophylla	
Daviesia triflora	
Dodonaea bursariifolia	
Dodonaea inaequifolia	
Dodonaea pinifolia	
Dodonaea viscosa	sticky hopbush
Eremophila decipiens	slender fuchsia
Eremophila ionantha	violet-flowered eremophila
Eremophila oppositifolia	weeooka
Eremophila scoparia	broom bush
Exocarpos aphyllus	leafless ballart
Gastrolobium microcarpum	sandplain poison
Gastrolobium parviflorum	
Gastrolobium spinosum	prickly poison
Gastrolobium tricuspidatum	
Gastrolobium trilobum	bullock poison
Grevillea acuaria	
Grevillea huegelii	
Grevillea tenuiflora	tassel grevillea
Hakea laurina	pincushion hakea
Hakea lissocarpha	honey bush
Hakea multilineata	grass-leaf hakea
Hakea petiolaris	sea urchin hakea
Hakea preissii	needle tree
Hakea varia	variable-leaved hakea
Hibbertia commutata	
Hibbertia exasperata	
Hibbertia hypericoides	yellow buttercups
Hovea chorizemifolia	holly-leaved hovea

Hypocalymma angustifolium	white myrtle
Leptomeria preissiana	
Leptospermum erubescens	roadside teatree
Lycium australe	
Australian boxthorn	
Melaleuca acuminata	
Melaleuca adnata	
Melaleuca atroviridis	
Melaleuca brophyi	
Melaleuca cucullata	
Melaleuca cuticularis	saltwater paperbark
Melaleuca halmaturorum	
Melaleuca hamata	
Melaleuca hamulosa	
Melaleuca lanceolata	
Rottnest teatree	
Melaleuca lateriflora	gorada
Melaleuca marginata	
Melaleuca pauperiflora	boree
Melaleuca radula	graceful honeymyrtle
Melaleuca rhaphiophylla	swamp paperbark
Melaleuca scalena	
Melaleuca strobophylla	
Melaleuca teuthidoides	
Melaleuca thyoides	
Melaleuca uncinata group	broom bush
Melaleuca viminea	mohan
Olearia muelleri	
Goldfields daisy	
Olearia sp. Kennedy Range	
Petrophile divaricata	
Petrophile shuttleworthiana	
Petrophile squamata	
Petrophile striata	
Phebalium filifolium	slender phebalium
Phebalium lepidotum	
Phebalium microphyllum	
Phebalium tuberculosum	
Pimelea argentea	silvery-leaved pimelea
Pittosporum angustifolium	
Platysace maxwellii	karno
Rhadinothamnus rudis	
Santalum acuminata	quandong
Santalum spicatum	sandalwood
Scaevola spinescens	currant bush
Senna artemisioides	
Styphelia tenuiflora	common pinheath
Templetonia sulcata	centipede bush
Trymalium elachophyllum	
Trymalium ledifolium	
Westringia cephalantha	

Xanthorrhoea drummondii	
Chenopods	
Atriplex acutibractea	toothed saltbush
Atriplex paludosa	marsh saltbush
Atriplex semibaccata	berry saltbush
Atriplex stipitata	mallee saltbush
Atriplex vesicaria	bladder saltbush
Enchylaena lanata / tomentosa complex	barrier saltbush
Maireana brevifolia	small-leaf bluebush
Maireana erioclada	
Maireana marginata	
Maireana trichoptera	downy bluebush
Rhagodia drummondii	
Rhagodia preissii	
Sclerolaena diacantha	grey copperburr
Tecticornia spp.	samphire
Threlkeldia diffusa	coast bonefruit
Forbs	
Actinobole uliginosum	flannel cudweed
Asteridea athrixioides	
Blennospora drummondii	
Borya nitida	pincushions
Borya sphaerocephala	pincushions
Brachyscome ciliaris	
Brachyscome lineariloba	
Caesia micrantha	pale fringe-lily
Caladenia flava	cowslip orchid
Calandrinia calyptrata	pink purslane
Calandrinia eremaea	twining purslane
Calotis hispidula	bindy eye
Carpobrotus modestus	inland pigface
Centipeda crateriformis subsp. *crateriformis*	
Chamaescilla corymbosa	blue squill
Chamaexeros serra	little fringe-leaf
Cotula coronopifolia	waterbuttons
Crassula colorata	dense stonecrop
Crassula exserta	
Dampiera juncea	rush-like dampiera
Dampiera lindleyi	
Daucus glochidiatus	Australian carrot
Dianella brevicaulis	
Dichopogon capillipes	
Disphyma crassifolium	round-leaved pigface
Drosera macrantha	bridal rainbow
Erodium cygnorum	blue heronsbill
Gilberta tenuifolia	
Gnephosis drummondii	
Gnephosis tenuissima	
Gnephosis tridens	
Gonocarpus nodulosus	
Goodenia berardiana	

Helichrysum leucopsideum	
Helichrysum luteoalbum	Jersey cudweed
Lagenophora huegelii	
Lawrencella rosea	
Lepidium rotundum	veined peppercress
Podolepis capillaris	wiry podolepis
Podolepis lessonii	
Podotheca angustifolia	sticky longheads
Poranthera microphylla	small poranthera
Pterostylis sanguinea	
Ptilotus spathulatus	
Rhodanthe laevis	
Senecio glossanthus	slender groundsel
Spergularia marina	
Stylidium calcaratum	book triggerplant
Thysanotus patersonii	
Trachymene cyanopetala	
Trachymene ornata	spongefruit
Trachymene pilosa	native parsnip
Velleia cycnopotamica	
Waitzia acuminata	orange immortelle
Zygophyllum ovatum	dwarf twinleaf
Graminoids	
Amphipogon caricinus - strictus complex	greybeard grass
Austrostipa elegantissima	
Austrostipa hemipogon	
Austrostipa nitida	
Austrostipa trichophylla	
Centrolepis polygyna	wiry centrolepis
Desmocladus asper	
Desmocladus flexuosus	
Gahnia ancistrophylla	hook-leaf saw sedge
Gahnia australis	
Harperia lateriflora	
Juncus bufonius	toad rush
Lachnagrostis filiformis	blowngrass
Lepidosperma leptostachyum	
Lepidosperma resinosum	
Lepidosperma sp. aff. tenue	
Lepidosperma tenue	
Lepidosperma viscidum	sticky sword sedge
Lomandra effusa	scented matrush
Lomandra micrantha subsp. *micrantha*	small-flower matrush
Lomandra nutans	
Meeboldina coangustata	
Mesomelaena preissii	
Neurachne alopecuroides	foxtail mulga grass
Rytidosperma caespitosum	
Rytidosperma setaceum group	
Schoenus nanus	tiny bog-rush
Schoenus sculptus	gimlet bog-rush

Schoenus subfascicularis	

Diagnostic 5 Vegetation condition

Minimum condition for patches of the WA Wheatbelt Woodlands ecological community. For each category, both the weed cover and mature tree presence criteria must apply plus one of either patch size or patch width, depending on whether the patch is a roadside remnant or not.

Category A:

Patch corresponds to a condition of pristine / excellent / very good (Keighery, 1994) or a high RCV (RCC, 2014).

Exotic plant species account for 0 to 30% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees (diameter at breast height (dbh) of 30 cm or above) may be present or absent.

Patch size (non-roadside) 2 ha or more with no gap in native vegetation cover exceeding 50 m width.

……**TEC**

Patch width roadside only (based on the native understorey component not width of the tree canopy) 5 m or more.

……**TEC**

Patch corresponds to a condition of pristine / excellent / very good (Keighery, 1994) or a high RCV (RCC, 2014).

Exotic plant species account for 0 to 30% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees (diameter at breast height (dbh) of 30 cm or above) may be present or absent.

Patch size (non-roadside) less than 2 ha.

……**NOT** TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) less than 5 m.

……**NOT** TEC

Category B:

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014).

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Patch size (non-roadside) 2 ha or more with no gap in native vegetation cover exceeding 50 m width.

……**TEC**

Patch width roadside only (based on the native understorey component not width of the tree canopy) 5 m or more.

……**TEC**

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014), **AND** retains important habitat features.

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Patch size (non-roadside) less than 2 ha.

…… ……**NOT** TEC

Patch width roadside only (based on the native understorey component not width of the tree canopy) less than 5 m.

…… ……**NOT** TEC

Category C:

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014), **AND** retains important habitat features.

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Less than 5 mature trees per 0.5 ha are present.

Minimum patch size (non-roadside) 5 ha or more.

……**TEC**

Patch size (non- roadside) less than 5 ha

…… ……**NOT** TEC

Category D:

Patch corresponds to a condition of degraded to good (Keighery, 1994) or a medium-Low to medium-high RCV (RCC, 2014).

Exotic plant species account for more than 50 to 70% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Minimum patch size (non-roadside) 5 ha or more.

……**TEC**

Patch width roadside only (based on the native understorey component not width of the tree canopy) 5 m or more

……**TEC**

Patch corresponds to a condition of degraded to good (Keighery, 1994) or a medium-low to medium-high RCV (RCC, 2014).

Exotic plant species account for more than 50 to 70% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Less than 5 mature trees per 0.5 ha are present.

…… ……NOT **TEC**

Appendix 7 Fauna species identified in the desktop review

Scientific name	Common name	Conservation status			Source			
		EPBC Act	WC Act	DBCA	Birdata	NatureMap	EPBC Pr otected Matters	DBCA Threatened Fauna
Invertebrates								
Idiosoma nigrum	Shield-back Trapdoor Spider	VU	EN			●	●	●
Throscodectes xederoides	Mogumber Bush Cricket			P3		●		●
Amphibians								
Heleioporus eyrei	Moaning Frog					●		
Neobatrachus pelobatoides	Humming Frog					●		
Reptiles								
Crenadactylus ocellatus. ocellatus	Clawless Gecko					●		
Ctenophorus reticulatus	Western Netted Dragon					●		
Diplodactylus granariensis granariensis						●		
Delma fraseri	Fraser's Delma					●		
Delma grayii	Side-barred Delma					●		
Ctenotus fallens						●		
Ctenotus pantherinus pantherinus	Leopard Ctenotus					●		
Ctenotus schomburgkii	Barred Widesnout Ctenotus					●		
Eremiascincus richardsonii	Broad-banded Sand Swimmer					●		
Gehyra variegata						●		
Lerista distinguenda	South-western Orange-tailed Slider					●		
Morethia obscura	Planin Red-throated Skink					●		
Tiliqua rugosa rugosa	Shingleback Skink					●		
Brachyurophis semifasciatus	Southern Shovel-nosed Snake					●		
Pseudechis australis	Mulga Snake					●		
Pseudonaja mengdeni	Western Brown Snake					●		
Birds								
Dromaius novaehollandiae	Emu				●	●		
Leipoa ocellata	Malleefowl	VU	VU					●
Coturnix pectoralis	Stubble Quail				●			
Biziura lobata	Musk Duck				●	●		
Cygnus atratus	Black Swan				●	●		
Stictonetta naevosa	Freckled Duck					●		
Tadorna tadornoides	Australian Shelduck				●	●		
Chenonetta jubata	Australian Wood Duck				●	●		
Malacorhynchus membranaceus	Pink-eared Duck				●	●		
Anas rhynchotis	Australasian Shoveler				●	●		
Anas gracilis	Grey Teal				●	●		

Scientific name	Common name	Conservation status			Source			
		EPBC Act	WC Act	DBCA	Birdata	NatureMap	EPBC Pr otected Matters	DBCA Threatened Fauna
Anas castanea	Chestnut Teal				●	●		
Anas superciliosa	Pacific Black Duck				●	●		
Aythya australis	Hardhead					●		
Oxyura australis	Blue-billed Duck			P4		●		
Tachybaptus novaehollandiae	Australasian Grebe				●	●		
Podiceps cristatus	Great Crested Grebe					●		
Poliocephalus poliocephalus	Hoary-headed Grebe				●	●		
Columba livia	Rock Pigeon						●	
Streptopelia senegalensis	Laughing Dove				●	●	●	
Streptopelia chinensis	Spotted Dove						●	
Phaps chalcoptera	Common Bronzewing				●	●		
Ocyphaps lophotes	Crested Pigeon				●	●		
Aegotheles cristatus	Australian Owlet-nightjar				●	●		
Apus pacificus	Fork-tailed Swift	Mig	Mig				●	
Pelecanus conspicillatus	Australian Pelican					●		
Anhinga novaehollandiae	Australasian Darter				●	●		
Microcarbo melanoleucos	Little Pied Cormorant				●	●		
Phalacrocorax carbo	Great Cormorant					●		
Phalacrocorax sulcirostris	Little Black Cormorant				●	●		
Ardea pacifica	White-necked Heron				●	●		
Ardea modesta	Eastern Great Egret				●	●	●	
Ardea ibis	Cattle Egret						●	
Egretta novaehollandiae	White-faced Heron				●	●		
Nycticorax caledonicus	Nankeen Night-heron				●	●		
Threskiornis molucca	Australian White Ibis				●			
Threskiornis spinicollis	Straw-necked Ibis				●	●		
Platalea flavipes	Yellow-billed Spoonbill				●	●		
Platalea regia	Royal Spoonbill					●		
Elanus axillaris	Black-shouldered Kite				●			
Haliaeetus leucogaster	White-bellied Sea-eagle						●	
Haliastur sphenurus	Whistling Kite				●	●		
Accipiter fasciatus	Brown Goshawk				●	●		
Circus assimilis	Spotted Harrier				●	●		
Circus approximans	Swamp Harrier					●		
Aquila audax	Wedge-tailed Eagle				●	●		
Falco cenchroides	Nankeen Kestrel				●	●		

Scientific name	Common name	Conservation status			Source			
		EPBC Act	WC Act	DBCA	Birdata	NatureMap	EPBC Protected Matters	DBCA Threatened Fauna
Falco berigora	Brown Falcon				●	●		
Falco longipennis	Australian Hobby				●	●		
Falco peregrinus	Peregrine Falcon		OS			●		●
Fulica atra	Eurasian Coot				●	●		
Gallinula tenebrosa tenebrosa	Dusky Moorhen					●		
Porphyrio porphyrio	Purple Swamphen					●		
Porzana fluminea	Australian Spotted Crake					●		
Porzana pusilla palustris	Baillon's Crake					●		
Porzana tabuensis	Spotless Crake					●		
Ardeotis australis	Australian Bustard							
Burhinus grallarius	Bush Stone-curlew							
Himantopus himantopus	Black-winged Stilt				●	●		
Recurvirostra novaehollandiae	Red-necked Avocet					●		
Cladorhynchus leucocephalus	Banded Stilt					●		
Charadrius ruficapillus	Red-capped Plover					●		
Elseyornis melanops	Black-fronted Dotterel				●	●		
Thinornis rubricollis	Hooded Plover			P4		●		
Vanellus tricolor	Banded Lapwing				●			
Rostratula australis	Australian Painted Snipe	EN	EN				●	
Actitis hypoleucos	Common Sandpiper	Mig	Mig		●	●		
Numenius madagascariensis	Eastern Curlew	CR & Mig	VU & Mig				●	
Calidris acuminata	Sharp-tailed Sandpiper	Mig	Mig			●	●	
Calidris ruficollis	Red-necked stint		Mig			●		
Calidris ferruginea	Curlew Sandpiper	CR & Mig	VU & Mig			●	●	
Calidris melanotos	Pectoral Sandpiper	Mig	Mig				●	
Tringa glareola	Wood Sandpiper		Mig					
Tringa nebularia	Common Greenshank	Mig	Mig					
Limosa limosa	Black-tailed Godwit	Mig	Mig					
Gelochelidon nilotica	Gull-billed Tern	Mig	Mig			●		
Sterna hybrida	Whiskered Tern					●		
Chroicocephalus novaehollandiae	Silver Gull					●		
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	VU			●		
Calyptorhynchus banksii samueli	Red-tailed Black Cockatoo				●			
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	EN		●	●	●	●
Calyptorhynchus baudinii	Baudin's Cockatoo	EN	EN			●		●

Scientific name	Common name	Conservation status			Source			
		EPBC Act	WC Act	DBCA	Birdata	NatureMap	EPBC Pr otected Matters	DBCA Threatened Fauna
Eolophus roseicapillus	Galah				●	●		
Platycercus icterotis	Western Rosella					●		
Cacatua leadbeateri	Major Mitchells Cockatoo					●		
Cacatua pastinator derbyi	Western Corella				●	●		
Cacatua pastinator butleri	Butler's Corella					●		
Cacatua sanguinea	Little Corella				●	●		
Cacatua tenuirostris	Western Long-billed Corella					●		
Barnardius zonarius	Australian Ringneck				●	●		
Purpureicephalus spurius	Red-capped Parrot				●	●		
Neophema elegans	Elegant Parrot				●	●		
Chalcites basalis	Horsfield's Bronze-cuckoo				●			
Chalcites lucidus	Shining Bronze-cuckoo				●			
Cacomantis pallidus	Pallid Cuckoo				●	●		
Cacomantis flabelliformis	Fan-tailed Cuckoo				●	●		
Ninox novaeseelandiae	Southern Boobook				●			
Tyto javanica	Eastern Barn Owl				●			
Dacelo novaeguineae	Laughing Kookaburra				●	●		
Todiramphus sanctus	Sacred Kingfisher				●	●		
Merops ornatus	Rainbow Bee-eater				●	●	●	
Climacteris rufa	Rufous Treecreeper				●			
Malurus splendens	Splendid Fairy-wren				●	●		
Malurus leucopterus	White-winged Fairy-wren				●	●		
Malurus lamberti	Variegated Fairy-wren					●		
Malurus elegans	Red-winged Fairy-wren				●	●		
Sericornis frontalis	White-browed Scrubwren				●	●		
Smicrornis brevirostris	Weebill				●	●		
Gerygone fusca	Western Gerygone				●	●		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				●	●		
Acanthiza uropygialis	Chestnut-rumped Thornbill				●	●		
Acanthiza inornata	Western Thornbill				●	●		
Acanthiza apicalis	Inland Thornbill				●	●		
Pardalotus punctatus	Spotted Pardalote				●	●		
Pardalotus striatus	Striated Pardalote				●	●		
Acanthorhynchus superciliosus	Western Spinebill				●	●		
Lichenostomus virescens	Singing Honeyeater				●			
Lichenostomus leucotis	White-eared Honeyeater				●	●		

Scientific name	Common name	Conservation status			Source			
		EPBC Act	WC Act	DBCA	Birdata	NatureMap	EPBC Pr otected Matters	DBCA Threatened Fauna
Lichenostomus ornatus	Yellow-plumed Honeyeater				●			
Purnella albifrons	White-fronted Honeyeater				●	●		
Manorina flavigula	Yellow-throated Miner				●	●		
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				●	●		
Anthochaera lunulata	Western Wattlebird				●	●		
Anthochaera carunculata	Red Wattlebird				●	●		
Epthianura albifrons	White-fronted Chat				●	●		
Glyciphila melanops	Tawny-crowned Honeyeater				●			
Lichmera indistincta	Brown Honeyeater				●	●		
Phylidonyris novaehollandiae	New Holland Honeyeater				●	●		
Phylidonyris niger	White-cheeked Honeyeater				●	●		
Melithreptus brevirostris	Brown-headed Honeyeater				●	●		
Melithreptus lunatus	White-naped Honeyeater				●			
Pomatostomus superciliosus	White-browed Babbler				●			
Daphoenositta chrysoptera	Varied Sittella				●			
Coracina novaehollandiae	Black-faced Cuckoo-shrike				●	●		
Lalage sueurii	White-winged Triller				●			
Pachycephala pectoralis	Golden Whistler				●			
Pachycephala rufiventris	Rufous Whistler				●	●		
Colluricincla harmonica	Grey Shrike-thrush				●	●		
Artamus cinereus	Black-faced Woodswallow				●	●		
Artamus cyanopterus	Dusky Woodswallow				●	●		
Cheramoeca leucosterna	White-backed Swallow					●		
Cracticus torquatus	Grey Butcherbird				●	●		
Cracticus nigrogularis	Pied Butcherbird				●	●		
Cracticus tibicen	Australian Magpie				●	●		
Strepera versicolor	Grey Currawong				●	●		
Rhipidura albiscapa	Grey Fantail				●	●		
Rhipidura leucophrys	Willie Wagtail				●	●		
Corvus coronoides	Australian Raven				●	●		
Corvus bennetti	Little Crow				●	●		
Corvus orru	Torresian Crow				●			
Grallina cyanoleuca	Magpie-lark				●	●		
Microeca fascinans	Jacky Winter				●	●		
Petroica boodang (multicolor campbelli)	Scarlet Robin				●	●		
Petroica goodenovii	Red-capped Robin				●	●		

Scientific name	Common name	Conservation status			Source			
		EPBC Act	WC Act	DBCA	Birdata	NatureMap	EPBC Protected Matters	DBCA Threatened Fauna
Eopsaltria griseogularis	Western Yellow Robin				●			
Myiagra inquieta	Restless Flycatcher					●		
Cincloramphus mathewsi	Rufous Songlark				●			
Zosterops lateralis	Silvereye				●	●		
Megalurus gramineu	Little Grassbird					●		
Hylacola cauta whitlocki	Shy Groundwen					●		
Hirundo neoxena	Welcome Swallow				●	●		
Petrochelidon ariel	Fairy Martin				●	●		
Petrochelidon nigricans	Tree Martin				●	●		
Sturnus vulgaris	Common Starling						●	
Dicaeum hirundinaceum	Mistletoebird				●	●		
Taeniopygia guttata	Zebra Finch							
Anthus novaeseelandiae	Australasian Pipit				●			
Motacilla cinerea	Grey Wagtail	Mig	Mig				●	
Mammals								
Tachyglossus aculeatus	Short-beaked Echidna							
Dasyurus geoffroii	Western Quoll	VU	VU			●	●	●
Isoodon fusciventer	Quenda			P4		●		
Parantechinus apicalis	Dibbler	EN	EN			●		●
Phascogale calura	Red-tailed Phascogale	EN	CD				●	
Sminthopsis crassicaudata	Fat-tailed Dunnart							
Sminthopsis dolichura	Little long-tailed Dunnart					●		
Macropus fuliginosus	Western Grey Kangaroo					●		
Chalinolobus gouldii	Gould's Wattled Bat					●		
Mus musculus	House Mouse						●	
Notomys longicaudatus	Long-tailed Hopping-mouse	EX	EX			●		
Notomys macrotis	Big-eared Hopping-mouse	EX	EX			●		
Notomys mitchellii	Mitchell's Hopping-mouse					●		
Rattus rattus	Black Rat						●	
Oryctolagus cuniculus	Rabbit						●	
Vulpes vulpes	Red Fox						●	
Felis catus	Cat						●	
Sus scrofa	Pig						●	

Appendix 8 Flora species inventory for the study area

Family	Taxon
Amaranthaceae	*Ptilotus drummondii*
Amaranthaceae	*Ptilotus manglesii*
Amaranthaceae	*Ptilotus polystachyus*
Apiaceae	*Daucus glochidiatus*
Apiaceae	*Platysace cirrosa*
Apiaceae	*Xanthosia candida*
Apiaceae	*Xanthosia ciliata*
Araliaceae	*Hydrocotyle* ?*callicarpa*
Araliaceae	*Trachymene cyanopetala*
Asparagaceae	*Arthropodium dyeri*
Asparagaceae	**Asparagus asparagoides* (WoNS)
Asparagaceae	*Chamaescilla corymbosa*
Asparagaceae	*Dichopogon capillipes*
Asparagaceae	*Laxmannia squarrosa*
Asparagaceae	*Lomandra* ?*preissii*
Asparagaceae	*Lomandra maritima*
Asparagaceae	*Lomandra micrantha* subsp. *micrantha*
Asparagaceae	*Lomandra rupestris*
Asparagaceae	*Lomandra* sp.
Asparagaceae	*Lomandra* sp. sterile
Asteraceae	*Angianthus preissianus*
Asteraceae	**Arctotheca calendula*
Asteraceae	**Cotula bipinnata*
Asteraceae	*Hyalosperma cotula*
Asteraceae	**Hypochaeris glabra*
Asteraceae	**Hypochaeris radicata*
Asteraceae	*Lagenophora huegelii*
Asteraceae	**Monoculus monstrosus*
Asteraceae	*Olearia rudis*
Asteraceae	*Podolepis aristata* subsp. *aristata*
Asteraceae	*Podolepis gracilis*
Asteraceae	*Podolepis lessonii*
Asteraceae	*Pterochaeta paniculata*
Asteraceae	*Rhodanthe citrina*
Asteraceae	*Siloxerus multiflorus*
Asteraceae	**Sonchus asper*
Asteraceae	**Sonchus oleraceus*
Asteraceae	**Ursinia anthemoides*
Asteraceae	**Ursinia anthemoides* subsp. *anthemoides*
Boraginaceae	*Heliotropium curassavicum*
Boryaceae	*Borya sphaerocephala*
Brassicaceae	**Raphanus raphanistrum*

Family	Taxon
Campanulaceae	*Wahlenbergia gracilenta*
Caryophyllaceae	**Petrorhagia dubia*
Casuarinaceae	*Allocasuarina* ?*campestris*
Casuarinaceae	*Allocasuarina campestris*
Casuarinaceae	*Allocasuarina huegeliana*
Casuarinaceae	*Allocasuarina humilis*
Casuarinaceae	*Casuarina obesa*
Celastraceae	*Stackhousia pubescens*
Celastraceae	*Tripterococcus brunonis*
Chenopodiaceae	*Atriplex semilunaris*
Chenopodiaceae	*Enchylaena lanata*
Chenopodiaceae	*Maireana marginata*
Chenopodiaceae	*Rhagodia* ?*drummondii*
Chenopodiaceae	*Salicornia quinqueflora* subsp. *quinqueflora*
Chenopodiaceae	*Tecticornia lepidosperma*
Chenopodiaceae	*Tecticornia* sp. sterile 1
Colchicaceae	*Burchardia congesta*
Cyperaceae	*Baumea rubiginosa*
Cyperaceae	*Ficinia nodosa*
Cyperaceae	*Lepidosperma calcicola*
Cyperaceae	*Lepidosperma costale*
Cyperaceae	*Lepidosperma leptostachyum*
Cyperaceae	*Lepidosperma pubisquameum*
Cyperaceae	*Lepidosperma* sp.
Cyperaceae	*Lepidosperma squamatum*
Cyperaceae	*Lepidosperma tenue*
Cyperaceae	*Mesomelaena preissii*
Cyperaceae	*Mesomelaena pseudostygia*
Cyperaceae	*Schoenus clandestinus*
Cyperaceae	*Tetraria octandra*
Dilleniaceae	*Hibbertia commutata*
Dilleniaceae	*Hibbertia hibbertioides* var. *hibbertioides*
Dilleniaceae	*Hibbertia hypericoides*
Dilleniaceae	*Hibbertia lasiopus*
Dilleniaceae	*Hibbertia miniata* (P4)
Dilleniaceae	*Hibbertia montana* (P4)
Dilleniaceae	*Hibbertia polystachya*
Dioscoreaceae	*Dioscorea hastifolia*
Droseraceae	*Drosera* ?*macrantha*
Droseraceae	*Drosera* sp.
Elaeocarpaceae	*Tetratheca confertifolia*
Ericaceae	*Astroloma compactum*
Ericaceae	*Astroloma serratifolium*

Family	Taxon
Ericaceae	*Leucopogon darlingensis* subsp. *rectus* (P2)
Ericaceae	*Leucopogon planifolius*
Euphorbiaceae	?*Beyeria lechenaultii* (sterile)
Euphorbiaceae	*Euphorbia drummondii*
Fabaceae	*Acacia acuminata*
Fabaceae	*Acacia anarthros* (P3)
Fabaceae	*Acacia applanata*
Fabaceae	*Acacia drummondii* subsp. *affinis* (P3)
Fabaceae	*Acacia huegelii*
Fabaceae	*Acacia lasiocarpa*
Fabaceae	*Acacia lasiocarpa* var. *lasiocarpa*
Fabaceae	*Acacia lasiocarpa* var. *sedifolia*
Fabaceae	*Acacia microbotrya*
Fabaceae	*Acacia pulchella*
Fabaceae	*Acacia pulchella* var. *goadbyi*
Fabaceae	*Acacia pulchella* var. *pulchella*
Fabaceae	*Acacia shuttleworthii*
Fabaceae	*Acacia* sp. seedling
Fabaceae	*Acacia tetragonophylla*
Fabaceae	*Acacia willdenowiana*
Fabaceae	*Bossiaea eriocarpa*
Fabaceae	*Bossiaea spinescens*
Fabaceae	*Daviesia angulata*
Fabaceae	*Daviesia debilior* subsp. *sinuans* (P3)
Fabaceae	*Daviesia decurrens*
Fabaceae	*Daviesia hakeoides*
Fabaceae	*Gastrolobium calycinum*
Fabaceae	*Gastrolobium capitatum*
Fabaceae	*Gastrolobium polystachyum*
Fabaceae	*Gastrolobium spathulatum*
Fabaceae	*Gastrolobium spinosum*
Fabaceae	*Gompholobium aristatum*
Fabaceae	*Gompholobium tomentosum*
Fabaceae	*Hovea pungens*
Fabaceae	*Kennedia coccinea*
Fabaceae	*Kennedia prostrata*
Fabaceae	**Lupinus cosentinii*
Fabaceae	*Trifolium* ?*hirtum*
Fabaceae	**Trifolium campestre*
Fabaceae	**Trifolium hirtum*
Gentianaceae	**Centaurium tenuiflorum*
Goodeniaceae	*Dampiera alata*
Goodeniaceae	*Dampiera lavandulacea*

Family	Taxon
Goodeniaceae	*Goodenia pulchella*
Goodeniaceae	*Goodenia* sp. sterile
Goodeniaceae	*Goodenia trichophylla*
Goodeniaceae	*Lechenaultia biloba*
Goodeniaceae	*Lechenaultia floribunda*
Goodeniaceae	*Verreauxia reinwardtii*
Haemodoraceae	*Anigozanthos humilis* subsp. *humilis*
Haemodoraceae	*Conostylis androstemma*
Haemodoraceae	*Conostylis candicans*
Haemodoraceae	*Conostylis setigera* subsp. *setigera*
Haloragaceae	*Glischrocaryon aureum*
Haloragaceae	*Gonocarpus cordiger*
Hemerocallidaceae	*Dianella revoluta*
Hemerocallidaceae	*Johnsonia pubescens*
Hemerocallidaceae	*Stypandra glauca*
Hemerocallidaceae	*Tricoryne elatior*
Hemerocallidaceae	*Tricoryne humilis*
Hypoxidaceae	*Pauridia glabella var. leptantha*
Iridaceae	**Freesia alba* x *leichtlinii*
Iridaceae	**Freesia* sp.
Iridaceae	*Freesia* sp. sterile
Iridaceae	**Gladiolus caryophyllaceus*
Iridaceae	*Gladiolus* sp. sterile
Iridaceae	*Orthrosanthus laxus* var. *gramineus*
Iridaceae	*Orthrosanthus laxus* var. *laxus*
Iridaceae	*Patersonia* ?*occidentalis* var. *occidentalis*
Iridaceae	*Patersonia* ?*occidentalis*
Iridaceae	*Patersonia occidentalis*
Iridaceae	*Patersonia rudis* subsp. *rudis*
Iridaceae	**Romulea rosea*
Iridaceae	**Romulea rosea* var. *australis*
Iridaceae	**Romulea rosea* var. *communis*
Juncaceae	**Juncus acutus* subsp. *acutus*
Lamiaceae	*Hemiandra pungens*
Lamiaceae	*Hemigenia incana*
Lauraceae	*Cassytha glabella* forma *casuarinae*
Lauraceae	*Cassytha pomiformis*
Lauraceae	*Cassytha racemosa* forma *racemosa*
Malvaceae	**Malva parviflora*
Malvaceae	*Seringia velutina*
Malvaceae	*Thomasia foliosa*
Malvaceae	*Thomasia grandiflora*
Myrtaceae	*Calothamnus pachystachyus* (P4)

Family	Taxon
Myrtaceae	*Calothamnus sanguineus*
Myrtaceae	*Corymbia calophylla*
Myrtaceae	*Ericomyrtus tenuior*
Myrtaceae	*Eucalyptus accedens*
Myrtaceae	*Eucalyptus camaldulensis*
Myrtaceae	*Eucalyptus loxophleba*
Myrtaceae	*Eucalyptus loxophleba* subsp. *loxophleba*
Myrtaceae	*Eucalyptus rudis*
Myrtaceae	*Eucalyptus wandoo*
Myrtaceae	*Eucalyptus wandoo* subsp. *wandoo*
Myrtaceae	*Hypocalymma angustifolium*
Myrtaceae	*Leptospermum erubescens*
Myrtaceae	*Melaleuca lateriflora*
Myrtaceae	*Melaleuca lateritia*
Myrtaceae	*Melaleuca marginata*
Myrtaceae	*Melaleuca parviceps*
Myrtaceae	*Melaleuca radula*
Myrtaceae	*Melaleuca rhaphiophylla*
Myrtaceae	*Melaleuca scalena*
Myrtaceae	*Melaleuca sclerophylla* (P3)
Myrtaceae	*Melaleuca trichophylla*
Myrtaceae	*Verticordia serrata* var. *ciliata*
Oleaceae	**Olea europaea* subsp. *europaea*
Orchidaceae	*Ericksonella saccharata*
Orchidaceae	*Eriochilus dilatatus* subsp. *multiflorus*
Oxalidaceae	**Oxalis pes-caprae*
Oxalidaceae	**Oxalis purpurea*
Phyllanthaceae	*Phyllanthus calycinus*
Phyllanthaceae	*Poranthera microphylla*
Poaceae	**Aira caryophyllea*
Poaceae	**Aira cupaniana*
Poaceae	*Amphipogon caricinus*
Poaceae	*Amphipogon turbinatus*
Poaceae	*Austrostipa campylachne*
Poaceae	*Austrostipa elegantissima*
Poaceae	*Austrostipa exilis*
Poaceae	*Austrostipa hemipogon*
Poaceae	*Austrostipa macalpinei*
Poaceae	*Austrostipa semibarbata*
Poaceae	*Austrostipa variabilis*
Poaceae	**Avena barbata*
Poaceae	**Avena sativa*
Poaceae	**Briza maxima*

Family	Taxon
Poaceae	**Briza minor*
Poaceae	*Bromus arenarius*
Poaceae	**Bromus diandrus*
Poaceae	**Bromus rubens*
Poaceae	*Chloris truncata*
Poaceae	**Cynodon dactylon*
Poaceae	*Dactyloctenium radulans*
Poaceae	**Ehrharta calycina*
Poaceae	**Ehrharta longiflora*
Poaceae	*Enteropogon ramosus*
Poaceae	**Eragrostis curvula*
Poaceae	**Hordeum glaucum*
Poaceae	**Hordeum leporinum*
Poaceae	**Hordeum marinum*
Poaceae	**Lolium perenne*
Poaceae	**Lolium perenne* x *rigidum*
Poaceae	**Lolium rigidum*
Poaceae	*Neurachne alopecuroidea*
Poaceae	**Parapholis incurva*
Poaceae	**Pentameris airoides*
Poaceae	**Pentameris airoides* subsp. *airoides*
Poaceae	Poaceae sp.
Poaceae	Poaceae sp. seedling
Poaceae	**Polypogon monspeliensis*
Poaceae	*Rytidosperma caespitosum*
Poaceae	**Triticum aestivum*
Polygalaceae	*Comesperma integerrimum*
Polygalaceae	*Comesperma volubile*
Primulaceae	**Lysimachia arvensis*
Proteaceae	*Adenanthos cygnorum*
Proteaceae	*Banksia armata*
Proteaceae	*Banksia armata* var. *armata*
Proteaceae	*Banksia bipinnatifida* subsp. *multifida*
Proteaceae	*Banksia fraseri* var. *fraseri*
Proteaceae	*Banksia kippistiana* var. *kippistiana*
Proteaceae	*Banksia nobilis* subsp. *nobilis*
Proteaceae	*Banksia serratuloides* subsp. *serratuloides* (VU, EPBC Act; WC Act)
Proteaceae	*Banksia sessilis*
Proteaceae	*Banksia sessilis* var. *sessilis*
Proteaceae	*Banksia sphaerocarpa* var. *sphaerocarpa*
Proteaceae	*Conospermum densiflorum* subsp. *unicephalatum* (EN, EPBC Act; WC Act)
Proteaceae	*Grevillea bipinnatifida* subsp. *bipinnatifida*

Family	Taxon
Proteaceae	*Grevillea drummondii* (P4)
Proteaceae	*Grevillea synapheae* subsp. *synapheae*
Proteaceae	*Hakea chromatropa* (P1)
Proteaceae	*Hakea erinacea*
Proteaceae	*Hakea incrassata*
Proteaceae	*Hakea lissocarpha*
Proteaceae	*Hakea prostrata*
Proteaceae	*Hakea stenocarpa*
Proteaceae	*Isopogon* sp.
Proteaceae	*Persoonia coriacea*
Proteaceae	*Persoonia sulcata* (P4)
Proteaceae	*Petrophile striata*
Proteaceae	*Synaphea grandis* (P4)
Proteaceae	*Synaphea rangiferops* (P2)
Proteaceae	*Synaphea* sp.
Proteaceae	*Synaphea* sp. GNH
Proteaceae	*Synaphea spinulosa* subsp. *major*
Pteridaceae	*Cheilanthes austrotenuifolia*
Restionaceae	*Desmocladus asper*
Restionaceae	*Desmocladus lateriticus*
Restionaceae	*Lepidobolus preissianus*
Restionaceae	*Loxocarya cinerea*
Rhamnaceae	*Spyridium globulosum*
Rhamnaceae	*Trymalium odoratissimum* subsp. *odoratissimum*
Rubiaceae	*Opercularia vaginata*
Rutaceae	*Boronia ovata*
Santalaceae	*Santalum acuminatum*
Sapindaceae	*Dodonaea divaricata*
Solanaceae	**Solanum nigrum*
Solanaceae	*Solanum* sp.
Stylidiaceae	*Levenhookia stipitata*
Stylidiaceae	*Stylidium caricifolium*
Stylidiaceae	*Stylidium leptophyllum*
Stylidiaceae	*Stylidium pubigerum*
Stylidiaceae	*Stylidium* sp. sterile
Stylidiaceae	*Stylidium zeicolor*
Typhaceae	*Typha orientalis*
Urticaceae	*Parietaria cardiostegia*
Xanthorrhoeaceae	*Xanthorrhoea preissii*

Appendix 9 Eucalypt woodlands of the Western Australian wheatbelt TEC – site assessment

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
CalTEC001	CAL17001	946	Medium woodland; Wandoo	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo*	Bare to sparse understorey	Chenopods:*Tecticornia* spp Graminoids: Grasses	TEC Patch type: non- roadside, > 5 ha. Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
CalTEC002	CAL17002	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC003	CAL17003	946	Medium woodland; Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo*				NOT TEC[1]
CalTEC004	CAL17004	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC005	CAL17005	950	Medium woodland; *Casuarina obesa*	No, Not TEC								NOT TEC
CalTEC006	CAL17006	946	Medium woodland, Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC007	CAL17007	352	Medium woodland; York Gum	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC008	CAL17008	946	Medium woodland; Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus wandoo*	Bare to sparse understorey	Graminoids: Grasses	TEC Patch type: non- roadside, < 5 ha. No, Not TEC	NOT TEC
CalTEC009	CAL17009	946	Medium woodland; Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (15% cover): *Eucalyptus wandoo*				NOT TEC[1]
CalTEC010	CAL17010	946	Medium woodland; Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	No, > 10% E*ucalyptus wandoo (3% cover)*	No, Not TEC				NOT TEC
CalTEC011	CAL17011	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC012	CAL17012	7	Medium woodland; York gum (*Eucalyptus loxophleba*) & wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Co-dominant species (10% cover) *Eucalyptus loxophleba* subsp. *loxophleba;* (10% cover) *Acacia acuminata*				NOT TEC
CalTEC013	CAL17013	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC014	CAL17014	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC015	CAL17015	946	Medium woodland; Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
CalTEC016	CAL17016	973	Low forest; paperbark (*Melaleuca rhaphiophylla*)	No, Not TEC								NOT TEC
CalTEC017	CAL17017	973	Low forest; paperbark (*Melaleuca rhaphiophylla*)	No, Not TEC								NOT TEC

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
CalTEC018	CAL17018	946	Medium woodland; Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, = 10%	Dominant species (10% cover): *Eucalyptus wandoo*				NOT TEC[1]
CalTEC019	CAL17019	946	Medium woodland; Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (20% cover): *Eucalyptus wandoo*				NOT TEC[1]
CalTEC020	CAL17020	4	Medium woodland; Marri and Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Dominant species (30% cover): *Corymbia calophylla*				NOT TEC[1]
CalTEC021	CAL17021A	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (10% cover): *Eucalyptus wandoo*. Associated canopy species (not co-dominant): *Corymbia calophylla* (5% cover)				NOT TEC[1]
CalTEC022	CAL17022	946	Medium woodland; Wandoo	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (40% cover): *Eucalyptus wandoo*	Bare to sparse understorey	Graminoids: Grasses	TEC Patch type: non- roadside, > 5 ha. Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
na	CALP20001	7	Medium woodland; York gum (*E. loxophleba*) & wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
na	CALP20002	36	Shrublands; thicket, *Acacia-Casuarina* alliance species	No, Not TEC								NOT TEC
na	CALP20004	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
na	GAP020	7	Medium woodland; York gum (*E. loxophleba*) & wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (47% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus wandoo* subsp. *wandoo*, *Eucalyptus rudis*	Bare to sparse understorey		No, Not TEC Patch type: non- roadside, < 5 ha Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. No, Not TEC less than 5 mature trees per 0.5 ha.	NOT TEC
na	GAP021	946	Medium woodland; Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (35% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC[1]
na	GAP022	946	Medium woodland; Wandoo	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC
TEC062	na	7	Medium woodland; York Gum (*Eucalyptus loxophleba*) and Wandoo	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (30% cover): *Eucalyptus loxophleba* subsp. *loxophleba*	Bare to sparse understorey	Graminoids: *Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
TEC063	na	7	Medium woodland; York Gum (*Eucalyptus loxophleba*) and Wandoo	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (30% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus rudis* subsp. *rudis*	Bare to sparse understorey	Graminoids: *Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
TEC065	na	352	Medium woodland; York Gum	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (25% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey		Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
TEC066	na	352	Medium woodland; York Gum	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (30% cover): *Eucalyptus accedens*, *Eucalyptus loxophleba* subsp. *loxophleba*	Bare to sparse understorey		Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
TEC068	na	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes		Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
TEC068A	na	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
TEC069	na	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Degraded		Yes, > 10%	Dominant species (45% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus rudis* subsp. *rudis*	Bare to sparse understorey	No, Not TEC: No native understorey		NOT TEC
TEC070	na	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC
TEC071	na	946	Medium woodland, Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (25% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC[1]
TEC072	na	946	Medium woodland, Wandoo	Yes	Degraded to Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Calothamnus quadrifidus, Enchylaena lanata / tomentosa complex; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC073	na	946	Medium woodland, Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Enchylaena lanata / tomentosa complex; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC074	na	946	Medium woodland, Wandoo	Yes		Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Calothamnus quadrifidus; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC076	na	946	Medium woodland; Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (25% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Calothamnus quadrifidus; Forbs: Podolepis lessonii; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category D. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC077	na	946	Medium woodland, Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (35% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Hibbertia hypericoides, Melaleuca radula; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC078	na	352	Medium woodland; York Gum	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (3% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Chenopods: *Enchylaena lanata / tomentosa complex; Graminoids: Austrostipa elegantissima, Lepidosperma tenue, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC079	na	352	Medium woodland; York Gum	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Graminoids: *Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC080	na	352	Medium woodland; York Gum	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Acacia microbotrya, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers.	NOT TEC
TEC081	na	352	Medium woodland; York Gum	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus loxophleba* subsp. *loxophleba*, *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
TEC082	na	352	Medium woodland; York Gum	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus loxophleba* subsp. *loxophleba*	Bare to sparse understorey	Graminoids: *Austrostipa elegantissima, Neurachne alopecuroides*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC083	na	352	Medium woodland; York Gum	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Hakea lissocarpha, Melaleuca radula; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers.	NOT TEC[1]
TEC084	na	4	Medium woodland; Marri and Wandoo	Yes		Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Dominant species *Corymbia calophylla*		Graminoids: *Austrostipa elegantissima*		NOT TEC
TEC085	na	946	Medium woodland, Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	No, Not TEC					NOT TEC
TEC086	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (25% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Calothamnus quadrifidus; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC087	na	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Excellent	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (40% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Acacia pulchella, Allocasuarina humilis, Bossiaea eriocarpa, Calothamnus quadrifidus; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC[1]
TEC088	na	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (28% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Acacia pulchella, Allocasuarina humilis, Banksia sessilis, Bossiaea eriocarpa, Hakea lissocarpha; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC[1]
TEC089	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Dominant species *Corymbia calophylla*				NOT TEC
TEC090	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Dominant species *Corymbia calophylla*				NOT TEC
TEC091	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Dominant species *Corymbia calophylla*	Bare to sparse understorey	Shrubs: *Acacia pulchella, Allocasuarina humilis, Banksia sessilis, Bossiaea eriocarpa, Calothamnus quadrifidus subsp. asper, Conostylis setigera; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees may be present or absent.	NOT TEC
TEC092	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): Eucalyptus wandoo subsp. wandoo	Bare to sparse understorey	Shrubs: *Acacia pulchella, Allocasuarina humilis, Banksia sessilis, Bossiaea eriocarpa, Conostylis setigera, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees may be present or absent.	NOT TEC[1]
TEC094	na	999	Medium woodland; Marri	No, Not TEC								NOT TEC

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
TEC095	na	999	Medium woodland; Marri	No, Not TEC								NOT TEC
TEC096	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (25% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Bossiaea eriocarpa, Hakea varia, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC096a	na	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (25% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Bossiaea eriocarpa, Hakea varia, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC097	na	999	Medium woodland; Marri	No, Not TEC								NOT TEC
TEC098	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Allocasuarina humilis, Bossiaea eriocarpa, Calothamnus quadrifidus; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category B. Exotic plant species account for 30–50% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
TEC099	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	No, Not TEC					NOT TEC
TEC100	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	No, Not TEC					NOT TEC
TEC101	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	No, Not TEC					NOT TEC
TEC102	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (25% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Bossiaea eriocarpa, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Lepidosperma tenue, Neurachne alopecuroides*	Patch type: roadside, < 5 m. No, Not TEC	NOT TEC
TEC103	na	1132	Medium forest; Marri	No, Not TEC								NOT TEC
TEC104	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Co-dominant species (25% cover) *Eucalyptus wandoo* subsp. *wandoo*; (15% cover) *Corymbia calophylla*				NOT TEC
TEC105	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good		Yes, > 10%	No, Not TEC: Dominant species *Corymbia calophylla*		Graminoids: *Austrostipa elegantissima*		NOT TEC
TEC107	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC[1]
TEC108	na	946	Medium woodland, Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%					NOT TEC
TEC109	na	946	Medium woodland, Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC[1]

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
TEC110	na	946	Medium woodland, Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC[1]
TEC112	na	946	Medium woodland; Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%					NOT TEC
TEC113	na	946	Medium woodland, Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%					NOT TEC
TEC114	na	946	Medium woodland, Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Co-dominant species (20% cover) *Eucalyptus wandoo* subsp. *wandoo*; (10% cover) *Corymbia calophylla*	Bare to sparse understorey	Shrubs: *Allocasuarina humilis, Bossiaea eriocarpa; Graminoids: Austrostipa elegantissima*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees may be present or absent.	NOT TEC
TEC115	na	999	Medium woodland; Marri	No, Not TEC								NOT TEC
TEC116	na	999	Medium woodland; Marri	No, Not TEC								NOT TEC
TEC117	na	4	Medium woodland; Marri and Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%					NOT TEC
TEC119	na	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (20% cover): *Eucalyptus wandoo* subsp. *wandoo*				NOT TEC
TEC120	na	4	Medium woodland; Marri and Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Co-dominant species (20% cover) *Eucalyptus wandoo* subsp. *wandoo*; (10% cover) *Corymbia calophylla*				NOT TEC
na	NN3.1	7	Medium woodland; York Gum (*Eucalyptus loxophleba*) and Wandoo	Yes	Degraded	Location: AVW02					Patch type: roadside, ≥ 5 m. Category D. Vegetation condition is degraded. Mature trees may be present with at least 5 trees per 0.5 ha. Exotic plant species account for 50–70% of total vegetation cover in the understorey.	NOT TEC
TEC064	NN3.1a	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (20% cover): *Eucalyptus rudis* subsp. *rudis*	Bare to sparse understorey	Shrubs: *Melaleuca rhaphiophylla*	Patch type: roadside, ≥ 5 m. Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
na	NN3.2	7	Medium woodland; York gum (*E. loxophleba*) & wandoo	Yes	Degraded	Location: AVW02					Patch type: roadside, ≥ 5 m. Category D. Vegetation condition is degraded. Mature trees may be present with at least 5 trees per 0.5 ha Exotic plant species account for more than 50–70% (60%) of total vegetation cover in the understorey.	NOT TEC (degraded)
na	S3A21	352	Medium woodland; York Gum	Yes	Degraded	Location: AVW02	Yes, > 10%	Dominant species (39% cover): *Eucalyptus loxophleba* subsp. *loxophleba*; Other tree canopy species: none present	Bare to sparse understorey		Patch type: roadside, ≥ 5 m. Category D. Exotic plant species account for less than 1% of total vegetation cover in the understorey. Mature trees may be present with at least 5 trees per 0.5 ha.	NOT TEC (degraded)
TEC067	S3A22	1182	Medium woodland; *Eucalyptus rudis* and *Melaleuca rhaphiophylla*	Yes	Degraded		Yes, > 10%	Dominant species (15% cover): *Eucalyptus loxophleba* subsp. *loxophleba*	Bare to sparse understorey		No, Not TEC Patch type: Roadside, <5 m Category D. Exotic plant species account for 50–70% of total vegetation cover in the understorey layers. Mature trees are present with at least 5 trees per 0.5 ha.	NOT TEC
na	S3A23	946	Medium woodland, Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC						NOT TEC

TEC site	Quadrat #	Veg code	Vegetation association	Eucalypt woodland quadrat?	Vegetation condition	Diagnostic 1 - Location	Diagnostic 2 – Min. crown canopy	Diagnostic 3 - Dominant tree canopy	Diagnostic 4 - Understorey category	Diagnostic 4a - Understorey species	Diagnostic 5 - Vegetation condition	Outcome
na	S3A24	950	Medium woodland, *Casuarina obesa*	No, Not TEC								NOT TEC
na	S3A27	999	Medium woodland; Marri	No, Not TEC								NOT TEC
na	S3A28	1034	Medium woodland; marri, wandoo & powderbark	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Co-dominant species (18%) *Corymbia calophylla*; (16%) *Eucalyptus wandoo*				NOT TEC
na	S3A29	4	Medium woodland; Marri and Wandoo	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	No, Not TEC: Dominant species (20%) *Corymbia calophylla*				NOT TEC
TEC106	S3A30	4	Medium woodland; Marri and Wandoo	Yes	Good - Very Good		Yes, > 10%	No, Not TEC: Dominant species (30% cover) *Eucalyptus wandoo* subsp. *wandoo*; Co-dominant species (10% cover) *Corymbia calophylla*				NOT TEC
TEC111	S3A32	946	Medium woodland; Wandoo	Yes	Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%					NOT TEC
TEC116b	S3A33	999	Medium woodland; Marri	No, Not TEC								NOT TEC
na	S3A45	1132	Medium forest; marri	No, Not TEC								NOT TEC
TEC075	S3A47	946	Medium woodland; Wandoo	Yes	Degraded	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus wandoo* subsp. *wandoo*	Bare to sparse understorey	Shrubs: *Allocasuarina humilis, Calothamnus quadrifidus, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides,*	Patch type: roadside, ≥ 5 m. Category D. Vegetation condition is degraded. Mature trees (≥30cm DBH)4 are present with at least 5 trees per 0.5 ha. Exotic plant species account for less than 1% of total vegetation cover in the understorey.	NOT TEC
TEC093	S3AB20001	1034	Medium woodland; Marri, Wandoo and Powderbark	Yes	Very Good	Location: JAF01, but north of Perth and on edge of Darling Scarp. No, not TEC	Yes, > 10%	Dominant species (30% cover): *Eucalyptus accedens*	Bare to sparse understorey	Shrubs: *Acacia pulchella, Allocasuarina humilis, Bossiaea eriocarpa, Hibbertia hypericoides; Graminoids: Austrostipa elegantissima, Neurachne alopecuroides*	Patch type: roadside, ≥ 5 m. Category A. Exotic plant species account for 0–30% of total vegetation cover in the understorey layers. Mature trees may be present or absent.	NOT TEC

[1] Patch dominated by *E. wandoo* that retains a mostly native understorey (Excellent, Very Good); however, doesn't meet location criteria.