



Main Roads Western Australia

Albany Ring Road Stage 2 and 3B

Native Vegetation Clearing Permit Supporting Document

July 2021

This report has been prepared by GHD for Main Roads Western Australia and may only be used and relied on by Main Roads Western Australia for the purpose agreed between GHD and the Main Roads Western Australia as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Main Roads Western Australia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Main Roads Western Australia and others who provided information to GHD (including Government authorities], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Abbreviations

ARR	Albany Ring Road
BC Act	<i>Biodiversity Conservation Act 2016</i>
BOM	Bureau of Meteorology
CAWS Act	<i>Country Areas Water Supply Act 1947</i>
CEMP	Construction Environmental Management Plan
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environmental Regulation
EP Act	<i>Environmental Protection Act 1986</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
NVCP	Native Vegetation Clearing Permit
PEC	Priority Ecological Community
RIWI Act	<i>Rights in Water and Irrigation Act 1914</i>
TEC	Threatened Ecological Community
WoNS	Weeds of National Significance

Defined terms

Term	Definitions
ARR stages	<ul style="list-style-type: none"> • Stage 1 of the ARR is the east to west connection of Menang Drive linking Chester Pass Road to Albany Highway. Construction of one carriageway of Stage 1 was completed in March 2007. • Stage 2 of the ARR is the southern link of the ring road and is located between the Lower Denmark Road Link and Frenchman Bay Road. Stage 2 works end west of Festing Street. • Stage 3 of the ARR is the western link of the ring road and is located between the intersection of Albany Highway and Lower Denmark Road. Stage 3 is separated into two sections for environmental approvals purposes: <ul style="list-style-type: none"> – Part a – from Albany Highway along Link Road to South Western Highway. – Part b – South Western Highway to Lower Denmark Road. • Stage 4 of the ARR is the duplication of Princess Royal Drive from Hanrahan Road to York Street including duplication of the existing Princess Royal Drive Bridge over rail east of Festing Street.
Main Roads	Main Roads Western Australia.
Proposal area	The Proposal area comprises a 96.65 ha development envelope for Stage 2 and 3b (only).
NVCP application area	The Native Vegetation Clearing Permit (NVCP) application area comprises 15.67 ha of native vegetation within the Proposal area.
Study area	The Study area includes a 10 km buffer of the Proposal area.

Table of contents

1.	Introduction.....	1
1.1	Proposal background	1
1.2	Purpose of this report.....	2
1.3	Supporting technical studies	2
1.4	Location and land ownership	2
2.	Description of clearing activities	4
3.	Existing environment.....	5
3.1	Climate	5
3.2	Land use	5
3.3	Geology and soils	5
3.4	Hydrology	7
3.5	Flora and vegetation	8
3.6	<i>Phytophthora</i> dieback	13
3.7	Fauna	14
3.8	Conservation areas	17
3.9	Regional ecological linkages	18
3.10	Environmentally Sensitive Areas	18
4.	Potential impacts	19
4.1	Impact avoidance through design.....	19
4.2	Potential impacts to vegetation and flora	19
4.3	Potential impacts to fauna and fauna habitat	20
4.4	Land degradation, water quality and flooding	20
5.	Environmental management framework	22
6.	Assessment against the 10 Clearing Principles.....	27
7.	Offsets	39
8.	References	40

Table index

Table 1	Soil descriptions occurring within the Proposal area (GoWA, 2020).....	6
Table 2	Extent of vegetation associations mapped within the Proposal area (GoWA, 2019).....	10
Table 3	Vegetation types present within the Proposal area	11
Table 4	Black Cockatoo habitat within native vegetation in the NVCP application area	16
Table 5	Assessment against the Ten Clearing Principles	28

Appendices

Appendix A – Figures

Appendix B – Summary of land parcels intercepted by the NVCP application area

Appendix C – Biological Survey, Albany Ring Road (Southern Ecology, 2020a)

Appendix D – *Prasophyllum paulinae*, Targeted Regional Flora Survey (Southern Ecology, 2020c)

Appendix E – Albany Ring Road Black Cockatoo Habitat Assessment (Biota, 2019b)

Appendix F – Albany Ring Road, Western Ringtail Possum Assessment (Biota, 2020)

Appendix G – Memorandum to Main Roads Western Australia, Defining Possum in the South Coast population (Southern Ecology, 2019)

Appendix H – Western Ringtail Possum Management Plan

Appendix I – *Phytophthora* Dieback Management Plan: Albany Ring Road (Southern Ecology, 2020b)

1. Introduction

1.1 Proposal background

Main Roads Western Australia (Main Roads) is proposing to construct the Albany Ring Road (ARR) to provide for the long-term transport needs of Albany. The ARR will be a dedicated freight route around the City of Albany, in the Great Southern Region of Western Australia (WA) enabling the effective movement of freight to and from the Port of Albany. The ARR will cater for the travel demands associated with growth in grain, woodchip and other agricultural industries, increased mining production, increased population growth, urban expansion and the expected increase in tourists.

The current alignment of the ARR has been endorsed by government and consists of four stages:

- Stage 1 of the ARR is the east to west connection of Menang Drive linking Chester Pass Road to Albany Highway. Construction of one carriageway of Stage 1 was completed in March 2007.
- Stage 2 of the ARR is the southern link of the ring road and is located between the Lower Denmark Road Link and Frenchman Bay Road. Stage 2 works end west of Festing Street.
- Stage 3 of the ARR is the western link of the ring road and is located between the intersection of Albany Highway and Lower Denmark Road. Stage 3 is separated into two sections for environmental approvals purposes:
 - Part a – from Albany Highway along Link Road to South Western Highway.
 - Part b – from South Western Highway along George Street to Lower Denmark Road.
- Stage 4 of the ARR is the duplication of Princess Royal Drive from Hanrahan Road to York Street including duplication of the existing Princess Royal Drive Bridge over rail east of Festing Street.

Main Roads is proposing to commence construction of Stages 2 and 3b (the Proposal) in 2021.

Road construction and associated infrastructure for the Proposal includes the following components:

- Approximately 7 km of new dual carriage road
- Grade separated interchanges at South Coast Highway and Frenchman Bay Road
- Bridges and culverts
- Water retention basins and other drainage structures
- Landscaping and revegetation works
- Modifications to local roads
- Realignment to the Albany-Wagin railway line between George Street and the Hanrahan/Frenchman Bay Interchange
- Other road infrastructure including, but not limited to; lighting, noise barriers, fencing, road safety barriers, a fauna underpass and a rope bridge, and signs.

1.2 Purpose of this report

This document has been prepared in support of an application for a native vegetation clearing permit (NVCP) under Section 51E of Part V of the *Environmental Protection Act 1986* (EP Act) for the clearing required for the Proposal.

The Proposal will clear up to 15.67 hectares (ha) of native vegetation (“NVCP application area”) within a development envelope of 96.65 ha for ARR Stage 2 and 3b only. The remaining area within the Proposal area includes non-native revegetation and / or plantation vegetation and already cleared land (Figure 1, Appendix A).

This document includes:

- An overview of works required and description of clearing activities to be undertaken (Section 2)
- An overview of existing environment (Section 3)
- Potential impacts identified (Section 4)
- Environmental management measures to be implemented to minimise clearing impacts (Section 5)
- An assessment against the Ten Clearing Principles, as defined in Schedule 5 of the EP Act (Section 6).

1.3 Supporting technical studies

The environmental assessment for this NVCP was informed by a number of biological surveys undertaken within and in the vicinity of the Proposal area (Figure 2, Appendix A).

The biological surveys include the following:

- Biological Survey, Albany Ring Road (Southern Ecology, 2020a) (Appendix C)
- Prasophyllum paulinae, Targeted Regional Flora Survey (Southern Ecology, 2020c) (Appendix D)
- Albany Ring Road Black Cockatoo Habitat Assessment (Biota, 2019b) (Appendix E)
- Appendix F – Albany Ring Road, Western Ringtail Possum Assessment (Biota, 2020) (Appendix F)
- Memorandum to Main Roads Western Australia, Defining Possum in the South Coast population (Southern Ecology, 2019) (Appendix G)
- Albany Ring Road Stage 2 and 3b Western Ringtail Possum Management Plan (Main Roads, 2020) (Appendix H)
- Phytophthora Dieback Management Plan: Albany Ring Road (Southern Ecology, 2020b) (Appendix I)

1.4 Location and land ownership

The Proposal will connect the intersection of South Western Highway and Link Road, with Princess Royal Drive. Stage 2 of the ARR is the southern link of the ring road located between the Lower Denmark Road George Street Intersection and Frenchman Bay Road. The end of the proposed Stage 2 works occurs west of Festing Street. Stage 3b proposes to connect South Western Highway to Lower Denmark Road. This will comprise of a dual carriageway road that connects the intersection of the South Western Highway with ARR in the north and Hanrahan Road with ARR in the south.

The NVCP application area intersects over 100 land parcels which comprise varying tenure including: freehold; crown; unallocated crown land (UCL); reserve; easement; road and other (GoWA, 2020). A summary table of land parcel information is provided in Appendix B.

Land, within the proposed alignment, will be acquired by Main Roads and designated as a road reserve pursuant to Section 28 (1) of the *Land Administration Act 1997*, prior to commencement of construction works.

2. Description of clearing activities

Clearing or disturbance within the 96.65 ha Proposal area is comprised of the following:

- 15.67 ha (16.2%) native vegetation
- 44.95 ha (46.5%) pastoral and cleared land
- 36.03 ha (37.3%) of non-native vegetation (including revegetation and planted species)

This NVCP application assessment addresses proposed clearing of 15.67 ha of native vegetation only (NVCP application area). The following works are required to facilitate construction of the Proposal:

- Earthworks, embankments and pavement construction (cut and fill as required)
- Modification of the Albany to Wagin railway line
- Modification of local roads including severance, realignment or reconfiguration
- Site geotechnical investigations along alignment (if required)
- Installation of drainage infrastructure as required (swales, pits/ pipes)
- Installation of new street lighting
- Relocation of existing services where required
- Installation of pavement marking and signage.

Laydown areas for the placement of construction materials and site offices are expected to be located in already cleared areas within the Proposal area.

Clearing of vegetation will be undertaken using traditional earth moving machinery such as bulldozers. Topsoil will be striped separately and stockpiled for later reuse.

3. Existing environment

For the purposes of the desktop searches and existing environment a Study area was defined, which included a 10 km buffer of the Proposal area (Figure 3, Appendix A).

3.1 Climate

Albany experiences a Mediterranean climate with cool, wet winters and warm, dry summers. Rainfall is generally received in winter (June - August). The area also receives periodic summer rainfall as a result of thunderstorm activity or rain-bearing depressions from tropical cyclones.

The closest Bureau of Meteorology (BoM) weather station with sufficient historical data is Albany (site number 009500), located approximately 1.7 km east of the Proposal area, at its closest point. Climate data from this station indicates the mean maximum temperature ranges from 22.9 °C in February to 15.8 °C in July. The mean minimum temperature ranges from 15.6 °C in February to 8.2 °C in July. The mean annual rainfall is 925.1 mm, with approximately 103 rain days a year (BoM, 2020).

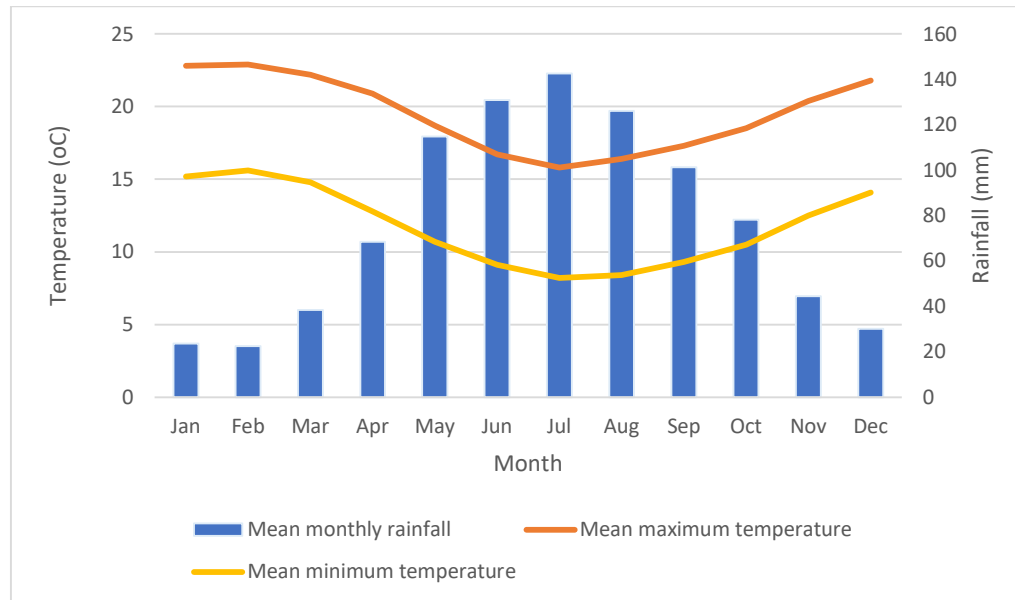


Plate 1 Albany Site Number 9500 Climate Data (1877-2020) (BoM, 2020)

3.2 Land use

Much of the land within the Proposal area is reserved for roads followed by other land uses including agriculture, rail, parks and recreation, light and general industry and rural small holdings (GoWA, 2020). The Western Australian Planning Commission (WAPC) included the inclusion of the proposed route into the town planning scheme in March 2001. The indicative boundary of the ARR is shown on the Albany Local Planning Strategy Urban Map 9B and discussed in the Local Planning Scheme No. 1 and the Local Planning Strategy (DPLH 2019).

3.3 Geology and soils

3.3.1 Regional geology

Regional geological mapping (1:250,000) indicates the NVCP application area is underlain by the following (Allen & Sofoulis, 1984):

- Czs – Sand – white, grey or brown; commonly contains iron pisoliths and overlies laterite

- *Qc – Colluvium – sand, silt, clay*
- *Qe – Estuarine and lagoonal deposits – clay, silt and sand*
- *Pgp – Porphyritic biotite granite and adamellite.*

3.3.2 Soils

Eight soils types have been mapped, by Department of Primary Industries and Regional Development (DPIRD), within NVCP application area (GoWA, 2020). The soil unit ID, name, description and known salinity and water erosion risks for these soil types are presented in Table 1.

Table 1 Soil descriptions occurring within the Proposal area (GoWA, 2020)

Soil unit ID	Name	Description	Salinity risk	Water erosion risk	Stage 2	Stage 3b
242TbOW	Owingup Subsystem	Plains with swamps, lunettes and dunes. Yellow solonetzic soils, organic loams and diatomaceous earth;	3 to 10 % of map unit has a moderate to high salinity risk or is presently saline.	3 to 10 % of map unit has a high to extreme water erosion risk.	✓	✓
242TbCOy	Collis yellow duplex Phase	Gravelly yellow duplex soils.	<3 % of map unit has a moderate to high salinity risk or is presently saline.	<3 % of map unit has a high to extreme water erosion risk.	✓	
242MmGAs	Gardner Sandy Phase	Leached sands and podzols		10 to 30 % of map unit has a high to extreme water erosion risk.	✓	
242MmGAg	Gardner granite Phase	Granite outcrop.		10 to 30 % of map unit has a high to extreme water erosion risk.	✓	
242KgDMs	Dempster slope Phase	Sands and gravels on smooth slopes.		<3 % of map unit has a high to extreme water erosion risk.		✓
242KgDMc	Dempster crest Phase	Sands and laterite on elongate crests.		<3 % of map unit has a high to extreme water erosion risk.		✓
242KgS7h	Minor Valleys S7 slope Phase	Broad valleys in sedimentary rocks; 30 m relief; smooth slopes. Deep sands and iron podzols on slopes.	<3 % of map unit has a moderate to high salinity risk or is presently saline.	3 to 10 % of map unit has a high to extreme water erosion risk.		✓
242TbMTy	Mattaband yellow duplex Phase	Gravelly yellow and yellow duplex soils; Jarrah-Marri-Yellow Tingle forest.	<3% of map unit has a moderate to high salinity risk or is presently saline	<3% of map unit has a high to extreme water erosion risk		✓

3.3.1 Topography

The surface elevation ranges from approximately 60 m Australian Height Datum (AHD) in the northern end to 12 m AHD at the southern end of Stage 3b (GoWA, 2020). There are a series of undulations on Link Road and George Street, with low points associated with wetland vegetation.

Stage 2 of the NVCP application area is generally low lying with elevation ranging from approximately 12 m AHD at the western end to 2 m AHD at the eastern end (GoWA, 2020). There are also several elevated areas in Stage 2, to a maximum of approximately 44 m AHD, associated with outcropping granite.

3.4 Hydrology

3.4.1 Groundwater

The NVCP application area along Lower Denmark Road (Stage 2) intercepts the northern extent of the Albany Groundwater Protection Area (GPA) protected under the *Rights in Water and Irrigation Act 1914* (RIWI Act). Lower Denmark Road forms the northern boundary of this GPA (GoWA, 2020).

The NVCP application area does not intercept any Public Drinking Water Source Areas (PDWSA), however the northern extent of the South Coast Water Reserve lies directly adjacent to along the southern side of Lower Denmark Road. This PDWSA is managed under the *Country Areas Water Supply Act 1947* (CAWS Act) (GoWA, 2020).

DWER groundwater salinity mapping indicates the whole of the Proposal area (including the NVCP application area) has low to moderate salinity, with a Total Dissolved Solids (TDS) of 500-1000 mg/L (GoWA, 2020).

Available mapping and databases indicate that there is no potential for Groundwater Dependent Ecosystems to occur within the NVCP application area (BoM, 2019).

3.4.2 Surface water

The NVCP application area is located within the Torbay Inlet catchment of the Denmark Basin and Princess Royal Harbour catchment of the Albany Basin in the South West Division. On a sub-catchment level, the NVCP area falls within the Seven Mile Creek and Robinson Drain Sub catchments (GoWA, 2020).

Stage 2, along Lower Denmark Road, is intercepted by a number of artificial channels. These channels flow north to south across Lower Denmark Road, connecting to Robinson Drain, and ultimately drain to Princess Royal Harbour (Southern Ecology, 2020a). Vegetation within the artificial channels is mapped as Planted Trees and Woody Weeds, within the exception of a small area which intercepts the NVCP application area and is comprised of the *Homalospermum firmum/ Callistemon glaucus* Peat Thicket vegetation type (Southern Ecology, 2020a).

Stage 3b crosses a tributary of Five Mile Creek approximately 500 m to the north of Lower Denmark Road (GHD, 2006). Vegetation present within this watercourse is mapped as Planted Trees and Woody Weeds and is not included in the NVCP application area (Southern Ecology, 2020a).

The NVCP application area does not intercept any RIWI Act Rivers.

3.4.3 Wetlands

The NVCP application area does not intercept any wetlands categorised as the following (GHD, 2020b; GoWA, 2020):

- Directory of Important Wetlands in Australia (DBCA-045)
- Redbook Recommended Conservation Reserves 1976-1991 (DBCA-029)
- South Coast Significant Wetlands (DBCA-018)
- Ramsar Sites (DBCA-010) and Water Information Reporting (DWER, 2019)

The closest Nationally Important Wetland is Oyster Harbour, which lies approximately 8 km to the east of the NVCP application area (GoWA, 2020).

The Gledhow Conservation Category Wetlands, as mapped in the South Coast Significant Wetlands dataset, are located 250 m to 500 m south south-west of the NVCP application area and west of Allerton Street. In addition Conservation Category wetland Seven Mile Creek, within the King River Suite, is located approximately 2-3 km west (Figure 4, Appendix A) (GoWA, 2020).

3.5 Flora and vegetation

3.5.1 Regional biogeography

The Proposal area is located within the Jarrah Forest Interim Biogeographic Regionalisation of Australia (IBRA) region and the Southern Jarrah Forest subregion (JAF02) (Commonwealth of Australia, 2012).

The Southern Jarrah Forrest sub-region is described as a duricrusted plateau of Yilgarn Craton characterised by Jarrah-Marri forest on laterite gravels and, in the eastern part, by Wandoo - Marri woodlands on clayey soils. Eluvial and alluvial deposits support *Agonis* shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands (Hearn, Williams, Comer, & Beecham, 2002).

3.5.2 Broad vegetation mapping and extents

Vegetation associations

Broad scale (1:250,000) pre-European vegetation mapping (Beard, 1979) indicates the Proposal area intersects two vegetation associations.

- Medium forest, jarrah-marri (Association 3)
- Low forest; jarrah, *Eucalyptus staeri* and *Allocasuarina fraseriana* (Association 978).

The pre-European mapping has been adapted and digitised by Shepherd *et al.* (2002). The extent of the vegetation associations have been determined by the state-wide vegetation remaining extent calculations maintained by the Department of Biodiversity, Conservation and Attractions (DBCA) (GoWA, 2019). As shown in Table 2, the current extents of all vegetation associations that intersect the Proposal area are above 30% of the pre-European extent at the State, IBRA bioregion, IBRA subregion and Local Government Authority (LGA) levels.

3.5.3 Vegetation types and condition

The Proposal area is predominantly cleared, with approximately 44.95 ha (46.5%) cleared, 15.67 ha (16.2%) of native vegetation and 36.03 ha (37.3%) of non-native vegetation (including revegetation and plantation).

Southern Ecology (2020a) described 11 vegetation types within the NVCP application area (15.67 ha), these included two granite, six upland and three wetland vegetation types (Table 3) (Figure 5, Appendix A). Vegetation units were aligned to those described as part of the Albany Regional Vegetation Survey (ARVS) (Sandiford & Barrett, 2010). The ARVS provides a local and regional overview of the native vegetation of the Albany region.

The condition of native vegetation within the NVCP application area ranges from Excellent to Completely Degraded (Figure 6, Appendix A) (Southern Ecology, 2020a). Historical clearing and aggressive weed species have influenced the structure and composition of the native vegetation and a high proportion of the vegetation present.

Table 2 Extent of vegetation associations mapped within the Proposal area (GoWA, 2019)

Pre-European Vegetation Associations	Scale	Pre-European extent (ha)	Current extent (ha)	% Remaining	% of Remaining in DBCA managed lands
3	State: WA	2,661,404.62	1,803,427.48	67.76	81.5
	IBRA bioregion: Jarrah Forest	2,390,591.54	1,604,101.56	67.10	81.00
	Sub-region: Southern Jarrah Forest	1,482,491.85	880,655.65	59.40	78.50
	LGA: City of Albany	50,509.32	16,024.66	31.73	38.24
978	State: WA	53,230.64	18,855.77	35.42	9.47
	IBRA bioregion: Jarrah Forest	53,016.57	18,751.03	35.37	9.48
	Sub-region: Southern Jarrah Forest	53,016.57	18,751.03	35.37	9.48
	LGA: City of Albany	52,154.39	18,719.90	35.89	9.67

Table 3 Vegetation types present within the Proposal area

Vegetation type	Extent within Proposal area					
	Excellent	Very Good	Good	Degraded	Completely Degraded	Total (ha)
<u>Native vegetation</u>						
<i>Evandra aristata</i> Sedgeland		0.64				0.64
<i>Hakea</i> spp Shrubland/Woodland Complex	0.75					0.75
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket		0.81			0.41	1.22
Jarrah, Marri, Sheoak Laterite Forest	0.16	0.32		0.33		0.81
Jarrah, Sheoak, <i>E. staeri</i> Sandy Woodland				0.47		0.47
Marri, Jarrah Forest, Peppermint Woodland		0.03	0.96	3.08	0.45	4.52
Mosaic <i>T. marginata</i> / <i>Gastrolobium bilobum</i> Granite Shrubland/Yate Woodland				0.28		0.28
Peppermint Low Forest					1.27	1.27
<i>Taxandria juniperina</i> Closed Forest		1.2		1.00	3.12	5.32
<i>Taxandria marginata</i> Granite Shrubland				0.29		0.29
<i>Eucalyptus occidentalis</i> Woodland					0.11	0.11
Total native vegetation clearing area	0.91 (5.8%)	3.00 (19.13%)	0.96 (6.12%)	5.45 (34.76%)	5.36 (34.18%)	15.68 ha

3.5.4 Significant ecological communities

The Southern Ecology (2020a) Biological Assessment did not identify any Threatened Ecological Communities (TECs) listed under the EPBC Act or BC Act, or Priority Ecological Communities (PECs) listed by the DBCA within the survey area (Appendix C).

The following two TECs and four PECs were identified as occurring in the vicinity of the Proposal area (Southern Ecology, 2020a):

- Subtropical and Temperate Coastal Saltmarsh TEC (Vulnerable) - occurs over 4 km from the Proposal area on the margin of Princess Royal Harbour and is confined to marine saline habitats
- Proteaceae Dominated Kwongan Shrubland TEC (Endangered) - The Proposal area falls outside (approximately 6 km) the South East Coastal Botanical Province; therefore, the Proteaceae Dominated Kwongan Shrubland TEC is not applicable
- Four PECs are known from nearby locations, *Banksia coccinea* Thicket (P1), Coastal *Melaleuca incana*, *Taxandria juniperina* (P1), *Banksia littoralis*, *Melaleuca incana* (P1) have distinctive dominant species that are absent from the Proposal area. *Astartea scoparia* Swamp Thicket (P1 PEC) may have previously occurred in the wetland areas on Lower Denmark Road, however this area is now obscured by a high level of disturbance and altered drainage.

3.5.5 Flora diversity

A NatureMap database search (DBCA, 2007-) identified 1,343 native flora taxa and 321 naturalised (introduced) taxa within 10 km of the Proposal area (the Study area). Southern Ecology (2020a) identified 337 flora taxa from 65 families, including 60 weeds within their survey area. The plant families most represented were Myrtaceae (40 taxa), Fabaceae (37 taxa), Cyperaceae (27 taxa) and Proteaceae (25 taxa).

The diversity of the Proposal area is significantly less than that of the surrounding area, with more than 83% of the Proposal area being cleared land, plantation or revegetation and woody weeds.

3.5.6 Significant flora

Southern Ecology (2020a) also completed a likelihood of occurrence assessment for significant plant species (taxa) identified in their desktop searches. This assessment identified 69 species, with 35 considered likely or possible to occur and were considered during the field assessments:

- Six Threatened flora listed under the EPBC Act and/ or BC Act: *Banksia goodii*, *Caladenia harringtoniae*, *Chordifex abortivus*, *Drakaea micrantha*, *Isopogon uncinatus* and *Verticordia fimbrilepis* subsp. *Australis*.
- Two Priority (P) 1 species: *Thomasia multiflora* and *Thomasia purpurea* x *solanacea*.
- Seven P2 species: *Conospermum quadripetalum*, *Isopogon buxifolius* var. *buxifolius*, *Leucopogon bracteolaris*, *Leucopogon cymbiformis*, *Schoenus* sp. Grassy (E. Gude & J. Harvey 250), *Thelymitra variegata* and *Stylidium falcatum*.
- Ten P3 species: *Acacia ataxiphylla* subsp. *ataxiphylla*, *Andersonia auriculata*, *Andersonia setifolia*, *Chorizema carinatum*, *Corybas abditus*, *Juncus meianthus*, *Leucopogon alternifolius*, *Leucopogon interruptus*, *Synaphea preissii* and *Verticordia endlicheriana* var. *angustifolia*.

- Ten P4 species: *Banksia seneciifolia*, *Banksia serra*, *Drosera fimbriata*, *Gahnia sclerioides*, *Gonocarpus pusillus*, *Gonocarpus simplex*, *Lysinema lasianthum*, *Microtis pulchella*, *Microtis quadrata* and *Spyridium spadiceum*.

The presence of five significant flora taxa were confirmed by Southern Ecology (2020a) during the field surveys:

- *Prasophyllum paulinae* (P1) – historical records exist from a private property within the survey area, with the precise location unknown. Targeted surveys of potential habitat were undertaken and no individuals were recorded, however it appears this species may require fire to emerge.
- *Synaphea incurva* (P3) – two populations, totalling eight individuals were recorded on road verges in the survey area.
- *Boronia crassipes* (P3) – associated with *Homalospermum firmum* and *Empodisma gracillimum* on peat and sand. Several large populations are known within the vicinity of Albany.
- *Andersonia* sp. *Jamesii* (J. Liddel 84) (P4) – one population of 22 individuals was recorded in the large City of Albany Reserve on George Street, one individual was recorded on Albany Highway.
- *Thysanotus isantherus* (P4) – two individuals were recorded on the western slopes of Mt Melville.

No Threatened or Priority flora species listed under Commonwealth or State legislation were recorded in the NVCP application area (Southern Ecology, 2020a). However, the following Priority flora were identified within 50 m of the NVCP application area (Figure 7, Appendix A):

- Two *Synaphea incurva* (P3) individuals, estimated to be less than 1 % of the known population
- 13 *Andersonia* sp. *Jamesii* (J. Liddel 84) (P4) individuals were recorded in the NVCP application area, estimated to be 1 % of the known population
- One *Thysanotus isantherus* (P4) individual was identified within 10 m of the NVCP application area at Mount Melville (Southern Ecology, 2020a).

3.5.7 Weeds

Southern Ecology (2020a) recorded 60 weed species within the survey area. Of which, five were listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* and Weeds of National Significance (WoNS) including:

- Blackberry (*Rubus species*)
- Bridal creeper (*Asparagus asparagoides*)
- Gorse (*Ulex europaeus*)
- Arum Lily (*Zantedeschia aethiopica*)
- Lantana (*Lantana camara*).

Blackberry and Gorse have been identified within 50 m of the southern end of the NVCP application area at Mount Melville (Southern Ecology, 2020a).

3.6 *Phytophthora dieback*

The Proposal area is in a dieback susceptible region, based on rainfall (within the 600 – 800 mm rainfall zone (CALM, 2003)), soils, drainage and vegetation.

Dieback surveys undertaken by Southern Ecology (2020b) identified the majority of the Proposal area as excluded or uninterpretable, typically due to existing road and agricultural disturbance, as well as lack of indicator species that could be impacted by the pathogen. The south west side of South Western Highway was mapped as infested, as was vegetation to the west of Roundhay Street and east side of Hanrahan Road intersection.

3.7 Fauna

3.7.1 Fauna diversity

The *NatureMap* database search identified 730 fauna species previously recorded within 10 km of the Proposal area (the Study area) (Southern Ecology, 2020a). This total comprised 262 birds, 37 reptiles, 52 mammals, 12 amphibians, and 148 invertebrates and 219 fish. Of the 730 fauna species previously recorded, 714 were native species and 16 were naturalised (introduced) species.

The *NatureMap* database search is provided in Appendix D of the Southern Ecology (2020a) Biological Survey report, which is included in Appendix E of this NVCP application assessment.

3.7.2 Fauna habitat

The fauna habitat assessment completed by Southern Ecology (2018) primarily focused on the identification of fauna habitat based on vegetation type. For the purposes of this assessment, it was assumed the fauna habitats broadly align with vegetation types.

However, subsequent targeted species investigations for Black Cockatoos and WRP habitat led to minor adjustments in the type, quality and amount of habitat estimated in the Proposal. Targeted fauna assessments also provided regional context to enable holistic assessment of the impacts by the Proposal in relation to the surrounding area by Biota (2019b; 2020) for Black Cockatoos (Appendix E) and Western Ringtail Possum (Appendix F). Southern Ecology (2019) conducted a study regarding the categorisation of the WRP habitat within the Albany area (Appendix G).

The desktop fauna survey work undertaken by Southern Ecology (2018) identified the following general findings on the five fauna habitats found within the Proposal area:

- The *Hakea spp.* Shrubland/Woodland Complex offers potential foraging habitat for Carnaby's Cockatoos and offers habitat for WRPs
- The Jarrah/ Marri/ Sheoak Laterite Forest offers potential foraging, breeding and roosting habitat for all three Black Cockatoo species, provides potential suitable habitat for WRP, Quenda and may provide potential habitat for the South-Western Brush-tailed Phascogale, Masked Owl and Fork-tailed Swift
- The *Homalospermum firmum*, *Callistemon glaucus* Peat Thicket offers potential foraging and roosting habitat for Carnaby's Cockatoos, WRPs, Quenda and may offer habitat for the Fork-tailed Swift
- Non-native planted vegetation offers potential roosting habitat for all three Black Cockatoo species, habitat for Quenda and the Fork-tailed Swift
- Non-native areas where invasive weeds comprise >75 % of the vegetation offer potential habitat for Quenda and may offer habitat for the Fork-tailed Swift.

3.7.3 Significant fauna

Searches of the EPBC Act Protected Matters database, DBCA NatureMap database and previous studies identified the presence or potential presence of significant fauna species within

10 km of the Proposal area. The desktop searches undertaken by Southern Ecology (2018) recorded (Appendix C):

- 22 species listed under the EPBC Act and/or the BC Act that could occur within the Proposal area
- 19 migratory bird species protected under international agreement
- Seven DBCA Priority listed species.

Field assessments confirmed that habitats within the Proposal area are currently being utilised by five significant fauna species recorded during desktop searches. These included:

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered (EN)).
- Baudin's Cockatoo (*Calyptorhynchus baudinii*) (EN).
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) (Vulnerable (VU)).
- Western Ringtail Possum (*Pseudocheirus occidentalis*) (Critically Endangered (CR)).
- Southern Brown Bandicoot, Quenda (*Isoodon obesulus* subsp. *fusciventer*) (P4).

In addition to the above species, seven significant fauna species listed under state legislation were considered to possibly occur in the Proposal area despite not being recorded during field investigations:

- South-western Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) (Conservation Dependent (CD))
- Masked Owl (*Tyto novaehollandiae* subsp. *novaehollandiae*) (P3)
- Short-nosed Snake (*Elapognathus minor*) (P2)
- Fork-tailed Swift (*Apus pacificus*) (International Agreement (IA))
- Woollybush bee (*Hylaeus globuliferus*) (P3)
- Water-rat, Rakali (*Hydromys chrysogaster*) (P4)
- Peregrine Falcon (*Falco peregrinus*) (Other specially protected fauna (OS)).

Black Cockatoos

The Proposal area falls within the known breeding range of all three Black Cockatoo species. The NVCP application area contains 13.28 ha of native vegetation that is suitable habitat for the Black Cockatoo (Figure 8, Appendix A) and comprises the following Black Cockatoo habitat:

- 5.54 ha of breeding and high-quality foraging habitat
- 1.22 ha of low-quality foraging habitat
- 12.06 ha of roosting habitat (5.54 ha overlaps with the breeding and high-quality foraging habitat)

A summary of Black Cockatoo habitat type, description and corresponding native vegetation type have been presented in Table 4.

Table 4 Black Cockatoo habitat within native vegetation in the NVCP application area

Habitat type	Habitat type description	Vegetation type	Area of vegetation type (ha)	Total area (ha)
Breeding and high quality foraging	Eucalypt woodland or forest	Jarrah, Marri, Sheoak Laterite Forest	0.48	5.54
		Jarrah/ Sheoak/ <i>E. staeri</i> Sandy Woodland	0.34	
		Marri/ Jarrah Forest/ Peppermint Woodland	4.44	
		Mosaic <i>T. marginata</i> / <i>Gastrolobium bilobum</i> Granite Shrubland/ Yate Woodland	0.28	
Low quality foraging	Degraded Eucalypt Woodlands with Allocasuarina, Hakea Shrubland and Homalospermum Wetlands	Hakea spp Shrubland/ Woodland Complex	0.75	1.22
		Jarrah/ Marri/ Sheoak Laterite Forest	0.33	
		Jarrah/ Sheoak/ <i>E. staeri</i> Sandy Woodland	0.14	
Roosting (includes the 5.54 ha of foraging roosting and breeding detailed above)	Eucalypt Woodland or Forrest, Tall Taxandria Forest and <i>Evandra arista</i> dominated sedgeland ¹	Jarrah, Marri, Sheoak Laterite Forest	0.48	12.06
		Jarrah/ Sheoak/ <i>E. staeri</i> Sandy Woodland	0.34	
		Marri/ Jarrah Forest/ Peppermint Woodland	4.44	
		Mosaic <i>T. marginata</i> / <i>Gastrolobium bilobum</i> Granite Shrubland/ Yate Woodland	0.28	
		<i>Taxandria juniperina</i> Closed Forest	4.67	
		<i>Evandra aristata</i> Sedgeland	0.64	
		<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket	1.21	

¹Southern Ecology (2020a) identified *Taxandria juniperina* woodlands as providing high quality roosting for black cockatoos and Sedgelands with patches of *Leptospermum laevigatum*, *Acacia longifolia* and occasional *Eucalyptus globulus* as providing low quality roosting for Black Cockatoos.

A total of 236 suitable DBH trees were identified within the Proposal area, of which 191 were native Black Cockatoo potential breeding trees. The remaining 45 DBH trees were *Eucalyptus gomphocephala* which are not native to the Albany region and likely planted. Of the 191 suitable native DBH trees within the Proposal Area, 24 have hollows. Of these, 14 trees have hollows unsuitable for Black Cockatoo use, with the remaining 10 trees containing 14 potentially suitable breeding hollows (Southern Ecology, 2020a).

There are no confirmed breeding sites within 10 km of the Proposal area (Southern Ecology, 2018).

Biota (2019b) has estimated that up to 8,756 ha of foraging habitat, based upon the ARVS data, is available within a 12 km radius. This radius was chosen as it represents the typical maximum distance that Black Cockatoos will fly from roosting locations to forage, under the hypothetical premise that cockatoos were roosting (Biota, 2019b).

No roosting sites were identified or observed during repeated visits to the Proposal during the Black Cockatoo habitat assessment (Biota, 2019b). Roosting sites for Carnaby's Cockatoo occur in Marri, Jarrah Forest, Peppermint Woodland outside of the Proposal area at Mount Melville (Southern Ecology, 2020a).

Western Ringtail Possum

An assessment of WRP habitat categories undertaken by Southern Ecology (2020a), identified approximately 19.18 ha of native and non-native vegetation currently being used by WRPs within the Proposal area.

Of which, 11.92 ha is native vegetation including 0.87 ha of Core habitat, 0.04 ha Core (Urban) habitat and 11.01 ha Supporting habitat. The WRP habitat categories include 10 of the 11 native vegetation types identified within the NVCP application area (Figure 9, Appendix A).

Other WRP habitat identified within the NVCP area includes:

- 1.81 ha of linkage habitat
- 0.56 ha of likely linkage habitat.

The clearing associated with this NVCP application relates to a road corridor, typically no more than 100 m wide that intersects areas of WRP habitat. In areas where WRP have been recorded in the NVCP application area, extensive areas of habitat are known to occur beyond the road reserve within the local area. Accordingly, it is considered that home ranges of individual WRPs will be affected to varying degrees, with most home ranges expected to only be partially cleared.

Based on Biota (2020) density estimate of 0.14 to 0.36 individuals/ha for Supporting habitat, and those used by City of Albany of 2.45 individuals/ha for Core habitat (Biota, 2019a), it is predicted that less than 6 WRPs would potentially have their home range reduced or impacted (to varying degrees) within the NVCP application area.

It is estimated there are more than 3,000 individual WRPs in the sub-population around Albany. The potential impact to the home ranges of up to 6 WRPs within the NVCP area represents 0.2 % of the population.

Southern Brown Bandicoot (Quenda)

The entire NVCP application area (15.67 ha) is considered to be potential habitat for Quenda (Southern Ecology, 2020a). The habitat utilised by this species are widespread and well represented in the local region.

South Western Brush-tailed Phascogale

The likelihood of occurrence assessment by Southern Ecology (2020a) indicates that habitat for South Western Brush-tailed Phascogale possibly occurs within NCVP area, within Marri and Jarrah woodland and forest vegetation types, however individuals were not identified during the field surveys. Targeted night trapping is typically required to verify presence of this species. South-western Brush-tailed Phascogale habitat includes Jarrah, Marri, Sheoak Laterite Forest and Marri, Jarrah Forest and Peppermint Woodland. A total of 5.8 ha of suitable habitat is present in the Proposal area.

3.8 Conservation areas

The NVCP application area, and wider Proposal area, does not intersect or occur within any DBCA managed areas (GoWA, 2020). The closest areas include (Figure 10, Appendix A):

- Reserve 23088 Unnamed Conservation Park located approximately 500 m north.
- 5205 (A) Gledhow Nature Reserve located approximately 500 m north.

3.9 Regional ecological linkages

The NVCP area and wider Proposal area is located within a regional linkage corridor known as the Coastal Corridor, which is a Priority 1 Corridor defined as one that links two or more very high nature conservation value areas (Forest Region and Two Peoples Bay Nature Reserve). This corridor is approximately 500 km long and links Walpole in the west to Cape Arid National Park in the east (Wilkins, Gilfillan, Watson, & Sanders, 2006).

The NVCP application area also contains a number of potential and / or possible linkage areas that provide or aid fauna movement on a local scale, particularly for WRPs.

3.10 Environmentally Sensitive Areas

No Environmentally Sensitive Areas (ESAs) have been identified within the NVCP application area, or wider Proposal area, during desktop and site investigations (GoWA, 2020; Southern Ecology, 2020a). The closest ESA is located approximately 2.7 km to the east of the Proposal on Mount Clarence, Albany (Figure 10, Appendix A).

4. Potential impacts

4.1 Impact avoidance through design

Main Roads utilized the hierarchy of avoid, minimise, reduce and rehabilitate to minimise the environmental impacts of the Proposal. Potential impacts to conservation significant fauna particularly Black Cockatoo species and WRPs, have been carefully considered.

Impacts will be avoided or minimised through the following measures:

- Selecting an alignment that fulfils safety objectives with the smallest practicable construction footprint
 - The width of the Proposal footprint was reduced between Albany Highway and Lower Denmark Road to reduce the Proposal footprint
 - Connections at selected existing roads will be removed and access to suburbs and key transport routes will be controlled at key sections along the alignment which reduce the Proposal footprint
- Minimising clearing of native vegetation and fauna habitat through the detailed design process
 - The Project was redesigned at South Western Highway to remove the requirement for a road realignment through native vegetation west of George Street
 - The Project was amended between Hanrahan Road and Princess Drive to minimise clearing impact and impacts to WWII tanks.
 - Approximately 69 % of the native vegetation within the Proposal area is in Degraded or worse condition.
 - Overall reductions of the project footprint has reduced size from 129.75 ha to 96.55 ha.
- Inclusion of infrastructure to facilitate fauna movement, such as underpasses, rope-bridges, modified drainage structures and/or strategically placed fencing during the detailed design process.

Further avoidance measures will be considered during the detailed design phase.

4.2 Potential impacts to vegetation and flora

The Proposal will involve the clearing of 15.67 ha of native vegetation, which ranges in condition from Excellent to Good (31%) to Degraded to Completely Degraded (69%).

The Proposal is in a *Phytophthora* dieback susceptible bioregion, with significant protectable vegetation adjacent to the NVCP application area. A Dieback Management Plan (Southern Ecology, 2020b) has been completed and project specific Construction Environmental Management Plan (CEMP) will be developed for the Proposal.

The Proposal may also result in a range of indirect impacts on adjacent vegetation including smothering from dust and the introduction and spread of weeds. No significant weed presence was identified in the NVCP application area. Three DBCA listed Priority flora were identified within 50m of the NVCP application area (Southern Ecology, 2020a). None are within the direct footprint but could be indirectly impacted through dust or accidental clearing. Potential indirect impacts will be managed as part of the CEMP.

4.3 Potential impacts to fauna and fauna habitat

- The Proposal will clear up to 15.67 ha of native vegetation and includes: 13.28 ha of habitat for Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo habitat, including approximately:
 - 5.54 ha of breeding and high quality foraging habitat for all three species.
 - 1.22 ha of low quality foraging habitat.
 - 12.06 ha potential roosting habitat (including 5.54 ha of habitat that overlaps with breeding and high quality foraging)
 - 191 suitable DBH native trees, including 24 trees with hollows, of which 14 were unsuitable for use and 10 trees had 14 potentially suitable breeding hollows.
- Approximately 11.92 ha of WRP habitat including:
 - 0.87 ha Core habitat
 - 0.04 ha Core (Urban) habitat
 - 11.01 ha Supporting habitat
 - 2.37 ha Linkage habitat
- 5.8 ha of potential habitat for South-western Brush-tailed Phascogale
- Clearing of 15.67 ha of native vegetation also includes potential habitat for:
 - Southern Brown Bandicoot (Quenda)
 - Masked Owl
 - Short-nosed Snake
 - Fork-tailed Swift
 - Woollybush Bee
 - Water-rat (Rakali)
 - Peregrine falcon.

The NVCP application area is located within a regional linkage corridor known as the Coastal Corridor, which is a Priority 1 Corridor defined as one that links two or more very high nature conservation value areas (Forest Region and Two Peoples Bay Nature Reserve). This corridor is approximately 500 km long and links Walpole in the west to Cape Arid National Park in the east (Wilkins, Gilfillan, Watson, & Sanders, 2006). The NVCP application area also contains a number of potential and / or possible linkage areas that provide or aid fauna movement on a local scale, particularly for WRPs.

The NVCP application area is located adjacent to an existing road, therefore the impacts are expected to be less significant than bisecting contiguous vegetation.

Indirect impacts to fauna include injury and death through vehicle strikes and during construction, as well as secondary impacts such as dust, noise and vibration. All potential impacts will be managed under the project CEMP.

4.4 Land degradation, water quality and flooding

Department of Primary Industries and Regional Development (DPIRD) Flood Risk Mapping (DPIRD-007) indicates the following:

- The NVCP application area on George Street (Stage 3b) is mapped as “<3% of the map unit has a moderate to high flood risk”, with the exception of the tributary of Five Mile Creek which is mapped as “3-10% of the map unit has a moderate to high flood risk”.
- The majority of Stage 2 along Lower Denmark Road is mapped as “10-30% of the map unit has a moderate to high flood risk” with the exception of granite outcrops which have “<3% of the map unit has a moderate to high flood risk”.

A comprehensive Flood Study was completed to assess the following (GHD, 2019b):

- Flood depths for critical Annual Exceedance Probability (AEP) events and durations
- Quantity flood impacts on existing infrastructure as a result of the proposed road infrastructure
- Identify any flood mitigation measures that are required for maintaining flood impacts at acceptable levels.

Results of the Flood Study propose the following (GHD, 2019b):

- Propose a V-drain on the upstream side of the road alignment to divert local ponding
- Design of culverts, as required, on George Street to avoid ponding
- Updated flood modelling and drainage design at the detailed design stage with all proposed waterway crossing design for 5 % and 1 % AEP events.

As surface water management measures will be implemented as part of the detailed design stage, including culverts, swales and similar as required, it is considered that the proposed clearing is not at variance to this principle.

5. Environmental management framework

A Construction Environmental Management Plan (CEMP) will be prepared for construction of the Proposal. Mitigation measures in the CEMP will include, but may not be limited to, the following:

- Vegetation clearing management:
 - The removal of vegetation will be restricted to the minimum area required for construction works and comply with the native vegetation clearing permit for the Proposal.
 - Clearing of native vegetation will be avoided through consideration of potential impacts during the detailed design phase
 - A ground disturbance permit process will be developed by the Contractor and signed off by the Main Roads Superintendent or delegate
 - Vehicles, plant and equipment to be fitted with fire extinguishers and restricted to designated cleared areas
 - Prior to clearing, the final road design will be assessed against the proposed clearing area to ensure the required clearing area is no more than the approved area
 - Clearing areas will be clearly demarcated and marked with flagging and approved by the Construction Contractor Environmental Management Representative prior to clearing commencing
 - Additional areas required for construction such as laydown areas, stockpile areas and vehicle turn around, will be located in areas cleared for permanent works.
 - Vehicles and machinery traffic will be confined to the disturbance area to prevent damage to retained vegetation and land.
 - Machinery and materials will not be placed against trees, in vegetation or waterways.
- Fauna management:
 - Black Cockatoo habitat (including Suitable DBH Trees) and WRP habitat within the construction site boundary that is not required to be cleared will be marked and identified as no-go areas and demarcated on relevant drawings
 - Additional areas required for construction such as laydown areas, stockpile areas and vehicle turn around, will be located in areas cleared for permanent works or areas that do not contain Black Cockatoo habitat
 - Revegetation within the road reserve will use local native species. Species chosen will be selected based on habitat suitability for Black Cockatoo, WRP and potential to be resistant to drought. Key components to the revegetation are to include:
 - Species selection will be determined by a suitably qualified expert with experience in rehabilitation and/or landscaping
 - Revegetation will involve a combination of tube stock and/or direct seeding
 - Weed control will occur during the establishment period of the revegetation within the first two years of establishment.
 - Directional clearing will occur to allow fauna to relocate to areas of existing vegetation

- Temporary traffic management measures including management of vehicle speeds, and the use of variable message boards to alert road users to the possible presence of WRP on the roadway, will be implemented during construction/road works activities
- Speed limits between 40-80 km/hr will be applied throughout the construction site for safety purposes to reduce the risk of vehicle strikes during construction
- A list of local wildlife rescue organisations and carers will be maintained on site to contact in the event of fauna injury.
- A suitably experienced zoologist/environmental scientist will be on-site at all times during clearing of breeding habitat for Black Cockatoos/WRP and must maintain radio communication with machinery operators
- Where the trees with suitable nest hollow for Black Cockatoos will require clearing for the Proposal, the hollows will be visually inspected where safe and practicable via drone, pole camera or elevated platform. Where not in use the hollows will be 'blocked' to prevent breeding. Blocking can be undertaken with wood and nails or expanding non-toxic foam or similar
- Where blocking of the nest hollow cannot be undertaken (e.g., timing, access), a pre-clearing fauna assessment will be undertaken by a suitably experienced person to determine if the hollow is being used by Black Cockatoos
- Where a suitable nest hollow has been blocked prior to the Black Cockatoo breeding season, the tree may be felled as part of the standard vegetation clearing process
- Where a suitable nest hollow has not been blocked and the pre-clearing fauna assessment has not identified any Black Cockatoo occupation of the nest hollow, prior to clearing the tree will be 'bumped gently' with a machine, in accordance with the DBCA Procedures to minimise the risk to Western Ringtail Possums during vegetation clearing and building demolition (Department of Parks and Wildlife (DPaW) 2015). The machine operator and zoologist will wait and observe the tree for a short time after. If no Black Cockatoo appears to be present following being bumped gently then the tree shall be pushed over slowly to minimise risk of injury to any undetected animal (if present)
- If a Black Cockatoo nestling is present in the hollow, the tree will not be felled until the nestling has fledged
- Any Black Cockatoos showing signs of injury or illness will be recorded and taken by a qualified fauna handler to a veterinarian or qualified wildlife carer
- Where trees that are known to be Black Cockatoo habitat are retained but are located within 10 m of the edge of the road seal the risk of vehicle strike will be assessed to determine if wildlife hazard signage is required
- A post-clearing survey shall be undertaken to ensure no injured Black Cockatoo individuals are present
- Revegetation shall not include foraging or breeding plant species within 10 m of the road
- Within 7 days prior to clearing, trees with hollows used by or suitable for use by Carnaby's Cockatoo will be inspected by a suitably qualified person to confirm that there are no hollows being used by Black Cockatoo within the area to be cleared.
- Pre-clearing fauna assessment and spotlighting will be undertaken by a suitably qualified person over two nights within the five nights prior to clearing. Assessment is

to include hollows, dreys, ground debris, dense ground-level vegetation, timber and logs

- No night-time clearing of vegetation will occur
- Vacant dreys will be removed prior to clearing where they are accessible, in accordance with the DBCA Procedures to minimise the risk to Western Ringtail Possums during vegetation clearing and building demolition (DPaW 2015)
- Vacant tree hollows suitable for possums will be removed or blocked prior to clearing where they are accessible. Blocking may include wood nailed over the hollow, non-toxic expanding foam or similar
- Cleared vegetation will be chipped immediately or transported at least 100 m from WRP habitat before further processing
- Movement/disturbance of clearing stockpiles will be confined to the period between one hour after sunrise and one hour prior to sunset
- Habitat clearing is to commence from existing edge lines/roads and progress towards habitat that will be retained, where possible
- If WRPs are observed during clearing operations, the tree containing the animal shall be left for up to 48 hours to allow for the animal to vacate, while clearing continues in adjacent vegetation. If the tree continues to be occupied after 48 hours, the animal will be coerced/moved to a safe area outside of the clearing footprint by the appointed zoologist/environmental scientist/fauna spotter in accordance with Procedures to minimise the risk to Western Ringtail Possums during vegetation clearing and building demolition (DPaW 2015). This may include removal using an elevated platform or gently pushing over the tree as detailed below
- Trees, as noted above, that are observed to support WRP after 48 hours will be 'bumped gently' with a machine prior to felling. The operator and spotter will wait and observe the tree for a short time. If the animal remains in the tree, the tree shall be pushed over slowly onto vegetation within the clearing area that is yet to be cleared. The 'soft felling' of habitat trees will provide a 'cushion' for the vegetation being felled, minimising the risk of injury to the animal and allowing any WRP present with the opportunity to safely vacate
- Felled trees with hollows will be checked immediately for WRPs after felling and prior to further processing. If it is not possible to fully inspect the hollow the tree will be left on the ground overnight to allow time for any undetected fauna to vacate
- Any WRP showing signs of injury or illness will be recorded and taken by a qualified fauna handler to a veterinarian or qualified wildlife carer
- A post-clearing survey shall be undertaken to ensure no injured WRP individuals are present.
- A fauna underpass (ARR) and rope bridge (Hanrahan Road) will be included in detailed design to minimise impact of fauna habitat clearing on landscape connectivity for the WRP. The fauna underpass and rope bridge will also minimise likelihood of fauna strike by providing alternative linkages between patches of remnant vegetation
- Where trees that are known to be Black Cockatoo habitat are retained but are located within 10 m of the edge of the road seal, the risk of vehicle strike will be assessed to determine if wildlife hazard signage is required

- No Black Cockatoo foraging species will be planted within 10 m of the edge of the road.
- Erosion and sediment control:
 - A Landscape Management Plan will be prepared for revegetation works within temporary construction areas, roadsides and medians, as required.
 - Water carts and/or surface stabilisation measures (e.g. hydro mulch) will be used to minimise dust, erosion and sedimentation generated from cleared areas.
 - Sediment to be captured in stormwater runoff and treated within basins/swales prior to discharge to waterways to prevent spread of dieback.
 - Temporary drainage structures within or adjacent Black Cockatoo or WRP habitat will be designed and constructed such that scouring or erosion within adjacent vegetated areas does not occur.
 - Site specific erosion and sediment controls will be established to prevent direct run off into adjacent water courses and wetlands.
 - Topsoil will be harvested, stockpiled and reused in accordance with Main Roads Environmental Guideline Topsoil Management/ Topsoil Management Plan.
- Weed and pest management:
 - Contractor induction will include familiarisation with and discussion of Black Cockatoos/WRP, Phytophthora dieback management and hygiene management
 - Heavy plant and machinery will be inspected by the contractor prior to entry at the work site and be confirmed to be clean and free of vegetation and soil material. Entry and exit records will be kept for CoE points
 - Effective clean down prior to accessing the CoE point will be conducted to remove soil and plant material (including weed seeds). The key components of a suitable washdown are:
 - Effluent is captured during washdown i.e. sump, for later transport and disposal, or diverted into excluded/infested areas
 - Cleaned objects exit washdown area without becoming re-contaminated
 - Safe entry, departure of vehicles by operators is maintained
 - Timing of operations and construction (particularly in Protectable Areas) will be conducted in dry soil conditions where possible (generally between November and April)
 - Demarcation of Protectable Areas should be check/retaped shortly prior to construction
 - Basic raw material imported into Protectable areas should be low risk for Phytophthora contamination
 - WoNS and Declared Pests within the construction site boundary will be controlled according to the weed control management outlined by Weeds Australia (<http://weeds.ala.org.au/>) with the aim of controlling weed spread
 - Topsoil containing Declared Pests or WoNS shall not be reused in revegetation or revegetation
 - Topsoil from infected or potentially infected dieback areas shall be segregated and not used in non-infected areas

- Sediment to be captured in stormwater runoff and treated within basins/swales prior to discharge to waterways to prevent spread of dieback on site
- Topsoil within the Proposed Action Area will be harvested, stockpiled and reused in accordance with Main Roads Environmental Guideline Topsoil Management.
- Dieback protectable areas will be identified and established within the Proposed Action area and adjacent land to guide dieback hygiene practices including restrictions on equipment and vehicle movement, soil movement, and Clean on Entry and/or Exit (CoE). A Dieback Management Plan (Southern Ecology, 2020b) has been developed for Proposal and will be utilised during the clearing of the Proposal area (Appendix I).

6. Assessment against the 10 Clearing Principles

Schedule 5 of the EP Act defines Ten 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 the Proposal has been assessed against the Ten Clearing Principles, 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.

The assessment has been based on clearing of 15.67 ha of native vegetation within the NVCP application area. The assessment indicates that the Proposal is at variance with principles (a), (b) and (f) and is unlikely to be, or not, at variance with the other principles.

Offsets are likely to be required to compensate for the residual impacts associated with the proposed clearing of conservation significant fauna habitat (see Section 7).

Table 5 Assessment against the Ten Clearing Principles

Principle	Assessment	Outcome
(a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	<p>The NVCP application area includes 15.67 ha of native vegetation, comprising upland, granites and wetland vegetation types. The NVCP application area has a high level of biodiversity. Eleven native vegetation types were identified within the NVCP area, of which approximately 31.1% is Excellent to Good condition, and represents high biodiversity vegetation. Approximately 68.9% is Degraded to Completely Degraded in condition. This reflects the context of the site, between an existing road and surrounding areas of remnant vegetation.</p> <p>A desktop assessment completed by Southern Ecology (2020a) determined that two Federally listed TECs and four PECs may occur within the Project. No TECs listed under the EPBC Act, or PECs listed by DBCA were identified within the NVCP application area (Southern Ecology, 2020a).</p> <p>A total of 342 taxa were recorded during surveys completed by Southern Ecology (2020a). The species assemblages were typical of the local region and the vegetation types encountered.</p> <p>No Threatened flora species listed under Commonwealth were recorded in the NVCP application area (Southern Ecology, 2020a). In addition, no Priority flora were recorded within the NVCP application area (Southern Ecology, 2020a). However, three DBCA listed Priority flora and/or their habitats were identified within 50 m of the NVCP application area and have the potential to be indirectly impacted without appropriate construction management:</p> <ul style="list-style-type: none"> • Two <i>Synaphea incurva</i> (P3) individuals, estimated to be less than 1 % of the known population • 13 <i>Andersonia</i> sp. <i>Jamesii</i> (P4) individuals were recorded in the NVCP application area, estimated to be 1 % of the known population • One <i>Thysanotus isantherus</i> (P4) individual. <p>The desktop fauna survey work undertaken by Southern Ecology (2018) identified the following five fauna habitats within the Proposal area:</p> <ul style="list-style-type: none"> • <i>Hakea</i> spp. Shrubland/Woodland Complex • Jarrah/ Marri/ Sheoak Laterite Forest • <i>Homalospermum firmum</i>, <i>Callistemon glaucus</i> Peat Thicket • Non-native planted vegetation • Non-native areas where invasive weeds comprise >75 % of the vegetation. 	At variance to this principle

Principle		Assessment	Outcome
		<p>Field assessments confirmed that 15.67 ha of native vegetation habitat within the NVCP application area is utilised by five significant fauna species, including:</p> <ul style="list-style-type: none"> • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) (EN) • Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) (EN) • Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (VU) • Western Ringtail Possum (<i>Pseudocheirus occidentalis</i>) (CR) • Southern Brown Bandicoot, Quenda (<i>Isodon fusciventer</i>) (P4). <p>An additional seven significant fauna species listed under state legislation were considered to possibly occur in the NVCP application area despite not being recorded during field investigations (See Principle b).</p> <p>The NVCP application area is located within a regional linkage corridor known as the Coastal Corridor, which is a Priority 1 Corridor defined as "one that links two or more very high nature conservation value areas" (Forest Region and Two Peoples Bay Nature Reserve). This corridor is approximately 500 km long and links Walpole in the west to Cape Arid National Park in the east (Wilkins, Gilfillan, Watson, & Sanders, 2006).</p> <p>The native vegetation within the NVCP application area includes vegetation in Excellent to Good condition, contains Priority listed species habitat and provides habitat for significant fauna species. The proposed clearing is considered to be at variance with this principle.</p>	
(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	<p>The proposed clearing will result in the clearing of up to 15.67 ha of native vegetation within the NVCP application area. Field assessments confirmed that 15.67 ha of native vegetation habitat within the NVCP application area is utilised by five significant fauna species, including:</p> <ul style="list-style-type: none"> • Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>) (EN) • Baudin's Cockatoo (<i>Calyptorhynchus baudinii</i>) (EN) • Forest Red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) (VU) • Western Ringtail Possum (<i>Pseudocheirus occidentalis</i>) (CR) • Southern Brown Bandicoot, Quenda (<i>Isodon fusciventer</i>) (P4). <p>In addition to the above species, seven significant fauna species were considered to possibly occur in the NVCP application area despite not being recorded during field investigations:</p> <ul style="list-style-type: none"> • South-western Brush-tailed Phascogale (<i>Phascogale tapoatafa wambenger</i>) (CD) 	At variance to this principle

Principle	Assessment	Outcome
fauna indigenous to Western Australia	<ul style="list-style-type: none"> Masked Owl (<i>Tyto novaehollandiae</i> subsp. <i>novaehollandiae</i>) (P3) Short-nosed Snake (<i>Elapognathus minor</i>) (P2) Fork-tailed Swift (<i>Apus pacificus</i>) (IA) Woollybush bee (<i>Hylaeus globuliferus</i>) (P3) Water-rat, Rakali (<i>Hydromys chrysogaster</i>) (P4) Peregrine Falcon (<i>Falco peregrinus</i>) (OS). <p>Clearing of up to 15.67 ha of native vegetation will impact the following significant fauna:</p> <ul style="list-style-type: none"> Removal of up to 13.28 ha of native vegetation habitat for Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo habitat, including approximately: <ul style="list-style-type: none"> 5.54 ha of foraging and high quality breeding habitat 1.22 ha of low quality Black Cockatoo foraging habitat 12.06 ha of roosting habitat (including the 5.54 ha of foraging and high quality breeding habitat listed above) Clearing of up to 191 suitable native DBH Trees (including 24 trees with hollows, of which 14 were unsuitable for use and 10 trees had 14 potentially suitable breeding hollows) Clearing of approximately 11.92 ha of WRP habitat <ul style="list-style-type: none"> 0.87 ha of Core habitat 0.04 ha of Core (Urban) habitat 11.01 ha Supporting habitat 2.37 ha of Linkage and Likely Linkage habitat Clearing of up to 15.67 ha of Southern Brown Bandicoot habitat Clearing of 5.80 ha of potential habitat for South-western Brush-tailed Phascogale. <p><u>Black Cockatoos</u></p> <p>Biota (2019b) estimated that at least 8,756 ha of native vegetation is present within 12 km of the NVCP application area, constituting foraging habitat for Black Cockatoo. Additional native and non-native foraging habitat is also likely to occur in this area. A 12 km radius was chosen as it represents the typical maximum distance that Black Cockatoos will fly from roosting or breeding locations to forage (Biota, 2019b). No roosting evidence was recorded</p>	

Principle	Assessment	Outcome
	<p>during the survey, however potential roosting habitat occurs throughout the NVCP application area, totalling 12.06 ha of native vegetation. The clearing of up to 13.28 ha of potential native vegetation habitat for Black Cockatoos is likely to be minor on a local and regional scale. The proposed clearing represents 0.15% of suitable native vegetation in the region (12 km radius). A total of 191 suitable DBH trees are located within the NCVP application area. Of these, 24 trees with hollows have been identified, of which 14 were unsuitable for use. Ten trees have 14 potentially suitable breeding hollows. No breeding evidence including chews were identified in the surveys.</p> <p>Based on this information, it is expected that the proposed clearing in the NVPC area will represent a small portion of available habitat for the population of Black Cockatoos in the local area, and will have limited impacts to foraging, roosting and breeding success.</p> <p><u>Western Ringtail Possum</u></p> <p>Based on Biota (2020) density estimate of 0.14 to 0.36 individuals/ha for Supporting habitat, and those used by City of Albany of 2.45 individuals/ha for Core habitat (Biota, 2019a), it is predicted that less than 6 WRPs would potentially have their home range reduced or impacted (to varying degrees) within the NVCP application area (native vegetation only).</p> <p>It is estimated there are more than 3,000 individual WRPs in the sub-population around Albany. The potential impact to the home ranges of up to 6 WRPs within the NVCP application area represents 0.2 % of the population.</p> <p>Where the Proposal area intersects areas of remnant vegetation, engineered structures will be considered to maintain fauna connectivity and managed in accordance with the WRP management plan (Main Roads, 2020) (Appendix H).</p> <p><u>Southern Brown Bandicoot, Quenda</u></p> <p>The entire NVCP application area (15.67 ha) is considered to be potential habitat for Quenda (Southern Ecology, 2020a). The habitat utilised by this species are widespread and well represented in the local area, therefore impact by the proposed clearing is not considered to be significant.</p> <p><u>South-western Brush-tailed Phascogale</u></p> <p>The likelihood of occurrence assessment by Southern Ecology (2020a) indicates that habitat for this species possibly occurs within NCVP area within Marri and Jarrah woodland and forest vegetation types, however individuals were not identified during the field surveys. Targeted night trapping is typically required to verify</p>	

Principle	Assessment	Outcome
	<p>presence of this species. As with Black Cockatoo and WRP habitat, South-western Brush-tailed Phascogale habitat including Jarrah, Marri, Sheoak Laterite Forest and Marri, Jarrah Forest and Peppermint Woodland are well represented within 12 km of the NVCP application area. Therefore it is considered unlikely that clearing of 5.80 ha of native vegetation would not significantly impact this species.</p> <p><u>Masked Owl</u></p> <p>The likelihood of occurrence assessment by Southern Ecology (2020a) indicates that this species possibly occurs within the NVCP application area, due to presence of suitable hollows for nesting in Eucalypt woodland/ forest vegetation types and prey, however was not identified during the field surveys. These habitat types are well represented within 12 km of the NVCP application area, as such, it is considered unlikely that clearing of 15.67 ha of native vegetation would significantly impact this species.</p> <p><u>Short-nosed Snake</u></p> <p>Habitat for the Short-nosed Snake is not well known and there are few recorded of its presence on the South Coast, therefore habitat may possibly occur within the NVCP application area. Vegetation types within the NCVP area are well represented with the surrounding locality, therefore it is considered unlikely that clearing of 15.67 ha of native vegetation would significantly impact this species.</p> <p><u>Fork-tailed Swift</u></p> <p>The Fork-tailed Swift is a migratory bird and does not breed within Australia, however the NVCP area provides possible foraging habitat for this species (Southern Ecology, 2020a). Vegetation types within the NCVP application area are well represented with the surrounding locality, therefore it is considered unlikely that clearing of 15.67 ha of native vegetation would significantly impact this species.</p> <p><u>Woollybush bee</u></p> <p>The only type specimen (1929) of the Woollybush Bee is known from the Albany area. Its potential habitat is unknown therefore may occur within the NVCP application area (Southern Ecology, 2020a). Vegetation types within the NCVP area are well represented with the surrounding locality, therefore it is considered unlikely that clearing of 15.67 ha of native vegetation would significantly impact this species.</p> <p><u>Water-rat, Rakali</u></p>	

Principle		Assessment	Outcome
		<p>The likelihood of occurrence assessment by Southern Ecology (2020a) indicates that the Rakali is known to occur in Lake Powell to the west, and possibly occurs within the NVCP application area. One artificial drain that crosses Lower Denmark Road, connecting to the Robinson Road drain, is intercepted by the NVCP application area and may provide habitat for this species. However not signs of this species were identified during the field surveys (Southern Ecology, 2020a).</p> <p><u>Peregrine Falcon</u></p> <p>Southern Ecology (2020a) identified that suitable habitat exists for this species within all forest and woodland vegetation communities within the NVCP application area however this species is not common and was not recorded during the field surveys.</p> <p>Given the proposed clearing will impact significant habitat for fauna indigenous to Western Australia, particularly Black Cockatoo and WRPs, the proposed clearing is considered to be at variance to this principle.</p>	
(c)	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	<p>The desktop assessment identified that 69 conservation significant flora have previously been recorded within the Study area. Of these, six Threatened flora, listed under the EPBC Act and/ or BC Act, were considered likely or possible to occur within the Survey area (Southern Ecology, 2020a). However no Threatened Flora were identified within the Survey or NVCP application area during the field surveys (Southern Ecology, 2020a).</p> <p>It is considered that the proposed clearing is not at variance to this principle.</p>	Not at variance to this principle
(d)	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for, the	<p>The desktop assessment identified no State listed TECs as occurring in the vicinity of the Proposal area:</p> <p>No TECs listed under the BC Act were identified within the Proposal and NVCP application area during the field surveys.</p> <p>It is considered that the proposed clearing is not at variance to this principle.</p>	Not at variance to this principle

Principle		Assessment	Outcome																																						
	maintenance of a threatened ecological community.																																								
(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.	<p>Broad scale (1:250,000) pre-European vegetation mapping (Beard 1979) mapping indicates the NVCP application area intersects two vegetation associations:</p> <ul style="list-style-type: none">• Medium forest, jarrah-marri (Association 3)• Low forest; jarrah, <i>Eucalyptus staeri</i> and <i>Allocasuarina fraseriana</i> (Association 978). <p>The current extent of these vegetation associations is greater than 30 % of the pre-European extent at the State, IBRA bioregion, IBRA subregion and Local Government Authority (LGA) levels.</p> <table><tr><th>Pre-European Vegetation Associations</th><th>Scale</th><th>Pre-European extent (ha)</th><th>Current extent (ha)</th><th>% Remaining</th><th>% of Remaining in DBCA managed lands</th></tr><tr><td rowspan="4">3</td><td>State: WA</td><td>2,661,404.62</td><td>1,803,427.48</td><td>67.76</td><td>81.5</td></tr><tr><td>IBRA bioregion: Jarrah Forest</td><td>2,390,591.54</td><td>1,604,101.56</td><td>67.10</td><td>81.00</td></tr><tr><td>Sub-region: Southern Jarrah Forest</td><td>1,482,491.85</td><td>880,655.65</td><td>59.40</td><td>78.50</td></tr><tr><td>LGA: City of Albany</td><td>50,509.32</td><td>16,024.66</td><td>31.73</td><td>38.24</td></tr><tr><td rowspan="2">978</td><td>State: WA</td><td>53,230.64</td><td>18,855.77</td><td>35.42</td><td>9.47</td></tr><tr><td>IBRA bioregion: Jarrah Forest</td><td>53,016.57</td><td>18,751.03</td><td>35.37</td><td>9.48</td></tr></table>	Pre-European Vegetation Associations	Scale	Pre-European extent (ha)	Current extent (ha)	% Remaining	% of Remaining in DBCA managed lands	3	State: WA	2,661,404.62	1,803,427.48	67.76	81.5	IBRA bioregion: Jarrah Forest	2,390,591.54	1,604,101.56	67.10	81.00	Sub-region: Southern Jarrah Forest	1,482,491.85	880,655.65	59.40	78.50	LGA: City of Albany	50,509.32	16,024.66	31.73	38.24	978	State: WA	53,230.64	18,855.77	35.42	9.47	IBRA bioregion: Jarrah Forest	53,016.57	18,751.03	35.37	9.48	Not at variance to this principle
Pre-European Vegetation Associations	Scale	Pre-European extent (ha)	Current extent (ha)	% Remaining	% of Remaining in DBCA managed lands																																				
3	State: WA	2,661,404.62	1,803,427.48	67.76	81.5																																				
	IBRA bioregion: Jarrah Forest	2,390,591.54	1,604,101.56	67.10	81.00																																				
	Sub-region: Southern Jarrah Forest	1,482,491.85	880,655.65	59.40	78.50																																				
	LGA: City of Albany	50,509.32	16,024.66	31.73	38.24																																				
978	State: WA	53,230.64	18,855.77	35.42	9.47																																				
	IBRA bioregion: Jarrah Forest	53,016.57	18,751.03	35.37	9.48																																				

Principle		Assessment						Outcome
			Sub-region: Southern Jarrah Forest	53,016.57	18,751.03	35.37	9.48	
			LGA: City of Albany	52,154.39	18,719.90	35.89	9.67	
		The Proposal will result in direct loss of approximately 15.67 ha of native vegetation. Loss of this vegetation will not result in any of the vegetation associations being reduced to less than 30 % at any level. At a regional scale the impacts of the Proposal are not significant. The proposed clearing is not at variance to 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 NVCP application area does not intercept any watercourses or wetlands categorised as per the following (GHD, 2020b; GoWA, 2020): <ul style="list-style-type: none">• DBCA's Directory of Important Wetlands in Australia (DBCA-045)• Redbook Recommended Conservation Reserves 1976-1991 (DBCA-029)• South Coast Significant Wetlands (DBCA-018)• Ramsar Sites (DBCA-010)• RIWI Act Rivers (DWER-036). The closest Nationally Important Wetland is Oyster Harbour, which lies approximately 8 km to the east of the NVCP application area (GoWA, 2020). The Gledhow Conservation Category Wetlands, as mapped in the DBCA South Coast Significant Wetlands dataset, are located 250 m to 500 m south and south-west of the NVCP application area and west of Allerton Street. In addition Conservation Category wetlands Seven Mile Creek, within the King River Suite, is located approximately 2-3 km west (Figure 4, Appendix A) (GoWA, 2020). Whilst there are no mapped wetlands with the NCVP area there are three vegetation types, predominantly located along Lower Denmark Road, that are considered to be wetland habitats. These vegetation associations are						At variance to this principle.

Principle		Assessment	Outcome
		<p>dependent on surface or subsurface expression of groundwater and include the following (Southern Ecology, 2020a):</p> <ul style="list-style-type: none"> • <i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket • <i>Evandra aristata</i> Sedgeland • <i>Taxandria juniperina</i> Closed Forest <p>The NVCP application area intercepts 7.17 ha of these vegetation types which are mapped as being Very Good (2.65 ha) to Degraded/Completely Degraded (4.53 ha) condition.</p> <p>Given the clearing of 2.65 ha of wetland vegetation types of Very Good condition, it is considered the proposed clearing is at variance to this principle.</p>	
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	<p>Surface geology within the NVCP application area along Lower Denmark Road (Stage 2) is described as "plains with swamps" with the exception of granite outcrops. Stage 3b, along George Street and South Western Highway, is described as sands over laterite (GoWA, 2020).</p> <p>The DPIRD salinity risk mapping within the NVCP application area, along Lower Denmark Road (Stage 2), is largely mapped as "3-10% of map unit has a moderate to high salinity risk or is presently saline". The majority of Stage 3b is mapped as "<3% of map unit has a moderate to high salinity risk or is presently saline" (GoWA, 2020).</p> <p>The DPIRD water erosion risk mapping indicates that the NVCP application area along Lower Denmark Road, is mapped as "3-10% of map unit has a high to extreme water erosion risk", with the exception of the Mount Melville area which is mapped as "10-30% of map unit has a high to extreme water erosion risk", due to presence of granite and steep slopes. The majority of Stage 3b is mapped as "<3% of map unit has a high to extreme water erosion risk" (GoWA, 2020).</p> <p>The clearing of vegetation within the NVCP area has the potential to cause short term impacts during construction. Based on the proposed management actions (including revegetation of temporally disturbed areas), clearing is unlikely to cause appreciable deterioration in the quality of the land.</p> <p>A CEMP will be prepared to address issues such as erosion, and land degradation.</p> <p>It is considered that the proposed clearing is not likely to be at variance to this principle.</p>	Not likely to be at variance to 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.	<p>The NVCP application area does not intersect or occur within any DBCA managed areas (GoWA, 2020). The closest areas include:</p> <ul style="list-style-type: none"> • Reserve 23088 Unnamed Conservation Park located approximately 500 m north • 5205 (A) Gledhow Nature Reserve located approximately 500 m north. <p>The proposed clearing is not expected to result in any direct or indirect to these conservation areas.</p> <p>The proposed clearing is not at variance to this principle.</p>	Not at variance to 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.	<p>The NVCP application area, along Lower Denmark Road (Stage 2), intercepts the northern extent of the Albany Groundwater Protection Area protected under the RIWI Act. Lower Denmark Road forms the northern boundary of this area (GoWA, 2020).</p> <p>The NVCP does not intercept any PDWSA however the northern extent of the South Coast Water Reserve is along Lower Denmark Road and is managed under the CAWS Act (GoWA, 2020).</p> <p>According to the GoWA (2020) mapping, the NVCP area is mapped within an area having low risk of water erosion and flooding, with the exception of areas along Lower Denmark Road.</p> <p>The clearing of vegetation within the NVCP application area has the potential to cause short term impacts during construction. Based on the proposed management actions (including revegetation of temporally disturbed areas), clearing is unlikely to cause appreciable deterioration in the quality of surface or underground water.</p> <p>A CEMP will be prepared to address issues such as erosion and surface and groundwater quality.</p> <p>It is considered that the proposed clearing is not likely to be at variance to this principle.</p>	Not likely to be at variance to this principle.

Principle		Assessment	Outcome
(j)	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	<p>Department of Primary Industries and Regional Development (DPIRD) Flood Risk Mapping (DPIRD-007) indicates the following:</p> <ul style="list-style-type: none"> • The NVCP application area on George Street (Stage 3b) is mapped as "<3% of the map unit has a moderate to high flood risk", with the exception of the tributary of Five Mile Creek which is mapped as "3-10% of the map unit has a moderate to high flood risk" • The majority of Stage 2 along Lower Denmark Road is mapped as "10-30% of the map unit has a moderate to high flood risk" with the exception of granite outcrops which have "<3% of the map unit has a moderate to high flood risk". <p>A Concept Design Flood Study (GHD, 2019b) was completed and recommended the following:</p> <ul style="list-style-type: none"> • A V-drain on the upstream side of the road alignment to divert local ponding • Design of culverts, as required, on George Street to avoid ponding • Updated flood modelling and drainage design at the detailed design stage with all proposed waterway crossing design for 5 % and 1 % AEP events. <p>Main Roads has a long and successful history of managing surface water drainage for its road projects and it will continue to manage drainage effectively for its projects. Appropriate surface water management measures will be implemented as part of the detailed design stage, including culverts, swales and similar as required. It is considered that the proposed clearing is not likely to be at variance to this principle.</p>	Not likely to be at variance to this principle.

7. Offsets

Environmental offsets are conservation actions that provide environmental benefits intended to counterbalance significant residual environmental impacts associated with a proposal (GoWA, 2014). Main Roads have considered requirements to counterbalance the residual impacts through environmental offsets for Stage 2 and 3b of the ARR. Consideration has been given to requirements of the Western Australian Government's Environmental Offset Policy (GoWA, 2011), the Western Australian Offset Guideline (GoWA, 2014) and the Australian Government's EPBC Act Environmental Offset Policy (DSEWPAC, 2012).

Main Roads operates on a hierarchy of avoid, minimize, reduce, rehabilitate and offset environmental impacts. This hierarchy is achieved primarily through changes in scope and design, development and implementation of the CEMP and finally, if required, development of an offset proposal. Application of the management hierarchy has been documented throughout this document.

Offsets are expected to be required to compensate for the residual impacts associated with the proposed clearing of conservation significant fauna habitat.

If required, identification of suitable offsets will occur in accordance with the state and federal offset policies and guidelines.

8. References

- Allen, A. D., & Sofoulis, J. (1984). *1:250,000 Geological Series Map, Mount Barker - Albany WA Sheet SI 50-11 and part of Sheet SI 50-15*. Government of Western Australia.
- Beard, J. S. (1979). *Vegetation Survey of Western Australia: the Vegetation of the Perth Area Western Australia, map and explanatory memoir 1:250,000 series*. Applecross: Vegmap Publications.
- Biota . (in prep.). *A Regional Survey of the Western Ringtail Possum*. Unpublished report for Main Roads Western Australia.
- Biota. (2019a). *Albany Heritage Park Trail: Western Ringtail Possum Impact Assessment*. Unpublished report for City of Albany.
- Biota. (2019b). *Albany Ring Road Cockatoo Habitat Assessment*. Unpublished report for Main Roads Western Australia.
- Biota. (2020). *Albany Ring Road Project Western Ringtail Possum Assessment*. Unpublished report prepared for Main Roads Western Australia.
- BoM. (2019). *Groundwater Dependent Ecosystem Atlas*. Retrieved 2019, from Bureau of Meteorology: <http://www.bom.gov.au/water/groundwater/gde/map.shtml>
- BoM. (2020). *Climate statistics for Australian locations - Albany Site Number 9500*. Retrieved from Australian Government Bureau of Meteorology: http://www.bom.gov.au/climate/averages/tables/cw_009500.shtml
- CALM. (2003). *Phytophthora cinnamomi and disease caused by it, Volume I – Management Guidelines*. Perth: Department of Conservation and Land Management.
- Commonwealth of Australia. (2012). *Australia's Bioregions (IBRA) Version 7*. Retrieved August 2020, from Department of Agriculture, Water and the Environment: <https://www.environment.gov.au/fed/catalog/main/home.page>
- DBCA. (2007-). *NatureMap: Mapping Western Australia's Biodiversity*. Retrieved 2019, from Department of Biodiversity, Conservation and Attractions: <https://naturemap.dbca.wa.gov.au/>
- DER. (2014). *Assessment and Management of Contaminated Sites, Contaminated Sites Guidelines*. Perth: DER.
- DSEWPAC. (2012). *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*. Department of Sustainability, Environment, Water, Population and Communities.
- GHD. (2006). *Main Roads WA, Report on Albany Ring Road stage 2 and 3, Environmental Review and Impact Assessment, November 2006*. Unpublished report for Main Roads Western Australia.
- GHD. (2019a). *Albany Ring Road Concept & Feasibility Project (Stage 2, 3A & 3B): Contaminated Sites and Acid Sulfate Soil Constraints Assessment*. Unpublished report prepared for Main Roads Western Australia.
- GHD. (2019b). *Albany Ring Road, Concept Design Flood Study*. Unpublished report for Main Roads Western Australia.
- GHD. (2020a). *Albany Ring Road Concept and Feasibility (Stages 2 and 3b), Baseline Contamination Site Assessment Report*. Unpublished report prepared for Main Roads Western Australia.
- GHD. (2020b). *Albany Ring Road, Acid Sulfate Soils Desktop Assessment, ISCA Infrastructure Sustainability Planning Rating Tool, January 2020*. Unpublished report prepared for Main Roads Western Australia.
- GoWA. (2011). *WA Environmental Offsets Policy*. Government of Western Australia.
- GoWA. (2014). *WA Environmental Offsets Guidelines*. Government of Western Australia.
- GoWA. (2014). *WA Environmental Offsets Guidelines*. Retrieved from http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/WA%20Environmental%20Offsets%20Guideline%20August%202014.pdf
- GoWA. (2019). *2018 Statewide Vegetation Statistics incorporating the CAR (Full Report). Current as of March 2019*. WA Department of Biodiversity, Conservation and Attractions. Retrieved from <https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics>
- GoWA. (2020). *data.wa.gov.au*. Retrieved August 2020, from <https://data.wa.gov.au/>
- Hearn, S., Williams, K., Comer, S., & Beecham, B. (2002). *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions*. Perth: Department of Conservation and Land Management.
- Main Roads. (2020). *Albany Ring Road Stage 2 and 3b Western Ringtail Possum Management Plan*. Unpublished report prepared by Main Roads Western Australia.

- Sandiford, E., & Barrett, S. (2010). *Albany Regional Vegetation Survey Extent, Type and Status: A project funded by the Western Australian Planning Commission (EnviroPlanning "Integrating NRM into Land Use Planning" and State NRM Program)*. Western Australia: South Coast Natural Resource Management Inc. and City of Albany for the Department of Environment and Conservation.
- Shepherd, D. P., Beeston, G. R., & Hopkins, A. J. (2002). *Native Vegetation in Western Australia – Extent, Type and Status, Resource Management Technical Report 249*. Perth: Department of Agriculture WA.
- Southern Ecology. (2018). *Biological Survey, Albany Ring Road*. Unpublished report prepared for Main Roads Western Australia.
- Southern Ecology. (2019). *Memorandum to Main Roads Western Australia, Defining habitat categories for Western Ringtail Possum in the South Coast population, 31st October 2019*. Unpublished memorandum prepared for Main Roads Western Australia.
- Southern Ecology. (2020a). *Biological Survey: Albany Ring Road*. Unpublished report prepared on behalf of Main Roads Western Australia.
- Southern Ecology. (2020b). *Phytophthora Dieback Management Plan: Albany Ring Road*. Unpublished report for Main Roads Western Australia.
- Southern Ecology. (2020c). *Prasophyllum paulinae Targeted Regional Flora Survey*. Unpublished report for Main Roads Western Australia.
- Wilkins, P., Gilfillan, S., Watson, J., & Sanders, A. (2006). *The Western Australian South Coast Corridor Network - a bioregional strategy for nature conservation*. Albany, Western Australia: Department of Conservation and Land Management (CALM) and South Coast Regional Initiative Planning Team (SCRIPT).

Appendices

Appendix A – Figures

Figure 1 Proposal and Native Vegetation Clearing Permit Application area

Figure 2 Proposal and survey area boundaries

Figure 3 Study area

Figure 4 Hydrology constraints

Figure 5 Vegetation types within the Native Vegetation Clearing Permit Application area

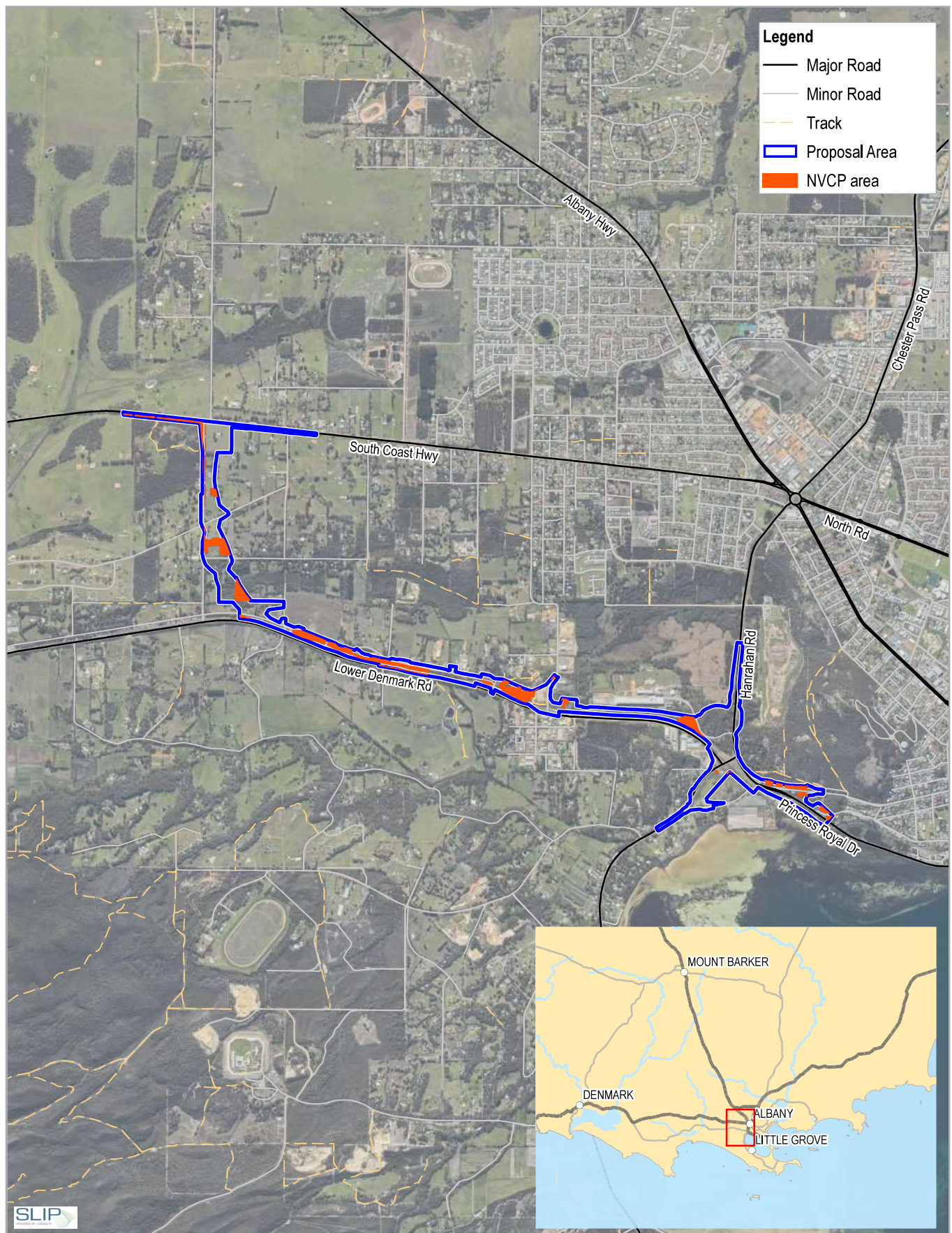
Figure 6 Vegetation condition within the Native Vegetation Clearing Permit Application area

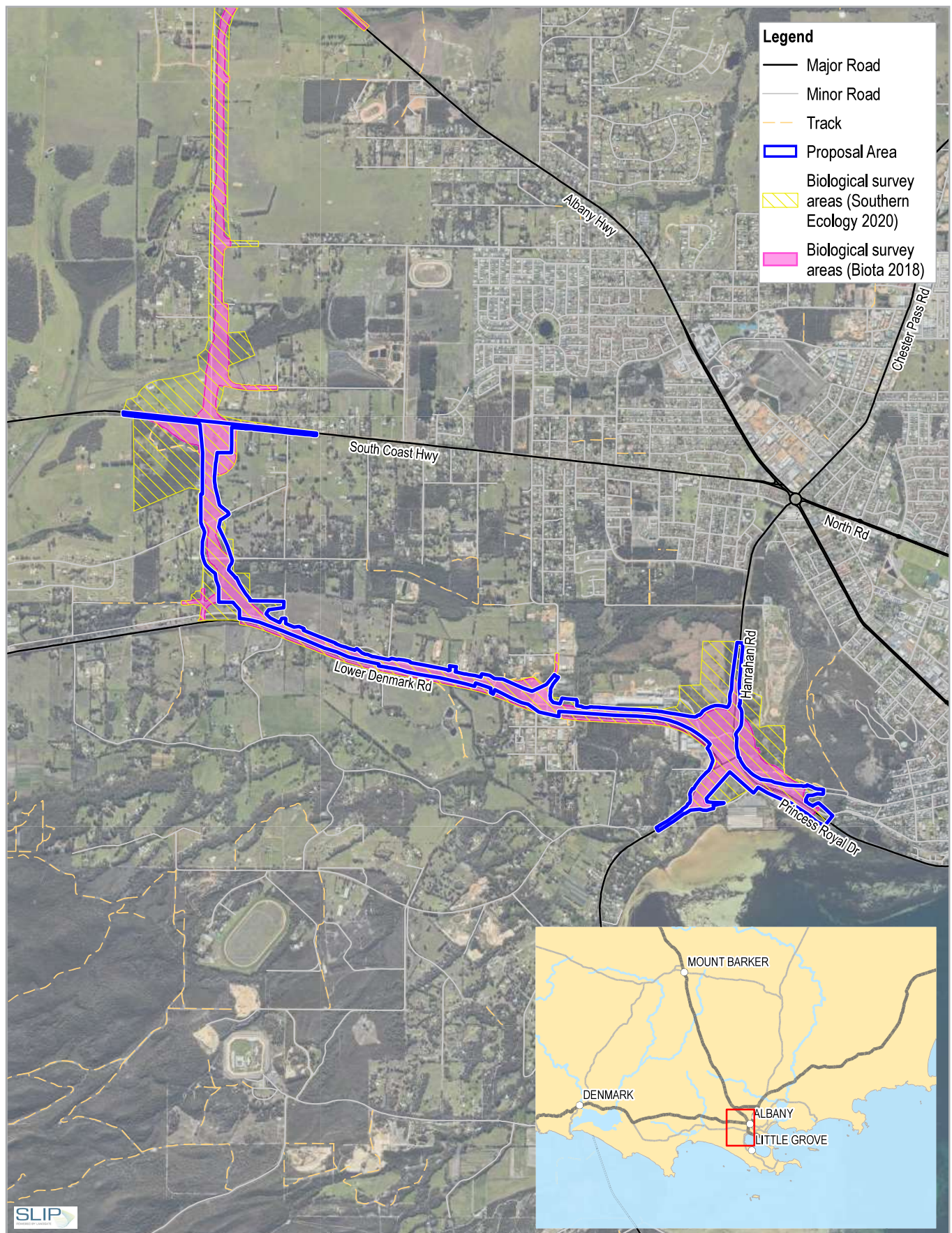
Figure 7 Priority flora and priority flora habitat within the Native Vegetation Clearing Permit Application area

Figure 8 Black Cockatoo habitat within the Native Vegetation Clearing Permit Application area

Figure 9 Western Ringtail Possum habitat within the Native Vegetation Clearing Permit Application area

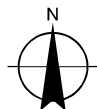
Figure 10 Land use constraints





Paper Size ISO A4
0 0.2 0.4 0.6 0.8
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



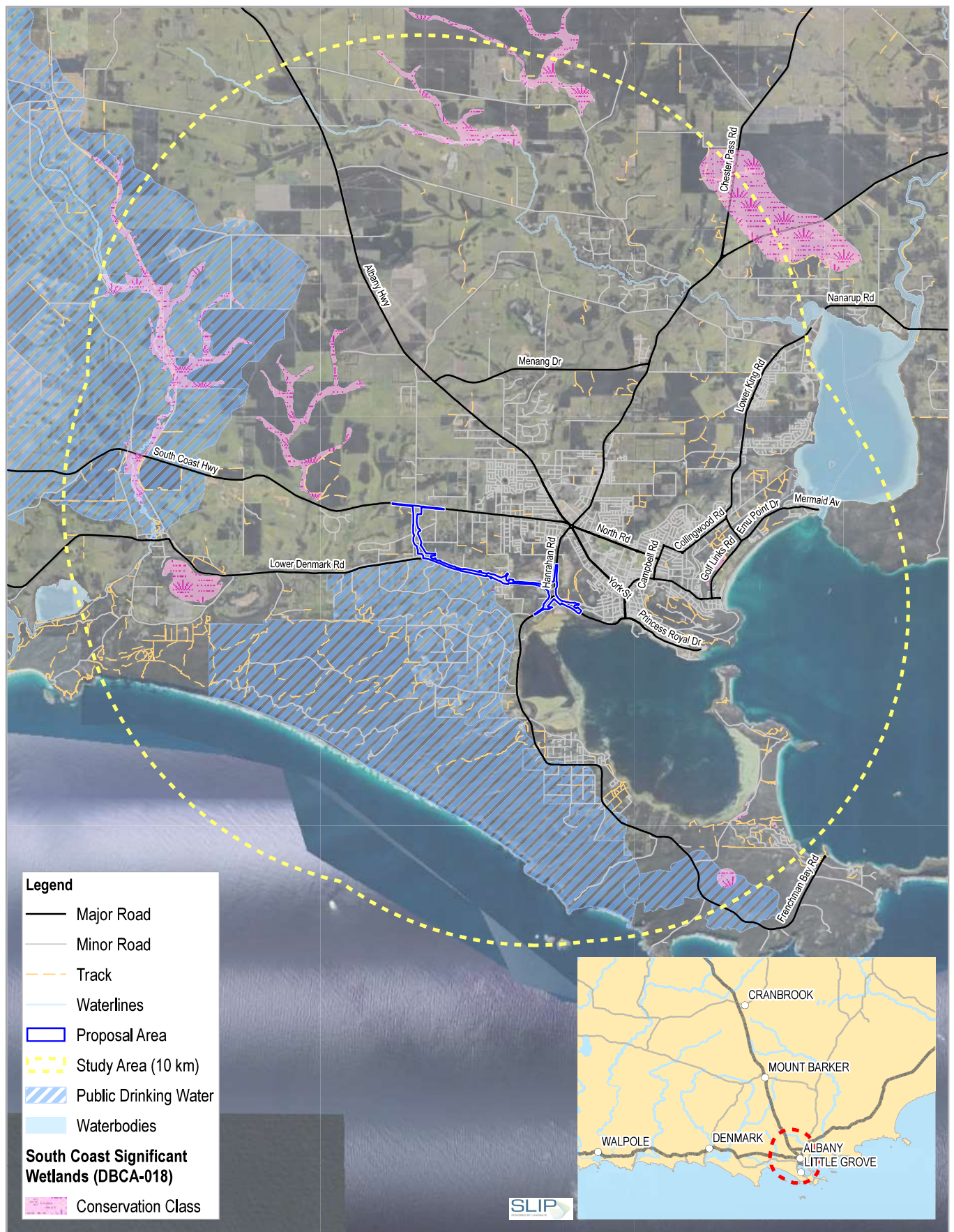
**Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b**

Project No. 12533824
Revision No. 0
Date 7/07/2021

Proposal and survey area boundaries

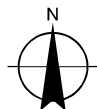
FIGURE 2





Paper Size ISO A4
0 1 2 3 4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

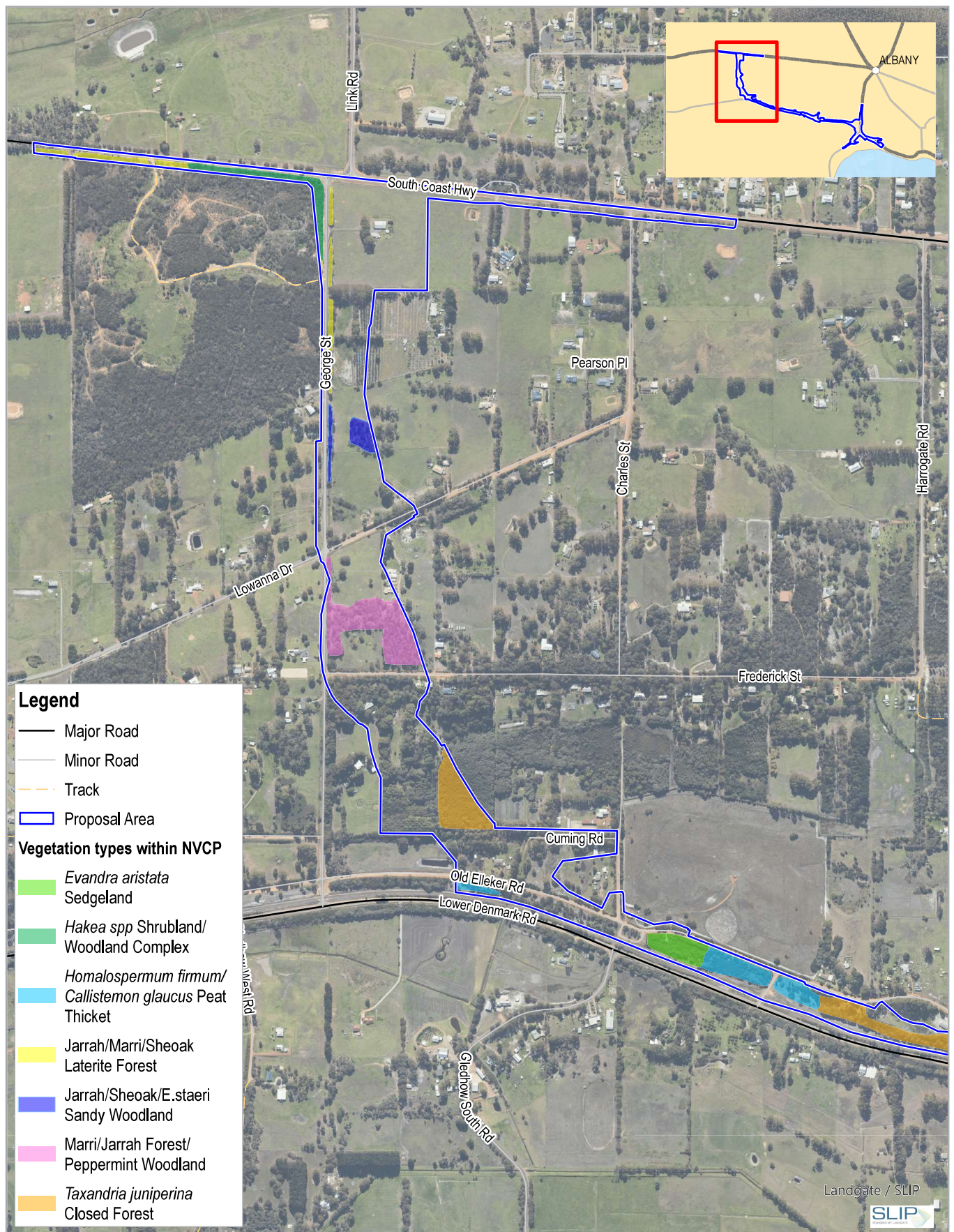


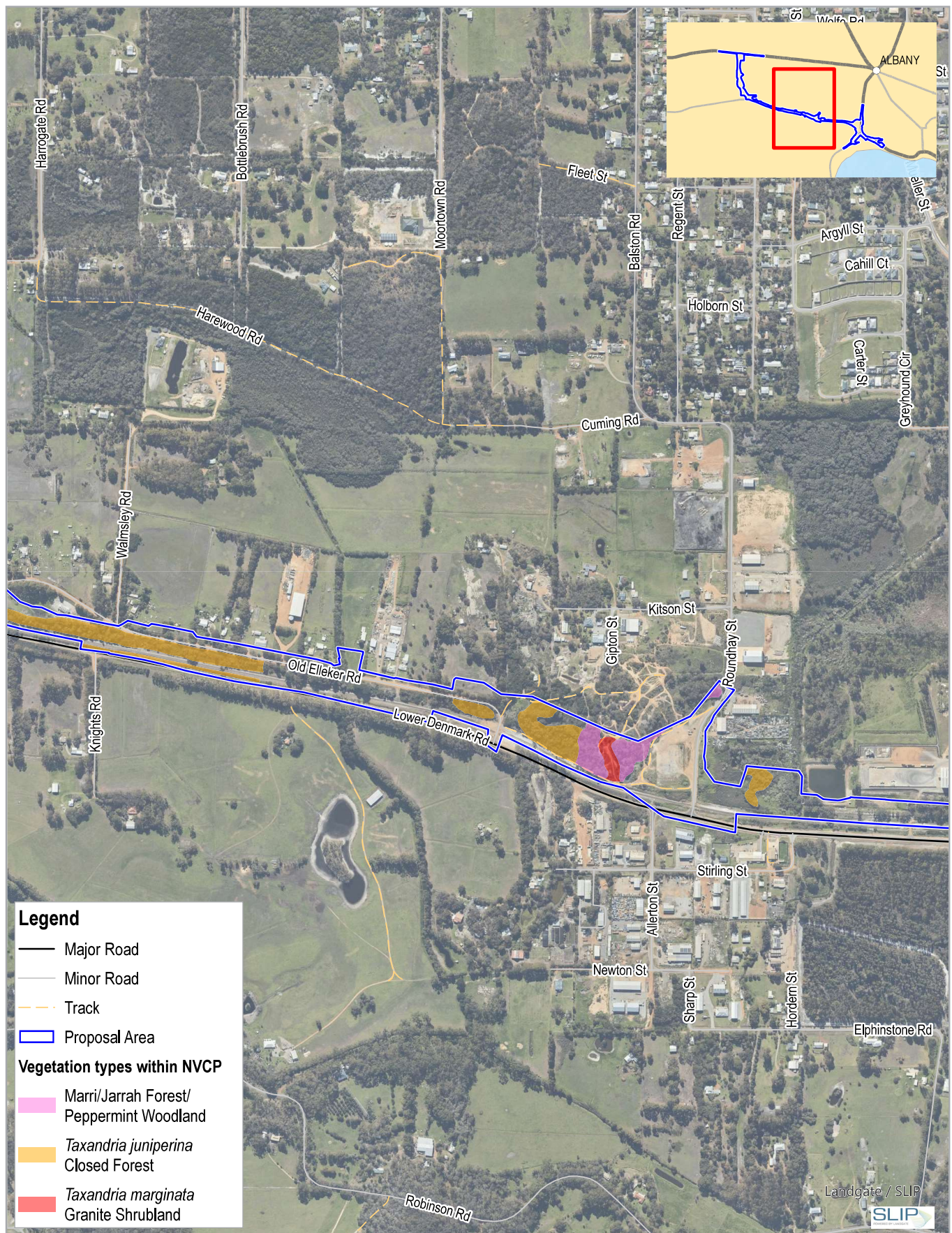
**Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b**

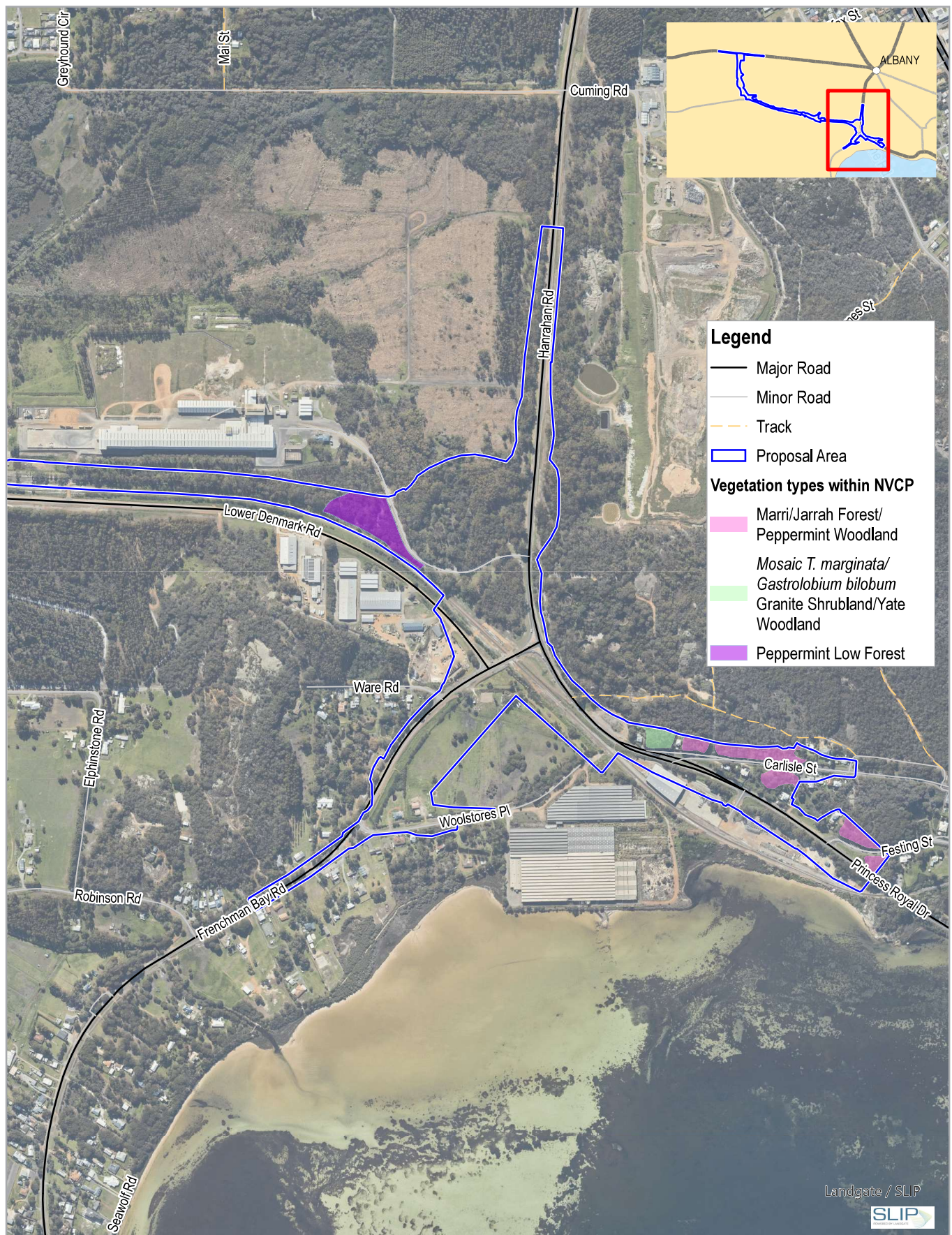
Project No. 12533824
Revision No. 0
Date 7/07/2021

Hydrology constraints

FIGURE 4

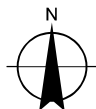






Paper Size ISO A4
0 100 200 300 400
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

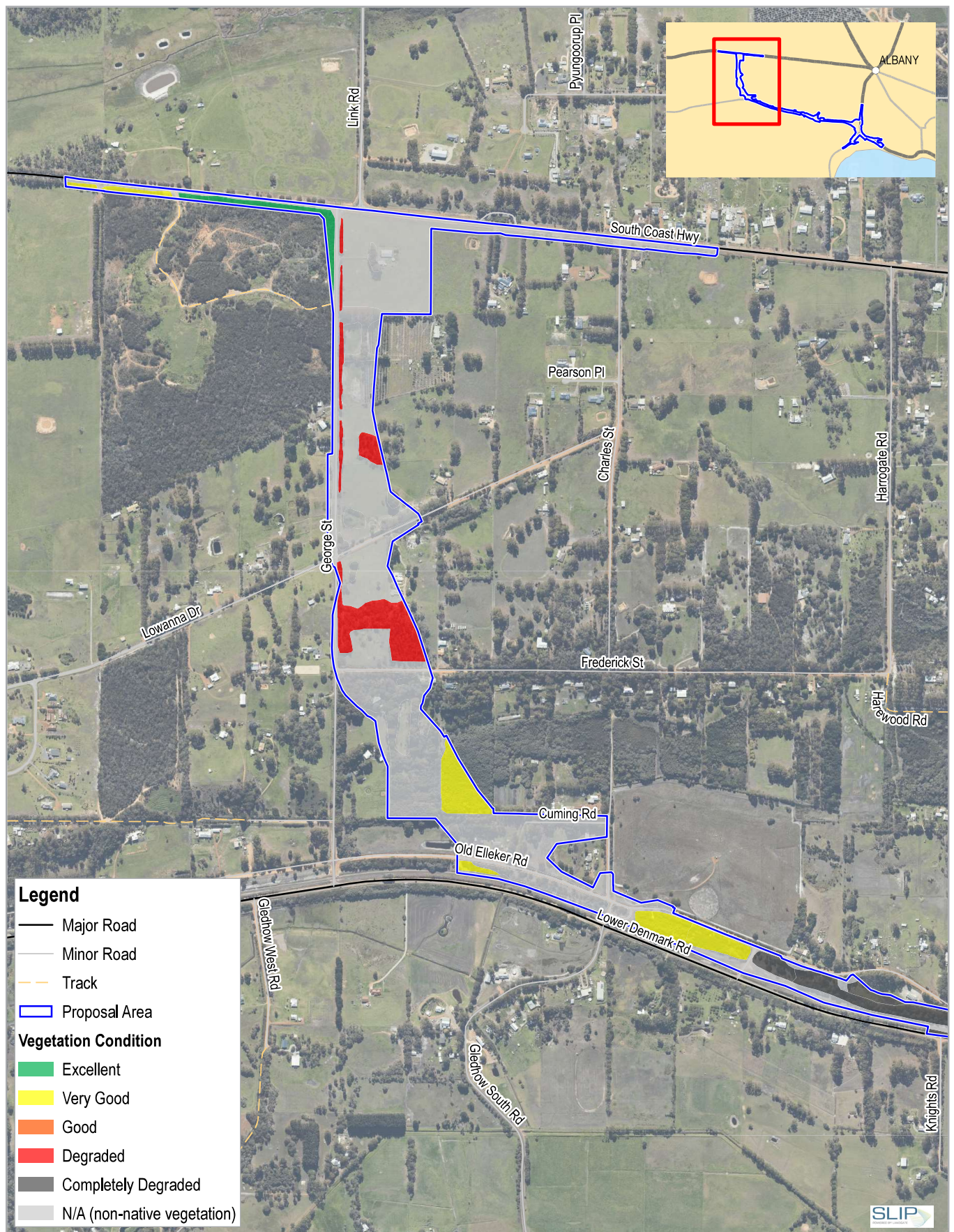


Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b

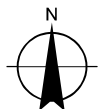
Vegetation types within NVCP area

Project No. 12533824
Revision No. 0
Date 7/07/2021

Page 3 of 3
FIGURE 5



Paper Size ISO A4
 0 100 200 300 400
 Metres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50

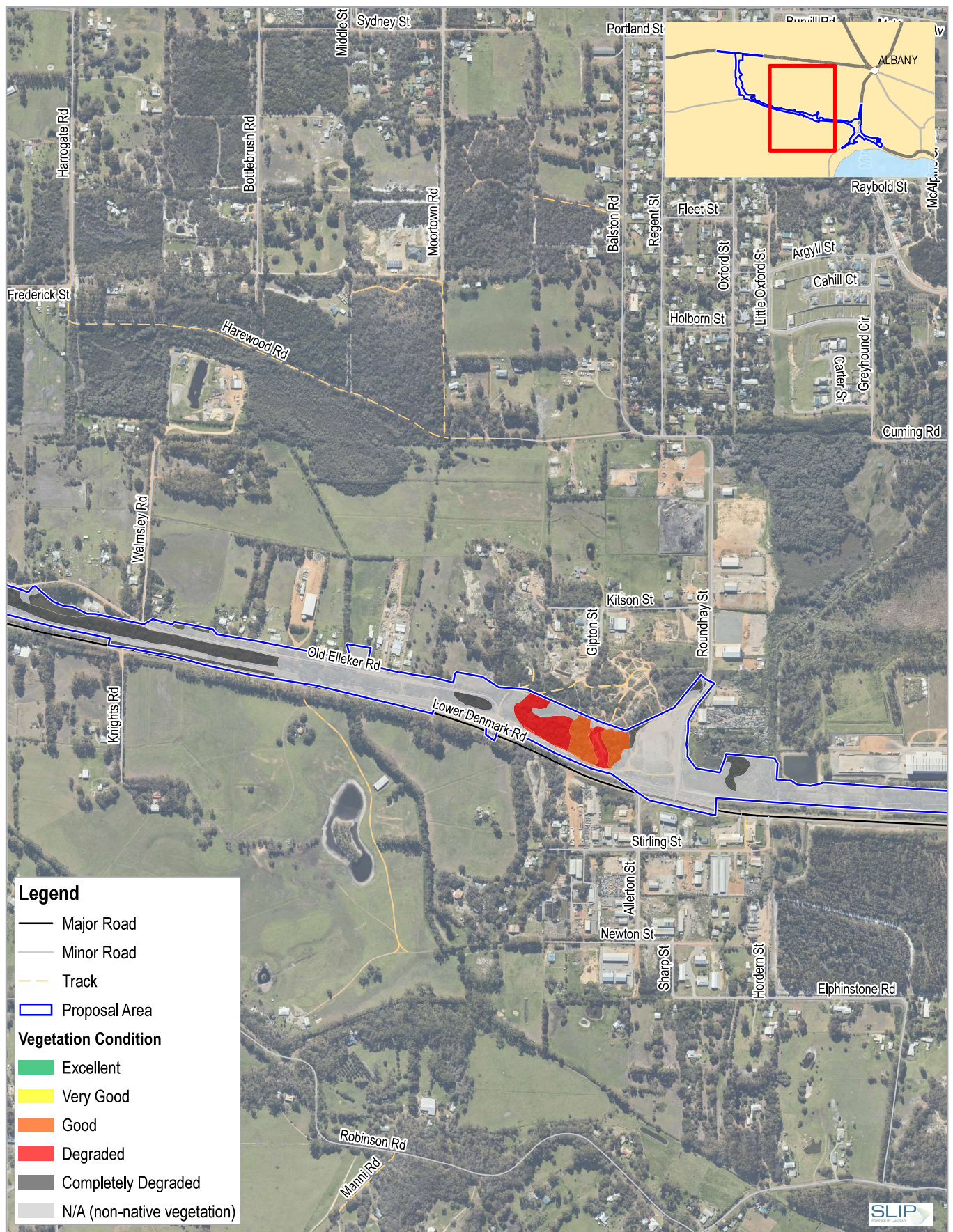


Main Roads Western Australia Albany Ring Road
 Project Stages 2 and 3b

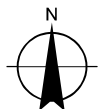
**Vegetation condition
 within NVCP area**

Project No. 12533824
 Revision No. 0
 Date 7/07/2021

**Page 1 of 3
 FIGURE 6**



Paper Size ISO A4
0 100 200 300 400
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

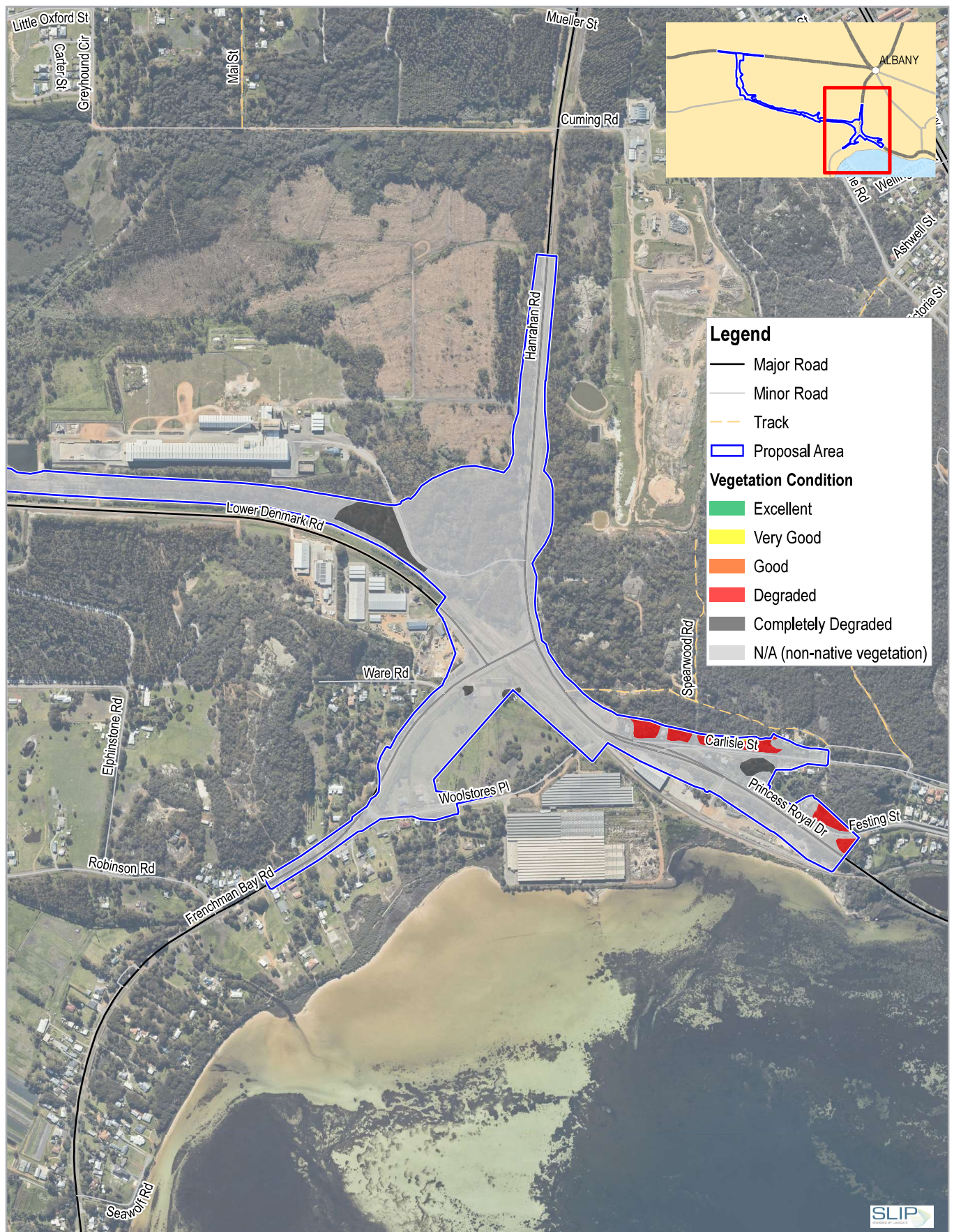


Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b

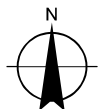
**Vegetation condition
within NVCP area**

Project No. 12533824
Revision No. 0
Date 7/07/2021

**Page 2 of 3
FIGURE 6**



Paper Size ISO A4
 0 100 200 300 400
 Metres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50

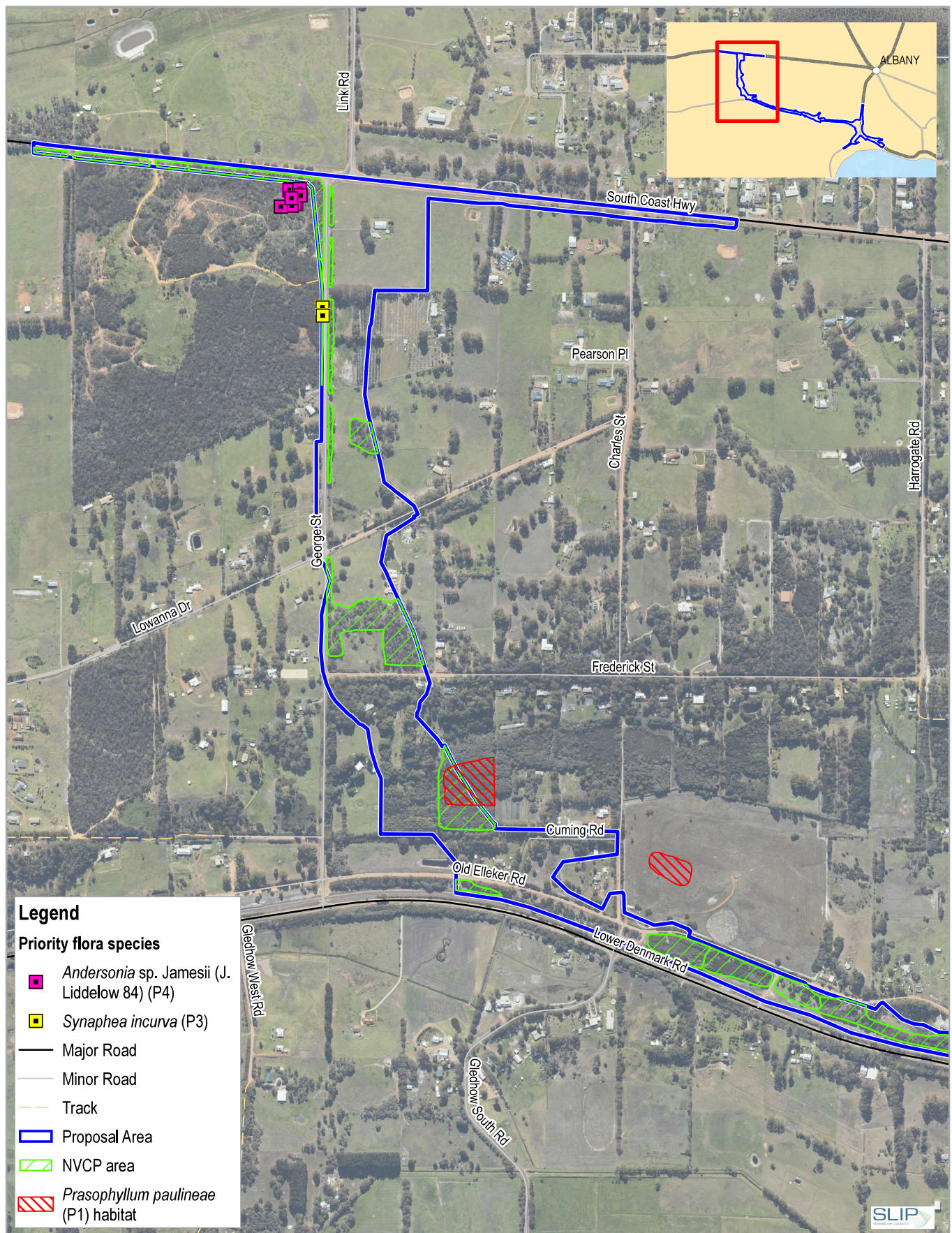


Main Roads Western Australia Albany Ring Road
 Project Stages 2 and 3b

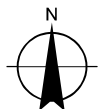
**Vegetation condition
 within NVCP area**

Project No. 12533824
 Revision No. 0
 Date 7/07/2021

**Page 3 of 3
 FIGURE 6**



Paper Size ISO A4
0 75 150 225 300
Meters
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b

Project No. 12533824
Revision No. 0
Date 7/07/2021

**Priority flora and
priority flora habitat within NVCP area**

FIGURE 7

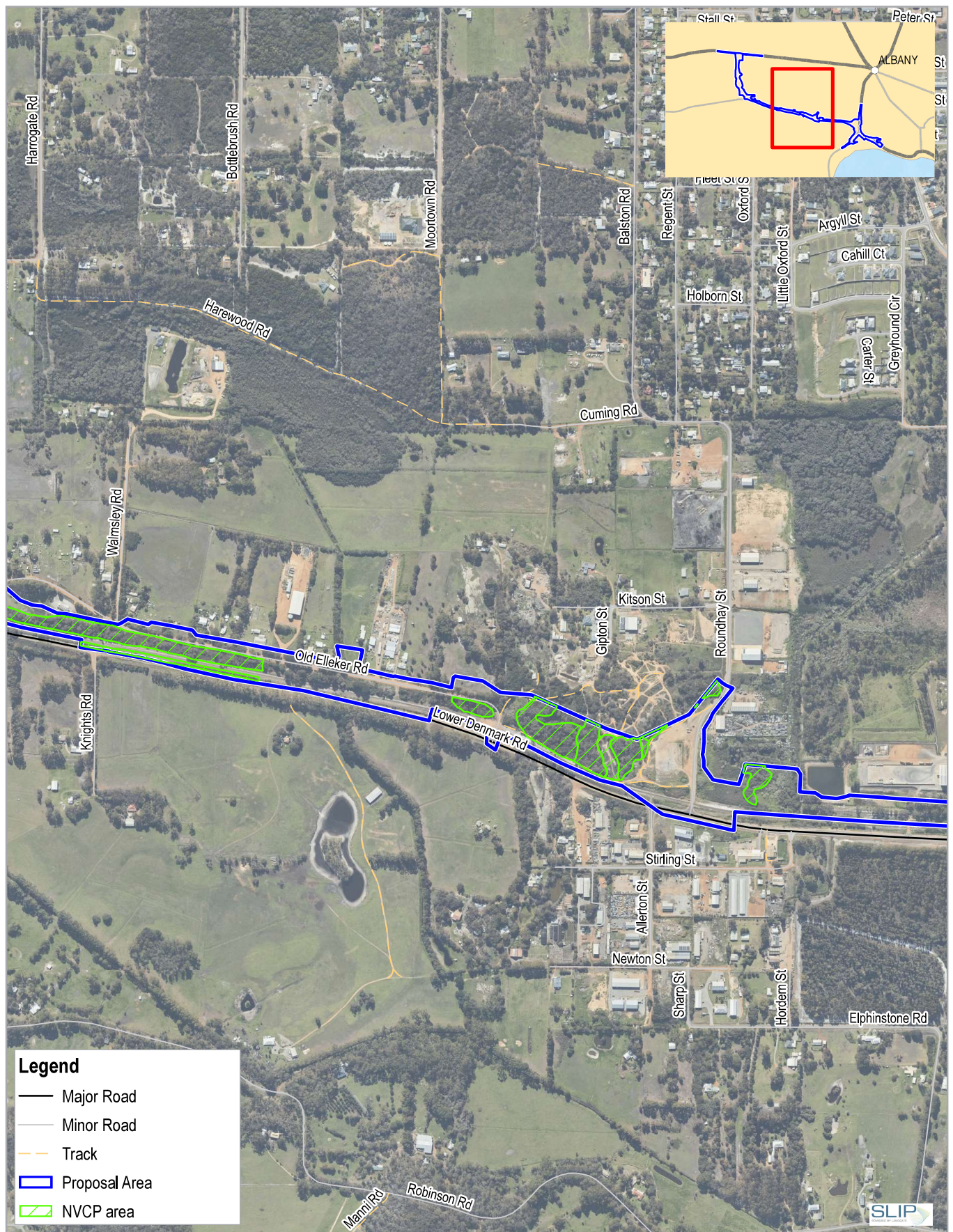
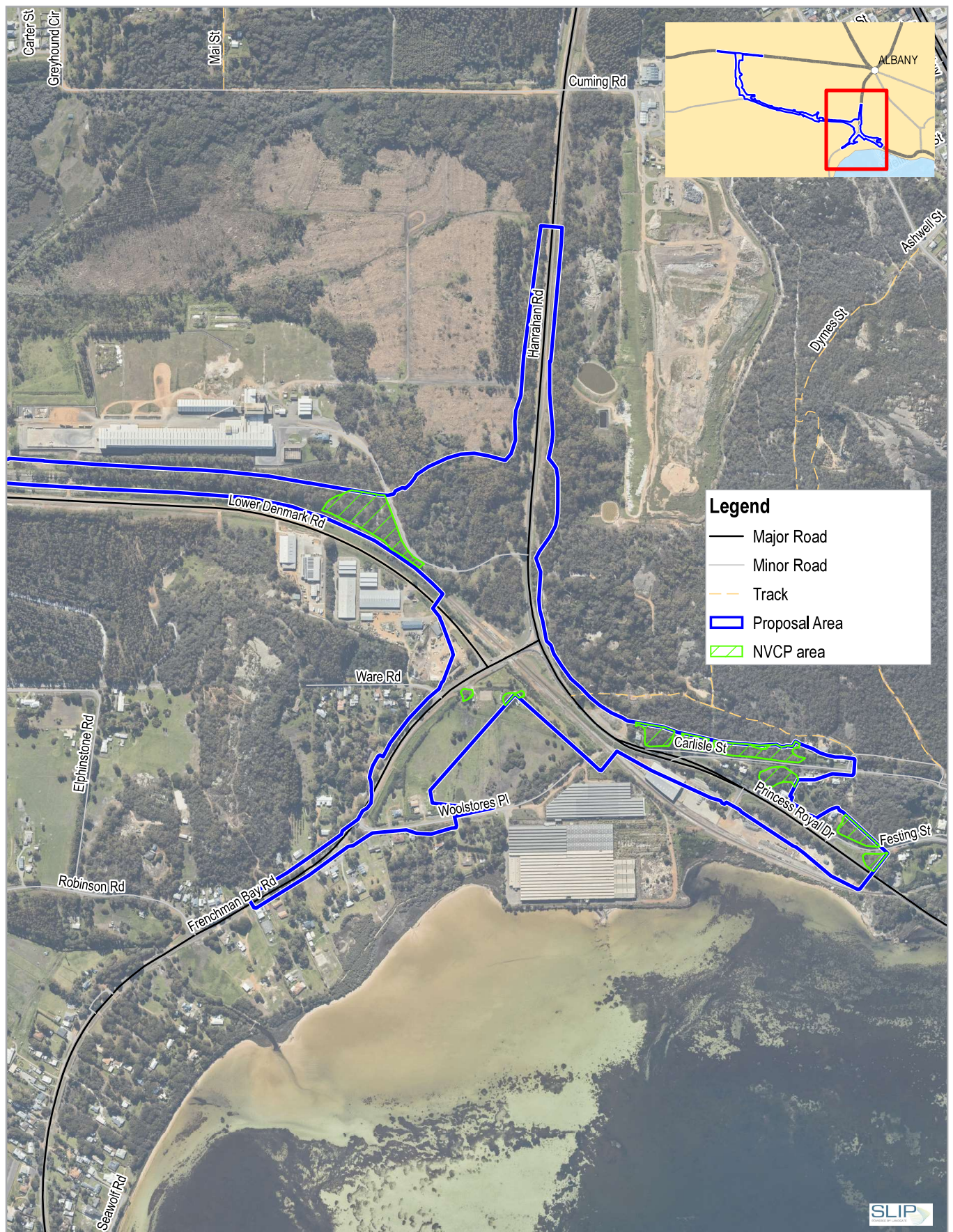
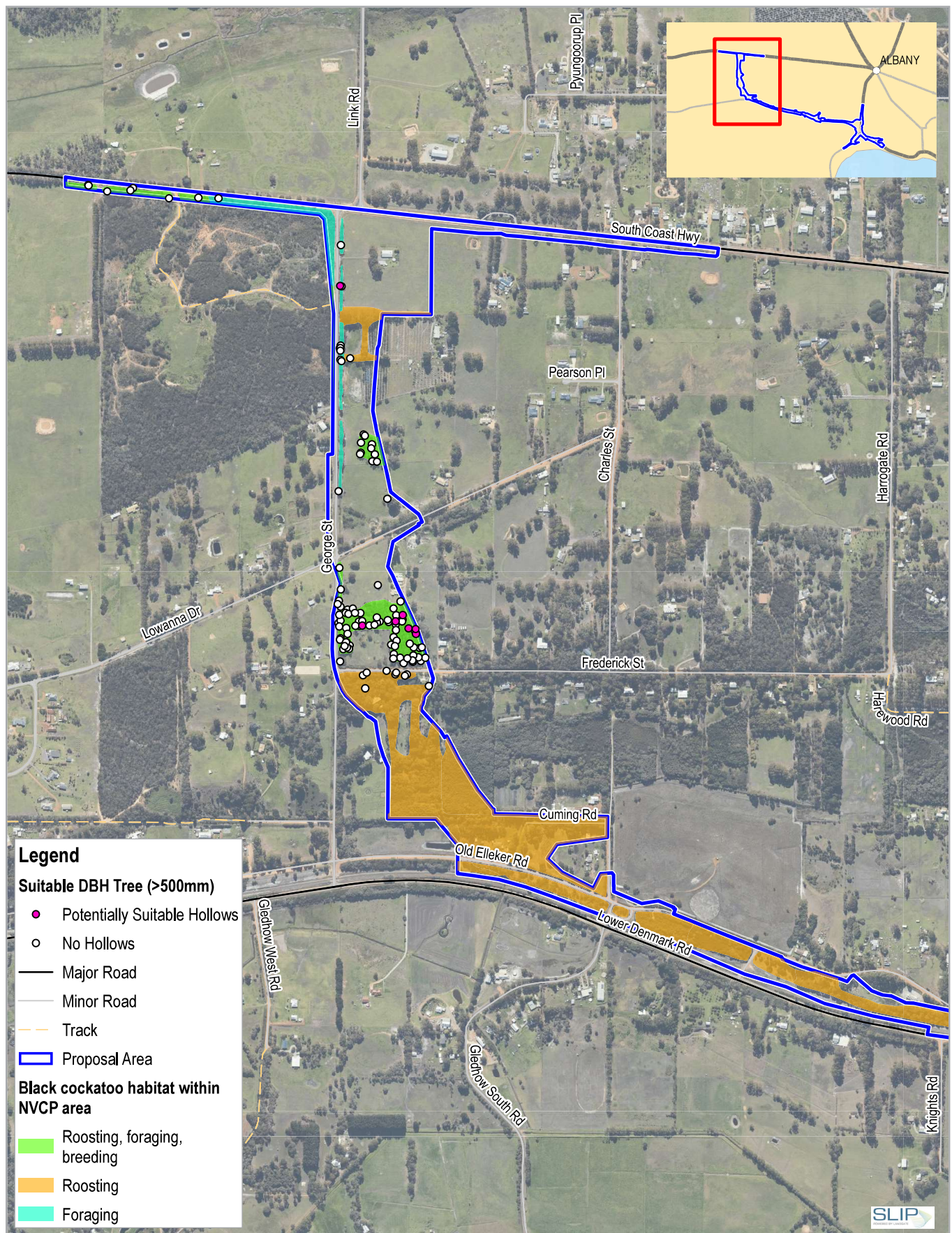


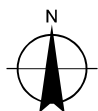
FIGURE 7





Paper Size ISO A4
0 50 100 150 200
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

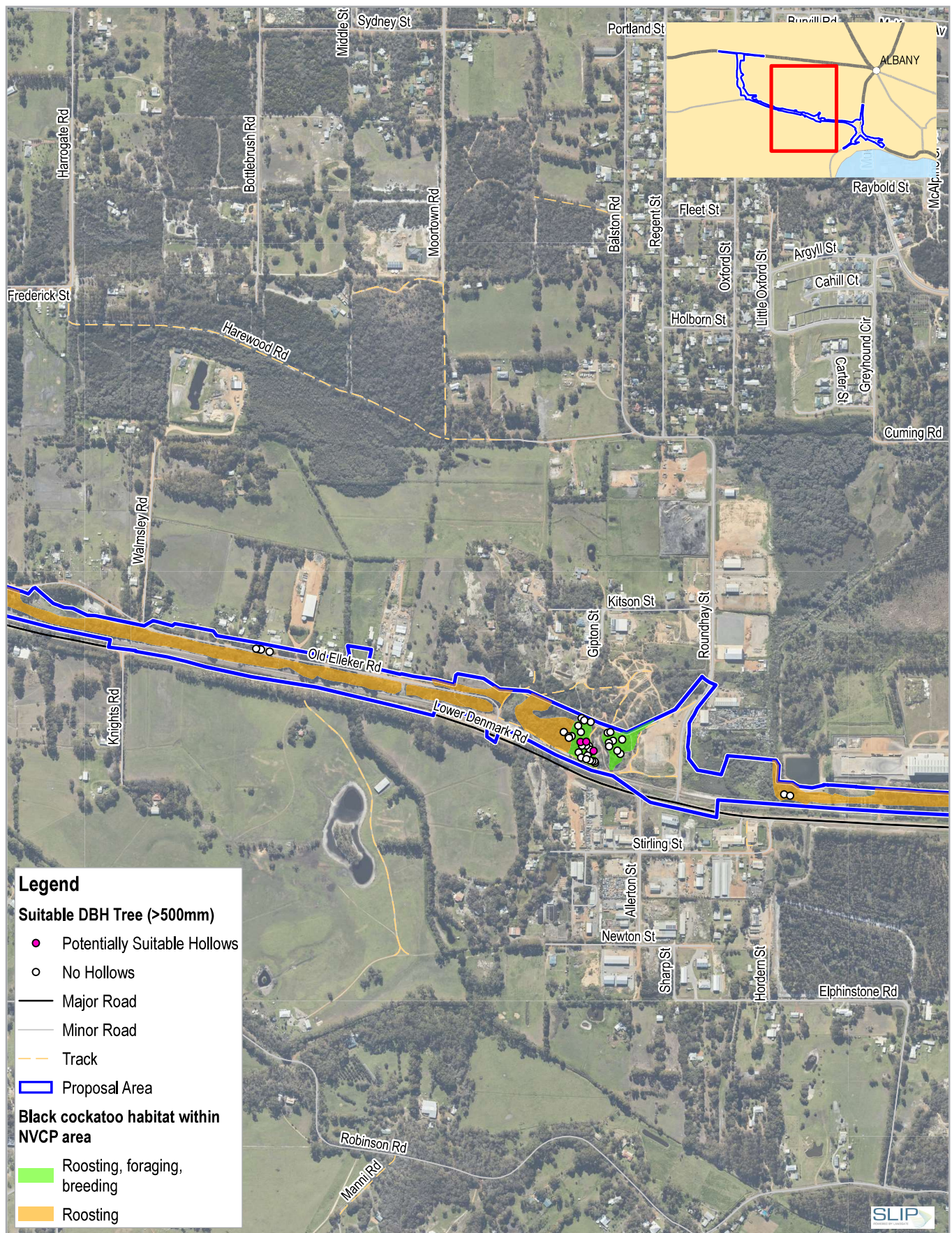


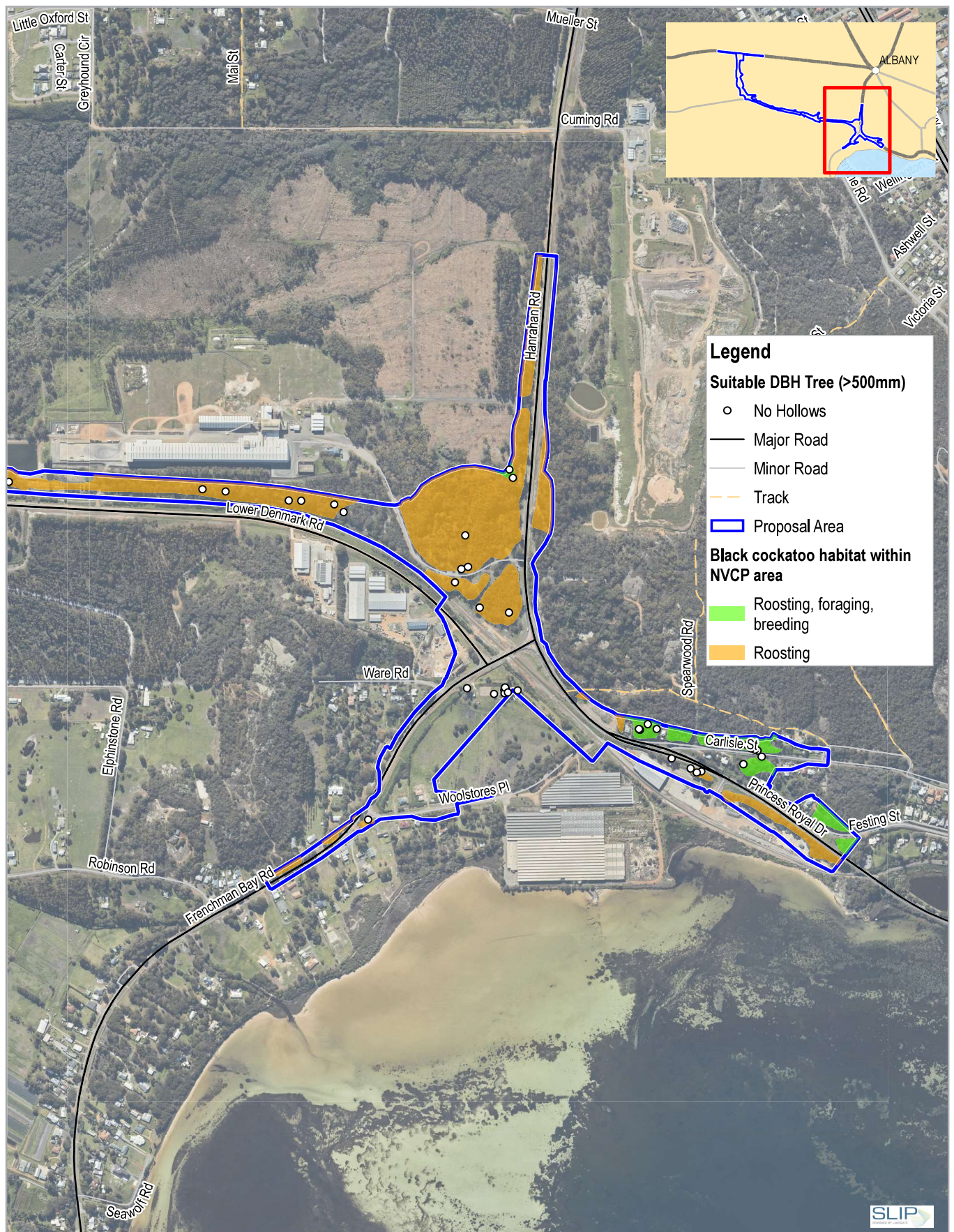
Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b

**Black Cockatoo
habitat within NVCP area**

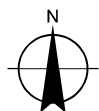
Project No. 12533824
Revision No. 0
Date 7/07/2021

**Page 1 of 3
FIGURE 8**





Paper Size ISO A4
0 50 100 150 200
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

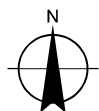
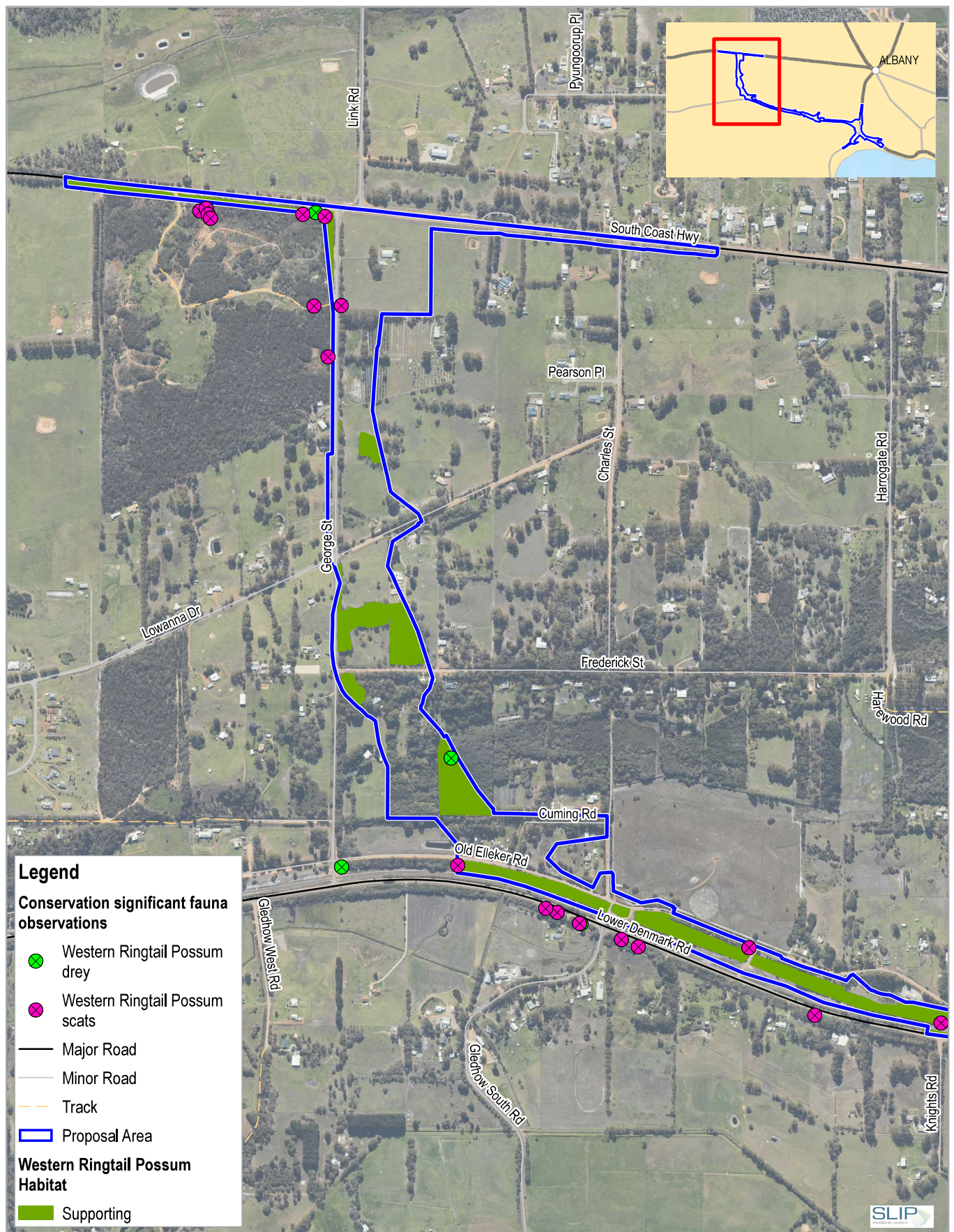


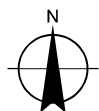
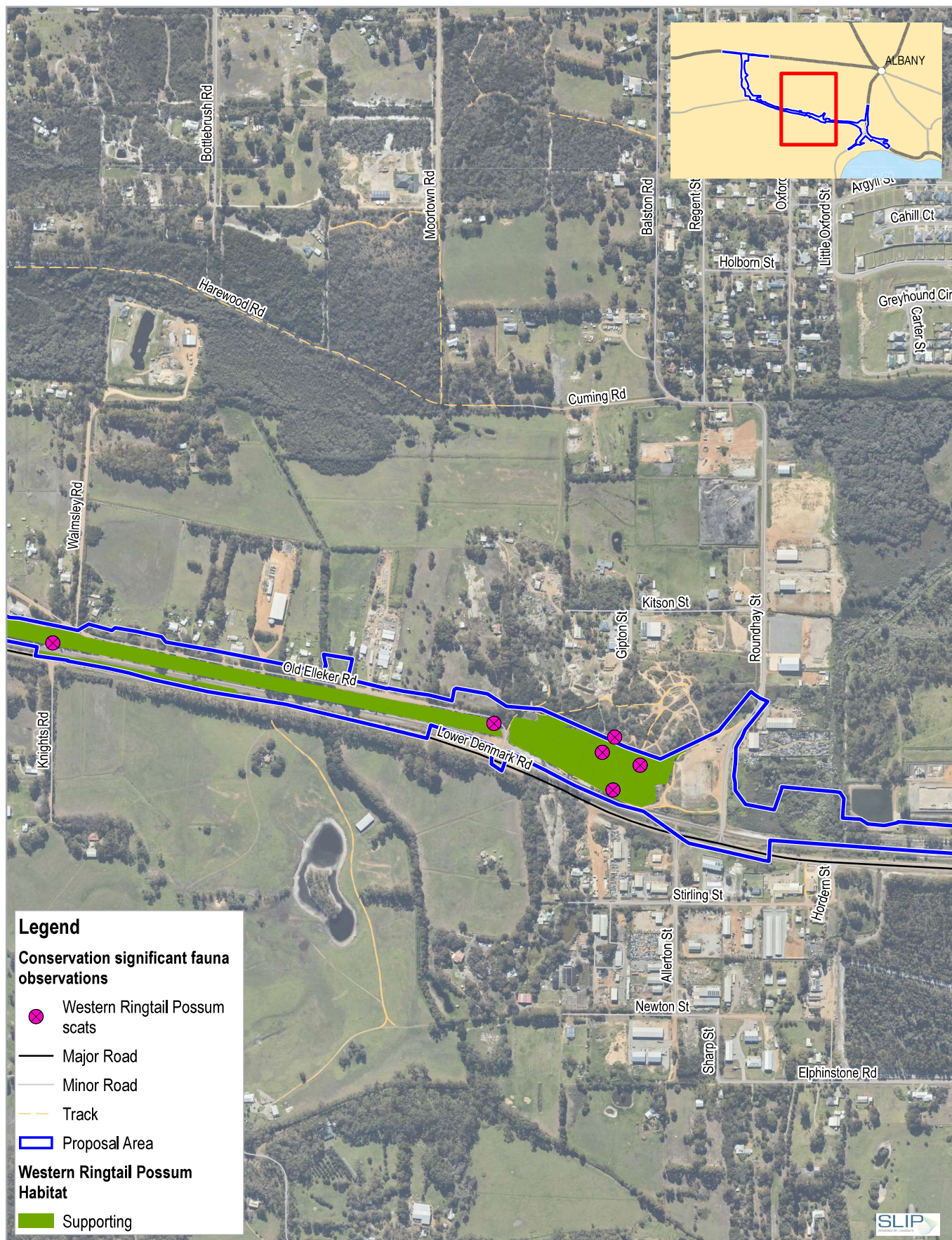
Main Roads Western Australia Albany Ring Road
Project Stages 2 and 3b

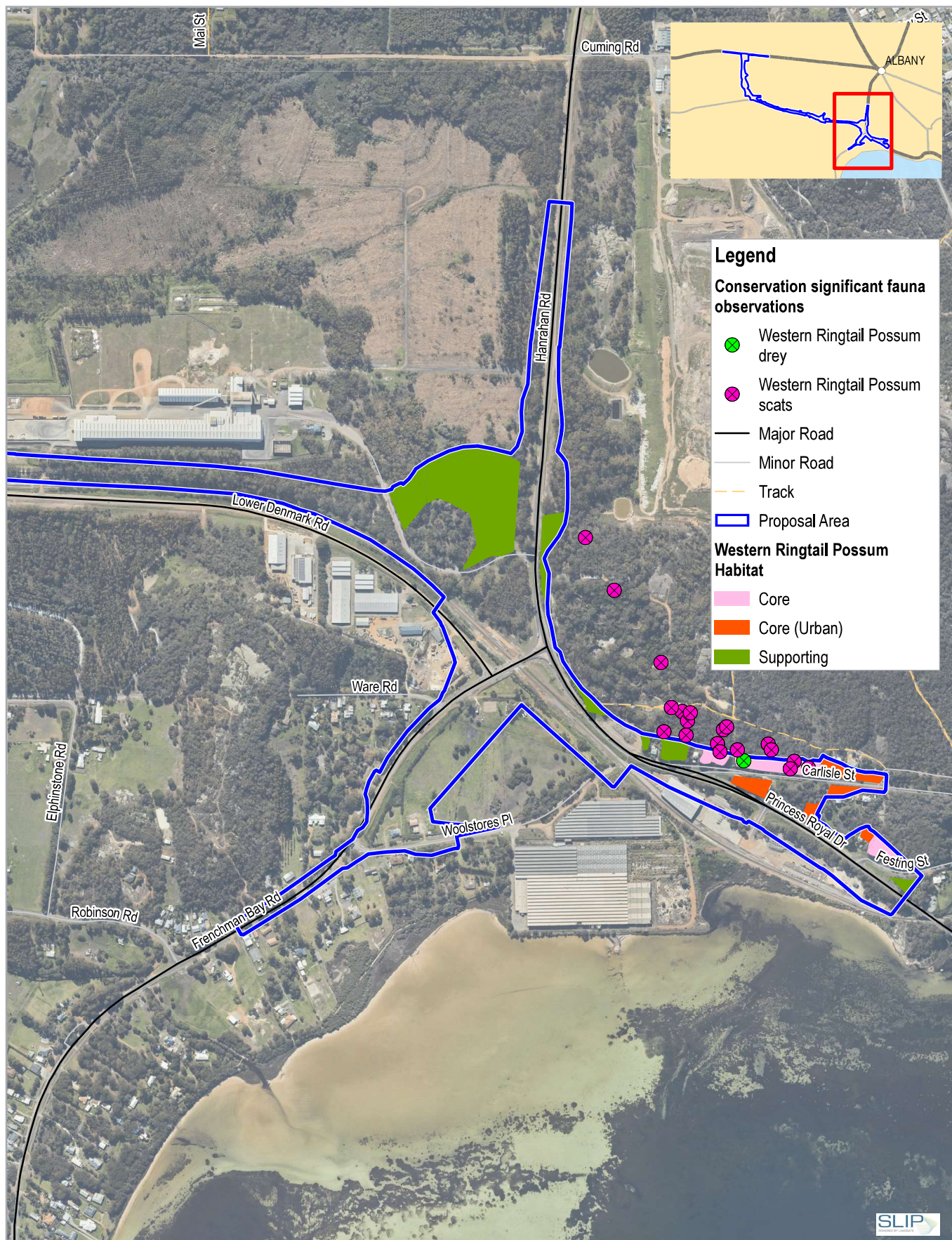
**Black Cockatoo
habitat within NVCP area**

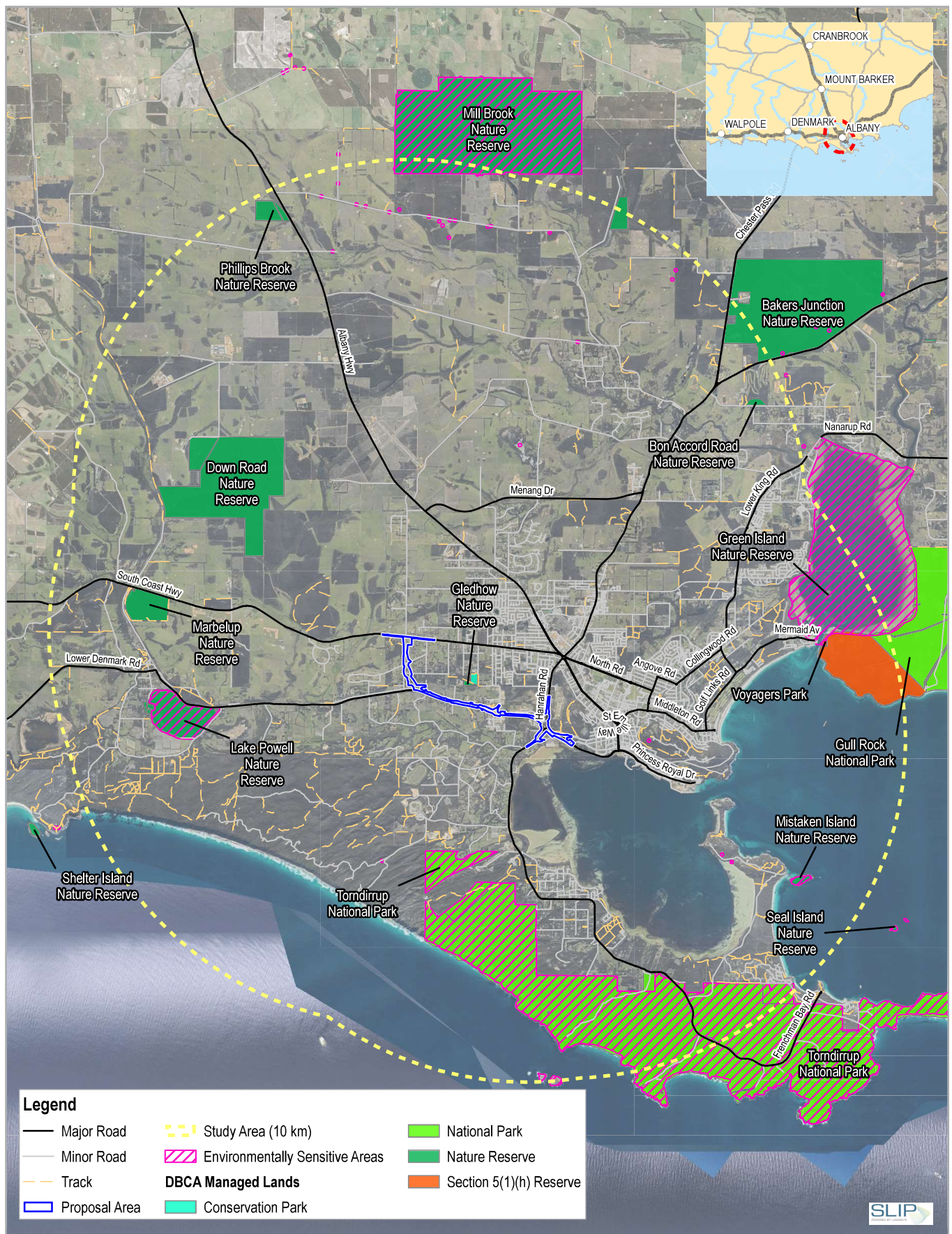
Project No. 12533824
Revision No. 0
Date 7/07/2021

**Page 3 of 3
FIGURE 8**









Appendix B – Summary of land parcels intercepted by the NVCP application area

Appendix B Land Parcel Information

Land Owner	Lot Number	Address	Certificate of Title	PIN	Land ID
Private	625	100 Festing Street, MOUNT MELVILLE 6330	001903000111	583893	1820156
Private	52	42 Frederick Street, GLEDHOW 6330	001492000262	587846	1894793
Private	110	25 George Street, GLEDHOW 6330	002223000452	11106020	3269506
Commissioner of Main Roads	620	460 Princess Royal Drive, MOUNT MELVILLE 6330	002042000523	583858	1820152
Commissioner of Main Roads	616	452 Princess Royal Drive, MOUNT MELVILLE 6330	000804000013	583867	1820148
Commissioner of Main Roads	64	109 George Street, GLEDHOW 6330	001438000939	587859	1894805
Commissioner of Main Roads	15	11 George Street, GLEDHOW 6330	001811000129	587862	1283846
Private	201	198 Hanrahan Road, MOUNT ELPHINSTONE 6330	002818000699	12038204	4071176
Private	594	9 Carlisle Street, MOUNT MELVILLE 6330	001863000072	583886	1820126
Private	65	59 Lowanna Drive, GLEDHOW 6330	001438000940	587863	1894806
Private	9		002526000626	1214930	1298486
Private	1157		000123000109A	583846	1820515
Private	140	23 Woolstores Place, MOUNT ELPHINSTONE 6330	001290000605	583842	3024892
Private	8	42 Lowanna Drive, GLEDHOW 6330	001643000199	587860	1268224
Private	53	24 Frederick Street, GLEDHOW 6330	001492000263	587845	1894794
Private	125	47917 South Coast Highway, MARBELUP 6330	001792000397	592382	1682412
Shire of Albany	50	4 Old Elleker Road, GLEDHOW 6330	001565000230	11560283	3589818
State of Western Australia	1350		LR003009000754	583850	1820610
State of Western Australia	617	454 Princess Royal Drive, MOUNT MELVILLE 6330	LR003150000628	583864	1820149
State of Western Australia	615	450 Princess Royal Drive, MOUNT MELVILLE 6330	LR003150000627	583868	1820147
State of Western Australia	614	20 Carlisle Street, MOUNT MELVILLE 6330	LR003150000626	583870	1820146
State of Western Australia	613		LR003150000625	583871	1820145
State of Western Australia	602	18 Carlisle Street, MOUNT MELVILLE 6330	LR003150000635	583873	1820134
State of Western Australia	601	16 Carlisle Street, MOUNT MELVILLE 6330	LR003150000634	583875	1820133
State of Western Australia	600	14 Carlisle Street, MOUNT MELVILLE 6330	LR003150000633	583877	1820132
State of Western Australia	599	281 Grey Street West, MOUNT MELVILLE 6330	LR003150000632	583879	1820131
State of Western Australia	598	279 Grey Street West, MOUNT MELVILLE 6330	LR003150000631	583880	1820130
State of Western Australia	597	277 Grey Street West, MOUNT MELVILLE 6330	LR003150000630	583881	1820129
State of Western Australia	596	13 Carlisle Street, MOUNT MELVILLE 6330	LR003139000710	583896	1820128
State of Western Australia	590	430 Princess Royal Drive, MOUNT MELVILLE 6330	LR003139000707	583898	1820122
State of Western Australia	595	11 Carlisle Street, MOUNT MELVILLE 6330	LR003139000709	583899	1820127
State of Western Australia	589	428 Princess Royal Drive, MOUNT MELVILLE 6330	LR003139000706	583900	1820121
State of Western Australia	95	28 George Street, GLEDHOW 6330	LR003037000820	592488	1894831
State of Western Australia	127		LR003116000179	1196283	1894856
State of Western Australia	127		LR003116000179	1196284	1894856
State of Western Australia	1454	84 Festing Street, MOUNT MELVILLE 6330	LR003109000850	1211540	1820691
State of Western Australia	0		000156000035	1311720	3045750
State of Western Australia	44		LR003008000848	11786504	3816532
Shire of Albany	619	458 Princess Royal Drive, MOUNT MELVILLE 6330	001115000827	583860	1820151
Shire of Albany	618	456 Princess Royal Drive, MOUNT MELVILLE 6330	001352000711	583862	1820150
Private	573	273 Grey Street West, MOUNT MELVILLE 6330	001002000346	583882	1820108

Road and Rail Lots (PIN Number): 1270602, 1270617, 1270693, 1270696, 1270701, 1274125, 1274130, 1274135, 1274135, 1274169, 1277633, 1277634, 1277635, 1277636, 1277638, 1279745, 1279749, 1279765, 1279875, 1279876, 1279877, 1286874, 1286875, 1286876, 1286879, 1286881 and 11398175.

Unallocated Crown Land Lots (PIN Number): 583742, 583845, 583864, 583868, 583870, 583871, 583873, 583875, 583877, 583879, 583880, 583881, 583896, 583898, 583899, 583900, 592360, 1150024 and 11786504

Reserve Lots (PIN Number) 583746, 583850. 592360. 592488. 1150024, 1196283, 1196284 and 1211540

Easement Lots (PIN Number) 11761510 and 12166600.

Appendix C – Biological Survey, Albany Ring Road (Southern Ecology, 2020a)

Biological Survey: Albany Ring Road



**Report prepared for
Main Roads Western Australia
January 2020**

**Damien Rathbone BScHons
& Dr Sandra Gilfillan**



Assessment for:

Main Roads Western Australia

Prepared by:

Southern Ecology

© DA Rathbone 2020. Reproduction of this report and maps in whole or in part is prohibited without the approval of the author or the client. The information provided within this report is accurate and correct to the best of the author's knowledge. No liability is accepted for loss, damage or injury arising from its use. The report should be read, distributed and referred to in its entirety.

Citation: Rathbone, DA & Gilfillan, S (2020). Biological Survey: Albany Ring Road. Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Rev. No.	Date	Author	File Name
Draft (Rev A)	20/1/2020		
Draft (Rev B)	11/02/2020		
Final (Rev 0)	24/2/2020		

REPORT CONTENTS

1	SUMMARY	6
2	INTRODUCTION.....	7
2.1	Project Background.....	7
2.2	Scope and Objectives	7
2.3	Local and Regional Context	8
2.3.1	Location and tenure	8
2.3.2	Biological Environment	8
2.3.3	Surface Water and Hydrology	9
2.3.4	Soil-Landscapes	9
2.4	State and Commonwealth Conservation and Pest Categories	10
3	METHODS.....	1
3.1	Personnel	1
3.2	Desktop Assessment	1
3.3	Likelihood of Occurrence Assessment.....	1
3.4	Field Assessment.....	2
3.4.1	Field Survey Schedule and Type	2
3.4.2	Weather	4
3.5	Vegetation Assessment.....	5
3.6	Targeted Flora Search	6
3.7	Weeds	6
3.8	Fauna Habitat Assessment	6
3.9	Targeted Fauna Search	7
3.9.1	Western Ringtail Possum (<i>Pseudocheirus occidentalis</i>) (T-CR).....	7
3.9.2	Black Cockatoo Species	9
3.10	Regional Significance of Fauna Habitat	9
3.11	Survey Limitations.....	10
4	FLORA RESULTS	12
4.1	Desktop Assessment	12
4.1.1	Flora.....	12
4.1.2	Vegetation.....	12
4.2	Field Assessment.....	13
4.2.1	Vegetation	13
4.2.2	Regional and Local Significance of Vegetation.....	24
4.2.3	Flora.....	26
4.2.4	Conservation Significant Flora	26
4.2.5	Weeds.....	29
5	FAUNA RESULTS.....	30
5.1	Desktop Assessment	30

5.2	Fauna Habitat	30
5.3	Targeted Conservation Significant Fauna	32
5.3.1	Western Ringtail Possum (<i>Pseudocheirus occidentalis</i>) (T-CR).....	32
5.3.2	Black Cockatoo Species	34
5.4	Other Conservation Significant Fauna	37
5.5	Regional Significance of Fauna Habitats	40
6	CONCLUSIONS.....	40
7	REFERENCES	42
8	APPENDIX A - Conservation Status Definitions	46
9	APPENDIX B – Map Series (see attached)	48
10	APPENDIX C - Plant Taxa Inventory	49
11	APPENDIX D - Floristic Quadrat Data.....	53
12	APPENDIX E - Likelihood of Occurrence Analysis	69
13	APPENDIX F - Significant Flora, Weed and Tree Locations	79
14	APPENDIX G - TPFL forms (see attached)	100
15	APPENDIX H - Naturemap and PMST search results (see attached)	100

LIST OF FIGURES, TABLES AND PLATES

Figure 1. Survey Area location	1
Table 1. Matrix of habitat suitability and effectiveness of field surveys to determine the likely presence of conservation significant flora and fauna post survey.....	2
Table 2. Field dates, survey type and approximate time expended.....	3
Figure 2. Rainfall statistics for 36 months that encompassed the assessment period compared with historical averages (all years available) from the nearest weather station (Albany 9500) (BOM 2019).	4
Table 3. Vegetation condition scale (EPA 2016a).....	6
Table 4. Habitat categories of Western Ringtail Possums (adapted from DEWHA (2009)).	8
Table 5. Habitat categories of Black Cockatoos (adapted from DEWHA (2009) and DSEWPaC (2012)).	9
Table 6. Assessment of potential survey limitations for flora and fauna.	11
Table 7. Extent (ha) and condition of remnant and non-native vegetation in the Survey Area.....	14
Table 8. Extent (ha) of pre-European vegetation associations from the Survey Area (Government of Western Australia [GoWA] 2019).....	24
Table 9. Overall extent and reservation status of vegetation associations from the Survey Area and local status derived from the Albany Regional Vegetation Survey (Sandiford and Barrett 2010). Includes IUCN I-IV reserves with Albany Region (<35 km radius).	24
Plate 1 and 2. <i>Prasophyllum macrostachyum</i> , the common congener of <i>P. paulinae</i> (P1) found within the Survey Area and the regional distribution of <i>P. paulinae</i> (DPaW 2019a).....	27
Plate 3 and 4. <i>Synaphea incurva</i> (P3) and regional distribution (DPaW 2019a).	27
Plate 5 and 6. <i>Boronia crassipes</i> (P3) and regional distribution (DPaW 2019a).	28
Plate 7 and 8. <i>Andersonia</i> sp. <i>Jamesii</i> (J. Liddel 84) (P4) and regional distribution (DPaW 2019a).....	28
Plate 9 and 10. <i>Thysanotus isantherus</i> (P4) and regional distribution (DPaW 2019a).	29
Table 10. Conservation significant fauna and known (x) or potentially (?) associated vegetation within the Survey Area compared to the larger Albany Regional Vegetation Survey Area (Sandiford and Barrett 2010). Information is not sufficient to determine the habitat of the Recherche Cape Barren Goose (VU), Short-nosed Snake (P2) and Woollybush Bee (P3).	31
Table 11. Extent of Western Ringtail Possum habitat in the Survey Area.....	32
Table 12. Western Ringtail Possum Linkages within the Survey Area.	33
Table 13. Count of hollows with an entrance size greater than 100 mm in potential breeding trees for Black Cockatoo species. .	35
Table 14. Summary of breeding, feeding and roosting habitat for three species of Black Cockatoo in the Survey Area.....	36

1 SUMMARY

Main Roads Great Southern Region are proposing to construct stage two and three of the Albany Ring Road Project. Southern Ecology was engaged to assess a broad project envelope (338 ha) for potential environmental constraints.

FLORA

- A total of 342 plant taxa from 65 families were recorded within and adjacent to 32 floristic quadrats established in the Survey Area.
- Populations of four Priority-listed flora were recorded: - *Synaphea incurva* (P1), *Boronia crassipes* (P3), *Andersonia* sp. Jamesii (J. Liddelow 84) (P4) and *Thysanotus isantherus* (P4). A previously recorded population of *Prasophyllum paulinae* (P1) is known from the Survey Area; the potential exists for it to re-emerge following fire.
- Five Declared Pests and/or Weeds of National Significance (WONS) were recorded: - Blackberry (**Rubus* species complex), Bridal Creeper (**Asparagus asparagoides*), Gorse (**Ulex europaeus*), Arum Lily (**Zantedeschia aethiopica*) and Lantana (**Lantana camara*).
- Vegetation condition graded from Completely Degraded to Excellent; Large areas of vegetation associated with shire reserves and intact wetlands on private property were classified as Excellent.
- Thirteen vegetation associations were described: - four occur exclusively in wetland habitats (*Homalospermum firmum*/*Callistemon glaucus* Peat Thicket, *Evandra aristata* Sedgeland, *Taxandria juniperina* Closed Forest and *Melaleuca preissiana* Low Woodland), three are associated with granite outcrops (*Taxandria marginata*, *Gastrolobium bilobum* and *Leucopogon assimilis* Shrublands) and six generally occur on uplands (*Hakea* spp. Shrubland/Woodland Complex, Jarrah/Marri/Sheoak Laterite Forest, Jarrah/Sheoak/*E. staeri* Sandy Woodland, Marri/Jarrah Coastal Hills Forest, Marri/Jarrah Forest/Peppermint Woodland and Peppermint Low Forest).
- Two Threatened and four Priority Ecological Communities occur in the vicinity; no vegetation in the Survey Area meets the requisite criteria for these communities. Several vegetation associations can be consigned as being significant due to their association with wetlands, granite refugia, low reservation status or low overall extent.

FAUNA

- Five significant fauna species were present within the Survey Area: - Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (T-EN), Baudin's Cockatoo (*Calyptorhynchus baudinii*) (T-EN), Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) (T-VN), Western Ringtail Possum (*Pseudocheirus occidentalis*) (T-CR), and Southern Brown Bandicoot (*Isodon obesulus* subsp. *fusciventer*) (P4).
- Western Ringtail Possum (WRP) scats were observed widely across the Survey Area, in multiple habitats of varying condition. *Core* and *supporting habitats* and *potential habitat linkages* were identified.
- Foraging and potential breeding habitat for three Black Cockatoo species occurred throughout the Survey Area, in all the Eucalypt Woodland/Forest habitats. Large areas of potential roosting sites were identified among both native and introduced tree species.
- No hollows were determined to be occupied or showed recent use by Cockatoo species. 60 trees contained hollows potentially suitable for the Carnaby's Cockatoo; 18 trees contained hollows potentially suitable for Forest Red-tailed Black Cockatoo and three trees contained hollows potentially suitable for Baudin's Cockatoo. In total, 662 potential breeding trees were recorded (DBH ≥ 500mm, with or without hollows) comprising of four tree species.

2 INTRODUCTION

2.1 Project Background

Main Roads Great Southern Region are proposing to construct a heavy haulage route around the City of Albany for the transport of materials to the City's port, called the Albany Ring Road Project. The project is a staged development to support freight growth and long-term transport needs in the City of Albany in Western Australia. The project will connect Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road allowing access to the Southern Ports Authority Albany Port (Figure 1). Stage one of the project, the construction and upgrade of Menang Drive to Chester Pass Road to Albany Highway was completed in 2017. Stages two and three are proposed.

Southern Ecology was engaged by Main Roads to assess the project envelope (the Survey Area) for potential constraints related to vegetation, flora, fauna or other environmentally sensitive sites. This report presents the results from survey effort from 2017 to 2019 for the project. The total Survey Area is 338 hectares (ha).

2.2 Scope and Objectives

The objective of the biological survey is to delineate key flora, fauna, soil, groundwater and surface water (wetlands) values within the Survey Area and to determine potential sensitivity to impact. The outcome of the survey and information supplied in the biological survey report will be used to inform the environmental assessment and approvals process. The scope of works included the following:

- Complete a desktop assessment of the survey area to identify:
 - Biological features and constraints which may be in or nearby the survey area.
 - Significant flora, vegetation/ecological communities, fauna, soil/land system, groundwater and surface water values and potential sensitivity to impact.
 - Likelihood of occurrence assessment for Threatened/Priority flora and fauna species that potentially occur.
 - Identify broad pre-European vegetation type(s).
- Conduct a detailed two-phase vegetation and flora survey to:
 - Verify and ground truth the desktop assessment findings.
 - Undertake vegetation association and condition mapping, including defining patches of planted and remnant native vegetation.
 - Identify and map the presence of any Threatened or Priority ecological communities (TECs or PECs).
 - Complete patch assessments for vegetation types which may potentially align with TECs against approved conservation advice.
 - Complete targeted searches to record the presence of any Threatened and Priority flora, Weeds of National Significance (WoNS) or Declared Pests, and map the extent of populations if encountered. Any Threatened flora to be mapped with a differential GPS.
 - Assess the flora species diversity, density, composition, structure and weed cover within marked quadrats.

- Conduct a Level 1 fauna survey, black cockatoo habitat and WRP assessments to:
 - Identify and map fauna habitat, including a summary of conservation significant fauna considered likely or possible to occur, or fauna recorded in each habitat type.
 - Map wetland habitat and riparian habitat if present.
 - Record native and non-native fauna within the Survey Area.
 - Identify and map of black cockatoo foraging habitat, roosting, potential breeding and actual breeding trees as per Commonwealth guidelines¹.
 - Identify and map Western Ringtail habitat as per Commonwealth guidelines.
- Provide a combined flora, vegetation, fauna and black cockatoo and western ringtail possum assessment report.

2.3 Local and Regional Context

2.3.1 Location and tenure

The Survey Area is located within the Southern Jarrah Forest subregion of the Jarrah Forest Interim Biogeographic Regionalisation of Australia (IBRA) Region (Department of the Environment [DoE] 2014a). It intersects shire reserves, private property and road reserves mainly to the west of the City of Albany and is centred on Link Rd, South Coast Highway, George St, Lower Denmark Rd and Albany Port Rd (Figure 1).

The Survey Area includes one large City of Albany reserve with remnant vegetation (Res 28465, 28466 & 28467; corner of South Coast Highway and George St) that is vested for gravel extraction and rubbish purposes. Several smaller reserves within the Survey Area are vested for railway, drainage, public utilities or other purposes. One gazetted conservation reserve (Gledhow Nature Reserve) and one Public Park (Mt Melville) occur within the vicinity of the Survey Area (Appendix B).

2.3.2 Biological Environment

The Survey Area occurs circles the western and southern interface between the urban and agricultural zones of Albany that was largely cleared for agricultural purposes in the 19th and 20th century. Three large patches of remnant vegetation remain within the Survey Area: Eucalypt and She-Oak Woodlands on George St Reserve (~30 ha), Forest and Granites on the lower southern slopes of Mt Melville (~12 ha) and a large wetland on Link Rd (6 ha). Other significant corridors of vegetation occur along Lower Denmark Rd and many narrow road reserves throughout the Survey Area continue to support native species. Large areas between Lower Denmark Rd and the Albany Port Rd have regenerated after clearing and/or have been planted with non-indigenous Eucalypts and Pine Trees.

Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) that overlies the Survey Area indicates the native vegetation is currently (or was previously) composed of three associations:

- Albany_3 - “Forest. Mainly jarrah and marri *Eucalyptus marginata*, *Corymbia calophylla*.”
- Albany_51 - “Sedgeland. *Cyperaceae*, *Restionaceae*, *Juncaceae*.”

¹ Biota undertook additional assessments of potential cockatoo breeding trees in 2019, which incorporated a reassessment of some trees (those occurring in the disturbance envelope) previously assessed by Southern Ecology in 2017, plus additional trees due to an expansion of the project footprint.

- Albany_978 - “Low forest, woodland or low woodland with scattered trees *Eucalyptus marginata*, *Banksia* spp., *Allocasuarina* spp.”

The Survey Area also occurs within the zone mapped during the Albany Regional Vegetation Survey (Sandiford and Barrett 2010), which provides meso-scale vegetation information and provides a context for assessing the regional conservation significance of vegetation associations. Eleven mapping Units have previously been mapped within the Survey Area:

- *Evandra aristata* Sedgeland (Unit 46)
- *Gastrolobium bilobum*/*Hakea elliptica* Granite Shrubland/Yate Woodland (Unit 23)
- *Hakea* spp Shrubland/Woodland Complex (Unit 31)
- *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (Unit 47)
- Jarrah/Marri/Sheoak Laterite Forest (Unit 12)
- Jarrah/Sheoak/*E. staeri* Sandy Woodland (Unit 13)
- Marri/Jarrah Coastal Hills Forest (Unit 17)
- Marri/Jarrah Forest/Peppermint Woodland (Unit 10)
- Peppermint Low Forest (Unit 2)
- *Taxandria juniperina* Closed Forest (Unit 59)
- *Taxandria marginata* Granite Shrubland (Unit 24).

2.3.3 Surface Water and Hydrology

The northern section of the Survey Area (Link Rd) intersects a broad drainage channel that supports a large area of seasonally wet or inundated wetland vegetation, which sheds water westward into Five Mile Creek and eventually into Lake Powell. The hydrology of the southern section of the Survey Area (Lower George St, Lower Denmark Rd) is largely altered by artificial channels installed early in the late 19th to make the peaty swaps more suitable for agriculture. These drains divert water south of the Survey Area into Robinson and eventually empty into Princess Royal Harbour.

Oyster Harbor represents the closest Nationally Important Wetland, with occurs 8 km east of the Survey Area and is hydrologically discrete. No Ramsar wetlands occur within the vicinity of the Survey Area.

2.3.4 Soil-Landscapes

Seven soil-landscapes (Department of Agriculture and Food Western Australia [DAFWA] 2017) are mapped within the Survey Area:

- Collis yellow duplex - “Gravelly yellow duplex soils; Jarrah-Marri forest.”
- Dempster crest - “Sands and laterite on elongate crests; Jarrah-Albany Blackbutt-Marri forest.”
- Dempster slope - “Sands and gravels on smooth slopes; Albany blackbutt-sheoak low forest.”
- Gardner granite - “Granite outcrop.”
- Mataband yellow duplex - “Gravelly yellow and yellow duplex soils; Jarrah-Marri-Yellow Tingle forest.”
- Minor Valleys S7 slope - “Broad valleys in sedimentary rocks; 30 m relief; smooth slopes. Deep sands and iron podzols on slopes; Albany Blackbutt-jarrah-sheoak woodland. Podzols and yellow duplex soils on floors; paperbark woodland, teatree heath.”
- Owingup Subsystem - “Plains with swamps, lunettes and dunes. Yellow solonchic soils, organic loams and diatomaceous earth. Wattle-Paperbark thickets, Teatree heath and reeds. Podzols on dunes; Banksia-Sheoak woodland.”

2.4 State and Commonwealth Conservation and Pest Categories

Commonwealth and State regulatory authorities maintain lists of vegetation, flora and fauna that are assigned into categories of conservation significance or pest status. An overview of the codes and categories used for conservation and pest status in Western Australia that are relevant to this biological survey are provided in Appendix A.



Figure 1. Survey Area location

3 METHODS

3.1 Personnel

The assessment was conducted by Damien Rathbone (botanist) and Dr Sandra Gilfillan (zoologist), with field assistance by Keith Smith, Anna de-Haan, Dylan Lehmann, Kirsty Vogel and Fin Pope-Gilby.

The flora survey (desktop and field assessment) was primarily conducted by Damien Rathbone (BScHons Plant Science, Scientific License 012382). Damien has over 14 years of experience conducting biological surveys in southern Western Australia. Within the South Coast region, he has previously undertaken Department of Biodiversity, Conservation and Attractions (DBCA) regional surveys (Albany Regional Vegetation Survey, Fitzgerald River National Park Flora Survey, Ravensthorpe Range Flora Survey), threatened species survey and recovery implementation, and has 10 scientific publications. Damien is also an accredited interpreter for dieback assessments on DBCA estate (Accreditation PDI-032).

Dr Sandra Gilfillan has worked extensively in the Great Southern and South Coast regions for the past 20 years. She has extensive experience in threatened species recovery planning, research and monitoring, including work on both Western Ringtail Possums (DBCA and Oyster Harbour Catchment Group) and Carnaby's Cockatoo (BirdLife Western Australia) and has a well-developed knowledge of the faunal ecology of the region.

3.2 Desktop Assessment

A desktop assessment of known or potential significant vegetation, flora and fauna within a 10 km radius of the Survey Area (the Study Area) was undertaken using the following sources:

- NatureMap (DBCA 2019a; results attached in Appendix H).
- Protected Matters Search Tool (PMST) (Department of the Environment and Energy [DotEE] 2019a; results attached in Appendix H).
- Threatened and Priority flora and fauna records from [DBCA] and/or the Western Australian Herbarium as supplied by Main Roads (16th July 2019) (mapped in Appendix B).
- PEC and TEC mapping from the Species and Communities Branch, DBCA, as supplied by Main Roads (16th July 2019) (mapped in Appendix B).

Prior to conducting the survey, the records returned from the database searches were assessed for their spatial accuracy. All valid species recorded were reviewed to determine key morphological characteristics, flowering times, habitat preferences and the likelihood and location of potentially suitable habitat within the Survey Area. This information was used to optimise the targeted flora and fauna surveys and the location of floristic quadrats (section 3.5, 3.6 and 3.9).

3.3 Likelihood of Occurrence Assessment

Following the field survey, all conservation significant flora and fauna species identified in the database searches that were not detected during the survey were assessed to determine their likelihood of occurrence in the Survey Area (post-survey likelihood of occurrence, Appendix F). Habitat suitability was determined from information in herbarium voucher labels, published descriptions, and knowledge from the authors. Survey effectiveness reflected the probability of detecting a particular species where

suitable habitat was present, which could be dependent on thoroughness of the survey, flowering period or timing of emergence (i.e. annuals or disturbance responsive species). Each species in the post-survey likelihood of occurrence (Appendix F) was assessed on a case by case basis according to the general categories summarized in Table 1.

Table 1. Matrix of habitat suitability and effectiveness of field surveys to determine the likely presence of conservation significant flora and fauna post survey.

		Survey Effectiveness		
		No survey limitations present that would have prevented detection; all habitats were thoroughly surveyed	Moderate survey limitations present (i.e. inconspicuous or cryptic species; dense vegetation)	Major survey limitations present (i.e. species is a post fire ephemeral and habitat are long unburnt; habitat inaccessible)
Habitat and Proximity	Species reliably recorded within close vicinity (<2 km) and suitable habitat present	Unlikely	Possible	Likely
	Species previously recorded within vicinity (2-10 km) but suitable habitat unknown	Unlikely	Possible	Possible
	Species previously recorded within vicinity (2-10 km) and suitable habitat present	Unlikely	Possible	Possible
	No suitable habitat appears to be present	Highly Unlikely	Unlikely	Possible

3.4 Field Assessment

3.4.1 Field Survey Schedule and Type

Various field surveys for vegetation, flora and fauna were undertaken over three years and included three spring seasons (October 2017 to October 2019) (Table 2). The majority of the Survey Area was assessed in 2017 and 2018; some minor additional areas were included in 2019 due to potential changes in the project envelope. Some key areas (such as the known population of *Prasophyllum paulinae*) were surveyed over repetitive seasons.

Surveys were conducted in accordance with the Environmental Protection Authority (EPA) Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a), Technical Guidance - Sampling methods for Terrestrial Vertebrate Fauna Surveys (EPA and DEC 2010) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) guidance for significant species (e.g. black cockatoos). Overall the survey effort comprised:

- Detailed flora and vegetation survey for the entire survey area.
- Targeted flora survey for *Prasophyllum paulinae* (including a targeted regional survey, see Appendix I).
- Level 1 fauna survey.
- Targeted fauna survey for Western Ringtail Possum.
- Targeted fauna survey for Black Cockatoos (Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Baudin's Cockatoo (*Calyptorhynchus baudinii*); and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*).

Survey effort derived from GPS tracklogs is shown on Map E, Appendix B.

Table 2. Field dates, survey type and approximate time expended.

Date	Personnel	Survey Type	Area	Survey Effort (hours)
24 th October 2017	Damien Rathbone, Sandra Gilfillan	Vegetation Mapping, Targeted flora survey of upland and granites. Targeted Fauna Survey, Fauna Habitat Assessment	Survey Area	14
25-26 th October 2017	Sandra Gilfillan	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	6
31 st October 2017	Sandra Gilfillan and Dylan Lehmann	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	14
7 th November 2017	Damien Rathbone, Sandra Gilfillan and Dylan Lehmann	Targeted flora survey of wetlands. Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	21
9 th November 2017	Damien Rathbone, Sandra Gilfillan	Vegetation Mapping, Targeted flora survey of wetlands. Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	12.5
13 th November 2017	Sandra Gilfillan and Kirsty Vogel	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	14
15 th November 2017	Sandra Gilfillan and Kirsty Vogel	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	12
21 st November 2017	Sandra Gilfillan and Dylan Lehmann	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	10
22 nd November 2017	Damien Rathbone and Fin Pope-Gilby	Floristic Quadrat Assessment	Survey Area	10
23 rd November 2017	Damien Rathbone, Fin Pope-Gilby and Sandra Gilfillan	Floristic Quadrat Assessment, Targeted Fauna Survey and Fauna Habitat Assessment	Survey Area	21
24 th November 2017	Damien Rathbone and Fin Pope-Gilby	Floristic Quadrat Assessment	Survey Area	14
27 th November 2017	Damien Rathbone and Fin Pope-Gilby	Floristic Quadrat Assessment	Survey Area	14
28 th November 2017	Damien Rathbone and Fin Pope-Gilby, Sandra Gilfillan	Floristic Quadrat Assessment, Targeted Fauna Survey and Fauna Habitat Assessment	Survey Area	21
30 th November 2017	Damien Rathbone, Sandra Gilfillan and Dylan Lehmann	Targeted Flora Survey, Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	10
7 th December 2017	Sandra Gilfillan	Targeted Fauna Survey and Fauna Habitat Assessment	Survey Area	5
11 th December 2017	Sandra Gilfillan	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	3
13-14 th December 2017	Sandra Gilfillan	Targeted Fauna Survey, Fauna Habitat Assessment and Cockatoo Tree Assessment	Survey Area	8
22 nd January 2018	Sandra Gilfillan	Targeted Fauna Survey and Fauna Habitat Assessment	Survey Area	4
20 th September 2018	Damien Rathbone	Targeted Flora Survey of uplands and Granites	Survey Area	7
17 th October 2018	Damien Rathbone	Targeted Flora Survey	Survey Area	7
30 th October 2018	Damien Rathbone, Keith Smith, Anna de-Haan	Targeted Flora Survey for <i>Prasophyllum paulinae</i>	Survey Area	15
21 st November 2018	Damien Rathbone	Targeted Flora Survey of Wetlands	Survey Area	7
30 th July 2019	Damien Rathbone	Targeted Flora Survey	Survey Area	7
2 nd , 8 th , 9 th , 13 th , 19 th August 2019	Damien Rathbone	Vegetation Mapping and Targeted Flora Survey	Survey Area and Additional 2019 Survey Areas	24
12-13 th August 2019	Sandra Gilfillan	Targeted Fauna Survey and Fauna Habitat Assessment	Additional 2019 Survey Areas	8
18 th October 2019	Damien Rathbone, Keith Smith	Targeted Flora Survey (including <i>Prasophyllum paulinae</i>)	Survey Area and Additional 2019 Survey Areas	16
TOTAL:				304.5

3.4.2 Weather

Daily weather observations recorded from Albany were used to describe local rainfall and temperatures preceding the survey (Figure 2). Overall rainfall in the three-year survey period was below average, counteracted by a mean to above mean rainfall in the two months preceding spring in each year.

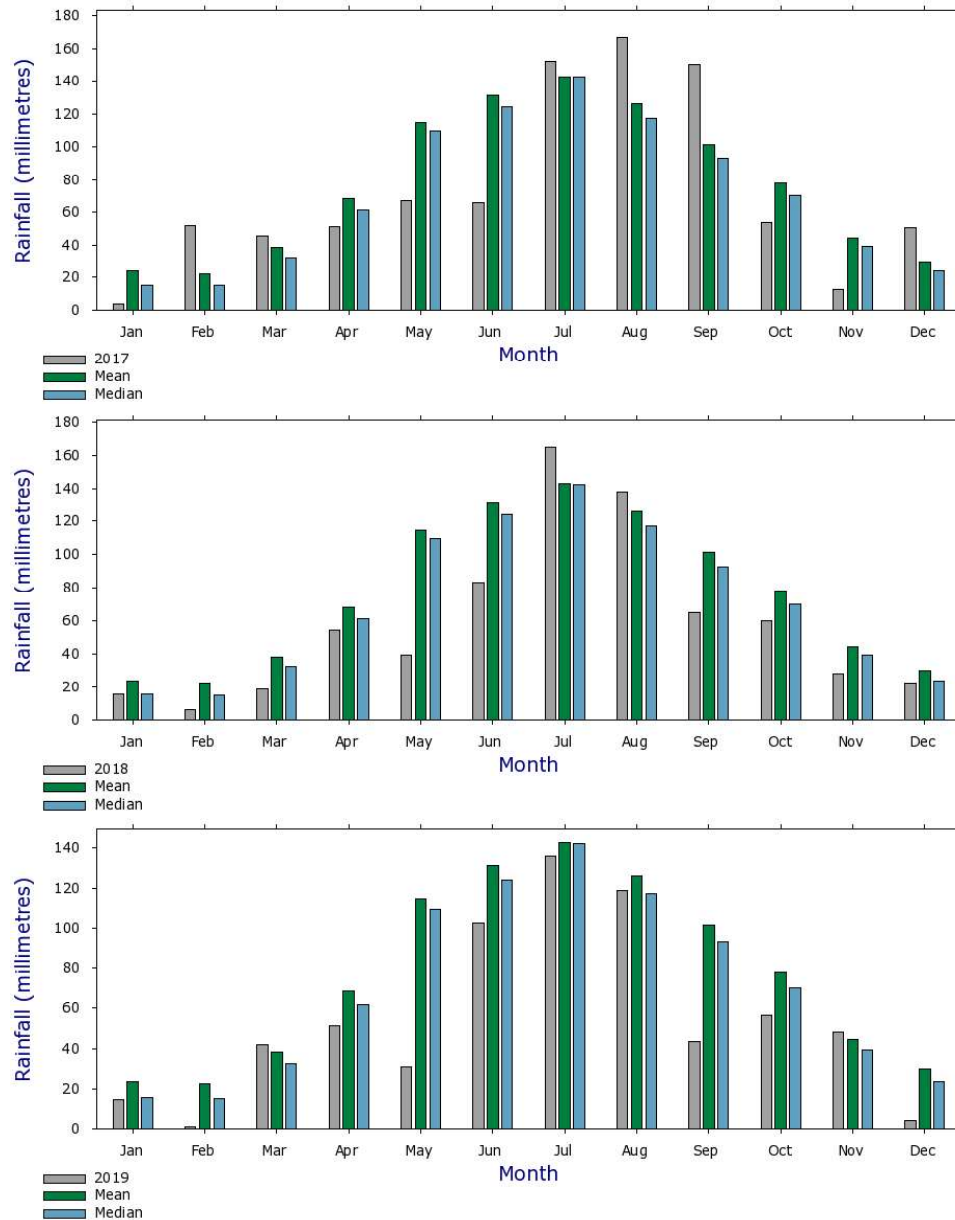


Figure 2. Rainfall statistics for 36 months that encompassed the assessment period compared with historical averages (all years available) from the nearest weather station (Albany 9500) (BOM 2019).

3.5 Vegetation Assessment

The vegetation and flora survey were undertaken in accordance with requirements of the EPA guidance document (EPA 2016a). Information acquired during the desktop review assisted in the design of the field survey. Pre-survey planning involved the examination of 1:5,000 scale orthophotos, soil and topography layers and existing records of conservation significant flora and vegetation.

The Survey Area was traversed by foot and vehicle and a vegetation assessment was conducted using floristic quadrats where the following attributes were recorded:

- Location and site description – GPS coordinate of NW corner using a handheld GPS (Garmin 64), other corners were measured using a vertex (Nikon 36) and compass. Quadrats dimensions are 10 m x 10 m unless stated. All four corners are marked with posts (temporarily) and UV stable flagging tape (3-5 years longevity).
- Species inventory – all vascular plant species present, including weed species. Species that were not confidently identified during the field survey were collected for identification in the Albany Regional Herbarium or Western Australian Herbarium.
- Foliar cover – the estimated percentage cover for each stratum and dominant species (up to three) within each stratum were noted. Vegetation structure was recorded in accordance with the National Vegetation Information System (Executive Steering Committee for Australian Vegetation Information [ESCAVI] 2003).
- Vegetation condition – according to the current vegetation condition classification (Table 3).
- Photographs – four photographs overlooking the quadrat were combined into a panorama.

The intensity of sampling with quadrats in each vegetation community varied depending on the area of extent, condition and species turnover. Regulatory guidance (EPA 2016a) indicates a minimum of three quadrats per vegetation type is recommended. In this survey, quadrats were specifically placed in vegetation with the highest apparent condition category and the number of quadrats was largely dependent on the total area of each community. Five associations were assessed by three or more quadrats (maximum of nine quadrats) and granite mosaics (included three associations as mosaics) were assessed in four quadrats. Three associations were assessed by less than three quadrats (*Taxandria juniperina* Closed Forest, *Evandra aristata* Sedgeland and Marri/Jarrah Coastal Hills Forest) due to a low overall extent or low extent in Good to Excellent condition. Two associations were not assessed by quadrats as were predominantly in Completely Degraded condition (assessed by opportunistic mapping sites only).

Quadrat information was used to define vegetation types that were manually aligned with Units described in the Albany Regional Vegetation Survey (Sandiford and Barrett 2010). Floristic similarity was assessed using two-way tables and field observations. Cladistics analysis was not conducted and was not considered necessary for alignment with these Units.

Table 3. Vegetation condition scale (EPA 2016a).

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks (dieback can be present in this category, but impacts are inconspicuous).
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

3.6 Targeted Flora Search

Targeted searches for potential Threatened and Priority flora identified from the desktop assessment were conducted over several field visits the Survey Area (details provided in Table 2). The searches were conducted in the appropriate season to detect most of the Threatened or Priority species considered possible to occur. The Survey Area was initially assessed to identify vegetation types and condition (see section 3.5). Vegetation and habitat types that were identified as potentially suitable for Threatened or Priority flora were surveyed by an intensive pattern of meandering transects. Where encountered, population census and site information of Threatened or Priority flora was recorded using a handheld GPS (Garmin 64) and in accordance with the Threatened and Priority Flora Report Form Field Manual (Department of Environment and Conservation [DEC] 2010). Population size was determined by either direct counts, or by estimation of plant density using transects or suitably sized quadrats. Additional regional targeted survey (outside the Survey Area) was conducted for *Prasophyllum paulinae* (P1), detailed in Appendix I.

3.7 Weeds

Cleared or pasture areas were not comprehensively surveyed, therefore not all weeds within the Survey were necessarily recorded. All weeds considered to be significant (Declared pests (DPIRD 2019) or Weeds of National Significance (WoNS) (DotEE 2019b)) or that were commonly encountered within remnant vegetation were recorded and/or mapped.

3.8 Fauna Habitat Assessment

A fauna habitat assessment was undertaken for conservation significant fauna that could potentially occur in the Survey Area determined from the desktop survey. The fauna habitat assessment primarily focused on the identification of fauna habitat based on vegetation type. Opportunistic recording of evidence (sightings, bird calls, tracks, scats, bones and feeding signs) of conservation significant fauna was also undertaken.

The likelihood of occurrence of significant fauna was determined by an assessment of the availability of potentially suitable habitat; its current known distribution and on any actual opportunistic sightings or signs of a species.

3.9 Targeted Fauna Search

Identification and quantification of habitat for Western Ringtail Possum and three species of Black Cockatoo (Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo) was specifically undertaken within the Survey Area, in accordance with EPBC Act guidelines (DEWHA 2009; DSEWPaC 2012). Habitat quality was categorised to identify important areas for each species.

3.9.1 Western Ringtail Possum (*Pseudocheirus occidentalis*) (T-CR)

The EPBC Act Significant Impact Guidelines for the WRP pertain only to the population occurring on the southern Swan Coastal Plain (DEWHA 2009), and to date, no guidelines have been developed for the South Coast population, which can be defined as a significant population under the aforementioned guidelines.

The South Coast population of WRP differs from the Swan Coastal Plain population in terms of habitat preference, refuge types and possibly other aspects of their ecology. For example, the presence of Peppermint (*Agonis flexuosa*) is not necessary for the presence of the species; habitats with high densities are largely confined to Marri/Jarrah/Sheoak communities within 20 km of the coast; diets can be quite broad and a small percentage of individuals use refugia on the ground (Van Helden *et al.* 2018; Van Helden unpub. data; Van Helden and Close pers. com.; Mathieson *et al.* in review; Gilfillan 2008 and S. Gilfillan pers. obs.). The EPBC Act Significant Impact Guidelines for the Swan Coastal Plain may therefore have limited application to the South Coast population.

The EPBC Act Significant Impact Guidelines categorised three areas as important for the WRP: *Core habitat*, *Primary corridors* and *Supporting habitat*. As these definitions in themselves are not specific to the Swan Coastal Plain they can potentially be used interchangeably. Using these habitat categories as a guide, plus current available data on Western Ringtail Possum ecology, habitat categories were defined for the South Coast population².

Habitat category definitions were defined for the South Coast population by:

1. Surveying for signs of the species within the Survey Area. Presence within a habitat patch was assessed by the observation of dreys and scats. All dreys seen were recorded. Absence of dreys, however, does not indicate absence of WRP (Gilfillan 2008). Scat searches were comprehensive, covering the entire remnant, therefore they provided an indication of the distribution of the species. The area of occupancy of WRP was based on the presence of scats or dreys. Where either of these signs were observed it was assumed that WRP would be using any continuous vegetation of similar habitat type extending from where the observations were made. Scat abundance is not an accurate measure of absolute abundance unless scat deposition and decay rates are known, but can be used as an indication of relative abundance (Wayne *et al.* 2006). In this survey the number of individual scat observations was used to aid the delineation of Western Ringtail Possum habitat.
2. Correlating available data on densities and home ranges of WRP with vegetation type. Data on densities was gathered from the following sources (Biota in prep; 2018; 2019: Gilfillan and Comer 2018; Van Helden *et al.* 2018; Van Helden pers. com.).

² NB: the defined categories should be considered draft (for details see Gilfillan 2019) and it is recommended they are presented to the Western Ringtail Possum Recovery Team for discussion and review.

- Gathering expert opinion of what constitutes habitat categories. Western Ringtail Possum researchers from the University of Western Australia were consulted on this matter (Paul Close and Bronte Van Helden).

The habitat categories and their definitions are outlined in Table 4. The extent of these categories within the Survey Area was mapped (Appendix B). In addition, the habitat categories were mapped (desktop assessment only) within a 5 km buffer of the Survey Area to give a regional context (see Gilfillan and Rathbone 2019).

Table 4. Habitat categories of Western Ringtail Possums (adapted from DEWHA (2009)).

Habitat Category	Areas mapped within the Survey Area.
Core <ul style="list-style-type: none"> likely contain sites necessary for breeding and dispersal, and support recruitment and population maintenance large remnants able to support multiple home ranges 	<ul style="list-style-type: none"> Any remnant patch >1ha with an established density of > 1/ha; OR <ul style="list-style-type: none"> Any remnant patch with an established abundance of >50 As a precautionary principal, any Jarrah, Marri or Sheoak forest or woodland, or Peppermint Low Forest remnant that is >50 ha in size until densities are established Urban areas with gardens generally having a > 30% canopy cover plus movement pathway such as fences and rooves
Supporting <ul style="list-style-type: none"> likely contain lower numbers of individuals and possibly survivorship likely provide an opportunity for an immigration source and emigration destination to allow for natural fluctuations in the species' fecundity may be breeding occurring or not can be native or non-native vegetation, including urban gardens 	<ul style="list-style-type: none"> any area with an established density of <1/ha, or established as individuals present (excluding linkages) OR <ul style="list-style-type: none"> any area with an established abundance of <50, or established as individuals present (excluding linkages) As a precautionary principal, any Jarrah, Marri or Sheoak forest or woodland, or Peppermint Low Forest remnant that is < 50 ha in size until densities are established Urban areas with gardens generally having a < 30% canopy cover and less movement pathways
Linkage <ul style="list-style-type: none"> no resident individuals, movement of animals only do not need to be continuous, but can contain small gaps, as Western Ringtail Possums can come to the ground to move short distances any structure that allows movement of individuals at a small to medium scale (e.g. street-scape/road-side non-native plantings, wind-breaks, plantations, fence lines) 	<ul style="list-style-type: none"> Linkage; scats or record of ringtail Linkage likely; no evidence of WRP, however links two areas of occupied habitat Linkage possible; no evidence of WRP, but links areas of vegetation that are potential habitat for WRP
Primary Corridor <ul style="list-style-type: none"> provide major connectivity between areas of occupation regional scale containing multiple home ranges breeding occurring provides movements and habitat (residents) 	<ul style="list-style-type: none"> Coastal Corridor (from West Cape Howe NP to Cheyne's Beach – this may extend either east or west with new records)

3.9.2 Black Cockatoo Species

Black Cockatoos (Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (T-EN); Baudin's Cockatoo (*Calyptorhynchus baudinii*) (T-EN); and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii subsp. naso*) (T-VU))

Breeding, foraging and roosting habitat was assessed in accordance with the EPBC Act Referral guidelines for the three threatened Black Cockatoo species (Table 5) (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC 2012). This included recording the species, location, number and behaviour of any observed Black Cockatoos; recording the number, location and species of breeding trees above or equal to a diameter at breast height (DBH) of 500 mm and notes on whether trees contain hollows; the presence and extent of potential and known foraging habitat (identification of areas with known feeding species and observations of feeding evidence); and the presence and extent of potential roosting habitat. For Tuart (*Eucalyptus gomphocephala*) many trees branched well below breast height. In these cases, the diameter was measured below the first branch. For Pine (*Pinus radiata*) only an estimate of whether the DBH was greater than or less than 500 mm was taken, as the value of pines as a food source is not dependent on this threshold value. Pine saplings were recorded and specifically noted as such.

The survey timing potentially coincided with the use of hollows by nesting cockatoos, however the assessment was made only from ground level therefore limiting the detectability of active, or recently active hollows. Where a hollow was visible but an assessment of suitability or hollow entrance could not be made, the notation of 'possible' was made (a follow-up detailed assessment of breeding trees using a drone was undertaken by Biota (2019b).

Recording of feeding evidence by Black Cockatoos was not exhaustive, but a sufficient sample of records were taken for each habitat patch, in order to assist in characterising that patch as current feeding habitat. However, any area within the range of the black cockatoos that contains known food or plant species is considered to be potential foraging habitat for the species (DSEWPaC 2012).

Table 5. Habitat categories of Black Cockatoos (adapted from DEWHA (2009) and DSEWPaC (2012)).

High quality foraging habitat (high_feed)	habitat patches consisting of a high coverage of feeding trees with a mature canopy. (NB: Pines not included in habitat assessment)
High quality breeding habitat (high_breed)	habitat patches consisting of a high number of potential breeding trees (≥500 mm DBH)
High quality roosting habitat (high_roost)	habitat patches consisting of a high number of potential roosting trees
Low quality foraging habitat (low_feed)	habitat patches consisting of a low coverage of feeding trees with a mature canopy
Low quality breeding habitat (low_breed)	habitat patches consisting of a low number of potential breeding trees (≥500 mm DBH)
Low quality roosting habitat (low_roost)	habitat patches consisting of a low number of potential roosting trees

3.10 Regional Significance of Fauna Habitat

A regional perspective on the significance of fauna habitat within the Survey Area was determined by comparing the extent of vegetation associations suitable for significant species as a proportion of the total habitat within the Albany Regional Vegetation Survey Area (approximately 30 km radius around Albany) (Sandiford and Barrett 2010). Regional significance is also discussed with respect to the range of the conservation significant species.

3.11 Survey Limitations

In accordance with the EPA (2016a) document *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* and EPA (2010) an assessment of potential survey limitations was undertaken (Table 6). No avoidable limitations were identified that can be expected to have affected the reliability of the results of the field survey.

Seasonal conditions preceding the field assessment have the potential to affect the emergence of annual species and the flowering of perennial species. The Survey Area occurs within a high rainfall zone and the assessment was conducted after close to average rainfall (Figure 3.1.2). Consequently, soil moisture conditions were not considered a major limitation for the emergence and flowering of Threatened or Priority flora species.

The information provided within this report is accurate and correct to the best of the author's knowledge. However, no liability is accepted for loss, damage or injury arising from its use. Plant populations can fluctuate over time, particularly after disturbance events such as fire and drought. Consequently, all mapping, vegetation descriptions and population estimates within this report should not be considered accurate indefinitely.

Table 6. Assessment of potential survey limitations for flora and fauna.

Potential for limitation	Assessment
Availability of contextual information	<p>Flora: Regional vegetation mapping (Sandiford and Barrett 2010) and flora records from the DBCA were available to allow for an appropriate level of contextual information prior to the field survey. Due to the proximity to Albany the environmental values within the survey area are considerably to be well documented.</p> <p>Fauna: There has been no comprehensive classification of fauna habitats across the region, so it was necessary to base fauna habitats on ARVS vegetation units. No regional biological (fauna) survey has been carried out for the region. Local assessments for Western Ringtail Possum were considered during the assessment (Oyster Harbour Catchment Group surveys (Mt Melville and Mt Adelaide/Clarence)).</p>
Personnel experience	<p>Flora and fauna: The senior ecologists conducting the assessments are competent with extensive experience (>10 years) in surveying south coast biota.</p>
Proportion of flora and fauna recorded or identification issues	<p>Flora: All specimens collected were identified to species level. The survey intensity (including surveys from 2017 to 2019) is considered sufficient to have recorded all or most of the native species present in the Survey Area.</p> <p>Fauna: Five out of 14 species potentially occurring were identified in the field (by signs only): three species of Black Cockatoo (feeding signs only); Western Ringtail Possum (scats and dreys); Quenda (diggings). For non-targeted fauna species only opportunistic sampling was undertaken, thus this was biased toward species that can easily be detected by sightings or by prominent signs such as scats or diggings. For example, Quenda diggings are easily detected and therefore the distribution of Quenda determined by the survey is likely to be a close approximation of its true distribution. Nocturnal, cryptic, less common species or seasonal visitors were not likely to have been identified during the survey. For example, the Brush-tailed Phascogale is a nocturnal species and is very difficult to detect by signs and requires trapping to determine presence. For these reasons the focus in this survey was on identifying potential suitable habitat rather than presence of these species.</p>
Extent of survey and site access	<p>Flora: The area of survey is relatively large, however is mainly non-native vegetation. The areas of intact native vegetation were adequately surveyed and no major access restrictions were present. The survey intensity (including surveys in 2017, 2018 and 2019) is considered sufficient to have recorded most of the native species present in the Survey Area.</p> <p>Fauna: The intensity of the targeted fauna surveys was adequate; all areas of remnant vegetation were surveyed completely. Access was generally not hindered, traversing the wetlands on Link Rd is challenging and at times impossible due to very thick vegetation and blackberry infestations.</p>
Timing/weather/season/cycle	<p>Flora: The survey timing was undertaken specifically to target potential significant flora determined from the desktop assessment. Surveys were stratified from early to late Spring over multiple years, which therefore captured a wide breadth of flowering times. Within the southern Jarrah forest region September and October is appropriate for botanical surveys in upland areas; November to January is appropriate for lowland/wetland areas.</p> <p>Whilst below average rainfall occurred in all three years, this was counteracted by high rainfall preceding the spring surveys, such that the seasonal conditions were considered appropriate for recording the flora values present.</p> <p>Fauna: Timing of surveys may not have been within the breeding season of the Forest Red-tailed Black Cockatoo (breeding can occur at any time of year depending on resource availability).</p>
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey	<p>Flora: Large areas of Survey Area on Lower Denmark road adjacent to the railway line were slashed in 2019, therefore may change the short-term structure and floristics of those areas. Most of the fire ages present were estimated to be > 5 years, therefore the previous fire regime is not expected to affect the recording of the flora values present. Some long unburnt areas may have reduced to ability to detect some fire ephemeral species (see desktop assessment for more details).</p> <p>Fauna: No disturbances were likely to have affected the fauna survey results.</p>

4 FLORA RESULTS

4.1 Desktop Assessment

4.1.1 Flora

The desktop assessment identified that 70 conservation significant flora have previously been recorded in the vicinity (<10 km) of the Survey Area (mapped in Appendix B). A post-survey likelihood of occurrence assessment of conservation significant flora (Appendix E) was undertaken following the field visits to determine the suitability of habitats encountered and the effectiveness of the survey effort and timing. The assessment determined the following conclusions:

- Five species identified in the desktop assessment were recorded in the Survey Area.
- Suitable or potentially suitable habitat for 38 conservation significant flora was present in the Survey Area, based on general soil and landform characteristics. However, none of these species were recorded during the survey. No survey limitations (i.e. flowering time, absence of disturbance) were identified for any of these species that would have prevented their detection during the survey, therefore they are considered unlikely to be present.
- One threatened orchid, *Caladenia harringtoniae* (T) was considered to potentially occur associated with granite on Mt Melville. Targeted surveys were conducted at the appropriate time of year and no individuals were detected. However, there remains the possibility for this species to emerge after fire.
- Four Priority-listed annual taxa that occur in wetlands/damplands were considered possible to occur within the Survey Area: *Drosera paleacea* (P1), *Gonocarpus simplex* (P4), *Microtis pulchella* (P4) and *Microtis quadrata* (P4). These taxa flower in summer and are most prolific after fire, therefore would have been difficult or impossible to detect during the survey (fire has been absent from the majority of the Survey Area for >10 years).
- Two Priority-listed species are inconspicuous and may not have been flowering during the surveys, therefore may have been difficult to detect if in low numbers (*Schoenus* sp. Grassy (E. Gude & J. Harvey 250) (P2) and *Laxmannia jamesii* (P4)).
- Fourteen species were considered 'Unlikely' to occur as no (or very limited) suitable habitat was present in the Survey Area.
- Five species were considered 'Unlikely' to occur as the Survey Area is outside their known range (records in the study area are geo-spatial errors).

4.1.2 Vegetation

The desktop assessment determined that two TECs may occur within the Survey Area: “*Subtropical and temperate saltmarsh*” (Vulnerable) and “*Proteaceae Dominated Kwongkan Shrublands*” (Endangered) (DotEE 2019a) (Mapped in Appendix B). The “*Subtropical and temperate saltmarsh*” community is confined to the saline tidal margins of Princess Royal Harbour and Torbay inlet and is considered highly unlikely to occur with the Survey Area. The “*Proteaceae Dominated Kwongkan Shrublands*” only applies to vegetation within the Southeast Coastal Floristic Province, therefore cannot be applied within the Survey Area.

Four PECs occur directly adjacent to the Survey Area (DPaW 2019b, Appendix B). *Banksia coccinea* Thicket (P1), Coastal *Melaleuca incana/Taxandria juniperina* (P1), *Banksia littoralis/Melaleuca incana* (P1) and *Astartea scoparia* Swamp Thicket (P1). All of these communities were considered during the field assessment.

4.2 Field Assessment

4.2.1 Vegetation

Thirteen native vegetation associations were described from the Survey Area: - four occur exclusively in wetland habitats, three are associated with granite outcrops and six generally occur on uplands of sand or predominantly laterite. Three granite shrublands/woodland combinations occurred that varied below the resolution of mapping used in this assessment 1:5000, therefore were mapped as mosaics (all mosaics represent 50% proportions of each association) (Table 7).

Remnant vegetation covered a total of 80.7 ha (24%) of the 338 ha Survey Area and was represented in condition scales grading from Completely Degraded (native understory very sparse or absent) to Excellent (no obvious disturbance). The condition of the majority of the remnant vegetation (61%) was classified as Very Good or Excellent.

Remaining areas were mainly comprised of roads, tracks, commercial or residential areas and pasture. Five additional non-native vegetation types were mapped (total of 98.99 ha), comprised of weeds, revegetation or plantations.

Vegetation descriptions for native and non-native vegetation is provided below; mapping is provided in Appendix B.

Table 7. Extent (ha) and condition of remnant and non-native vegetation in the Survey Area.

Vegetation Association (ARVS Unit)	Condition					Total:
	Completely Degraded	Degraded	Good	Very Good	Excellent	
Uplands						
Hakea spp. Shrubland/Woodland Complex (31)		1.72		0.47	2.52	4.71
Jarrah/Marri/Sheoak Laterite Forest (12a)	2.50	7.21	0.14	2.76	19.90	32.51
Jarrah/Sheoak/E. staeri Sandy Woodland (13)		0.94			3.29	4.24
Marri/Jarrah Coastal Hills Forest (17)					2.13	2.13
Marri/Jarrah Forest/Peppermint Woodland (10)	0.70	3.61	1.17	5.59		11.07
Peppermint Low Forest (2)	1.42					1.42
Granites						
Taxandria marginata Granite Shrubland (24)		0.85		0.42	0.58	1.85
Gastrolobium bilobum Granite Shrubland/Yate Woodland (23)	0.14	0.56		0.42	0.23	1.35
Leucopogon assimilis Granite Shrubland (25)					0.35	0.35
Wetlands						
Evandra aristata Sedgeland (46)				0.64		0.64
Homalospermum firmum/Callistemon glaucus Peat Thicket (47)	1.93	1.68		1.96	4.96	10.53
Melaleuca preissiana Low Woodland (49)	1.12			0.06		1.18
Taxandria juniperina Closed Forest (59)	4.44	1.48	0.05	2.75		8.72
Sub-total:	12.25	18.05	1.36	15.07	33.96	80.70
Non-native Vegetation						
Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)						74.51
Woody Weeds (Victorian Tea Tree, Taylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)						7.14
Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)						2.16
Revegetation (mixed shrubs and trees generally <10 years old)						5.58
Isolated Plants (Pasture and herbaceous weeds with isolated native plants)						9.60
Completely Cleared						158.63
Grand Total:						338.32

Hakea spp. Shrubland/Woodland Complex:

Soil: White sand with heavy laterite gravel and rocks (<30mm)

Landform: Hill crest

Represented in quadrat 1, 2, 3 & 32

Total of 4.71 ha, Degraded to Excellent Condition

Concordant with Unit 31(Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Mallee <10m	10-30%	<i>Eucalyptus marginata</i> , <i>Eucalyptus staeri</i> , <i>Allocasuarina fraseriana</i>
Shrubs >2m	10-70%	<i>Hakea ferruginea</i> , <i>Hakea lasiantha</i> , <i>Hakea ceratophylla</i> , <i>Hakea trifurcata</i> , <i>Hakea lasiantha</i>
Shrubs 1-2m	10-30%	<i>Acacia browniana</i> var. <i>browniana</i> , <i>Acacia myrtifolia</i> , <i>Agonis theiformis</i> , <i>Allocasuarina humilis</i> , <i>Beaufortia decussata</i> , <i>Petrophile diversifolia</i> , <i>Leucopogon verticillatus</i> , <i>Leucopogon obovatus</i> subsp. <i>obovatus</i>
Shrubs <1m	10-30%	<i>Hibbertia microphylla</i> , <i>Hovea trisperma</i> , <i>Dasygogon bromeliifolius</i> , <i>Synaphea gracillima</i> , <i>Xanthorrhoea platyphylla</i> , <i>Sphaerolobium grandiflorum</i> , <i>Sphenotoma capitata</i> , <i>Pultenaea verruculosa</i> , <i>Andersonia</i> sp. <i>Jamesii</i> (J. Liddelow 84)
Sedges	<10%	<i>Lepidosperma drummondii</i> , <i>Lepyrodia hermaphrodita</i> , <i>Anarthria gracilis</i> , <i>Anarthria prolifera</i> , <i>Mesomelaena tetragona</i> , <i>Tetraria octandra</i>

Jarrah/Marri/Sheoak Laterite Forest:

Soil: Grey sand with laterite gravel

Landform: Middle to upper hill-slopes

Represented in quadrat 4, 5, 6 & 7

Total of 32.51 ha, Completely Degraded to Excellent condition

Concordant with Unit 12a (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	30-70%	<i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Allocasuarina fraseriana</i>
Shrubs >2m	10-30%	<i>Banksia grandis</i> , <i>Persoonia longifolia</i> (dieback free areas only), <i>Hakea amplexicaulis</i>
Shrubs 1-2m	10-30%	<i>Beaufortia decussata</i> , <i>Bossiaea linophylla</i> , <i>Agonis theiformis</i> , <i>Xanthorrhoea platyphylla</i> , <i>Leucopogon verticillatus</i>
Shrubs <1m	10-30%	<i>Acacia browniana</i> var. <i>browniana</i> , <i>Dasygogon bromeliifolius</i> , <i>Hibbertia cunninghamii</i> , <i>Logania serpyllifolia</i> subsp. <i>serpyllifolia</i>
Sedges	30/70 %	<i>Patersonia umbrosa</i> var. <i>umbrosa</i> , <i>Desmodcladus fasciculatus</i> , <i>Tetraria octandra</i> , <i>Lomandra pauciflora</i> , <i>Tetraria</i> sp. Jarrah Forest (R. Davis 7391)

Jarrah/Sheoak/*E. staeri* Sandy Woodland:

Soil: Grey sand

Landform: Middle hill-slopes

Represented in quadrat 8, 21 & 25

Total 4.23 ha, Degraded to Excellent condition

Concordant with Unit 13 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	30-70%	<i>Eucalyptus marginata</i> , <i>Eucalyptus staeri</i> , <i>Allocasuarina fraseriana</i> , <i>Corymbia calophylla</i>
Shrubs >2m	10-30%	<i>Banksia grandis</i> (dieback free areas only)
Shrubs 1-2m	10-30%	<i>Bossiaea linophylla</i> , <i>Agonis theiformis</i> , <i>Xanthorrhoea platyphylla</i> , <i>Leucopogon verticillatus</i> , <i>Hakea ruscifolia</i> , <i>Leucopogon obovatus</i> subsp. <i>obovatus</i>
Shrubs <1m	10-30%	<i>Acacia browniana</i> var. <i>browniana</i> , <i>Dasyopogon bromeliifolius</i> , <i>Hibbertia cunninghamii</i> , <i>Xanthosia rotundifolia</i> , <i>Opercularia hispidula</i> , <i>Hibbertia cuneiformis</i>
Sedges	30/70 %	<i>Anarthria scabra</i> , <i>Patersonia umbrosa</i> var. <i>umbrosa</i> , <i>Tetraria octandra</i> , <i>Tetraria</i> sp. Jarrah Forest (R. Davis 7391), <i>Johnsonia lupulina</i>

Marri/Jarrah Coastal Hills Forest:

Soil: Brown loamy sand, granite boulders

Landform: Middle - upper hill-slopes

Represented in quadrat 11 & 12

Total 2.13 ha, Excellent condition

Concordant with Unit 17 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	30-70%	<i>Corymbia calophylla</i> , <i>Eucalyptus cornuta</i> , <i>Agonis flexuosa</i>
Shrubs >2m	<10%	<i>Bossiaea linophylla</i> , <i>Gastrolobium bilobum</i>
Shrubs 1-2m	10-30%	<i>Hovea elliptica</i> , <i>Leucopogon obovatus</i> subsp. <i>obovatus</i>
Shrubs <1m	10-30%	<i>Tremandra stelligera</i> , <i>Opercularia hispidula</i> , <i>Hibbertia cuneiformis</i> , <i>Hibbertia furfuracea</i> ,
Sedges/Grasses	10-30%	<i>Loxocarya cinerea</i> , <i>Microlaena stipoides</i> , <i>Poa porphyroclados</i> , <i>Stypandra glauca</i> , <i>Tetrarrhena laevis</i> , <i>Tetraria octandra</i> , <i>Lepidosperma tenue</i>

Marri/Jarrah Forest/Peppermint Woodland:

Soil: Brown or grey sand, sometimes granite boulders

Landform: Middle - lower hill-slopes

Represented in quadrat 9, 15 & 20

Total 11.07 ha, Completely Degraded to Excellent condition

Concordant with Unit 10 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	30-70%	<i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i> , <i>Eucalyptus cornuta</i> , <i>Agonis flexuosa</i>
Shrubs >2m	<10%	<i>Bossiaea linophylla</i> , <i>Hovea elliptica</i> , <i>Agonis theiformis</i>
Shrubs 1-2m	10-30%	<i>Hovea elliptica</i> , <i>Leucopogon obovatus</i> subsp. <i>obovatus</i>
Shrubs <1m	10-30%	<i>Pteridium esculentum</i> , <i>Tremandra stelligera</i> , <i>Opercularia hispidula</i> , <i>Hibbertia furfuracea</i> , <i>Hibbertia cuneiformis</i> , <i>Xanthosia rotundifolia</i>
Sedges/Grasses	30-70%	<i>Loxocarya cinerea</i> , <i>Tetrarrhena laevis</i> , <i>Tetraria octandra</i>

Peppermint Low Forest:

Soil: White sand

Landform: Lower hill-slopes, dunes

Not represented in quadrats

Total 1.42 ha, Completely Degraded condition

Concordant with Unit 2 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	30-70%	<i>Agonis flexuosa</i>
Ground	<10%	* <i>Aira caryophylla</i> , * <i>Anthoxanthum odoratum</i> , * <i>Briza minor</i>

***Taxandria marginata* Granite Shrubland:**

Soil: Shallow brown loam or sand
Landform: Granite outcrop
Represented in quadrat 10 and 19
Total 1.85 ha, Degraded to Excellent condition
Concordant with Unit 24 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Shrubs >2m	10-30%	<i>Taxandria marginata</i> , <i>Anthocercis viscosa</i> , <i>Dodonaea ceratocarpa</i> , <i>Acacia crassiuscula</i>
Sedges/Grasses	10-30%	<i>Lepidosperma hopperi</i> , <i>Lepidosperma tenue</i> , <i>Patersonia limbata</i> , <i>Stypandra glauca</i>

***Gastrolobium bilobum* Granite Shrubland/Yate Woodland:**

Soil: Shallow brown loam or sand
Landform: Granite outcrop
Represented in quadrat 14
Total in mosaic 1.35 ha, Completely Degraded to Excellent condition
Concordant with Unit 23 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	<10%	<i>Eucalyptus cornuta</i>
Shrubs 1-2m	10-30%	<i>Gastrolobium bilobum</i> , <i>Dodonaea ceratocarpa</i> , <i>Hibbertia furfuracea</i> , <i>Leucopogon obovatus</i> subsp. <i>obovatus</i> , <i>Pimelea rosea</i> subsp. <i>rosea</i>
Sedges/Grasses	30-70%	<i>Lepidosperma hopperi</i> , <i>Lepidosperma tenue</i> , <i>Stypandra glauca</i> , <i>Loxocarya cinerea</i>

Leucopogon assimilis Granite Shrubland:

Soil: Shallow brown loam or sand
 Landform: Granite outcrop
 Represented in quadrat 13
 Total in mosaic 0.35 ha, Excellent condition
 Concordant with Unit 25 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree >10m	<10%	<i>Eucalyptus cornuta</i>
Shrubs >2m	30-70%	<i>Gastrolobium bilobum</i> , <i>Dodonaea ceratocarpa</i>
Shrubs <1m	10-30%	<i>Leucopogon assimilis</i> , <i>Leucopogon obovatus</i> subsp. <i>obovatus</i> , <i>Hibbertia diamesogenos</i> , <i>Leucopogon pendulus</i> , <i>Verticordia plumosa</i> , <i>Andersonia sprengelioides</i>
Sedges/Grasses/Herbs	30-70%	<i>Borya sphaerocephala</i> , <i>Stypandra glauca</i> , <i>Loxocarya cinerea</i> , <i>Microlaena stipoides</i> , <i>Neurachne alopecuroides</i>

Evandra aristata Sedgeland:

Soil: Grey sand
 Landform: Wetland/valley floor
 Represented in quadrat 18
 Total 0.64 ha, Very Good condition
 Concordant with Unit 46 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Tree <10m	<10%	<i>Nuytsia floribunda</i>
Shrubs 1-2m	10-30%	<i>Beaufortia sparsa</i> , <i>Adenanthos obovatus</i> , <i>Jacksonia horrida</i> , <i>Melaleuca thymoides</i> , <i>Taxandria parviceps</i>
Shrubs <1m	10-30%	<i>Hypocalymma strictum</i> , <i>Boronia crenulata</i> , <i>Boronia spathulata</i> , <i>Dampiera linearis</i> , <i>Dasypogon bromeliifolius</i>
Sedges/Grasses/Herbs	30-70%	<i>Evandra aristata</i> , <i>Gymnoschoenus aenops</i> , <i>Anarthria laevis</i> , <i>Anarthria prolifera</i> , <i>Anarthria scabra</i> , <i>Xyris lanata</i>

***Homalospermum firmum*/Callistemon glaucus Peat Thicket:**

Soil: Grey sand, with peat

Landform: Wetland/valley floor

Represented in quadrat 16, 17, 22, 23, 24, 26, 27, 28, 29

Total 10.53 ha, Degraded to Excellent

Concordant with Unit 47 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Shrubs 1-2m	30-70%	<i>Callistemon glaucus</i> , <i>Homalospermum firmum</i> , <i>Taxandria linearifolia</i> , <i>Boronia crassipes</i> , <i>Hakea linearis</i> , <i>Sphaerolobium vimineum</i>
Sedges	>70%	<i>Empodisma gracillimum</i> , <i>Gymnoschoenus anceps</i> , <i>Leptocarpus tenax</i> , <i>Schoenus multiglumis</i> , <i>Xyris lanata</i>

***Melaleuca preissiana* Low Woodland:**

Soil: Sand

Landform: Wetland/valley floor

Not represented in quadrats

Total 1.18 ha, Completely Degraded to Very Good condition

Concordant with Unit 49 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Shrubs >2m	30-70%	<i>Melaleuca preissiana</i> , <i>Melaleuca raphiophylla</i>
Ground	>70%	* <i>Holcus lanatus</i> , * <i>Anthoxanthum odoratum</i> , <i>Baumea</i> species, <i>Centella asiatica</i>

Taxandria juniperina Closed Forest:

Soil: Sand
Landform: Wetland/valley floor
Represented in quadrat 30 & 31
Total 8.72 ha, Completely Degraded to Excellent condition
Concordant with Unit 59 (Sandiford and Barrett 2010)



Lifeform	% Cover	Dominant taxa
Shrubs >2m	>70%	<i>Taxandria juniperina</i> , <i>Homalospermum firmum</i> , <i>Astartea species</i>
Grasses	>10%	<i>Leptocarpus scariosus</i> , <i>Baumea acuta</i> , <i>Lepidosperma striatum</i>

Non-native Vegetation

Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)



Woody Weeds (Victorian Tea Tree, Taylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)



Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)



Revegetation (mixed shrubs and trees generally <10 years old)



Isolated Plants (Pasture and herbaceous weeds with isolated native plants)



4.2.2 Regional and Local Significance of Vegetation

Four vegetation types described from the Survey Area are considered wetland habitats as they are dependent on surface or subsurface expression of ground water (*Homalospermum firmum*/*Callistemon glaucus* Peat Thicket, *Evandra aristata* Sedgeland, *Taxandria juniperina* Closed Forest and *Melaleuca preissiana* Low Woodland). Three vegetation types are associated with granite outcrops, which are considered to be significant due to their restricted distribution, high number of conservation significant taxa and their role as climate refugia (*Taxandria marginata*, *Gastrolobium bilobum* and *Leucopogon assimilis* Shrublands).

Within the local region, there is approximately 35% total remnant vegetation, of which 19% and 39% occur in IUCN or Crown reserves, respectively (includes Albany Regional Vegetation Survey Area of 125,415 ha) (Sandiford and Barrett 2010). The current extent of pre-European vegetation associations in the Survey Area are above 30% at state and local government jurisdictions (Table 8). When aligned with mapping Units in the Albany Regional Vegetation Survey, eight of the 13 associations from the Survey Area have very low overall extent or low representation in reserves or (Table 9). Conservation criteria applied in the Albany Regional Vegetation Survey defines that six of the association are rare (<1,500 ha in total) and five are poorly represented in the conservation estate (<10% in IUCN reserves).

Table 8. Extent (ha) of pre-European vegetation associations from the Survey Area (Government of Western Australia [GoWA] 2019).

Vegetation Association	Western Australia			City of Albany (LGA)		
	Pre-European Extent	Current Extent	% Remaining	Pre-European Extent	Current Extent	% Remaining
3 - Medium forest; jarrah-marri	2,661,405	1,803,437	68	50,509	16,025	32
51 - Sedgeland; reed swamps, occasionally with heath	59,085	33,058	56	17,586	5,751	33
978 - Low forest; jarrah, <i>Eucalyptus staeri</i> & <i>Allocasuarina fraseriana</i>	53,231	18,856	36	52,154	18,720	36

Table 9. Overall extent and reservation status of vegetation associations from the Survey Area and local status derived from the Albany Regional Vegetation Survey (Sandiford and Barrett 2010). Includes IUCN I-IV reserves with Albany Region (<35 km radius).

Vegetation Type	Current Extent		Reserve IUCN I-IV	
	ha	%	ha	%
<i>Leucopogon assimilis</i> Granite Shrubland	17	0.1	8	50
<i>Taxandria marginata</i> Granite Shrubland	109	0.2	21	19.1
<i>Gastrolobium bilobum</i> Granite Shrubland/Yate Woodland	163	0.4	2	1.3
<i>Melaleuca preissiana</i> Low Woodland	679	1.5	53	7.7
<i>Taxandria juniperina</i> Closed Forest	779	1.8	77	9.9
Peppermint Low Forest	1,232	2.8	281	22.8
Marri/Jarrah Coastal Hills Forest (17)	1,238	2.8	625	50.5
Marri/Jarrah Forest/Peppermint Woodland	1,597	3.6	107	6.7
<i>Evandra aristata</i> Sedgeland (46)	1,747	4	219	12.5
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket (47)	2,083	4.7	263	12.6
<i>Hakea</i> spp. Shrubland/Woodland Complex (31)	2,366	5.4	1073	45.4
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland (13)	5,148	11.7	1334	25.9
Jarrah/Marri/Sheoak Laterite Forest	13,144	29.8	1,273	9.8

Two TECs are known in the vicinity the Survey Area; no vegetation meets the requisite criteria for either community. *Subtropical and Temperate Coastal Saltmarsh* TEC (Vulnerable) occurs approximately 100m from the Survey Area on the margin of Princess Royal Harbor and is confined to marine saline habitats (DotE 2013). The Survey Area falls outside (~6 km) the South East Coastal Botanical Province, therefore the *Proteaceae Dominated Kwongkan Shrubland* TEC (Endangered) is not applicable to vegetation within the Survey Area (DotE 2014b).

Four PECs occur directly adjacent to the Survey Area (DBCA 2019b, Appendix B). *Banksia coccinea* Thicket (P1), Coastal *Melaleuca incana/Taxandria juniperina* (P1) and *Banksia littoralis/Melaleuca incana* (P1) have distinctive dominant species that are absent from the Survey Area. *Astartea scoparia* Swamp Thicket (P1) may have previously occurred in the wetland areas on Lower Denmark Road that is now obscured by a high level of disturbance and altered drainage. No PECs were recorded in the Survey Area.

4.2.3 Flora

Thirty-two floristic quadrats were established within the Survey Area (Appendix D). A total of 342 taxa from 65 families, including 61 weeds were recorded from the Survey Area (including opportunistic observations; Appendix C). The plant families most represented were Myrtaceae (40 taxa), Fabaceae (38), Cyperaceae (27) and Proteaceae (25). Quadrat diversity varied from nine to 51 taxa per quadrat, with an average of 23.3. The most species rich vegetation was *Hakea* spp. Shrubland/Woodland Complex (average 36.5 taxa per quadrat) and the lowest was *Taxandria juniperina* Closed Forest (average 13 taxa per quadrat).

4.2.4 Conservation Significant Flora

Habitat or populations of five significant flora were recorded or are previously known from the Survey Area that are mapped (Appendix B) and discussed below. Population and location data are provided in Appendix F and Threatened and Priority Flora forms are provided in Appendix G.

Prasophyllum paulinae (P1)

Prasophyllum paulinae is a Priority 1 taxon from the Orchidaceae family, known only from two wetland habitats in the vicinity of Albany, both recorded following fire. The first voucher and type specimen were collected in 1988 and 1993, respectively, from a regenerating swamp on private property (P222501) that occurs within the Survey Area. The taxon was named in dedication to the late Pauline Herberle (Jones and Clements 1996), the family of who still own the property. The precise location of the early collections is uncertain due to inaccurate geo-tags, but was noted to be locally frequent within a degraded swamp with black, peaty, alkaline soil on the Heberle's property, Frederick Street, Gledhow (Western Australian Herbarium Accession no. 04514238).

Extensive survey was undertaken of the Herberle's property (in the Survey Area) over several days in spring 2017, 2018 and 2019. All suitable habitat was occupied by a common congener, *Prasophyllum macrostachyum* (Plate 1), and no individuals concordant with the description of *P. paulinae* were detected. A large area of regenerating wetland vegetation and seasonally inundated firebreaks occur at the southern end of the Herberle's property, which is considered the most likely location of the early collections of *P. paulinae*. Currently the area is composed of a tall, long unburnt (>20 years) closed forest of *Taxandria juniperina* and *Homalospermum firmum* (Plate 2). This area has been defined as a known population location for *P. paulinae* (Appendix B). The failure to detect *P. paulinae* during the surveys does not exclude its presence from the previously known habitat or its potential to emerge in future years, particularly after fire.

Prasophyllum paulinae is also known from one other population in a peat wetland at Two Peoples Bay, east of Albany. Population monitoring after a fire in 2010, indicates it co-occurred with other *Prasophyllum* species and that numbers peaked (over 100 individuals) two years after the fire, then declined thereafter. The last plants (23 individuals) were seen in 2015 (Anna de Haan pers. comm.).

Suitable habitat for *Prasophyllum paulinae* is considered to be recently burnt *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket and *Taxandria juniperina* Closed Forest. A total of 19.25 ha of these Units occurs within the Survey Area that are long unburnt (mapped in Appendix B). Targeted survey for *Prasophyllum paulinae* in these areas over consecutive springs has not detected any individuals. However, the potential exists for it to emerge following fire within this habitat.

Regional surveys for *Prasophyllum paulinae* were undertaken by Southern Ecology in spring 2019, which successfully detected some individuals (outside the Survey Area) that meet the taxonomic

description of the taxon. The details of these surveys are presented in a separate report (Rathbone 2020).



Plate 1 and 2. *Prasophyllum macrostachyum*, the common congener of *P. paulinae* (P1) found within the Survey Area and the regional distribution of *P. paulinae* (DPaW 2019a).

***Synaphea incurva* (P3)**

Synaphea incurva is a Priority 3 taxon from the Proteaceae family, known from a very narrow range between Redmond State Forest and Hassel National Park (Plate 4). It is commonly associated with heath or woodlands with laterite gravel and sand. Two populations, totalling eight individuals were recorded on road verges in the Survey Area (Plate 3).



Plate 3 and 4. *Synaphea incurva* (P3) and regional distribution (DPaW 2019a).

***Boronia crassipes* (P3)**

Boronia crassipes is a Priority 3 taxon from the Rutaceae family, known from wetlands between Albany and Walpole (Plate 6). It is commonly associated with *Homalospermum firmum* and *Empodisma gracillimum* on peat and sand. Several large populations are known within the vicinity of Albany. In the Survey Area, one population with 1,018 individuals was recorded in the broad drainage channel on Link Rd (Plate 5).



Plate 5 and 6. *Boronia crassipes* (P3) and regional distribution (DPaW 2019a).

***Andersonia* sp. Jamesii (J. Liddelow 84) (P4)**

Andersonia sp. Jamesii (J. Liddelow 84) is a Priority 4 taxon from the Ericaceae family, known from a relatively narrow range around Albany (Plate 8). It is commonly associated with poorly drained lateritic areas, often on hill crests in *Eucalyptus marginata*/*E. staeri* woodlands. In the Survey Area, a population of 22 individuals was recorded in the large City of Albany Reserve on George St and one individual was recorded on Albany Highway (Plate 7).



Plate 7 and 8. *Andersonia* sp. Jamesii (J. Liddelow 84) (P4) and regional distribution (DPaW 2019a).

***Thysanotus isantherus* (P4)**

Thysanotus isantherus is a Priority 4 taxon known from several coastal granite outcrops between Betty's Beach and Walpole and a disjunct occurrence near Cape Leeuwin (Plate 10). It is commonly associated with shallow soil herblands on the margin of granite sheets. It is inconspicuous due to its small size (<15 cm), its dull pink flowers and its leaves that wither to an underground tuber during dry periods. Two individuals were recorded on the western slopes of Mt Melville (Plate 9).



Plate 9 and 10. *Thysanotus isantherus* (P4) and regional distribution (DPaW 2019a).

4.2.5 Weeds

A total of sixty-one weeds were recorded from areas of remnant vegetation. Five significant weeds were recorded and mapped within the Survey Area (Appendix B): Blackberry (**Rubus* species complex, WoNS, Declared Pest) and Bridal Creeper (**Asparagus asparagoides*, WoNS, Declared Pest) were frequently observed in multiple habitats; Gorse (**Ulex europaeus*, WoNS, Declared Pest), Arum Lily (**Zantedeschia aethiopica*, Declared Pest) and Lantana (**Lantana camara*, WoNS, Declared Pest) were recorded as isolated occurrences. Other large woody weeds recorded widely in remnant vegetation, that are of concern to the City of Albany include **Acacia longifolia*, **Psoralea pinnata* and **Dipogon lignosus*. A variety of other agricultural weeds occurred under planted vegetation, or adjacent to pasture areas (see Appendix C). The survey of these agricultural areas was not extensive and it is possible more weeds occur in these areas.

5 FAUNA RESULTS

5.1 Desktop Assessment

The likelihood of occurrence assessment of conservation significant fauna identified for the Survey Area is included in Appendix E. Field assessments confirmed that habitats within the Survey Area are currently being utilised by five conservation significant fauna species; Carnaby's Cockatoo (*Calyptrorhynchus latirostris*) (T-EN), Baudin's Cockatoo (*Calyptrorhynchus baudinii*) (T-EN), Forest Red-tailed Black Cockatoo (*Calyptrorhynchus banksii naso*) (T-VN), Western Ringtail Possum (*Pseudocheirus occidentalis*) (T-CR), and Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) (P4). One significant fauna species was considered likely to occur in the Survey Area - Water Rat (*Hydromys chrysogaster*) (P4), and seven conservation significant fauna species were considered to possibly occur in the Survey Area: - Carter's Freshwater Mussel (*Westralunio carteri*) (VU), South-western Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) (CD), Masked Owl (*Tyto novaehollandiae* subsp. *novaehollandiae*) (P3), Peregrine Falcon (*Falco peregrinus*) (OS), Fork-tailed Swift (*Apus pacificus*) (IA), Short-nosed Snake (*Elapognathus minor*) (P2) and the Woollybush bee (*Hylaeus globuliferus*) (P3).

5.2 Fauna Habitat

The vegetation types identified in Section 4.2 can be used to categorise general fauna habitats. The known or potential vegetation types associated with significant fauna in the Survey Area is presented in Table 10. There was a variety of fauna habitats identified within the Survey Area, from lowland wetlands to Eucalypt forest woodlands and shrublands on the western slopes of Mt. Melville. Planted Eucalypts also provide some habitat for fauna as do some highly altered vegetation with high percentages of weeds.

Some vegetation associations are mapped (Appendix B) that are not indicated as suitable habitat in Table 10. For example, *Evandra aristata* Sedgeland and *Hakea* spp. Shrubland/Woodland Complex are not considered suitable for Baudin's and Forest Red-tailed Black Cockatoos. However, in some instances have been mapped as habitat due to the presence of potentially suitable night roosting trees.

Some non-remnant vegetation, such as Bluegum and pine plantations, scattered trees over pasture grasses, or revegetation provide a habitat for some significant species. These are included in Table 10 and discussed further in the following sections.

Table 10. Conservation significant fauna and known (x) or potentially (?) associated vegetation within the Survey Area compared to the larger Albany Regional Vegetation Survey Area (Sandford and Barrett 2010). Information is not sufficient to determine the habitat of the Recherche Cape Barren Goose (VU), Short-nosed Snake (P2) and Woollybush Bee (P3).

Fauna Habitat and associated Vegetation Associations (ARVS Unit no.)	Ha within Survey Area	Camaby's Cockatoo (EN)	Baudin's Cockatoo (EN)	Forest Red-tailed Black-Cockatoo (VU)	Western Ringtail Possum (CF)	Quenda (P4)	Brush-tailed Phascogale (CD)	Masked Owl (P3)	Water Rat (P4)	Peregrine Falcon (OS)	Carters Freshwater Mussel (VU)
Eucalypt (Jarrah/Marri) Woodland/Forest											
Jarrah/Marri/Sheoak Laterite Forest (12)	32.51	x	x	x	x	x	?	?		?	
Jarrah/Sheoak/ <i>Eucalyptus staeri</i> Sandy Woodland (13)	4.24	x	x	x	x	x	?			?	
Marri/Jarrah Coastal Hills Forest (17)	2.13	x	x	x	x	x	?	?		?	
Marri/Jarrah Forest/Peppermint Woodland (10)	11.07	x	x	x	x	x	?			?	
Non-Eucalypt Woodland /Forest											
<i>Taxandria juniperina</i> Closed Forest (59)	8.72	x	x	x	x	x					
<i>Melaleuca preissiana</i> Low Woodland (49)	1.18				x	x					
Peppermint Low Forest (2)	1.42				x						
Shrubland/woodland											
<i>Hakea</i> spp. Shrubland/Woodland Complex (31)	4.71	x			x						
Mosaic <i>Taxandria marginata</i> / <i>Gastrolobium bilobum</i> Granite Shrubland/Yate Woodland (23/24)	2.57	x		x	x	x					
Shrubland											
Mosaic <i>Taxandria marginata</i> / <i>Leucopogon assimilis</i> Granite Shrubland (24/25)	0.98				x	x					
Wetland											
<i>Evandra aristata</i> Sedgeland (46)	0.64	x			x	x			?		
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket (47)	10.53	x			x	x			?		?
Non-remnant vegetation											
Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)	74.51	x	x	x							
Woody Weeds (Victorian Tea Tree, <i>Taylorina</i> , Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)	7.14				x	x					
Other Weeds (<i>Watsonia</i> , Bracken Fern or Blackberry with isolated native plants)	2.16					x					
Revegetation (mixed shrubs and trees generally <10 years old)	5.58					?					
Isolated Plants (Pasture and herbaceous weeds with isolated native plants)	9.60										
Total extent (ha) in Survey Area (excluding non-remnant vegetation)	80.7	77.12	58.67	61.24	80.7	74.57	49.95	34.64	11.17	49.95	10.53
Extent in Survey Area as proportion (%) of the total potential habitat in the ARVS Survey Area (DPaW 2013b)		0.18	0.20	0.25	0.19	0.18	0.36	0.21	0.17	NA	NA

5.3 Targeted Conservation Significant Fauna

5.3.1 Western Ringtail Possum (*Pseudocheirus occidentalis*) (T-CR)

Preferred habitat for the WRP on the south coast of Western Australia is not well understood. The species has been recorded in coastal heath, Jarrah/Marri woodland and forest, Jarrah/Sheoak woodland, peppermint woodlands, myrtaceous heaths and shrublands, Bullich (*Eucalyptus megacarpa*) dominated riparian zones and Karri forest (*Eucalyptus diversifolia*). In the vegetation associations mapped in the Albany Region (35 km radius from Albany in Sandiford and Barrett (2010)), most ringtail records were from *Coastal limestone heath vegetation* unit 5b (DPaW 2014). Recent spotlight surveys have found high numbers in *Coastal Hills Forest*, *Jarrah Woodland* and *Marri/Jarrah Forest/Peppermint Woodland* on Mt Clarence/Adelaide and Mt Melville within the Albany town site (S. Gilfillan unpubl. data). Recent radio collaring of individuals determined home ranges of 0.88 ± 0.12 ha (mean \pm SE), and were commonly associated at night with Marri and Jarrah, suggesting a preference for these species as foraging trees. Daytime refuges included dreys, large trees, tree hollows (Marri only) and thick ground cover (Van Helden *et al.* 2017).

The field assessment determined that the Western Ringtail Possum occupied 111.5 ha (approximately 33%) of the Survey Area (Appendix B, Table 11). A wide range of vegetation types in various levels of condition were utilised (Jarrah, Marri and Sheoak woodlands, Jarrah/Marri Forest, *Taxandria juniperina* Woodland) that varied in condition from Degraded to Excellent.

Non-native vegetation was also utilised such as exotic Eucalypt species plantations, particularly where the weed species Sydney Golden Wattle (*Acacia longifolia*) and Victorian Tea Tree (*Leptospermum laevigatum*) provide patches of thick mid-storey (where dreys were frequently found). Western Ringtail Possum scats were also found at the base of many pine trees.

Table 11. Extent of Western Ringtail Possum habitat in the Survey Area

	Area (ha)
Core	10.2
Supporting	100.2
Core (Urban)	1.1
Supporting (Urban)	Not present
Total	111.5

5.3.1.1 Core habitat

A total of 11.3 ha of core habitat occurs within the Survey Area with 1.1 ha within urban areas. Core habitat was concentrated at the southern end of the Survey Area and is contiguous with core habitat on Mt Melville. No other core habitat exists within the Survey Area. In preliminary surveys (Rathbone and Gilfillan 2018) the City of Albany Reserve on the corner of George St and South Coast Hwy was considered core habitat. However, the updated data used to define core habitat (any area with an established density of <1 /ha) precludes this from being assigned core status with a density of only 0.14/ha (Biota 2018). Core habitat was only a small percentage of estimated core habitat within the 5 km buffer ($<0.5\%$) (Table 11).

5.3.1.2 Supporting habitat

A total of 100.2 ha of supporting habitat occurs within the Survey Area. Supporting habitat is distributed throughout the Survey Area, with the George St Reserve providing the largest native remnant of suitable supporting habitat. Mature planted trees in the east of the Survey Area also constituted supporting habitat. These were planted tree assemblages with a varying density of largely non-native mid-storey species (from very spare to dense thickets of, particularly, Victorian Tea Tree and Sydney Golden Wattle). The two patches of *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (ARVS Unit 47) on Link Rd are considered supporting habitat. Very limited scat searches were performed here due the thick nature of the vegetation and no scats were observed. However, the presence of Western Ringtail Possums in the adjoining Eucalypt woodland to the north suggests this habitat is likely to be used, particularly due to the thick vegetation providing many opportunities for refuge. Supporting habitat within the Survey Area was fairly continuous along Lower Denmark Rd.

5.3.1.3 Linkages

Three linkage types were mapped within the Survey Area (Table 12). The number of linkages is a more useful measure than area as the number reflects the degree of opportunity for individuals to move through the landscape. A rectangle, for example, of linkage habitat will provide less distance for movement than the same area covering a narrow linear linkage.

Table 12. Western Ringtail Possum Linkages within the Survey Area.

Linkage Type	Survey Area	
	No. of Linkages	Area
Linkage	28	43.7
Linkage_likely	18	10.9
Linkage_possible	20	11.1

An important *Potential habitat linkage* occurs along the rail reserve, adjacent to both sides of Lower Denmark Rd, forming a partial link between the core habitats of the eastern edge of the Survey Area and the large are of supporting habitat in the George St Reserve. Small, narrow *Habitat linkages* also occur in patches of roadside vegetation, along Link Rd, south of Lancaster Rd and on George St.

5.3.1.4 Primary Corridors

There are three primary corridors within the South Coast Population:

- King River
- Kalgan River
- Coastal Corridor (from West Cape Howe NP to Cheyne's Beach – this may extend either east or west with new records)

On a regional scale, the southern section for the Survey Area covering the intersection of the Hanrahan Rd/Frenchman's Bay Road and Princess Royal Drive forms part of the Coastal Corridor within the South Coast Macro Corridor Network. This Corridor Network was developed as a strategic planning tool to

provide guidance at a regional level as to where protection and enhancement of major corridor linkages should be targeted (Wilkins *et al.* 2006). The Coastal Corridor (Forest to Two Peoples Bay Corridor) is a Priority 1 Corridor which is defined as one that links two or more *very high nature conservation value* areas (Forest Region and Two People Bay NR). On a local scale the Survey Area is within Strategic Zone B of the Coastal Corridor.

5.3.2 Black Cockatoo Species

Black Cockatoos (*Carnaby's Cockatoo (Calyptorhynchus latirostris) (T-EN); Baudin's Cockatoo (Calyptorhynchus baudinii) (T-EN); and Forest Red-tailed Black Cockatoo (Calyptorhynchus banksii subsp. naso) (T-VU)*

Carnaby's Cockatoo (*Calyptorhynchus latirostris) (T-EN)*

Habitats considered suitable for this species are uncleared or remnant native Eucalypt woodlands or forests containing Marri, Jarrah or Karri and shrublands or Kwongan heathland dominated by *Hakea*, *Dryandra*, *Banksia* and *Grevillea* (DSEWPaC 2012). On the south coast they feed on Jarrah and Marri seeds and a wide variety of mainly proteaceous species. Breeding hollows occur in Jarrah and Marri and generally have an entrance diameter >200 mm and occur in trees that are 120–150 years old. Trees approaching 680 mm DBH are close to developing suitable hollows (Pittman *et al.* 2007, Whitford and William 2002, DPaW 2013a).

Communal night roosting occurs at different sites throughout the year. Groups of birds will roost in a suitable tree or group of tall trees, usually close to a water source (known to drink at dams and farm troughs) and within an area of quality foraging habitat. The cockatoos fly to feeding areas each day before returning to the night roost, however, use of a particular night roost site may vary from daily to weekly. Night roosts are generally located in the tallest trees in an area; on the south coast potential roost trees include Marri, Karri, Blackbutt, *Taxandria juniperina*, Tuart (planted), introduced Eucalypts (for example Blue Gum) and introduced pines (DSEWPaC 2012).

Baudin's Cockatoo (*Calyptorhynchus baudinii) (T-EN)*

Baudin's Cockatoo occurs in high-rainfall areas, usually at sites that are heavily forested and dominated by Marri, Jarrah and Karri. It also occurs in woodlands of Wandoo (*E. wandoo*), Blackbutt (*E. patens*), Flooded Gum (*E. rudis*), and Yate (*E. cornuta*) (DSEWPaC, 2012). Baudin's cockatoo feeds mainly on the seeds of Marri, but may also feed on the seed of *Banksia* spp., *Hakea* spp. and *Erodium botrys*. Additionally, Baudin's Cockatoo feeds on invertebrate larvae and on apple, pear and persimmon in domestic and commercial fruit orchards (Chapman 2008). There is very little breeding information and the breeding biology of this species remains poorly known (Johnstone and Kirkby 2008). Known breeding trees include Karri, Marri, Wandoo and Tuart. Hollows suitable for Baudin's Cockatoo are likely to be in trees 500 mm or greater DBH and suitable hollows usually have a diameter of 300–400 mm (Johnstone & Storr 1998; Higgins 1999; Saunders 1974, 1979).

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii subsp. naso) (T-VN)*

Forest Red-tailed Black Cockatoo commonly occur in Jarrah, Karri and Marri forests and also in a range of other forest and woodland types, including Blackbutt, Wandoo and Tuart (*E. gomphocephala*), Albany Blackbutt, Yate and Flooded Gum (DSEWPaC, 2012). Ninety percent of the Forest Red-tailed Black Cockatoo total diet consists of Marri and Jarrah seeds (Johnstone & Kirkby 1999), and it depends on both feed trees during breeding periods (Johnstone *et al.* 2013). Other feed trees include Blackbutt, Albany Blackbutt, Forest Sheoak (*Allocasuarina torulosa*), Snottygobble (*Persoonia* spp.) and Karri.

Breeding occurs almost exclusively in Marri. Johnson *et al.* (2013) found by measuring 128 breeding trees that mean DBH was 2790 mm, mean estimated age was 222 years, and mean hollow entrance size was 300 mm x 340 mm. However, Whitford *et al.* (2015) state a more realistic minimum age for trees bearing suitable hollows is approximately 120–150 years (tree diameters of 500–600 mm) and most nest hollows occurred in intermediate-sized trees.

Black Cockatoo Breeding Habitat

The Survey Area occurs within the known distribution and predicted breeding range of Carnaby's Cockatoo and Baudin's Cockatoo. Forest Red-tailed Black Cockatoo are known to occur and may breed in suitable trees anywhere within their range of occurrence (DSEWPaC 2012). There are no confirmed breeding sites for any of the three Cockatoo species within 10 km of the Survey Area.

Potential breeding habitat for all three black Cockatoo species (Table 14) considered to be of high quality occurs in two large areas of Eucalypt Woodland/Forest on the southern slopes of Mt Melville and George St Reserve; several smaller patches are distributed throughout the Survey Area (total of 43.63 ha). Lower quality potential breeding habitat occurs in some of the narrow strips of roadside Eucalypt Woodland/Forest vegetation on Link Rd, George St (8.08 ha) and in areas of *Eucalyptus gomphocephala* (5.35 ha). *Eucalyptus gomphocephala* is restricted to the swan coastal plain and all occurrences within the Survey Area due to ornamental planting (approximately 70 years old). Many of the tree were ≥ 500 mm DBH, although none contained hollows at present.

No trees within the Survey Area contain hollows that were currently occupied or showed recent use by Cockatoo species. A total of 175 hollows with an entrance estimated to be greater than 100 mm were recorded within 120 alive and dead trees of *Corymbia calophylla* and *Eucalyptus marginata* (Table 13). Based on suitability of host species and current entrance size, 60 trees contained hollows potentially suitable for Carnaby's Cockatoo (*Eucalyptus marginata* or *Corymbia calophylla* with hollow entrance ≥ 200 mm), 18 trees contained hollows potentially suitable for Forest Red-tailed Black Cockatoo (*Corymbia calophylla* with hollow entrance ≥ 200 mm) and three trees contained hollows potentially suitable for Baudin's Cockatoo (*Corymbia calophylla* with hollow entrance ≥ 300 mm). Additional assessments using a drone (Biota 2019b) of all potential breeding trees within the disturbance envelope of the project were determined to be currently unsuitable for breeding.

In total, 662 potential breeding trees were recorded (DBH ≥ 500 mm, with or without hollows) comprising of the tree species *Corymbia calophylla* (287), *Eucalyptus marginata* (279), planted *Eucalyptus gomphocephala* (62), dead stags of *Eucalyptus marginata*/*Corymbia calophylla* (29) and *E. staeri* (5).

Table 13. Count of hollows with an entrance size greater than 100 mm in potential breeding trees for Black Cockatoo species.

Tree Species	Hollow entrance (mm)		
	100-199	200-299	≥ 300
<i>Corymbia calophylla</i>	18	16	3
<i>Eucalyptus marginata</i>	69	34	14
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	11	4	6

Black Cockatoo Breeding Feeding Habitat

Evidence of feeding was widely overserved for all three species across the Survey Area (mapped in Appendix B, Table 14). Diagnostic evidence of feeding on fruits of *Corymbia calophylla*, *Eucalyptus marginata* and *E. staeri* of all three Black Cockatoo species was observed and on planted Pine tree by Carnaby's Cockatoo.

High quality feeding habitat for all three species of Black Cockatoo was mapped in all the large Eucalypt Woodland and Forest remnants (43.63 ha). Lower quality potential feeding habitat occurred in some degraded Eucalypt remnants (8.08 ha) with *Allocasuarina* and *Hakea* in isolated patches and narrow roadside corridors (3.40 ha). Wetland areas that contained frequent *Callistemon glaucus* were also mapped as low-quality feeding habitat for Carnaby's Cockatoo (6.51 ha), which is considered a minor food source for this species (Johnston 2013).

Black Cockatoo Roosting Habitat

Confirmed roost sites for Carnaby's Cockatoo occur in Marri Jarrah Forest/Peppermint Woodland on Mt Melville, only 350 m from the eastern edge of the Survey Area and in tall *Taxandria juniperina* trees at Lake Seppings (4.8 km from the Survey Area). There are no confirmed roosting sites within 10 km for Baudin's Cockatoos or Forest Red-tailed Black Cockatoo. However, some Black cockatoo flocks around Albany are mixed flocks comprising both Carnaby's and Baudin's Cockatoos and thus the confirmed roosting sites for Carnaby's Cockatoos may contain some Baudin's individuals (Sarah Comer, South Coast Regional Ecologist, DCBA, *pers.com.*)

Potential roosting habitat for all three species of Black Cockatoo occurred throughout the Survey Area (Appendix B, Table 14). As there were numerous water sources within the Survey Area (including dams, man-made pools and farm water troughs) all areas with tall trees suitable for roost sites are considered potential roosting areas. They include native Eucalypt Woodland/Forests, *Taxandria juniperina* woodlands, exotic Eucalypt plantations and introduced pine trees (67.3 ha). Other areas of low-quality potential roosting habitat occur in Sedgeland with patches of **Leptospermum laevigatum*, **Acacia longifolia* and occasional **Eucalyptus globulus*.

Table 14. Summary of breeding, feeding and roosting habitat for three species of Black Cockatoo in the Survey Area.

Habitat Type	Description	Carnaby's Cockatoo	Baudin's Cockatoo	Forest Red- tailed Black Cockatoo	Total
High quality feeding and potential breeding and roosting	Eucalypt Woodland or Forest	+	+	+	43.63
Low quality feeding and potential breeding and roosting	Degraded Eucalypt Woodland with <i>Allocasuarina</i> and <i>Hakea</i> Shrubland	+	+	+	8.08
High quality potential roosting habitat	Mature Planted Trees and tall <i>Taxandria</i> Forest	+	+	+	67.30
Low quality potential roosting habitat	Sedgeland with <i>*Leptospermum laevigatum</i> , <i>*Acacia longifolia</i> and occasional <i>*Eucalyptus globulus</i>	+	+	+	9.08
Low quality feeding habitat	Degraded/isolated remnants Eucalypt Woodland or Forest with <i>Allocasuarina</i> and <i>Hakea</i> Shrubland	+	+	+	3.40
Low quality feeding habitat	Wetlands with <i>Callistemon glaucus</i>	+			6.51
Low quality potential breeding habitat	Planted <i>Eucalyptus gomphocephala</i>	+	+	+	5.35
Total:					143.36

5.4 Other Conservation Significant Fauna

Quenda (*Isoodon obesulus* subsp. *fusciventer*) (P4)

The Quenda occurs in wet or dry sclerophyll forest through to open woodland and scrubby, dense vegetation on sandy soils. The species often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover (Paull 2008).

Characteristic diggings of this species were observed throughout the Survey Area in all vegetation types from Degraded to Excellent condition. Diggings were also observed in some plantation areas and areas dominated by weeds (Appendix B). One roadkill was observed on the Old Denmark Rd, near the corner of George St and a skull and lower jaw bones were found in the small roadside remnant east on Albany Hwy.

Carter's Freshwater Mussel (*Westralunio carteri*) (VU)

The current distribution of the Carter's Freshwater Mussel is restricted to freshwater streams, rivers, reservoirs and lakes within 50-100 km of the coast with mean salinity <1.6 ppt. Patchy distribution occurs in sandy/muddy sediments with greatest densities associated with exposed submerged tree roots (*Eucalyptus rudis*, *Melaleuca* spp. and others), woody debris and overhanging riparian vegetation near stream banks and edges of lakes/dams. Precise habitat requirements and quantification of density within habitat types are in the early stages of study for this species; juveniles may require specific micro-habitats and are difficult to locate in the wild. The species is semi-parasitic, therefore requires presence of host fish species (SWCC date unknown).

Potentially suitable habitat exists within an artificial dam in the Link Road wetland. It is not known if this habitat provides specific requirements such as suitable micro-habitat for juveniles or presence of host fish species.

South-western Brush-tailed Phascogale, Wambenger (*Phascogale tapoatafa wambenger*) (CD)

The Brush-tailed Phascogale in south-west WA inhabits Eucalypt woodland and open forests, and is found less commonly in wetter forests. The species has an arboreal foraging habit and a preference for mature trees for nesting hollows, although sometimes smaller trees have the potential to provide these (Abbott and Whitford 2001). Rees *et al.* (2006) found that suitable hollows for this species in Victoria ranged in diameter at breast height (DBH) from 25 to 171 cm, with a mean DBH for the trees used by each individual phascogale of >80 cm. Hollow entrance sizes for Brush-tailed Phascogales are small, > 5 cm diameter, with large hollow chamber size. This species was not directly observed during the survey.

A confirmed record of the South-western Brush-tailed Phascogale in Mira Mar (an Albany suburb approximately 4 km from the Survey Area) in March 2017 indicates they possibly occur within the Albany area. This species was targeted in a community fauna survey of Mt. Melville Reserve (bounding the eastern edge of the Survey Area) in 2014/15 by the installation of nest boxes. After one year no Brush-tailed Phascogales were found to be using the nest boxes. Spotlighting was also carried out during the survey and no Brush-tailed Phascogale were observed (Gilfillan and Maciejewski 2015). However, targeted trapping for this species was not carried out. Potentially suitable habitat exists in the Marri and Jarrah woodland and forest vegetation types within the Survey Area (Table 10).

Fork-tailed Swift, Pacific Swift (*Apus pacificus*) (1A)

The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above the ground. It does not breed in Australia, and therefore breeding habitat is not required. This species was

not observed during the survey. Habitats that provide a source of insects would most likely comprise all the vegetation types present within the Survey Area.

Short-nosed Snake (*Elapognathus minor*) (P2)

There are only a few records for this species on the South Coast and therefore its habitat is not well known. This species was not observed during the survey. As the habitat is not well known, it is possible that suitable habitat may exist within the Survey Area, however the vegetation types cannot be confirmed.

Masked Owl (southern subsp.) (*Tyto novaehollandiae* subsp. *novaehollandiae*) (P3)

The Masked Owl inhabits forests, woodlands, timbered waterways and open country on the fringe of these areas and require tall Eucalypts with suitable hollows for nesting and roosting and adjacent areas for foraging that support an abundance of principally terrestrial mammals, although arboreal mammals can also be taken. They may also use caves for nesting. Masked Owls are territorial, and pairs remain in or near the territory all year round (Garnett 2000).

This species was not observed during the survey. It possibly occurs as hollows suitable for nesting are present within the Eucalypt woodland/forest vegetation types and prey in the form of terrestrial mammals (Quenda, rabbits) are also present within the Survey Area.

Spotlighting during a fauna survey of Mt. Melville Reserve (bounding the eastern edge of the Survey Area) in 2014/15 (Gilfillan and Maciejewski 2015) did not observe and Masked Owls and none were heard, however no targeted playback for the species was carried out.

Woollybush Bee (*Hylaeus globuliferus*) (P3)

Hylaeus are typically small to medium-sized bees with black, relatively hairless bodies and most species have characteristic white, cream or yellow marks on the face and thorax. Vacated borer holes in tree trunks and dead branches, hollow pithy stems and the vacated burrows of other bees or wasps are commonly used (WAM 2018).

This species was not observed during the survey. Only the type specimen (1929) is known from the Albany area. Its habitat within the South Coast is not known, therefore the species may possibly occur. However, the vegetation types cannot be identified at this point in time.

Water-rat, Rakali (*Hydromys chrysogaster*) (P4)

Rivers, estuaries, swamps, lakes, dams/reservoirs, creeks, damplands, floodplains, sumpland, protected coastal beaches and islands (Olsen 2008). In Western Australia, Rakali are the only aquatic mammal in freshwater ecosystems. They require prey such as flat feeding sites such as logs, rocks or sheltered areas on the river bank to consume prey and a suitable substrate to dig burrows (Olsen 2008; Trocini *et al.* 2015). At Two Peoples Bay individuals preferentially utilised wetland habitats characterised by dense, low-lying vegetation (0–30 cm from ground), low-density canopy cover and shallow, narrow water bodies (Speldewinde *et al.* 2013). Evidence of rakali has been found at sites with relatively poor habitat and other studies in the eastern states have identified Rakali populations in less than optimal habitats, such as irrigation drainage channels and polluted urban water-bodies (Scott and Grant 1997)

No signs of this species were found; however, it is known to occur in Lake Powell which is connected to the natural broad drainage channel that intersects the Survey Area north of South Coast Highway that flows west into Five Mile Creek and eventually into Lake Powell. In addition, farm dams, and roadside drainage channels particularly along Lower Denmark Rd, may provide habitat for this species.

Peregrine Falcon (*Falco peregrinus*) (OS)

Peregrine Falcon occur in a variety of habitats from woodlands to open grasslands and coastal cliffs. Prey consists of other birds. It requires abundant prey and secure nest sites, and prefers coastal and inland cliffs or open woodlands near water. Suitable habitat exists for this species (all forest/woodland vegetation communities) however this species is not common and therefore may only be encountered occasionally.

5.5 Regional Significance of Fauna Habitats

Habitat for all significant fauna species known or potentially occurring within the Survey Area (for which data is available) is represented outside of the Survey Area (Table 10). All of the fauna species for which ranges are well known are wide ranging, and thus the Survey Area represents only a small area of their total range. It should be noted, however that the Western Ringtail Possum South Coast population may be an isolated sub-population and is considered a separate management unit (DPaW 2014). Thus, when considering range for this species, the South Coast range is the most appropriate scale.

Ranges of the Short-nosed snake and Woollybush Bee are not well known, therefore the regional context of their ranges cannot be discussed. In addition, the Survey Area is situated at the eastern edge of the range of the Brush-tailed Phascogale and Baudin's Cockatoo's predicted breeding range, and possibly the Short-nosed Snake (from current known records).

In terms of regional connectivity, the southern section of the Survey Area (in the area of the Hanrahan Rd and Frenchman's Bay Rd. intersection) serves as an important link between the central Albany area of Western Ringtail Possum core habitat and that to the south west (Robinson, Big Grove and the Torndirrup Peninsula).

6 CONCLUSIONS

Southern Ecology conducted primary flora and fauna assessments in the Survey Area in 2017 that were followed up with assessments in 2018 and 2019 to address changes in the project design and to consolidate the biological information. The surveys have included a Detailed and Targeted Flora Assessment (covering a range from July to November) and Level 1 Fauna, Black Cockatoo and Western Ringtail Possum Assessment and a regional Targeted Survey for *Prasophyllum paulinae* (P1).

A wide range of vegetation types were recorded from wetlands, granite outcrops and lateritic uplands and quartzitic sands that were primarily in Very Good or Excellent condition. The vegetation described constitutes 0.18% of the 35% remnant vegetation that remains within the region (Albany Regional Vegetation Area), which reflects the long history of European occupation in Albany and the utilisation of land suitable for agriculture. Of the thirteen associations described, six are recognised as locally rare (<1,500 ha in total), five are poorly represented in the conservation estate (<10% in IUCN reserves), four are considered wetland vegetation recognised under State acts.

A total of 342 taxa were recorded in 32 floristic quadrats with an average of 23.3 species per quadrat. The species assemblages were typical of the local region and the vegetation types encountered. However, overall species richness was reduced due to weed infestation of granite communities, the long unburnt condition of the wetlands and the impacts of *Phytophthora* Dieback in the upland lateritic areas. Four Priority-listed flora were recorded (*Synaphea incurva* (P3), *Boronia crassipes* (P3), *Andersonia* sp. Jamesii (J. Liddelow 84) (P4) and *Thysanotus isantherus* (P4)) and one previously known population of *Prasophyllum paulinae* (P1) is known from the Survey Area.

Targeted surveys for *Prasophyllum paulinae* within two wetland vegetation associations in the Survey Area (total of 19.25 ha) did not detect any individuals. However, the potential exists for it to emerge following fire within this habitat. Regional Targeted Surveys were conducted that targeted recently burnt areas of suitable habitat, which identified a new population estimated to comprise 50 plants outside the Survey Area.

Survey limitations did not generally affect the confidence of the survey results. However, the absence of fire or other disturbance may have impeded the detection of five conservation significant flora that generally occur in wetland areas or granite refuges.

Five significant fauna species were present within the Survey Area: - Carnaby's Cockatoo (*Calyptrorhynchus latirostris*) (T-EN), Baudin's Cockatoo (*Calyptrorhynchus baudinii*) (T-EN), Forest Red-tailed Black Cockatoo (*Calyptrorhynchus banksii naso*) (T-VN), Western Ringtail Possum (*Pseudocheirus occidentalis*) (T-CR), and Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) (P4).

Western Ringtail Possums scats and dreys were observed widely across the Survey Area, in multiple native and non-native habitats of varying condition. Albany occurs in the centre of the south coast population of WRP, which has been poorly understood until recently. As part of this assessment the EPBC Act Significant Impact Guidelines categories were adapted south coast population and *core* and *supporting habitats* and *potential habitat linkages* were identified for the Survey Area.

Foraging and potential breeding habitat for three Black Cockatoo species occurred throughout the Survey Area, in all the Eucalypt Woodland/Forest habitats. Large areas of potential roosting sites were identified among both native and introduced tree species. No trees within the Survey Area contain hollows that were currently occupied or showed recent use by Cockatoo species. However, based on suitability of host species and current entrance size, up to 60 trees contained hollows potentially suitable for Black Cockatoo species.

7 REFERENCES

- Abbott, I., & Whitford, K. (2001) Conservation of vertebrate fauna using hollows in forests of south-west Western Australia: strategic risk assessment in relation to ecology, policy, planning, and operations management. *Pacific Conservation Biology*, 7(4), 240-255.
- Allen, G.R., Hamar, S. and Allen, M. (2002). Field Guide to Freshwater Fishes of Australia. Western Australian Museum, 2002
- Baczocha, N and Start, AN (1997) Status and ecology of the dibbler, (*Parantechinus apicalis*) in Western Australia. 1996 annual report. Unpublished report to Environment Australia. Department of Conservation and Land Management, Perth.
- Barrett, S (1998) A biological survey of mountains in southern Western Australia. Report on Project No. AW03 to Australian Nature Conservation Agency National Reserves System Cooperative Program. Department of Conservation and Land Management, Perth.
- Biota (2018). Albany Ring Road Project Western Ringtail Possum Assessment. Unpublished report prepared for Main Roads Western Australia, Biota Environmental Sciences, Perth, Western Australia.
- Biota (2019a). Albany Mounts Western Ringtail Possum Population Assessment. Unpublished Report. Prepared for City of Albany, Biota Environmental Sciences, Perth, Western Australia.
- Biota (2019b) Albany Ring Road Black Cockatoo Habitat Assessment. Unpublished report prepared for Main Roads Western Australia, Biota Environmental Sciences, Perth, Western Australia.
- Bray, D.J. (2017) *Lepidogalaxias salamandroides* in Fishes of Australia, accessed 12 Nov 2019, <http://fishesofaustralia.net.au/home/species/3918>.
- Bray, JD and Gomon, MF (2011) *Geotria australis* in Fishes of Australia, accessed 22 Feb 2018, <http://fishesofaustralia.net.au/home/species/3415>.
- Burbidge, AH, Blyth, J, Danks, A, Gillen, K and Newbey, B (1997) Western ground parrot interim recovery plan 1996 to 1999. Interim Recovery Plan No. 6. Western Australian Department of Conservation and Land Management.
- Bureau of Meteorology (BOM) (2019) Climate Data Online. Commonwealth of Australia. URL: <http://www.bom.gov.au/climate/data/index.shtml>.
- Chapman, T. (2008) Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan. Western Australia: Department of Environment and Conservation.
- Danks, A, Burbidge, A, Burbidge, A and Smith, G (1996) Noisy Scrub-bird Recovery Plan. Wildlife Management Recovery Plan. 12. WA Dept Conservation & Land Management, Perth. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/recovery/noisy-scrub-bird/index.html>.
- de Tores, PJ, Hayward, MW, Dillon, MJ and Brazell, RI (2007) Review of the distribution, causes for the decline and recommendations for management of the Quokka, *Setonix brachyurus* (Macropodidae: Marsupialia), an endemic macropod marsupial from south-west Western Australia. *Conservation Science Western Australia* 6, 13-73.
- Department of Agriculture and Food Western Australia [DAFWA] (2017) NRM SLIP. Available from: <https://maps.agric.wa.gov.au/nrinfo/>
- Department of Biodiversity, Conservation and Attractions [DBCA] (2019a) NatureMap: Mapping Western Australia's Biodiversity. URL: <https://naturemap.dpaw.wa.gov.au/>
- Department of Biodiversity, Conservation and Attractions [DBCA] (2019b) Priority Ecological Communities for Western Australia Version 28. Species and Communities Branch, Department of Parks and Wildlife, Perth, WA.
- Department of Environment and Conservation [DEC] (2010) *Threatened and Priority Flora Report Form - Field Manual*. Version 1.0.
- Department of Environment and Conservation [DEC] (2013). *Quokka Setonix brachyurus Recovery Plan. Wildlife Management Program No. 56*. Department of Environment and Conservation, Perth, WA

- Department of Environment, Water, Heritage and the Arts [DEWHA] (2009) Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, WA.
- Department of Parks and Wildlife [DPaW] (2013a) Carnaby's cockatoo (*Calyptorhynchus latirostris*) Recovery Plan. Department of Parks and Wildlife, Perth, Western Australia.
- Department of Parks and Wildlife [DPaW] (2013b). Albany Regional Vegetation Survey Phase 2 (ARVS2) Conservation Planning Report. Draft for Working Group Meeting - 4 November 2013.
- Department of Parks and Wildlife [DPaW] (2014) Western Ringtail Possum (*Pseudocheirus occidentalis*) Recovery Plan. Wildlife Management Program No. 58. Department of Parks and Wildlife, Perth.
- Department of Primary Industries and Regional Development [DPIRD] (2019) List of Declared plants in Western Australia. Available from: <https://www.agric.wa.gov.au/pests-weeds-diseases/weeds/declared-plants>.
- Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] (2012) Referral guidelines for three species of Western Australian black cockatoos.
- Department of the Environment (2019). Pandion cristatus in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Fri, 22 Nov 2019 17:31:32 +110
- Department of the Environment [DotE] (2013) Conservation Advice for Subtropical and Temperate Coastal Saltmarsh.
- Department of the Environment [DotE] (2014a) Interim Biogeographic Regionalisation of Australia, Version 7. Available from: <http://www.environment.gov.au/topics/land/nrs/science-maps-and-data/australiasbioregions-ibra>.
- Department of the Environment [DotE] (2014b) Approved Conservation Advice for Proteaceae Dominated Kwongan Shrublands of the southeast coastal floristic province of Western Australia.
- Department of the Environment and Energy [DotEE] (2019a) *Protected Matters Search Tool*. URL: <https://www.environment.gov.au/epbc/protected-matters-search-tool>
- Department of the Environment and Energy [DotEE] (2019b) *Weeds of National Significance*. URL: <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>
- Environmental Protection Authority [EPA] (2016a) *Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment*.
- Environmental Protection Authority and Department of Environment and Conservation [EPA & DEC] (2010) Technical Guidance Terrestrial Vertebrate Fauna Surveys (eds B.M. Hyder, J. Dell and M.A. Cowan). Perth, Western Australia.
- Executive Steering Committee for Australian Vegetation Information [ESCAVI] (2003) *Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0*. Department of the Environment and Heritage, Canberra.
- Friend, T (2004) Dibbler Recovery Plan: July 2003-June 2013. Western Australia Department of Conservation and Land Management, Perth.
- Garnett, ST and Crowley, GM (2000) The Action Plan for Australian Birds 2000. Canberra: Environment Australia. pp. 377–378.
- Gilfillan, S (2008) Western Ringtail Possum (*Pseudocheirus occidentalis*) Survey and Data Collation in the Great Albany Area. Phase 1 Final Report. Prepared for the Department of Environment and Conservation, Albany Regional Office.
- Gilfillan, S and Rathbone, DA (2019). Western Ringtail Possum Habitat assessment for the Albany Ring Road Stage 2 and 3. Unpublished memorandum to Main Roads Western Australia by Southern Ecology, 31st October 2019.
- Gilfillan, S. (2019). Defining habitat categories for Western Ringtail Possum in the South Coast population. Unpublished memorandum to Main Roads Western Australia by Southern Ecology, 31st October 2019.
- Gilfillan, S. and Comer, S. (2018). Western Ringtail Possums in Albany: Core Habitat, Abundance, and Distribution. Report prepared for the Oyster Harbour Catchment Group. Partners: City of Albany,

- Department of Biodiversity, Conservation and Attractions, and the Centre of Excellence in Natural Resource Management at UWA. Final Report. November 2018.
- Gilfillan, S. and Maciejewski, S. (2015). Community Fauna Survey of Mt Melville/Kardarup, for the City of Albany. Report prepared by Sandra Gilfillan, June 2015.
- Government of Western Australia. (2019). 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of March 2019. WA Department of Biodiversity, Conservation and Attractions, Perth. URL: <https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics>.
- Halse, S.A., A.A. Burbidge, J.A.K. Lane, B. Haberley, G.B. Pearson & A. Clarke (1995). Size of the Cape Barren Goose population in Western Australia. *Emu*. 95:77--83.
- Higgins, PJ (ed) (1999) Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird. Oxford University Press, Melbourne.
<https://library.dbca.wa.gov.au/static/FullTextFiles/070691.pdf>
- Johnston, T (2013) Food resource availability for Carnaby's cockatoo *Calyptorhynchus latirostris* on the Swan Coast Plain. Masters Thesis, Edith Cowan University. Retrieved from <http://ro.ecu.edu.au/theses/595>
- Johnstone, RE & T. Kirkby (2008) Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (*Calyptorhynchus baudinii*) in South-west Western Australia. Records of the Western Australian Museum. 25:107-118.
- Johnstone, RE and Storr, GM (1998) Handbook of Western Australian Birds. Volume 1 - Non-Passerines (Emu to Dollarbird), Oxford University Press.
- Johnstone, RE, Kirby, T. and Sarti, K (2013) The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* Gould in south-western Australia. I. Characteristics of nest trees and nest hollows. *Pacific Conservation Biology* 19(2) 121 – 142.
- Jones, D and Clements, M (1996) A reassessment of *Prasophyllum gracile* and *P. macrostachyum* (Orchidaceae), with the description of *P. paulinae*, a new species from south-west Western Australia. *Nuytsia* 10(3): 409-418.
- Marchant, S and PJ Higgins (1990) Handbook of Australian, New Zealand and Antarctic Birds. Volume One - Ratites to Ducks. Melbourne, Victoria: Oxford University Press.
- Morgan DL, Gill, HS and Potter, IC (1995) Life cycle, growth and diet of. Balson's pygmy perch in its natural habitat of acidic pools in South-Western. *Australian Journal of Fish Biology* 47: 808-825.
- Olsen PD. Water-rat, *Hydromys chrysogaster*. In: Van Dyck S and Strahan R, (eds.). *The mammals of Australia*. New
- Paull, DJ (2008) Southern Brown Bandicoot. In Van Dyck, S. and R. Strahan (Eds.) *The Mammals of Australia*. Reed New Holland. Sydney.
- Pavey, C (2006) National Recovery Plan for the Greater Bilby I. Northern Territory Department of Natural Resources, Environment and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/m-lagotis.html>.
- Pittman, H, Scott, R, Stojanovic, D and McLellan, L (2007) Caring for Carnaby's. *Wingspan* 17: No. 4.
- Rathbone, DA & Gilfillan, S (2018). Biological Survey: Albany Ring Road. Unpublished report by Southern Ecology for Main Roads Western Australia (SE1721).
- Rathbone, DA (2020). *Prasophyllum paulinae Targeted Regional Flora Survey*. Unpublished report by Southern Ecology for Main Roads Western Australia.
- Rix, M and Harvey, M (2009) Populations of Main's Assassin Spider (*Austrarchaea mainae*) near Albany. Western Australian Museum.
- Rix, M and Harvey, M (2012) Australian Assassins, Part II: A review of the new assassin spider genus *Zephyrarchaea* (Araneae, Archaeidae) from southern Australia. *ZooKeys* 191: 1-62. <https://doi.org/10.3897/zookeys.191.3070>
- Sandiford, EM and Barrett S (2010) Albany Regional Vegetation Survey, Extent Type and Status. Report for the Department of Environment and Conservation, Western Australia.
- Saunders, DA (1979) The availability of tree hollows for use as nest sites by white-tailed black cockatoos. *Australian Wildlife Research*, 6, 205-16.

- Saunders, DA (1974) The occurrence of the white-tailed black cockatoo, *Calyptorhynchus baudinii*, in Pinus plantations in Western Australia. *Australian Wildlife Research* 1: 45- 54.
- Scott AC and Grant T (1997). Impacts of water management in the Murray-Darling Basin on the platypus (*Ornithorhynchus anatinus*) and the water rat (*Hydromys chrysogaster*). Canberra: CSIRO Land and Water 1997.
- Shepherd, DP, Beeston, GR, & Hopkins, AJM (2002) Native Vegetation in Western Australia: Extent, Type and Status. *Resource Management Technical Report* 249.
- Simpson, K, Day, N, and Trusler P (2004) Field Guide to the Birds of Australia – 7th edition. Ringwood, Victoria: Viking O'Neil.
- Speldewinde Peter C., Close Paul, Weybury Melissa, Comer Sarah (2013) Habitat preference of the Australian water rat (*Hydromys chrysogaster*) in a coastal wetland and stream, Two Peoples Bay, south-western Australia. *Australian Mammalogy* **35**, 188-194.
- SWCC (date unknown). South West Catchments Council. Carter's freshwater mussel, case study. southwestsnapshot.com.au
- Trocini S., Barrett G., Howard K. and Ramalho C. (2015) Rakali Community Survey 2014-2015. Report prepared by WWF-Australia and the Western Australian Department of Parks and Wildlife. WWF-Australia, Perth, WA.
- Van Dyke, S and Strahan, R. (2008) The Mammals of Australia. Third Edition. New Holland Publishing, Sydney Australia.
- Van Helden, BE, Speldewinde, PC, Close, PG, Comer, SJ (2017) Use of urban bushland remnants by the western Ringtail Possum (*Pseudocheirus occidentalis*): short-term home-range size and habitat use in Albany, Western Australia. *Australian Mammalogy*. <https://doi.org/10.1071/AM17026>.
- Wayne, A. F., Cowling, A., Ward, C. G., Rooney, J. F., Vellios, C. V., Lindenmayer, D. B., & Donnelly, C. F. (2006) A comparison of survey methods for arboreal possums in jarrah forest, Western Australia. *Wildlife Research*, 32(8), 701-714.
- Western Australian Herbarium [WAH] (1998–) *Florabase – the Western Australian Flora*. Department of Parks and Wildlife. <https://florabase.dpaw.wa.gov.au>.
- Western Australian Museum [WAM] (2018) Native Bees. Government of Western Australia. URL: <http://museum.wa.gov.au/research/collections/terrestrial-zoology/entomology-insect-collection/entomology-factsheets/native-bees>
- Whitford, KR and Williams, MR (2002) Hollows in jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees: II. Selecting trees to retain for hollow dependent fauna. *Forest Ecology and Management*. 160: 215 -278.
- Whitford KR, Wiseman D, McCaw WL, Bradshaw FJ (2015). Characteristics of nest trees and nest hollows used by the forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) in south-west Western Australia: comments on Johnstone *et al.* (2013). *Pacific Conservation Biology* 21, pp. 133–145.
- Wilkins, P., Gilfillan, S., Watson, J. and Sanders, A. (ed). 2006. The Western Australian South Coast Macro Corridor Network – a bioregional strategy for nature conservation, Department of Conservation and Land Management (CALM) and South Coast Regional Initiative Planning Team (SCRIPT), Albany, Western Australia.

8 APPENDIX A - Conservation Status Definitions

Table A1. Acts relevant to environmental impact assessment.

<i>Environment Protection and Biodiversity Conservation [EPBC] Act 1999</i>	https://www.legislation.gov.au/Details/C2016C00777
<i>Environmental Protection [EP] Act 1986</i>	https://www.slp.wa.gov.au/legislation/statutes.nsf/law_a252.html
<i>Biodiversity Conservation [BC] Act 2016</i>	https://www.slp.wa.gov.au/legislation/statutes.nsf/law_a147120.html

Table A2. The categories for flora and fauna listed as Threatened or specially protected. Taxa can be recognised as Threatened (T) or Conservation Dependent under Commonwealth (EPBC) and / or State (BC) Acts.

Threat category	Definition
Threatened - Critically Endangered (T-CR)	Considered to be facing an extremely high risk of extinction in the wild
Threatened – Endangered (T-EN)	Considered to be facing a very high risk of extinction in the wild
Threatened – Vulnerable (T-VN)	Considered to be facing a high risk of extinction in the wild
Threatened - Presumed extinct (T-EX)	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died.
Conservation dependant (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened
Migratory birds protected under international agreement (IA)	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
Other specially protected fauna (OS)	Fauna otherwise in need of special protection to ensure their conservation

Table A3. Flora or fauna that are potentially threatened but do not meet the survey criteria or are otherwise data deficient are listed under Priority categories with the Department of Biodiversity, Conservation and Attractions.

Category	Description
Priority One (P1)	Known from few locations (generally <5), small populations and/or occurring on land with insecure tenure
Priority Two (P2)	Known from few locations (generally <5), small populations with some occurring on land with secure tenure
Priority Three (P3)	Known from several locations with habitat not under imminent threat
Priority Four (P4)	(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

Table A4. Categories for ecological communities listed as Threatened (TEC). Communities can be recognised as Threatened under Commonwealth (EPBC) and / or State (BC) Acts.

Category	Description
Presumed totally destroyed (PU)	Adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.
Critically Endangered (CR)	Adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
Endangered (EN)	Adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.
Vulnerable (VU)	Adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium (within approximately 50 years) to long-term future.

Table A5. The categories for ecological communities listed as Priority (PEC) with the Department of Biodiversity, Conservation and Attractions.

Category	Description
Priority One (P1)	Known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha) and are currently under threat
Priority Two (P2)	Known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years)
Priority Three (P3)	Known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or; (iii) made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc
Priority Four (P4)	Adequately known, rare but not threatened or meet criteria for Near Threatened or that have been recently removed from the threatened list. These communities require regular monitoring
Priority Five (P5)	Conservation dependant ecological communities. Not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years

Table A6. Species that are 'introduced' or 'weeds' can potentially be listed under the state Biosecurity Management Act (DPIRD 2019) or under the commonwealth Weeds of National Significance (WoNS) (DotEE 2019b).

Category	Description
Declared Pest, Prohibited - s12	Prohibited organism and may only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions
Permitted - s11	Permitted organisms must satisfy any applicable import requirements when imported. They may be subject to an import permit if they are potential carriers of high-risk organisms
Declared Pest - s22(2)	Declared pests must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia
Permitted, Requires Permit - r73	Regulation 73 permitted organisms may only be imported subject to an import permit. These organisms may be subject to restriction under legislation other than the Biosecurity and Agriculture Management Act 2007. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions
WoNS	Weeds of National Significance – this is nationally recognised list of weeds agreed by Australian governments based on an assessment process that prioritised weeds based on their invasiveness, potential for spread and environmental, social and economic impacts. Consideration was also given to their ability to be successfully managed.

9 APPENDIX B – Map Series 1-8 A-B (see attached)

CONTENTS:

Overview and Index Map

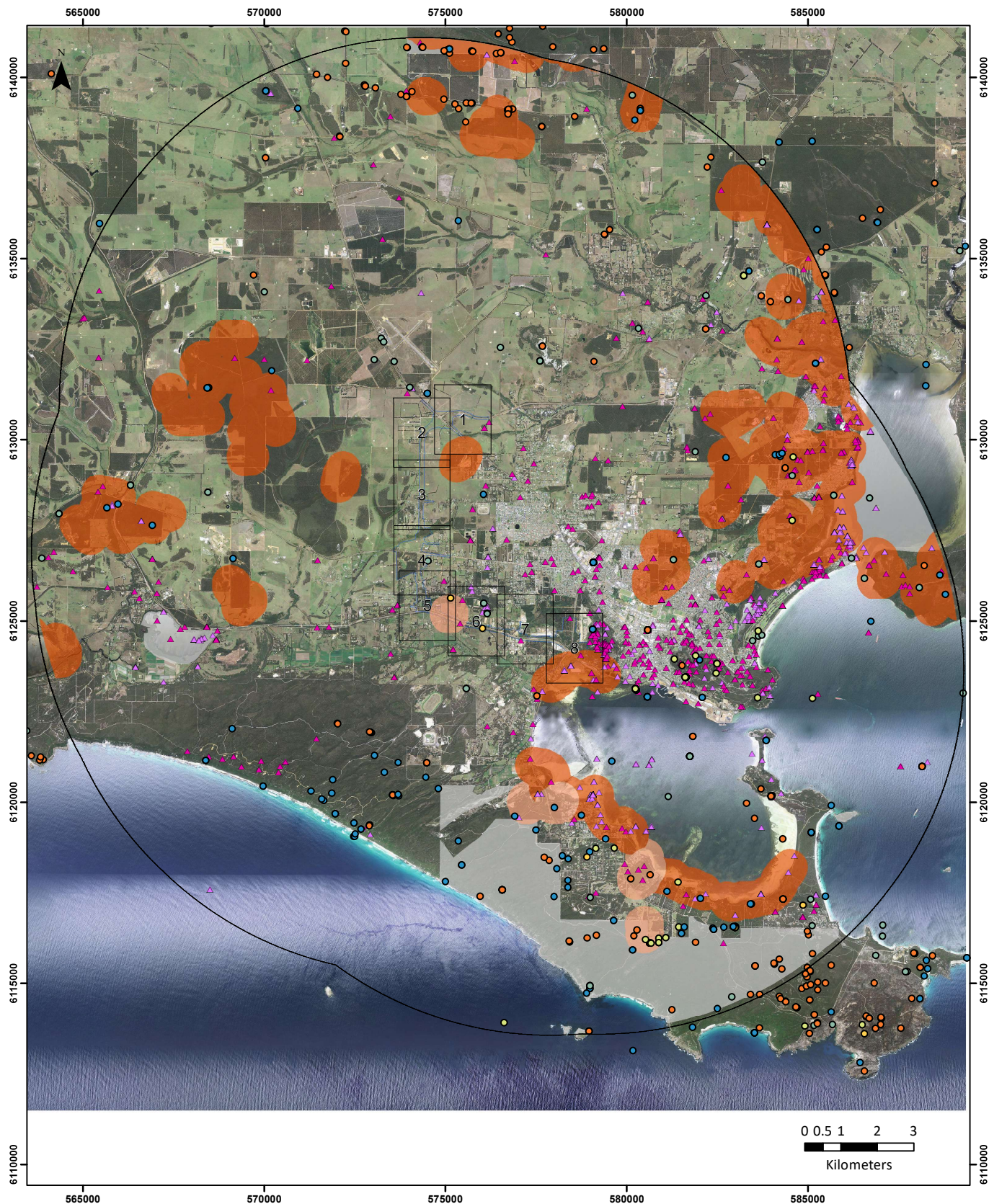
Map 1-8A - Vegetation Type and Conservation Significant Flora

Map 1-8B - Vegetation Condition and Weeds

Map 1-8C - Black Cockatoo Species Habitat and Significant Fauna Habitat Trees

Map 1-8D - Western Ringtail Possum Habitat and Fauna Observations

Map 1-8E - Survey Effort (derived from GPS track log)



Overview Map and Desktop Biological Data within the Study Area, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:100,000



Damien Rathbone | Ecologist

- Map Series Index 1-8
- Survey Area
- Survey Area 10 km Buffer

Conservation Significant Flora (DBCA)

- X
- T
- 1
- 2
- 3
- 4

Conservation Significant Fauna (DBCA)

- ▲ Threatened Fauna
- ▲ Other Fauna (Priority, IA, CD)

Conservation Significant Vegetation (DBCA)

- Threatened Ecological Community
- Priority Ecological Community
- Environmentally Sensitive Areas (ESA)



Map 1A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Giffilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Association

- Hakea* spp Shrubland/Woodland Complex
- Jarrah/Marri/Sheoak Laterite Forest
- Jarrah/Sheoak/*E. staeri* Sandy Woodland
- Homalosperrum firmum*/*Callistemon glaucus* Peat Thicket
- Woody Weeds (Victorian Tea Tree, Taylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)
- Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum,uart, other Eucalypts and Peppermint generally > 10 years old)
- Revegetation (mixed shrubs and trees generally <10 years old)
- Isolated Plants (Pasture and herbaceous weeds with isolated native plants)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. Jamesii (J. Liddel 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 2A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Giffillan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



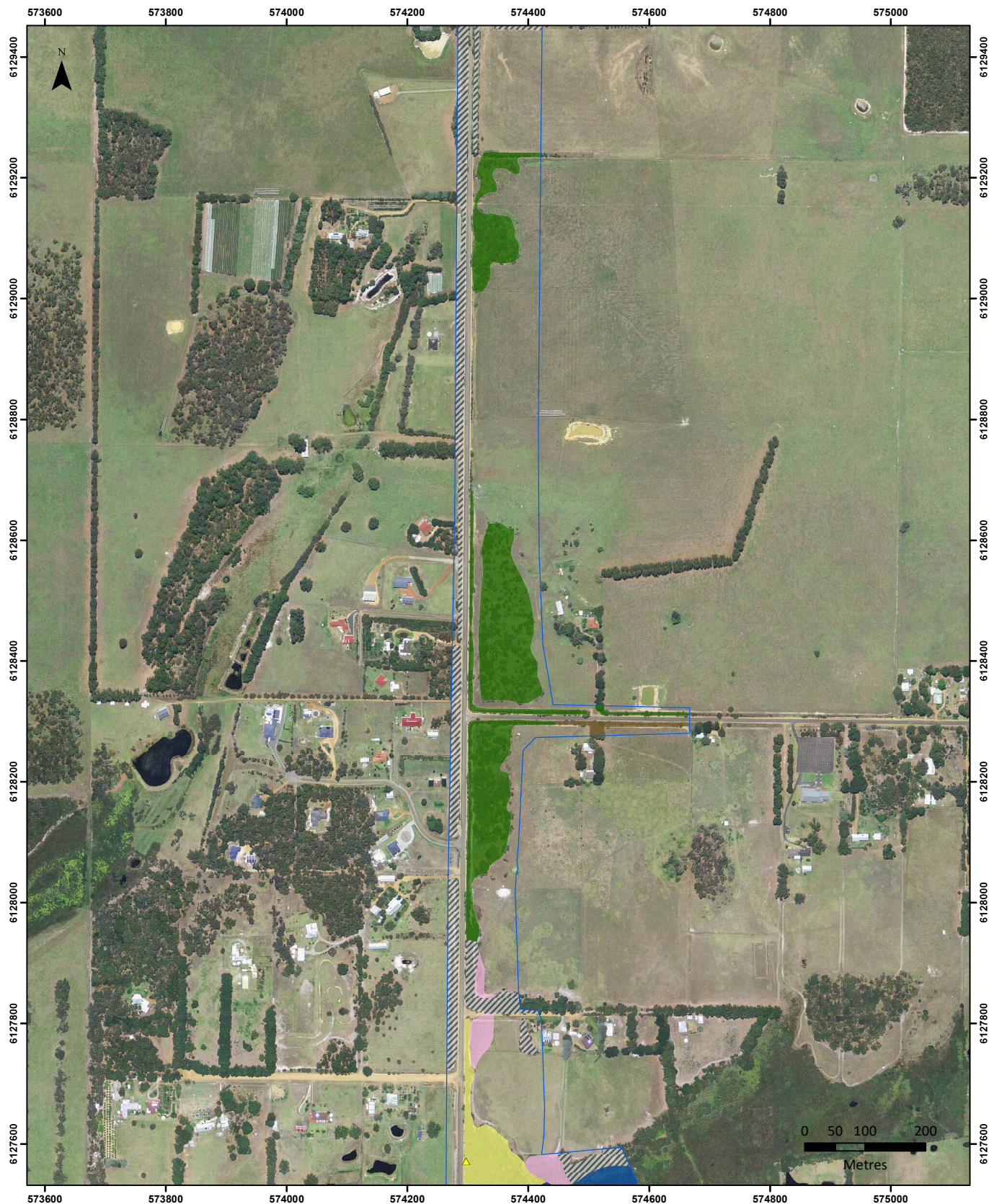
Damien Rathbone | Ecologist

Vegetation Association

- Hakea* spp Shrubland/Woodland Complex
- Jarrah/Marri/Sheoak Laterite Forest
- Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Revegetation (mixed shrubs and trees generally <10 years old)
- Isolated Plants (Pasture and herbaceous weeds with isolated native plants)
- Cleared

Conservation Significant Flora

- ▲ *Boronia crassipes* (P3)
- ▲ *Synaphea incurva* (P3)
- ▲ *Andersonia* sp. Jamesii (J. Liddelow 84) (P4)
- ▲ *Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 3A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
Report Reference: Rathbone, DA & Giffillan, S (2020). Biological Survey: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



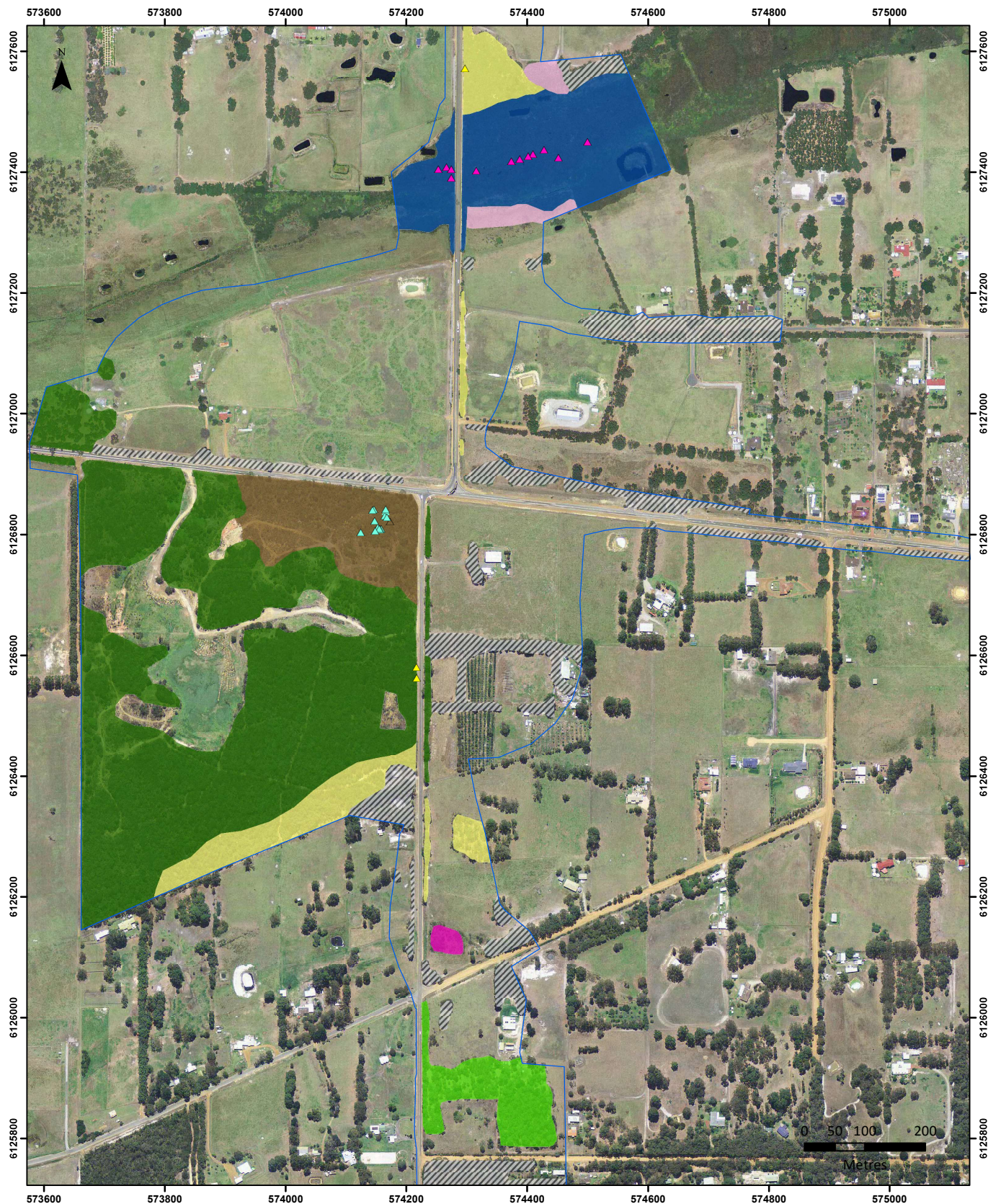
Damien Rathbone | Ecologist

Vegetation Association

- Hakea* spp Shrubland/Woodland Complex
- Jarrah/Marri/Sheoak Laterite Forest
- Jarrah/Sheoak/*E.staeri* Sandy Woodland
- Homalosperrum firmum*/*Callistemon glaucus* Peat Thicket
- Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Isolated Plants (Pasture and herbaceous weeds with isolated native plants)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. Jamesii (J. Liddel 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 4A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gittlan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



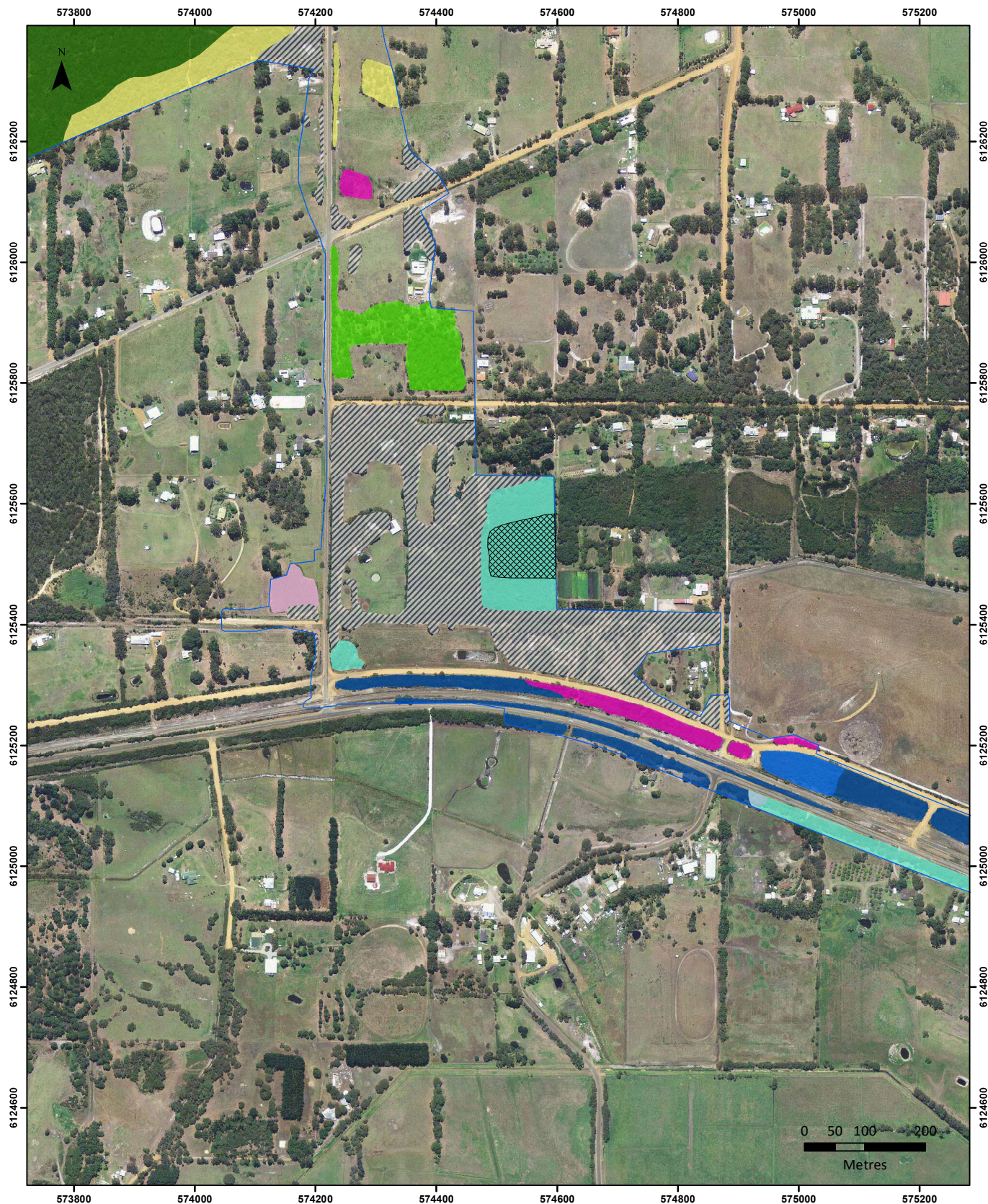
Damien Rathbone | Ecologist

Vegetation Association

- Hakea* spp Shrubland/Woodland Complex
- Jarrah/Marri/Sheoak Laterite Forest
- Jarrah/Sheoak/*E.staeri* Sandy Woodland
- Marri/Jarrah Forest/Peppermint Woodland
- Homalospermum firmum*/*Callistemon glaucus* Peat Thicket
- Woody Weeds (Victorian Tea Tree, Teylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)
- Other Weeds (Walsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Isolated Plants (Pasture and herbaceous weeds with isolated native plants)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. Jamesii (J. Liddellow 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 5A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Giffillan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



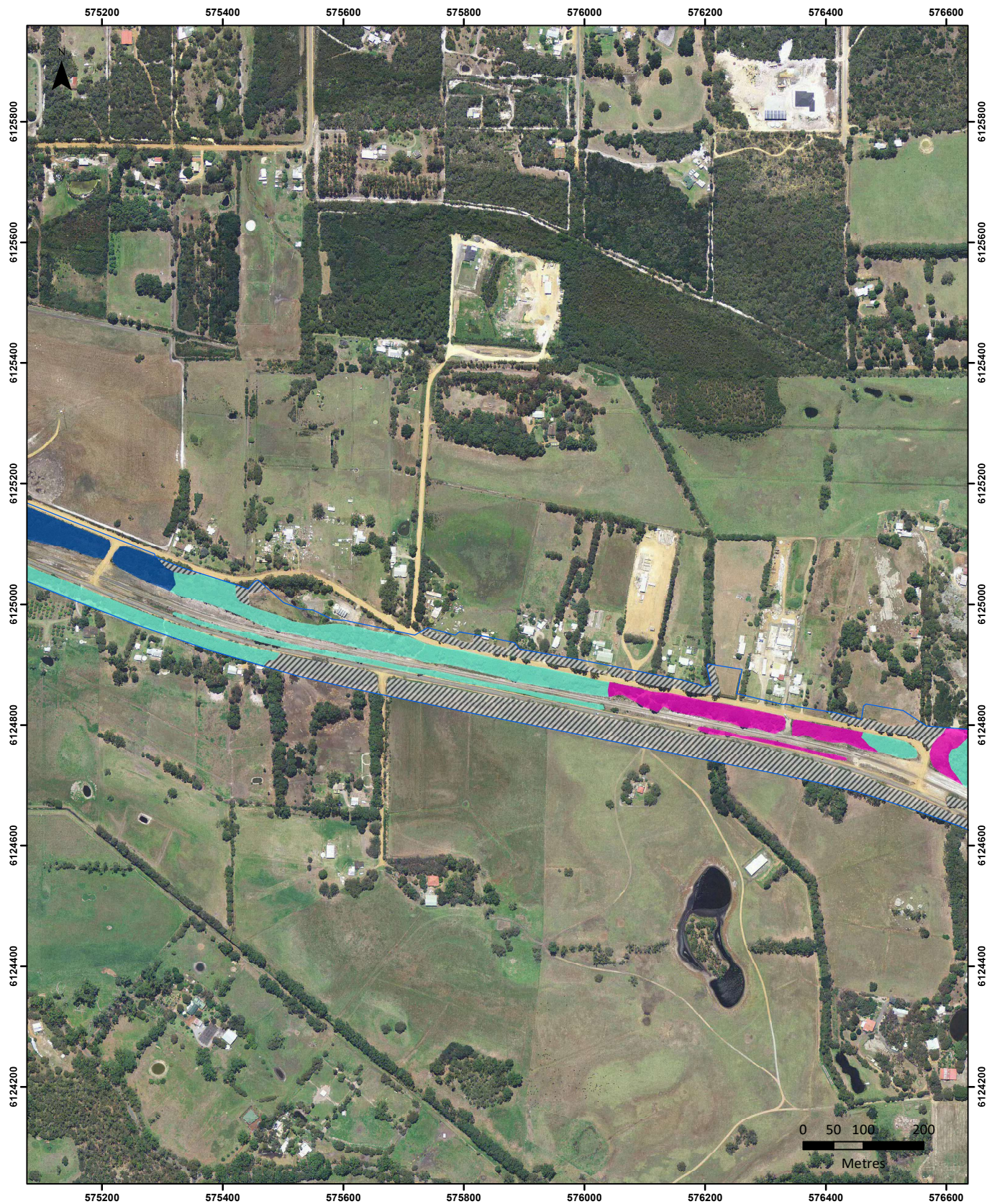
Damien Rathbone | Ecologist

Vegetation Association

- Jarrah/Marri/Sheoak Laterite Forest
- Jarrah/Sheoak/E.staeri Sandy Woodland
- Marri/Jarrah Forest/Peppermint Woodland
- Homalospennum firmum/Callistemon glaucus Peat Thicket
- Evandra aristata Sedgeland
- Melaleuca preissiana Low Woodland
- Taxandria juniperina Closed Forest
- Woody Weeds (Victorian Tea Tree, Taylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)
- Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. Jamesii (J. Liddellow 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 6A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gittlan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



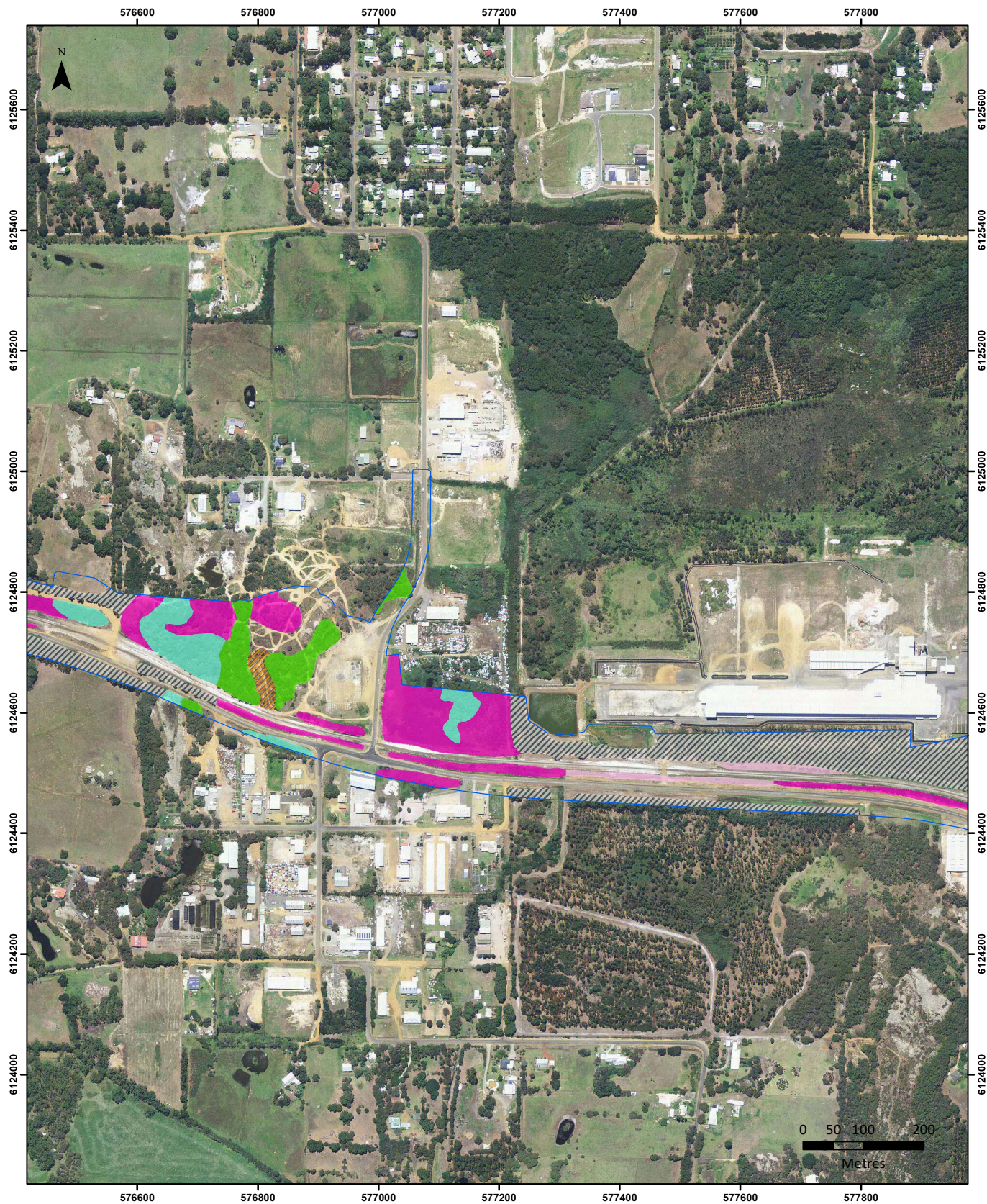
Damien Rathbone | Ecologist

Vegetation Association

- Homalospermum firmum*/*Callistemon glaucus* Peat Thicket
- Taxandria juniperina* Closed Forest
- Woody Weeds (Victorian Tea Tree, Tayloria, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. *Jamesii* (J. Liddellow 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 7A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gittlan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



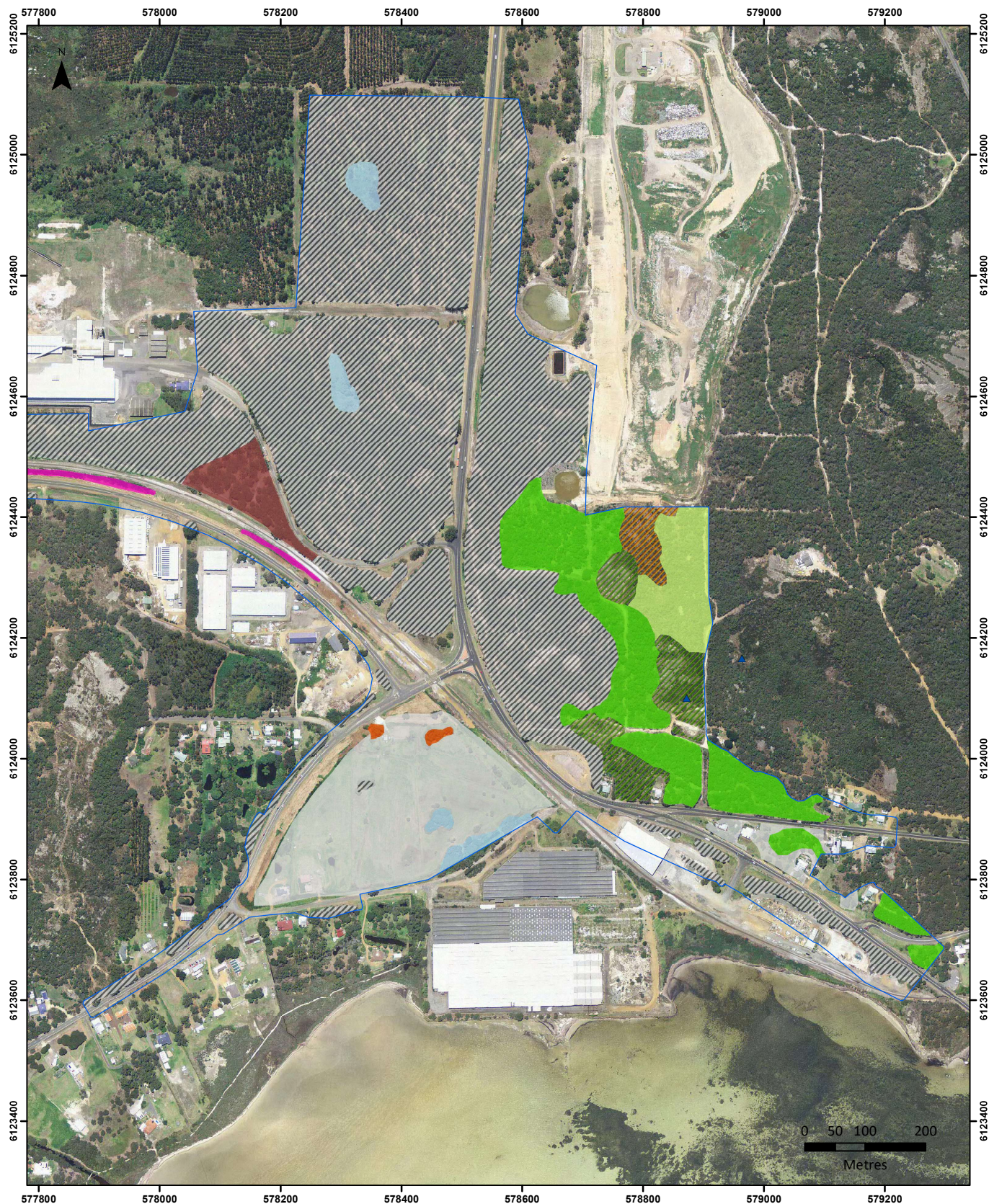
Damien Rathbone | Ecologist

Vegetation Association

- Marri/Jarrah Forest/Peppermint Woodland
- Taxandria juniperina Closed Forest
- Mosaic *T. marginata*/Leucopogon assimilis Granite Shrubland; *Taxandria marginata* Granite Shrubland
- Woody Weeds (Victorian Tea Tree, Taylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)
- Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. Jamesii (J. Liddellow 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 8A: Vegetation Type and Conservation Significant Flora, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
Report Reference: Rathbone, DA & Gittlan, S (2020). Biological Survey: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Association

- Mami/Jarrah Forest/Peppermint Woodland
- Mami/Jarrah Coastal Hills Forest
- Yate Woodland
- Peppermint Low Forest
- Melaleuca preissiana Low Woodland
- Mosaic *T. marginata*/*Gastrolobium bilobum* Granite Shrubland/Yate Woodland
- Mosaic *T. marginata*/*Leucopogon assimilis* Granite Shrubland; *Taxandria marginata* Granite Shrubland
- Woody Weeds (Victorian Tea Tree, Taylorina, Sydney Wattle, Kangaroo Acacia or Bamboo with isolated native plants)
- Other Weeds (Watsonia, Bracken Fern or Blackberry with isolated native plants)
- Mature Planted Trees (Iron Barks, Blue Gum, Tuart, other Eucalypts and Peppermint generally > 10 years old)
- Isolated Plants (Pasture and herbaceous weeds with isolated native plants)
- Cleared

Conservation Significant Flora

- Boronia crassipes* (P3)
- Synaphea incurva* (P3)
- Andersonia* sp. Jamesii (J. Liddel 84) (P4)
- Thysanotus isantherus* (P4)
- Prasophyllum paulinae* (P1) Habitat
- Survey Area



Map 1B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- *Asparagus asparagoides*
- *Lantana camara*
- *Rubus fruticosus aggregate*
- *Ulex europaeus*
- *Zantedeschia aethiopica*
- Survey Area



Map 2B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



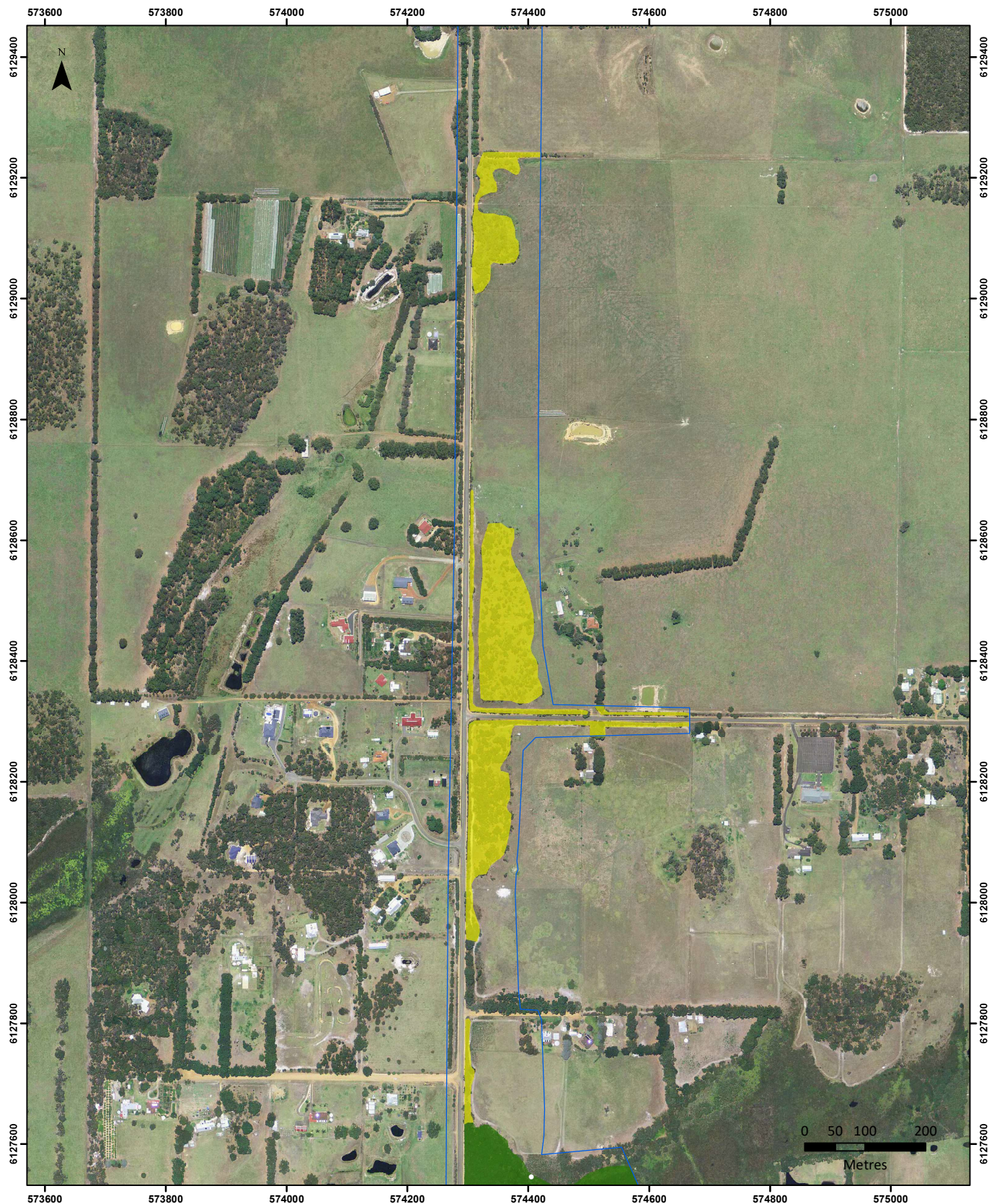
Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- Asparagus asparagoides*
- Lantana camara*
- Rubus fruticosus aggregate*
- Ulex europaeus*
- Zantedeschia aethiopica*
- Survey Area



Map 3B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



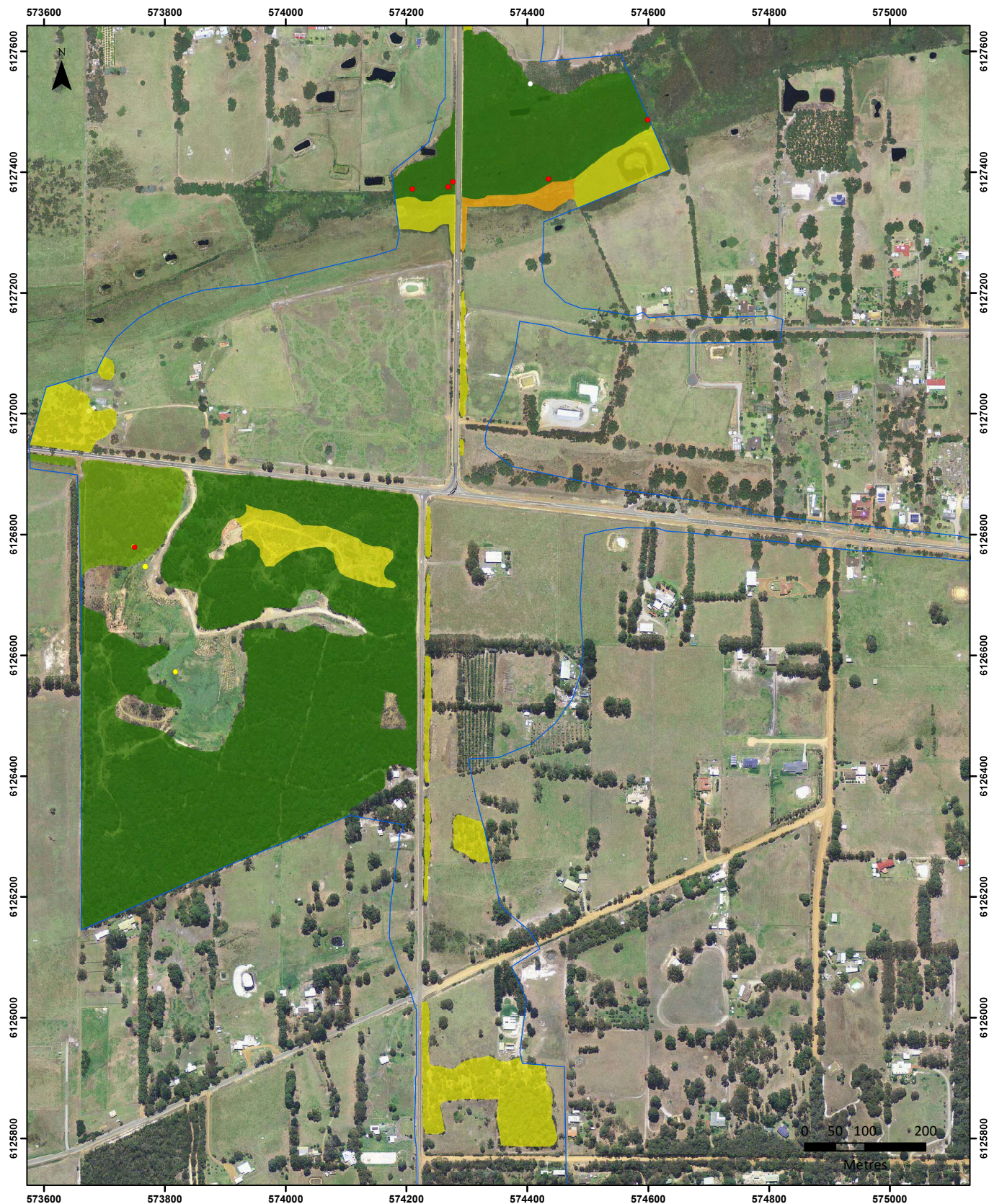
Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- *Asparagus asparagoides*
- *Lantana camara*
- *Rubus fruticosus aggregate*
- *Ulex europaeus*
- *Zantedeschia aethiopica*
- Survey Area



Map 4B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- Asparagus asparagoides*
- Lantana camara*
- Rubus fruticosus aggregate*
- Ulex europaeus*
- Zantedeschia aethiopica*
- Survey Area



Map 5B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- *Asparagus asparagoides*
- *Lantana camara*
- *Rubus fruticosus aggregate*
- *Ulex europaeus*
- *Zantedeschia aethiopica*
- Survey Area



Map 6B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- *Asparagus asparagoides*
- *Lantana camara*
- *Rubus fruticosus aggregate*
- *Ulex europaeus*
- *Zantedeschia aethiopica*
- Survey Area



Map 7B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillian, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



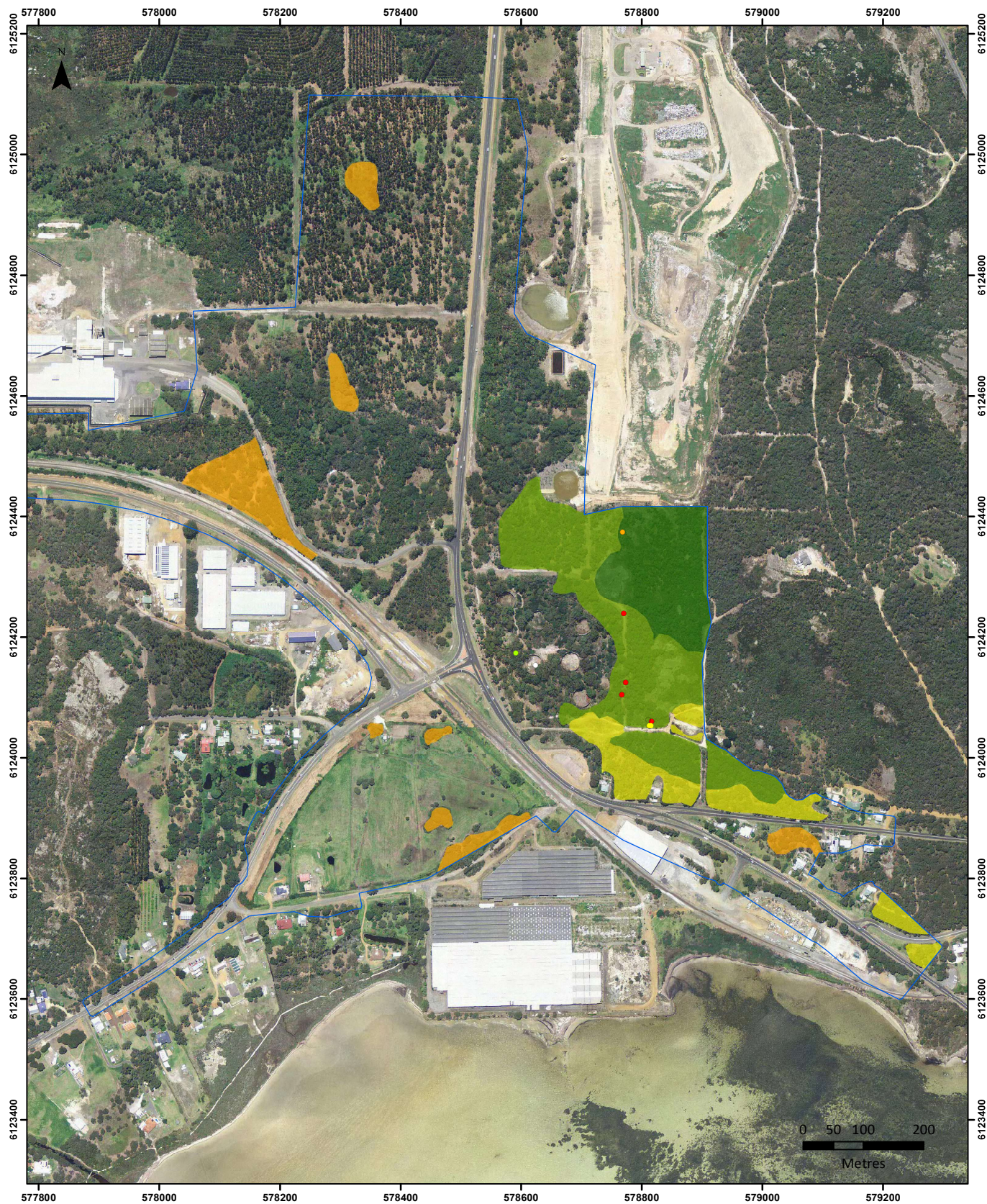
Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- Asparagus asparagoides*
- Lantana camara*
- Rubus fruticosus aggregate*
- Ulex europaeus*
- Zantedeschia aethiopica*
- Survey Area



Map 8B: Vegetation Condition and Weeds, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Vegetation Condition

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

Weeds

- Asparagus asparagoides*
- Lantana camara*
- Rubus fruticosus aggregate*
- Ulex europaeus*
- Zantedeschia aethiopica*
- Survey Area



Map 1C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

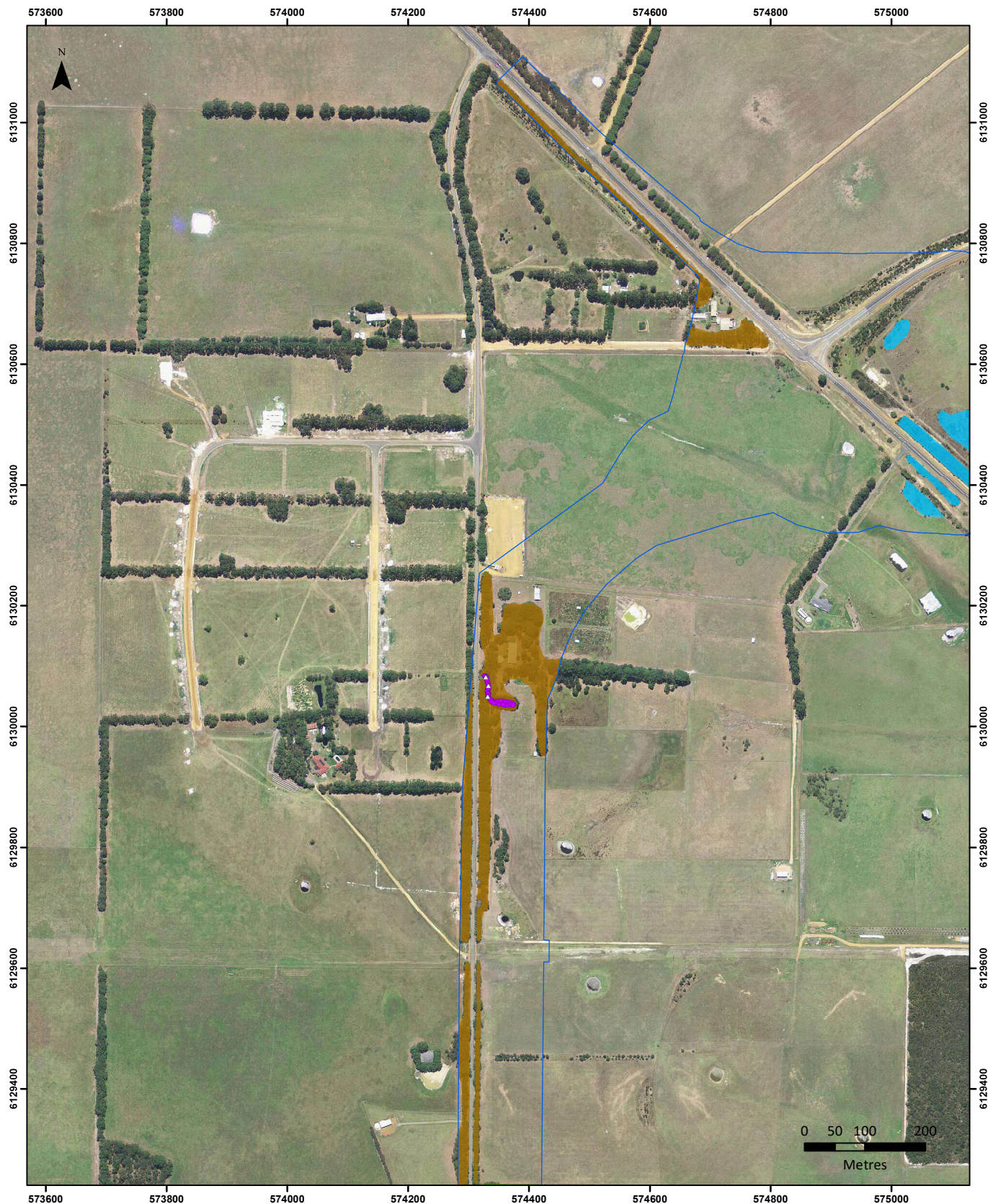
- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 2C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

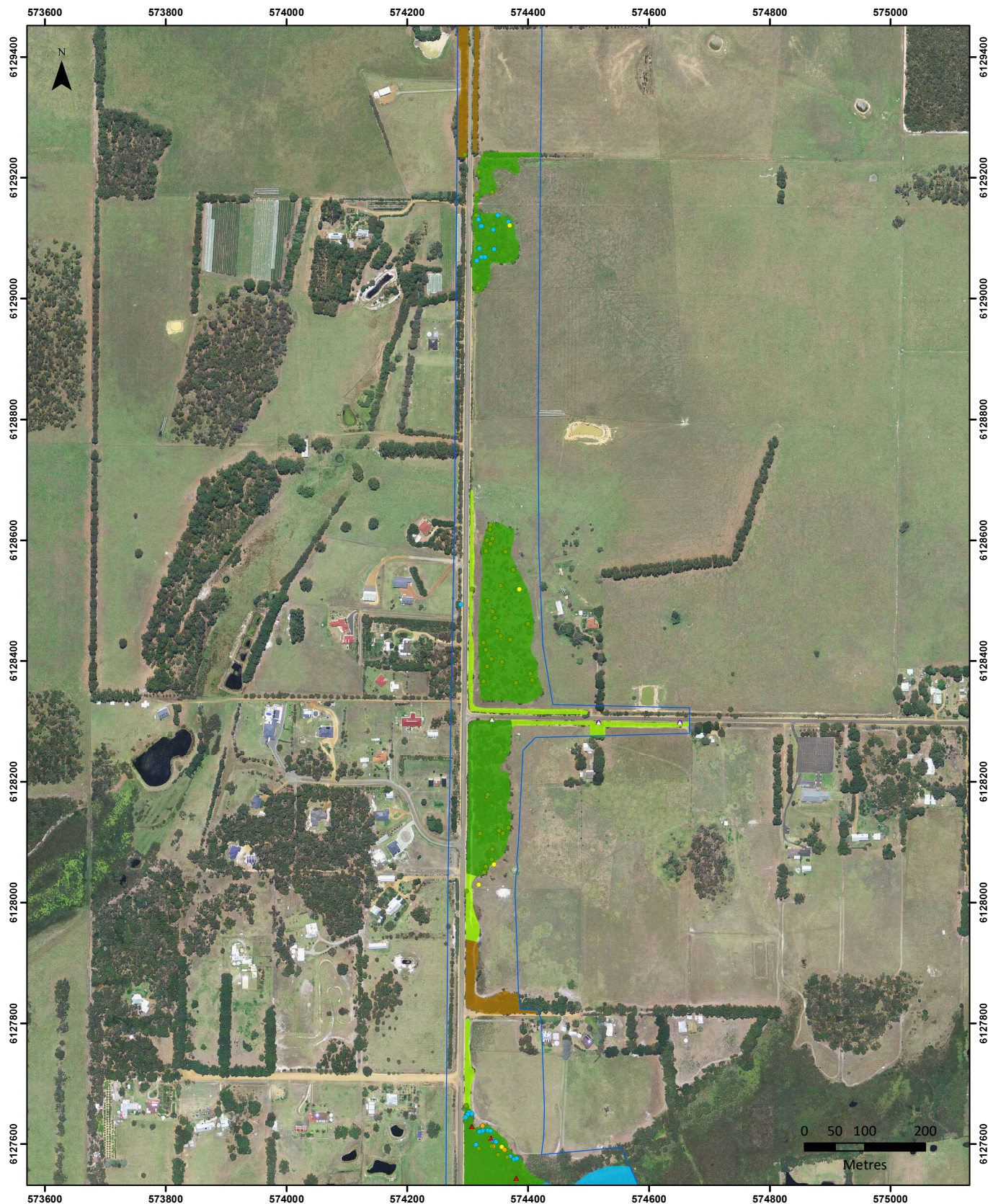
- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 3C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

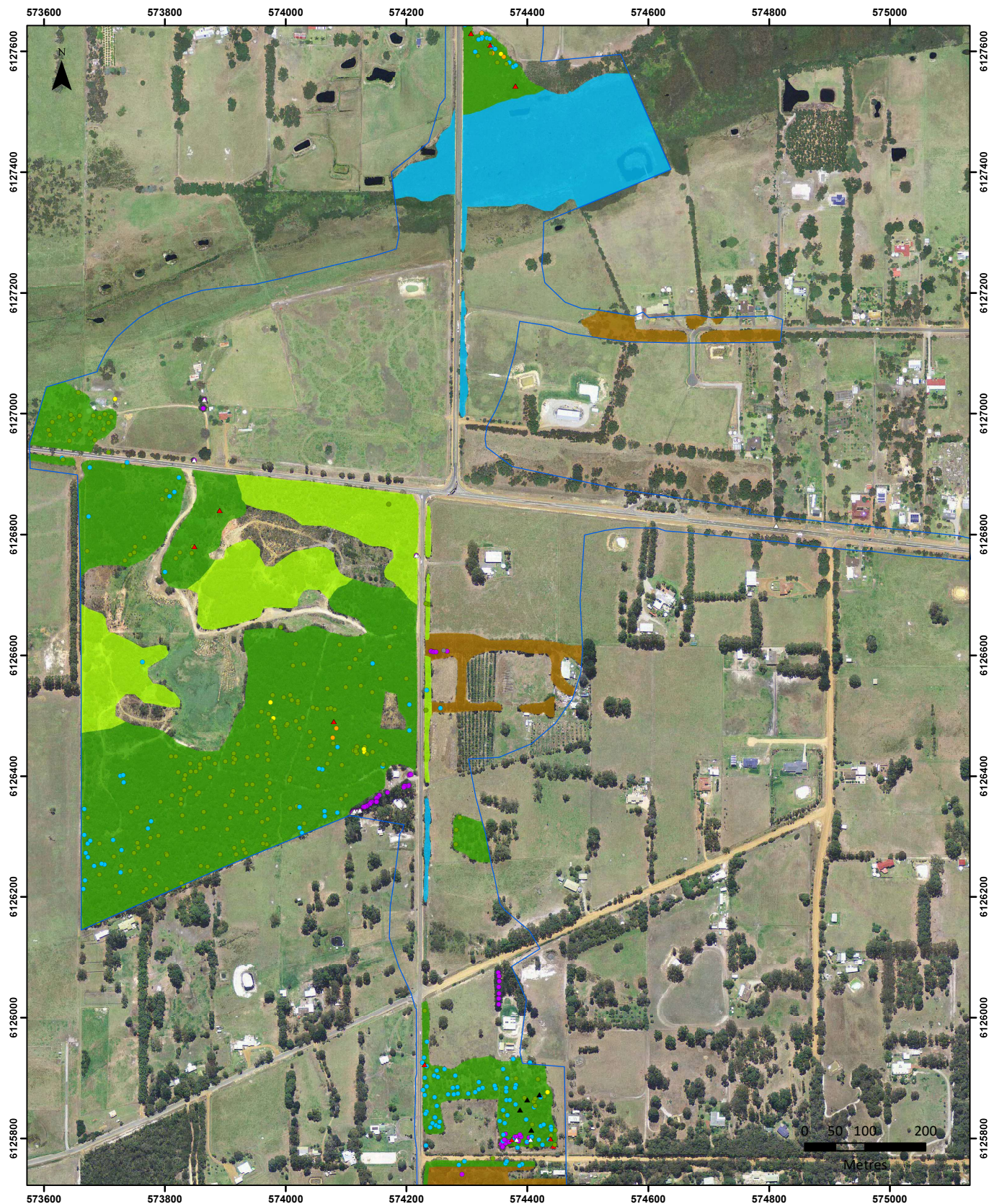
- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 4C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillfillan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

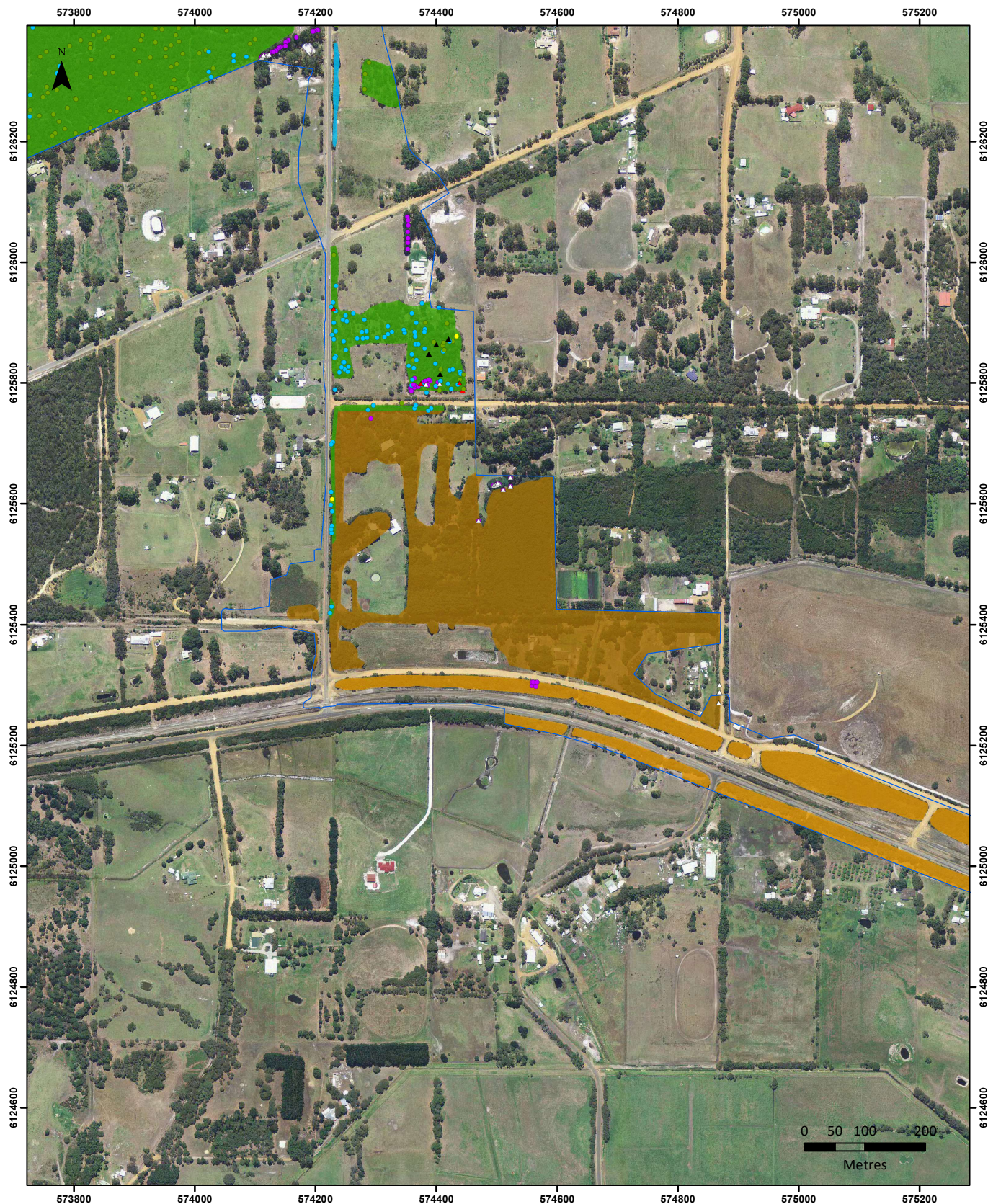
- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 5C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 6C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

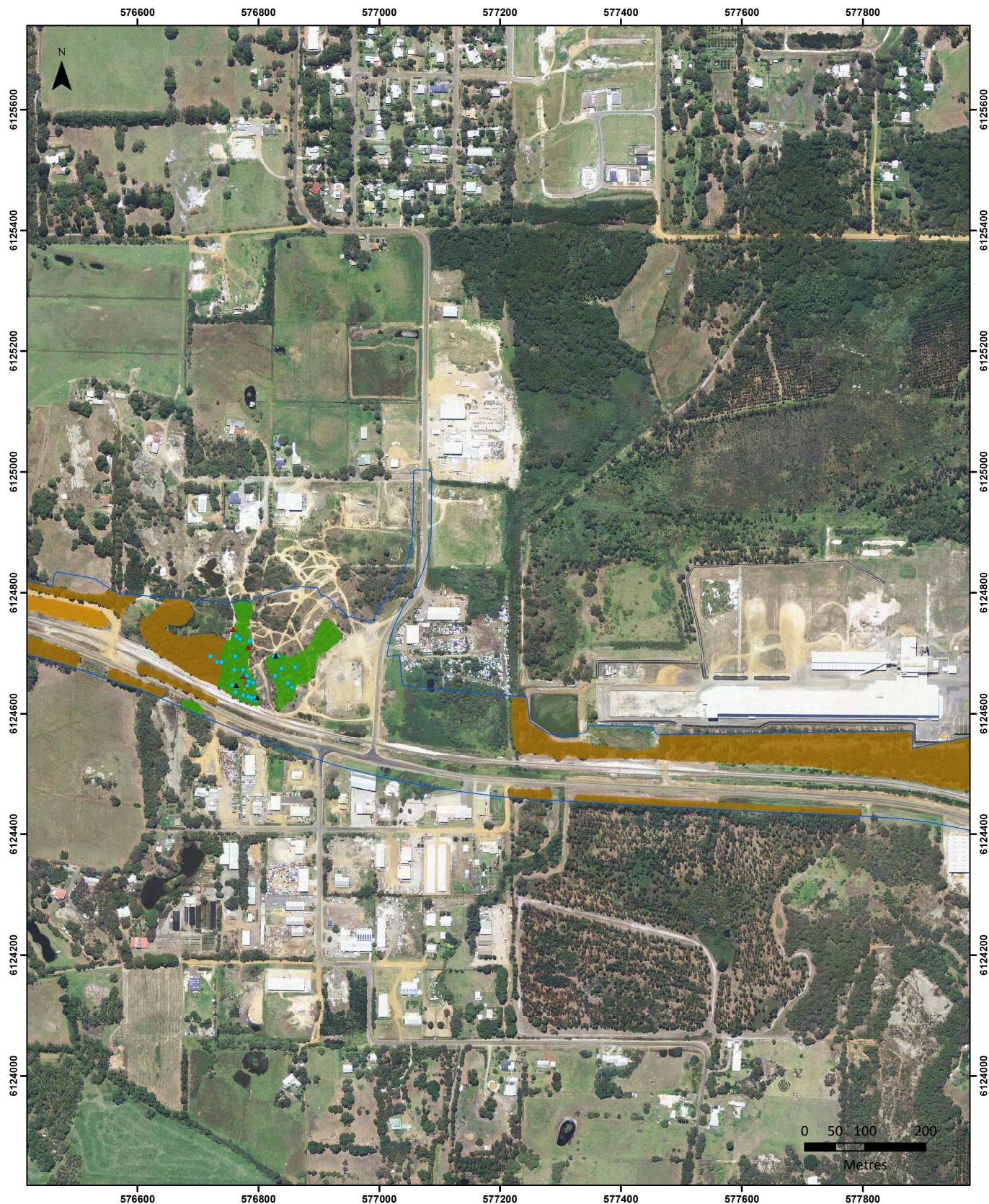
- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 7C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

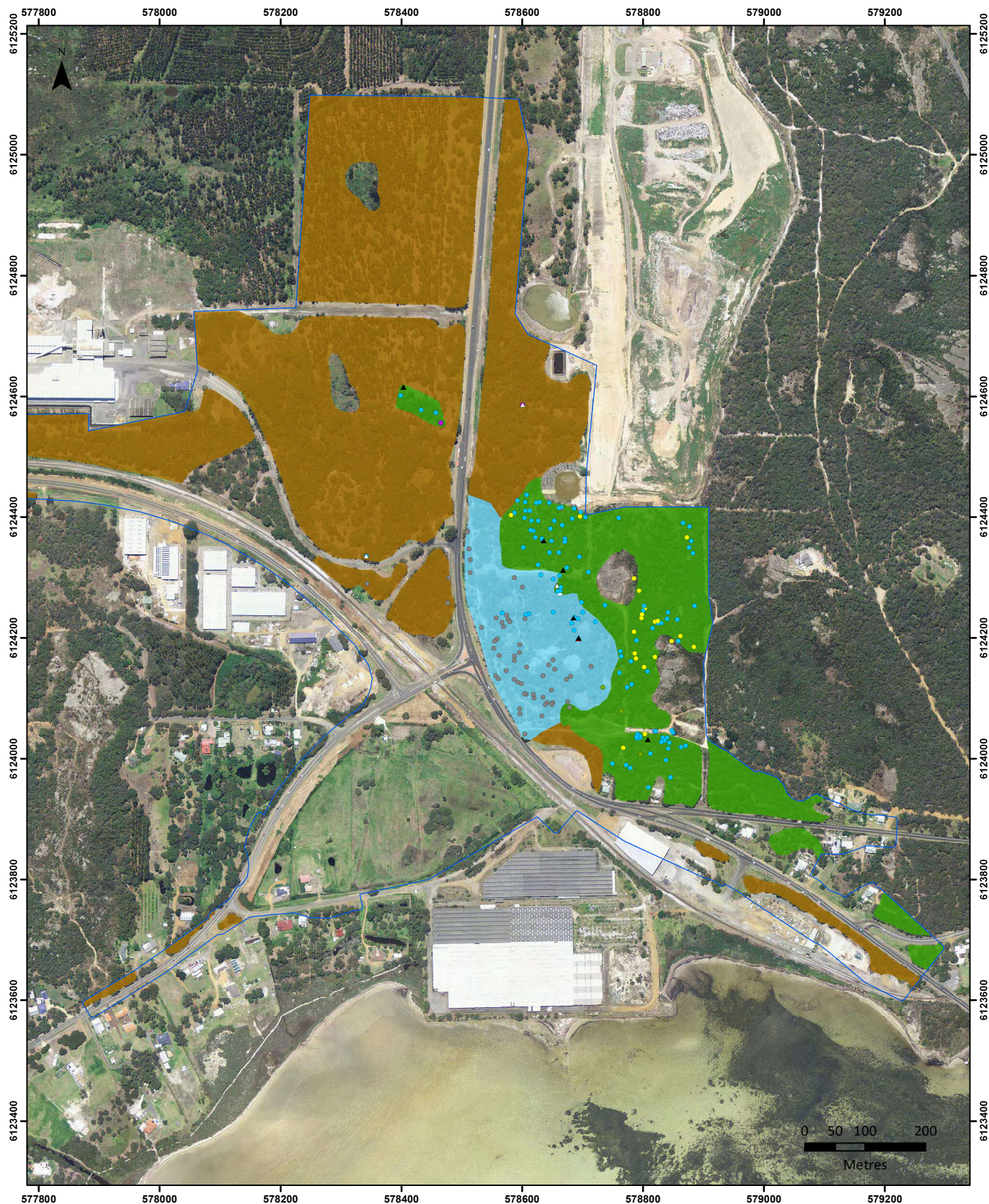
- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginalata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 8C: Cockatoo Habitat and Potential Breeding Trees, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Black Cockatoo Species Habitat

- High quality breeding, roosting and feeding habitat
- Low quality breeding, roosting and feeding habitat
- High quality roosting habitat
- Low quality roosting habitat
- Low quality breeding habitat
- Low quality feeding habitat

Significant Fauna Habitat Trees

- *Eucalyptus marginata*
- *Eucalyptus staeri*
- *Eucalyptus gomphocephala*
- *Corymbia calophylla*
- Dead *Eucalyptus/Corymbia* sp.
- *Pinus radiata*

Cockatoo Observations

- ▲ Baudin's Cockatoo (T) feeding evidence
- △ Carnaby's Cockatoo (T) feeding evidence
- ▲ Red-tailed Black Cockatoo (T) feeding evidence
- Survey Area



Map 1D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 2D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

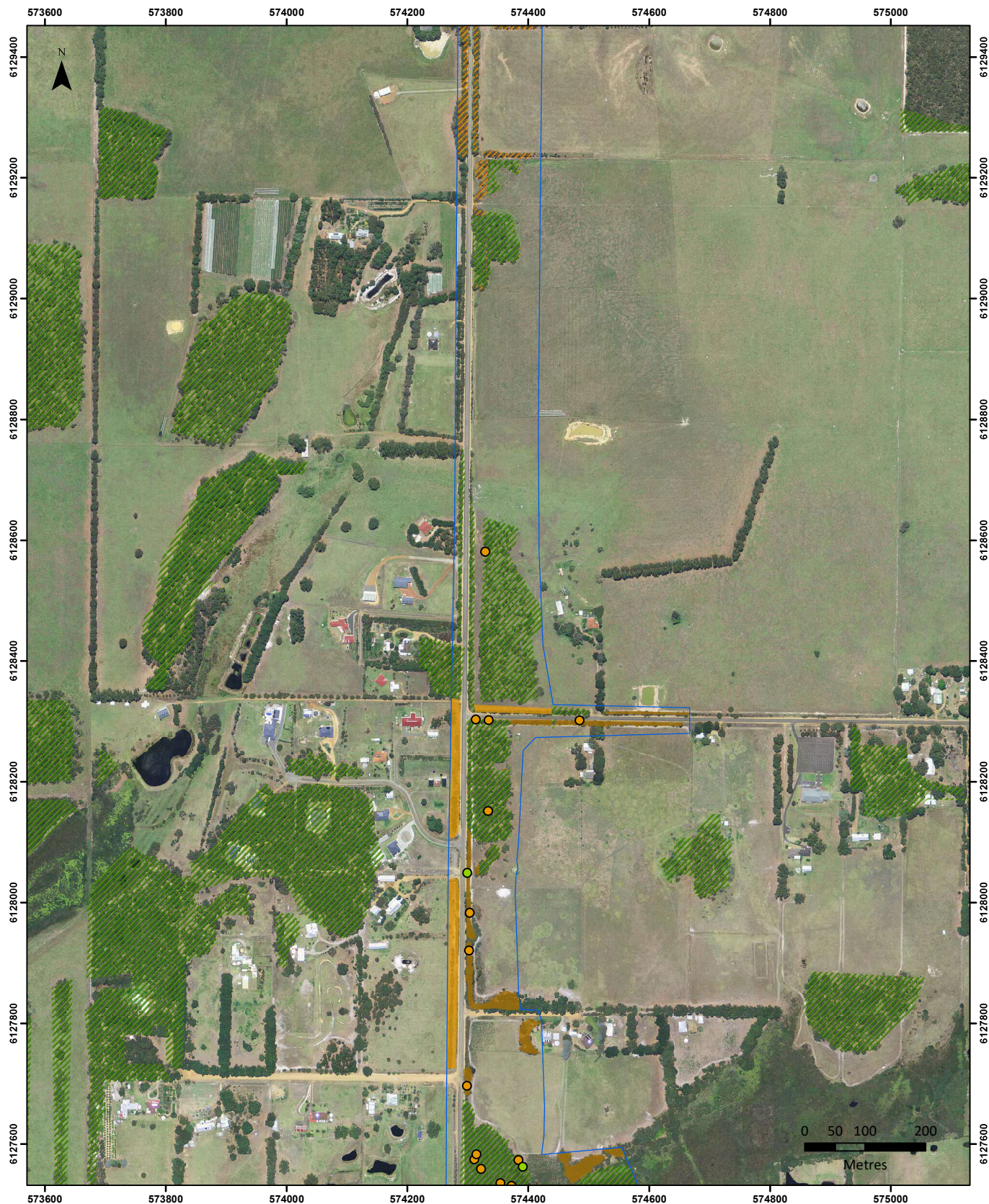
- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 3D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 4D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

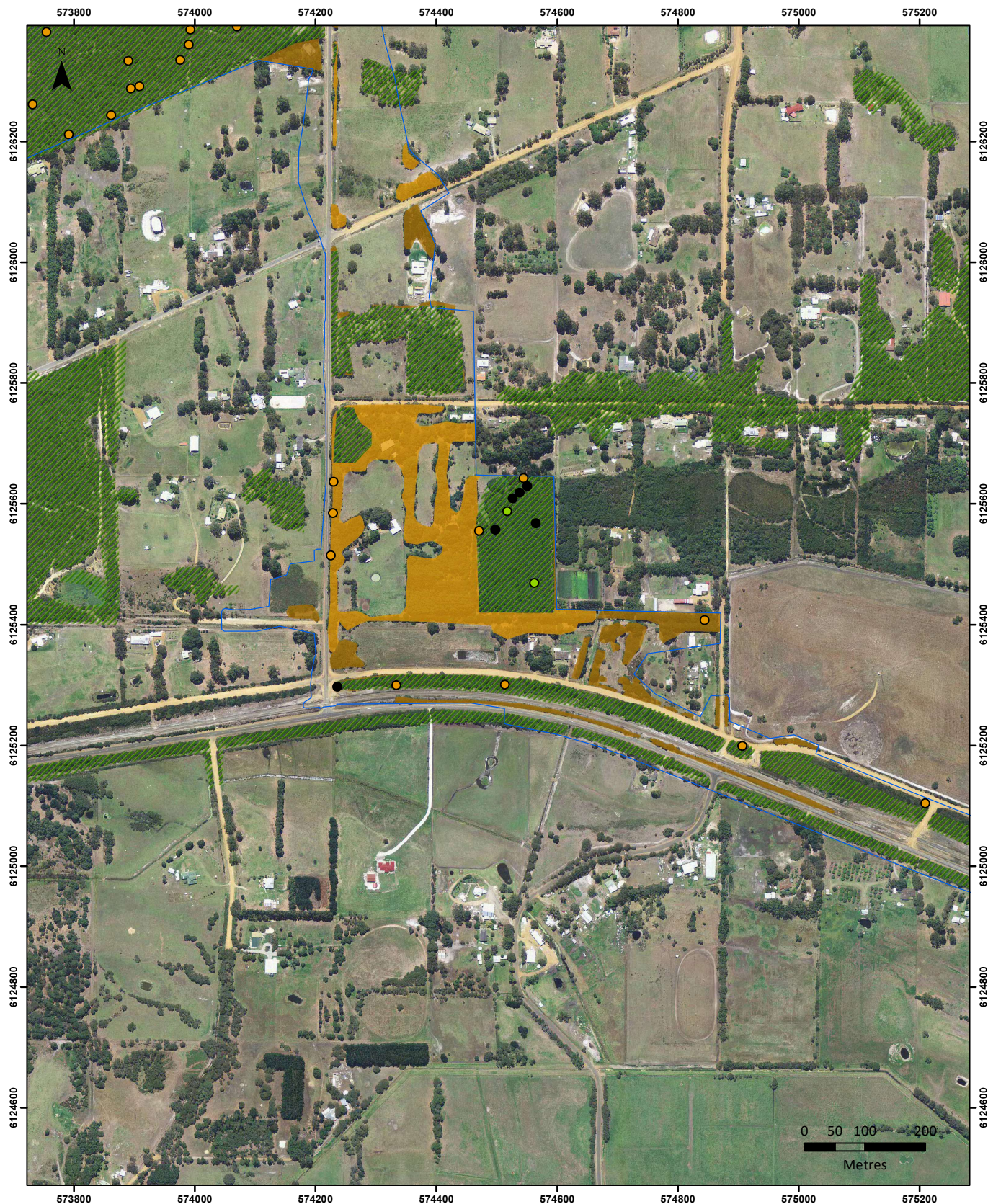
- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 5D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 6D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

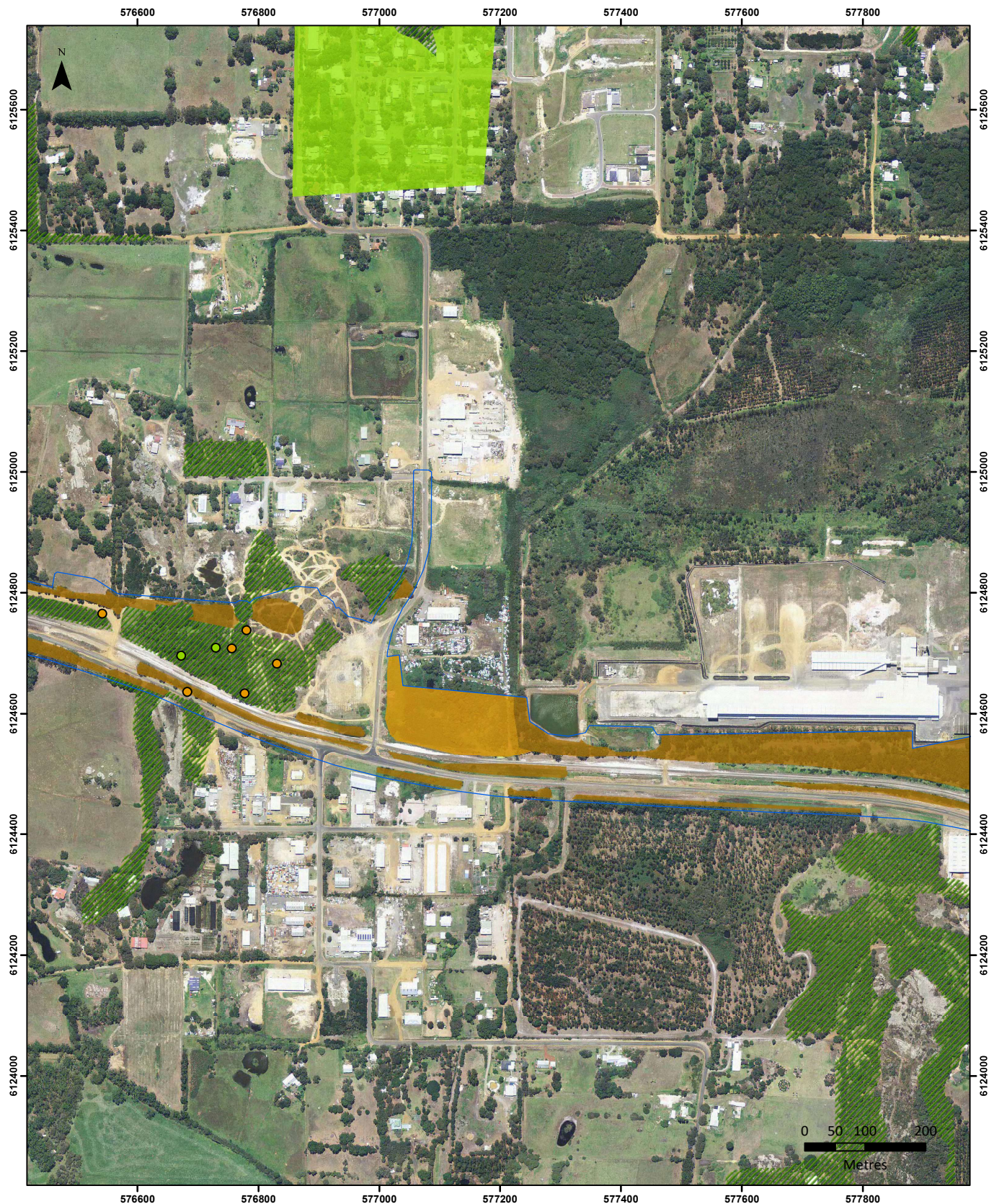
- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 7D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillian, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

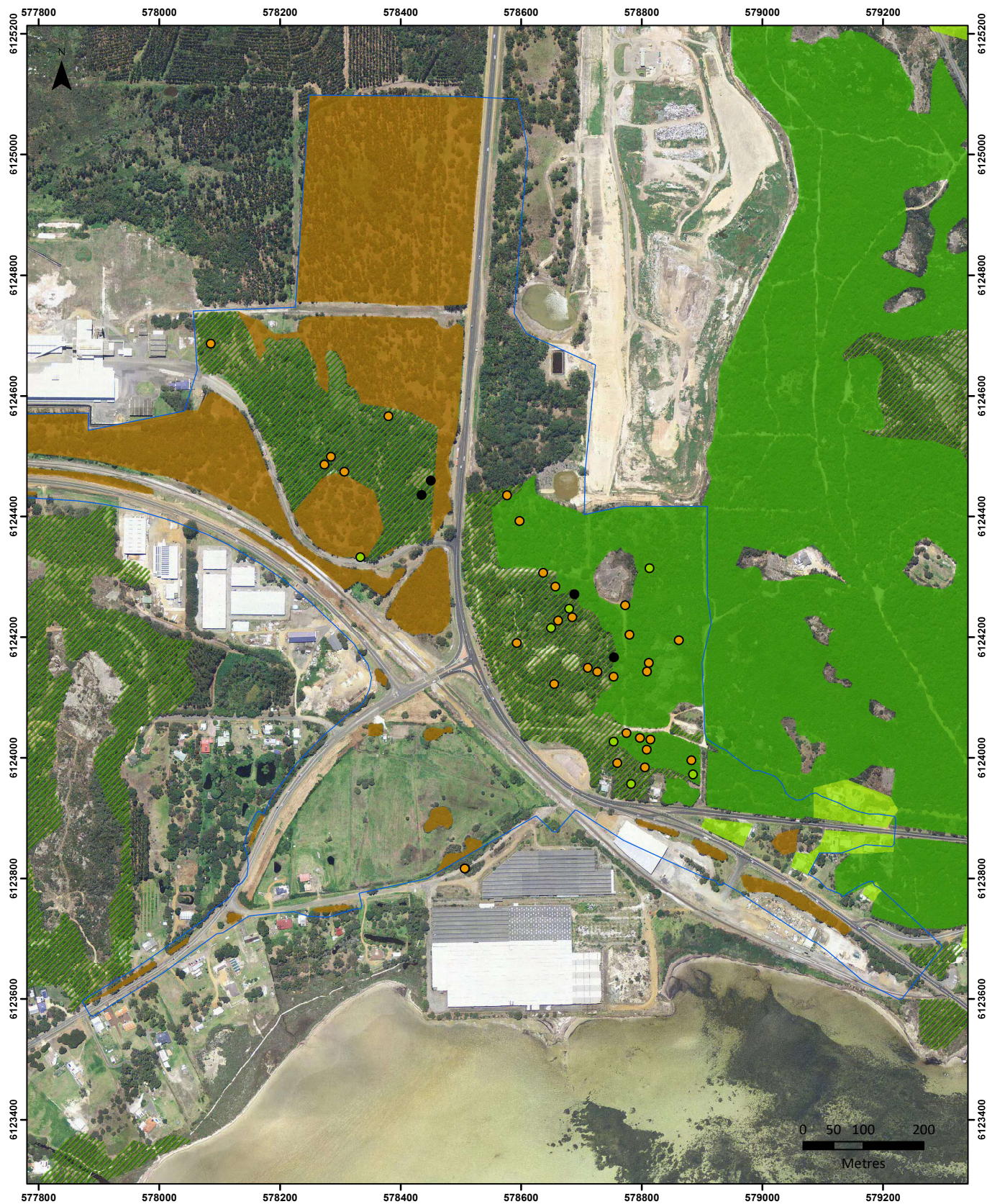
- Core
- Core (Urban)
- Supporting

Western Ringtail Possum Habitat Linkages

- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 8D: Western Ringtail Possum Habitat and Fauna Observations, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Western Ringtail Possum Habitat

- Core
- Core (Urban)
- Supporting
- Linkage
- Linkage likely
- Linkage possible

Fauna Observations

- Western Ringtail Possum Scats
- Western Ringtail Possum Drey
- Quenda Evidence
- Potential Brush-tail Phascogale Occupied Hollow
- Survey Area



Map 1E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



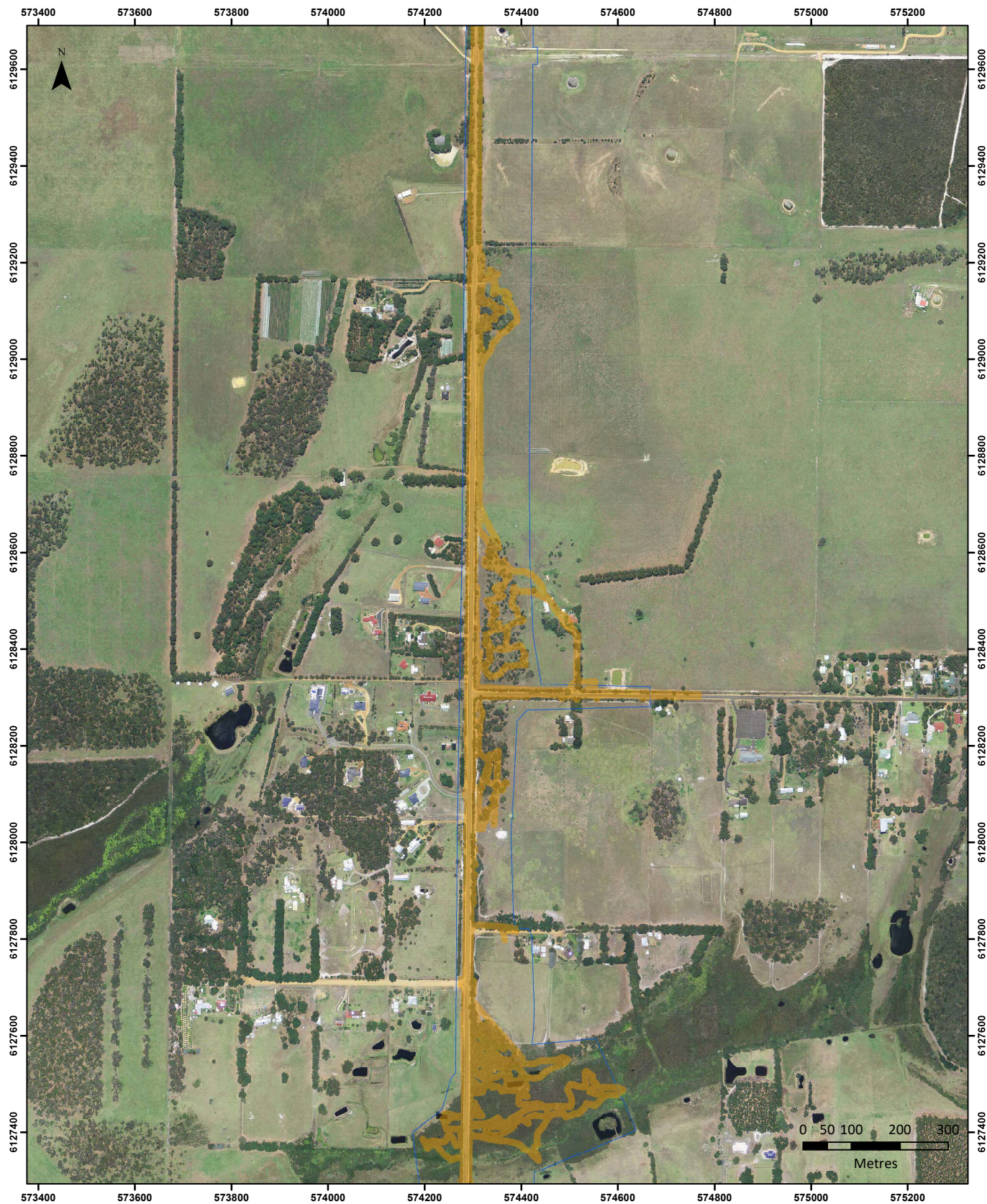
Map 2E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



Map 3E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



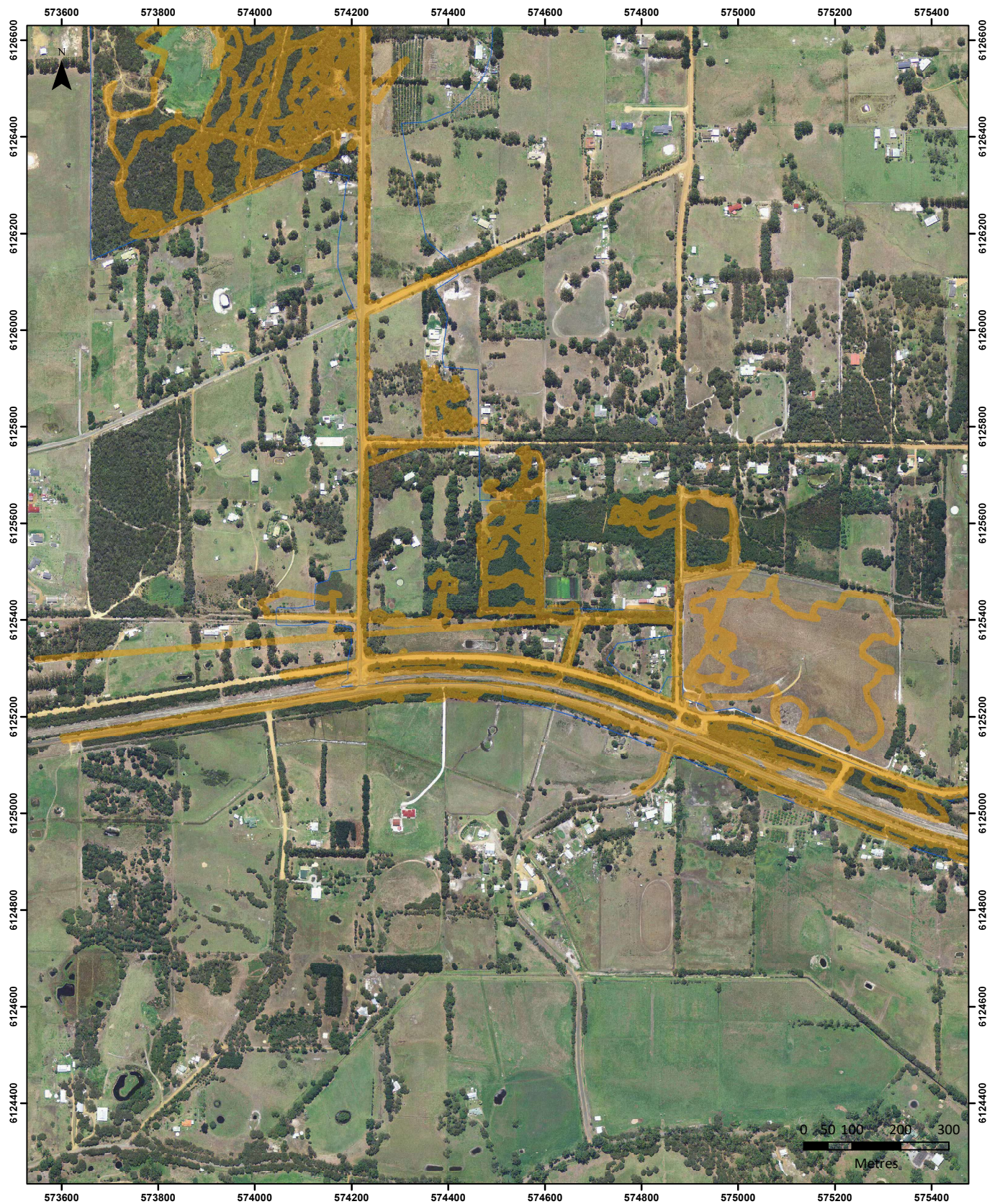
Map 4E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



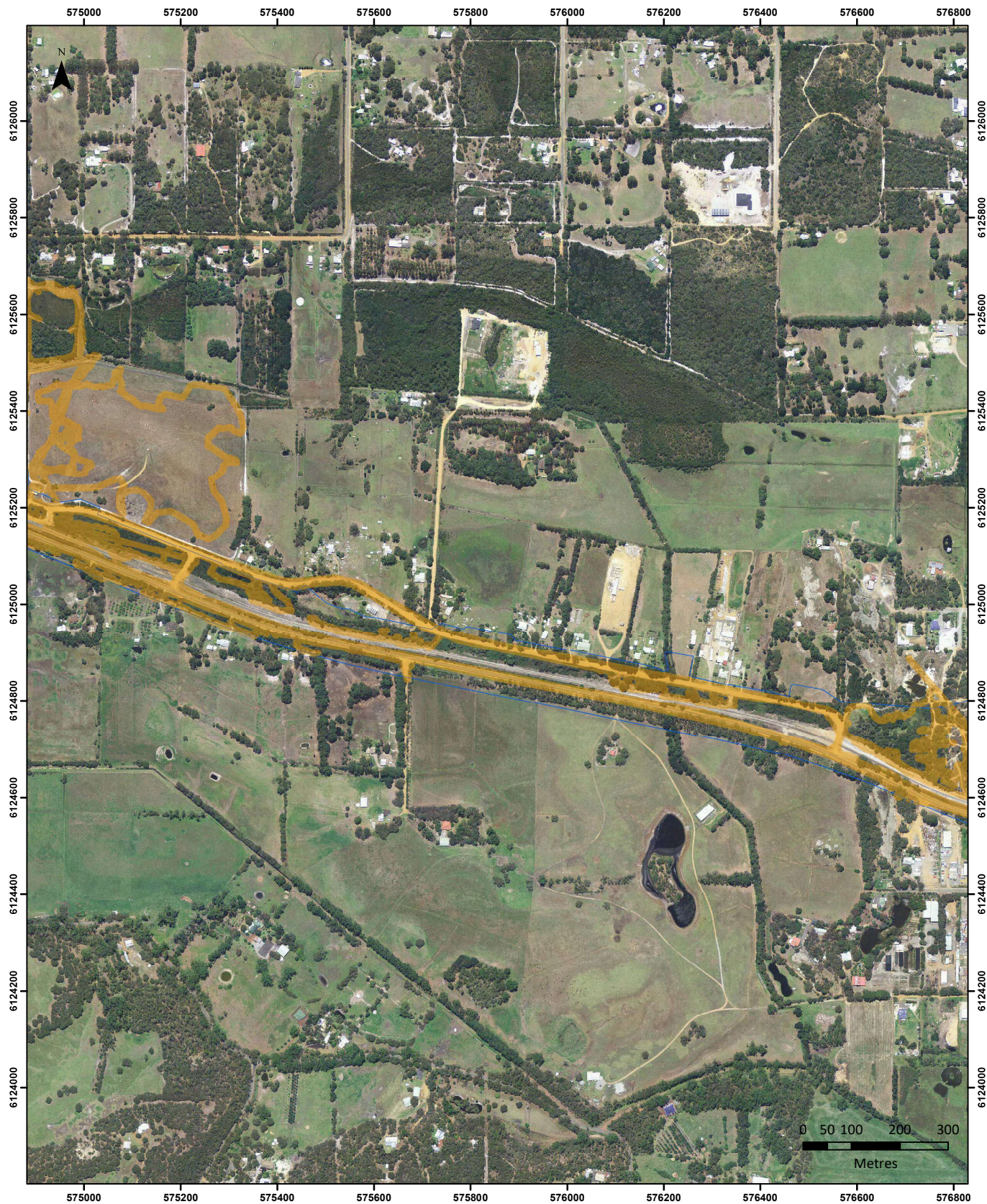
Map 5E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



Map 6E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



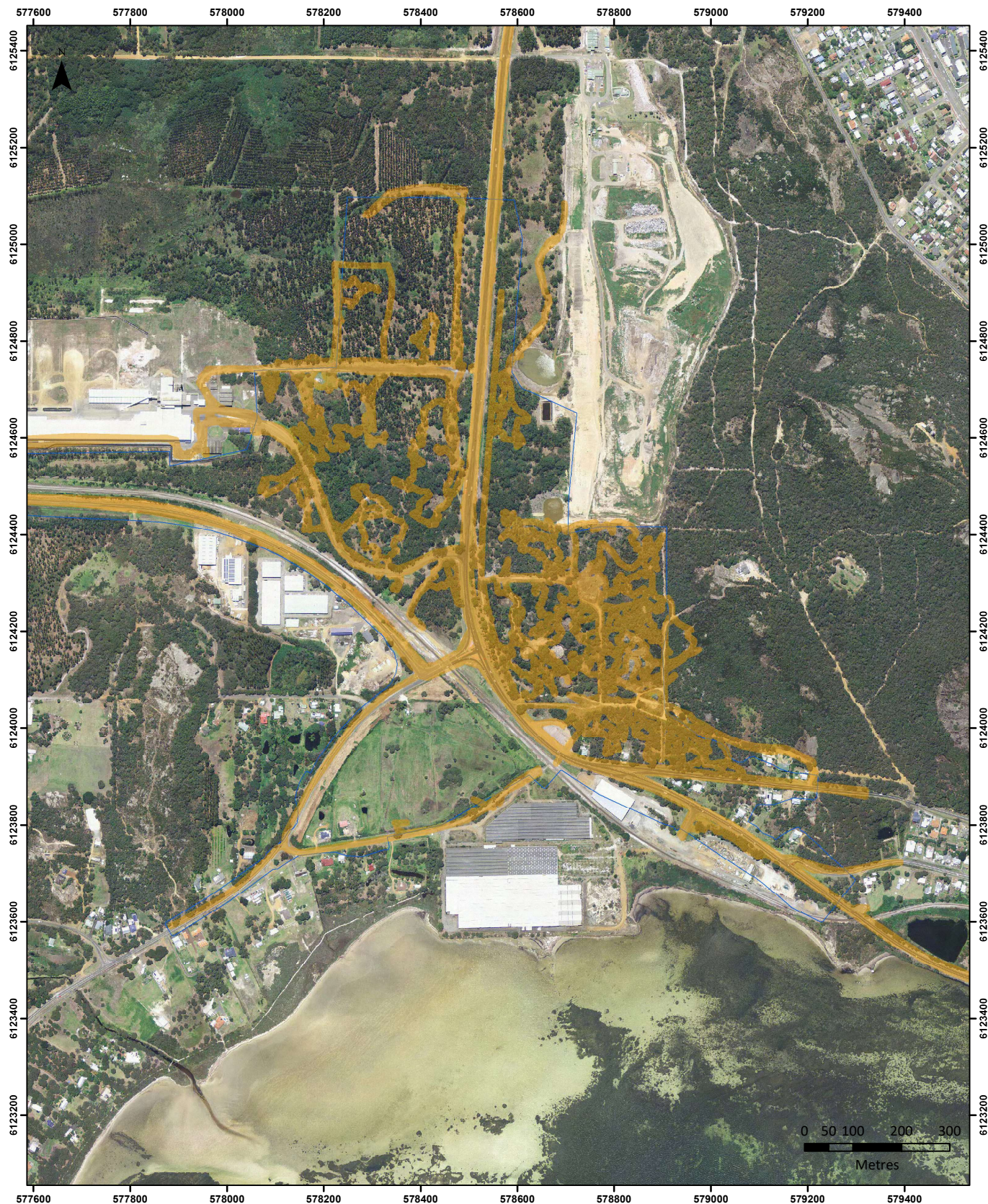
Map 7E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area



Map 8E: Survey Effort Derived from GPS Track Logs, Albany Ring Road.

Map produced by Damien Rathbone on 20/01/2020.
 Report Reference: Rathbone, DA & Gillilan, S (2020). Biological Survey: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
 Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

- Survey Effort
- Survey Area

10 APPENDIX C - Plant Taxa Inventory

Table C1: Vascular plant taxa recorded opportunistically in the Survey Area. Nomenclature and status according WAH (1998-), DotEE (2017b) and DPIRD (2018). *denotes weed taxon.

Family	Taxon (Status)	Family	Taxon (Status)
Anarthriaceae	<i>Anarthria gracilis</i>		<i>Lepidosperma angustatum</i>
	<i>Anarthria laevis</i>		<i>Lepidosperma drummondii</i>
	<i>Anarthria prolifera</i>		<i>Lepidosperma gladiatum</i>
	<i>Anarthria scabra</i>		<i>Lepidosperma hopperi</i>
	<i>Lyginia barbata</i>		<i>Lepidosperma striatum</i>
Apiaceae	* <i>Foeniculum vulgare</i>		<i>Lepidosperma tenue</i>
	<i>Actinotus omnifertilis</i>		<i>Mesomelaena graciliceps</i>
	<i>Centella asiatica</i>		<i>Mesomelaena tetragona</i>
	<i>Daucus glochidiatus</i>		<i>Schoenus acuminatus</i>
	<i>Xanthosia huegelii</i>		<i>Schoenus caespitius</i>
	<i>Xanthosia rotundifolia</i>		<i>Schoenus cruentus</i>
	<i>Xanthosia singuliflora</i>		<i>Schoenus multigumis</i>
Araceae	* <i>Zantedeschia aethiopica</i> (Declared Pest)		<i>Schoenus obtusifolius</i>
Asparagaceae	* <i>Asparagus asparagoides</i> (WONS)		<i>Schoenus sp. infertile</i>
	* <i>Asparagus declinatus</i>		<i>Schoenus sp. striate</i>
	<i>Chamaescilla corymbosa</i>		<i>Tetraria octandra</i>
	<i>Lomandra micrantha</i>		<i>Tetraria sp. Jarrah Forest (R. Davis 7391)</i>
	<i>Lomandra pauciflora</i>		<i>Tricostularia neesii</i>
	<i>Lomandra purpurea</i>	Dasypogonaceae	<i>Dasypogon bromeliifolius</i>
	<i>Lomandra sericea</i>		<i>Kingia australis</i>
	<i>Thysanotus gracilis</i>	Dennstaedtiaceae	<i>Histiopteris incisa</i>
	<i>Thysanotus isantherus</i> (P4)		<i>Pteridium esculentum</i>
	<i>Thysanotus multiflorus</i>	Dilleniaceae	<i>Hibbertia cuneiformis</i>
	<i>Thysanotus sparteus</i>		<i>Hibbertia cunninghamii</i>
	<i>Thysanotus thyrsoides</i>		<i>Hibbertia diamesogenos</i>
Asteraceae	* <i>Coryza bonariensis</i>		<i>Hibbertia furfuracea</i>
	* <i>Sonchus oleraceus</i>		<i>Hibbertia microphylla</i>
	* <i>Taraxacum khatoonae</i>	Droseraceae	<i>Drosera erythrorhiza</i>
	<i>Lagenophora huegelii</i>		<i>Drosera glanduligera</i>
	<i>Millotia tenuifolia</i>		<i>Drosera menziesii</i>
	<i>Senecio minimus</i>		<i>Drosera pallida</i>
Boryaceae	<i>Borya sphaerocephala</i>		<i>Drosera pulchella</i>
Campanulaceae	<i>Lobelia anceps</i>		<i>Drosera stolonifera</i>
	<i>Lobelia heterophylla</i>	Elaeocarpaceae	<i>Tetratheca affinis</i>
Caryophyllaceae	* <i>Petrorhagia dubia</i>		<i>Tremandra diffusa</i>
	* <i>Sagina maritima</i>		<i>Tremandra stelligera</i>
Casuarinaceae	<i>Allocasuarina fraseriana</i>	Ericaceae	<i>Andersonia sp. Jamesii</i> (J. Liddelow 84) (P4)
	<i>Allocasuarina humilis</i>		<i>Andersonia sprengelioides</i>
Centrolepidaceae	<i>Aphelia brizula</i>		<i>Astroloma pallidum</i>
Cephalotaceae	<i>Cephalotus follicularis</i>		<i>Brachyloma baxteri</i>
Chenopodiaceae	<i>Rhagodia preissii</i>		<i>Cosmelia rubra</i>
Cyatheaceae	* <i>Cyathea cooperi</i>		<i>Leucopogon assimilis</i>
Cyperaceae	<i>Baumea acuta</i>		<i>Leucopogon australis</i>
	<i>Baumea arthropophylla</i>		<i>Leucopogon glabellus</i>
	<i>Baumea juncea</i>		<i>Leucopogon obovatus</i> subsp. <i>obovatus</i>
	<i>Baumea rubiginosa</i>		<i>Leucopogon obovatus</i> subsp. <i>revolutus</i>
	<i>Cyathochaeta avenacea</i>		<i>Leucopogon pendulus</i>
	<i>Cyathochaeta equitans</i>		<i>Leucopogon verticillatus</i>
	<i>Evandra aristata</i>		<i>Sphenotoma capitata</i>
	<i>Gymnoschoenus anceps</i>		<i>Sphenotoma squarrosa</i>
	<i>Isolepis cernua</i>	Euphorbiaceae	* <i>Ricinus communis</i>

Family	Taxon (Status)	Family	Taxon (Status)
Fabaceae	* <i>Acacia baileyana</i>	Hemerocallidaceae	<i>Agrostocrinum hirsutum</i>
	* <i>Acacia longifolia</i>		<i>Caesia micrantha</i>
	* <i>Acacia melanoxylon</i>		<i>Dianella revoluta</i>
	* <i>Acacia paradoxa</i>		<i>Johnsonia lupulina</i>
	* <i>Chamaecytisus palmensis</i>		<i>Stypandra glauca</i>
	* <i>Dipogon lignosus</i>		<i>Tricoryne elatior</i>
	* <i>Ornithopus compressus</i>		<i>Tricoryne humilis</i>
	* <i>Psoralea pinnata</i>	Hydrocharitaceae	<i>Ottelia ovalifolia</i>
	* <i>Trifolium angustifolium</i>	Iridaceae	* <i>Freesia alba</i> x <i>leichtlinii</i>
	* <i>Trifolium arvense</i>		* <i>Gladiolus undulatus</i>
	* <i>Ulex europaeus</i> (WONS)		* <i>Moraea setifolia</i>
	<i>Acacia alata</i>		* <i>Romulea rosea</i>
	<i>Acacia browniana</i> var. <i>browniana</i>		* <i>Watsonia meriana</i> var. <i>bulbillifera</i>
	<i>Acacia crassiuscula</i>		<i>Patersonia limbata</i>
	<i>Acacia divergens</i>		<i>Patersonia occidentalis</i>
	<i>Acacia drummondii</i>		<i>Patersonia umbrosa</i> var. <i>umbrosa</i>
	<i>Acacia myrtifolia</i>	Juncaceae	* <i>Juncus articulatus</i>
	<i>Acacia pentadenia</i>		* <i>Juncus capitatus</i>
	<i>Bossiaea dentata</i>		<i>Juncus caespiticius</i>
	<i>Bossiaea linophylla</i>		<i>Juncus pallidus</i>
	<i>Callistachys lanceolata</i>		<i>Juncus planifolius</i>
	<i>Callistachys</i> sp. south-coast variant (M. Carter 180)	Lauraceae	<i>Luzula meridionalis</i>
	<i>Chorizema reticulatum</i>		<i>Cassytha racemosa</i>
	<i>Gastrolobium bilobum</i>	Lentibulariaceae	<i>Utricularia multifida</i>
	<i>Gastrolobium sericeum</i>	Lindsaeaceae	<i>Lindsaea linearis</i>
	<i>Gompholobium knightianum</i>	Loganiaceae	<i>Orianthera serpyllifolia</i> subsp. <i>serpyllifolia</i>
	<i>Gompholobium polymorphum</i>	Loranthaceae	<i>Nuytsia floribunda</i>
	<i>Hardenbergia comptoniana</i>	Lythraceae	* <i>Lythrum hyssopifolia</i>
	<i>Hovea elliptica</i>	Malvaceae	<i>Thomasia angustifolia</i>
	<i>Hovea trisperma</i>		<i>Thomasia purpurea</i>
	<i>Isotropis cuneifolia</i>		<i>Myrtaceae</i>
	<i>Jacksonia horrida</i>		* <i>Eucalyptus botryoides</i>
	<i>Paraserianthes lophantha</i>		* <i>Eucalyptus cladocalyx</i>
	<i>Pultenaea verruculosa</i>		* <i>Eucalyptus globulus</i>
	<i>Sphaerolobium grandiflorum</i>		* <i>Eucalyptus robusta</i>
	<i>Sphaerolobium hygrophilum</i>		* <i>Leptospermum laevigatum</i>
	<i>Sphaerolobium medium</i>		<i>Agonis flexuosa</i>
	<i>Sphaerolobium vimineum</i>		<i>Agonis theiformis</i>
Gentianaceae	* <i>Centaurium erythraea</i>		<i>Astartea corniculata</i>
Geraniaceae	* <i>Pelargonium capitatum</i>		<i>Astartea glomerulosa</i>
Goodeniaceae	<i>Dampiera leptoclada</i>		<i>Astartea scoparia</i>
	<i>Dampiera linearis</i>		<i>Astartea</i> sp.
	<i>Dampiera loranthifolia</i>		<i>Beaufortia decussata</i>
	<i>Dampiera pedunculata</i>		<i>Beaufortia sparsa</i>
	<i>Diaspasis filifolia</i>		<i>Callistemon glaucus</i>
	<i>Goodenia coerulea</i>		<i>Corymbia calophylla</i>
	<i>Scaevola striata</i>		<i>Corymbia ficifolia</i> (planted)
			<i>Darwinia oederoides</i>
Haemodorumaceae	<i>Anigozanthos flavidus</i>		<i>Eucalyptus conferruminata</i> (planted)
	<i>Conostylis setigera</i>		<i>Eucalyptus cornuta</i>
	<i>Haemodorum laxum</i>		<i>Eucalyptus gomphocephala</i> (planted)
	<i>Haemodorum spicatum</i>		<i>Eucalyptus marginata</i>
Haloragaceae	<i>Gonocarpus diffusus</i>		<i>Eucalyptus megacarpa</i>
	<i>Trihaloragis hexandra</i> subsp. <i>hexandra</i>		<i>Eucalyptus patens</i>
			<i>Eucalyptus salubris</i> (planted)

Family	Taxon (Status)	Family	Taxon (Status)
	<i>Eucalyptus staeri</i>		<i>Amphipogon amphipogonoides</i>
	<i>Eucalyptus marginata</i> x <i>staeri</i>		<i>Amphipogon laguroides</i>
	<i>Homalospermum firmum</i>		<i>Austrostipa mollis</i>
	<i>Hypocalymma cordifolium</i>		<i>Microlaena stipoides</i>
	<i>Hypocalymma scarosum</i>		<i>Neurachne alopecuroidea</i>
	<i>Kunzea baxteri</i> (planted)		<i>Poa porphyroclados</i>
	<i>Melaleuca diosmifolia</i> (planted)		<i>Rytidosperma setaceum</i>
	<i>Melaleuca preissiana</i>		<i>Tetrarrhena laevis</i>
	<i>Melaleuca raphiophylla</i>	Polygalaceae	<i>Comesperma confertum</i>
	<i>Melaleuca thymoides</i>		<i>Comesperma virgatum</i>
	<i>Pericalymma spongiocaula</i>	Proteaceae	<i>Adenanthos obovatus</i>
	<i>Taxandria juniperina</i>		<i>Banksia grandis</i>
	<i>Taxandria linearifolia</i>		<i>Conospermum caeruleum</i>
	<i>Taxandria marginata</i>		<i>Grevillea occidentalis</i>
	<i>Taxandria parviceps</i>		<i>Grevillea pilulifera</i>
	<i>Verticordia plumosa</i>		<i>Grevillea pulchella</i>
Olacaceae	<i>Olax benthamiana</i>		<i>Hakea amplexicaulis</i>
Orchidaceae	* <i>Disa bracteata</i>		<i>Hakea ceratophylla</i>
	<i>Caladenia flava</i>		<i>Hakea drupacea</i>
	<i>Cryptostylis ovata</i>		<i>Hakea elliptica</i>
	<i>Diuris</i> sp.		<i>Hakea ferruginea</i>
	<i>Elythranthera brunonis</i>		<i>Hakea florida</i>
	<i>Lyperanthus serratus</i>		<i>Hakea lasiantha</i>
	<i>Microtis media</i>		<i>Hakea linearis</i>
	<i>Prasophyllum brownii</i>		<i>Hakea oleifolia</i>
	<i>Prasophyllum macrostachyum</i>		<i>Hakea ruscifolia</i>
	<i>Pterostylis vittata</i>		<i>Hakea trifurcata</i>
	<i>Thelymitra canaliculata</i>		<i>Persoonia elliptica</i>
	<i>Thelymitra crinita</i>		<i>Persoonia graminea</i>
	<i>Thelymitra granitosa</i>		<i>Persoonia longifolia</i>
	<i>Thelymitra macrophylla</i>		<i>Petrophile divaricata</i>
	<i>Thelymitra</i> sp.		<i>Petrophile diversifolia</i>
Orobanchaceae	* <i>Parentucellia latifolia</i>		<i>Petrophile squamata</i>
Oxalidaceae	* <i>Oxalis incarnata</i>		<i>Stirlingia tenuifolia</i>
	* <i>Oxalis purpurea</i>		<i>Synaphea gracillima</i>
	* <i>Oxalis violacea</i>		<i>Synaphea incurva</i> (P3)
Phytolaccaceae	* <i>Phytolacca octandra</i>	Ranunculaceae	<i>Clematis pubescens</i>
Pinaceae	* <i>Pinus pinaster</i>	Restionaceae	<i>Chordifex isomorphus</i>
	* <i>Pinus radiata</i>		<i>Chordifex laxus</i>
Pittosporaceae	* <i>Pittosporum undulatum</i>		<i>Desmocladius fasciculatus</i>
	<i>Billardiera fusiformis</i>		<i>Desmocladius flexuosus</i>
	<i>Billardiera heterophylla</i>		<i>Empodisma gracillimum</i>
	<i>Billardiera variifolia</i>		<i>Hypolaena fastigiata</i>
Plantaginaceae	* <i>Plantago lanceolata</i>		<i>Leptocarpus denmarkicus</i>
	<i>Veronica plebeia</i>		<i>Leptocarpus scarosus</i>
Poaceae	* <i>Aira caryophyllea</i>		<i>Leptocarpus tenax</i>
	* <i>Anthoxanthum odoratum</i>		<i>Leptocarpus tephinus</i>
	* <i>Avena barbata</i>		<i>Lepyrodia hermaphrodita</i>
	* <i>Briza maxima</i>		<i>Loxocarya cinerea</i>
	* <i>Briza minor</i>		<i>Tremulina tremula</i>
	* <i>Cenchrus clandestinus</i>	Rhamnaceae	<i>Spyridium globulosum</i>
	* <i>Cortaderia selloana</i>		<i>Trymalium odoratissimum</i>
	* <i>Holcus lanatus</i>	Rosaceae	* <i>Cotoneaster glaucophyllus</i>
	* <i>Lolium perenne</i>		* <i>Rubus species complex</i> (WONS)

Family	Taxon (Status)
Rubiaceae	* <i>Coprosma repens</i> <i>Opercularia hispidula</i>
Rutaceae	<i>Boronia crassipes</i> (P3) <i>Boronia crenulata</i> <i>Boronia juncea</i> subsp. <i>laniflora</i> <i>Boronia spathulata</i> <i>Rhadinothamnus anceps</i>
Sapindaceae	<i>Dodonaea ceratocarpa</i> <i>Dodonaea viscosa</i>
Schizaeaceae	<i>Schizaea fistulosa</i>
Solanaceae	* <i>Solanum laciniatum</i> <i>Anthocercis viscosa</i>
Stylidiaceae	<i>Levenhookia dubia</i> <i>Stylidium despectum</i> <i>Stylidium imbricatum</i> <i>Stylidium luteum</i> <i>Stylidium plantagineum</i> <i>Stylidium pygmaeum</i> <i>Stylidium spathulatum</i>
Thymelaeaceae	<i>Pimelea rosea</i> subsp. <i>rosea</i>
Typhaceae	<i>Typha orientalis</i>
Verbenaceae	* <i>Lantana camara</i> (WONS)
Xanthorrhoeaceae	<i>Xanthorrhoea platyphylla</i>
Xyridaceae	<i>Xyris lacera</i> <i>Xyris lanata</i>

11 APPENDIX D - Floristic Quadrat Data

Quadrat: 1

Date: 22/11/2017

Description: Hill crest with laterite gravel and white sand

Mapping Unit: *Hakea* spp. Shrubland/Woodland Complex

Vegetation Condition: Very Good

Location: 574224mE 6126834mN

Photo:



Floristics:

Upper (<10m, 30-70%): *Eucalyptus staeri*.

Middle 1 (2-4m, 30-70%): **Acacia longifolia*, **Leptospermum laevigatum*, **Psoralea pinnata*, *Hakea ferruginea*, *Hakea lasiantha*.

Middle 2 (<2m, 10-30%): *Acacia browniana* var. *browniana*, *Acacia myrtifolia*, *Agonis theiformis*, *Grevillea pilulifera*, *Xanthorrhoea platyphylla*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon verticillatus*, *Petrophile squamata*, *Taxandria parviceps*.

Ground (<1m, 10-30%): *Dasypogon bromeliifolius*, *Desmocladius fasciculatus*, *Anarthria prolifera*, *Anarthria scabra*, *Agrostocrinum hirsutum*, *Amphipogon amphipogonoides*, *Anarthria gracilis*, *Billardiera heterophylla*, *Billardiera variifolia*, *Chordifex laxus*, *Conostylis setigera*, *Cyathochaeta avenacea*, *Dampiera pedunculata*, *Drosera menziesii*, *Hibbertia microphylla*, *Hovea trisperma*, *Lepyrodia hermaphrodita*, *Levenhookia dubia*, *Lomandra micrantha* subsp. *teretifolia*, *Lomandra sericea*, *Mesomelaena tetragona*, *Schoenus acuminatus*, *Sphenotoma capitata*, *Synaphea gracillima*, *Tetraria octandra*, *Tricoryne humilis*, *Xanthosia huegelii*, **Anthoxanthum odoratum*, **Gladiolus undulatus*.

Quadrat: 2

Date: 22/11/2017

Description: Hill crest with white sand with laterite gravel

Mapping Unit: *Hakea* spp. Shrubland/Woodland Complex

Vegetation Condition: Excellent

Location: 574145mE, 6126849mN

Photo:



Floristics:

Upper: (<10m, 10-30%) *Eucalyptus marginata* x *staeri*.

Middle: (1-2m, 10-30%) *Acacia myrtifolia*, *Agonis theiformis*, *Allocasuarina humilis*, *Beaufortia decussata*, *Petrophile diversifolia*, *Xanthorrhoea platyphylla*, *Leucopogon obovatus* subsp. *obovatus*, *Hakea ceratophylla*, *Hakea ferruginea*, **Leptospermum laevigatum*.

Ground: (1m, 30-70%) *Acacia browniana* var. *browniana*, *Acacia drummondii*, *Amphipogon amphipogonoides*, *Anarthria gracilis*, *Anarthria prolifera*, *Andersonia* sp. *Jamesii* (J. Liddel 84), *Billardiera variifolia*, *Boronia spathulata*, *Cassytha racemosa*, *Chordifex laxus*, *Chorizema reticulatum*, *Conostylis setigera*, *Cyathochaeta avenacea*, *Dampiera loranthifolia*, *Dasypogon bromeliifolius*, *Desmocladius fasciculatus*, *Goodenia coerulea*, *Grevillea pilulifera*, *Haemodorum laxum*, *Hibbertia microphylla*, *Hovea trisperma*, *Lepidosperma angustatum*, *Lepidosperma drummondii*, *Lepyrodia hermaphrodita*, *Lindsaea linearis*, *Lomandra sericea*, *Mesomelaena tetragona*, *Pericalymma spongicaule*, *Pultenaea verruculosa*, *Schoenus acuminatus*, *Schoenus* sp. *striate*, *Sphaerolobium grandiflorum*, *Sphenotoma capitata*, *Stirlingia tenuifolia*, *Taxandria parviceps*, *Tetraria octandra*, *Thelymitra crinita*, *Tremulina tremula*, *Xanthosia huegelii*, *Xanthosia singuliflora*.

Quadrat: 3**Date:** 22/11/2017**Description:** Small perched wetland (potentially artificial due to gravel extraction) peat over sand**Mapping Unit:** Mapped within *Hakea* spp Shrubland/Woodland Complex**Vegetation Condition:** Very Good**Location:** 574095mE, 6126841mN**Photo:****Floristics:**

Upper: (2-4m, >70%) *Taxandria linearifolia*, *Taxandria parviceps*, *Acacia myrtifolia*, *Allocasuarina fraseriana*, *Callistemon glaucus*, *Hakea ferruginea*, *Homalospermum firmum*, *Leucopogon obovatus* subsp. *revolutus*.

Ground: (<1m, 10-30%) *Billardiera heterophylla*, *Dampiera leptoclada*, *Drosera pulchella*, *Gymnoschoenus anceps*, *Lepidosperma angustatum*, *Lepidosperma striatum*, *Lomandra sericea*, *Mesomelaena tetragona*, *Thysanotus sparteus*, *Xanthosia huegelii*, **Acacia longifolia*, **Gladiolus undulatus*.

Quadrat: 4**Date:** 22/11/2017**Description:** Hill crest with grey sand**Mapping Unit:** Jarrah/Marri/Sheoak Laterite Forest**Vegetation Condition:** Excellent**Location:** 574185mE 6126657mN**Photo:****Floristics:**

Upper: (>10m, 10-30%) *Eucalyptus marginata*

Middle: (2m, 10-30%) *Beaufortia decussata*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon verticillatus*, *Acacia browniana* var. *browniana*, *Agonis theiformis*, *Allocasuarina fraseriana*.

Ground: (<1m, 30-70%) *Anarthria scabra*, *Cyathochaeta avenacea*, *Dampiera leptoclada*, *Dasypogon bromeliifolius*, *Desmocladius fasciculatus*, *Drosera pallida*, *Hibbertia cunninghamii*, *Lindsaea linearis*, *Logania serpyllifolia* subsp. *serpyllifolia*, *Lomandra pauciflora*, *Lomandra sericea*, *Patersonia umbrosa* var. *umbrosa*, *Synaphea gracillima*, *Tetraria octandra*, *Thelymitra macrophylla*, *Xanthorrhoea platyphylla*, **Acacia longifolia*.

Quadrat: 5**Date:** 22/11/2017**Description:** Upper hill slope with grey sand**Mapping Unit:** Jarrah/Marri/Sheoak Laterite Forest**Vegetation Condition:** Very Good**Location:** 573739mE 6126842mN**Photo:****Floristics:****Upper:** (>10m, 30-70%) *Eucalyptus marginata*, *Corymbia calophylla*, *Allocasuarina fraseriana*.**Middle:** (2m, 10-30%) *Agonis theiformis*, *Acacia browniana* var. *browniana*, *Petrophile diversifolia*, *Beaufortia decussata*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon verticillatus*, *Xanthorrhoea platyphylla*.**Ground:** (<1m, 30-70%) *Agrostocrinum hirsutum*, *Anarthria scabra*, *Billardiera variifolia*, *Bossiaea linophylla*, *Conostylis setigera*, *Cyathochaeta avenacea*, *Dasypogon bromeliifolius*, *Desmodium fasciculatus*, *Gompholobium knightianum*, *Hakea amplexicaulis*, *Logania serpyllifolia*, *Lomandra sericea*, *Patersonia umbrosa* var. *umbrosa*, *Stylidium plantagineum*, *Tetraria octandra*, *Tetraria* sp. Jarrah Forest (R. Davis 7391).

Quadrat: 6**Date:** 22/11/2017**Description:** Middle hill-slope with grey sand**Mapping Unit:** Jarrah/Marri/Sheoak Laterite Forest**Vegetation Condition:** Very Good/Excellent**Location:** 573757mE 6126236mN**Photo:****Floristics:****Upper:** (>10m, 30-70%) *Eucalyptus marginata*, *Allocasuarina fraseriana*.**Middle:** (>2m, 10-30%) *Banksia grandis*, *Bossiaea linophylla*, *Acacia myrtifolia*, *Agonis theiformis*, *Leucopogon obovatus*, *Leucopogon verticillatus*, *Melaleuca thymoides*, *Taxandria parviceps*, *Kingia australis*.**Ground:** (<1m, 30-70%) *Anarthria scabra*, *Anarthria prolifera*, *Billardiera heterophylla*, *Conospermum caeruleum*, *Cyathochaeta equitans*, *Dasypogon bromeliifolius*, *Johnsonia lupulina*, *Lepidosperma angustatum*, *Opercularia hispidula*, *Patersonia umbrosa* var. *umbrosa*, *Persoonia longifolia*, *Schoenus multiglumis*, *Xanthosia rotundifolia*, *Holcus lanatus*.

Quadrat: 7**Date:** 22/11/2017**Description:** Middle hill-slope with grey sand**Mapping Unit:** Jarrah/Marri/Sheoak Laterite Forest**Vegetation Condition:** Very Good/Excellent**Location:** 573942mE 6126424mN**Photo:****Floristics:****Upper:** (<10m, 30-70%) *Eucalyptus marginata*, *Allocasuarina fraseriana*, *Agonis flexuosa*.**Middle:** (2m, 10-30%) *Bossiaea linophylla*, *Beaufortia decussata*, *Leucopogon obovatus*.**Ground:** (<1m, 30-70%) *Amphipogon amphipogonoides*, *Anarthria prolifera*, *Anigozanthos flavidus*, *Billardiera variifolia*, *Caesia micrantha*, *Cyathochaeta avenacea*, *Dasypogon bromeliifolius*, *Hibbertia cunninghamii*, *Lepidosperma angustatum*, *Lepidosperma angustatum*, *Lindsaea linearis*, *Lomandra pauciflora*, *Lomandra sericea*, *Opercularia hispidula*, *Patersonia umbrosa* var. *umbrosa*, *Scaevola striata*, *Schoenus multiglumis*, *Xanthosia rotundifolia*.

Quadrat: 8**Date:** 22/11/2017**Description:** Middle hill-slope with grey sand**Mapping Unit:** Jarrah/Sheoak/*E. staeri* Sandy Woodland**Vegetation Condition:** Very Good/Excellent**Location:** 574188mE 6126436mN**Photo:****Floristics:****Upper:** (<10m, 30-70%) *Eucalyptus marginata*, *Allocasuarina fraseriana*.**Middle:** (2m, 10-30%) *Beaufortia decussata*, *Acacia browniana* var. *browniana*, *Agonis theiformis*, *Leucopogon obovatus*, *Xanthorrhoea platyphylla*, *Persoonia longifolia*.**Ground:** (<1m, 30-70%) *Anarthria scabra*, *Cyathochaeta avenacea*, *Dasypogon bromeliifolius*, *Drosera menziesii*, *Lepidosperma angustatum*, *Opercularia hispidula*, *Patersonia umbrosa* var. *umbrosa*, *Tetraria octandra*, *Thelymitra crinita*, *Xanthosia rotundifolia*.

Quadrat: 9**Date:** 23/11/2017**Description:** Middle hill-slope. Outcropping granite boulders**Mapping Unit:** Marri/Jarrah Forest/Peppermint Woodland**Vegetation Condition:** Very Good**Location:** 578825mE 6124018mN**Photo:****Floristics:****Upper:** (>10m, 30-70%) *Corymbia calophylla*, *Eucalyptus marginata*, *Agonis flexuosa*.**Middle:** (2m, 10-30%) *Acacia alata*, *Agonis theiformis*, *Bossiaea linophylla*, *Hovea elliptica*, *Leucopogon obovatus*, *Xanthorrhoea platyphylla*, **Pittosporum undulatum*.**Ground:** (<1m, 30-70%) *Billardiera variifolia*, *Lepidosperma tenue*, *Loxocarya cinerea*, *Opercularia hispidula*, *Tetrarrhena laevis*, *Tremandra stelligera*, *Xanthosia rotundifolia*, **Anthoxanthum odoratum*, **Asparagus asparagoides*, **Briza maxima*, **Holcus lanatus*, **Lythrum hyssopifolia*, **Sonchus oleraceus*, **Taraxacum khatoonae*.

Quadrat: 10**Date:** 23/11/2017**Description:** Granite outcrop**Mapping Unit:** *Taxandria marginata* Granite Shrubland**Vegetation Condition:** Very Good**Location:** 578848mE 6124117mN**Photo:****Floristics:****Upper:** (2-3m, 10-30%) *Taxandria marginata*, *Acacia crassiuscula*, *Anthocercis viscosa*.**Ground:** (<1m, 10-30%) *Lepidosperma hopperi*, *Lepidosperma tenue*, *Patersonia limbata*, *Stypandra glauca*, *Diuris* sp., *Drosera stolonifera*, *Juncus pallidus*, **Aira caryophyllaea*, **Anthoxanthum odoratum*, **Briza maxima*, **Briza minor*, **Ornithopus compressus*, **Psoralea pinnata*, **Watsonia meriana* var. *bulbillifera*.

Quadrat: 11

Date: 23/11/2017

Description: Granite boulders, brown loamy sand

Mapping Unit: Marri/Jarrah Coastal Hills Forest

Vegetation Condition: Very Good/Excellent

Location: 578868mE 6124198mN

Photo:



Floristics:

Upper: (>10m, 10-30%) *Corymbia calophylla*, *Eucalyptus cornuta*, *Agonis flexuosa*.

Middle: (2-4m, 10-30%) *Bossiaea linophylla*, *Clematis pubescens*, *Gastrolobium bilobum*, *Leucopogon obovatus* subsp. *obovatus*, *Hovea elliptica*.

Ground: (<1m, 30-70%) *Hibbertia cunninghamii*, *Lepidosperma tenue*, *Loxocarya cinerea*, *Microlaena stipoides*, *Opercularia hispidula*, *Poa porphyroclados*, *Stypandra glauca*, *Tetrarrhena laevis*, *Thomasia angustifolia*, *Tremandra stelligera*, *Xanthorrhoea platyphylla*, **Anthoxanthum odoratum*, **Asparagus asparagoides*, **Avena barbata*, **Briza maxima*, **Lythrum hyssopifolia*.

Quadrat: 12

Date: 23/11/2017

Description: Granite boulders, dark brown loamy sand

Mapping Unit: Marri/Jarrah Coastal Hills Forest

Vegetation Condition: Very Good

Location: 578863mE 6124350mN

Photo:



Floristics:

Upper: (>10m, 10-30%) *Corymbia calophylla*, *Eucalyptus cornuta*.

Middle: (2m, 10-30%) *Acacia myrtifolia*, *Gastrolobium bilobum*, *Hibbertia cuneiformis*, *Hibbertia furfuracea*, *Hovea elliptica*, *Rhagodia preissii*, *Leucopogon obovatus* subsp. *obovatus*.

Ground: (<1m, 10-30%) *Billardiera heterophylla*, *Clematis pubescens*, *Daucus glochidiatus*, *Lepidosperma tenue*, *Loxocarya cinerea*, *Microlaena stipoides*, *Opercularia hispidula*, *Poa porphyroclados*, *Tetraria octandra*, *Tremandra stelligera*, **Anthoxanthum odoratum*, **Asparagus asparagoides*, **Watsonia meriana* var. *bulbillifera*.

Quadrat: 13

Date: 23/11/2017

Description: Granite outcrop, brown loamy sand.

Mapping Unit: *Leucopogon assimilis* Granite Shrubland

Vegetation Condition: Very Good/Excellent

Location: 578796mE 6124359mN

Photo:



Floristics:

Upper: (2m, 30-70%) *Dodonaea ceratocarpa*, *Eucalyptus cornuta*, *Gastrolobium bilobum*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon pendulus*, *Leucopogon Verticordia plumosa*, *assimilis*.

Ground: (<1m, 30-70%) *Andersonia sprengeloides*, *Austrostipa mollis*, *Billardiera heterophylla*, *Borya sphaerocephala*, *Hibbertia diamesogenos*, *Lepidosperma tenue*, *Luzula meridionalis*, *Microlaena stipoides*, *Neurachne alopecuroides*, *Schoenus sp. infertile*, *Stypandra glauca*, **Acacia longifolia*, **Anthoxanthum odoratum*, **Briza maxima*, **Briza minor*, **Centaurium erythraea*, **Ornithopus compressus*, **Parentucellia latifolia*, **Romulea rosea*, **Trifolium arvense*.

Quadrat: 14

Date: 23/11/2017

Description: Granite outcrop margin, brown loamy sand

Mapping Unit: *Taxandria marginata*/ *Gastrolobium bilobum* Granite Shrubland

Vegetation Condition: Very Good/Excellent

Location: 578781mE 6124287mN

Photo:



Floristics:

Upper: (>10m, <10%) *Eucalyptus cornuta*.

Middle: (2m, 10-30%) *Dodonaea ceratocarpa*, *Gastrolobium bilobum*, *Hibbertia furfuracea*, *Leucopogon obovatus* subsp. *obovatus*, *Pimelea rosea* subsp. *rosea*, *Rhagodia preissii*.

Ground: (<1m, 30-70%) *Billardiera heterophylla*, *Lepidosperma tenue*, *Loxocarya cinerea*, *Stypandra glauca*, **Acacia longifolia*, **Anthoxanthum odoratum*, **Briza maxima*, **Briza minor*, **Parentucellia latifolia*, **Plantago lanceolata*, **Trifolium angustifolium*, **Trifolium arvense*, **Watsonia meriana* var. *bulbillifera*.

Quadrat: 15**Date:** 23/11/2017**Description:** Hill slope with light grey sand**Mapping Unit:** Marri/Jarrah Forest/Peppermint Woodland**Vegetation Condition:** Very Good**Location:** 578746mE 6124229mN**Photo:****Floristics:****Upper:** (>10m, 30-70%) *Corymbia calophylla*, *Eucalyptus cornuta*.**Middle:** (2m, 30-70%) *Leucopogon obovatus* subsp. *obovatus*, *Agonis theiformis*, *Bossiaea linophylla*, **Acacia longifolia*, **Psoralea pinnata*.**Ground:** (<1m, 10-30%) *Anigozanthos flavidus*, *Hibbertia cuneiformis*, *Hibbertia furfuracea*, *Lepidosperma gladiatum*, *Loxocarya cinerea*, *Opercularia hispidula*, *Pteridium esculentum*, *Tetraria octandra*, **Anthoxanthum odoratum*, **Asparagus asparagoides*, **Cenchrus clandestinus*, **Cenchrus clandestinus*, **Gladiolus undulatus*, **Holcus lanatus*, **Pelargonium capitatum*, **Taraxacum khatoonae*.

Quadrat: 16**Date:** 23/11/2017**Description:** Wetland, peat over sand**Vegetation Condition:** Very Good**Mapping Unit:** *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket**Location:** 575182mE 6125118mN**Photo:****Floristics:****Upper:** (4m, >70%) *Eucalyptus marginata*, *Homalospermum firmum*, *Beaufortia sparsa*, *Adenanthos obovatus*, *Astartea scoparia*., *Bossiaea linophylla*, *Leucopogon australis*, **Acacia longifolia*.**Ground:** (<1m, 10-30%) *Gastrolobium sericeum*, *Anarthria prolifera*, *Anarthria scabra*, *Anigozanthos flavidus*, *Austrostipa mollis*, *Billardiera heterophylla*, *Cyathochaeta avenacea*, *Hypolaena fastigiata*, *Johnsonia lupulina*, *Lomandra pauciflora*, *Meeboldina scariosa*, *Tricoryne elatior*, *Tricoryne elatior*, *Xyris lanata*, **Watsonia meriana* var. *bulbillifera*.

Quadrat: 17**Date:** 23/11/2017**Description:** Wetland, peat over sand**Mapping Unit:** *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket**Vegetation Condition:** Very Good**Location:** 574417mE 6125317mN**Photo:****Floristics:**

Upper: (4m, >70%) *Homalospermum firmum*, *Beaufortia sparsa*, *Callistachys lanceolata*, *Astartea* sp., *Taxandria juniperina*, *Taxandria linearifolia*, **Eucalyptus globulus*.

Ground: (<1m, 30-70%) *Empodisma gracillimum*, *Acacia divergens*, *Hypocalymma cordifolium*, *Lepidosperma striatum*, *Lobelia heterophylla*, *Meeboldina scariosa*, *Opercularia hispidula*, *Patersonia occidentalis*, *Patersonia umbrosa* var. *umbrosa*, *Anarthria prolifera*, *Pteridium esculentum*, **Watsonia meriana* var. *bulbillifera*.

Quadrat: 18**Date:** 23/11/2017**Description:** Wetland, grey sand**Mapping Unit:** *Evandra aristata* Sedgeland**Vegetation Condition:** Very Good**Location:** 574971mE 6125166mN**Photo:****Floristics:**

Upper: (4m, <10%) *Nuytsia floribunda*.

Middle: () *Beaufortia sparsa*, *Evandra aristata*.

Ground: () *Amphipogon laguroides*, *Anarthria laevis*, *Anarthria prolifera*, *Anarthria scabra*, *Acacia myrtifolia*, *Adenanthos obovatus*, *Agonis flexuosa*, *Billardiera heterophylla*, *Boronia crenulata*, *Boronia spathulata*, *Dampiera linearis*, *Dasypogon bromeliifolius*, *Gymnoschoenus anceps*, *Homalospermum firmum*, *Hypocalymma strictum*, *Hypolaena fastigiata*, *Jacksonia horrida*, *Lyginia barbata*, *Melaleuca thymoides*, *Opercularia hispidula*, *Patersonia limbata*, *Schoenus cruentus*, *Sphenotoma capitata*, *Taxandria parviceps*, *Xyris lanata*, **Leptospermum laevigatum*.

Quadrat: 19

Date: 23/11/2017

Description: Granite outcrop, brown loamy sand.

Mapping Unit: *Taxandria marginata* Granite Shrubland

Vegetation Condition: Degraded/Good

Location: 576814mE 6124669mN

Photo:



Floristics:

Upper: (<10m, 10-30%) *Corymbia calophylla*, *Agonis flexuosa*.

Middle: (2m, 10-30%) *Agonis theiformis*, *Bossiaea linophylla*, *Dodonaea ceratocarpa*, *Hibbertia furfuracea*, *Lomandra pauciflora*, *Loxocarya cinerea*, *Microlaena stipoides*, *Stypandra glauca*, *Tetraria octandra*, *Tremandra stelligera*.

Ground: (<1m, 10-30%) **Anthoxanthum odoratum*, **Asparagus asparagoides*, **Avena barbata*, **Briza maxima*, **Freesia alba x leichtlinii*, **Gladiolus undulatus*, **Lythrum hyssopifolia*, **Watsonia meriana* var. *bulbillifera*, *Astroloma pallidum*, *Austrostipa mollis*, *Billardiera variifolia*, *Cyathochaeta avenacea*, *Desmodcladus fasciculatus*, *Dianella revoluta*, *Lepidosperma tenue*, *Leucopogon obovatus* subsp. *obovatus*, *Xanthorrhoea platyphylla*.

Quadrat: 20

Date: 23/11/2017

Description: Swale adjacent to granite outcrop, brown loam

Mapping Unit: Marri/Jarrah Forest/Peppermint Woodland

Vegetation Condition: Very Good

Location: 576759mE 6124635mN

Photo:



Floristics:

Upper: (<10m, 30-70%) *Corymbia calophylla*, *Eucalyptus marginata*, *Agonis flexuosa*.

Middle: (2m, 30-70%) *Agonis theiformis*, *Bossiaea linophylla*, *Hibbertia cuneiformis*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon verticillatus*.

Ground: (<1m, 30-70%) *Anarthria scabra*, *Billardiera heterophylla*, *Dasyopogon bromeliifolius*, *Hardenbergia comptoniana*, *Hypolaena fastigiata*, *Lomandra purpurea*, *Loxocarya cinerea*, *Patersonia umbrosa* var. *umbrosa*, *Pteridium esculentum*, *Schoenus multiglumis*, *Tremandra diffusa*, **Anthoxanthum odoratum*, **Asparagus asparagoides*, **Oxalis purpurea*, **Oxalis violacea*, **Pelargonium capitatum*, **Taraxacum khatoonae*, **Watsonia meriana* var. *bulbillifera*.

Quadrat: 21

Date: 24/11/2017

Description: Middle hill-slope, grey sand

Mapping Unit: Jarrah/Sheoak/E.staeri Sandy Woodland

Vegetation Condition: Excellent

Location: 574326mE 6127589mN

Photo:



Floristics:

Upper: (<10m, 30-70%) *Eucalyptus marginata*, *Corymbia calophylla*.

Middle: (2m, 30-70%) *Agonis theiformis*, *Banksia grandis*, *Beaufortia decussata*, *Persoonia elliptica*, *Xanthorrhoea platyphylla*, *Acacia browniana* var. *browniana*, *Bossiaea linophylla*, *Hakea florida*, *Kingia australis*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon verticillatus*.

Ground: (<1m, 30-70%) *Anarthria prolifera*, *Billardiera variifolia*, *Desmocladius fasciculatus*, *Gompholobium polymorphum*, *Hibbertia cunninghamii*, *Johnsonia lupulina*, *Lepidosperma angustatum*, *Lomandra pauciflora*, *Lomandra sericea*, *Opercularia hispidula*, *Patersonia umbrosa* var. *umbrosa*, *Tetraria octandra*, *Tetraria* sp. Jarrah Forest (R. Davis 7391), *Xanthosia rotundifolia*.

Quadrat: 22

Date: 24/11/2017

Description: Wetland, peat over sand

Mapping Unit: *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket

Vegetation Condition: Excellent

Location: 574397mE 6127513mN

Photo:



Floristics:

Upper: (>2m, 30-70%) *Callistemon glaucus*, *Beaufortia sparsa*, *Taxandria parviceps*.

Ground: (<1m, 30-70%) *Anarthria scabra*, *Baumea rubiginosa*, *Cephalotus follicularis*, *Drosera pulchella*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Histiopteris incisa*, *Homalospermum firmum*, *Leptocarpus tenax*, *Schizaea fistulosa*, *Schoenus multiglumis*, *Sphaerolobium vimineum*, *Xanthosia rotundifolia*, *Xyris lanata*, **Rubus anglocandicans*, *Eucalyptus marginata*.

Quadrat: 23

Date: 24/11/2017

Description: 5 x 20 m dimensions. Wetland around artificial dam

Mapping Unit: *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket

Vegetation Condition: Excellent

Location: 574400mE 6127491mN

Photo:



Floristics:

Upper: (2m, 10-30%) *Callistemon glaucus*, *Hakea florida*, *Taxandria linearifolia*.

Ground: (<1m, 10-30%) *Baumea rubiginosa*, *Cassytha racemosa*, *Diaspasis filifolia*, *Drosera pallida*, *Drosera pulchella*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Lepidosperma striatum*, *Leptocarpus tenax*, *Meeboldina scariosa*, *Sphaerolobium vimineum*, *Stylidium pygmaeum*, *Thelymitra canaliculata*, *Xyris lanata*, **Anthoxanthum odoratum*, **Cortaderia selloana*.

Quadrat: 24

Date: 24/11/2017

Description: Wetland. Peat over sand

Mapping Unit: *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket

Vegetation Condition: Excellent

Location: 574452mE 6127424mN

Photo:



Floristics:

Upper: (2m, 10-30%) *Callistemon glaucus*, *Homalospermum firmum*, *Boronia crassipes*, *Taxandria linearifolia*.

Ground: (>1m, >70%) *Acacia divergens*, *Dampiera leptoclada*, *Diaspasis filifolia*, *Drosera menziesii*, *Empodisma gracillimum*, *Lepidosperma striatum*, *Leptocarpus tenax*, *Meeboldina tephрина* ms, *Schoenus multiglumis*, *Sphaerolobium vimineum*, **Holcus lanatus*.

Quadrat: 25**Date:** 24/11/2017**Description:** Lower hill-slope, grey sand**Mapping Unit:** Jarrah/Sheoak/*E. staeri* Sandy Woodland**Vegetation Condition:** Very Good/Excellent**Location:** 574300mE 6127524mN**Photo:****Floristics:****Upper:** (<10m, 30-70%) *Corymbia calophylla*, *Eucalyptus marginata*.**Middle:** (2m, 30-70%) *Agonis theiformis*, *Banksia grandis*, *Beaufortia decussata*, *Bossiaea linophylla*, *Hakea ruscifolia*, *Hibbertia cuneiformis*, *Leucopogon obovatus* subsp. *obovatus*, *Leucopogon verticillatus*, *Persoonia longifolia*, *Xanthorrhoea platyphylla*.**Ground:** (<1m, 30-70%) *Amphipogon amphipogonoides*, *Anarthria prolifera*, *Desmodcladus fasciculatus*, *Drosera pallida*, *Haemodorum spicatum*, *Lepidosperma angustatum*, *Mesomelaena graciliceps*, *Opercularia hispidula*, *Patersonia umbrosa* var. *umbrosa*, *Scaevola striata*, *Tetraria octandra*, *Tricostularia neesii*, *Xanthosia rotundifolia*.

Quadrat: 26**Date:** 27/11/2017**Description:** Wetland, peat over sand**Mapping Unit:** *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket**Vegetation Condition:** Excellent**Location:** 574270mE 6127433mN**Photo:****Floristics:****Upper:** (4m, 30-70%) *Callistemon glaucus*, *Hakea linearis*, *Taxandria juniperina*, *Taxandria linearifolia*, **Psoralea pinnata*.**Ground:** (<1m, >70%) *Baumea acuta*, *Baumea rubiginosa*, *Diaspasis filifolia*, *Drosera menziesii*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Leptocarpus tenax*, *Schoenus multiglumis*, *Sphaerolobium vimineum*, *Thysanotus sparteus*, *Xyris lanata*, **Holcus lanatus*, **Rubus anglocandicans*.

Quadrat: 27

Date: 27/11/2017

Description: Wetland, peat over sand

Mapping Unit: *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket

Vegetation Condition: Excellent

Location: 574254mE 6127408mN

Photo:



Floristics:

Upper: (3m, 30-70%) *Callistemon glaucus*, *Homalospermum firmum*, *Boronia crassipes*.

Ground: (1m, >70%) *Acacia divergens*, *Baumea rubiginosa*, *Dampiera leptoclada*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Leptocarpus tenax*, *Schoenus multiglumis*, *Xyris lanata*.

Quadrat: 28

Date: 27/11/2017

Description: Wetland peat over sand. ex.

Mapping Unit: *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket

Vegetation Condition: Excellent

Location: 574566mE 6127504mN

Photo:



Floristics:

Upper: (3m, 30-70%) *Callistemon glaucus*, *Homalospermum firmum*, *Cosmelia rubra*, *Taxandria linearifolia*.

Ground: (1m, >70%) *Acacia divergens*, *Astartea corniculata*, *Baumea acuta*, *Baumea rubiginosa*, *Dampiera leptoclada*, *Drosera menziesii*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Leptocarpus tenax*, *Schoenus multiglumis*, *Xyris lanata*, **Rubus anglocandicans*.

Quadrat: 29**Date:** 27/11/2017**Description:** Wetland, peat over sand**Mapping Unit:** *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket**Vegetation Condition:** Excellent**Location:** 574307mE 6127407mN**Photo:****Floristics:****Upper:** (2m, 30-70%) *Callistemon glaucus*, *Homalospermum firmum*, *Taxandria linearifolia*, *Boronia crassipes*.**Ground:** (1m, >70%) *Acacia divergens*, *Baumea rubiginosa*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Leptocarpus tenax*, *Schoenus multiglumis*, *Sphaerolobium vimineum*.

Quadrat: 30**Date:** 28/11/2017**Description:** Wetland, peat over sand**Mapping Unit:** *Taxandria juniperina* Closed Forest**Vegetation Condition:** Very Good**Location:** 574485mE 6125533mN**Photo:****Floristics:****Upper:** (10m, >70%) *Taxandria juniperina*, *Homalospermum firmum*.**Ground:** (<1m, <10%) *Acacia divergens*, *Baumea acuta*, *Lepidosperma striatum*, *Leptocarpus scariosus*, *Tetrarrhena laevis*, **Acacia melanoxylon*, **Anthoxanthum odoratum*.

Quadrat: 31

Date: 28/11/2017

Description: Wetland, peat over sand. Firebreak

Mapping Unit: *Taxandria juniperina* Closed Forest

Vegetation Condition: Very Good

Location: 574591mE 6125459mN

Photo:



Floristics:

Upper: (10m, 30-70%) *Taxandria juniperina*, *Rhadinothermus anceps*,

Ground: (<1m, <10%) *Aphelia brizula*, *Baumea acuta*, *Chamaescilla corymbosa*, *Drosera pulchella*, *Isolepis cernua*, *Lobelia heterophylla*, *Microtis media*, *Prasophyllum macrostachyum*, *Thelymitra* sp., *Utricularia bifida*, **Acacia longifolia*, **Anthoxanthum odoratum*, **Briza maxima*, **Briza minor*, **Gladiolus undulatus*.

Quadrat: 32

Date: 28/11/2017

Description: Middle hill-slope, grey sand with laterite gravel

Mapping Unit: *Hakea* spp Shrubland/Woodland Complex

Vegetation Condition: Very Good/Excellent

Location: 573977mE 6126876mN

Photo:



Floristics:

Upper: (<10m, 10-30%) *Eucalyptus marginata*, *Allocasuarina fraseriana*.

Middle: (2m, 10-30%) *Hakea ferruginea*, *Taxandria parviceps*, *Agonis theiformis*, *Acacia browniana* var. *browniana*, *Acacia myrtifolia*, *Grevillea pilulifera*, *Xanthorrhoea platyphylla*.

Ground: (<1m, 30-70%) *Anarthria gracilis*, *Anarthria prolifera*, *Anarthria scabra*, *Billardiera heterophylla*, *Boronia spathulata*, *Cyathochaeta avenacea*, *Dampiera loranthifolia*, *Dasypogon bromeliifolius*, *Desmocladius fasciculatus*, *Haemodorum laxum*, *Hibbertia microphylla*, *Hovea trisperma*, *Lepidosperma drummondii*, *Lomandra sericea*, *Mesomelaena tetragona*, *Patersonia umbrosa* var. *umbrosa*, *Sphaerolobium medium*, *Tetraria octandra*, *Tetraria* sp. Jarrah Forest (R. Davis 7391), *Thysanotus sparteus*, *Xanthosia rotundifolia*.

12 APPENDIX E - Likelihood of Occurrence Analysis

A post-survey likelihood of occurrence of all conservation significant species (flora and fauna) was assessed based on the presence of suitable habitat and survey effectiveness (see section 3.3).

Table E1. Likelihood of occurrence of conservation significant flora recorded in the vicinity of the Survey Area (<10 km). NM = Naturemap, PMST = Protected Matters Search Tool, WAHERB = Western Australia Herbarium Database, TPFL = Threatened and Priority Flora Database.

Status, Taxon [FAMILY]	Data source	Description, Habitat & Distribution	Habitat Suitability in the Survey Area	Post -Survey Likelihood of Occurrence and Survey Effectiveness
T (Previously considered extinct) <i>Acacia prismifolia</i> [Fabaceae]	NM, WAHERB	Shrub, 0.15-0.5 m high. Rocky slopes. Laterite gravel pit in road verge.	Habitat preferences poorly understood for this taxon recently rediscovered near Cranbrook. Generally, habitats in Survey Area are not considered suitable.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
T <i>Banksia brownii</i> [Proteaceae]	NM, PMST, WAHERB, TPFL	Bushy, non-lignotuberous shrub or tree (small), 1-6 m high. Flowers cream & brown/orange- red, Mar to Jul. Sand over laterite, gravel, loam over granite. In gullies.	Potential habitat around Mt Melville, however highly impacted by Phytophthora and weeds.	Unlikely. Very conspicuous shrub and no survey limitations would have prevented detection if present in the Survey Area.
T <i>Banksia goodii</i> [Proteaceae]	NM, PMST, WAHERB, TPFL	Lignotuberous, prostrate shrub, ca 0.2 m high. Flowers orange- brown-red, May or Nov. White or grey sand over laterite.	Potential habitat in Unit 13, however highly impacted by Phytophthora and weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
T <i>Banksia verticillata</i> [Proteaceae]	NM, PMST, WAHERB, TPFL	Non-lignotuberous shrub or tree (rarely), 1.3-6 m high. Flowers yellow-orange, Jan to Apr. Sandy loam. On or beside granite outcrops.	Potential habitat around Mt Melville, however highly impacted by Phytophthora and weeds.	Unlikely. Very conspicuous shrub and no survey limitations would have prevented detection if present in the Survey Area.
T <i>Caladenia harringtoniae</i> [Orchidaceae]	NM, PMST, WAHERB, TPFL	Tuberous, perennial, herb, 0.2- 0.4 m high. Flowers pink, Oct to Nov. Sandy loam. Winter-wet flats, margins of lakes, creeklines, granite outcrops. Generally, more abundant after fire.	Potential habitat around Mt Melville, however is long unburnt and highly impacted by weeds.	Possible. Survey was appropriately timed, however may emerge after fire.
T <i>Caladenia granitiora</i> [Orchidaceae]	PMST	Tuberous, perennial, herb, 0.2- 0.35 m high. Fl. cream & white & red, Oct to Nov. Shallow soil crevices on granite. Coastal areas.	Potential habitat around granites on Mt Melville, however no actual records in the Study Area.	Unlikely. Known from coastal granites east of the Study Area. Survey was appropriately timed to detect if present.
T <i>Chordifex abortivus</i> [Restionaceae]	NM, PMST, WAHERB	Rhizomatous, erect perennial, herb, to 0.5 m high. Flowers brown, Sep to Oct. Sand. Low rises & undulating areas.	Has the potential to occur in a wide range of habitats.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
T <i>Conostylis misera</i> [Haemodoraceae]	NM, PMST, WAHERB	Rhizomatous, tufted perennial, grass-like or herb, 0.05-0.18 m high. Flowers yellow, Oct to Nov. White or grey sand, sandy loam. Winter-wet flats.	Generally known from wet habitat further inland than Survey Area.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
T <i>Diuris drummondii</i> [Orchidaceae]	PMST	Tuberous, perennial, herb, 0.5- 1.05 m high. Fl. yellow, Nov to Dec or Jan. Low-lying depressions, swamps. Generally, more abundant after fire.	Known from black sand over granite (Torndirrup NP). Habitat in Survey Area is degraded and impacted by weeds.	Unlikely. Limited suitable habitat in Survey Area, however may emerge after fire.
T <i>Drakea micrantha</i> [Orchidaceae]	NM, PMST, WAHERB, TPFL	Tuberous, perennial, herb, 0.15- 0.3 m high. Flowers red & yellow, Sep to Oct. White-grey sand.	Potential habitat in in moist areas in Unit 13 and in Taxandria thickets, however generally occurs further inland and west of the Survey Area.	Unlikely. Survey was appropriately timed to detect if present, however may emerge after fire.
T <i>Isopogon uncinatus</i> [Proteaceae]	NM, PMST, WAHERB, TPFL	Tufted spreading or prostrate, non-lignotuberous shrub, 0.05- 0.4 m high. Flowers yellow/cream, Oct to Nov. Loam or sand on granite, peaty sand. Swampy depressions, hillslopes.	Potential habitat around Mt Melville, however highly impacted by Phytophthora and weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.

Status, Taxon [FAMILY]	Data source	Description, Habitat & Distribution	Habitat Suitability in the Survey Area	Post -Survey Likelihood of Occurrence and Survey Effectiveness
T <i>Kennedia glabrata</i> [Fabaceae]	PMST	Prostrate shrub, 0.05-0.5 m high, to 5 m wide. Fl. red, Aug to Nov. Soil pockets, sandy soils. Granite outcrops.	Potential habitat around granites on Mt Melville, however no actual records in the Study Area.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
T <i>Sphenotoma drummondii</i> [Ericaceae]	PMST	Tufted shrub, 0.15-0.5 m high. Fl. white, Sep to Dec. Stony or shallow soils over granite or quartzite. Steep rocky slopes, crevices of rocks.	Potential habitat around granites on Mt Melville, however no actual records in the Study Area.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
T <i>Verticordia fimbriolepis</i> subsp. <i>australis</i> [Malvaceae]	NM, PMST, TPFL	Slender shrub, 0.2-0.4 m high. Flowers pink, Oct to Dec. Shallow sand, clay loam. Granite outcrops.	Potential habitat around Mt Melville, however highly impacted by Phytophthora and weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P1 <i>Caladenia evanescens</i> [Orchidaceae]	NM, WAHERB	Tuberous, perennial, herb, 0.15-0.2 m high. Flowers green-cream-yellow, Nov. Sand. Consolidated sand dunes.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P1 <i>Coleanthera coelophylla</i> [Ericaceae]	WAHERB	Erect shrub, 0.3-0.6 m high. Flowers pink/white, Sep to Nov. Gravelly sandy soils.	Known to occur further inland. Record in Study Area has low geo-accuracy.	Unlikely. Survey Area is considered outside the range of this taxon. Survey was appropriately timed to detect if present.
P1 <i>Drosera paleacea</i> [Droseraceae]	NM	Fibrous-rooted, rosetted perennial, herb, to 0.03 m high, to 0.015 m wide. Fl. white-cream, Sep to Dec or Jan. White sand, sandy clay.	Recently recorded from Banksia littoralis swamp in the Torndirrup area.	Possible. Other wetlands in Survey Area may be suitable. Survey was appropriately timed to detect if present, however may be more abundant after disturbance such as fire or slashing.
P1 <i>Prasophyllum paulinae</i> [Orchidaceae]	NM, WAHERB	Tuberous, perennial, herb, 0.15-0.4 m high. Fl. green-purple-red, Sep to Nov. Black, peaty soils. Swamps.	Recorded from <i>Taxandria/Homalospermum</i> swamp in Survey Area.	Known habitat present. Survey was appropriately timed to detect; however, it requires fire to germinate.
P1 <i>Thomasia multiflora</i> [Malvaceae]	NM, WAHERB	Spreading shrub, 0.3-1 m high, to 2 m wide. Flowers pink-purple, Sep to Oct. Black sand. Seasonally wet areas, granite outcrops.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. <i>Thomasia purpurea</i> (common congener) was present in suitable habitat within Survey Area.
P1 <i>Thomasia purpurea</i> x <i>solanacea</i> [Malvaceae]	NM, WAHERB, TPFL	Shrub, 0.5-0.8 m high. Flowers pink-purple, Nov to Dec or Jan. Grey sand over limestone. Creek sides.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P2 <i>Agrostocrinum scabrum</i> subsp. <i>littorale</i> [Hemerocallidaceae]	NM, WAHERB	Rhizomatous, perennial, herb, to 0.15 m high. Flowers blue, Oct to Nov. Shallow granite loams. Coastal slopes.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P2 <i>Astartea transversa</i> [Myrtaceae]	NM, WAHERB	Spreading shrub to 0.5 m. Flowers pink to white in April-May. Grey sand, wetlands/winter wet.	Suitable habitat in Unit 47.	Unlikely. Survey conducted outside flowering time (autumn), however is a distinctive shrub likely to be detected if present.
P2 <i>Conospermum quadripetalum</i> [Proteaceae]	NM, WAHERB, TPFL	Diffuse, straggly shrub, 0.3-1 m high. Fl. blue/white, Sep to Nov. Sandy clay, grey sand. Flats behind coastal hills.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P2 <i>Conospermum spectabile</i> [Proteaceae]	NM, WAHERB	Erect, compact shrub, 0.5-0.8 m high. Flowers white & blue, Oct to Nov. Sandy soils.	Generally, occurs further inland.	Unlikely. Survey appropriately timed and is a distinctive shrub likely to be detected if present.
P2 <i>Gyrostemon thesioides</i> [Gyrostemonaceae]	NM, WAHERB, TPFL	Straggling, decumbent shrub, to 0.7 m high. Flowers red-orange-yellow/yellow-green, Nov. Sand over limestone. Consolidated coastal dunes.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P2 <i>Isopogon buxifolius</i> var. <i>buxifolius</i> [Proteaceae]	NM, WAHERB	Upright shrub, 0.45-1 m high. Flowers pink-cream, Jul to Dec. Grey sand. Swampy areas.	Suitable habitat in Unit 47.	Unlikely. Survey appropriately timed and is a distinctive shrub likely to be detected if present.
P2 <i>Leucopogon bracteolaris</i> [Ericaceae]	NM, WAHERB	Shrub, 0.25-1 m high. Flowers white, Feb or May or Jul or Oct. Stony sand, gravelly loam.	Generally known from the Stirling Range. Record in Study Area is a geospatial error.	Unlikely. Survey Area is considered outside the range of this taxon.
P2 <i>Leucopogon cymbiformis</i> [Ericaceae]	NM, WAHERB	Dense, erect or spreading shrub, 0.1-0.6(-0.8) m high. Flowers white, Jul to Nov or Feb to Mar.	Wide range of suitable habitats	Unlikely. Survey appropriately timed and is a distinctive shrub likely to be detected if present.

Status, Taxon [FAMILY]	Data source	Description, Habitat & Distribution	Habitat Suitability in the Survey Area	Post -Survey Likelihood of Occurrence and Survey Effectiveness
		White/grey or yellow sand, lateritic gravelly soils. Sandplains, wet flats, foothills.		
P2 <i>Schoenus</i> sp. Grassy (E. Gude & J. Harvey 250) [Cyperaceae]	NM, WAHERB	Rhizomatous, perennial, grass- like or herb (sedge), to 0.7 m high. Fl. yellow. Black silt. Swamps.	Potentially suitable habitat in Unit 47, 49 or 59.	Possible. Not detected in wetlands in Survey Area, however may be difficult to detect if present in low numbers.
P2 <i>Stenanthemum sublineare</i> [Rhamnaceae]	NM,	Erect shrub, to 0.1 m high. Fl. green, Oct to Dec. Littered white sand. Coastal plain.	Potential habitat in Eucalypt woodlands (12, 13, 10).	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P2 <i>Stylidium articulatum</i> [Stylidiaceae]	NM, WAHERB	Rosetted perennial, herb, 0.15- 0.25 m high, Leaves erect to spreading, oblanceolate, 3-8 cm long, 5-14 mm wide, apex subacute to acute, glabrous. Scape glandular in upper half. Inflorescence paniculate. Flowers pink, Nov to Dec. Sandy loam, granite. Hills, coastal heath.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P2 <i>Stylidium falcatum</i> [Stylidiaceae]	NM, WAHERB, TPFL	Perennial, herb, 0.15-0.35(-0.6) m high. Flowers white, Oct to Nov. Sand, gravelly clay loam. Plains, lateritic ridges.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P2 <i>Thelymitra variegata</i> [Orchidaceae]	NM, WAHERB	Tuberous, perennial, herb, 0.1- 0.35 m high. Flowers orange & red & purple & pink, Jun to Sep. Sandy clay, sand, laterite.	Potential habitat in sandy Eucalypt woodlands (Unit 13).	Unlikely. Habitat not highly suitable, survey appropriately timed to be detected if present.
P3 <i>Acacia ataxiphylla</i> subsp. <i>ataxiphylla</i> [Fabaceae]	NM, WAHERB	Prostrate, sprawling shrub, 0.15- 0.5 m high, to 1 m wide. Flowers yellow, Nov to Dec or Jan. Gravelly clay loam, white/grey sand. Flats, roadsides.	Wide range of suitable habitats	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Andersonia auriculata</i> [Ericaceae]	NM, WAHERB, TPFL	Erect or spreading shrub, 0.1- 0.3(-0.5) m high. Flowers white & blue, Apr to Oct. Grey or peaty sand, often over laterite. Swampy areas, granite outcrops.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Andersonia setifolia</i> [Ericaceae]	NM, WAHERB	Decumbent to erect, cushion- forming shrub, 0.05-0.15 m high. Flowers red/white, Jun to Oct. Sandy & gravelly soils. Hillslopes & breakaways.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Andersonia</i> sp. Mitchell River [Ericaceae]	NM	Low, spreading, cushion-like shrub, 0.05-0.4 m high. Fl. blue/blue-white-pink, Jun to Sep. Grey sand over laterite or granite.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Austrostipa mundula</i> [Poaceae]	NM, WAHERB	Perennial caespitose grass to 0.5m. Grey sand.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P3 <i>Boronia crassipes</i> [Rutaceae]	NM, WAHERB	Erect, spindly shrub, 0.5-2 m high. Flowers red-pink, Aug to Sep. Sand, peaty sand. Winter- wet swamps, creeklines.		Present (See section 4.2.4)
P3 <i>Caustis</i> sp. Boyanup [Cyperaceae]	WAHERB	Rhizomatous, clumped perennial, grass-like or herb (sedge), 0.7-1 m high. White or grey sand.	Mike Hislop (Western Australian Herbarium) has indicated the taxonomy of this entity is poorly supported.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Chorizema carinatum</i> [Fabaceae]	NM, WAHERB	Erect or spreading shrub, 0.1- 0.6 m high. Flowers yellow, Oct to Dec. Sand, sandy clay.	Potential habitat in laterite woodlands (12, 31)	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Corybas abditus</i> [Orchidaceae]	NM, WAHERB	Tuberous, perennial, dwarf herb, 0.01-0.02 m high. Fl. red-purple, Oct to Nov. Black peaty soils. Winter-wet swamps.	Potentially suitable habitat in wetland Units 47, 49 or 59.	Unlikely. Survey appropriately timed to be detected if present.

Status, Taxon [FAMILY]	Data source	Description, Habitat & Distribution	Habitat Suitability in the Survey Area	Post -Survey Likelihood of Occurrence and Survey Effectiveness
P3 <i>Juncus meianthus</i> [Juncaceae]	NM, TPFL	Tufted perennial, herb, 0.05-0.2 m high, to 0.4 m wide. Flowers brown, Nov to Dec or Jan. Black sand, sandy clay. Creeks, seepage areas.	Wide range of suitable habitats.	Unlikely. Survey appropriately timed, however may be difficult to detect if in low numbers.
P3 <i>Lachnagrostis billardiarei</i> subsp. <i>billardiarei</i> [Poaceae]	NM, WAHERB	Annual, herb. Fl. purple/green, Dec. Sand over granite. Hilltops. <i>Melaleuca cuticularis</i> .	No suitable habitat in the Survey Area.	Unlikely. No suitable habitat present.
P3 <i>Leucopogon altissimus</i> [Ericaceae]	NM, WAHERB	Erect shrub to 2 m high. Inflorescence pendulous, flowers creamy - white. Grey or brown sandy loam over granite.	Generally, occurs east of the Survey Area.	Unlikely. Survey Area outside taxon's range.
P3 <i>Melaleuca ringens</i> [Myrtaceae]	WAHERB	Bushy shrub, 0.4-2.5 m high. Fl. cream-yellow, Sep to Oct. Sand. Limestone ridges & clifftops.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P3 <i>Poa billardiarei</i> [Poaceae]	NM, WAHERB, TPFL	Tussock grass to 0.5 m. Foredunes, drift sands.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P3 <i>Synphea incurva</i> [Proteaceae]	NM, WAHERB, TPFL	Clumped, spreading shrub. Flowers yellow, Sep to Nov. Gravelly loam, sandy soils. Slopes.		Present (See section 4.2.4)
P3 <i>Synphea preissii</i> [Proteaceae]	NM, WAHERB	Erect, low shrub, 0.15-0.4 m high. Flowers yellow, Jul to Nov. Sand, gravelly loam.	Suitable habitat in lateritic soils (Unit 12, 31)	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P3 <i>Verticordia endlicheriana</i> var. <i>angustifolia</i> [Myrtaceae]	NM, WAHERB	Erect shrub, 0.3-0.5 m high. Flowers yellow, Oct to Nov. Sandy clay. Granite outcrops.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Adenanthos x cunninghamii</i> [Proteaceae]	NM, WAHERB, TPFL	Erect open shrub, 1-3 m high. Flowers red/pink-red, Mar or Sep to Oct. Grey sand. Coastal dunes & sandplains.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P4 <i>Andersonia</i> sp. <i>Jamesii</i> (J. Liddel 84) [Ericaceae]	NM, WAHERB, TPFL	Shrub, 0.5 m high x 0.1 m wide. Perennial, erect, open. Flowers pink / blue. Sandy clay, laterite.		Present (See section 4.2.4)
P4 <i>Banksia seneciifolia</i> [Proteaceae]	NM, WAHERB	Columnar, non-lignotuberos shrub, 0.6-1 m high. Fl. cream- yellow-brown, Jun or Aug. Sandy loam, sand. Rocky hillslopes.	Suitable habitat in lateritic soils (Unit 12, 31)	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Banksia serra</i> [Proteaceae]	NM, WAHERB	Erect, slender, non- lignotuberos shrub, 1-4(-7) m high. Flowers yellow/cream- green, Jul to Sep. Gravel, sand or clay loam over laterite. Hillslopes.	Suitable habitat in lateritic soils (Unit 12, 31)	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Corybas limpidus</i> [Orchidaceae]	NM, WAHERB	Tuberous, perennial, dwarf herb, 0.01 m high. Flowers red & green, Aug to Sep. Sand. Coastal dunes.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P4 <i>Drosera fimbriata</i> [Droseraceae]	NM, WAHERB, TPFL	Erect tuberous, perennial, herb, 0.05-0.15 m high. Flowers white, Sep to Oct. Deep white sand (often in <i>Banksia</i> shrublands), granite.	No suitable habitat (white sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P4 <i>Gahnia sclerioides</i> [Cyperaceae]	NM, WAHERB, TPFL	Lax, slender rhizomatous, perennial, grass-like or herb (sedge), 0.3-0.9 m high. Loam, sandy soils. Moist shaded situations.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Gonocarpus pusillus</i> [Haloragaceae]	NM, WAHERB	Prostrate annual, herb, 0.05-1.2 m high. Flowers green/yellow- red, Nov to Dec. Grey sandy clay. Winter-wet swamps.	Potentially suitable habitat in Unit 46, 47.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Gonocarpus simplex</i> [Haloragaceae]	NM, WAHERB, TPFL	Tufted perennial, herb, 0.2-0.6 m high. Fl. green/red-brown, Nov to Dec. Peaty sand. Swamps,	Potentially suitable habitat in Unit 46, 47.	Possible. Suitable habitat present, however none are recently burnt.

Status, Taxon [FAMILY]	Data source	Description, Habitat & Distribution	Habitat Suitability in the Survey Area	Post -Survey Likelihood of Occurrence and Survey Effectiveness
		seasonally inundated areas. Prolific after fire.		
P4 <i>Kunzea pauciflora</i> [Myrtaceae]	NM	Erect, compact shrub, (0.35- 0.5-1.2(-1.5) m high. Fl. pink, Aug to Nov.	Record in Survey Area is a geospatial error.	Unlikely. Survey Area is outside the taxon's range.
P4 <i>Laxmannia jamesii</i> [Asparagaceae]	WAHERB, TPFL	Tufted, stilt-rooted perennial, herb, 0.05-0.2 m high. Flowers red & white, May to Jul. Grey sand. Winter-wet locations.	Potential habitat in moist sandy soils (13, 46).	Possible. Not detected in wetlands in Survey Area, however may be difficult to detect if present in low numbers and not surveyed in peak flowering time.
P4 <i>Lepidium pseudotasmanicum</i> [Brassicaceae]	NM, WAHERB	Erect annual or biennial, herb, 0.2-0.4(-1) m high. Flowers white-green, Feb or Dec. Loam, sand.	Wide range of suitable habitats	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Lysinema lasianthum</i> [Ericaceae]	NM, WAHERB, TPFL	Spindly shrub, 0.25-0.7 m high. Flowers white-cream, Jul to Nov. Swamps, seasonally wet areas.	Potential habitat in moist sandy soils (13, 46).	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Microtis pulchella</i> [Orchidaceae]	NM, WAHERB	Tuberous, perennial, herb, 0.12- 0.25 m high. Flowers white, Nov to Dec or Jan. Peaty sand. Winter-wet swamps. Prolific after fire.	Potential habitat in wetlands (46, 47).	Possible. The absence of recent fire may have affected detection.
P4 <i>Microtis quadrata</i> [Orchidaceae]	NM, WAHERB	Erect herb with tuber, 0.4 m high. Greenish flowers. Grey sandy clay. Wet areas. Prolific after fire.	Potential habitat in wetlands (46, 47).	Possible. The absence of recent fire may have affected detection.
P4 <i>Myosotis australis</i> [Boraginaceae]	WAHERB	Erect or procumbent annual, herb, up to 0.3 m high. Fl. white/blue, Aug to Nov. Grey sand over limestone.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P4 <i>Spyridium spadiceum</i> [Rhamnaceae]	NM, WAHERB	Erect slender or weak semi- prostrate shrub, 0.15-3 m high. Flowers white, Aug to Dec or Jan to Feb or Apr. Sand or gravelly loam. Granitic hills.	Potential habitat around Mt Melville, however highly impacted by weeds.	Unlikely. No survey limitations would have prevented detection if present in the Survey Area.
P4 <i>Thomasia quercifolia</i> [Malvaceae]	NM, WAHERB, TPFL	Shrub to 1 m high. Pink purple flowers born in Apr, Aug, Oct, Nov or Dec. Karri loam or grey coastal sand.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P4 <i>Thomasia solanacea</i> [Malvaceae]	NM, WAHERB	Erect shrub, 0.5-3 m high. Flowers blue-purple-pink, Sep to Dec. Alluvium, sand over limestone, rocky loam. Coastal areas.	No suitable habitat (calcareous sand) present in the Survey Area.	Unlikely. No suitable habitat present.
P4 <i>Thysanotus isantherus</i> [Asparagaceae]	NM, WAHERB	Caespitose perennial, herb (with tuberous roots), to 0.15 m high. Flowers purple, Nov to Dec. Granite.		Present (See section 4.2.4)

Table E2. Likelihood of occurrence of conservation significant fauna recorded in the vicinity of the Survey Area (<10 km).

Taxon	Habitat	Likelihood of Occurrence
Mammals		
Bilby, Dalgyle (<i>Macrotis lagotis</i>) (T-VU)	Bilbies are now mostly restricted to the drier and least fertile parts of their former range with the exception of populations in the north of the NT and WA. Remaining populations occupy three major vegetation types, namely: open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Pavey 2006)	Highly Unlikely. Not within current known range. One uncertain record from 1969.
Chuditch, Western Quoll (<i>Dasyurus geoffroii</i>) (T-VU)	Eucalypt forest (especially Jarrah, <i>Eucalyptus marginata</i>), dry woodland and mallee shrublands (Van Dyke & Strahan, 2008). In Jarrah forest, Chuditch populations occur in both moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest. The Chuditch occurs at low densities, even in quality habitats of coastal areas. In Jarrah forest they shelter during the day in horizontal, hollow logs or earth burrows (DotEE 2016).	Unlikely. Suitable habitat is present, however the lack of secure, baited reserves Chuditch range widely and occur in very low densities. May use this survey area intermittently or as movement corridor.
Dibbler (<i>Parantechinus apicalis</i>) (T-EN)	Dibblers have been recorded over an extensive area and it is likely that they can occupy a diverse range of habitats (Friend, 2004). However, the species seem to prefer vegetation with a dense canopy greater than 1 m high which has been unburnt for at least 10 years or more (Baczocha & Start 1996). Mainland habitat is characterised by the presence of long-unburnt heathland, typified by sandy substrates and occasionally lateritic soils (Baczocha & Start 1996; Barrett 1998). This generalisation applies to records from Cheyne Beach, Torndirrup National Park and most records from Fitzgerald River National Park (Friend 2004)	Highly unlikely. No suitable habitat exists within the Survey Area
Quokka (<i>Setonix brachyurus</i>) (T-VU)	A range of vegetation types including dense forests and thickets, streamside vegetation, heaths and shrublands, <i>Taxandria linearifolia</i> dominated swamps in the Jarrah (<i>Eucalyptus marginata</i>) forest. On the south coast swamps, riparian areas, incised gullies and dense coastal heath (de Tores et al. 2007). Specifically, in the Two Peoples Bay area habitat critical to survival is known to comprise of coastal heath and thickets (<i>Eucalyptus staeri</i> , <i>Allocasuarina fraseriana</i> , <i>Hakea elliptica</i> with <i>Melaleuca striatum</i> , <i>Anarthria scabrum</i>); swamps (<i>Taxandria juniperina</i> , <i>T. linearifolia</i> , <i>Melaleuca lanceolata</i> with <i>Hakea nitida</i> , <i>Beaufortia sparsa</i> and <i>Gahnia trifida</i>); and riparian systems (<i>Eucalyptus megacarpa</i> , <i>Banksia littoralis</i> , <i>Lepidosperma</i> spp.) (DotEE 2016b)	Highly unlikely. No suitable habitat exists within the Survey Area
South-western brush-tailed phascogale, wambenger (<i>Phascogale tapoatafa wambenger</i>) (CD)	Woodland and open forests, and less commonly in wetter forests, tree species... The species has an arboreal foraging habit and a preference for mature trees for nesting hollows, although sometimes smaller trees have the potential to provide nesting hollows (Abbott and Whitford (2002). Rees et al. (2006) found that suitable hollows for this species in Victoria ranged in diameter at breast height (DBH) from 25 to 171 cm, with a mean DBH for the trees used by each individual phascogale of >80 cm. Hollow entrance sizes for Brush-tailed phascogales are small, > 5cm diameter (http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10613)	Possible. A confirmed record of South-western brush-tailed phascogale in Mira Mar (an Albany suburb) from March 2017 indicates they possibly occur within the Albany area. Suitable habitat exists within Marri and Jarrah Woodland and Forest within the Survey Area. Trees with potential hollows with entrance sizes suitable for this species were recorded. This species is difficult to detect by signs.
Western Ringtail Possum, ngwayir (<i>Pseudocheirus occidentalis</i>) (T-CR)	See main text	Present. See main text
Woylie, Brush-tailed Bettong (<i>Bettongia penicillata subsp. ogilbyi</i>) (T-CR)	Current habitat includes tall eucalypt forest and woodland, dense myrtaceous shrubland, Kwongan (proteaceous) or mallee heath (Yeatman and Groom 2012 and references therein). Thickets and other suitable habitat types such as heath, provide refuges for woylies against predators.	Highly Unlikely. Suitable habitat exists, however the lack of secure, baited reserves in the Survey Area reduces the likelihood of this species being present.
Quenda, Southern Brown Bandicoot (<i>Isodon obesulus subsp. fusciventer</i>) (P4)	See main text.	Present. See main text
Western Brush Wallaby (<i>Macropus irma</i>) (P4)	Habitat includes open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets. It is also found in some areas of mallee and heathland, and is uncommon in karri forest.	Unlikely. Potentially suitable habitat occurs, but no scats were observed during the survey.
Water-rat, Rakali (<i>Hydromys chrysogaster</i>) (P4)	See main text	Likely. See discussion in main text

Taxon	Habitat	Likelihood of Occurrence
Birds		
Australasian Bittern (<i>Botaurus poiciloptilus</i>) T (EN)	Densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands. In the southwest of Western Australia, the Bittern is found in beds of tall rush mixed with or near short fine sedge or open pools. It also occurs around swamps, lakes, pools, rivers and channels fringed with lignum <i>Muehlenbeckia</i> , cane grass <i>Eragrostis</i> or other dense vegetation (Marchant & Higgins 1990). It occasionally ventures into areas of open water or onto banks. Brackish water is tolerated in estuaries and tidal wetlands; sea coasts are avoided (Pickering 2013)	Highly Unlikely. No suitable habitat exists within the Study Area.
Baudin's Cockatoo, Long-billed black-cockatoo (<i>Calyptorhynchus baudinii</i>) T (EN)	See main text.	Present. See main text
Blue-billed Duck (<i>Oxyura australis</i>) (P4)	Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. Feeds by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer.	Highly Unlikely. No large permanent wetlands with open water are present.
Carnaby's Cockatoo, Short-billed black-cockatoo (<i>Calyptorhynchus latirostris</i>) T (EN)	See main text.	Present. See main text.
Eastern Curlew (<i>Numenius madagascariensis</i>) T (CR) & IA	Open mossy or transitional bogs, moss-lichen bogs and wet meadows, and on the swampy shores of small lakes; in the non-breeding season it is essentially coastal, occurring at estuaries, mangrove swamps, saltmarshes and intertidal flats, particularly those with extensive seagrass (<i>Zosteraceae</i>) meadows. BirdLife Australia http://www.birdlife.org.au/bird-profile/eastern-curlew	Highly Unlikely. No suitable habitat exists within the Survey Area.
Forest Red-tailed Black-Cockatoo (<i>Calyptorhynchus banksii subsp. naso</i>) T (VU)	See main text	Present. See main text.
Noisy Scrub-bird, Tjimiluk (<i>Atrichornis clamosus</i>) T (EN)	The Noisy Scrub-bird inhabits ecological communities that support a dense understorey or lower stratum of sedges and shrubs, a dense accumulation of leaf litter and an abundant population of litter-dwelling invertebrates. In the area between Oyster Harbour and Cheyne Beach, the core areas of male Noisy Scrub-bird territories are found in dense, long-unburnt vegetation characterised as low forest (5-15 m high), scrub/thicket and (rarely) heath. These vegetation formations occur in the gullies and drainage lines of hills and granite mountains and, in lowland areas, in overgrown swamps, lake margins and beside streams (Danks <i>et al.</i> 1996).	Highly Unlikely. No suitable habitat exists within the Survey Area.
Osprey, Eastern Osprey (<i>Pandion cristatus</i>) (AI)	Require extensive areas of open fresh, brackish or saline water for foraging. Frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes (DotE 2019)	Highly Unlikely. No suitable habitat exists within the Survey Area.
Recherche Cape Barren Goose (<i>Cereopsis novaehollandiae</i>) T (VU)	There is little published information available on the habitat of the Cape Barren Goose (south-western). It occurs on offshore islands and rocks, and at adjacent sites on the mainland. It inhabits grasslands and low fields of succulent herbs (comprised of <i>Carpobrotus</i> sp.), and occasionally occurs in open areas in taller and denser vegetation (although islands that are covered by woodlands or thickets support few birds) (Halse <i>et al.</i> 1995; Johnstone & Storr 1998). The bird has also been recorded on and near lakes and freshwater 'soaks', on the mainland (Halse <i>et al.</i> 1995).	It is only an occasional visitor to Albany area. It was recorded in 2003 within 10 km of the Survey Area but no signs were observed during the survey. It is considered unlikely given the nature, scale and location of the Survey Area.

Taxon	Habitat	Likelihood of Occurrence
Western Bristlebird (<i>Dasyornis longirostris</i>) T (EN)	The Western Bristlebird is restricted to floristically diverse low dense coastal heathland. The distribution of the Western Bristlebird is fragmented, with populations in Fitzgerald National Park separated from those in the Hassell Beach/Waychinicup National Park/Two Peoples Bay Nature Reserve area. Within this distribution, the species occurs in heathland that is 0.5–1.5 m tall, comprising a diverse variety of shrubs such as banksias, paperbarks, hakeas, sheoaks and <i>Leptospermum</i> sp. The Western Bristlebird occurs in similar areas to the Western Whipbird (<i>Psophodes nigrogularis nigrogularis</i>), Noisy Scrub-bird (<i>Atrichornis clamosus</i>) and the western subspecies of the Ground Parrot (<i>Pezoporus wallicus flaviventris</i>).	Highly Unlikely. No suitable habitat exists within the Survey Area.
Western Ground Parrot (<i>Pezoporus flaviventris</i>) T (CR)	The vegetation types used by Ground Parrots can be broadly characterised as sedgeland, temperate shrub heaths, temperate graminoid heaths or sub-tropical graminoid heaths (Burbidge <i>et al.</i> 1997). There is only one population remaining of the western subspecies of the Ground Parrot, in coastal heath east of Albany in southwest Western Australia. There are only two remaining areas of refuge, Arid and Fitzgerald River National Parks, with about 110 individuals still thought to live in the wild.	Highly Unlikely. No suitable habitat exists within the Survey Area.
Western Whipbird (western heath) (<i>Psophodes nigrogularis subsp. nigrogularis</i>) T (EN)	The western heath subspecies of the Western Whipbird is known only to occur in one small population in south Western Australia, in the Two-Peoples Bay- Mt Manypeaks region. The population at Two Peoples Bay-Mt Manypeaks region is estimated as less than 100 pairs and occurs in dense coastal heath (Simpson and Day, 2004, Smith, 1991). The preferred habitat is thicket, a two to three-metre-high formation of varied floristic composition. Other vegetation associations are used infrequently, although all nests are usually found in dense heath adjacent to areas of thicket (Smith, 1991). Restricted to a small coastal strip east of Albany from Two Peoples Bay and Mount Gardner in the south west to about Cape Riche Road in the north east, with the South Coast Highway as an approximate inland boundary. In this area it occurs in heath-like thicket associations on coastal dunes and in low, dense mallee woodland or shrubland with understorey of dense, stunted shrubs	Unlikely. The western heath subspecies of the Western Whipbird is restricted to the dense coastal heath in the Two-Peoples Bay- Mt Manypeaks region, east of the Survey Area. Given this species very specific habitat it is unlikely to occur in the Survey Area.
Malleefowl (<i>Leipoa ocellata</i>) T (VU)	Malleefowl are large and distinctive ground-dwelling birds. They occur in shrublands and low woodlands that are dominated by mallee vegetation throughout the wheatbelt and Jarrah forests, and coastal areas east of Waychinicup.	Highly unlikely. No suitable habitat present. Out of current known range.
Fork-tailed Swift, Pacific Swift (<i>Apus pacificus</i>) (IA)	The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. Does not breed in Australia.	Possible, but does not use on-ground habitat.
Glossy ibis (<i>Plegadis falcinellus</i>) (IA)	Non-breeding visitor to the south-west of Western Australia. Requires shallow water and mudflats, so is found in well-vegetated wetlands, floodplains (http://www.birdlife.org.au/bird-profile/glossy-ibis)	Highly unlikely. No suitable habitat present.
Masked Owl (southern subsp) (<i>Tyto novaehollandiae subsp. Novaehollandiae</i>) (P3)	Inhabits forests, woodlands, timbered waterways and open country on the fringe of these areas. The main requirements are tall Eucalypts with suitable hollows for nesting and roosting and adjacent areas for foraging that support an abundance of principally terrestrial mammals, although arboreal mammals can also be taken. Also use caves for nesting. Masked Owls are territorial, and pairs remain in or near the territory all year round (Garnett 2000).	Possible. Hollows suitable for nesting are present and abundant terrestrial mammals (Quenda) as prey also present.
Peregrine Falcon (<i>Falco peregrinus</i>) (OS)	A variety of habitats from woodlands to open grasslands and coastal cliffs. Prey consists of other birds. It requires abundant prey and secure nest sites, and prefers coastal and inland cliffs or open woodlands near water. http://www.birdlife.org.au/bird-profile/peregrine-falcon	Possible. Suitable habitat exists (all forest/woodland vegetation communities) however this species is not common.
Migratory Shorebirds		
Lesser Sand Plover (<i>Charadrius mongolus</i>) T (EN) & IA	Shorebirds are a group of wading birds that can be found feeding on swamps, tidal mudflats, beaches and open country.	Highly Unlikely. No suitable habitat exists within the Survey Area.
Great Knot (<i>Calidris tenuirostris</i>) T (CR) & IA	All those listed are migratory and do not breed in Australia, except for the Hooded Plover which breeds on sandy beaches, and also occurs on inland salt lakes in the South West of WA.	
Curlew Sandpiper (<i>Calidris ferruginea</i>) T (CR) & IA		

Taxon	Habitat	Likelihood of Occurrence
Ruddy Turnstone (<i>Arenaria interpres</i>) IA		
Sharp-tailed Sandpiper (<i>Calidris acuminata</i>)		
Sanderling (<i>Calidris alba</i>) IA		
Red-necked Stint (<i>Calidris ruficollis</i>) IA		
Greater Sand Plover (<i>Charadrius leschenaultii</i>) IA		
Bar-tailed Godwit (<i>Limosa lapponica</i>) IA		
Black-tailed Godwit (<i>Limosa limosa</i>) IA		
Whimbrel (<i>Numenius phaeopus</i>) IA		
Pacific Golden Plover (<i>Pluvialis fulva</i>)		
Grey Plover (<i>Pluvialis squatarola</i>) IA		
Grey-tailed Tattler (<i>Tringa brevipes</i>) IA		
Wood Sandpiper (<i>Tringa glareola</i>) IA		
Ruff Reeve (<i>Philomachus pugnax</i>) IA		
Hooded Plover (<i>Thinornis rubricollis</i>) IA		
Common Greenshank, greenshank (<i>Tringa nebularia</i>) IA		
Marsh Sandpiper, little greenshank (<i>Tringa stagnatilis</i>) IA		
Terek Sandpiper (<i>Xenus cinereus</i>) IA		
Reptiles		
Short-nosed Snake (<i>Elapognathus minor</i>) (P2)	See main text	Possible. See discussion in main text
Fish		
Balston's Pygmy Perch (<i>Nannatherina balstoni</i>) T (VU)	Inhabits acidic, tannin-stained freshwater pools, streams and lakes in peat flats within 30 km of the coast Margaret River and Two People's Bay. Typically found in freshwater with a pH range of 3.0–6.5 and seasonally fluctuating temperatures of 11–30 °C. It is typically found amongst inundated riparian vegetation where it is thought to feed and spawn, though adults are also found in open water. Larvae tend to be confined to shallow water < 10 cm deep amongst the flooded riparian vegetation, and as the larvae increase in size they gradually move to deeper waters (Morgan <i>et al.</i> 1995).	Highly Unlikely. No suitable habitat exists within the Survey Area.
Mud Minnow, Western Dwarf Galaxias (<i>Galaxiella munda</i>) T (EN)	Occurs in swift flowing streams within karri forests and is typically found near submerged vegetation, occasionally in the still water of ponds, swamps and roadside drains, and often inhabiting darkly tannin-stained and acidic water	Highly Unlikely. No suitable habitat exists within the Survey Area.
Pouched Lamprey (<i>Geotria australis</i>) (P3)	Adults spawn in the headwaters of freshwater rivers and streams, and when the larvae or ammocoetes hatch, they drift downstream and burrow into soft muddy sediments. They spend the next few years filter-feeding on micro-organisms from the water above. After metamorphosis, young adults migrate downstream to estuaries and coastal waters, where they feed parasitically by rasping flesh from other fishes with their toothy tongues. They eventually cease feeding and migrate back to freshwater to breed (Bray and Gomom 2011)	Highly Unlikely. No suitable habitat exists within the Survey Area.
Black-stripe Minnow, Black-striped Dwarf Galaxias (<i>Galaxiella nigrostriata</i>) T (EN)	Found only in coastal wetlands of south-west Western Australia. During summer when ephemeral pools dry out, they burrow into the moist soil below and aestivate until the rains return in autumn (Bray and Gomom 2011)	Highly Unlikely. No suitable habitat exists within the Survey Area.

Taxon	Habitat	Likelihood of Occurrence
Salamanderfish (<i>Lepidogalaxias salamandroides</i>) T (EN)	Live in small semi-permanent (ephemeral) pools and shallow streams and drains in generally acidic water around pH 4. Feeds mainly on aquatic insect larvae and small crustaceans. Are uniquely adapted to survive the desiccation of their habitat. When pools dry out, they burrow into the damp bottom sand which remains moistened by ground water (Allen et al 2002; Bray 2017)	Highly Unlikely. The species was recorded Lake Powel in 1976, but has since been found to be endemic to temperate freshwaters of south-west Western Australia, and known only from heathland peat flats between the Blackwood and Kent Rivers (Bray 2017)
Invertebrates		
Carter's Freshwater Mussel (<i>Westralunio carteri</i>) T (VU)	See main text	Possible. See discussion in main text
Banksia brownii plant-louse (<i>Trioza barrettiae</i>) T (EN)	Current records from the Stirling Range NP and the Vancouver Peninsula (Taylor and Moir 2014). It is closely associated with its only known host plant <i>Banksia brownii</i> .	Highly Unlikely. No <i>Banksia brownii</i> populations are present.
Western Archaeid Spider (<i>Zephyrarchaea mainae</i>) T (VU)	Associated with Gondwanan refugial habitats. Requires long unburnt low coastal peppermint (<i>Agonis flexuosa</i>) woodland with a coastal heath understorey and leaf litter accumulating on top of the understorey sedges (<i>Lepidosperma</i> and <i>Restionaceae</i>) that remain moist throughout the year (Rix and Harvey 2009). Specimens have been collected by beating and sifting sedges and low shrubs in dense coastal or near-coastal groves of Peppermint (<i>Agonis</i> sp.), with several outlying populations also known from wet Karri (<i>Eucalyptus diversicolor</i>) forest (Rix and Harvey 2012).	Highly unlikely, no suitable habitat exists within the Survey Area
Woolybush bee (<i>Hylaeus globuliferus</i>) (P3)	See main text	Possible. See discussion in main text
Helicarionid land snail (<i>Helicarion castanea</i>) (EX)	Unknown.	Highly Unlikely. Habitat unknown. Presumed Extinct

13 APPENDIX F - Significant Flora, Weed and Tree Locations

F1. Conservation Significant flora locations.

Taxon	Count	Easting	Northing	Zone	Cons_Code	SurveyDate
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	2					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	4					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	2					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	4					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Andersonia</i> sp. Jamesii (J. Liddelow 84)	1					
<i>Boronia crassipes</i>	10					
<i>Boronia crassipes</i>	5					
<i>Boronia crassipes</i>	20					
<i>Boronia crassipes</i>	6					
<i>Boronia crassipes</i>	5					
<i>Boronia crassipes</i>	5					
<i>Boronia crassipes</i>	100					
<i>Boronia crassipes</i>	15					
<i>Boronia crassipes</i>	100					
<i>Boronia crassipes</i>	750					
<i>Boronia crassipes</i>	1					
<i>Boronia crassipes</i>	1					
<i>Synaphea incurva</i>	1					
<i>Synaphea incurva</i>	4					
<i>Synaphea incurva</i>	3					
<i>Thysanotus isantherus</i>	1					
<i>Thysanotus isantherus</i>	1					

F2. Significant weed locations.

Taxon	Status	Easting	Northing	SurveyDate
<i>Asparagus asparagoides</i>	WONS	573748	6126781	22/11/2017
<i>Asparagus asparagoides</i>	WONS	578591	6124174	23/11/2017
<i>Lantana camara</i>	WONS	578768	6124375	23/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	573750	6126779	22/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	578816	6124060	23/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	578770	6124240	23/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	578774	6124125	23/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	578767	6124106	23/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	576754	6124737	23/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	574435	6127389	24/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	574277	6127385	27/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	574269	6127376	27/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	574210	6127373	27/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	574599	6127487	27/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	575023	6130503	30/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	574989	6130535	30/11/2017
<i>Rubus fruticosus aggregate</i>	WONS	576189	6124831	30/11/2017
<i>Ulex europaeus</i>	WONS	573763	6126758	22/11/2017
<i>Ulex europaeus</i>	WONS	573818	6126574	22/11/2017
<i>Ulex europaeus</i>	WONS	578812	6124053	23/11/2017

Taxon	Status	Easting	Northing	SurveyDate
<i>Ulex europaeus</i>	WONS	578811	6124064	23/11/2017
<i>Zantedeschia aethiopica</i>	Declared Pest	578624	6124155	23/11/2017
<i>Zantedeschia aethiopica</i>	Declared Pest	574405	6127547	24/11/2017

F3. Potential Black Cockatoo breeding tree locations.

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	574249	6125823	500	50	0	
<i>Corymbia calophylla</i>	574246	6125835	500	50	0	
<i>Corymbia calophylla</i>	574245	6125905	500	50	0	
<i>Corymbia calophylla</i>	573667	6126346	500	50	0	
<i>Corymbia calophylla</i>	574205	6126477	500	50	0	
<i>Corymbia calophylla</i>	578343	6124336	500	50	0	
<i>Corymbia calophylla</i>	578652	6124298	500	50	0	
<i>Corymbia calophylla</i>	578619	6124378	500	50	0	
<i>Corymbia calophylla</i>	578629	6124426	500	50	0	
<i>Corymbia calophylla</i>	578845	6123969	500	50	0	
<i>Corymbia calophylla</i>	576775	6124631	500	50	0	
<i>Corymbia calophylla</i>	574302	6127653	500	50	0	
<i>Corymbia calophylla</i>	574368	6129128	500	50	0	
<i>Corymbia calophylla</i>	578790	6124034	505	50	0	
<i>Corymbia calophylla</i>	574365	6125864	510	50	0	
<i>Corymbia calophylla</i>	574243	6125826	510	50	0	
<i>Corymbia calophylla</i>	574252	6125903	510	50	0	
<i>Corymbia calophylla</i>	573738	6126920	510	50	0	
<i>Corymbia calophylla</i>	573726	6126402	510	50	0	
<i>Corymbia calophylla</i>	578663	6124278	510	50	0	
<i>Corymbia calophylla</i>	574227	6125552	510	50	0	
<i>Corymbia calophylla</i>	574364	6125759	510	50	0	
<i>Corymbia calophylla</i>	578763	6124178	515	50	0	
<i>Corymbia calophylla</i>	578780	6124162	515	50	0	
<i>Corymbia calophylla</i>	578631	6124305	520	50	0	
<i>Corymbia calophylla</i>	576785	6124720	520	50	0	
<i>Corymbia calophylla</i>	574422	6125821	520	50	0	
<i>Corymbia calophylla</i>	574360	6125847	520	50	0	
<i>Corymbia calophylla</i>	578774	6124119	520	50	0	
<i>Corymbia calophylla</i>	574233	6125920	520	50	0	
<i>Corymbia calophylla</i>	573630	6126927	520	50	0	
<i>Corymbia calophylla</i>	573816	6126871	520	50	0	
<i>Corymbia calophylla</i>	574205	6126519	520	50	0	
<i>Corymbia calophylla</i>	578877	6124385	520	50	0	
<i>Corymbia calophylla</i>	578622	6124367	520	50	0	
<i>Corymbia calophylla</i>	576762	6124696	520	50	0	
<i>Corymbia calophylla</i>	574350	6129139	520	50	0	
<i>Corymbia calophylla</i>	574399	6125795	520	50	0	
<i>Corymbia calophylla</i>	578843	6124027	525	50	0	
<i>Corymbia calophylla</i>	573801	6126738	530	50	0	
<i>Corymbia calophylla</i>	578662	6124304	530	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	578683	6124398	530	50	0	
<i>Corymbia calophylla</i>	578666	6124387	530	50	0	
<i>Corymbia calophylla</i>	578653	6124394	530	50	0	
<i>Corymbia calophylla</i>	576756	6124647	530	50	0	
<i>Corymbia calophylla</i>	576826	6124694	535	50	0	
<i>Corymbia calophylla</i>	574439	6125820	540	50	0	
<i>Corymbia calophylla</i>	578623	6124424	540	50	0	
<i>Corymbia calophylla</i>	578779	6123986	540	50	0	
<i>Corymbia calophylla</i>	578792	6124040	540	50	0	
<i>Corymbia calophylla</i>	578842	6124018	540	50	0	
<i>Corymbia calophylla</i>	574319	6129083	540	50	0	
<i>Corymbia calophylla</i>	574322	6129121	540	50	0	
<i>Corymbia calophylla</i>	574326	6127624	540	50	0	
<i>Corymbia calophylla</i>	578682	6124225	545	50	0	
<i>Corymbia calophylla</i>	578858	6124195	545	50	0	
<i>Corymbia calophylla</i>	574326	6125885	550	50	0	
<i>Corymbia calophylla</i>	574250	6125913	550	50	0	
<i>Corymbia calophylla</i>	574061	6126412	550	50	0	
<i>Corymbia calophylla</i>	573763	6126590	550	50	0	
<i>Corymbia calophylla</i>	578457	6124573	550	50	0	
<i>Corymbia calophylla</i>	578840	6124232	550	50	0	
<i>Corymbia calophylla</i>	578760	6124400	550	50	0	
<i>Corymbia calophylla</i>	578614	6124379	550	50	0	
<i>Corymbia calophylla</i>	578587	6124408	550	50	0	
<i>Corymbia calophylla</i>	574315	6129064	550	50	0	
<i>Corymbia calophylla</i>	576739	6124686	550	50	0	
<i>Corymbia calophylla</i>	574329	6129069	550	50	0	
<i>Corymbia calophylla</i>	574302	6125875	560	50	0	
<i>Corymbia calophylla</i>	574234	6125961	560	50	0	
<i>Corymbia calophylla</i>	573669	6126273	560	50	0	
<i>Corymbia calophylla</i>	578886	6124254	560	50	0	
<i>Corymbia calophylla</i>	576795	6124622	560	50	0	
<i>Corymbia calophylla</i>	578686	6124214	565	50	0	
<i>Corymbia calophylla</i>	578841	6124242	565	50	0	
<i>Corymbia calophylla</i>	578791	6124041	570	50	0	
<i>Corymbia calophylla</i>	574228	6125881	570	50	0	
<i>Corymbia calophylla</i>	574086	6126449	570	50	0	
<i>Corymbia calophylla</i>	573732	6126402	570	50	0	
<i>Corymbia calophylla</i>	578592	6124428	570	50	0	
<i>Corymbia calophylla</i>	578608	6124437	570	50	0	
<i>Corymbia calophylla</i>	574366	6125763	570	50	0	
<i>Corymbia calophylla</i>	574381	6125889	580	50	0	
<i>Corymbia calophylla</i>	574263	6125916	580	50	0	
<i>Corymbia calophylla</i>	573674	6126831	580	50	0	
<i>Corymbia calophylla</i>	573667	6126302	580	50	0	
<i>Corymbia calophylla</i>	578606	6124411	580	50	0	
<i>Corymbia calophylla</i>	576794	6124626	580	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	574229	6125703	580	50	0	
<i>Corymbia calophylla</i>	574391	6125758	590	50	0	
<i>Corymbia calophylla</i>	574425	6125790	590	50	0	
<i>Corymbia calophylla</i>	573673	6126266	590	50	0	
<i>Corymbia calophylla</i>	573668	6126228	590	50	0	
<i>Corymbia calophylla</i>	578649	6124361	590	50	0	
<i>Corymbia calophylla</i>	576781	6124663	590	50	0	
<i>Corymbia calophylla</i>	576762	6124635	590	50	0	
<i>Corymbia calophylla</i>	574227	6125620	590	50	0	
<i>Corymbia calophylla</i>	578857	6124231	595	50	0	
<i>Corymbia calophylla</i>	578721	6124227	595	50	0	
<i>Corymbia calophylla</i>	578850	6124044	600	50	0	
<i>Corymbia calophylla</i>	578795	6124035	600	50	0	
<i>Corymbia calophylla</i>	574233	6125845	600	50	0	
<i>Corymbia calophylla</i>	574065	6126343	600	50	0	
<i>Corymbia calophylla</i>	573824	6126895	600	50	0	
<i>Corymbia calophylla</i>	578880	6124361	600	50	0	
<i>Corymbia calophylla</i>	578661	6124341	600	50	0	
<i>Corymbia calophylla</i>	578602	6124349	600	50	0	
<i>Corymbia calophylla</i>	578633	6124364	600	50	0	
<i>Corymbia calophylla</i>	578567	6124242	600	50	0	
<i>Corymbia calophylla</i>	578833	6124035	600	50	0	
<i>Corymbia calophylla</i>	574334	6127623	600	50	0	
<i>Corymbia calophylla</i>	574325	6127622	600	50	0	
<i>Corymbia calophylla</i>	574436	6125798	600	50	0	
<i>Corymbia calophylla</i>	578781	6124124	605	50	0	
<i>Corymbia calophylla</i>	574307	6127651	610	50	0	
<i>Corymbia calophylla</i>	578695	6124335	610	50	0	
<i>Corymbia calophylla</i>	574354	6125830	610	50	0	
<i>Corymbia calophylla</i>	578838	6123999	610	50	0	
<i>Corymbia calophylla</i>	574371	6127581	610	50	0	
<i>Corymbia calophylla</i>	574427	6125823	620	50	0	
<i>Corymbia calophylla</i>	578671	6124365	620	50	0	
<i>Corymbia calophylla</i>	578772	6123990	620	50	0	
<i>Corymbia calophylla</i>	576856	6124644	630	50	0	
<i>Corymbia calophylla</i>	574366	6125900	630	50	0	
<i>Corymbia calophylla</i>	574248	6125835	630	50	0	
<i>Corymbia calophylla</i>	578870	6124022	630	50	0	
<i>Corymbia calophylla</i>	574398	6125832	630	50	0	
<i>Corymbia calophylla</i>	574367	6125839	630	50	0	
<i>Corymbia calophylla</i>	574161	6126416	630	50	0	
<i>Corymbia calophylla</i>	573808	6126864	630	50	0	
<i>Corymbia calophylla</i>	578795	6124038	630	50	0	
<i>Corymbia calophylla</i>	576781	6124646	630	50	0	
<i>Corymbia calophylla</i>	576721	6124696	630	50	0	
<i>Corymbia calophylla</i>	574255	6125828	640	50	0	
<i>Corymbia calophylla</i>	578839	6124034	640	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	573727	6126241	640	50	0	
<i>Corymbia calophylla</i>	578664	6124285	640	50	0	
<i>Corymbia calophylla</i>	576763	6124729	640	50	0	
<i>Corymbia calophylla</i>	574346	6127605	640	50	0	
<i>Corymbia calophylla</i>	578835	6124031	650	50	0	
<i>Corymbia calophylla</i>	574320	6125882	650	50	0	
<i>Corymbia calophylla</i>	576860	6124678	650	50	0	
<i>Corymbia calophylla</i>	578433	6124578	650	50	0	
<i>Corymbia calophylla</i>	574316	6129137	650	50	0	
<i>Corymbia calophylla</i>	578764	6124170	655	50	0	
<i>Corymbia calophylla</i>	578819	6124046	655	50	0	
<i>Corymbia calophylla</i>	576832	6124696	655	50	0	
<i>Corymbia calophylla</i>	574278	6125874	660	50	0	
<i>Corymbia calophylla</i>	574320	6125895	660	50	0	
<i>Corymbia calophylla</i>	574277	6125885	660	50	0	
<i>Corymbia calophylla</i>	574365	6125878	660	50	0	
<i>Corymbia calophylla</i>	574338	6127622	660	50	0	
<i>Corymbia calophylla</i>	574225	6125598	660	50	0	
<i>Corymbia calophylla</i>	578800	6124246	670	50	0	
<i>Corymbia calophylla</i>	578645	6124342	670	50	0	
<i>Corymbia calophylla</i>	578613	6124411	670	50	0	
<i>Corymbia calophylla</i>	574319	6127621	670	50	0	
<i>Corymbia calophylla</i>	578611	6124241	680	50	0	
<i>Corymbia calophylla</i>	574229	6125934	680	50	0	
<i>Corymbia calophylla</i>	576784	6124653	680	50	0	
<i>Corymbia calophylla</i>	574226	6125558	690	50	0	
<i>Corymbia calophylla</i>	574233	6125887	690	50	0	
<i>Corymbia calophylla</i>	574086	6126340	690	50	0	
<i>Corymbia calophylla</i>	574023	6126349	690	50	0	
<i>Corymbia calophylla</i>	573700	6126254	690	50	0	
<i>Corymbia calophylla</i>	574230	6125873	690	50	0	
<i>Corymbia calophylla</i>	578659	6124278	690	50	0	
<i>Corymbia calophylla</i>	578652	6124243	690	50	0	
<i>Corymbia calophylla</i>	578605	6124425	690	50	0	
<i>Corymbia calophylla</i>	574287	6125756	690	50	0	
<i>Corymbia calophylla</i>	574407	6125804	690	50	0	
<i>Corymbia calophylla</i>	578822	6124226	695	50	0	
<i>Corymbia calophylla</i>	578698	6124260	700	50	0	
<i>Corymbia calophylla</i>	574232	6125789	700	50	0	
<i>Corymbia calophylla</i>	574234	6126544	700	50	0	
<i>Corymbia calophylla</i>	574027	6126307	700	50	0	
<i>Corymbia calophylla</i>	573665	6126213	700	50	0	
<i>Corymbia calophylla</i>	578671	6124359	700	50	0	
<i>Corymbia calophylla</i>	574333	6128180	700	50	0	
<i>Corymbia calophylla</i>	574318	6129131	700	50	0	
<i>Corymbia calophylla</i>	574228	6125588	700	50	0	
<i>Corymbia calophylla</i>	574376	6125798	700	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	578761	6124143	710	50	0	
<i>Corymbia calophylla</i>	574247	6125869	710	50	0	
<i>Corymbia calophylla</i>	574348	6125884	710	50	0	
<i>Corymbia calophylla</i>	574323	6129069	710	50	0	
<i>Corymbia calophylla</i>	574419	6125799	710	50	0	
<i>Corymbia calophylla</i>	578830	6124224	715	50	0	
<i>Corymbia calophylla</i>	574224	6125420	720	50	0	
<i>Corymbia calophylla</i>	574380	6125885	720	50	0	
<i>Corymbia calophylla</i>	574280	6125905	720	50	0	
<i>Corymbia calophylla</i>	578615	6124395	720	50	0	
<i>Corymbia calophylla</i>	576770	6124724	720	50	0	
<i>Corymbia calophylla</i>	578737	6124255	725	50	0	
<i>Corymbia calophylla</i>	574300	6127650	730	50	0	
<i>Corymbia calophylla</i>	574256	6126513	740	50	0	
<i>Corymbia calophylla</i>	573732	6126390	740	50	0	
<i>Corymbia calophylla</i>	578627	6124395	740	50	0	
<i>Corymbia calophylla</i>	574250	6125855	750	50	0	
<i>Corymbia calophylla</i>	578825	6124225	750	50	0	
<i>Corymbia calophylla</i>	574226	6125926	760	50	0	
<i>Corymbia calophylla</i>	574343	6129082	760	50	0	
<i>Corymbia calophylla</i>	574376	6125933	770	50	0	
<i>Corymbia calophylla</i>	573728	6126278	770	50	0	
<i>Corymbia calophylla</i>	574377	6127575	770	50	0	
<i>Corymbia calophylla</i>	574226	6125699	770	50	0	
<i>Corymbia calophylla</i>	574065	6126334	780	50	0	
<i>Corymbia calophylla</i>	576732	6124686	780	50	0	
<i>Corymbia calophylla</i>	574254	6125820	790	50	0	
<i>Corymbia calophylla</i>	578606	6124239	790	50	0	
<i>Corymbia calophylla</i>	574227	6125430	790	50	0	
<i>Corymbia calophylla</i>	578647	6124382	800	50	0	
<i>Corymbia calophylla</i>	578863	6124020	800	50	0	
<i>Corymbia calophylla</i>	574285	6125886	800	50	0	
<i>Corymbia calophylla</i>	574346	6125888	800	50	0	
<i>Corymbia calophylla</i>	573683	6126252	810	50	0	
<i>Corymbia calophylla</i>	574360	6125916	810	50	0	
<i>Corymbia calophylla</i>	574342	6129114	820	50	0	
<i>Corymbia calophylla</i>	576849	6124651	830	50	0	
<i>Corymbia calophylla</i>	578710	6124310	845	50	0	
<i>Corymbia calophylla</i>	574230	6125901	850	50	0	
<i>Corymbia calophylla</i>	578644	6124424	850	50	0	
<i>Corymbia calophylla</i>	578807	6124146	860	50	0	
<i>Corymbia calophylla</i>	578692	6124232	860	50	0	
<i>Corymbia calophylla</i>	578687	6124234	860	50	0	
<i>Corymbia calophylla</i>	578816	6124217	865	50	0	
<i>Corymbia calophylla</i>	574360	6125807	870	50	0	
<i>Corymbia calophylla</i>	574381	6127577	870	50	0	
<i>Corymbia calophylla</i>	578848	6124048	875	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	578627	6124322	880	50	0	
<i>Corymbia calophylla</i>	574296	6125763	880	50	0	
<i>Corymbia calophylla</i>	576774	6124663	890	50	0	
<i>Corymbia calophylla</i>	578821	6124045	890	50	0	
<i>Corymbia calophylla</i>	578809	6123954	900	50	0	
<i>Corymbia calophylla</i>	574240	6125819	910	50	0	
<i>Corymbia calophylla</i>	574056	6126413	920	50	0	
<i>Corymbia calophylla</i>	578697	6124408	920	50	0	
<i>Corymbia calophylla</i>	574023	6126316	940	50	0	
<i>Corymbia calophylla</i>	578674	6124316	940	50	0	
<i>Corymbia calophylla</i>	578686	6124414	970	50	0	
<i>Corymbia calophylla</i>	574144	6126587	980	50	0	
<i>Corymbia calophylla</i>	578812	6124009	980	50	0	
<i>Corymbia calophylla</i>	578700	6124242	985	50	0	
<i>Corymbia calophylla</i>	573676	6126911	990	50	0	
<i>Corymbia calophylla</i>	574288	6128495	1000	50	0	
<i>Corymbia calophylla</i>	574359	6125796	1000	50	0	
<i>Corymbia calophylla</i>	574269	6125874	1010	50	0	
<i>Corymbia calophylla</i>	574405	6125926	1030	50	0	
<i>Corymbia calophylla</i>	576788	6124626	1040	50	0	
<i>Corymbia calophylla</i>	574232	6125841	1070	50	0	
<i>Corymbia calophylla</i>	578802	6124253	1080	50	0	
<i>Corymbia calophylla</i>	574314	6125877	1080	50	0	
<i>Corymbia calophylla</i>	576783	6124628	1140	50	0	
<i>Corymbia calophylla</i>	574387	6125755	1150	50	0	
<i>Corymbia calophylla</i>	578749	6123993	1230	50	0	
<i>Corymbia calophylla</i>	574292	6127645	1300	50	0	
<i>Corymbia calophylla</i>	578399	6124601	550	50	0	
<i>Corymbia calophylla</i>	576761	6124672	550	50	1	100
<i>Corymbia calophylla</i>	576792	6124651	620	50	1	100
<i>Corymbia calophylla</i>	574323	6129121	730	50	1	100
<i>Corymbia calophylla</i>	576838	6124675	835	50	1	100
<i>Corymbia calophylla</i>	574365	6125885	660	50	2	100,100
<i>Corymbia calophylla</i>	573677	6126294	770	50	2	100,200
<i>Corymbia calophylla</i>	578790	6124037	510	50	1	150
<i>Corymbia calophylla</i>	578876	6124351	510	50	1	150
<i>Corymbia calophylla</i>	574227	6125564	540	50	1	150
<i>Corymbia calophylla</i>	578705	6124400	710	50	1	150
<i>Corymbia calophylla</i>	576774	6124673	950	50	1	150
<i>Corymbia calophylla</i>	578661	6124416	860	50	2	150,150
<i>Corymbia calophylla</i>	574314	6127600	690	50	3	150,150,150
<i>Corymbia calophylla</i>	578882	6124340	730	50	2	150,200
<i>Corymbia calophylla</i>	574341	6127608	520	50	1	200
<i>Corymbia calophylla</i>	578866	6124391	560	50	1	200
<i>Corymbia calophylla</i>	574285	6125875	570	50	1	200
<i>Corymbia calophylla</i>	573772	6126314	590	50	1	200
<i>Corymbia calophylla</i>	574440	6125815	620	50	1	200

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Corymbia calophylla</i>	573672	6126288	630	50	1	200
<i>Corymbia calophylla</i>	578665	6124417	650	50	1	200
<i>Corymbia calophylla</i>	573696	6126255	670	50	1	200
<i>Corymbia calophylla</i>	573777	6126326	690	50	1	200
<i>Corymbia calophylla</i>	574422	6125869	760	50	1	200
<i>Corymbia calophylla</i>	578604	6124399	810	50	1	200
<i>Corymbia calophylla</i>	574363	6125826	940	50	1	200
<i>Corymbia calophylla</i>	574384	6125785	1060	50	1	200
<i>Corymbia calophylla</i>	573715	6126294	850	50	2	200,300
<i>Corymbia calophylla</i>	574407	6125804	690	50	1	300
<i>Corymbia calophylla</i>	578789	6124196	920	50	1	340
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578802	6124152	500	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	574130	6126445	500	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578696	6124401	510	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578824	6124226	520	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578767	6124019	590	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578803	6124042	595	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578785	6124210	600	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578884	6124185	635	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	573980	6126497	640	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578803	6124249	660	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578788	6124167	670	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578798	6124234	670	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578820	6124228	770	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578801	6124254	820	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	573718	6127025	1650	50	0	
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	574343	6128064	900	50	1	100
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	574318	6128030	730	50	1	100
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	573975	6126522	730	50	5	100,100,100,200,300
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	574370	6129121	530	50	1	150
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578793	6124279	540	50	1	150
Dead Stag of <i>Eucalyptus marginata</i> or <i>Corymbia calophylla</i>	578785	6124299	560	50	1	150

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
Dead Stag of Eucalyptus marginata or Corymbia calophylla	574228	6125608	620	50	1	150
Dead Stag of Eucalyptus marginata or Corymbia calophylla	574434	6125878	570	50	2	150,150
Dead Stag of Eucalyptus marginata or Corymbia calophylla	574385	6128520	820	50	1	200
Dead Stag of Eucalyptus marginata or Corymbia calophylla	578847	6124195	615	50	1	300
Dead Stag of Eucalyptus marginata or Corymbia calophylla	578873	6124367	1370	50	3	300,200,200
Dead Stag of Eucalyptus marginata or Corymbia calophylla	578799	6124239	690	50	1	400
Dead Stag of Eucalyptus marginata or Corymbia calophylla	578824	6124229	810	50	1	400
Dead Stag of Eucalyptus marginata or Corymbia calophylla	578786	6124174	985	50	1	400
Eucalyptus gomphocephala	574317	6129742	500	50	0	
Eucalyptus gomphocephala	574317	6129704	500	50	0	
Eucalyptus gomphocephala	574318	6129710	500	50	0	
Eucalyptus gomphocephala	578607	6124107	510	50	0	
Eucalyptus gomphocephala	578556	6124138	510	50	0	
Eucalyptus gomphocephala	578558	6124199	520	50	0	
Eucalyptus gomphocephala	578596	6124189	530	50	0	
Eucalyptus gomphocephala	578665	6124414	550	50	0	
Eucalyptus gomphocephala	578574	6124238	560	50	0	
Eucalyptus gomphocephala	578593	6124127	560	50	0	
Eucalyptus gomphocephala	578562	6124172	560	50	0	
Eucalyptus gomphocephala	578600	6124284	590	50	0	
Eucalyptus gomphocephala	578515	6124330	600	50	0	
Eucalyptus gomphocephala	578587	6124133	610	50	0	
Eucalyptus gomphocephala	578620	6124101	620	50	0	
Eucalyptus gomphocephala	578619	6124107	620	50	0	
Eucalyptus gomphocephala	574262	6126608	630	50	0	
Eucalyptus gomphocephala	578651	6124094	630	50	0	
Eucalyptus gomphocephala	578509	6124378	630	50	0	
Eucalyptus gomphocephala	578642	6124094	640	50	0	
Eucalyptus gomphocephala	578675	6124095	650	50	0	
Eucalyptus gomphocephala	578555	6124195	650	50	0	
Eucalyptus gomphocephala	578649	6124091	660	50	0	
Eucalyptus gomphocephala	578678	6124086	670	50	0	
Eucalyptus gomphocephala	578561	6124133	670	50	0	
Eucalyptus gomphocephala	578638	6124091	690	50	0	
Eucalyptus gomphocephala	578557	6124233	690	50	0	
Eucalyptus gomphocephala	578654	6124149	730	50	0	
Eucalyptus gomphocephala	578576	6124231	760	50	0	
Eucalyptus gomphocephala	578608	6124153	770	50	0	
Eucalyptus gomphocephala	578649	6124114	780	50	0	
Eucalyptus gomphocephala	578635	6124102	800	50	0	
Eucalyptus gomphocephala	578569	6124220	820	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus gomphocephala</i>	578566	6124226	820	50	0	
<i>Eucalyptus gomphocephala</i>	578587	6124163	830	50	0	
<i>Eucalyptus gomphocephala</i>	578514	6124308	830	50	0	
<i>Eucalyptus gomphocephala</i>	578579	6124228	860	50	0	
<i>Eucalyptus gomphocephala</i>	578512	6124348	870	50	0	
<i>Eucalyptus gomphocephala</i>	578587	6124300	880	50	0	
<i>Eucalyptus gomphocephala</i>	574322	6130081	880	50	0	
<i>Eucalyptus gomphocephala</i>	578595	6124176	890	50	0	
<i>Eucalyptus gomphocephala</i>	578605	6124041	900	50	0	
<i>Eucalyptus gomphocephala</i>	578714	6124153	910	50	0	
<i>Eucalyptus gomphocephala</i>	578604	6124108	920	50	0	
<i>Eucalyptus gomphocephala</i>	578599	6124125	920	50	0	
<i>Eucalyptus gomphocephala</i>	578533	6124219	950	50	0	
<i>Eucalyptus gomphocephala</i>	578508	6124375	990	50	0	
<i>Eucalyptus gomphocephala</i>	578633	6124071	1010	50	0	
<i>Eucalyptus gomphocephala</i>	578573	6124146	1020	50	0	
<i>Eucalyptus gomphocephala</i>	578674	6124132	1050	50	0	
<i>Eucalyptus gomphocephala</i>	578680	6124137	1070	50	0	
<i>Eucalyptus gomphocephala</i>	578596	6124075	1090	50	0	
<i>Eucalyptus gomphocephala</i>	578587	6124170	1140	50	0	
<i>Eucalyptus gomphocephala</i>	578605	6124232	1150	50	0	
<i>Eucalyptus gomphocephala</i>	578553	6124183	1220	50	0	
<i>Eucalyptus gomphocephala</i>	578644	6124156	1230	50	0	
<i>Eucalyptus gomphocephala</i>	578635	6124138	1250	50	0	
<i>Eucalyptus gomphocephala</i>	578651	6124165	1370	50	0	
<i>Eucalyptus gomphocephala</i>	578596	6124083	1559	50	0	
<i>Eucalyptus gomphocephala</i>	578478	6124299	1201	50	0	
<i>Eucalyptus gomphocephala</i>	578477	6124258	1100	50	0	
<i>Eucalyptus gomphocephala</i>	578343	6124290	950	50	0	
<i>Eucalyptus marginata</i>	574131	6126449	500	50	0	
<i>Eucalyptus marginata</i>	574113	6126443	500	50	0	
<i>Eucalyptus marginata</i>	574023	6126480	500	50	0	
<i>Eucalyptus marginata</i>	574040	6126450	500	50	0	
<i>Eucalyptus marginata</i>	573969	6126436	500	50	0	
<i>Eucalyptus marginata</i>	573996	6126531	500	50	0	
<i>Eucalyptus marginata</i>	573911	6126368	500	50	0	
<i>Eucalyptus marginata</i>	573829	6126336	500	50	0	
<i>Eucalyptus marginata</i>	573960	6126507	500	50	0	
<i>Eucalyptus marginata</i>	573819	6126433	500	50	0	
<i>Eucalyptus marginata</i>	573851	6126409	500	50	0	
<i>Eucalyptus marginata</i>	573832	6126377	500	50	0	
<i>Eucalyptus marginata</i>	574332	6128176	500	50	0	
<i>Eucalyptus marginata</i>	574317	6129017	500	50	0	
<i>Eucalyptus marginata</i>	574337	6128626	500	50	0	
<i>Eucalyptus marginata</i>	574236	6126685	510	50	0	
<i>Eucalyptus marginata</i>	574079	6126454	510	50	0	
<i>Eucalyptus marginata</i>	574047	6126461	510	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus marginata</i>	574038	6126430	510	50	0	
<i>Eucalyptus marginata</i>	574018	6126351	510	50	0	
<i>Eucalyptus marginata</i>	574001	6126484	510	50	0	
<i>Eucalyptus marginata</i>	573936	6126432	510	50	0	
<i>Eucalyptus marginata</i>	573914	6126422	510	50	0	
<i>Eucalyptus marginata</i>	573769	6126214	510	50	0	
<i>Eucalyptus marginata</i>	573827	6126363	510	50	0	
<i>Eucalyptus marginata</i>	574341	6128089	520	50	0	
<i>Eucalyptus marginata</i>	574008	6126397	520	50	0	
<i>Eucalyptus marginata</i>	574362	6125838	520	50	0	
<i>Eucalyptus marginata</i>	574070	6126512	520	50	0	
<i>Eucalyptus marginata</i>	573983	6126471	520	50	0	
<i>Eucalyptus marginata</i>	573732	6126914	520	50	0	
<i>Eucalyptus marginata</i>	573749	6126771	520	50	0	
<i>Eucalyptus marginata</i>	573825	6126770	520	50	0	
<i>Eucalyptus marginata</i>	573690	6126157	520	50	0	
<i>Eucalyptus marginata</i>	574321	6128115	530	50	0	
<i>Eucalyptus marginata</i>	574157	6126563	530	50	0	
<i>Eucalyptus marginata</i>	573755	6126290	530	50	0	
<i>Eucalyptus marginata</i>	573859	6126414	530	50	0	
<i>Eucalyptus marginata</i>	573822	6126407	530	50	0	
<i>Eucalyptus marginata</i>	574363	6128581	530	50	0	
<i>Eucalyptus marginata</i>	574367	6128124	540	50	0	
<i>Eucalyptus marginata</i>	574081	6126511	540	50	0	
<i>Eucalyptus marginata</i>	574090	6126618	540	50	0	
<i>Eucalyptus marginata</i>	578734	6124118	540	50	0	
<i>Eucalyptus marginata</i>	574125	6126550	540	50	0	
<i>Eucalyptus marginata</i>	573969	6126287	540	50	0	
<i>Eucalyptus marginata</i>	573734	6126758	540	50	0	
<i>Eucalyptus marginata</i>	573935	6126364	540	50	0	
<i>Eucalyptus marginata</i>	574016	6126619	540	50	0	
<i>Eucalyptus marginata</i>	573891	6126271	540	50	0	
<i>Eucalyptus marginata</i>	573802	6126271	540	50	0	
<i>Eucalyptus marginata</i>	573992	6126647	540	50	0	
<i>Eucalyptus marginata</i>	573915	6126439	540	50	0	
<i>Eucalyptus marginata</i>	573853	6126369	540	50	0	
<i>Eucalyptus marginata</i>	574135	6126437	540	50	0	
<i>Eucalyptus marginata</i>	574118	6126450	540	50	0	
<i>Eucalyptus marginata</i>	574404	6128379	540	50	0	
<i>Eucalyptus marginata</i>	574118	6126449	550	50	0	
<i>Eucalyptus marginata</i>	573974	6126365	550	50	0	
<i>Eucalyptus marginata</i>	573935	6126387	550	50	0	
<i>Eucalyptus marginata</i>	573865	6126341	550	50	0	
<i>Eucalyptus marginata</i>	573767	6126245	550	50	0	
<i>Eucalyptus marginata</i>	573743	6126243	550	50	0	
<i>Eucalyptus marginata</i>	573875	6126398	550	50	0	
<i>Eucalyptus marginata</i>	574144	6126440	550	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus marginata</i>	574157	6126458	550	50	0	
<i>Eucalyptus marginata</i>	574332	6128601	550	50	0	
<i>Eucalyptus marginata</i>	574351	6127582	550	50	0	
<i>Eucalyptus marginata</i>	573626	6126995	550	50	0	
<i>Eucalyptus marginata</i>	574295	6129238	550	50	0	
<i>Eucalyptus marginata</i>	574006	6126394	560	50	0	
<i>Eucalyptus marginata</i>	573987	6126464	560	50	0	
<i>Eucalyptus marginata</i>	574408	6125823	560	50	0	
<i>Eucalyptus marginata</i>	574230	6126013	560	50	0	
<i>Eucalyptus marginata</i>	574115	6126594	560	50	0	
<i>Eucalyptus marginata</i>	574041	6126474	560	50	0	
<i>Eucalyptus marginata</i>	574003	6126486	560	50	0	
<i>Eucalyptus marginata</i>	574008	6126535	560	50	0	
<i>Eucalyptus marginata</i>	573793	6126358	560	50	0	
<i>Eucalyptus marginata</i>	574307	6128519	560	50	0	
<i>Eucalyptus marginata</i>	573678	6126970	570	50	0	
<i>Eucalyptus marginata</i>	574092	6126363	570	50	0	
<i>Eucalyptus marginata</i>	573970	6126329	570	50	0	
<i>Eucalyptus marginata</i>	573970	6126400	570	50	0	
<i>Eucalyptus marginata</i>	573671	6126773	570	50	0	
<i>Eucalyptus marginata</i>	573831	6126219	570	50	0	
<i>Eucalyptus marginata</i>	573842	6126421	570	50	0	
<i>Eucalyptus marginata</i>	574298	6128020	570	50	0	
<i>Eucalyptus marginata</i>	574339	6128484	570	50	0	
<i>Eucalyptus marginata</i>	573676	6126966	570	50	0	
<i>Eucalyptus marginata</i>	574052	6126512	580	50	0	
<i>Eucalyptus marginata</i>	574045	6126515	580	50	0	
<i>Eucalyptus marginata</i>	573900	6126352	580	50	0	
<i>Eucalyptus marginata</i>	573884	6126421	580	50	0	
<i>Eucalyptus marginata</i>	574376	6128552	590	50	0	
<i>Eucalyptus marginata</i>	574340	6128072	590	50	0	
<i>Eucalyptus marginata</i>	574021	6126521	590	50	0	
<i>Eucalyptus marginata</i>	574227	6125602	590	50	0	
<i>Eucalyptus marginata</i>	574123	6126608	590	50	0	
<i>Eucalyptus marginata</i>	573810	6126433	590	50	0	
<i>Eucalyptus marginata</i>	574018	6126492	600	50	0	
<i>Eucalyptus marginata</i>	574428	6125870	600	50	0	
<i>Eucalyptus marginata</i>	573966	6126302	600	50	0	
<i>Eucalyptus marginata</i>	573819	6126761	600	50	0	
<i>Eucalyptus marginata</i>	573934	6126273	600	50	0	
<i>Eucalyptus marginata</i>	573803	6126214	600	50	0	
<i>Eucalyptus marginata</i>	574339	6127598	600	50	0	
<i>Eucalyptus marginata</i>	574333	6128501	600	50	0	
<i>Eucalyptus marginata</i>	574118	6126438	610	50	0	
<i>Eucalyptus marginata</i>	574031	6126322	610	50	0	
<i>Eucalyptus marginata</i>	573682	6126997	610	50	0	
<i>Eucalyptus marginata</i>	574053	6126384	610	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus marginata</i>	574069	6126421	610	50	0	
<i>Eucalyptus marginata</i>	573860	6126251	610	50	0	
<i>Eucalyptus marginata</i>	573804	6126270	610	50	0	
<i>Eucalyptus marginata</i>	578796	6124008	610	50	0	
<i>Eucalyptus marginata</i>	574074	6126436	620	50	0	
<i>Eucalyptus marginata</i>	574171	6126851	620	50	0	
<i>Eucalyptus marginata</i>	573716	6126268	630	50	0	
<i>Eucalyptus marginata</i>	573631	6126925	630	50	0	
<i>Eucalyptus marginata</i>	573918	6126271	630	50	0	
<i>Eucalyptus marginata</i>	573931	6126279	630	50	0	
<i>Eucalyptus marginata</i>	573775	6126234	630	50	0	
<i>Eucalyptus marginata</i>	573842	6126382	630	50	0	
<i>Eucalyptus marginata</i>	574200	6126562	630	50	0	
<i>Eucalyptus marginata</i>	574162	6126420	630	50	0	
<i>Eucalyptus marginata</i>	574316	6129140	630	50	0	
<i>Eucalyptus marginata</i>	573961	6126325	640	50	0	
<i>Eucalyptus marginata</i>	574233	6126509	640	50	0	
<i>Eucalyptus marginata</i>	573973	6126388	640	50	0	
<i>Eucalyptus marginata</i>	573743	6126767	640	50	0	
<i>Eucalyptus marginata</i>	573803	6126873	640	50	0	
<i>Eucalyptus marginata</i>	573914	6126376	640	50	0	
<i>Eucalyptus marginata</i>	573858	6126420	640	50	0	
<i>Eucalyptus marginata</i>	574330	6128583	640	50	0	
<i>Eucalyptus marginata</i>	574380	6128364	640	50	0	
<i>Eucalyptus marginata</i>	574411	6125862	650	50	0	
<i>Eucalyptus marginata</i>	574106	6126580	650	50	0	
<i>Eucalyptus marginata</i>	573983	6126477	650	50	0	
<i>Eucalyptus marginata</i>	573979	6126535	650	50	0	
<i>Eucalyptus marginata</i>	573701	6127000	650	50	0	
<i>Eucalyptus marginata</i>	573684	6126957	670	50	0	
<i>Eucalyptus marginata</i>	573712	6126995	670	50	0	
<i>Eucalyptus marginata</i>	574099	6126547	680	50	0	
<i>Eucalyptus marginata</i>	573960	6126360	680	50	0	
<i>Eucalyptus marginata</i>	573982	6126482	680	50	0	
<i>Eucalyptus marginata</i>	574011	6126527	680	50	0	
<i>Eucalyptus marginata</i>	573648	6126993	680	50	0	
<i>Eucalyptus marginata</i>	573847	6126780	680	50	0	
<i>Eucalyptus marginata</i>	573776	6126299	680	50	0	
<i>Eucalyptus marginata</i>	574341	6128603	680	50	0	
<i>Eucalyptus marginata</i>	574343	6125767	680	50	0	
<i>Eucalyptus marginata</i>	574075	6126514	690	50	0	
<i>Eucalyptus marginata</i>	573962	6126289	690	50	0	
<i>Eucalyptus marginata</i>	573642	6126955	690	50	0	
<i>Eucalyptus marginata</i>	576777	6124640	690	50	0	
<i>Eucalyptus marginata</i>	574327	6128050	710	50	0	
<i>Eucalyptus marginata</i>	574043	6126452	710	50	0	
<i>Eucalyptus marginata</i>	573969	6126377	710	50	0	

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus marginata</i>	573755	6126349	710	50	0	
<i>Eucalyptus marginata</i>	573707	6126937	710	50	0	
<i>Eucalyptus marginata</i>	574069	6126545	720	50	0	
<i>Eucalyptus marginata</i>	573751	6126781	720	50	0	
<i>Eucalyptus marginata</i>	573796	6126859	720	50	0	
<i>Eucalyptus marginata</i>	573865	6126315	720	50	0	
<i>Eucalyptus marginata</i>	574407	6128369	720	50	0	
<i>Eucalyptus marginata</i>	573608	6126973	730	50	0	
<i>Eucalyptus marginata</i>	573659	6126997	730	50	0	
<i>Eucalyptus marginata</i>	574093	6126419	730	50	0	
<i>Eucalyptus marginata</i>	573952	6126341	730	50	0	
<i>Eucalyptus marginata</i>	573699	6126975	730	50	0	
<i>Eucalyptus marginata</i>	573610	6126965	740	50	0	
<i>Eucalyptus marginata</i>	573657	6127035	740	50	0	
<i>Eucalyptus marginata</i>	574337	6128618	740	50	0	
<i>Eucalyptus marginata</i>	573650	6126966	740	50	0	
<i>Eucalyptus marginata</i>	574030	6126586	750	50	0	
<i>Eucalyptus marginata</i>	574020	6126525	760	50	0	
<i>Eucalyptus marginata</i>	574100	6126369	780	50	0	
<i>Eucalyptus marginata</i>	573646	6126990	790	50	0	
<i>Eucalyptus marginata</i>	574008	6126347	800	50	0	
<i>Eucalyptus marginata</i>	573954	6126434	800	50	0	
<i>Eucalyptus marginata</i>	574318	6127593	800	50	0	
<i>Eucalyptus marginata</i>	573971	6126456	800	50	0	
<i>Eucalyptus marginata</i>	574332	6128392	800	50	0	
<i>Eucalyptus marginata</i>	573766	6126796	810	50	0	
<i>Eucalyptus marginata</i>	578764	6124079	810	50	0	
<i>Eucalyptus marginata</i>	574406	6125789	820	50	0	
<i>Eucalyptus marginata</i>	574359	6128117	850	50	0	
<i>Eucalyptus marginata</i>	573707	6126985	880	50	0	
<i>Eucalyptus marginata</i>	574297	6127664	880	50	0	
<i>Eucalyptus marginata</i>	573844	6126769	920	50	0	
<i>Eucalyptus marginata</i>	573827	6126223	920	50	0	
<i>Eucalyptus marginata</i>	573659	6126974	1010	50	0	
<i>Eucalyptus marginata</i>	574352	6128119	1070	50	0	
<i>Eucalyptus marginata</i>	574029	6126497	1070	50	0	
<i>Eucalyptus marginata</i>	573645	6126999	1080	50	0	
<i>Eucalyptus marginata</i>	574282	6126311	1140	50	0	
<i>Eucalyptus marginata</i>	574314	6129139	650	50	0	
<i>Eucalyptus marginata</i>	573904	6126312	540	50	0	
<i>Eucalyptus marginata</i>	574339	6128403	600	50	0	
<i>Eucalyptus marginata</i>	574400	6128462	790	50	0	
<i>Eucalyptus marginata</i>	574340	6128303	710	50	0	
<i>Eucalyptus marginata</i>	573614	6126987	620	50	0	
<i>Eucalyptus marginata</i>	574418	6125899	500	50	1	100
<i>Eucalyptus marginata</i>	573749	6126274	500	50	1	100
<i>Eucalyptus marginata</i>	573915	6126281	550	50	1	100

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus marginata</i>	573866	6126429	550	50	1	100
<i>Eucalyptus marginata</i>	574342	6128483	560	50	1	100
<i>Eucalyptus marginata</i>	574232	6126686	570	50	1	100
<i>Eucalyptus marginata</i>	573954	6126483	570	50	1	100
<i>Eucalyptus marginata</i>	573900	6126425	590	50	1	100
<i>Eucalyptus marginata</i>	573744	6126341	590	50	1	100
<i>Eucalyptus marginata</i>	573673	6126332	600	50	1	100
<i>Eucalyptus marginata</i>	573728	6126252	610	50	1	100
<i>Eucalyptus marginata</i>	573977	6126491	620	50	1	100
<i>Eucalyptus marginata</i>	574382	6125900	670	50	1	100
<i>Eucalyptus marginata</i>	574345	6128471	690	50	1	100
<i>Eucalyptus marginata</i>	573929	6126292	730	50	1	100
<i>Eucalyptus marginata</i>	573772	6126285	740	50	1	100
<i>Eucalyptus marginata</i>	574281	6126287	870	50	1	100
<i>Eucalyptus marginata</i>	574116	6126441	610	50	1	100
<i>Eucalyptus marginata</i>	574318	6129210	580	50	1	100
<i>Eucalyptus marginata</i>	573764	6126210	590	50	2	100,100
<i>Eucalyptus marginata</i>	573756	6126282	540	50	2	100,100
<i>Eucalyptus marginata</i>	574349	6128450	610	50	4	100,100,200,200
<i>Eucalyptus marginata</i>	573945	6126386	900	50	4	100,100,200,200
<i>Eucalyptus marginata</i>	574341	6129177	500	50	2	100,150
<i>Eucalyptus marginata</i>	573790	6126257	690	50	2	100,150
<i>Eucalyptus marginata</i>	574366	6127579	1140	50	2	100,150
<i>Eucalyptus marginata</i>	573917	6126429	510	50	2	100,200
<i>Eucalyptus marginata</i>	573952	6126354	620	50	2	100,200
<i>Eucalyptus marginata</i>	574330	6128419	660	50	2	100,300
<i>Eucalyptus marginata</i>	573914	6126431	500	50	1	150
<i>Eucalyptus marginata</i>	573790	6126302	500	50	1	150
<i>Eucalyptus marginata</i>	574337	6127609	520	50	1	150
<i>Eucalyptus marginata</i>	574166	6126453	520	50	1	150
<i>Eucalyptus marginata</i>	573692	6126238	630	50	1	150
<i>Eucalyptus marginata</i>	574358	6128115	880	50	1	150
<i>Eucalyptus marginata</i>	574445	6125791	1010	50	1	150
<i>Eucalyptus marginata</i>	573852	6126313	500	50	2	150,100
<i>Eucalyptus marginata</i>	573833	6126403	510	50	2	150,100
<i>Eucalyptus marginata</i>	574413	6125855	700	50	2	150,150
<i>Eucalyptus marginata</i>	574396	6125868	500	50	2	150,150
<i>Eucalyptus marginata</i>	573843	6126408	520	50	2	150,150
<i>Eucalyptus marginata</i>	574330	6128419	580	50	2	150,150
<i>Eucalyptus marginata</i>	574288	6126331	930	50	2	150,150
<i>Eucalyptus marginata</i>	574333	6128180	960	50	2	150,150
<i>Eucalyptus marginata</i>	574337	6128594	1030	50	2	150,150
<i>Eucalyptus marginata</i>	573724	6126207	590	50	3	150,150,150
<i>Eucalyptus marginata</i>	574326	6128366	710	50	2	150,200
<i>Eucalyptus marginata</i>	574412	6125867	730	50	2	150,200
<i>Eucalyptus marginata</i>	573827	6126355	530	50	1	200
<i>Eucalyptus marginata</i>	574013	6126584	540	50	1	200

Flora_sp	Easting	Northing	DBH_mm	Zone	Hollow	Hollow_Sz
<i>Eucalyptus marginata</i>	573873	6126431	560	50	1	200
<i>Eucalyptus marginata</i>	574354	6128526	580	50	1	200
<i>Eucalyptus marginata</i>	573832	6126396	650	50	1	200
<i>Eucalyptus marginata</i>	574439	6125806	660	50	1	200
<i>Eucalyptus marginata</i>	574446	6125814	710	50	1	200
<i>Eucalyptus marginata</i>	574357	6128399	720	50	1	200
<i>Eucalyptus marginata</i>	574354	6128442	820	50	1	200
<i>Eucalyptus marginata</i>	574330	6128060	920	50	1	200
<i>Eucalyptus marginata</i>	573927	6126340	500	50	2	200,200
<i>Eucalyptus marginata</i>	573692	6126288	550	50	2	200,200
<i>Eucalyptus marginata</i>	573972	6126504	630	50	2	200,200
<i>Eucalyptus marginata</i>	573908	6126333	740	50	2	200,200
<i>Eucalyptus marginata</i>	573828	6126307	750	50	2	200,200
<i>Eucalyptus marginata</i>	573812	6126368	660	50	3	200,200,100
<i>Eucalyptus marginata</i>	573785	6126221	550	50	4	200,200,150,100
<i>Eucalyptus marginata</i>	574315	6129174	760	50	1	300
<i>Eucalyptus marginata</i>	574327	6128431	570	50	1	300
<i>Eucalyptus marginata</i>	573871	6126250	900	50	1	300
<i>Eucalyptus marginata</i>	574181	6126648	540	50	1	300
<i>Eucalyptus marginata</i>	574370	6128436	700	50	1	300
<i>Eucalyptus marginata</i>	573857	6126373	610	50	2	300,200
<i>Eucalyptus marginata</i>	573719	6126219	630	50	2	300,200
<i>Eucalyptus marginata</i>	574143	6126539	520	50	2	300,300
<i>Eucalyptus marginata</i>	573921	6126453	600	50	2	300,300
<i>Eucalyptus marginata</i>	573693	6126995	520	50	1	350
<i>Eucalyptus marginata</i>	573981	6126346	570	50	1	400
<i>Eucalyptus staeri</i>	574078	6126464	540	50	0	
<i>Eucalyptus staeri</i>	574342	6127597	560	50	0	
<i>Eucalyptus staeri</i>	574325	6127631	670	50	0	
<i>Eucalyptus staeri</i>	574084	6126480	890	50	0	
<i>Eucalyptus staeri</i>	574361	6127591	1080	50	0	

F4. Fauna observations.

Fauna_Hab	Description	Easting	Northing
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	574406	6125814
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	574388	6125848
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	574400	6125864
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	574420	6125872
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578404	6124615
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	576829	6124696
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578668	6124312
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578635	6124362
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578808	6124032
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	576798	6124627
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	576763	6124646
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578693	6124200
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578685	6124233
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578897	6123935
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578910	6123954

Fauna_Hab	Description	Easting	Northing
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	578929	6124005
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	579031	6123926
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	579071	6123901
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	579023	6123916
Baudin_feed	Baudin's Cockatoo feeding evidence, Marri nuts	579017	6123928
Bodensee	Baudin's Cockatoo see, flock of 1-15 seen flying over	575504	6130098
Baudin_seen	Baudin's Cockatoo see, flock of 1-15 feeding in Marri, approx. 50m SE of this point	575441	6130224
Bird	Whistling kite circling	574244	6125244
BTPhas_hollow	Potential Brush-tailed Phascogale hollow in Sheoak, wear marks.	573929	6126429
Bush_rat	Bush rat burrow system	579105	6123743
BushRat_tunnel	Bush rat tunnel entrance, possible	574030	6126560
Carns_feed	Carnaby's Cockatoo feeding evidence, Marri nuts	574406	6125799
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574383	6125798
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574651	6128299
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574517	6128299
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	575495	6124957
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	578343	6124336
Carns_feed	Carnaby's feeding evidence, Marri nuts	578658	6124287
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574329	6130082
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574333	6130067
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574332	6130050
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	578601	6124587
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	573865	6127024
Carns_feed	Carnaby's Cockatoo feeding evidence	576305	6124809
Carns_feed	Carnaby's Cockatoo feeding evidence	576265	6124814
Carns_feed	Carnaby's Cockatoo feeding evidence	576259	6124815
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576250	6124817
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576117	6124826
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576113	6124831
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576156	6124831
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576192	6124831
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576152	6124831
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576168	6124832
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576155	6124832
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576125	6124833
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576166	6124834
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576102	6124843
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576101	6124843
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576123	6124844
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	576069	6124861
Carns_feed	Carnaby's Cockatoo feeding evidence	574868	6125270
Carns_feed	Carnaby's Cockatoo feeding evidence	574869	6125289
Carns_feed	Carnaby's Cockatoo feeding evidence	574869	6125301
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574470	6125573
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574511	6125623
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574523	6125629
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574495	6125631
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574496	6125631
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574498	6125632
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574500	6125632
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574504	6125633
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574502	6125634
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574523	6125644
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574111	6126340
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574112	6126341
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574120	6126343
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574118	6126343
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574114	6126343

Fauna_Hab	Description	Easting	Northing
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574114	6126343
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574122	6126344
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574123	6126344
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574219	6126765
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574216	6126766
Carns_feed	Carnaby's Cockatoo feeding evidence	574812	6126815
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	573849	6126924
Carns_feed	Carnaby's Cockatoo feeding evidence, pine cones	574340	6128303
Feral_bees	Feral bees in hollow	578647	6124382
Feral_bees	Feral bees in hollow	576838	6124675
Feral_bees	Feral bees in hollow	574363	6125826
Frog_call	Crinea glauertii heard	574426	6125244
Frog_call	Crinea glauertii heard	575420	6130164
Hollow_bees	Hollow with bees	573873	6126431
Quenda_dig	Quenda diggings	574963	6130563
Quenda_dig	Quenda diggings	578939	6123944
Quenda_dig	Quenda diggings	578964	6123956
Quenda_dig	Quenda diggings	574563	6125468
Quenda_dig	Quenda diggings	574518	6125588
Quenda_dig	Quenda diggings	576318	6124801
Quenda_dig	Quenda diggings	574243	6127421
Quenda_dig	Quenda diggings	574299	6128049
Quenda_dig	Quenda diggings	578333	6124332
Quenda_dig	Quenda diggings, many	578680	6124247
Quenda_dig	Quenda diggings	578650	6124215
Quenda_dig	Quenda diggings	578813	6124314
Quenda_dig	Quenda diggings	578754	6124026
Quenda_dig	Quenda diggings	578783	6123956
Quenda_dig	Quenda diggings	578885	6123972
Quenda_dig	Quenda diggings	576730	6124709
Quenda_dig	Quenda diggings	576673	6124696
Quenda_dig	Quenda diggings	574391	6127562
Quenda_dig	Quenda diggings	576184	6124836
Quenda_dig	Quenda diggings	578508	6123816
Quenda_dig	Quenda diggings	575025	6130496
Quenda_dig	Quenda diggings	578867	6123941
Quenda_dig	Quenda diggings	578897	6123949
Quenda_dig	Quenda diggings	578936	6123927
Quenda_dig	Quenda diggings	578990	6123952
Quenda_dig	Quenda diggings	578993	6123927
Quenda_dig	Quenda diggings	579064	6123897
Quenda_dig	Quenda diggings	579040	6123905
Quenda_dig	Quenda diggings	578957	6123926
Quenda_dig	Quenda diggings	578917	6123992
Quenda_dig	Quenda diggings	579011	6123792
Quenda_dig	Quenda diggings	574898	6125120
Quenda_dig	Quenda diggings	574989	6125081
Quenda_dig	Quenda diggings	575061	6125053
Quenda_dig	Quenda diggings	575120	6125047
Quenda_dig	Quenda diggings	575130	6125022
Quenda_dig	Quenda diggings	575357	6124945
Quenda_dig	Quenda diggings	574806	6125162
Quenda_dig	Quenda diggings	574380	6125248
Quenda_dig	Quenda diggings	575421	6130167
Quenda_dig	Quenda diggings	575496	6130099
Quenda_skull	Quenda skull	574957	6130568
RTBC_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	574906	6125119
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Marri nuts	574374	6125799
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Marri nuts	574438	6125800

Fauna_Hab	Description	Easting	Northing
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Marri nuts	574230	6125923
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	574080	6126490
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	573891	6126841
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	573849	6126780
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Marri nuts	578693	6124199
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Marri nuts	576783	6124710
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Marri nuts	576775	6124662
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	576758	6124739
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	574307	6127630
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah and Marri nuts	574339	6127610
RTBlack_feed	Red-tailed Black Cockatoo feeding evidence, Jarrah nuts	574381	6127543
RTP_drey	Western Ringtail Possum drey, possible, in Taxandria about 8m high	574565	6125568
RTP_drey	Western Ringtail Possum drey in Taxandria	574527	6125609
RTP_drey	Western Ringtail Possum drey in Taxandria	574551	6125629
RTP_drey	Western Ringtail Possum drey in Taxandria	574538	6125619
RTP_drey	Western Ringtail Possum drey, half collapsed	574498	6125557
RTP_drey	Western Ringtail Possum dreys (2) in Victorian Tea Tree	578435	6124435
RTP_drey	Western Ringtail Possum drey in Victorian Tea Tree	578451	6124459
RTP_drey	Western Ringtail Possum drey in Taxandria	574237	6125297
RTP_drey	Western Ringtail Possum drey in Hakea ?florida, not occupied but intact, 2m up tree	574175	6126860
RTP_drey	Western Ringtail Possum drey in Sydney Golden Wattle, probably unoccupied	578754	6124166
RTP_drey	Western Ringtail Possum drey, collapsed	578689	6124271
RTP_drey	Western Ringtail Possum drey, 6m up in Acacia longifolia	578925	6123931
RTP_drey	Western Ringtail Possum drey, intact	574809	6125161
RTP_drey	Western Ringtail Possum drey, in Callistachys	574451	6125244
RTP_scats	Western Ringtail Possum scats, one seen in fork of Swamp Mahogany	574845	6125407
RTP_scats	Western Ringtail Possum scats, one seen	574545	6125642
RTP_scats	Western Ringtail Possum scats, one seen, in fork of Swamp Mahogany	574471	6125555
RTP_scats	Western Ringtail Possum scats, one seen	576308	6124803
RTP_scats	Western Ringtail Possum scats, one seen	576301	6124814
RTP_scats	Western Ringtail Possum scats, one seen	576251	6124815
RTP_scats	Western Ringtail Possum scats, one seen, under Victorian Tea Tree	576683	6124635
RTP_scats	Western Ringtail Possum scats, one seen, under Sheoak	574231	6125636
RTP_scats	Western Ringtail Possum scats, one seen, under Sheoak	574229	6125585
RTP_scats	Western Ringtail Possum scats, one seen	574226	6125514
RTP_scats	Western Ringtail Possum scats, one seen, under Sheoak	574335	6128302
RTP_scats	Western Ringtail Possum scats, one seen	574314	6128303
RTP_scats	Western Ringtail Possum scats, one seen	578380	6124566
RTP_scats	Western Ringtail Possum scats, one seen, on very large Eucalyptus botryoides	578274	6124486
RTP_scats	Western Ringtail Possum scats, one seen, under Peppermint	578285	6124499
RTP_scats	Western Ringtail Possum scats, one seen	578308	6124474
RTP_scats	Western Ringtail Possum scats, one seen	574485	6128301
RTP_scats	Western Ringtail Possum scats, one seen	574334	6128151
RTP_scats	Western Ringtail Possum scats, one seen	574329	6128581
RTP_scats	Western Ringtail Possum scats, one seen	574514	6125301
RTP_scats	Western Ringtail Possum scats, one seen	574334	6125299
RTP_scats	Western Ringtail Possum scats, one seen	574907	6125199
RTP_scats	Western Ringtail Possum scats,	575210	6125104
RTP_scats	Western Ringtail Possum scats, one seen	575669	6124924
RTP_scats	Western Ringtail Possum scats, one seen	576542	6124765
RTP_scats	Western Ringtail Possum scats	576777	6124633
RTP_scats	Western Ringtail Possum scats, one seen	574204	6126515
RTP_scats	Western Ringtail Possum scats, one seen	574173	6126438
RTP_scats	Western Ringtail Possum scats, one seen	574141	6126469
RTP_scats	Western Ringtail Possum scats large and small (7mm length)	574162	6126420
RTP_scats	Western Ringtail Possum scats, one seen	574132	6126519
RTP_scats	Western Ringtail Possum scats, one seen	574135	6126508
RTP_scats	Western Ringtail Possum scats, one seen	574103	6126486

Fauna_Hab	Description	Easting	Northing
RTP_scats	Western Ringtail Possum scats, one seen	574113	6126417
RTP_scats	Western Ringtail Possum scats, one seen	574070	6126390
RTP_scats	Western Ringtail Possum scats, one seen	574075	6126426
RTP_scats	Western Ringtail Possum scats, one seen	574094	6126530
RTP_scats	Western Ringtail Possum scats, one seen	574104	6126562
RTP_scats	Western Ringtail Possum scats large and small (7mm length)	574197	6126851
RTP_scats	Western Ringtail Possum scats, one seen	574144	6126856
RTP_scats	Western Ringtail Possum scats, one seen	573993	6126385
RTP_scats	Western Ringtail Possum scats, one seen	573991	6126360
RTP_scats	Western Ringtail Possum scats, one seen	573976	6126335
RTP_scats	Western Ringtail Possum scats, one seen	573974	6126420
RTP_scats	Western Ringtail Possum scats, small (7mm length)	573997	6126475
RTP_scats	Western Ringtail Possum scats, one seen	574022	6126522
RTP_scats	Western Ringtail Possum scats, small (7mm length)	573764	6126843
RTP_scats	Western Ringtail Possum scats large and small (7mm length)	573747	6126853
RTP_scats	Western Ringtail Possum scats, one seen	573743	6126871
RTP_scats	Western Ringtail Possum scats, one seen	573898	6126864
RTP_scats	Western Ringtail Possum scats, one seen	573913	6126870
RTP_scats	Western Ringtail Possum scats large and small (7mm length)	573918	6126856
RTP_scats	Western Ringtail Possum scats, many seen	573923	6126846
RTP_scats	Western Ringtail Possum scats, one seen	574299	6127696
RTP_scats	Western Ringtail Possum scats, one seen	574302	6127920
RTP_scats	Western Ringtail Possum scats, one seen	574304	6127983
RTP_scats	Western Ringtail Possum scats, one seen	573891	6126333
RTP_scats	Western Ringtail Possum scats, one seen	573909	6126291
RTP_scats	Western Ringtail Possum scats, one seen	573987	6126622
RTP_scats	Western Ringtail Possum scats, one seen	573966	6126601
RTP_scats	Western Ringtail Possum scats, one seen	573965	6126516
RTP_scats	Western Ringtail Possum scats, one seen	573797	6126408
RTP_scats	Western Ringtail Possum scats, one seen	573767	6126401
RTP_scats	Western Ringtail Possum scats, one seen	573755	6126381
RTP_scats	Western Ringtail Possum scats, one seen	573732	6126261
RTP_scats	Western Ringtail Possum scats large and small (7mm length)	573792	6126211
RTP_scats	Western Ringtail Possum scats, one seen	573862	6126243
RTP_scats	Western Ringtail Possum scats, one seen	573894	6126287
RTP_scats	Western Ringtail Possum scats, one seen	573904	6126439
RTP_scats	Western Ringtail Possum scats, one seen	573925	6126493
RTP_scats	Western Ringtail Possum scats, one seen	573957	6126577
RTP_scats	Western Ringtail Possum scats, one seen	573995	6126680
RTP_scats	Western Ringtail Possum scats, one seen	574170	6126637
RTP_scats	Western Ringtail Possum scats, small (<10mm length)	573997	6126696
RTP_scats	Western Ringtail Possum scats, one seen	573932	6126752
RTP_scats	Western Ringtail Possum scats, one seen	573916	6126708
RTP_scats	Western Ringtail Possum scats, one seen	573932	6126687
RTP_scats	Western Ringtail Possum scats, one seen	574236	6126638
RTP_scats	Western Ringtail Possum scats, one seen	578086	6124686
RTP_scats	Western Ringtail Possum scats	578754	6124134
RTP_scats	Western Ringtail Possum scats, many, in Victorian Tea Tree grove	578727	6124143
RTP_scats	Western Ringtail Possum scats	578711	6124149
RTP_scats	Western Ringtail Possum scats, one seen	578685	6124233
RTP_scats	Western Ringtail Possum scats, one seen	578809	6124143
RTP_scats	Western Ringtail Possum scats, one seen	578780	6124204
RTP_scats	Western Ringtail Possum scats, one seen	578812	6124157
RTP_scats	Western Ringtail Possum scats, small, old	578797	6124033
RTP_scats	Western Ringtail Possum scats, one seen	578775	6124041
RTP_scats	Western Ringtail Possum scats, one seen	578862	6124195
RTP_scats	Western Ringtail Possum scats, one seen	576831	6124682
RTP_scats	Western Ringtail Possum scats, one seen	576781	6124738
RTP_scats	Western Ringtail Possum scats, one seen	578657	6124283

Fauna_Hab	Description	Easting	Northing
RTP_scats	Western Ringtail Possum scats, one seen	578662	6124227
RTP_scats	Western Ringtail Possum scats, one seen, under Tuart	578655	6124122
RTP_scats	Western Ringtail Possum scats, one seen	578593	6124190
RTP_scats	Western Ringtail Possum scats, one seen	578637	6124306
RTP_scats	Western Ringtail Possum scats, one seen	578773	6124252
RTP_scats	Western Ringtail Possum scats, one seen	578598	6124392
RTP_scats	Western Ringtail Possum scats, one seen	578577	6124435
RTP_scats	Western Ringtail Possum scats, one seen	578760	6123991
RTP_scats	Western Ringtail Possum scats, one seen	578806	6123984
RTP_scats	Western Ringtail Possum scats, one seen	578809	6124013
RTP_scats	Western Ringtail Possum scats, one seen	578815	6124030
RTP_scats	Western Ringtail Possum scats, one seen	578883	6123995
RTP_scats	Western Ringtail Possum scats, one seen	576756	6124708
RTP_scats	Western Ringtail Possum scats	574384	6127573
RTP_scats	Western Ringtail Possum scats, one seen	574373	6127531
RTP_scats	Western Ringtail Possum scats, one seen	574355	6127535
RTP_scats	Western Ringtail Possum scats, one seen	574322	6127559
RTP_scats	Western Ringtail Possum scats, one seen	574311	6127574
RTP_scats	Western Ringtail Possum scats, one seen	574315	6127583
RTP_scats	Western Ringtail Possum scats, one seen	578507	6123816
RTP_scats	Western Ringtail Possum scats	578890	6124001
RTP_scats	Western Ringtail Possum scats	578871	6123966
RTP_scats	Western Ringtail Possum scats	578876	6123950
RTP_scats	Western Ringtail Possum scats	578912	6123954
RTP_scats	Western Ringtail Possum scats	578976	6123965
RTP_scats	Western Ringtail Possum scats	578982	6123954
RTP_scats	Western Ringtail Possum scats	579029	6123930
RTP_scats	Western Ringtail Possum scats	579059	6123916
RTP_scats	Western Ringtail Possum scats	579021	6123914
RTP_scats	Western Ringtail Possum scats	578982	6123795
RTP_scats	Western Ringtail Possum scats	579035	6123780
RTP_scats	Western Ringtail Possum scats	579059	6123766
RTP_scats	Western Ringtail Possum scats	579111	6123741
RTP_scats	Western Ringtail Possum scats	574905	6125124
RTP_scats	Western Ringtail Possum scats	574946	6125106
RTP_scats	Western Ringtail Possum scats	575015	6125066
RTP_scats	Western Ringtail Possum scats	575049	6125059
RTP_scats	Western Ringtail Possum scats	575367	6124943
RTP_scats	Western Ringtail Possum scats	574805	6125162
RTP_scats	Western Ringtail Possum scats	574752	6125188
RTP_scats	Western Ringtail Possum scats	574724	6125198

14 APPENDIX G - TPFL forms (see attached)

15 APPENDIX H - Naturemap and PMST search results (see attached)

NatureMap Species Report

Created By Guest user on 25/11/2019

Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)

Current Names Only Yes

Core Datasets Only Yes

Method 'By Line'

Vertices 34° 57' 38" S, 117° 48' 58" E 34° 57' 56" S, 117° 48' 50" E 34° 59' 05" S, 117° 48' 50" E 34° 59'

Group By 51° S, 117° 48' 50" E 34° 59' 51" S, 117° 48' 48" E 35° 00' 42" S, 117° 48' 48" E 35° 00' 43" S, 117° 49' 04" E 35° 00' 46" S, 117° 49' 11" E 35° 00' 46" S, 117° 49' 19" E 35° 00' 56" S, 117° 49' 43" E 35° 00' 59" S, 117° 50' 07" E 35° 00' 60" S, 117° 50' 17" E 35° 01' 05" S, 117° 50' 27" E 35° 01' 09" S, 117° 50' 36" E 35° 01' 09" S, 117° 50' 49" E 35° 01' 09" S, 117° 51' 03" E 35° 01' 11" S, 117° 51' 20" E 35° 01' 16" S, 117° 51' 29" E 35° 01' 15" S, 117° 51' 38" E Kingdom

Kingdom	Species	Records
Animalia	86	4193
Fungi	3	13
Plantae	64	390
TOTAL	153	4596

	Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Animalia					
1.	41323	<i>Actitis hypoleucos</i> (Common Sandpiper)		IA	
2.	25554	<i>Apus pacificus</i> (Fork-tailed Swift, Pacific Swift)		IA	
3.	24208	<i>Arctocephalus forsteri</i> (New Zealand Fur Seal, long-nosed fur-seal)		S	
4.	24209	<i>Arctocephalus tropicalis</i> (Subantarctic fur-seal)		T	
5.	41326	<i>Ardenna carneipes</i> (Flesh-footed Shearwater, Fleahy-footed Shearwater)		T	
6.	41328	<i>Ardenna tenuirostris</i> (Short-tailed Shearwater)		IA	
7.	25736	<i>Arenaria interpres</i> (Ruddy Turnstone)		IA	
8.	24358	<i>Atrichornis clamosus</i> (Noisy Scrub-bird, tjimiluk)		T	
9.	25450	<i>Balaenoptera musculus</i> (Blue Whale)		T	
10.	24048	<i>Balaenoptera musculus</i> subsp. <i>brevicauda</i> (Pygmy Blue Whale)		T	
11.	24162	<i>Bettongia penicillata</i> subsp. <i>ogilbyi</i> (Woylie, Brush-tailed Bettong)		T	
12.	24345	<i>Botaurus poiciloptilus</i> (Australasian Bittern)		T	
13.	24779	<i>Calidris acuminata</i> (Sharp-tailed Sandpiper)		IA	
14.	24780	<i>Calidris alba</i> (Sanderling)		IA	
15.	25738	<i>Calidris canutus</i> (Red Knot, knot)		IA	
16.	24784	<i>Calidris ferruginea</i> (Curlew Sandpiper)		T	
17.	24788	<i>Calidris ruficollis</i> (Red-necked Stint)		IA	
18.	24790	<i>Calidris tenuirostris</i> (Great Knot)		T	
19.	24731	<i>Calyptorhynchus banksii</i> subsp. <i>naso</i> (Forest Red-tailed Black Cockatoo)		T	
20.	24733	<i>Calyptorhynchus baudinii</i> (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)		T	
21.	24734	<i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)		T	
22.	48400	<i>Calyptorhynchus</i> sp. (white-tailed black cockatoo)		T	
23.	34034	<i>Carcharias taurus</i> (Grey Nurse Shark)		T	
24.	34031	<i>Carcharodon carcharias</i> (Great White Shark)		T	
25.	25335	<i>Caretta caretta</i> (Loggerhead Turtle)		T	
26.	25551	<i>Cereopsis novaehollandiae</i> (Cape Barren Goose)		T	
27.	25575	<i>Charadrius leschenaultii</i> (Greater Sand Plover)		T	
28.	25576	<i>Charadrius mongolus</i> (Lesser Sand Plover)		T	
29.	24440	<i>Dasyornis longirostris</i> (Western Bristlebird)		T	
30.	24092	<i>Dasyurus geoffroyi</i> (Chuditch, Western Quoll)		T	
31.	25346	<i>Dermochelys coriacea</i> (Leatherback Turtle)		T	
32.	30836	<i>Diomedea exulans</i> subsp. <i>exulans</i> (Snowy Albatross)		T	
33.	25290	<i>Elapognathus minor</i> (Short-nosed Snake)		P2	
34.	24043	<i>Eubalaena australis</i> (Southern Right Whale)		T	
35.	25624	<i>Falco peregrinus</i> (Peregrine Falcon)		S	

	Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
36.	24475	<i>Falco peregrinus subsp. macropus</i> (Australian Peregrine Falcon)		S	
37.	34026	<i>Galaxiella munda</i> (mud minnow, western dwarf galaxias)		T	
38.	34027	<i>Galaxiella nigrostriata</i> (Black-stripe Minnow, black-striped dwarf galaxias)		T	
39.	34030	<i>Geotria australis</i> (Pouched Lamprey)		P3	
40.	34115	<i>Helicarion castanea</i> (a helicarionid land snail)		X	
41.	24215	<i>Hydromys chrysogaster</i> (Water-rat, Rakali)		P4	
42.	48587	<i>Hydroprogne caspia</i> (Caspian Tern)		IA	
43.	33977	<i>Hylaeus globuliferus</i> (woolybush bee)		P3	
44.	48588	<i>Isodon fusciventer</i> (Quenda, southwestern brown bandicoot)		P4	
45.	24557	<i>Leipoa ocellata</i> (Malleefowl)		T	
46.	47983	<i>Lepidogalaxias salamandroides</i> (Salamanderfish)		T	
47.	30932	<i>Limosa lapponica</i> (Bar-tailed Godwit)		IA	
48.	25741	<i>Limosa limosa</i> (Black-tailed Godwit)		IA	
49.	24690	<i>Macronectes giganteus</i> (Southern Giant Petrel)		IA	
50.	24168	<i>Macrotis lagotis</i> (Bilby, Dalgyte, Ninu)		T	
51.	34033	<i>Nannatherina balstoni</i> (Balston's Pygmy Perch)		T	
52.	24210	<i>Neophoca cinerea</i> (Australian Sea-lion)		T	
53.	48022	<i>Notamacropus irma</i> (Western Brush Wallaby)		P4	
54.	24798	<i>Numenius madagascariensis</i> (Eastern Curlew)		T	
55.	25742	<i>Numenius phaeopus</i> (Whimbrel)		IA	
56.	24497	<i>Oceanites oceanicus</i> (Wilson's Storm-petrel)		IA	
57.	24328	<i>Oxyura australis</i> (Blue-billed Duck)		P4	
58.	48591	<i>Pandion cristatus</i> (Osprey, Eastern Osprey)		IA	
59.	24097	<i>Parantechinus apicalis</i> (Dibbler)		T	
60.	41348	<i>Pezoporus flaviventris</i> (Western Ground Parrot)		T	
61.	24663	<i>Phaethon rubricauda</i> (Red-tailed Tropicbird)		P4	
62.	48070	<i>Phascogale tapoatafa subsp. wambenger</i> (South-western Brush-tailed Phascogale, Wambenger)		S	
63.	24802	<i>Philomachus pugnax</i> (Ruff, reeve)		IA	
64.	24073	<i>Physeter macrocephalus</i> (Sperm Whale)		T	
65.	24843	<i>Plegadis falcinellus</i> (Glossy Ibis)		IA	
66.	24382	<i>Pluvialis fulva</i> (Pacific Golden Plover)		IA	
67.	24383	<i>Pluvialis squatarola</i> (Grey Plover)		IA	
68.	24166	<i>Pseudocheirus occidentalis</i> (Western Ringtail Possum, ngwayir)		T	
69.	24388	<i>Psophodes nigrogularis subsp. nigrogularis</i> (Western Whipbird (western heath))		T	
70.	24715	<i>Puffinus huttoni</i> (Hutton's Shearwater)		T	
71.	42358	<i>Rhincodon typus</i> (Whale Shark)		S	
72.	24145	<i>Setonix brachyurus</i> (Quokka)		T	
73.	48116	<i>Stercorarius antarcticus</i> (Brown Skua)		P4	
74.	34007	<i>Thalassarche chlororhynchos</i> (Atlantic Yellow-nosed Albatross)		T	
75.	44607	<i>Thalassarche melanophris</i> (Black-browed Albatross)		T	
76.	48597	<i>Thalasseus bergii</i> (Crested Tern)		IA	
77.	48135	<i>Thinornis rubricollis</i> (Hooded Plover, Hooded Dotterel)		P4	
78.	24803	<i>Tringa brevipes</i> (Grey-tailed Tattler)		P4	
79.	24806	<i>Tringa glareola</i> (Wood Sandpiper)		IA	
80.	24808	<i>Tringa nebularia</i> (Common Greenshank, greenshank)		IA	
81.	24809	<i>Tringa stagnatilis</i> (Marsh Sandpiper, little greenshank)		IA	
82.	44626	<i>Trioxa barrettiae</i> (Banksia brownii plant-louse)		T	
83.	24855	<i>Tyto novaehollandiae subsp. novaehollandiae</i> (Masked Owl (southwest))		P3	
84.	34113	<i>Westralunio carteri</i> (Carter's Freshwater Mussel)		T	
85.	41351	<i>Xenus cinereus</i> (Terek Sandpiper)		IA	
86.	42361	<i>Zephyrarchaea mainae</i> (Main's assassin spider)		T	
Fungi					
87.	45013	<i>Amanita drummondii</i>		P3	
88.	18016	<i>Degelia flabellata</i>		P2	
89.	18015	<i>Usnea pulvinata</i>		P1	
Plantae					
90.	14725	<i>Acacia ataxiphylla subsp. ataxiphylla</i>		P3	
91.	3497	<i>Acacia prismifolia</i>		X	
92.	16876	<i>Adenanthos x cunninghamii</i>		P4	
93.	23502	<i>Agrostocrinum scabrum subsp. littorale</i>		P2	
94.	6301	<i>Andersonia auriculata</i>		P3	
95.	6319	<i>Andersonia setifolia</i>		P3	
96.	41737	<i>Andersonia sp. Jamesii</i> (J. Liddelw 84)		P4	
97.	16997	<i>Andersonia sp. Mitchell River</i> (B.G. Hammersley 925)		P3	
98.	42820	<i>Astartea transversa</i>		P2	
99.	35317	<i>Austrostipa mundula</i>		P3	
100.	1806	<i>Banksia brownii</i> (Feather-leaved Banksia)		T	
101.	1818	<i>Banksia goodii</i> (Good's Banksia)		T	

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
102.	32085 <i>Banksia seneciifolia</i>		P4	
103.	32084 <i>Banksia serra</i> (Serrate-leaved Dryandra)		P4	
104.	1854 <i>Banksia verticillata</i> (Albany Banksia)		T	
105.	4412 <i>Boronia crassipes</i>		P3	
106.	14313 <i>Caladenia evanescens</i>		P1	
107.	13621 <i>Caladenia harringtoniae</i>		T	
108.	1213 <i>Calectasia cyanea</i> (Blue Tinsel Lily)		T	
109.	17705 <i>Chordifex abortivus</i>		T	
110.	13113 <i>Chorizema carinatum</i>		P3	
111.	14003 <i>Conospermum quadripetalum</i>		P2	
112.	14004 <i>Conospermum spectabile</i>		P2	
113.	1441 <i>Conostylis misera</i> (Grass Conostylis)		T	
114.	12935 <i>Corybas abditus</i>		P3	
115.	12946 <i>Corybas limpidus</i>		P4	
116.	13635 <i>Drakaea micrantha</i>		T	
117.	3096 <i>Drosera fimbriata</i> (Manypeaks Sundew)		P4	
118.	3117 <i>Drosera paleacea</i> (Dwarf Sundew)		P1	
119.	17744 <i>Gahnia sclerioides</i>		P4	
120.	6162 <i>Gonocarpus pusillus</i>		P4	
121.	6166 <i>Gonocarpus simplex</i>		P4	
122.	2790 <i>Gyrostemon thesioides</i>		P2	
123.	12908 <i>Isopogon buxifolius</i> var. <i>buxifolius</i>		P2	
124.	2242 <i>Isopogon uncinatus</i>		T	
125.	14631 <i>Juncus meianthus</i>		P3	
126.	5838 <i>Kunzea pauciflora</i>		P4	
127.	25863 <i>Lachnagrostis billardierei</i> subsp. <i>billardierei</i>		P3	
128.	3042 <i>Lepidium pseudotasmanicum</i>		P4	
129.	6355 <i>Leucopogon alternifolius</i>		P3	
130.	33379 <i>Leucopogon altissimus</i>		P3	
131.	6363 <i>Leucopogon bracteolaris</i>		P2	
132.	6384 <i>Leucopogon cymbiformis</i>		P2	
133.	6460 <i>Lysinema lasianthum</i>		P4	
134.	1662 <i>Microtis pulchella</i> (Beautiful Mignonette Orchid)		P4	
135.	33742 <i>Microtis quadrata</i>		P4	
136.	6722 <i>Myosotis australis</i> (Southern Forget-me-not)		P4	
137.	35396 <i>Poa billardierei</i>		P3	
138.	48478 <i>Prasophyllum paulinae</i> (Pauline's Laughing Leek Orchid)		P1	
139.	16269 <i>Schoenus</i> sp. <i>Grassy</i> (E. Gude & J. Harvey 250)		P2	
140.	4833 <i>Spyridium spadiceum</i>		P4	
141.	19704 <i>Stenanthemum sublineare</i>		P2	
142.	7686 <i>Stylidium articulatum</i> (Stout Triggerplant)		P2	
143.	7724 <i>Stylidium falcatum</i> (Slender Beaked Triggerplant)		P2	
144.	16859 <i>Synaphea incurva</i>		P3	
145.	2327 <i>Synaphea preissii</i>		P3	
146.	1717 <i>Thelymitra variegata</i> (Queen of Sheba)		P2	
147.	5090 <i>Thomasia multiflora</i>		P1	
148.	17049 <i>Thomasia purpurea</i> x <i>solanacea</i>		P1	Y
149.	5096 <i>Thomasia quercifolia</i> (Oak Leaved Thomasia)		P4	
150.	5100 <i>Thomasia solanacea</i>		P4	
151.	1336 <i>Thysanotus isantherus</i>		P4	
152.	12420 <i>Verticordia endlicheriana</i> var. <i>angustifolia</i>		P3	
153.	12424 <i>Verticordia fimbriolepis</i> subsp. <i>australis</i>		T	

Conservation Codes

T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.



EPBC Act Protected Matters Report

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

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

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 24/09/19 12:09:50

[Summary](#)

[Details](#)

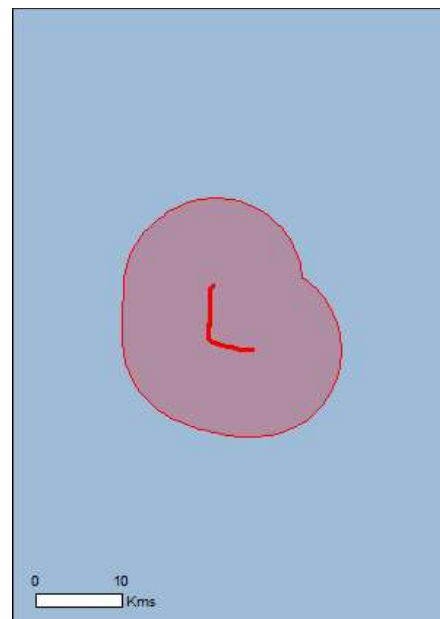
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are
©Commonwealth of Australia
(Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	62
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

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

Commonwealth Land:	3
Commonwealth Heritage Places:	None
Listed Marine Species:	90
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	10
Regional Forest Agreements:	None
Invasive Species:	27
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Proteaceae Dominated Kwongan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis longirostris Western Bristlebird [515]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Psophodes nigrogularis nigrogularis Western Heath Western Whipbird [64449]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Fish		
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat likely to occur within area
Insects		
Trioza barrettae Banksia brownii plant louse [87805]	Endangered	Species or species habitat known to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroi Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat known to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Banksia brownii Brown's Banksia, Feather-leaved Banksia [8277]	Endangered	Species or species habitat known to occur within area
Banksia goodii Good's Banksia [16727]	Vulnerable	Species or species habitat known to occur within area
Banksia verticillata Granite Banksia, Albany Banksia, River Banksia [8333]	Vulnerable	Species or species habitat likely to occur within area
Caladenia granitora [65292]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Caladenia harringtoniae Harrington's Spider-orchid, Pink Spider-orchid [56786]	Vulnerable	Species or species habitat known to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat known to occur within area
Chordifex abortivus Manypeaks Rush [64868]	Endangered	Species or species habitat likely to occur within area
Conostylis misera Grass Conostylis [21320]	Endangered	Species or species habitat likely to occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat known to occur within area
Isopogon uncinatus Albany Cone Bush, Hook-leaf Isopogon [20871]	Endangered	Species or species habitat known to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Sphenotoma drummondii Mountain Paper-heath [21160]	Endangered	Species or species habitat may occur within area
Verticordia fimbrilepis subsp. australis Southern Shy Featherflower [24630]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land

[[Resource Information](#)]

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

Name

Commonwealth Land -
Defence - ALBANY TRAINING DEPOT
Defence - ALBANY TRAINING DEPOT ; AIRTC ALBANY

Listed Marine Species

[[Resource Information](#)]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area

Name	Threatened	Type of Presence
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within

Name	Threatened	Type of Presence area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area

Name	Threatened	Type of Presence
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species

Name	Threatened	Type of Presence
Phycodurus eques Leafy Seadragon [66267]		habitat may occur within area Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Whales and other Cetaceans		
		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within

Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	area Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Down Road	WA
Gledhow	WA
Lake Powell	WA
Marbelup	WA
Mill Brook	WA
Mistaken Island	WA
Phillips Brook	WA
Torndirrup	WA
Unnamed WA23088	WA
Unnamed WA33308	WA

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

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom		Species or species habitat likely to occur

Name	Status	Type of Presence
[20126] Genista sp. X Genista monspessulana Broom [67538]		within area Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large- leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands		[Resource Information]
Name		State
Oyster Harbour		WA

Caveat

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

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

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

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

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-34.963858 117.820552,-34.96428 117.819522,-34.967586 117.8142,-34.982847 117.814114,-34.997895 117.814029,-34.998458 117.813428,-35.006894 117.813514,-35.008923 117.81344,-35.009872 117.813698,-35.011243 117.816015,-35.012157 117.817303,-35.01286 117.819362,-35.014441 117.823997,-35.01539 117.827087,-35.016585 117.834726,-35.017007 117.837087,-35.017569 117.839404,-35.018272 117.841464,-35.018975 117.84421,-35.019256 117.8473,-35.019397 117.851592,-35.019538 117.860518

Acknowledgements

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

- [Office of Environment and Heritage, New South Wales](#)
- [Department of Environment and Primary Industries, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment, Water and Natural Resources, South Australia](#)
- [Department of Land and Resource Management, Northern Territory](#)
- [Department of Environmental and Heritage Protection, Queensland](#)
- [Department of Parks and Wildlife, Western Australia](#)
- [Environment and Planning Directorate, ACT](#)
- [Birdlife Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [South Australian Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- [Australian Tropical Herbarium, Cairns](#)
- [eBird Australia](#)
- [Australian Government – Australian Antarctic Data Centre](#)
- [Museum and Art Gallery of the Northern Territory](#)
- [Australian Government National Environmental Science Program](#)
- [Australian Institute of Marine Science](#)
- [Reef Life Survey Australia](#)
- [American Museum of Natural History](#)
- [Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

Appendix D – *Prasophyllum paulinae*, Targeted
Regional Flora Survey (Southern Ecology, 2020c)

Prasophyllum paulinae
Targeted Regional Flora Survey



Report prepared for
Main Roads Western Australia
January 2020

Damien Rathbone | Ecologist



Assessment for:

Main Roads Western Australia

Prepared by:

Southern Ecology

© DA Rathbone 2020. Reproduction of this report and maps in whole or in part is prohibited without the approval of the author or the client. The information provided within this report is accurate and correct to the best of the author's knowledge. No liability is accepted for loss, damage or injury arising from its use. The report should be read, distributed and referred to in its entirety.

Rev. No.	Date	Author	File Name
Draft (Rev A)	24/01/2020		
Draft (Rev B)	11/02/2020		
Final (Rev 0)	17/02/2020		

REPORT CONTENTS

1	SUMMARY	4
2	INTRODUCTION.....	5
2.1	<i>Background</i>	5
2.2	<i>Scope of Works</i>	5
3	METHODS.....	6
3.1	<i>Desktop Assessment</i>	6
3.2	<i>Targeted Flora Search</i>	6
3.3	<i>Survey Limitations.....</i>	7
4	DESKTOP RESULTS	9
4.1	<i>Population Information</i>	9
4.2	<i>Previous Surveys.....</i>	9
4.3	<i>Habitat Characteristics.....</i>	10
4.4	<i>Identification of Regional Survey Areas.....</i>	13
4.5	<i>Potential habitat in the Albany Ring Road Project area.....</i>	13
5	FIELD SURVEY RESULTS.....	15
5.1	<i>2019 Field Survey Results</i>	15
5.2	<i>Morphological Trait Assessment</i>	16
5.3	<i>Population Estimate of <i>Prasophyllum paulinae</i></i>	20
6	CONCLUSIONS.....	22
7	REFERENCES	23
8	Appendix A - Survey Site Maps.....	23

1 SUMMARY

Prasophyllum paulinae is a geographically restricted orchid taxon, listed as Priority 1 by the Department of Biodiversity, Conservation and Attractions (DBCA) and has historically been recorded within the Albany Ring Road Project area. It is known only from two populations over a range of 20 km and is a tuberous orchid, which is presumed to only exhibit annual above-ground leaves and flowers during spring for several years after its habitat is disturbed by fire. To provide contextual information on potential impacts, Southern Ecology was engaged to complete a desktop assessment to identify suitable areas of habitat for *P. paulinae* and to conduct additional targeted surveys within the regional distribution of *P. paulinae* and within the Albany Ring Road project area.

The desktop assessment identified the habitat of *P. paulinae* to most likely be associated with recently burnt vegetation that aligns with two Albany Regional Vegetation Mapping Units (*Taxandria juniperina* Closed Forest (ARVS Unit 59) and *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (ARVS Unit 47). These units occupy 19.25 ha of the Albany Ring Road Project area and a total of 2,861 ha are mapped within the Albany Region (Sandiford and Barrett 2010). An analysis of available fire history information and historic aerial photographs indicated approximately 391 ha of these vegetation units occur within the range of *Prasophyllum paulinae* (± 15 km) and have been burnt since 2014. These areas were targeted for regional survey in October 2019.

Representative *Prasophyllum* specimens were collected over a range of sites to assess the application of the published description of *P. paulinae* (Jones and Clement 1996). The key diagnostic morphological characters that distinguish *P. paulinae* from the allied *P. macrostachyum* were assessed on a subset of 22 freshly collected specimens.

The assessment determined that five specimens (from one new population) exhibited all of the characters that align with *P. paulinae*. However, many specimens showed a combination of characters from both species (*P. paulinae* and *P. macrostachyum*) and several of the qualitative characters could potentially be influenced by the environment. The results of the morphological assessment were concordant with the findings of others and demonstrated inconsistencies in the taxonomy and the need for a broader reassessment of the group. Andrew Brown (ex. DBCA expert in Orchidaceae) viewed the specimens collected in this study and supported our interpretation of the taxonomy (Andrew Brown pers. comm.).

The desktop, field surveys and morphological assessment identified a new previously unknown population outside the Albany Ring Road Project area, estimated to comprise 50 plants and occupy 0.45 ha. No extant individuals were found in either of the two previously known populations during the targeted survey, presumably due to the absence of recent fire. Historical photos indicate population one occupies approximately 1.04 ha of the Albany Ring Road Project area. Whilst no individuals of *P. paulinae* have been recorded from this location despite extensive survey effort (spring 2017, 2018 and 2019), there remains the possibility for the taxon to emerge after fire.

Targeted searches in areas containing suitable habitat for *P. paulinae* within the Albany Ring Road Project area did not identify any individuals of the taxon (See main report). These areas have been subject to survey effort in 2017, 2018 and 2019, however are long-unburnt and some are highly degraded.

2 INTRODUCTION

2.1 Background

Main Roads Great Southern Region are proposing to construct a heavy haulage route around the City of Albany for the transport of materials to the City's port, called the Albany Ring Road Project. The project is a staged development to support freight growth and long-term transport needs in the City of Albany in Western Australia. The project will connect Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road allowing access to the Southern Ports Authority Albany Port (Figure 1). Stage one of the project, the construction and upgrade of Menang Drive to Chester Pass Road to Albany Highway was completed in 2017. Stages two and three are proposed.

Southern Ecology assessed a broad project envelope for potential environmental constraints for the project in 2017 (Rathbone and Gilfillan 2018), which identified that a Priority 1 listed taxon, *Prasophyllum paulinae*, was known to occur. The taxon was named in dedication to the late Pauline Herberle (Jones and Clements 1996). It is known only from two populations over a range of 20 km and is a tuberous orchid, which is presumed to only exhibit annual above-ground leaves and flowers during spring for several years after its habitat is disturbed by fire.

2.2 Scope of Works

To provide contextual information on the potential project impacts on this taxon, Southern Ecology was engaged by Main Roads to complete a desktop assessment to identify suitable areas of habitat for *P. paulinae* and to conduct additional targeted surveys within the regional distribution of *P. paulinae* and within the Albany Ring Road Project area. The outcomes of the desktop assessment and field surveys will be used to inform the environmental assessment and approvals process.

This report presents the results from the desktop assessment and targeted regional flora survey and should be read in conjunction with the detailed survey report of the project's biological survey area.

3 METHODS

3.1 Desktop Assessment

A desktop assessment of known populations of *P. paulinae* was undertaken using the following sources:

- Priority flora records from the Department of Biodiversity, Conservation and Attractions [DBCA].
- Voucher label information of specimens housed in the Western Australian Herbarium [WAH].
- The published description of *P. paulinae* (Jones and Clements 1996).

Extrapolation of potential habitat and potentially suitable areas for survey proposed for 2019 was undertaken using the following sources:

- Regional vegetation mapping (Sandiford and Barrett 2010).
- Fire history information (provided by DBCA and verbal communication from LGA's).
- Current and historic aerial photographs (Provided by Landgate and Main Roads Western Australia).

The results of the desktop assessment identified the regional survey should occur within the peak flowering period in mid-October, in the following locations:

- Re-survey of previously known populations (Gledhow and Two Peoples Bay) to confirm total number of extant individuals.
- Targeted regional survey of potential habitat within the six locations mapped in the desktop assessment (approx. 321 ha, plus 19.25 ha in the Albany Ring Road Project area).

3.2 Targeted Flora Search

A targeted search for *Prasophyllum paulinae* was undertaken within areas identified from the desktop assessment. In accordance with the EPA (2016) document, *Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment*, areas were initially surveyed via a meandering traverse to identify habitat areas and other colonies of orchids (i.e. other *Prasophyllum* species). Where habitat was identified, a more intensive overlay of meandering transects was surveyed. Where identified, population census and site information of was recorded in accordance with the Threatened & Priority Flora (TPFL) Database Manual (Department of Environment and Conservation [DEC] 2010). Population size was determined by either direct counts, or by estimation of plant density using transects or suitably sized quadrats.

3.3 Survey Limitations

In accordance with the EPA (2016) document *Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment*, an assessment of potential survey limitations was undertaken (Table 1).

Table 1. Assessment of potential survey limitations (EPA 2016).

Potential for Limitation	Assessment
Availability of contextual information	Regional vegetation mapping and flora records were available to allow for an appropriate level of contextual information prior to the field survey.
Personnel experience	The field assessment was conducted by Damien Rathbone (SL012382) and Keith Smith. Personnel undertaking the survey have in excess of 10 years' experience in botanical assessments within southern bioregions of WA. Damien has over 14 years of experience conducting biological surveys in southern Western Australia. Within the South Coast region, he has previously undertaken DBCA regional surveys (Albany Regional Vegetation Survey, Fitzgerald River National Park Flora Survey, Ravensthorpe Range Flora Survey), threatened species survey and recovery implementation, and has 10 scientific publications. Keith Smith is a local orchid expert and has previously surveyed and monitored <i>P. paulinae</i> (Population 2 at Two Peoples Bay) for the DBCA.
Identification issues	The taxonomy of <i>Prasophyllum</i> taxa is complex. Andrew Brown (ex. DBCA expert in Orchidaceae) has been consulted with and has provided guidance in relation to the taxonomy of the group. Specimens of possible <i>P. paulinae</i> were collected during the survey for further analysis and verification (see section 5.2 for further discussion).
Extent of survey and site access	The area of survey is relatively large, but is mostly accessible. No access issues were encountered during the field survey of the regional survey sites.
Survey intensity	Survey intensity at all regional survey sites was considered appropriate for the purpose of the survey. Survey effort included six person days using two senior botanists.
Survey timing	The survey was conducted in late October, which is considered appropriate for the <i>P. paulinae</i> . All vouchers of the taxon have been collected between 18-26 October 2019. Due to dry seasonal conditions a slight shift to early flowering may be expected. Survey timing was adjusted to account for possible early flowering.
Seasonal conditions	Below average rainfall has occurred for the year to date; therefore, it is anticipated that orchids may flower poorly and/or earlier than anticipated (Figure 1). Survey timing was adjusted to account for possible early flowering.
Disturbances	The time since previous fire is < 6 years in all areas proposed. Recent fire is considered an essential disturbance to detect <i>P. paulinae</i> .

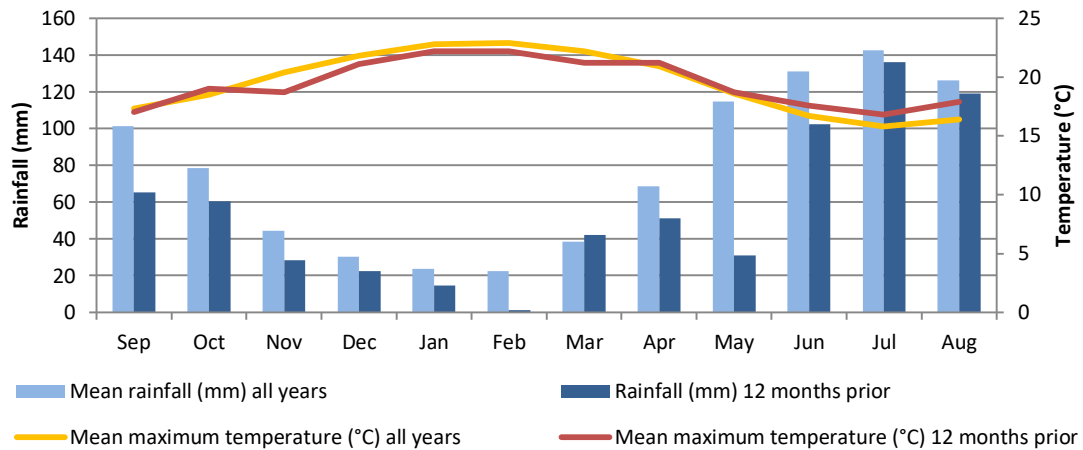


Figure 1. Climate statistics for 12 months prior (Sept 2018 - August 2019) to the assessment compared with historical averages (all years available) from the nearest weather station (Albany 9500) (BOM 2019). Total rainfall for 12-month period prior to the survey was 674 mm compared to the historic average of 922 mm.

4 DESKTOP RESULTS

4.1 Population Information

The first voucher and type specimens of *Prasophyllum paulinae* were collected in 1988 and 1993, respectively, from a regenerating swamp on private property (P222501) that occurs within the Albany Ring Road Project area (Table 2). The taxon was named in dedication to the late Pauline Herberle (Jones and Clements 1996), the family of whom owned the property up until 2018. The precise location of the early collections is uncertain due to inaccurate geo-tags, but was noted to be locally frequent within a degraded swamp with black, peaty, alkaline soil on the Heberle's property (Lot 53 Frederick Street, Gledhow; WAH Accession no. 04514238). A large area of regenerating wetland vegetation and seasonally inundated firebreaks occur at the southern end of the Herberle's property, which is considered the most likely location of the early collections of *P. paulinae*.

Prasophyllum paulinae is also known from a second population in a peat wetland at Two Peoples Bay, east of Albany (Table 2). Population monitoring after a fire in 2010, indicates it co-occurred with other *Prasophyllum* species and that numbers peaked (over 100 individuals) two years after the fire, then declined thereafter. The last plants (23 individuals) were seen in 2015 (Anna de Haan pers. com.).

Table 2. Voucher label information of specimens of *Prasophyllum paulinae* housed at the Herbarium of Western Australia from each known population.

Collection Details	Location	Site	Vegetation
Population 1 "Gledhow"			
22/10/1988 (PERTH 04514238, Sherwood, M.)	R. Heberle's property, Frederick Street, Gledhow.	Soil, sand.	In association with <i>Eucalyptus</i> sp. and <i>Agonis</i> sp.
20/10/1993 (PERTH 05724015, Jones, D.L.; Heberle, R.)	Cuthbert, near Albany, Darling district.	Gentle slope. Black, peaty, alkaline soil; degraded swamp.	Grasses and herbs.
Population 2 "Two Peoples Bay"			
26/10/2012 (Two duplicates PERTH 08674914 and 08674922, Barrett, S.; Smith, K.)	Reserve 24991, adjacent to Two Peoples Bay Nature Reserve, N of Two Peoples Bay Road.	Winter wet flat/drainage line. Peaty sand. Burnt Dec. 2011, hot fire.	<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket (ARVS Unit 47). With <i>Astartea corniculata</i> , <i>Sphaerolobium rostratum</i> , <i>S. fornicatum</i> , <i>Sphenotoma gracilis</i> , <i>Empodisma gracillimum</i> , <i>Gymnoschoenus anceps</i> , <i>Diaspasis filifolia</i> , <i>Drosera sulphurea</i> , <i>Prasophyllum fimbria</i> , <i>P. macrostachyum</i> , <i>P. cucullatum</i> .

4.2 Previous Surveys

No systematic regional survey for *Prasophyllum paulinae* has previously been conducted. Opportunistic surveys have been conducted by volunteers with the Adopt an Orchid Program and by the DBCA, however its taxonomy is complex and its habitat is often challenging to access.

The taxon was reported to be relatively common when it was first collected from degraded swamps in Gledhow. However, it has not been recorded from that location since the first collections were made. Extensive survey was undertaken of the Herberle's property over several days in spring 2017 and 2018 in association with biological surveys for the Albany Ring Road Project. All suitable habitat was occupied by a common congener, *Prasophyllum macrostachyum*, and no individuals concordant with the

description of *P. paulinae* were detected. It was concluded that failure to detect *P. paulinae* in two survey seasons did not exclude its presence from the previously known habitat and its absence may be largely due to the long period since disturbance by fire. There remains the possibility for the taxon to emerge at that location in future years, particularly after a fire event.

The second known population in a peat wetland at Two Peoples Bay, east of Albany (Population 2) was discovered by Anna de Haan during opportunistic surveys undertaken through the Adopt an Orchid Program in 2010-11, which was followed up with surveys of the population by the DBCA.

4.3 Habitat Characteristics

The putative location of the known population of *P. paulinae* at Gledhow (population 1) is currently composed of a tall, long unburnt (>20 years) closed forest of *Taxandria juniperina* and *Homalospermum firmum* (Plate 1). The vegetation at this site currently aligns with the regional vegetation mapping units *Taxandria juniperina* Closed Forest (ARVS Unit 59) and *Homalospermum firmum/Callistemon glaucus* Peat Thicket (ARVS Unit 49) (Plate 1). These are closely related vegetation units that may represent post fire seral stages, with *Taxandria juniperina* Closed Forest representing the climax community. At the time of the species discovery, the site was reported to be relatively open compared to the current vegetation structure, due to recently clearing or burning. Historic aerial photography from the site in 1961 (Figure 2) illustrates the general area was largely cleared and that a wet depression was evident that extended east of the Heberle's Property.

The second known population of *P. paulinae* at Two Peoples Bay (population 2) is composed of *Homalospermum firmum/Callistemon glaucus* Peat Thicket (ARVS Unit 47) (Plate 2) with other wetland species noted, including *Astartea corniculata*, *Sphaerolobium rostratum*, *S. fornicatum*, *Sphenotoma gracilis*, *Empodisma gracillimum*, *Gymnoschoenus anceps*, *Diaspasis filifolia*, *Drosera sulphurea*, *Prasophyllum fimbria*, *P. macrostachyum*, *P. cucullatum*. The site was burnt in a high intensity fire in December 2011.

Based on the existing desktop information the suitable habitat of *P. paulinae* is most likely to be associated with recently burnt areas of *Taxandria juniperina* Closed Forest (ARVS Unit 59) and *Homalospermum firmum/Callistemon glaucus* Peat Thicket (ARVS Unit 47). However, it is acknowledged that the taxon's specific habitat may only occur within a subset of the area mapped as these units and that it could be absent from suitable habitat due to historic reasons (has failed to disperse to the habitat or has become locally extinct).

It has also been noted in the taxon description and voucher labels that a common congener, *P. macrostachyum* is present at both populations; growing in similar swampy environments but with *P. macrostachyum* occurring in wetter conditions than *P. paulinae*, often growing with the base of the plants submerged. *Prasophyllum paulinae* is similar to *P. macrostachyum* but is much more robust with stouter stems and leaves, more numerous, crowded flowers in a sub-pyramidal spike, longer ovaries, shorter, broader lateral sepals and a broadly elliptic-obovate, obtuse labellum with a much thicker-textured callus (Jones and Clement 1996).



Plate 1. Likely habitat of *P. paulinae* (P1) at population 1; *Taxandria juniperina* Closed Forest (ARVS Unit 59).



Plate 2. Example of habitat of *P. paulinae* (P1) at population 2; *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (ARVS Unit 47).



Figure 2. Aerial photograph (1960) of the Herberle's Property (lot 53 Frederick St, Gledhow), where *P. paulinae* was first collected (Population 1).

4.4 Identification of Regional Survey Areas

An analysis of available fire history information and historic aerial photographs indicated approximately 391 ha of potentially suitable vegetation (ARVS units 47 and 59) occurs within the range of *Prasophyllum paulinae* (estimated as a 15 km radius from known populations) that has been burnt since 2014 (Table 3, Figure 3). Six sites are identified where the species has not previously been recorded, but it is considered possible to occur (Figure 3).

Table 3. Extent (ha) regional mapping units and fire history considered likely to be associated with the habitat of *P. paulinae*. Some areas occur as part of a mosaic mapping unit, which has been accounted for in the analysis.

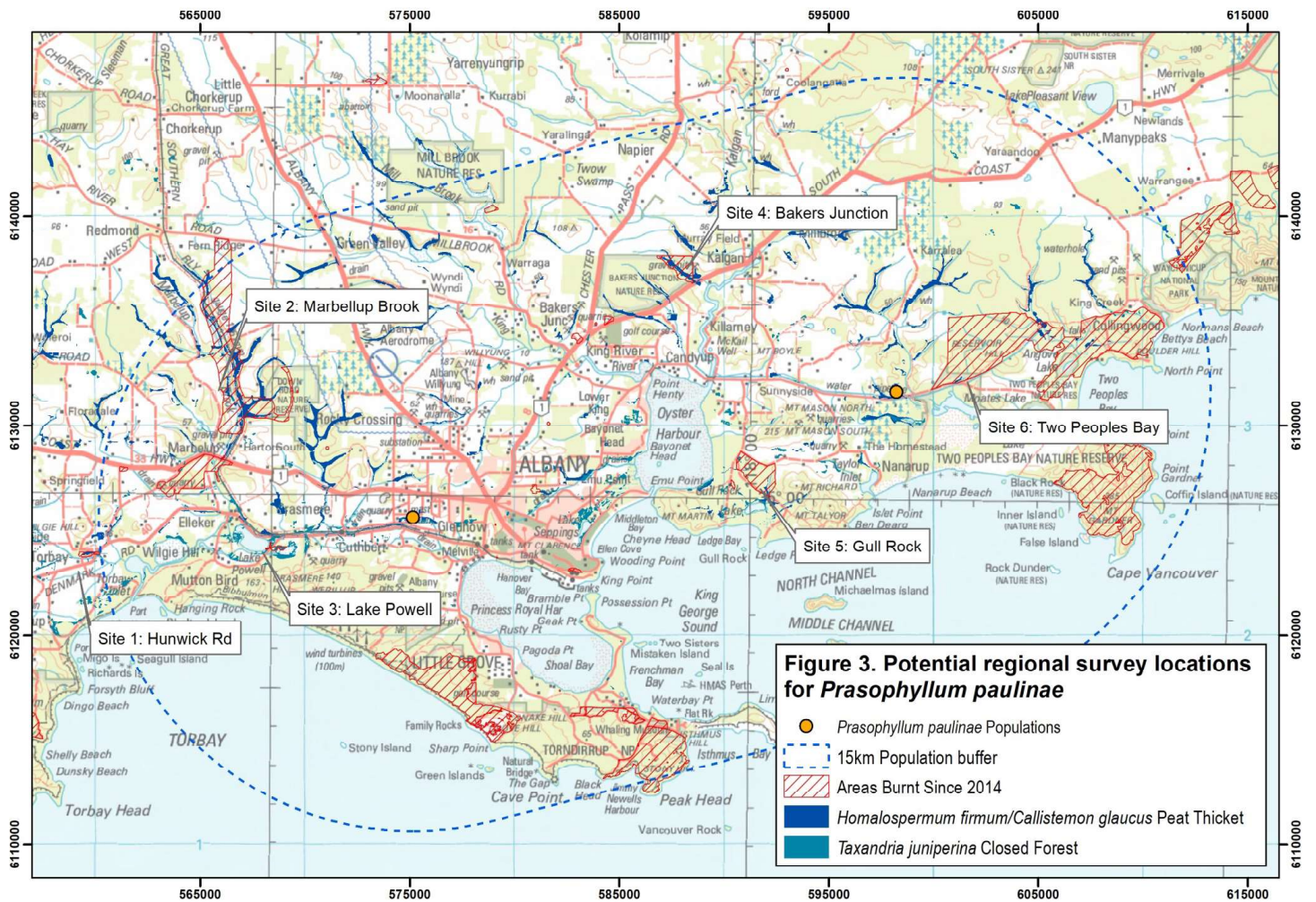
Vegetation Association	Total in ARVS (% in IUCN Reserves)	Area burnt since 2014 and within 15km of known population
<i>Homalospermum firmum</i> /Callistemon glaucus Peat Thicket (ARVS Unit 47)	2082 (12.6%)	321
<i>Taxandria juniperina</i> Closed Forest (ARVS Unit 59)	779 (9.9%)	70

4.5 Potential habitat in the Albany Ring Road Project area

Approximately 19.25 ha of long-unburnt vegetation within the Albany Ring Road Project aligns with habitats considered suitable for *Prasophyllum paulinae* (Table 4). Extensive targeted surveys have previously been conducted (2017 and 2018) within these areas, in which no individuals were recorded. As these areas have not been recently burnt and some are highly degraded, survey limitations are present. The previously known location of *P. paulinae* from within the project area occupies an area 1.04 ha, which has been deduced through assessment of historical aerial photos (Figure 2). A small reserve (R46057; 1.8 ha) east of the project area also has suitable wetland vegetation in Excellent condition (however is also long unburnt) and is contiguous with vegetation from the previously known population site.

Table 4. Extent (ha) condition (EPA 2016) of vegetation units suitable for *Prasophyllum paulinae* in the Albany Ring Road Project area.

Vegetation Association	Condition					Total
	Completely Degraded	Degraded	Good	Very Good	Excellent	
<i>Homalospermum firmum</i> /Callistemon glaucus Peat Thicket	1.93	1.68		1.96	4.96	10.53
<i>Taxandria juniperina</i> Closed Forest	4.44	1.48	0.05	2.75		8.72
	6.37	3.16	0.05	4.71	4.96	19.25



5 FIELD SURVEY RESULTS

5.1 2019 Field Survey Results

Field assessments of the proposed regional survey sites, a subset of the habitat in the project area and other opportunistic locations were undertaken (six person days) by two senior botanists on the 16-18 of October 2019. Of the 19.25 ha of potentially suitable within the Albany Ring Road project area, only the previously known population and selected areas were revisited. Areas targeted were road edges, slashed areas and dam walls where inter-fire germination of orchids may occur due to localised disturbance.

All of the survey efforts (GPS track log) are shown in Appendix A. A summary of the field observations and habitat suitability for each site are presented in Table 5.

Table 5. Field observations of *P. paulinae* survey sites. Mapping of survey effort and population information provided in Appendix A.

Site	Location	Date	Survey Notes
Gledhow (Population 1) and surrounds (Lot 50 and 53 Frederick St, Lot 64 Cuming Rd, Reserve 46057, Lower Denmark Rd, Link Rd).	Known population in ARR project area and surrounding areas	18 th October	No areas recently burnt therefore survey targeted firebreaks and slashed areas. Several <i>Prasophyllum</i> collections made for analysis. Collections made from Lot 64 Cuming Rd occur in a large fenced area owned by Broadcast Australia, this area is regularly slashed and is not mapped as remnant vegetation.
Link Rd Wetlands	ARR project area	18 th October	Large wetland area mostly long unburnt. Considered suitable habitat if burnt in the future. Survey undertaken of slashed areas, dams and roadsides where inter-fire germination is possible. No <i>Prasophyllum</i> species observed.
Two Peoples Bay (Population 2)	Known Population	16 th October	Large wetland burnt in 2011. Approximately 100 plants of <i>P. paulinae</i> previously observed (prior to 2015). Only several diminutive <i>P. macrostachyum</i> observed in 2019 despite intensive survey undertaken.
Hunwick South	Regional survey site (Site 1)	18 th October	Large wetland burnt in 9/11/2017. Relatively drier than other sites with prolific <i>Evandra aristata</i> , not considered suitable for <i>P. paulinae</i> . No <i>Prasophyllum</i> species observed.
Marbellup Brook	Regional survey site (Site 2)	17 th October	Extensive wetland system upper regions burnt 24/05/2018, lower regions burnt 18/01/2017. Large areas of potentially suitable habitat. Multiple <i>Prasophyllum</i> collections taken for analysis.
Lake Powell	Regional survey site (Site 3)	17 th October	Large wetland burnt in 1/02/2018. Relatively dry and heavy weed infestation in <i>Taxandria juniperina</i> , saline/brackish conditions near lake edge. Considered only partially suitable for <i>P. paulinae</i> . No <i>Prasophyllum</i> species observed.
Bakers Junction	Regional survey site (Site 4)	16 th October	Large wetland burnt in 25/10/2016. Considered to be potentially suitable habitat, however dense regeneration suggests optimal period of survey has past. Multiple <i>Prasophyllum macrostachyum</i> observed.
Gull Rock	Regional survey site (Site 5)	16 th October	Multiple wetland areas burnt 2/06/2017 and 20/03/2019. Relatively dry in <i>Taxandria juniperina</i> and many wetlands with narrow incised gullies. Considered only partially suitable for <i>P. paulinae</i> . No <i>Prasophyllum</i> species observed.
Two Peoples Bay, Angove Reserve entrance	Regional survey site (Site 6)	16 th October	Large wetland burnt in 1/01/2016. Considered ideally suitable habitat and fire age adequate for detection. No <i>Prasophyllum</i> species observed despite intensive survey undertaken.

Site	Location	Date	Survey Notes
Wright St, Elleker	Opportunistic site (Presented in map of regional site 3)	17 th October	Small wetland area burnt adjacent to fire shed, exact date unknown. No <i>Prasophyllum</i> species observed.
Old School Rd Elleker	Opportunistic site (Presented in map of regional site 3)	17 th October	Small wetland area between lower Denmark Rd and Old School Rd. Not burnt recently and no <i>Prasophyllum</i> species observed.
Lake Seppings	Opportunistic site	16 th October	Patchy wetlands mostly long unburnt and generally too dry for <i>P. paulinae</i> . No <i>Prasophyllum</i> species observed.
Norwood Rd	Opportunistic site	16 th October	Small wetland area adjacent to Norwood Rd. Not burnt recently and no <i>Prasophyllum</i> species observed.

5.2 Morphological Trait Assessment

The taxonomy of the genus *Prasophyllum* R. Br. is reported (Jones and Clement 1996) to be one of the most difficult of Australian orchid genera and considerable problems with identification of taxa occur due to the similarity of floral morphology between taxa and the difficulty of identifying dried herbarium specimens. Orchid experts (Andrew Brown pers. comm.) have also noted the potential limitation of the published description of *Prasophyllum paulinae*, which is derived from only one specimen.

The regional surveys undertaken as part of this study represent the largest systemic survey known for *Prasophyllum paulinae*. This provided an opportunity to make collections of fresh specimens of *Prasophyllum* species over a range of populations and habitat types, and to assess the application of the published description by David Jones (Jones and Clement 1996).

The key diagnostic morphological characters that distinguish *P. paulinae* from the allied *P. macrostachyum* are listed in Table 6. It was noted that several characters were defined only by qualitative judgments (i.e. thick or thin), which can be difficult to determine without any reference point. Ovary length was described to differ between taxa, however actual measurements for each taxon in their description are identical (i.e. 4 mm).

A subset of 22 fresh specimens that superficially resembled *P. paulinae* were assessed against the nine characters. The representative collections were from four wetland habitats, two from within Albany Ring Road Project area and two from outside the Project area. The assessment determined that five specimens (from one location) exhibited all of the characters that align with *P. paulinae*. However, many specimens showed a combination of characters from both species and several of the qualitative characters could potentially be influenced by the environment as follows:

- Two of the quantitative characters varied across a range of measurements expected in both taxa (i.e. *no. of flowers*, *ovary length*).
- Labellum characters were constant across all specimens (i.e. *labellum shape* was obtuse and *callus texture* was consistent in all specimens).
- Three of the qualitative characters separated the specimens into two groups (*flower arrangement*, *plant stature*, *flower separation*). However, these traits can potentially be influenced by plant age and site productively (i.e. flowers become more separated as the stem grows longer, young plants often have bud clusters at the apex and plants can be more robust on productive sites).

In summary, conflicting conclusions can be drawn, depending on which set of characters are used to base the specimen identification. A conservative approach was taken in identification in this analysis,

which determined the presence of extant plants of *P. paulinae* from one location. Plants attributed to *P. paulinae* had sub-pyramidal, clustered flowers on thick stems (>2mm) and generally had long ovaries and > 25 flowers. Other specimens attributed to *P. macrostachyum* had distinctly spaced, fewer flowers and were generally more diminutive. However, some of the labellum characters were consistent with the *P. paulinae* and some specimens showed intermediate characters (determined as ?*P. paulinae*).

Concordant with the findings of other experts (Andrew Brown pers. comm.), the analysis here demonstrates inconsistencies in the taxonomy of this taxon and highlights that a broader reassessment of the group may be warranted. Andrew Brown (ex. DBCA expert in Orchidaceae) viewed the specimens collected in this study and supported the interpretation of the taxonomy (Andrew Brown pers. comm.).

Table 6. Summary of morphological characters from Jones and Clement (1996) to distinguish the allied species *Prasophyllum paulinae* and *P. macrostachyum* and notes on how these were categorised or measured in the analysis.



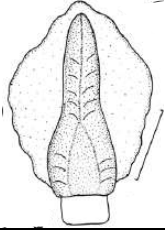
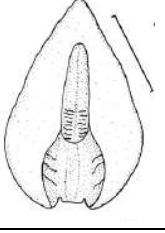
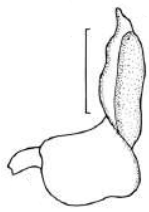
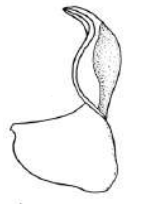
Key Characters	<i>P. paulinae</i>	<i>P. macrostachyum</i>	Notes
Overall flowers size (mm)	6	9	Vertical overall height of flowers measured to 1mm accuracy.
Flower arrangement	sub-pyramidal 	evenly spaced 	Qualitative judgement on shape, classified into two groups.
Plant stature	stout	slender	Diameter of flower stem measured as >2mm, or <2mm.
Flower separation on spike	strongly overlapping	widely spaced	Qualitative judgement on degree of overlap, classified into three groups: strongly overlapping, moderately overlapping and widely spaced.
No. of Flowers	25-70	15-30	Count of all flowers, including unopened buds.
Ovary length	4mm x 2.5mm	4mm x 1.5mm	<i>P. paulinae</i> noted to have longer ovaries. However, descriptions for both taxa are identical. Measured as overall length and width.
Lateral sepals	shorter broader	longer thinner	Qualitative judgement on shape. Measured as overall length and width.
Labellum shape	obtuse (wide point at 1/2) 	ovate (wide point at 1/3) 	Qualitative judgement on shape. Measured as position of widest point (either 1/2 or 1/3 from base of labellum).
Callus texture (viewed from side on)	thick 	thin 	Qualitative judgement on shape. Estimated as thick or thin without any reference point.

Table 7. Assessment of morphological characters of *Prasophyllum* species from four wetland locations. Two occur within the Albany Ring Road Project area (Lower Denmark Road Reserve (574963mE 6125156mN), Lot 53 Frederick St (574585mE, 6125551mN)) and two occur outside the Project area (Lot 64 Cuming Rd (574964mE, 6125349mN) and Marbellup Brook, Regional survey site 2 (566759mE, 6131584mN). *Collection Reference Number - these five specimens were dried and forwarded to the Western Australian Herbarium for vouchers.

Sample No.	Flowers size (mm)	Plant stature/stem diameter (mm)	Flower arrangement	Flower separation on spike	No. of flowers	Ovary length	Lateral sepals	Labellum shape	Callus texture	Determination
Lot 64 Cuming Rd (Population 1 and surrounding area)										
1	6	>2	sub-pyramidal	strongly overlapping	36	8	2.5x1	obtuse	?thick	<i>P. paulinae</i> *DAR1052
2	5	>2	sub-pyramidal	moderately spaced	32	7	3x1	obtuse	thick	<i>P. paulinae</i>
3	6	>2	sub-pyramidal	moderately spaced	20	5	2.5x1	obtuse	?thick	? <i>P. paulinae</i> *DAR1054
4	6	>2	sub-pyramidal	moderately spaced	24	5	2.5x1	obtuse	?thick	? <i>P. paulinae</i>
5	5	>2	sub-pyramidal	moderately spaced	27	6	4x1	obtuse	?thick	<i>P. paulinae</i>
6	6	>2	sub-pyramidal	moderately spaced	24	6	3x1	obtuse	?thick	? <i>P. paulinae</i>
7	5	>2	sub-pyramidal	moderately spaced	25	6	3x1	obtuse	?thick	<i>P. paulinae</i>
8	5	>2	sub-pyramidal	moderately spaced	22	5	2.5x1	obtuse	?thick	? <i>P. paulinae</i>
9	6	>2	sub-pyramidal	moderately spaced	35	4	3x1	obtuse	?thick	<i>P. paulinae</i> *DAR1053
10	5	>2	sub-pyramidal	moderately spaced	15	4	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
Lot 53 Frederick St (Population 1 and surrounding area)										
11	6	<2	evenly spaced	widely spaced	12	4	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
12	6	<2	sub-pyramidal	widely spaced	23	3	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
Marbellup Brook, Regional survey site 2										
13	5	<2	evenly spaced	moderately spaced	21	6	3x1	obtuse	?thick	<i>P. macrostachyum</i> *DAR1055
14	5	<2	evenly spaced	widely spaced	34	6	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
15	5	<2	evenly spaced	moderately spaced	24	6	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
16	5	<2	evenly spaced	moderately spaced	19	5	2.5x1	obtuse	?thick	<i>P. macrostachyum</i> *DAR1056
17	5	<2	evenly spaced	widely spaced	24	5	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
18	5	<2	evenly spaced	widely spaced	18	6	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
19	5	<2	evenly spaced	widely spaced	15	5	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
20	5	<2	evenly spaced	widely spaced	12	5	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
Lower Denmark Rd (Population 1 and surrounding area)										
21	5	<2	evenly spaced	widely spaced	10	4	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>
22	5	<2	evenly spaced	widely spaced	12	4	2.5x1	obtuse	?thick	<i>P. macrostachyum</i>

5.3 Population Estimate of *Prasophyllum paulinae*

The analysis in this assessment determined the presence of five extant plants of *P. paulinae* (Plate 3) from one location (Lot 64 Cuming Rd), which occurs outside the Albany Ring Road Project area. However, this population was also composed of some specimens with intermediate characters between *P. paulinae* and *P. macrostachyum*. Therefore, an accurate population assessment is limited due to the inherent ambiguity in the taxonomy and the impracticality of assessing each individual specimen by microscopy. A population estimate determined by field observation quantified 50 individuals attributable to *P. paulinae* to be present within the wetland habitat, which occupied 0.45 ha (population mapped in Appendix A).

The habitat at this site is composed of an unburnt, but regularly slashed, ground cover of predominantly native plants within a large fenced area owned by Broadcast Australia that houses an AM radio tower (Plate 4). The site has restricted access and the low groundcover is maintained to manage the needs of the tower and infrastructure. Importantly, this area is not mapped as remnant vegetation therefore highlights a limitation of using desktop spatial data to guide regional surveys. The presence of *P. paulinae* in this habitat is potentially due to the seasonal slashing that mimics burning (i.e. creates an open habitat without competition) and is facilitated by a reduction of browsing pressure.



Plate 3. *Prasophyllum paulinae*.



Plate 4. *Prasophyllum paulinae* habitat, Lot 64 Cuming Rd, Gledhow.

6 CONCLUSIONS

Suitable habitat of *P. paulinae* is most likely associated with recently burnt vegetation that aligns with two Albany Regional Vegetation Mapping Units (*Taxandria juniperina* Closed Forest (ARVS Unit 59) and *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (ARVS Unit 47). These units occupy 19.25 ha of the Albany Ring Road Project area and a total of 2,861 ha are mapped within the Albany Region. Of the 2,861 ha, 12% occurs within IUCN conservation reserves.

One previously known population of *P. paulinae* is recorded from the Albany Ring Road Project area (population one). Historical photos indicate population one occupies approximately 1.04 ha of the Albany Ring Road Project area. No extant individuals of *P. paulinae* were recorded at this location during the targeted survey (and during previous surveys in spring 2017 and 2018). Whilst no individuals of *P. paulinae* have been recorded from this location despite extensive survey effort, there remains the possibility for the taxon to emerge in future years, particularly after a fire event.

Targeted searches in areas containing suitable habitat for *P. paulinae* within the Albany Ring Road Project area did not identify any individuals of the taxon. These areas have been subject to survey effort in 2017, 2018 and 2019, however are long-unburnt and some are highly degraded.

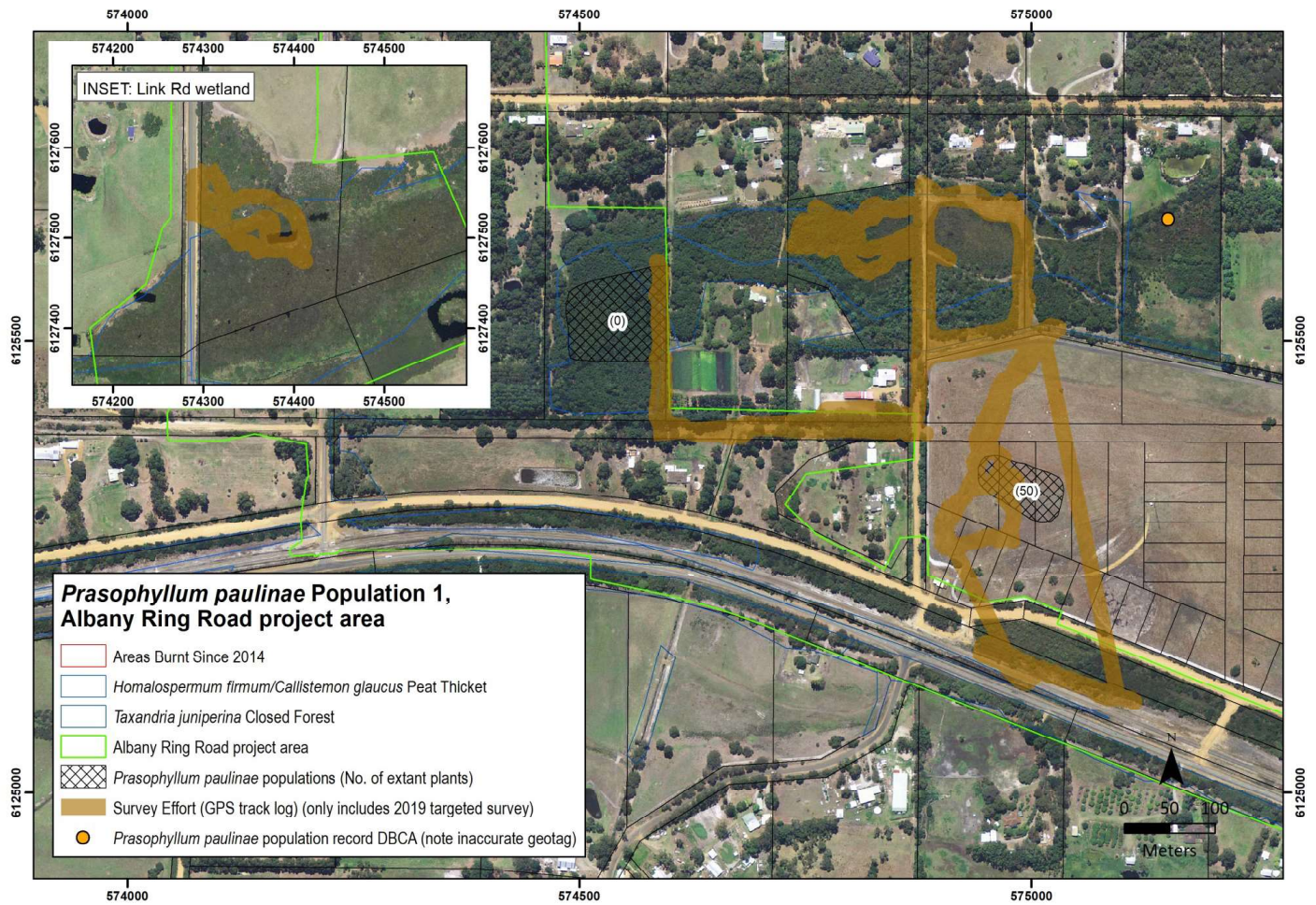
Targeted searches of regional survey areas (including population two, sites 1-6 and four opportunistic sites), identified a new previously unknown population of *P. paulinae*, outside the Albany Ring Road Project area. This population is estimated to comprise 50 plants within the wetland habitat and occupies 0.45 ha. The habitat at this site is composed of an unburnt, but regularly slashed, ground cover of predominantly native plants that occurs within a large fenced area. No individuals of *P. paulinae* were located at the other surveyed locations, which had suitable habitat of variable fire ages.

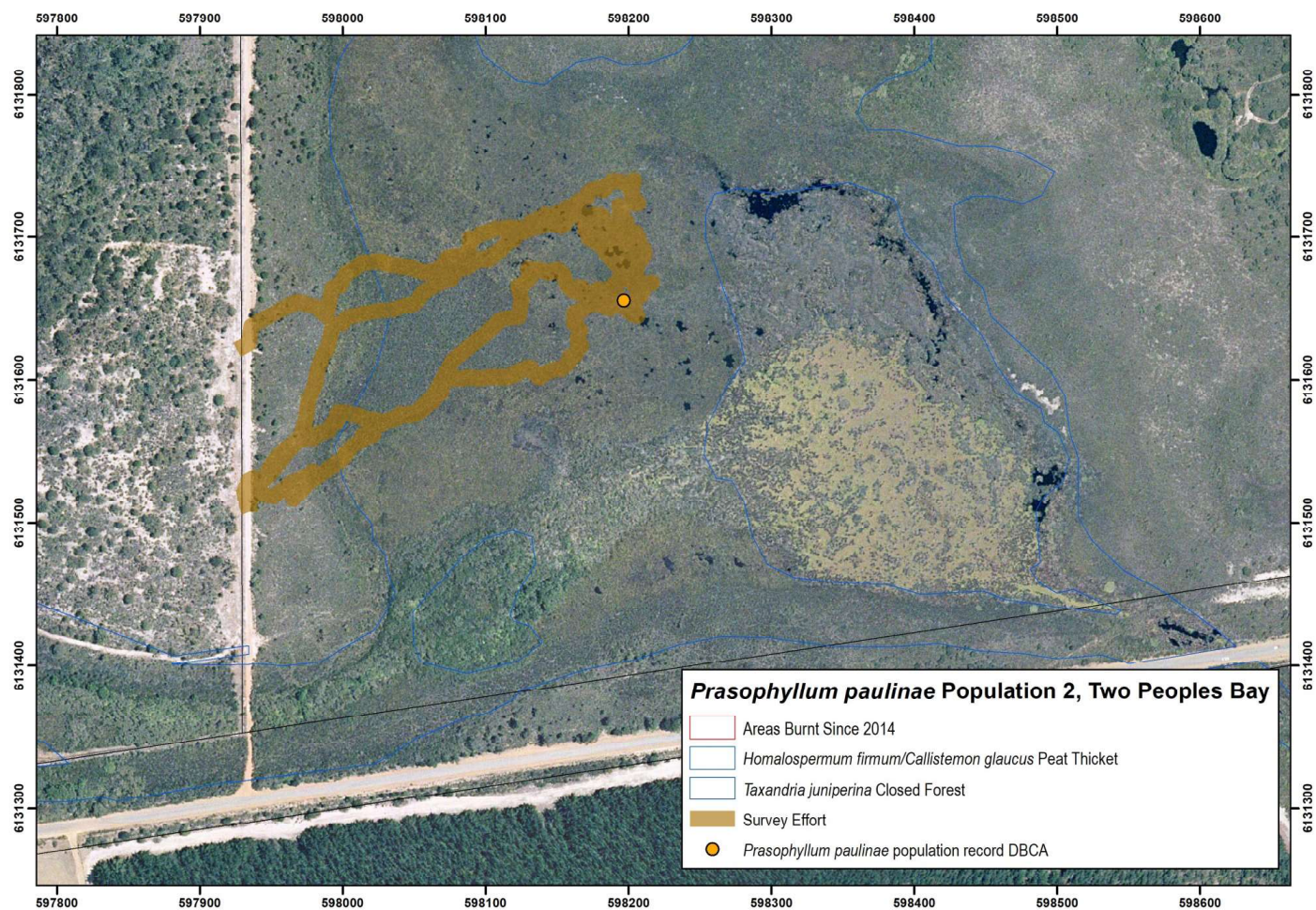
The regional surveys undertaken as part of this study represent the largest systemic survey known for *P. paulinae*. This provided an opportunity to make collections of fresh specimens of *Prasophyllum* species over a range of populations and habitat types, and to assess the application of the published description by David Jones (Jones and Clement 1996). Many specimens showed a combination of characters from species (*P. paulinae* and *P. macrostachyum*) and several of the qualitative characters could potentially be influenced by the environment. Concordant with the findings of others (Andrew Brown pers. comm.), the analysis demonstrated inconsistencies in the taxonomy and highlights the need for a broader reassessment of the group.

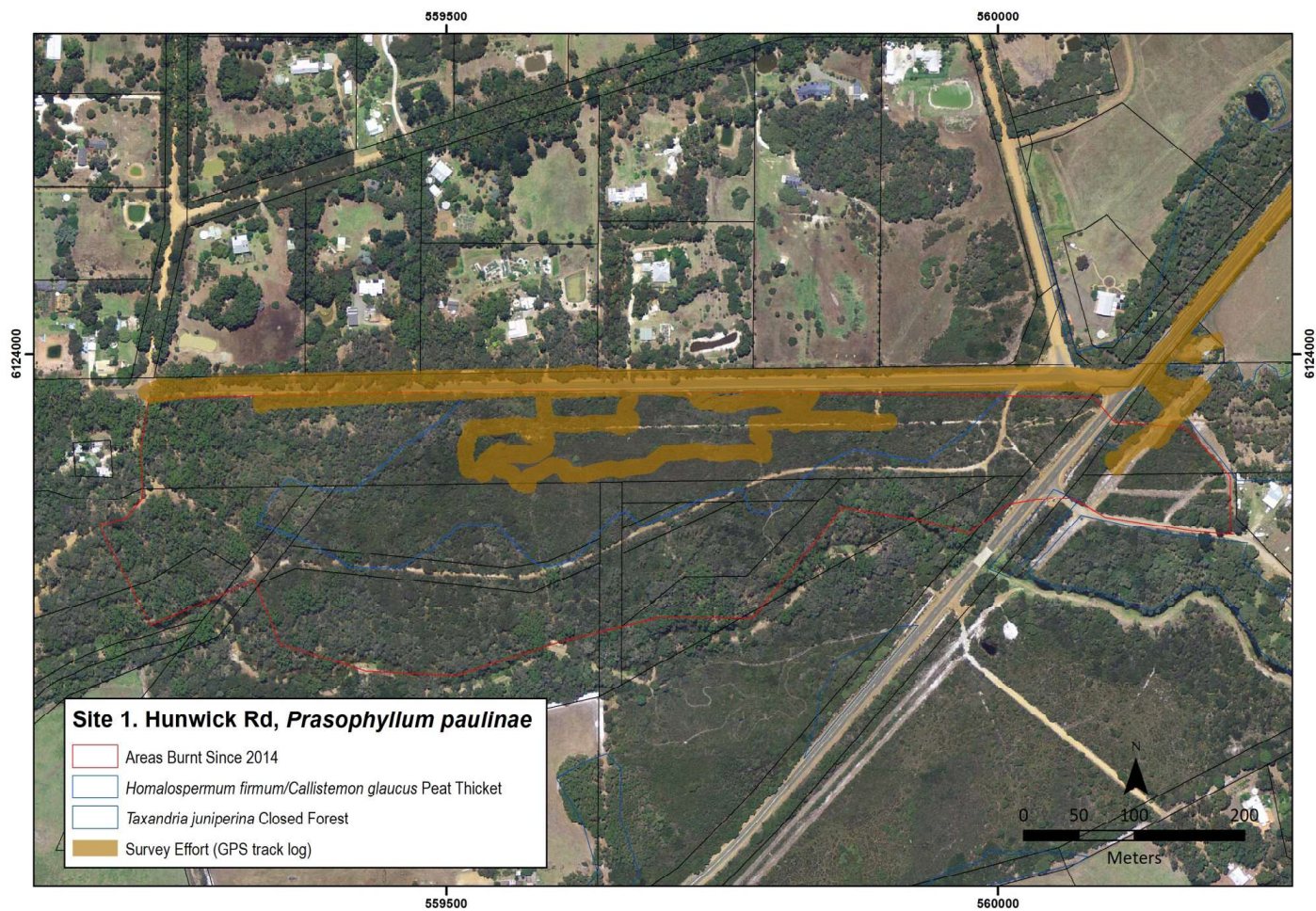
7 REFERENCES

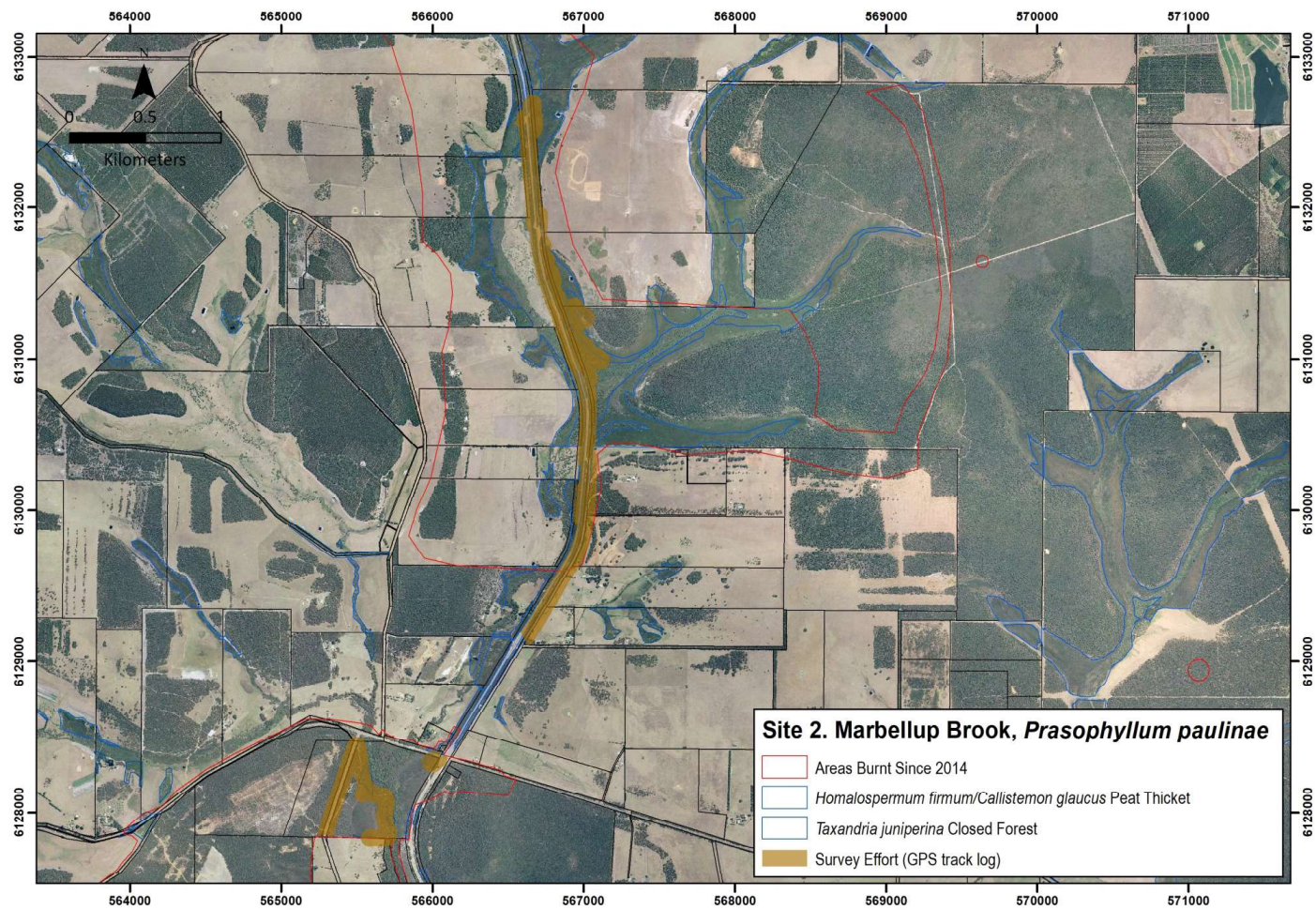
- Bureau of Meteorology (BOM) (2019) Climate Data Online. Commonwealth of Australia. URL: <http://www.bom.gov.au/climate/data/index.shtml>.
- Department of Environment and Conservation [DEC] (2010) *Threatened and Priority Flora Report Form - Field Manual*. Version 1.0.
- Environmental Protection Agency [EPA] (2016) *Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment*.
- Jones D and Clements, M (1996) A reassessment of *Prasophyllum gracile* and *P. macrostachyum* (Orchidaceae), with the description of *P. paulinae*, a new species from south-west Western Australia. *Nuytsia* 10: 3 (1998).
- Rathbone, DA & Gilfillan, S (2018). Biological Survey: Albany Ring Road. Unpublished report by Southern Ecology for Main Roads Western Australia (SE1721).
- Sandiford, E. M., & Barrett, S. (2010). Albany Regional Vegetation Survey, Extent Type and Status, A project funded by the Western Australian Planning Commission (EnviroPlanning "Integrating NRM into Land Use Planning" and State NRM Program), South Coast Natural Resource Management Inc. and City of Albany for the Department of Environment and Conservation. *Unpublished report. Department of Environment and Conservation, Western Australia*, 6.

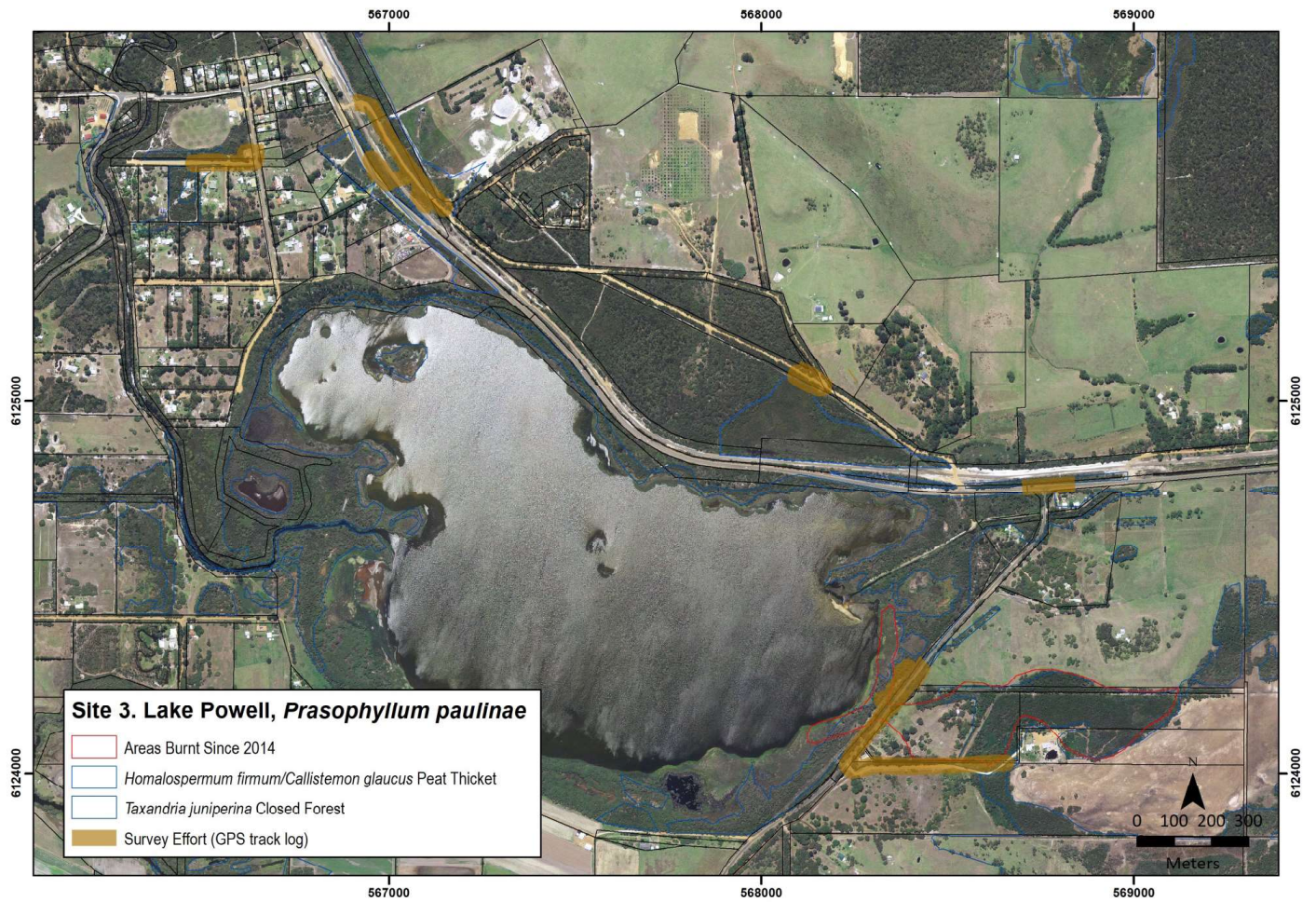
8 Appendix A - Survey Site Maps

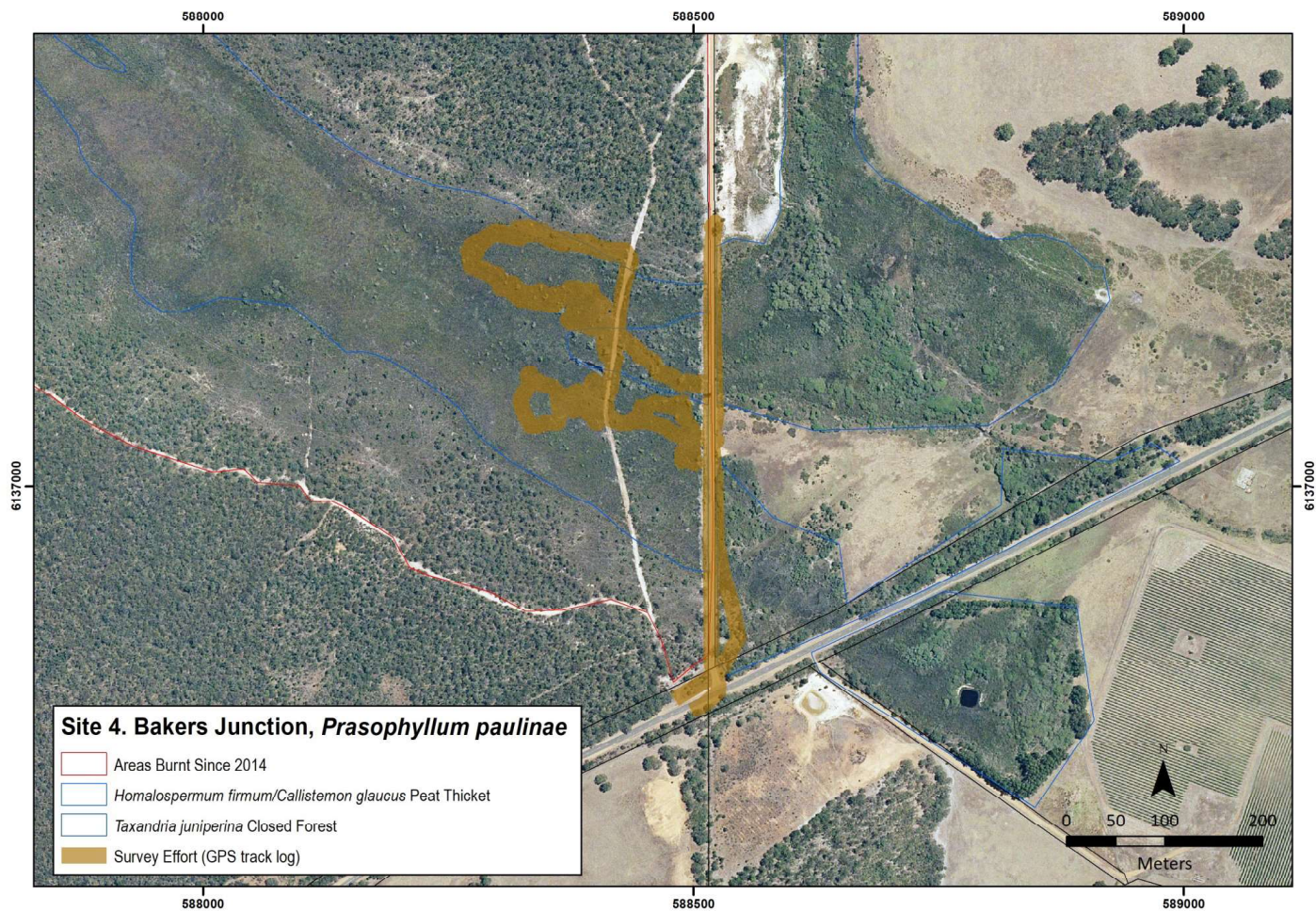


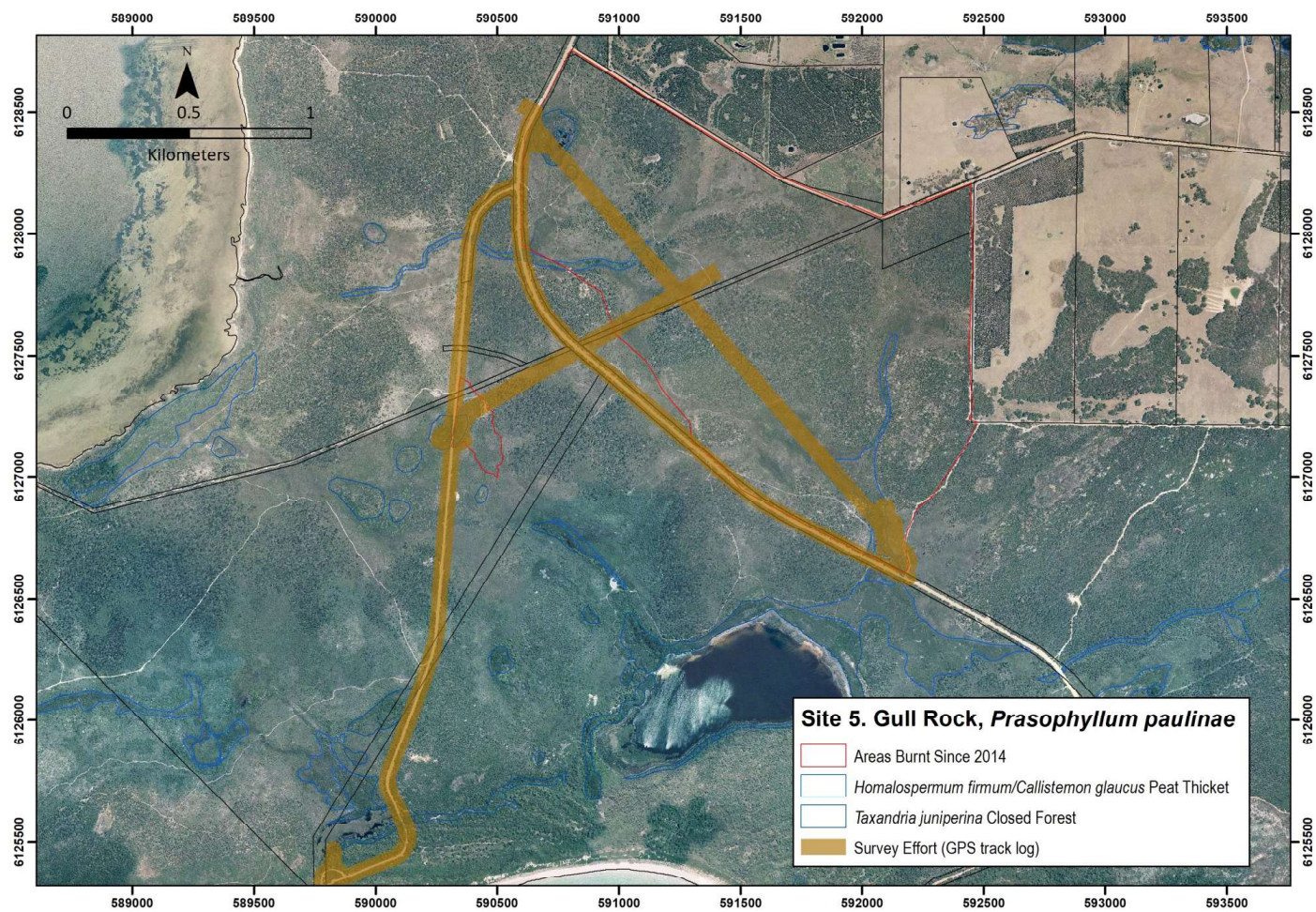


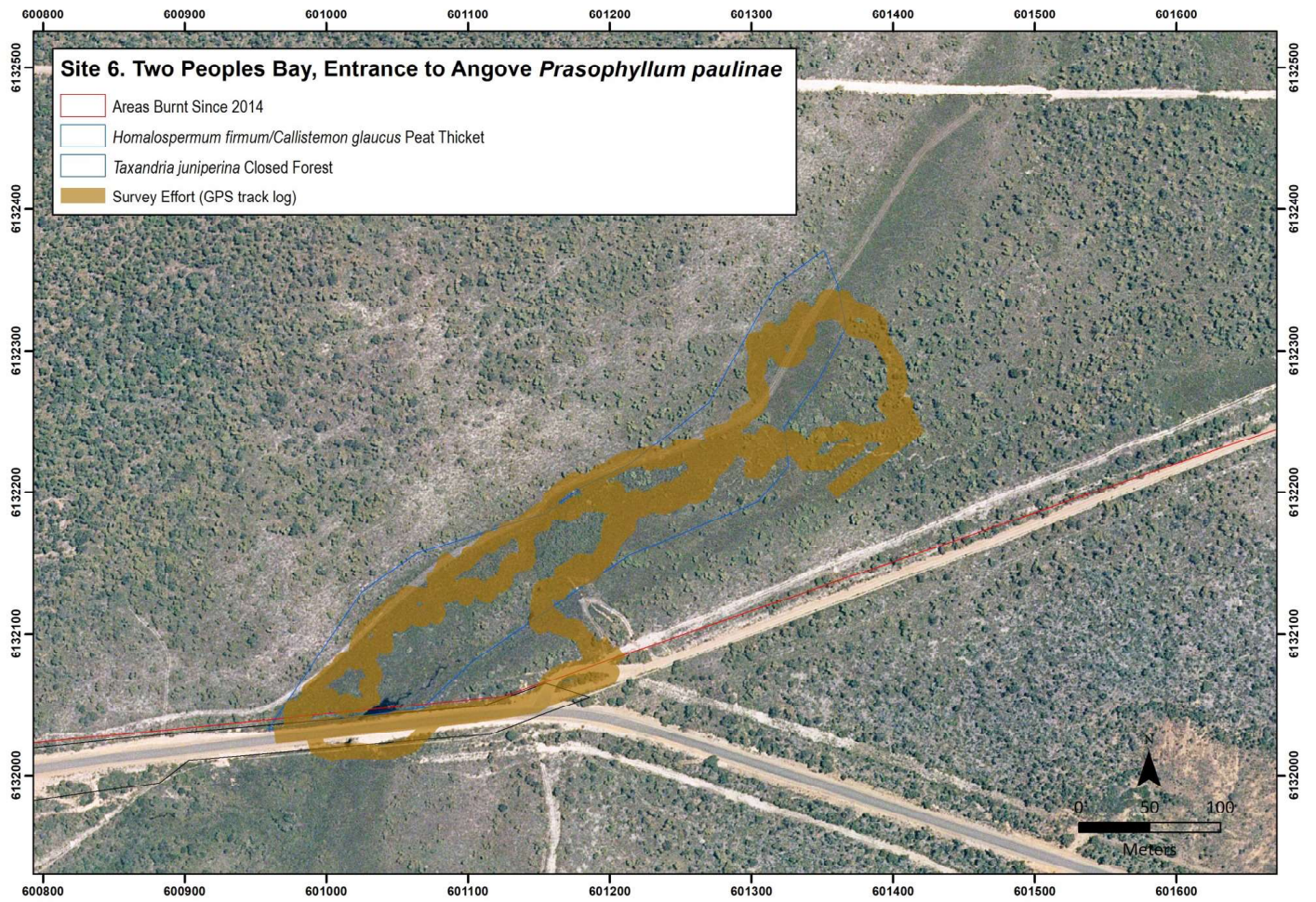


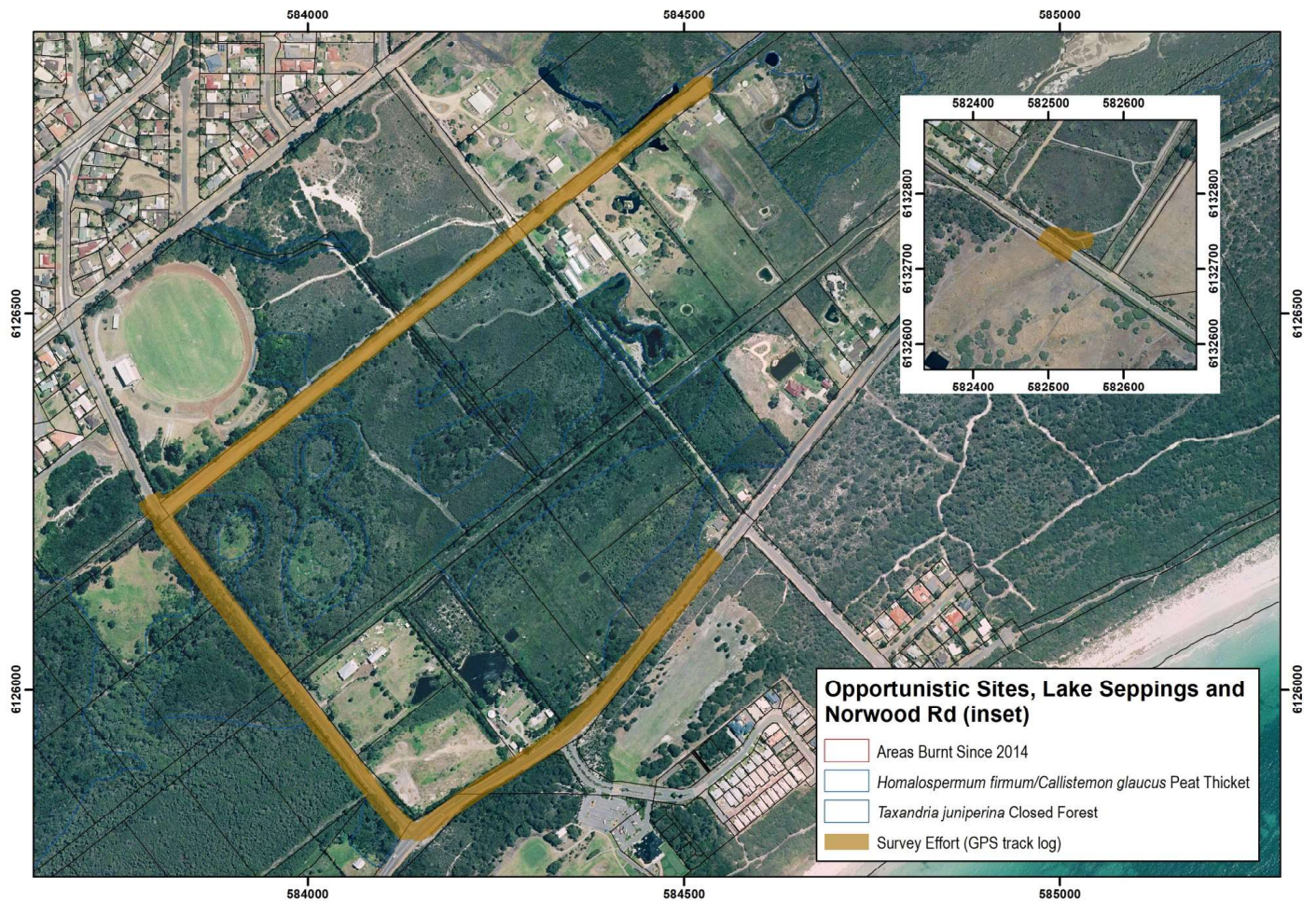








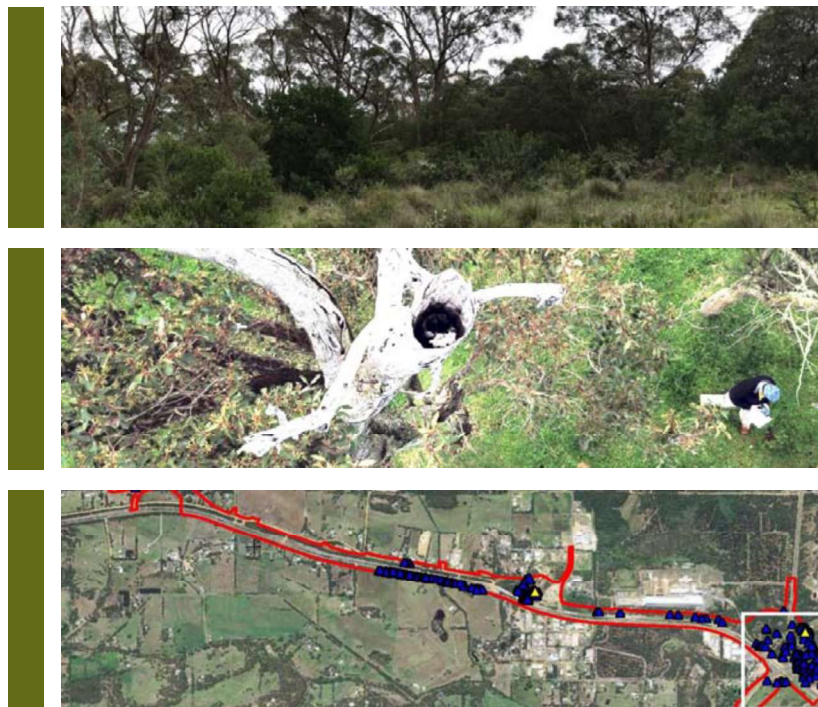




Appendix E – Albany Ring Road Black Cockatoo Habitat Assessment (Biota, 2019b)



Albany Ring Road Black-Cockatoo Habitat Assessment



Prepared for Main Roads WA

October 2019



© Biota Environmental Sciences Pty Ltd 2019

This document has been prepared to the requirements of the client identified on the cover page and no representation is made to any third party. It may be cited for the purposes of scientific research or other fair use, but it may not be reproduced or distributed to any third party by any physical or electronic means without the express permission of the client for whom it was prepared or Biota Environmental Sciences Pty Ltd.

This report has been designed for double-sided printing. Hard copies supplied by Biota are printed on recycled paper.

Albany Ring Road Black-cockatoo Habitat Assessment

Contents

1.0	Summary	7
2.0	Introduction	9
2.1	Project Background	9
2.2	Scope and Purpose of the Study	11
3.0	Target Species Overview	13
3.1	Carnaby's Cockatoo (<i>Calyptrorhynchus latirostris</i>)	13
3.2	Baudin's Cockatoo (<i>Calyptrorhynchus baudinii</i>)	13
3.3	Forest Red-tailed Black-Cockatoo (<i>Calyptrorhynchus banksii naso</i>)	14
4.0	Survey Methodology	15
4.1	Desktop Review	15
4.2	Field Survey	15
4.3	Survey Team and Timing	19
4.4	Legislation and Policy Conformance	20
4.5	Nomenclature	21
5.0	Results	23
5.1	Desktop Review: Presence in the Local Area	23
5.2	Suitable Diameter at Breast Height (DBH) Trees	23
5.3	Hollow Assessment	23
5.4	Foraging Habitat Assessment	27
6.0	Discussion	31
7.0	References	33

Appendix 1

Tree Hollow Data

Appendix 2

Foraging Habitat Scoring Tool

Appendix 3

Foraging Habitat Scoring

Tables

Table 4.1:	Breeding habitat for the three Threatened black-cockatoo species.	18
Table 4.2:	Categories of hollow suitability for black-cockatoo nesting.	19
Table 4.3:	State and Commonwealth legislation, policy and guidelines of most relevance to this study.	20
Table 5.1	Number of breeding habitat trees and hollows.	23
Table 5.2:	Application of the Foraging Habitat Scoring Tool (DotEE 2017).	28
Table 5.3:	Vegetation units (Rathbone and Gilfillan 2018) largely devoid of black-cockatoo foraging plants.	28

Table 6.1: Foraging habitat within the study area and ARVS equivalent within 12 km.	31
---	----

Figures

Figure 2.1: Location of the study area.	10
Figure 4.1: Effort applied to the recording of black-cockatoo habitat trees within the study area.	17
Figure 5.1: Black-cockatoo habitat trees recorded within the study area.	26
Figure 5.2: Potential black-cockatoo foraging habitat within the study area.	29
Figure 6.1: Extent of the vegetation units found within the study area in a 12 km radius based on the Albany Regional Vegetation Survey (Sandiford and Barrett 2010).	32

Plates

Plate 5.1: Pic 1_0002. Drone tree ARR_01 spout trunk, 14 cm diameter, depth inadequate.	24
Plate 5.2: Pic 2_0007.	24
Plate 5.3: Pic 3_0013.	24
Plate 5.4: Pic 4_0025.	24
Plate 5.5: Pic 6_0030.	24
Plate 5.6: Pic 10_0044.	24
Plate 5.7: Pic 12_059.	25
Plate 5.8: Pic 19_0069.	25
Plate 5.9: Pic 20_0083.	25
Plate 5.10: Pic 22_0094.	25
Plate 5.11: Tree ARR_21 drone image before contrast manipulation.	25
Plate 5.12: Tree ARR_21 drone image after contrast manipulation.	25

1.0 Summary

Main Roads Western Australia (Main Roads) is proposing to construct the Albany Ring Road, a staged development with the purpose of redirecting heavy vehicle traffic bound for the Port away from built up urban areas of the City of Albany. With Stage 1 completed in 2017, Main Roads is now proposing to undertake construction of Stages 2 and 3 of the Albany Ring Road project. The survey area for Stages 2 and 3 is known as the Ultimate Footprint (the area to which this report pertains). It is 12 km in length and consists of 185 ha, of which 144.7 ha are vegetated.

Habitat for black-cockatoos was assessed by foot-traversing as much of the woodland habitat in the study area as practicable. In larger vegetation fragments, a systematic approach was applied, whereby transects of 25 m spacing were overlain on the study area in GIS. A zoologist then walked down the middle of two 25 m transects, effectively using them as the boundary of a strip-search, and recorded the location of all trees within the strip. This was continued until the entire fragment had been searched. In small fragments or where there were singular trees, foot traverses were also undertaken and recorded via a track file. Foraging habitat descriptions were recorded while conducting foot traverses. For any tree supporting hollow/s, details of the hollows were taken, and a differential GPS was used to record an accurate location of the tree. These trees were also subject to a dedicated breeding hollow assessment, which included the use of a remotely piloted aircraft (RPA) to obtain images of the hollows.

A total of 516 'suitable diameter at breast height (DBH) trees' (>50 cm DBH) were recorded in the Ultimate Footprint during the survey. From these trees, a total of 48 hollows with entrance diameters of 10 cm or greater were recorded, 37 of which were considered to warrant further investigation during a dedicated hollow assessment. This follow-up hollow assessment included the use of an RPA with a camera mounted to take photographs of the hollows. This assessment indicated that none of the hollows were suitable for black-cockatoo breeding, primarily due to inadequate chamber size.

Potential foraging habitat within the study area was assessed using the detailed vegetation mapping of the study area (Rathbone and Gilfillan 2018). This comprised 17.4 ha of predominantly Jarrah and/or Marri woodland with varying mid- and under-storeys, in some places included foraging plants. Individual planted *Pinus radiata* were also recorded throughout the study area and represent foraging plants for white-tailed black-cockatoos.

This page is intentionally left blank.

2.0 Introduction

2.1 Project Background

Main Roads is proposing to construct the Albany Ring Road (ARR), a staged development with the purpose of redirecting heavy vehicle traffic bound for the Port away from built up urban areas of the City of Albany. When complete, the ARR will link four major roads (Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road), allowing alternative access to the Port and developing industrial area. With Stage 1 completed in 2017, Main Roads is now proposing to undertake construction of Stages 2 and 3 of the ARR project. The survey area for Stages 2 and 3 is known as the Ultimate Footprint. This is the subject of this report and is referred to as the study area throughout. It is 12 km in length and consists of 185 ha, of which 144.7 ha are vegetated.

Three species of black cockatoo are known to inhabit the Albany area, and all have been recorded within 10 km of the study area: Carnaby's Black-Cockatoo (*Calyptrorhynchus latirostris*), Baudin's Black-Cockatoo (*Calyptrorhynchus baudinii*) and the Forest Red-tailed Black-Cockatoo (*Calyptrorhynchus banksii naso*) (DSEWPaC 2012). All three species represent threatened fauna and are protected under both the Western Australian *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The area contains old growth remnant Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) trees, which have the potential to represent foraging and nesting habitat for all three species (DSEWPaC 2012). As part of a Biological Survey of the Albany Ring Road in 2017, Southern Ecology assessed threatened black-cockatoo habitat covering an area of 247 ha (Rathbone and Gilfillan 2018), of which 117.2 ha overlapped the Ultimate Footprint study area. During the 2017 survey, 265 habitat trees were identified within the area that intersects with the Ultimate Footprint survey area, and 53 hollows with diameters greater than 10 cm were recorded.

Since some sections of the study area had not been surveyed, and the status and value of some of the habitat trees that were surveyed may have changed since 2017, Main Roads commissioned Biota Environmental Sciences (Biota) to complete an updated assessment of black-cockatoo breeding habitat trees across the entire Ultimate Footprint study area.

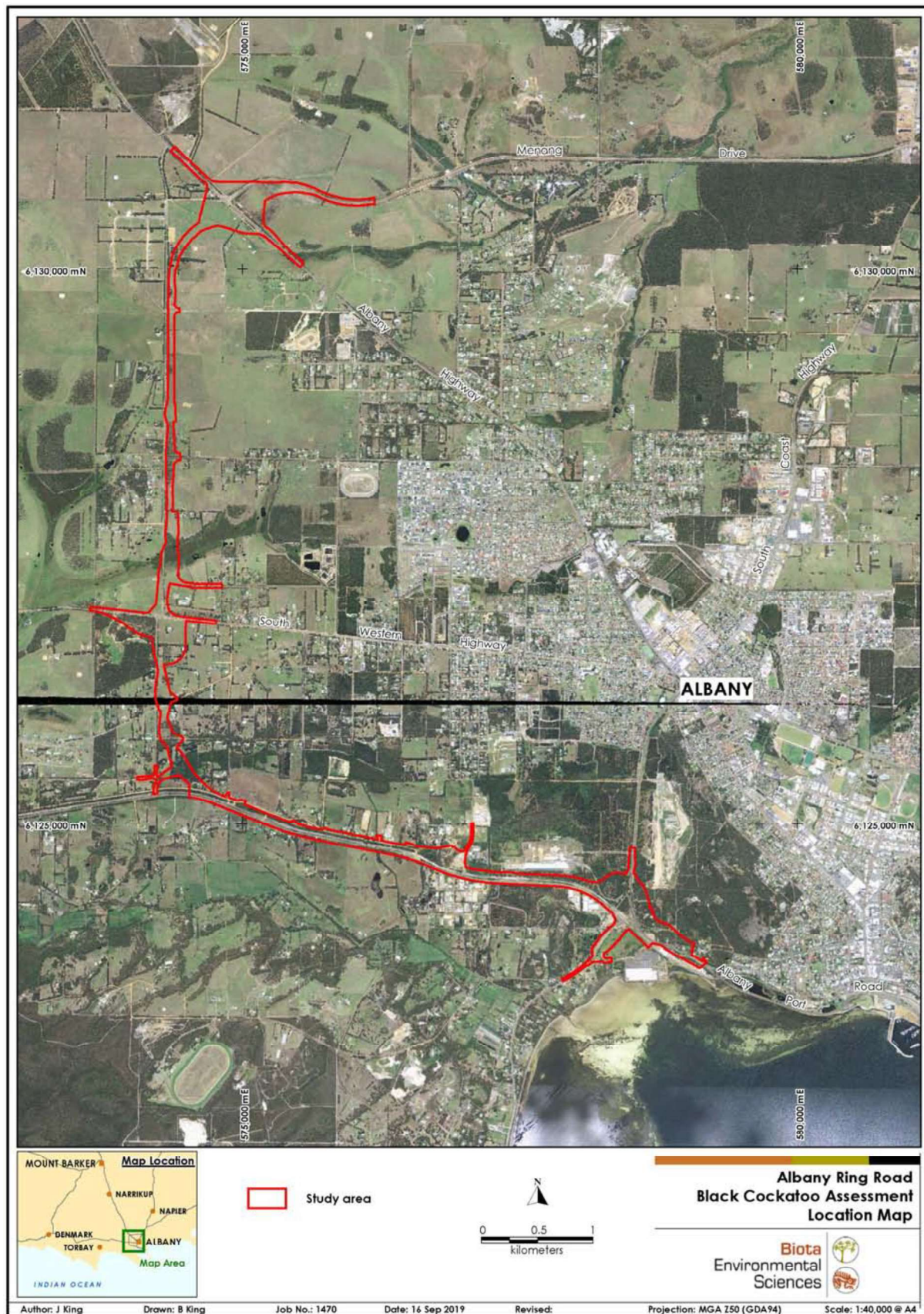


Figure 2.1: Location of the study area.

2.2 Scope and Purpose of the Study

The aim of the survey was to re-assess black cockatoo habitat values within the Ultimate Footprint (hereafter 'the study area'). This was undertaken by identifying trees suitable for black-cockatoo nesting, which represent breeding habitat as defined in the EPBC Act referral guidelines (DSEWPaC 2012)

Specifically, this was achieved by undertaking the following scope:

- assessment of black-cockatoo habitat trees (diameter at breast height (DBH) >500 mm) within the Ultimate Footprint study area, including a re-assessment of those trees previously identified by Southern Ecology (Rathbone and Gilfillan 2018);
- identification of habitat trees containing hollows >100 mm and corresponding measurements of diameter, depth and angle, as well as details on suitability/evidence of use by black-cockatoos;
- further investigation using a drone for hollows deemed suitable based on risk assessment criteria; and
- recording evidence of roosting or feeding and any physical observations of black-cockatoo species during the survey.

This page is intentionally left blank.

3.0 Target Species Overview

All three species of black-cockatoo are endemic to the southwest of Western Australia and have documented breeding areas overlapping the study area (Johnstone and Storr 1998, DSEWPac 2012). Black-cockatoos require tree hollows with suitable dimensions for nesting and breeding, which typically occur in larger trees over 200 years old (DSEWPac 2012). As such, breeding habitat trees are defined in the Federal guidelines as any tree with DBH equal to or greater than 500 mm (DSEWPac 2012). Activities such as logging and deforestation for agriculture have contributed to a decline in abundance and range of black-cockatoos, hence their listing as conservation significant species.

3.1 Carnaby's Cockatoo (*Calyptorhynchus latirostris*)

Carnaby's Black-Cockatoo is listed as threatened under both the State BC Act (Schedule 2 - Endangered) and the Commonwealth EPBC Act (Endangered).

This species is distributed from Kalbarri to Esperance. During the breeding season, between July and November, they have been historically concentrated in the Wheatbelt region (Johnstone and Storr 1998, Saunders et al. 2014b). Here, they primarily nest in Salmon Gum (*E. salmonophloia*) and Wandoo (*E. wandoo*) but are also known to nest in Tuart (*E. gomphocephala*), Marri (*Corymbia calophylla*), Red Morrel (*E. longicornis*) and York Gum (*E. loxophleba*) (Johnstone and Storr 1998).

Expansion in breeding range further south and west towards the Jarrah - Marri forests of the Darling Scarp and Tuart forests of the Swan Coastal Plain has occurred in the past 10 to 30 years (Johnstone et al. 2010). Long term studies show that Carnaby's Black-Cockatoos utilise hollows ranging from 10 – 65 cm in diameter (average 26 cm) and approximately 130 cm deep (Saunders et al. 2014a, 2014b). They also frequent coastal areas outside of the breeding season where they forage in large flocks (Saunders et al. 2011), feeding on the seeds of *Banksia*, *Dryandra* and *Eucalyptus* species such as Jarrah, Marri and Karri (*E. diversicolor*).

3.2 Baudin's Cockatoo (*Calyptorhynchus baudinii*)

Baudin's Black-Cockatoo is listed as threatened under both the State BC Act (Schedule 2 - Endangered) and the Commonwealth EPBC Act (Vulnerable).

Baudin's Black-Cockatoo occurs in the humid and subhumid areas of the Southwest, distributed from Gidgegannup in the north to Naturaliste National Park and Augusta; also occurring in the Stirling and Porongurup Ranges and east along the south coast to Waychinicup (Johnstone and Storr 1998). Between March and September, the majority of the population migrates north from the cooler Karri forest to the central and northern Darling Range and eastern Swan Coastal Plain (Johnstone et al. 2010). They feed mainly on the seeds of Marri trees, as well as various species of *Banksia* and *Hakea* (Johnstone and Storr 1998).

Although the breeding requirements of this species are still poorly known, breeding has been recorded in the Southwest, north to Serpentine and east to Kojonup and Albany (Johnstone et al. 2010). They nest mainly in hollows of Karri, Marri and Wandoo trees. Breeding typically occurs between March and October, but egg laying has also been reported less frequently in November and December (Johnstone and Storr 1998, 1998, Johnstone et al. 2010). Specific dimensions of hollows used for breeding have not previously been studied for Baudin's Black-Cockatoo, but are likely to be similar to those hollows used by Carnaby's Black-Cockatoo.

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

The Forest Red-tailed Black-Cockatoo is listed as threatened under both the State BC Act (Schedule 3 - Vulnerable) and the Commonwealth EPBC Act (Vulnerable).

This species occurs from Gingin in the north across to near Albany in the south (Johnstone and Storr 1998), typically nesting in Marri, Jarrah and Karri tree hollows with entrance diameters ranging from 10 x 12 cm to 44 x 150 cm (mean 28 x 30 cm), and depths of between 100 cm and 500 cm (average 144 cm) (Johnstone and Storr 1998, Johnstone et al. 2013). This species lays eggs between October and November and incubation is approximately 29 – 31 days, during which time the female stays with the egg and is fed by the male (Johnstone and Storr 1998). They feed mainly on Jarrah and Marri seeds but also Sheoak (*Allocasuarina fraseriana*), Snottygobble (*Persoonia longifolia*) and Swan River Blackbutt (*E. patens*) (Johnstone et al. 2010).

4.0 Survey Methodology

4.1 Desktop Review

The following sources of information were reviewed in relation to the study area:

1. A search of NatureMap, carried out on 9th September 2019 in relation to the three black-cockatoo species using a line search with a 10 km buffer on the following points: (i) 34° 57' 52.5168" S, 117° 49' 14.2968" E; (ii) 34° 59' 47.6592" S, 117° 48' 49.7844" E; (iii) 35° 0' 51.1164" S, 117° 49' 24.2292" E; and (iv) 35° 1' 23.9988" S, 117° 51' 44.3268" E;
2. Results of the Great Cocky Count Report (Peck et al. 2018), particularly in relation to known roosting areas for black-cockatoos;
3. The vegetation and fauna report of Southern Ecology (Rathbone and Gilfillan 2018), which addressed an overlapping study area. Detailed vegetation mapping over the study area was completed by Southern Ecology and provided to Biota as shapefiles;
4. Southdown Magnetite Project Summary of studies and impact assessment for Carnaby's Black-Cockatoo (Rev 12.7) (Everard and Bamford 2016)
5. Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (Vulnerable) *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptorhynchus banksii naso* (DoEE 2017).

4.2 Field Survey

The field survey methodology was performed in accordance with the Commonwealth referral guidelines for threatened black cockatoos (DSEWPac 2012, DoEE 2017).

4.2.1 Breeding Habitat Assessment

The field assessment aimed to determine whether suitable breeding habitat for black-cockatoos was present within the Ultimate Footprint study area. This included the reassessment of the 663 habitat trees identified by Southern Ecology during earlier assessments (Rathbone and Gilfillan 2018), which were relocated during the survey using a GPS.

The Commonwealth *Revised draft referral guideline for three black cockatoo species* (DoEE 2017) defines breeding habitat as those species of trees known to support breeding within the range of the species, which either have a suitable nest hollow or are of a suitable DBH to develop a nest hollow (being greater than 50 cm DBH for most Eucalypts, or 30 cm in the case of Wandoo and Salmon Gum).

The aim was to assess, as far as practicable, all potential breeding trees within the study area. Two approaches were taken:

1. Larger areas of continuous vegetation were identified from aerial imagery and overlain with 25 m spaced transects in GIS. Using a GPS, a biologist walked up the middle of each 25 m wide transect, assessing all trees within it;
2. In smaller treed areas (e.g. roadside verges and paddocks containing singular trees), a biologist would maintain a GPS track file while using aerial imagery to visit as many trees as possible.

All individual trees of species with the potential to form hollows (primarily Jarrah, Marri and Tuart) and with sufficient diameter to be considered breeding habitat trees (i.e. DBH >50 cm) were recorded using a GPS with accuracy equivalent to that of a differential GPS (i.e. accurate to within 1.5 m).

For trees that were observed to contain hollows potentially suitable for black-cockatoo nesting, the following information was recorded:

- DBH (approximately 1.3 m above the ground);
- tree height;
- tree species;
- height above the ground of each hollow;
- the estimated size of entry of the hollow;

Hollows that met the following risk assessment criteria were considered a potential breeding hollow warranting further investigation using a remotely piloted aircraft (RPA), as described in Section 4.2.1.1:

- whether the hollow was suitably open for access (i.e. not covered by branches);
- whether the orientation of the hollow was suitable for access (i.e. horizontal to upright; downward-facing hollows being unsuitable);
- whether the location of the hollow allows for the formation of a nesting cavity (e.g. if on a spout branch, was the branch large enough to support a nesting cavity);
- signs of cockatoo use (including wear around hollows, nut chews, scarring, scratch marks on trunks and branches, secondary evidence of feeding sites and moulted feathers).

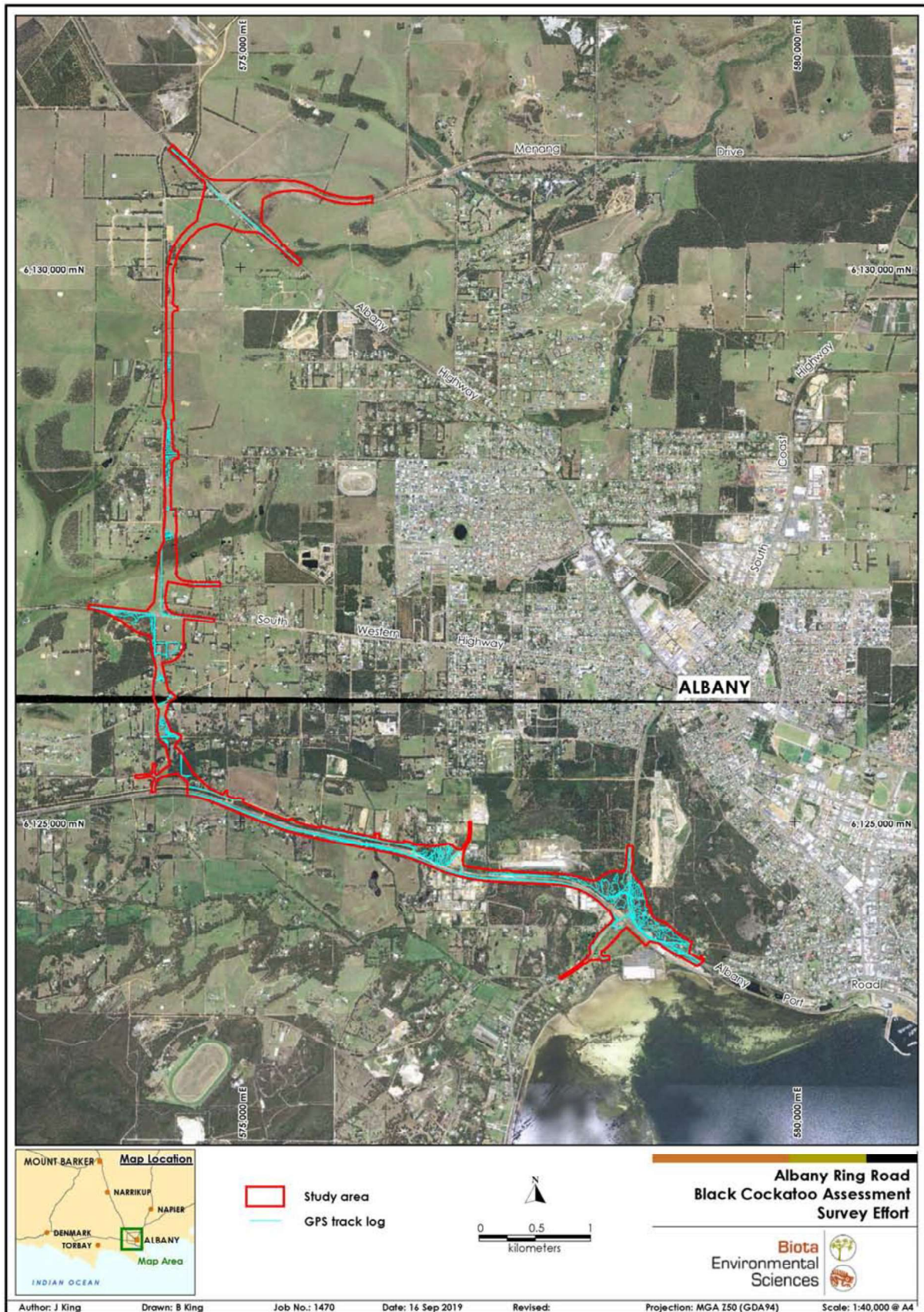


Figure 4.1: Effort applied to the recording of black-cockatoo habitat trees within the study area.

4.2.1.1 Black-cockatoo Breeding Hollow Assessment Field Methodology

Black-cockatoos breed in large hollow-bearing trees, generally within woodlands and forests (Johnstone and Kirkby 2011). Hollow formation results from a number of processes including fungal infection, termite activity and fire, and propensity for hollow formation varies between eucalyptus species (Whitford and Williams 2002). Studies on hollow formation in Jarrah/Marri forests identified a minimum tree age of 130 years before a tree would be suitable for hollow-dependent fauna (Whitford and Williams 2002). Habitat destruction, and the subsequent loss of suitable breeding hollows, has been identified as a process leading to population decline of black-cockatoos (Johnstone and Kirkby 2008). Furthermore, increased competition with both native and introduced species (e.g. Galahs, ducks and European honey bees) continues to reduce the availability of such trees for breeding sites (Johnstone et al. 2013).

Studies of the breeding behaviours of the three threatened black-cockatoo species have identified variation between the tree species and characteristics of hollows chosen for nesting (Table 4.1). For example, hollows formed in Jarrah are typically smaller than those in Marri, and Forest Red-tailed Black-Cockatoos breed predominantly in Marri in the Jarrah-Marri forest of the South-west (Johnstone et al. 2013). Breeding records of Carnaby's Black-Cockatoo on the Swan Coastal Plain indicate that the majority of their nests are in Tuart (Johnstone and Kirkby 2011).

Table 4.1: Breeding habitat for the three Threatened black-cockatoo species.

	Baudin's	Carnaby's	Forest Red-Tailed
Specific breeding habitat for the three black-cockatoo species	Nest in hollows in live or dead trees of Karri, Marri, Wandoo and Tuart.	Nest in hollows in live or dead trees of Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum, York Gum, Powderbark, Karri and Marri.	Nest in hollows in live or dead trees of Karri, Marri, Bullich, Swan River Blackbutt, Tuart and Jarrah.
Hollow Characteristics			
Aspect	No preference. Does not affect nesting success (Saunders 1979).	No preference. Does not affect nesting success (Saunders 1979).	–
Depth	Ranges from 0.1 to 2.5+ m (Johnstone and Kirkby 2011).	Majority between 0.5 and over 2.0 m, average just over 1 m (Saunders 1979).	1.0 - 5.0 m (Johnstone and Kirkby 2011).
Height above ground	No preference (Serventy and Whittell 1976).	No evidence that higher hollows are preferred (Saunders 1979).	No preference (Johnstone and Kirkby 2011).
Living or dead	No preference (Saunders 1979).	No preference (Saunders 1979).	No preference (Saunders 1979).
Entrance Diameter	–	–	>12 cm (Johnstone and Kirkby 2011).

For all hollow-bearing trees >50 cm DBH, which also contained hollows greater than approximately 10 cm dimension that were recorded during the black-cockatoo habitat mapping exercise (see Section 4.2.1), a follow-up survey was conducted using an RPA (DJI Mavic Pro). This aimed to assess the likelihood or evidence of black-cockatoo breeding within each hollow, as well as a better assessment of its suitability for breeding.

The RPA exercise was carried out by two biologists, one of whom is also an experienced RPA pilot. A pre-flight assessment of the tree was completed to ensure proper flight conditions and confirm the order in which hollows would be assessed. Prior to flight, the side of the tree was raked with a branch, which will generally cause any black-cockatoo or other bird species within a hollow to emerge. This provides an indication of hollow use and also reduces the likelihood of RPA-fauna collision.

During the flight stage of the RPA survey, the two participants were each tasked with a specific duty: (i) the pilot was responsible for flying the RPA; and (ii) the spotter monitored the surroundings to ensure the aircraft was not in close proximity to branches, and informed the pilot if any birds fled the hollows.

All accessible hollows with an entrance of 10 cm were examined with the RPA. Photographs were also taken as a visual reference and to aid future identification of the tree. These were also assessed in detail to determine if they represented suitable hollows and/or if they showed any signs of current or previous use by black-cockatoos (e.g. chew marks around hollow entrance, presence of chicks, eggs, feathers, chew/scratch marks).

Breeding suitability of the hollows examined was assessed against the criteria detailed in Table 4.2.

Table 4.2: Categories of hollow suitability for black-cockatoo nesting.

Category	Characteristics
Suitable with Evidence of Use	As for "Suitable" above, but also showing evidence of use that may be from black-cockatoos. The following represent the types of use that were searched for: <ul style="list-style-type: none"> • Fresh chews around the rim and inside of the hollow. • Freshly cleared vegetation around the entrance. • Eggs that were similar in appearance to those of black-cockatoos.
Suitable	<ul style="list-style-type: none"> • Entrance greater than 10 cm. • Branch width and depth large enough to support a nesting chamber. • Angle of entrance/egress suitable for black-cockatoo. • Entrance is clear of large branches would block access for black-cockatoo.
Not Suitable	Not a hollow, or hollow not suitable for black-cockatoo nesting.
Ground Assessment Only	The hollow could only be assessed from the ground due to limitations with RPA access (e.g. proximity to road traffic, within a prescribed no-fly zone, foliage covering hollow).

4.2.2 Foraging Habitat Assessment

Foraging habitat is defined as areas including plants of species known to support foraging within the range of each black-cockatoo species. While a broader range of species is utilised for foraging (including introduced species such as pines, **Pinus spp.*), Marri and Jarrah woodlands are particularly important to Baudin's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo, while proteaceous heaths (i.e. shrublands dominated by *Banksia*, *Hakea* and *Grevillea* species) are also utilised by Carnaby's Black-Cockatoo (DSEWPac 2012). The quality of the foraging habitat was scored using the elements of the habitat scoring tool described in the referral guideline (DotEE 2017) (Appendix 2).

The detailed vegetation mapping of the study area (Rathbone and Gilfillan 2018) was used in conjunction with the on-site breeding habitat assessment in order to apply the Foraging Habitat Scoring Tool (DotEE 2017) to the vegetation of the study area. Consideration was also given to the wider availability of foraging habitat for black-cockatoos by placing the study area in a 12 km context using mapping from the Albany Regional Vegetation Survey (Sandiford and Barrett 2010).

4.3 Survey Team and Timing

The field work was carried out over two phases, with the initial phase consisting of a habitat tree assessment, and the follow-up second phase involving investigation of hollows (>100 mm opening) potentially suitable for cockatoo nesting using a drone. The first phase was carried out over a period of three days from 5 – 7 August 2019 by two Biota biologists, Brandon King and Simon Colwill, together with Shane Priddle from Southwest Environmental. Shane Priddle and Brandon King carried out the assessment using the RPA in the following week, on 15 August 2019.

The survey timing fell within the recommended (DotEE 2017) South Coast regional window for Baudin's Black-cockatoo (March to September), as the species is likely to occur in foraging habitat and may occur in areas of the south coast region if breeding. Carnaby's Black-cockatoo would primarily occur in the Albany area from January to July to forage, following breeding further inland, however the species may also occur after July if breeding in local areas. Forest Red-tailed Black-Cockatoos are known to breed throughout the year.

The timing of the survey overlapped the beginning of the breeding period for the Carnaby's and Baudin's Black Cockatoo species, taking place near the end of winter, but was not within the usual peak breeding times.

A total of 46.2 mm of rainfall was recorded over the survey period from 5 – 14 August and temperatures were mild, ranging from a minimum of 8°C to a maximum of 21.6°C (data from the Bureau of Meteorology's Albany recording station (No. 9500)).

4.4 Legislation and Policy Conformance

All surveys were completed as far as practicable in accordance with relevant State and Commonwealth policy, and to a standard that would provide adequate information to assess the Proposal against principles and environmental aims relating to the environmental factor 'Terrestrial Fauna' (EPA 2016a).

Table 4.3 provides a summary of the most important and relevant legislation, policy and guidelines relating to this study.

Consistent with the most practically applicable and current policy in relation to the three black-cockatoo species occurring within South-west Western Australia, the current study primarily represents a habitat assessment, and as recommended under DSEWPac (2012) the following was undertaken:

*"Assess the extent, type and quality of the vegetation present, including the presence and extent of plants known to be used by the black cockatoos. In potential breeding habitat, measurements of the diameter at breast height of trees in the patch of woodland/forest must be made to determine whether the habitat meets the definition of 'breeding habitat'. Surveys for black cockatoo foraging habitat should be done in any remaining vegetation containing proteaceous heath/woodland, eucalypt woodlands or forest (particularly marri and jarrah forest) and in areas dominated by *Pinus* spp. Any area within the range of the black cockatoos that contains known food or nesting plant species is considered to be potential habitat for the species."*

While in draft form, the current assessment was conducted to the standard of "Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptrorhynchus latirostris* Baudin's Cockatoo (Vulnerable) *Calyptrorhynchus baudinii* Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptrorhynchus banksii naso*" (DotEE 2017), particularly in relation to assessment of foraging habitat.

Table 4.3: State and Commonwealth legislation, policy and guidelines of most relevance to this study.

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Commonwealth		
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (the EPBC Act).	The Australian Government's central piece of environmental legislation.	The Department of the Environment and Energy
Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (DotE 2013).	Details the species falling within the MNES category and what constitutes a significant impact.	The Department of the Environment and Energy
EPBC Act referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (<i>Calyptrorhynchus latirostris</i>), Baudin's Cockatoo (<i>Calyptrorhynchus baudinii</i>) and the Forest Red-tailed Black Cockatoo (<i>Calyptrorhynchus banksii naso</i>) (DSEWPac 2012)	Details distribution, ecology and recommended survey methodology.	The Department of the Environment and Energy

Legislation, Guideline or Policy	Application to this Study	Regulating Authority
Western Australia		
<i>Biodiversity Conservation Act 2016</i> (BC Act) and Biodiversity Conservation Regulations 2018	Western Australia's central environmental legislation. Came into effect 1 January 2019 and replaces the <i>Wildlife Conservation Act 1950</i> .	Department of Biodiversity, Conservation and Attractions
<i>Wildlife Conservation Act 1950</i> (WC Act)	Now defunct and replaced by the BC Act, however the most recently published Wildlife Conservation (Specially Protected Fauna) Notice 2018 under this act is current at time of writing.	Department of Biodiversity, Conservation and Attractions
Environmental Factor Guideline: Terrestrial Fauna (EPA 2016a).	Overall aim of the study is to provide adequate information to assess the proposal against the objective of the environmental factor Terrestrial Fauna; stated to be "To protect terrestrial fauna so that biological diversity and ecological integrity are maintained".	Environmental Protection Authority

4.5 Nomenclature

Consistent with the EPA (2016b) technical guidelines for terrestrial vertebrate fauna survey, the avifauna nomenclature is in accordance with Christidis and Boles (2008).

This page is intentionally left blank.

5.0 Results

5.1 Desktop Review: Presence in the Local Area

NatureMap records indicate that all three species have distributions that include the study area; Albany represents the southeastern extent of the distribution of the Forest Red-tailed Black-cockatoo and is well within the distribution of both Carnaby's Black-cockatoo and Baudin's Black-cockatoo.

The two white-tailed black-cockatoo species appear to be most commonly recorded in the Albany area. For example, the Great Cocky Count assessed 22 potential roost sites in the Albany area in 2018 and recorded 557 white-tailed cockatoos (Peck et al. 2018), while no Forest Red-tailed Black-cockatoo individuals were recorded from roost sites. The study area occurs within 12 km of two roost sites assessed during the Great Cocky Count, identified by the suburb names 'Kalgan' (approximately 12 km northeast of the study area), at which 219 white-tailed black-cockatoos were recorded in the 2018 counts; and 'McKail' (within 2 km of the study area), where 49 white-tail black-cockatoos were recorded. An additional known roost site is known from Lake Seppings, 4.8 km from the study area, however, no cockatoos were recorded there during the 2018 count.

A resident population of Carnaby's Black-cockatoo is known to occur within the Stirling Range National Park (Everard and Bamford 2016) and the species has been recorded from the Porongurup National Park.

5.2 Suitable Diameter at Breast Height (DBH) Trees

A total of 516 'suitable DBH trees' (> 50 cm DBH) were recorded in the study area during the survey (Table 5.1). Tuart (historically planted), Marri and Jarrah accounted for the largest proportion of breeding habitat trees at 42%, 31% and 22% respectively. Only Jarrah and Marri trees were found to support hollows, and in some cases a single tree supported up to three hollows.

Table 5.1 Number of breeding habitat trees and hollows.

Tree Species	Breeding Habitat Trees	Number of Hollows
<i>Corymbia calophylla</i> (Marri)	162	20
<i>Eucalyptus diversicolor</i> (Karri)	9	0
<i>Eucalyptus gomphocephala</i> (Tuart)	216	0
<i>Eucalyptus marginata</i> (Jarrah)	112	28
<i>Eucalyptus megacarpa</i> (Bullich)	17	0
Total	516	48

5.3 Hollow Assessment

A total of 48 'hollows' with an entrance diameter greater than or equal to 10 cm were recorded in Jarrah and Marri. Overall, the large majority of hollows (86%) were marginal in entrance size suitability (between 10 and 15 cm), with only six hollows with entrance dimensions greater than 15 cm and the largest being 30 cm across. Hollow bearing trees had an average DBH of 71.1 ± 2.6 cm; on average, hollows were located 5.7 ± 0.47 m above the ground and were 13.2 ± 0.8 cm in diameter.

Based on the conservative criteria employed during the ground-assessment, 37 of the 48 hollows were considered to warrant further investigation using the RPA. Results from the follow-up survey indicated that none of the hollows were suitable for black-cockatoo nesting, primarily because the depth of the chambers was not adequate (Plate 5.1 - Plate 5.10). While not possible to

ascertain from the ground-assessment, images obtained from the RPA revealed that many of the 'hollows' were actually not hollow or lacked sufficient space for a black-cockatoo to turn around inside (see Plate 5.11 and Plate 5.12). One hollow was occupied by a Common Brushtail Possum and another by feral bees.

The Tuart (*Eucalyptus gomphocephala*) occurring within the study area are not native and have been planted quite a few decades ago as indicated by their DBH but none were found to support hollows. However, Tuarts do have the potential to form hollows and are recognised as important breeding trees on the Swan Coastal Plain (Johnstone et al. 2010).



Plate 5.1: Pic 1_0002. Drone tree ARR_01; spout trunk, 14 cm diameter, depth inadequate.



Plate 5.2: Pic 2_0007.

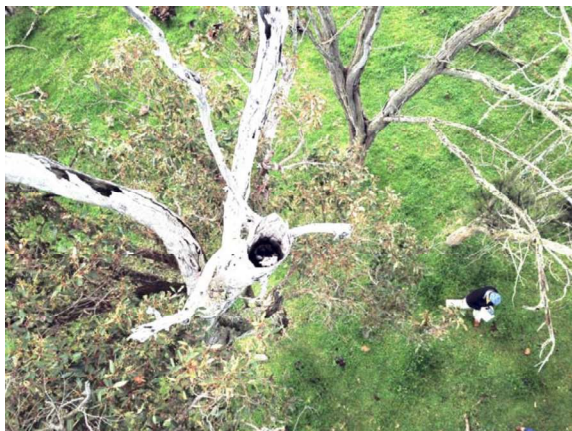


Plate 5.3: Pic 3_0013.



Plate 5.4: Pic 4_0025.



Plate 5.5: Pic 6_0030.



Plate 5.6: Pic 10_0044.



Plate 5.7: Pic 12_059.



Plate 5.8: Pic 19_0069.



Plate 5.9: Pic 20_0083.



Plate 5.10: Pic 22_0094.



Plate 5.11: Tree ARR_21; drone image before contrast manipulation.

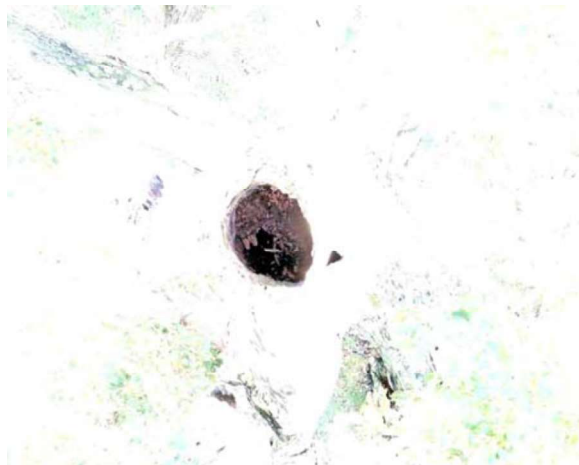


Plate 5.12: Tree ARR_21; drone image after contrast manipulation.

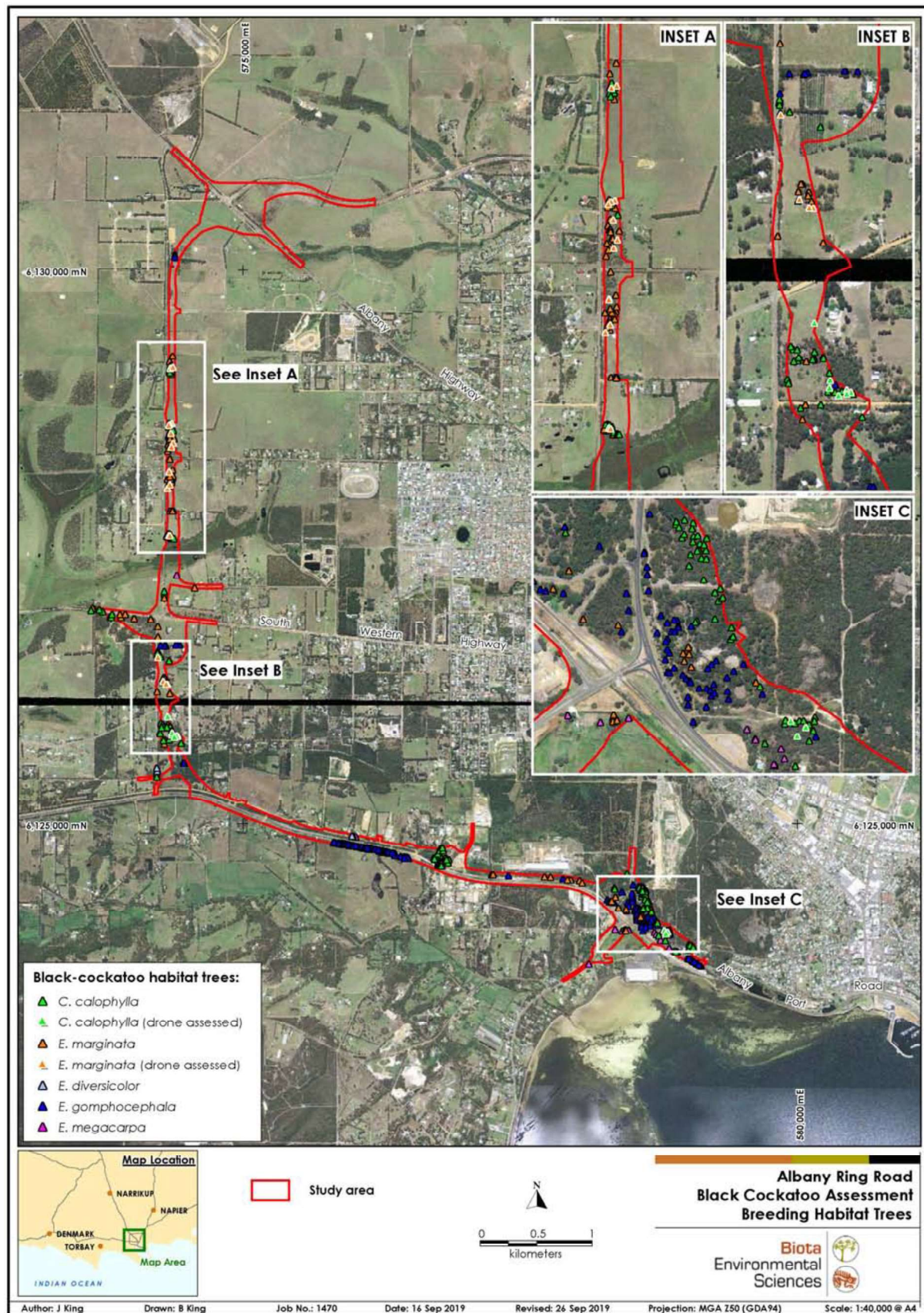


Figure 5.1: Black-cockatoo habitat trees recorded within the study area.

5.4 Foraging Habitat Assessment

The 185.0 ha study area includes 111.8 ha of cleared land, which is devoid of black-cockatoo foraging, breeding or roosting habitat. Using the detailed vegetation mapping of the study area prepared by Rathbone and Gilfillan (2018) as a guide, four vegetation units totalling 17.4 ha of native vegetation are likely to represent black-cockatoo foraging habitat. The foraging habitat quality score for each of these four vegetation units is shown in Table 5.2, while the scoring details are provided in Appendix 3. The distribution of this foraging habitat over the study area is shown in Figure 5.2. Table 5.3 includes descriptions of those vegetation units that are largely devoid of black-cockatoo foraging plants, however, in some areas of revegetation Jarrah and Marri have been planted which represent foraging plants.

Foraging habitat within the study area was largely represented by areas of Marri and Jarrah woodland, and evidence of all three species of black-cockatoo species utilising this habitat type has been previously described from characteristic chew marks on Marri nuts (Rathbone and Gilfillan 2018). The following vegetation units as described by Rathbone and Gilfillan (2018) were considered to represent the primary foraging habitat within the study area.

- Jarrah/Marri/Sheoak Laterite Forest with additional foraging plants including *Banksia grandis*, *Persoonia longifolia* and *Hakea amplexicaulis*;
- Marri/Jarrah Forest/Peppermint Woodland;
- Hakea spp. Shrubland/Woodland Complex with additional foraging plants including *E. marginata* and *Allocasuarina fraseriana*; and,
- Jarrah/Sheoak/*E. staeri* Sandy Woodland with additional foraging plants include *Banksia grandis* and *Hakea ruscifolia*.

In addition to these vegetation units, planted *Pinus radiata*, Jarrah and Marri occurred throughout the study area and also represent potential foraging habitat.

The Foraging Habitat Scoring Tool (DotEE 2017) has been applied to each vegetation type to assist with planning and offsetting (Table 5.2). It is important to note that the study area includes a buffer on the actual project disturbance footprint. Taking the entire study area into account, a starting score of High Quality is appropriate in many cases, as more than individual plants or small stands are included within this boundary, however, this is not necessarily the case for the smaller disturbance footprint, which should be scored separately.

Areas of Jarrah/Marri woodland returned foraging habitat scores indicative of very high quality for all three species of black-cockatoo. Areas largely devoid of Marri received lower scores for Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo (ranging from Low Quality to Quality). The scattered *Pinus radiata* throughout the study area were considered to represent singular/small groups of foraging plants for Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo, and as such qualified for a score indicating quality foraging habitat.

The Foraging Habitat Scoring Tool does include criteria that adjust the quality score downward, such as greater distances from known breeding areas and roosting sites. The study area occurs within the known breeding ranges of all three species as mapped in DotEE (2017), so no negative adjustments were applied on this basis. With regards to roosting sites, the Great Cocky Count includes at least two sites within 12 km of the study area, with white-tailed black-cockatoos recorded at both in 2018. In general, numbers of Forest Red-tailed Black-Cockatoos roosting in the vicinity of Albany are lower: no birds were recorded at roosts within 12 km of the study area in 2018, while in 2017 only 22 birds were recorded across the two roosts.

Table 5.2: Application of the Foraging Habitat Scoring Tool (DotEE 2017).

Low quality – 1-3; quality 4 – 5; high quality 6-7; very high quality 8-10.

Vegetation Unit	Area (ha)	Score		
		Baudin's	Carnaby's	Forest Red-tailed
Jarrah/Marri/Sheoak Laterite Forest	5.9	10	9	10
Marri/Jarrah Forest/Peppermint Woodland	5.7	10	9	10
Hakea spp. Shrubland/Woodland Complex	4.4	2	5	3
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1.4	4	3	10
Planted <i>Pinus radiata</i>	-	4	0	-
Planted Jarrah and Marri	-	6	3	1

Table 5.3: Vegetation units (Rathbone and Gilfillan 2018) largely devoid of black-cockatoo foraging plants.

Vegetation Units	Area (ha)
Cleared	111.8
Revegetation or Plantation ¹	33.2
<i>Taxandria juniperina</i> Closed Forest	5.9
>75% Invasive Weeds	5.6
<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket ²	4.8
Peppermint Low Forest	1.1
Mosaic <i>T. marginata</i> / <i>Gastrolobium bilobum</i> Granite Shrubland/Yate Woodland	1.0
<i>Evandra aristata</i> Sedgeland	0.5
<i>Taxandria marginata</i> Granite Shrubland	0.3
<i>Melaleuca preissiana</i> Low Woodland	0.1
Total	164.3

1. includes some individual *Pinus radiata* trees.2. *Callistemon* may be a foraging plant for Carnaby's Black-Cockatoo.

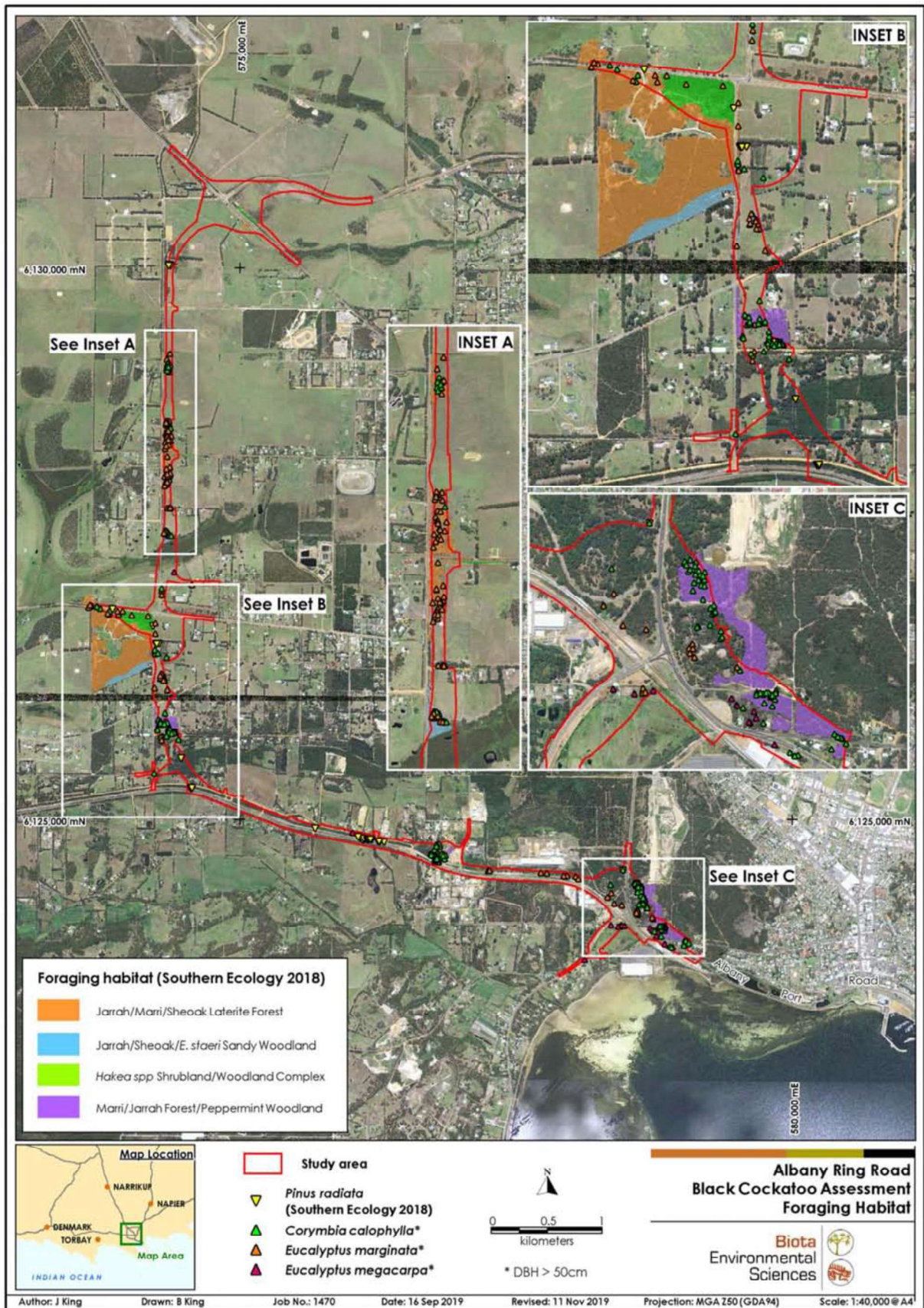


Figure 5.2: Potential black-cockatoo foraging habitat within the study area.

This page is intentionally left blank.

6.0 Discussion

Within the Ultimate Footprint study area, up to 516 'suitable DBH trees' and 48 hollows were identified and marked. None of the 37 hollows followed up during the RPA assessment were found to be suitable for nesting. For the most part, the dimensions of the hollow entrances were marginal and caverns inside were far too small to support nesting.

The black-cockatoo foraging habitat within the study area has been considered in the context of wider availability using the meso-scale mapping of concordant vegetation units from the Albany Regional Vegetation Survey (Sandiford and Barrett 2010), out to a radius of 12 km around the study area (see Figure 6.1). This radius was chosen as it represents the typical maximum distance that black-cockatoos will fly from roosting locations to forage, under the hypothetical premise that cockatoos were roosting within the study area. The areas of each vegetation unit within the study area and in a 12 km radius are detailed in Table 6.1, while their occurrence is illustrated in Figure 6.1. In the immediate vicinity of the study area, the same foraging vegetation units occur within the Albany Mounts and in the crown reserve south-west of the intersection of South Coast Highway and George Street. Larger swathes of these same vegetation units are found within the Stirling Range National Park, Down Road Nature Reserve and Bakers Junction Nature Reserve.

Table 6.1: Foraging habitat within the study area and ARVS equivalent within 12 km.

Study Area	ARVS Code	Complex Definition	Within Study Area (ha)	Within 12 km (ha)
Afra/Emar/Ccal/Athe	12a	Jarrah/Marri/Sheoak Laterite Forest	5.9	5,077.5
Ccal/Afle	10	Marri/Jarrah Forest/Peppermint Woodland	5.7	475.8
Hspp/Complex	31	Hakea spp. Shrubland/Woodland Complex	4.4	1,101.8
Emar/Afra/Esta	13	Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1.4	2,101.7
Total			17.4	8,756.8

32 Cube:Current:1470 (Albany Ring Road Cockatoo Tree Assessment):Documents:1470 ARR BC Assessment_Rev0.docx

7.0 References

- Christidis, L., and W. E. Boles (2008). *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing, Melbourne.
- DoE (2013). Matters of National Environmental Significance - Significant Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999*. Department of the Environment, Canberra, Australia.
- DoEE (2017). Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*). Department of the Environment and Energy, Commonwealth of Australia.
- DSEWPaC (2012). EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered), *Calyptorhynchus latirostris*; Baudin's cockatoo (vulnerable), *Calyptorhynchus baudinii*; Forest red-tailed black cockatoo (vulnerable), *Calyptorhynchus banksii naso*. Department of Sustainability, Environment, Water, Population and Communities, Commonwealth of Australia.
- EPA (2016a). *Environmental Factor Guideline: Terrestrial Fauna*. Environmental Protection Authority, Western Australia.
- EPA (2016b). *Technical Guidance: Terrestrial Fauna Surveys*. Environmental Protection Authority, Western Australia.
- Everard, C., and M. Bamford (2016). Southdown Magnetite Project Summary of studies and impact assessment Carnaby's Black-Cockatoo (Rev 12.7). Unpublished Report for Southdown Joint Venture, Bamford Consulting Ecologists.
- Johnstone, R. E., C. Johnstone, and T. Kirkby (2010). Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) on the Swan Coastal Plain (Lancelin – Dunsborough), Western Australia. Studies on distribution, status, breeding, food, movements and historical changes. Department of Planning, Western Australia.
- Johnstone, R. E., and T. Kirkby (2008). Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (*Calyptorhynchus baudinii*) in South-west Western Australia. *Records of the Western Australian Museum* 25:107–118.
- Johnstone, R. E., and T. Kirkby (2011). Black Cockatoos on the Swan Coastal Plain. Department of Planning, Western Australia.
- Johnstone, R. E., T. Kirkby, and K. Sarti (2013). The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* Gould in south-western Australia. I. Characteristics of nest trees and nest hollows. *Pacific Conservation Biology* 19:121–142. doi: 10.1071/PC130121.
- Johnstone, R. E., and G. M. Storr (1998). *Handbook of Western Australian Birds Volume I - Non-Passerines (Emu to Dollarbird)*. Western Australian Museum, Perth.
- Peck, A., G. Barrett, and M. Williams (2018). The 2018 Great Cocky Count: A community-based survey for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*). BirdLife Australia, Floreat, Western Australia.
- Rathbone, D., and S. Gilfillan (2018). Biological Survey: Albany Ring Road. Southern Ecology, Torbay WA.

- Sandiford, E. M., and S. Barrett (2010). Albany regional vegetation survey: Extent, type and status. A project funded by Western Australian Planning Commission (EnviroPlanning "Integrating NRM into Land Use Planning" and State NRM Program), South Coast Natural Resource Management Inc. and City of Albany for the Department of Environment and Conservation, Department of Environment and Conservation, Western Australia.
- Saunders, D. A. (1979). Distribution and Taxonomy of the White-tailed and Yellow-tailed Black-Cockatoos *Calyptrorhynchus* spp. *Emu* 79:215–227.
- Saunders, D. A., R. Dawson, A. Doley, J. Lauri, A. Le Souef, P. R. Mawson, K. Warren, and N. White (2014a). Nature conservation on agricultural land: a case study of the endangered Carnaby's Cockatoo *Calyptrorhynchus latirostris* breeding at Koobabbie in the northern wheatbelt of Western Australia. *Nature Conservation* 9:19–43.
- Saunders, D. A., P. Mawson, and R. Dawson (2011). The impact of two extreme weather events and other causes of death on Carnaby's Black Cockatoo: a promise of things to come for this species? *Pacific Conservation Biology* 17:141–148. doi: <https://doi.org/10.1071/PC110141>.
- Saunders, D. A., P. R. Mawson, and P. R. Dawson (2014b). Use of tree hollows by Carnaby's Cockatoo and the fate of large hollow-bearing trees at Coomallo Creek, Western Australia 1969–2013. *Biological Conservation* 177:185–193. doi: <https://doi.org/10.1016/j.biocon.2014.07.002>.
- Serventy, D. L., and H. M. Whittell (1976). *Birds of Western Australia*. University of Western Australia Press.
- Whitford, K., and M. R. Williams (2002). Hollows in jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees II. Selecting trees to retain for hollow dependent fauna. *Forest Ecology and Management* 160:215–232.

Appendix 1



Tree Hollow Data



Flora Species	DBH (mm)	Latitude	Longitude	Number of Hollows	Hollow Size/s (mm)	Comment
<i>Corymbia calophylla</i>	500	-35.0176983	117.8421097	2	100,100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	500	-35.0233359	117.8641153	1	150	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	550	-35.02327559	117.8636603	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	550	-34.9914124	117.8145234	1	100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	610	-35.0232296	117.8637886	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	700	-35.0077357	117.8155675	1	100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	740	-35.0076863	117.8154499	1	300	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	750	-35.0077681	117.8154498	1	100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	770	-35.0176226	117.8422384	2	100,100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	850	-35.020017	117.8616057	1	200	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Corymbia calophylla</i>	870	-35.0076482	117.814969	1	150	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	920	-35.0061519	117.8145263	2	150,100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	950	-35.0074739	117.8149892	1	200	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	1010	-35.0234957	117.8639284	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Corymbia calophylla</i>	1080	-35.0078189	117.8152168	1	150	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	500	-34.9862827	117.8144703	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	500	-34.9778163	117.814501	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	520	-34.9772517	117.8144266	2	300,100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	530	-34.9777293	117.814756	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	560	-34.9823121	117.8147209	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	570	-34.9823641	117.8145375	1	150	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	570	-34.9914377	117.8146041	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	580	-34.9837872	117.8145984	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	600	-34.9830831	117.8146528	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	600	-34.9840263	117.8143454	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	630	-34.9862442	117.8144751	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	650	-34.98421394	117.8145071	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	680	-34.983879	117.8148551	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	720	-34.9914673	117.8142802	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	730	-34.99167898	117.8148354	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	730	-35.0013403	117.8135289	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	730	-34.9875881	117.8143155	2	100,100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	750	-35.0029378	117.8141212	1	100	Ground assessment: Hollow(s) not suitable for BC nesting
<i>Eucalyptus marginata</i>	770	-34.98421476	117.8146859	1	200	Drone result: Unlikely suitable for BC nesting

Albany Ring Road Black-cockatoo Habitat Assessment

Flora Species	DBH (mm)	Latitude	Longitude	Number of Hollows	Hollow Size/s (mm)	Comment
<i>Eucalyptus marginata</i>	820	-35.0034959	117.8144761	2	200,100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	870	-35.0032962	117.8140749	1	120	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	910	-34.9872888	117.8145547	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	930	-34.9824702	117.8144144	1	100	Drone result: Unlikely suitable for BC nesting
<i>Eucalyptus marginata</i>	950	-35.0034871	117.8143589	1	100	Drone result: Unlikely suitable for BC nesting

Appendix 2

Foraging Habitat Scoring Tool



Table 3: Foraging habitat scoring tool

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black cockatoo
10 (Very high quality)	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation , and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of, successful rehabilitation , and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation , and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a score of ≥ 10 .
7 (High quality)	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as <i>Banksia</i> spp. (including <i>Dryandra</i> spp.), <i>Hakea</i> spp. and <i>Grevillea</i> spp., as well as native eucalypt woodland and forest that contains foraging species, including along roadsides. Does not include orchards, canola, or areas under a RFA.	Native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly marri, including along roadsides. Does not include orchards or areas under a RFA.	Jarrah and marri woodlands and forest, and edges of karri forests, including wandoo and blackbutt, within the range of the subspecies, including along roadsides. Does not include areas under a RFA.
5 (Quality)	Pine plantation or introduced eucalypts.	Pine plantation or introduced eucalypts.	Introduced eucalypts as well as the introduced Cape lilac (<i>Melia azedarach</i>).
1 (Low quality)	Individual foraging plants or small stand of foraging plants.	Individual foraging plants or small stand of foraging plants.	Individual foraging plants or small stand of foraging plants.
Additions	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat
+3	Is within the Swan Coastal Plain (important foraging area).	Is within the known foraging area (see map).	Jarrah and/or marri show good recruitment (i.e. evidence of young trees).
+3	Contains trees with suitable nest hollows.	Contains trees with suitable nest hollows.	Contains trees with suitable nest hollows.
+2	Primarily comprises marri.	Primarily contains marri.	Primarily contains marri and/or jarrah.
+2	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo).
+1	Is known to be a roosting site.	Is known to be a roosting site.	Is known to be a roosting site.
Subtractions	Context adjustor - attributes reducing functionality of foraging habitat	Context adjustor - attributes reducing functionality of foraging habitat	Context adjustor - attributes reducing functionality of foraging habitat quality
-2	No clear evidence of feeding debris.	No clear evidence of feeding debris.	No clear evidence of feeding debris.
-2	No other foraging habitat within 6 km.	No other foraging habitat within 6 km.	No other foraging habitat within 6 km.
-1	Is > 12 km from a known breeding location.	Is > 12 km from a known breeding location.	Is > 12 km from a known breeding location.
-1	Is > 12 km from a known roosting site.	Is > 12 km from a known roosting site.	Is > 12 km from a known roosting site.
-1	Is > 2 km from a watering point.	Is > 2 km from a watering point.	Is > 2 km from a watering point.
-1	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker).	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker).	Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker).

Appendix 3



Foraging Habitat Scoring



Appendix 3.1: Carnaby's Black-Cockatoo

Vegetation Description	Starting Score	+3: Is within the Swan Coastal Plain (important foraging area).	+3: Contains trees with suitable nest hollows.	+2: Primarily comprises Marri	+2: Contains trees with potential to be used for breeding (DBH \geq 50 cm)	+1: Is known to be a roosting site	-2: No clear evidence of feeding debris	-2 No other foraging habitat within 6 km	-2: Is >12 km from a known breeding location	-1: Is >12 km from a known roosting site	-1: Is >2 km from a watering point	-1: Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Final Score
Jarrah/Marri/Sheoak Laterite Forest	7				2								9
Marri/Jarrah Forest/Peppermint Woodland	5			2	2								9
Hakea spp. Shrubland/Woodland Complex	7						-2						5
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1				2								3
Planted <i>Pinus radiata</i>	1						-2						0
Planted Jarrah and Marri	1				2								3

Appendix 3.2: Baudin's Black-Cockatoo

Vegetation Description	Starting Score	+3: Is within the known foraging area	+3: Contains trees with suitable nest hollows.	+2: Primarily comprises Marri	+2: Contains trees with potential to be used for breeding (DBH \geq 50 cm)	+1: Is known to be a roosting site	-2: No clear evidence of feeding debris	-2 No other foraging habitat within 6 km	-2: Is >12 km from a known breeding location	-1: Is >12 km from a known roosting site	-1: Is >2 km from a watering point	-1: Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Final Score
Jarrah/Marri/Sheoak Laterite Forest	7	3			2								12
Marri/Jarrah Forest/Peppermint Woodland	7	3		2	2								14
Hakea spp. Shrubland/Woodland Complex	1	3					-2						2
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	1	3			2								4
Planted <i>Pinus radiata</i>	1	3											4
Planted Jarrah and Marri	1	3			2								6

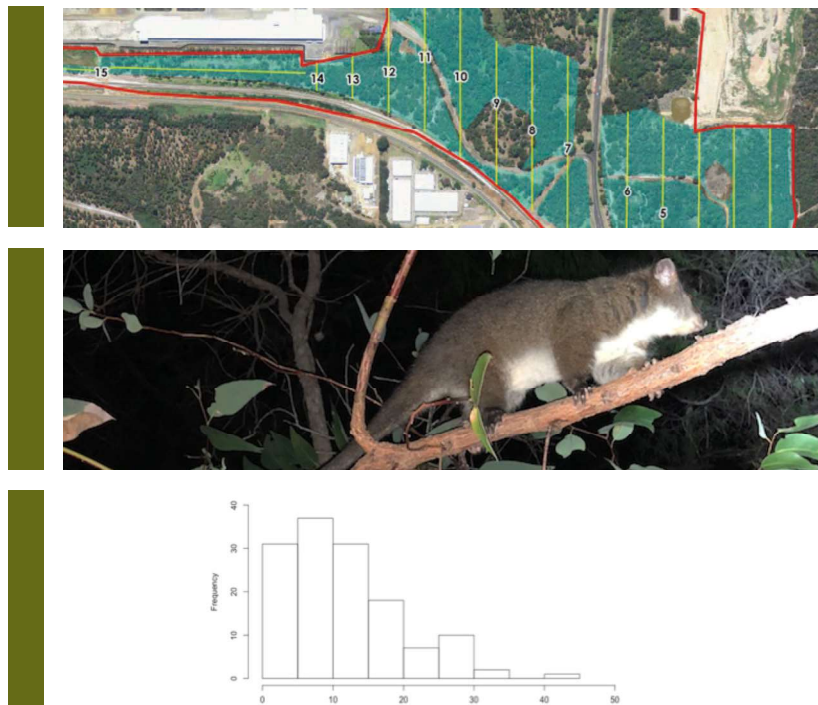
Appendix 3.3: Forest Red-tailed Black-Cockatoo

Vegetation Description	Starting Score	+3: Jarrah shows good recruitment.	+3: Contains trees with suitable nest hollows.	+2: Primarily Contains Marri and/or Jarrah	+2: Contains trees with potential to be used for breeding (DBH ≥ 50 cm)	+1: Is known to be a roosting site	-2: No clear evidence of feeding debris	-2 No other foraging habitat within 6 km	-2: Is >12 km from a known breeding location	-1: Is >12 km from a known roosting site	-1: Is >2 km from a watering point	-1: Disease present (e.g. <i>Phytophthora cinnamomi</i> or marri canker)	Final Score
Jarrah/Marri/Sheoak Laterite Forest	7	3		2	2								14
Marri/Jarrah Forest/Peppermint Woodland	7	3		2	2								14
Hakea spp. Shrubland/Woodland Complex	1	3											4
Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland	7	3			2		-2						10
Planted <i>Pinus radiata</i>	-												-
Planted Jarrah and Marri	1				2		-2						1

Appendix F – Albany Ring Road, Western Ringtail Possum Assessment (Biota, 2020)

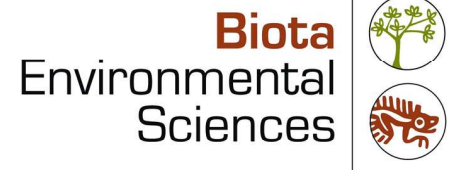


Albany Ring Road Project Western Ringtail Possum Assessment



Main Roads Western Australia

May 2020



© Biota Environmental Sciences Pty Ltd 2020

This document has been prepared to the requirements of the client identified on the cover page and no representation is made to any third party. It may be cited for the purposes of scientific research or other fair use, but it may not be reproduced or distributed to any third party by any physical or electronic means without the express permission of the client for whom it was prepared or Biota Environmental Sciences Pty Ltd.

This report has been designed for double-sided printing. Hard copies supplied by Biota are printed on recycled paper.

Albany Ring Road WRP Assessment

Contents

1.0	Summary	7
2.0	Introduction	9
2.1	Project Background	9
2.2	Current IUCN Conservation Ranking of the Western Ringtail Possum: Rationale and Threats	9
2.3	Study Purpose	10
2.4	Scale of Consideration	10
3.0	Methods	13
3.1	Survey Timing, Personnel and Permits	13
3.2	Survey Design	13
4.0	Results	21
4.1	Project Area	21
4.2	Local Context Area: Down Road Nature Reserve	23
5.0	Discussion	27
6.0	References	31

Appendix 1

Raw Observation Data

Tables

Table 2.1:	Description of project tiers used to provide context for the Albany Ring Road Western Ringtail Possum Assessment.	10
Table 3.1:	Vegetation units (after Sandiford and Barrett 2010) surveyed as part of the Western Ringtail Possum distance sampling program in the Down Road Nature Reserve.	14
Table 4.1:	Key summary statistics from the Distance Sampling program for Western Ringtail Possum observations (equals clusters) in the CSBP and Old Tip sites (ER = Encounter Rate, n = number of observations, k = number of transects, cv = coefficient of variation).	23
Table 4.2:	Density estimates for Western Ringtail Possums (individuals) in the CSBP and Old Tip sites (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).	23
Table 4.3:	Abundance estimates for Western Ringtail Possums (individuals) in Bakers Junction Nature Reserve (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).	23
Table 4.4:	Key summary statistics from the Distance Sampling program for Western Ringtail Possum observations (equals clusters) in Down Road Nature Reserve (ER = Encounter Rate, n = number of observations, k = number of transects, cv = coefficient of variation).	24
Table 4.5:	Density estimates for Western Ringtail Possums (individuals) in Down Road Nature Reserve (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).	24

Table 4.6:	Abundance estimates for Western Ringtail Possums (individuals) in Down Road Nature Reserve (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).	24
Table 5.1:	Density and population estimates for four sites at which distance sampling has been undertaken in the Albany region.	28
Table 5.2:	Broader extent of the sampled vegetation units within the ARVS (Sandiford and Barret 2010) and the estimated abundance of Western Ringtail Possum given an average density of 0.5 ha ⁻¹ .	29

Figures

Figure 2.1	The Albany Ring Road Project Area and Down Road Nature Reserve Study Area.	11
Figure 2.2:	Locations of the Project Area, Down Road Nature Reserve and additional contextual sites (Bakers Junction Nature Reserve, Mt Clarence, Mt Adelaide and Mt Melville).	12
Figure 3.1:	Distance sampling transects (Transects 2 – 14) within the CSBP site and strip transects (Transects 15 to 24) within the Albany Ring Road Project Area.	16
Figure 3.2:	Strip transects (Transects 19 to 60) within the Albany Ring Road Project Area (continued).	17
Figure 3.3:	Distance sampling transects (Transects 52 – 61) within the Old Tip site and strip transects (Transects 50 to 95) within the Albany Ring Road Project Area (continued).	18
Figure 3.4:	Strip transects (Transects 92 to 95) within the Albany Ring Road Project Area (continued).	19
Figure 3.5:	Proposed transects layout for the Western Ringtail Possum distance sampling program in the Down Road Nature Reserve study area.	20
Figure 4.1:	Histogram of all Western Ringtail Possum observations from Down Road Nature Reserve, Bakers Junction Nature Reserve, the Old Tip site and the CSBP site (n=137) (n.b. observations include occasions where two individuals were seen together. The tally of individuals was 156).	22
Figure 4.2:	Histogram of Western Ringtail Possum observations from Down Road Nature Reserve, Bakers Junction Nature Reserve, the Old Tip site and the CSBP site with hazard-rate Probability Detection Function and truncation at 20 m.	22
Figure 4.3:	Histogram of all Western Ringtail Possum observations from the Down Road Nature Reserve (n=80) (note: observations include occasions where two individuals were seen together. The tally of individuals was 86).	24
Figure 4.4:	Histogram of Western Ringtail Possum observations from the Down Road Nature Reserve with half-normal Probability Detection Function and truncation at 20 m.	24
Figure 4.5:	Observations of the Western Ringtail Possum within the Project Area from both Distance Sampling and Strip Sampling.	25
Figure 4.6:	Locations from which Western Ringtail Possums were recorded within the Down Road Nature Reserve.	26

1.0 Summary

The Albany Ring Road project is a proposed staged development to support freight growth in the City of Albany, by creating an alternative route for heavy vehicles accessing Albany Port and remove the necessity for these vehicles to travel through built up urban areas of the City. Stage 1 is complete and Stage 2 and Stage 3, the focus of this study, will connect Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road allowing access to the port.

This report presents the results of sampling for the Western Ringtail Possum within the Albany Ring Road Project Area (the "Project Area" hereafter) as well as local and regional contextual sampling. Central to the overall assessment of the significance of the Western Ringtail Possum habitat encompassed by the Project Area is the provision of local and regional context. To provide local context, distance sampling was undertaken in the Down Road Nature Reserve located approximately 4 km north-west of the Project Area. The contextual assessment is extended further by comparison with abundance estimates derived for Bakers Junction Nature Reserve, Mt Melville, Mt Clarence and Mt Adelaide. Finally, the assessment extrapolates the density estimates to the extent of the Albany Regional Vegetation Survey to provide an 'Around Albany' sub-population estimate. Assumptions are presented that provide caveats relevant to this extrapolation of density estimates.

Two sampling methods were used within the Project Area: (i) strip sampling was employed in areas where the habitat comprised individual isolated trees or narrow strips of vegetation, and (ii) distance sampling was used over larger remnants (the Old Tip site and CSBP site). At the Down Road Nature Reserve context site, distance sampling was applied to the entire site.

Within the Project Area 16.2 km of strip transects yielded 13 observations of Western Ringtail Possums and, when the expected number of individuals based on distance sampling in the Old Tip site and CSBP site are included, the abundance estimate for the Project Area increased to between 20 and 37 individuals. For the area of habitat sampled (92.2 ha) this represents a density estimate ranging between 0.22 – 0.40 individuals per hectare.

The sampled area of Down Road Nature Reserve (363 ha) was estimated to support 452 ± 85 (95% CI 312 – 656) individuals for a density estimate of 1.246 ± 0.234 individuals per hectare.

At a regional scale, further distance sampling effort has been applied to three other remnant habitat sites, at Bakers Junction Nature Reserve, Mt Melville, Mt Clarence and Mt Adelaide where a combined estimate of 1,480 (95% CI 894 – 2,465) Western Ringtail Possums in an area of 4,400 ha was calculated.

If an average density estimate of 0.8 individuals per hectare (derived from the two largest areas surveyed: Down Road Nature Reserve and Bakers Junction Nature Reserve) is extrapolated to the mapped extent of the vegetation units surveyed within the Albany Regional Vegetation Survey boundary (a combined area of 21,633 ha), an estimate of 17,306 Western Ringtail Possums is obtained. Not all of this habitat would necessarily be utilised by Western Ringtail Possums, due either to land clearing that has occurred since 2010 (when the mapping was completed), recent fires or degradation from a variety of pressures. Nor is it necessarily accurate to apply a uniform density across the region encompassed by the mapping. However, the approach does indicate that the population estimate for the 'Around Albany' sub-population is considerably larger than the 500 reported in the IUCN assessment, perhaps by an order of magnitude.

This page intentionally blank.

2.0 Introduction

2.1 Project Background

The Albany Ring Road project is a proposed staged development to support freight growth in the City of Albany, by creating an alternative route for heavy vehicles accessing Albany Port and remove the necessity for these vehicles to travel through built up urban areas of the City. Stage 1 is complete and Stage 2 and Stage 3, the focus of this document, will connect Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road allowing access to the port (Figure 2.1).

A biological assessment of Stages 2 and 3 was undertaken in late 2017 (Rathbone and Gilfillan 2018) and determined that the Western Ringtail Possum *Pseudocheirus occidentalis*, which is listed as Critically Endangered at both State and Commonwealth levels, utilised a large proportion of the study area. Rathbone and Gilfillan (2018) categorised habitat as either Core, Supporting, Linkages or Likely Linkages. They subsequently identified areas of Core habitat in the southern section of their survey area, coincident with reserves and some remnants on private property. Supporting habitat included large areas in the east of their survey area predominantly within land owned by CSBP. Important habitat linkages were identified along the rail reserve, between Elleker Road and the railway line and along Link Road, south of Lancaster Road and on George Street. Much of the remaining habitat was identified as Likely Linkages.

2.2 Current IUCN Conservation Ranking of the Western Ringtail Possum: Rationale and Threats

The most recent assessment of the conservation status of the Western Ringtail Possum took place in 2014 and was published in 2017 (Burbidge and Zichy-Woinarski 2017). This re-assessment determined that the conservation ranking should be Critically Endangered under the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. The key elements of the justification for the ranking were:

- An area of occupancy of <500 km² (area of occurrence 40,000 km²).
- Small severely fragmented populations.
- A continuing decline (threats being a drying climate, urban development, inappropriate fire regime, predation by foxes and cats).
- The upper Warren sub-population, which was identified as the largest prior to 2002, underwent a severe decline (>95%) between 1998 and 2009 (from >10,000 individuals to near extirpation).
- Remaining fragmented populations in coastal habitats also rapidly declining (equating to an overall population decline of >80% in the past 10 years).
- Predicted further decline of >80% within the next 10 years.

The following 2015 abundance estimates are quoted within the IUCN Red List for the five recognised subpopulations of Western Ringtail Possum with Dr B. Jones cited as the source:

- Southern Swan: 2,000
- Cape to Cape: 500
- Other Forest Rivers: 300
- Upper Warren: 100
- Around Albany: 500

These subpopulation estimates yield a 2015 total of about 3,400 adult Western Ringtail Possums (Burbidge and Zichy-Woinarski 2017). At the time of assessment they were considered to occur "...patchily in coastal areas from near Bunbury to the Leeuwin-Naturaliste National Park and near Albany (B. Jones pers. comm)." The authors go on to say that "Most of these fragmented habitat remnants are on private land" (Burbidge and Zichy-Woinarski 2017).

2.3 Study Purpose

This study details the results of targeted sampling for the Western Ringtail Possum within the Project Area as well as at a context site, the Down Road Nature Reserve (Figure 2.1). These results are also placed in further regional scale context by comparison with density estimates for Bakers Junction Nature Reserve, Mt Melville, Mt Clarence and Mt Adelaide which have been reported on separately (Figure 2.2). Finally, results of this local and regional work are placed in the wider “Around Albany” context.

2.4 Scale of Consideration

Four scales of geographic context are applied in this study (Project Area, Down Road Nature Reserve, Regional Scale and ‘Around Albany sub-population’) as defined in Table 2.1 and shown in Figure 2.1 and Figure 2.2.

To define the ‘Around Albany’ Western Ringtail Possum subpopulation identified (but undefined) in the IUCN conservation ranking published in 2017 (Burbidge and Zichy-Woinarski 2017), we have considered it to be equivalent to the extent of the Albany Regional Vegetation Survey (Sandiford and Barrett 2010). This is considered an appropriate definition for the ‘Around Albany’ sub-population as Sandiford and Barrett (2010) provides a detailed (67 native vegetation units mapped) thematic layer within which potential Western Ringtail Possum habitat can be identified, and for which density estimates can be extrapolated from the aforementioned distance sampling programs.

Table 2.1: Description of project tiers used to provide context for the Albany Ring Road Western Ringtail Possum Assessment.

Tiers	Description
Project Area	Various polygons along the length of the proposed Albany Ring Road route encompassing an area of 92.2 hectares (ha) (Figure 2.1).
Down Road Nature Reserve	The area adjacent to the Project Area within which a local context was ascertained. Specifically, the context is provided by a distance sampling program undertaken in the Down Road Nature Reserve that surveyed 21.8 kilometres (km) of line transects over seven nights. The reserve encompasses approximately 777.3 ha of which approximately 363 ha encompasses vegetation units sampled by the survey. Approximately one third of the reserve was burnt one month prior to the survey and this area has been estimated and excluded from all calculations.
Regional Scale	Extends context to include results of distance sampling programs in Bakers Junction Nature Reserve, Mt Melville, Mt Clarence and Mt Adelaide (Biota 2018a).
‘Around Albany’ sub-population	The IUCN species account for the Western Ringtail Possum (Burbidge and Zichy-Woinarski 2017) identifies ‘Around Albany’ as one of five sub-populations for the species. The geographic extent of this sub-population is not described any further by the IUCN account. This study recommends that for the purpose of this assessment, an area coincident with the boundary of the Albany Regional Vegetation Survey (ARVS) (Sandiford and Barrett 2010) be used to circumscribe the range of the ‘Around Albany’ subpopulation. The ARVS provides a description and extent of vegetation types encompassing 124,415 ha, bounding the Albany town site by 30 km to the east and west and 20 km to the north.

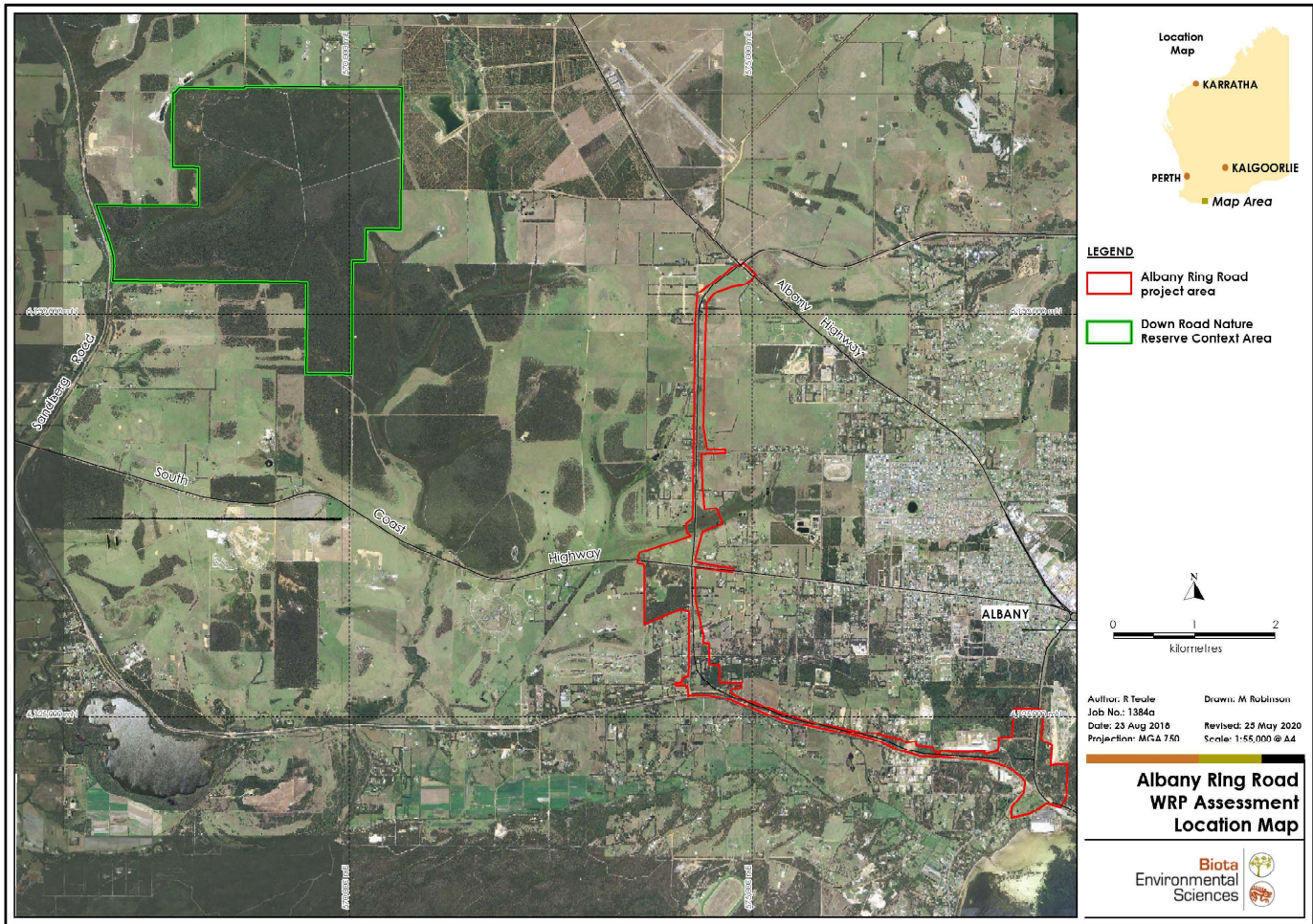


Figure 2.1 The Albany Ring Road Project Area and Down Road Nature Reserve Study Area.

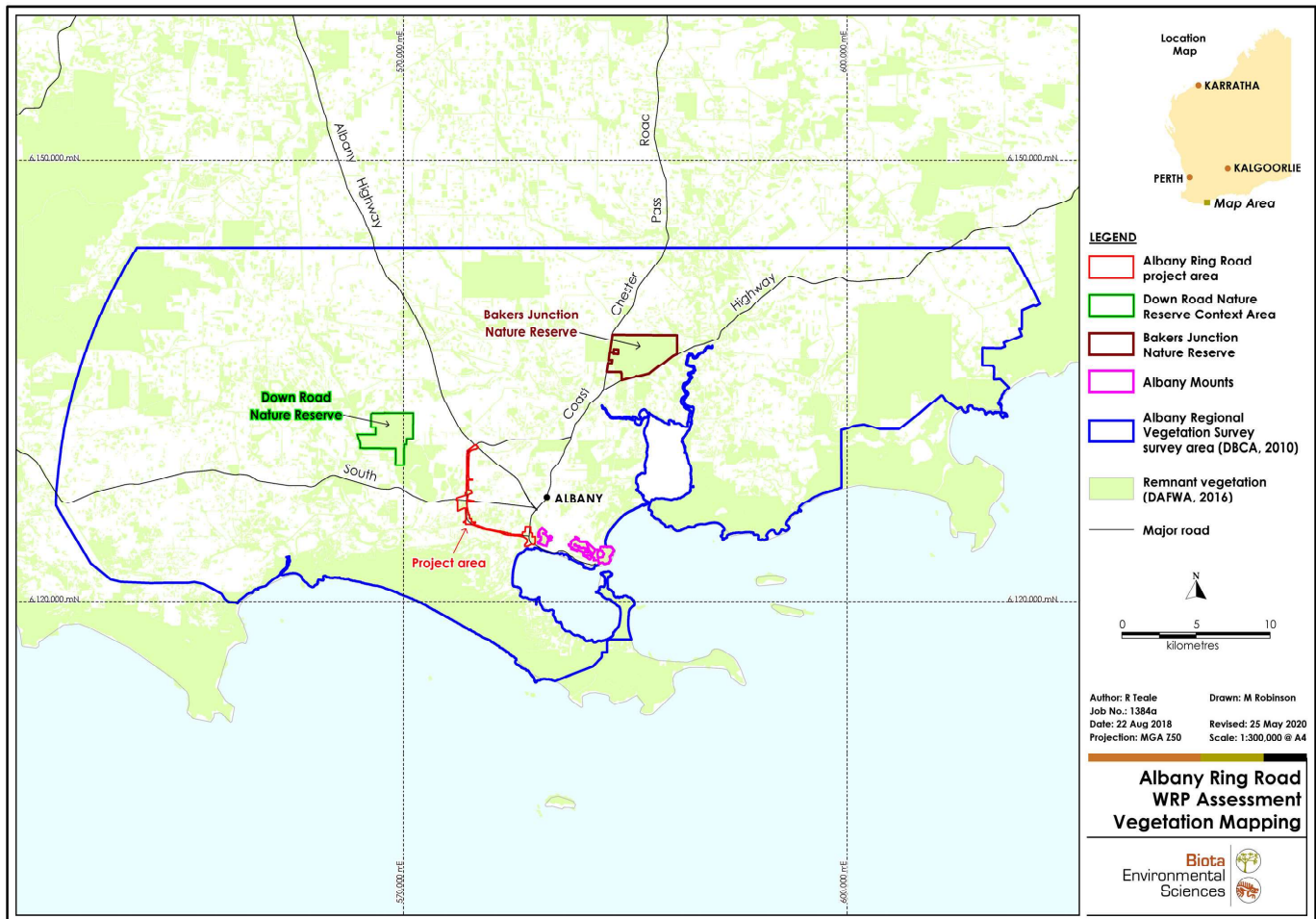


Figure 2.2: Locations of the Project Area, Down Road Nature Reserve and additional contextual sites (Bakers Junction Nature Reserve, Mt Clarence, Mt Adelaide and Mt Melville).

3.0 Methods

3.1 Survey Timing, Personnel and Permits

The survey was undertaken over 11 nights between 5 July and 21 July 2018 by Roy Teale, Stewart Ford, Victoria Ford and Zoe Hamilton all of Biota Environmental Sciences under a Department of Biodiversity, Conservation and Attractions (DBCA) Regulation 17 Licence to take fauna for scientific purposes (08-002410-1).

3.2 Survey Design

3.2.1 Project Area: Strip Transects and Line Transect Distance Sampling

Areas of scattered trees and shrubs and narrow vegetation remnants within the Project Area were surveyed using strip transects (Figure 3.1 - Figure 3.4). Each transect was at most 20 m in width and varied in length between 35 m and 1,376 m. The total length of strip transects in the Project Area was 16.2 km. The 20 m width was selected to yield greater than 90% probability of detection as derived from modelled detection functions fitted to perpendicular distances of Western Ringtail Possum sightings data from other studies (see Section 4.1).

Each 20 m wide strip transect was systematically searched for Western Ringtail Possums by a zoologist using a high-powered head torch. Survey work commenced at approximately 30 min after sunset and ended by 12:30 am. In some areas where the Road Reserve comprised scattered single trees, spotlighting was conducted from a vehicle. In all cases, the location of an observed possum was recorded using a handheld GPS while standing directly below the possum.

When complete detectability is less certain (i.e. probability of detection is less than 1.0, such as when surveying over large areas) other approaches must be adopted that allow the probability of detection and the effective survey area to be estimated. Distance sampling is one such method and is a robust and well documented approach to estimating density. Line transect distance sampling was undertaken at two locations within the Project Area; the George Street Old Tip site and the CSBP Fertiliser site. The Old Tip site encompassed approximately 35 ha and was sampled by ten line transects spaced at 75 m intervals yielding a total effort (combined transect length) of 3.9 km. The CSBP site encompassed approximately 17 ha and was traversed by nine line transects spaced at 75 m intervals with a combined effort of 2.3 km. Distance sampling of these sites followed the methodology in Section 3.3.2.

3.2.2 Down Road Nature Reserve: Line Transect Distance Sampling

To provide local context for the assessment of the habitat within the Project Area, a distance sampling approach (Buckland et al. 2001) was used to estimate the density and abundance of Western Ringtail Possums within the Down Road Nature Reserve (Study Area). Down Road Nature Reserve is a large habitat remnant (777.3 ha) that lies approximately 4 km to the west of the Project Area (see Figure 2.1) and was considered likely to support Western Ringtail Possums.

A total of 50 km of transect was initially proposed for survey (Biota 2018b) however, a fire burnt approximately one third of the Reserve one month prior to the survey and these burnt sections were excluded. The Study Area sampling program was subsequently designed around 17 north-south and 47 east-west oriented parallel line-transects spaced 75 m apart and spanning the entire extent of unburnt sections of the Nature Reserve (Figure 3.5). However, transects generally took longer to complete than initially anticipated, especially those transects within the *Hakea* spp. Shrubland / Woodland Complex vegetation unit (of the ARVS by Sandiford and Barrett (2010)), and the majority of the transects within this vegetation unit were not sampled. Of the initial 50 km of planned transects (Biota 2018b), 21.8 km were actually sampled during this study.

Sandiford and Barrett (2010) define 11 vegetation units within the Down Road Nature Reserve, of which three (considered to represent primary habitat for Western Ringtail Possum) were surveyed as part of the distance sampling program (Table 3.1).

Table 3.1: Vegetation units (after Sandiford and Barrett 2010) surveyed as part of the Western Ringtail Possum distance sampling program in the Down Road Nature Reserve.

Vegetation unit / wetland feature	Area in Reserve (prior to the May 2018 fires)
Jarrah/Marri/Sheoak Laterite Forest (Unit 12)	302.3 ha
Jarrah/Sheoak/ <i>Eucalyptus staeri</i> Sandy Woodland (Unit 13)	65.4 ha
<i>Hakea</i> spp. Shrubland / Woodland Complex (Unit 31)	258.1 ha

Two zoologists (Roy Teale and Stewart Ford) undertook the survey within the Down Road Nature Reserve. Each transect was walked by one observer using a high-powered head torch (Led Lenser XEO 19R model) to detect animals. The location of each observation was recorded using a Hemisphere R330 Differential GPS, typically providing accuracy to within 1.5 m. The following data were recorded for each observation:

- species (Western Ringtail Possum or Common Brushtail Possum);
- observer;
- animal location using GPS standing directly underneath;
- time;
- number of individuals;
- cue: Seen (eyeshine), seen (no eyeshine), heard or silhouette; and
- tree type.

Walking pace along transects was generally equivalent to approximately 0.5 km per hour.

3.2.2.1 Data Analysis

There were sufficient observations of Western Ringtail Possums ($n=80$) yielded by the Down Road Nature Reserve distance sampling program to independently model a detection function (required to derive animal density estimates using distance sampling approaches; Buckland et al. (2001)). However, the number of observations yielded by the distance sampling program within the Old Tip and CSBP sites ($n = 7$ after truncation) was fewer than the number generally recognised as being suitable for modelling a detection function ($n=60$ to 80) (Buckland et al. 2001). Hence, observations from these two small remnants (CSBP site and the old George Street Tip site) were pooled with observations from Down Road Nature Reserve and Bakers Junction Nature Reserve to yield a global detection function with derived parameter estimates which were then stratified by Reserve and remnant.

Perpendicular distances to each observation from the transect were calculated using MapInfo Professional Geographical Information System (GIS) v12.5 from the GPS location taken at the point of observation. Perpendicular distance data were analysed using the 'mrds' (Laake et al. 2013) and 'Distance' (Miller 2013) packages in R statistical software (R Core Team 2013). Probability Detection Functions were modelled based on the histogram of perpendicular distance measurements to individuals and pairs (clusters). Perpendicular distance data were plotted as histograms with customised cut-points and examined to determine whether evasive movement of animals was occurring prior to detection. Stepped lower initial intervals that increase away from the centreline can indicate movement away from the observer, while initially high then decreasing intervals indicate relatively little movement away from the observers (Buckland et al. 2001). Both can lead to bias in density estimation.

Histograms were right truncated as necessary to achieve better model fit, optimally at the distance at which detection probability was 0.15 as recommended by Buckland et al. (2001), but other truncation distances were tested as part of the model selection phase. Akaike's Informative Criterion (AIC) is a quantitative method of model selection and was used to select between potential models (Buckland et al. 2001). In addition to AIC, candidate models were also compared using visual inspection of their fit to histograms of the perpendicular distance, goodness of fit quantile-quantile (Q-Q) plots, Kolmogorov-Smirnov (K-S) and Cramér-von Mises

(CvM) test statistics (Buckland et al. 2004). The half-normal and hazard rate keys were used for modelling the Probability Detection Function, with or without adjustment terms (Buckland et al. 2001).

The selected model was used to estimate the following parameters:

1. the encounter rate (n/L), where n was the number of observed clusters and L was the total length of the transect;
2. the average probability of detection (p);
3. a density estimate (D); and
4. an estimate of the number of animals in the specified area (N).

Variation in the Probability Detection Function caused by observers (factor covariate: observer) and study area (factor covariate: study area) were modelled. The effect of time elapsed since survey commencement (minutes past 18:30) was also examined to see if observer fatigue played a role in affecting detection rates. Only the results from the preferred model are discussed here.

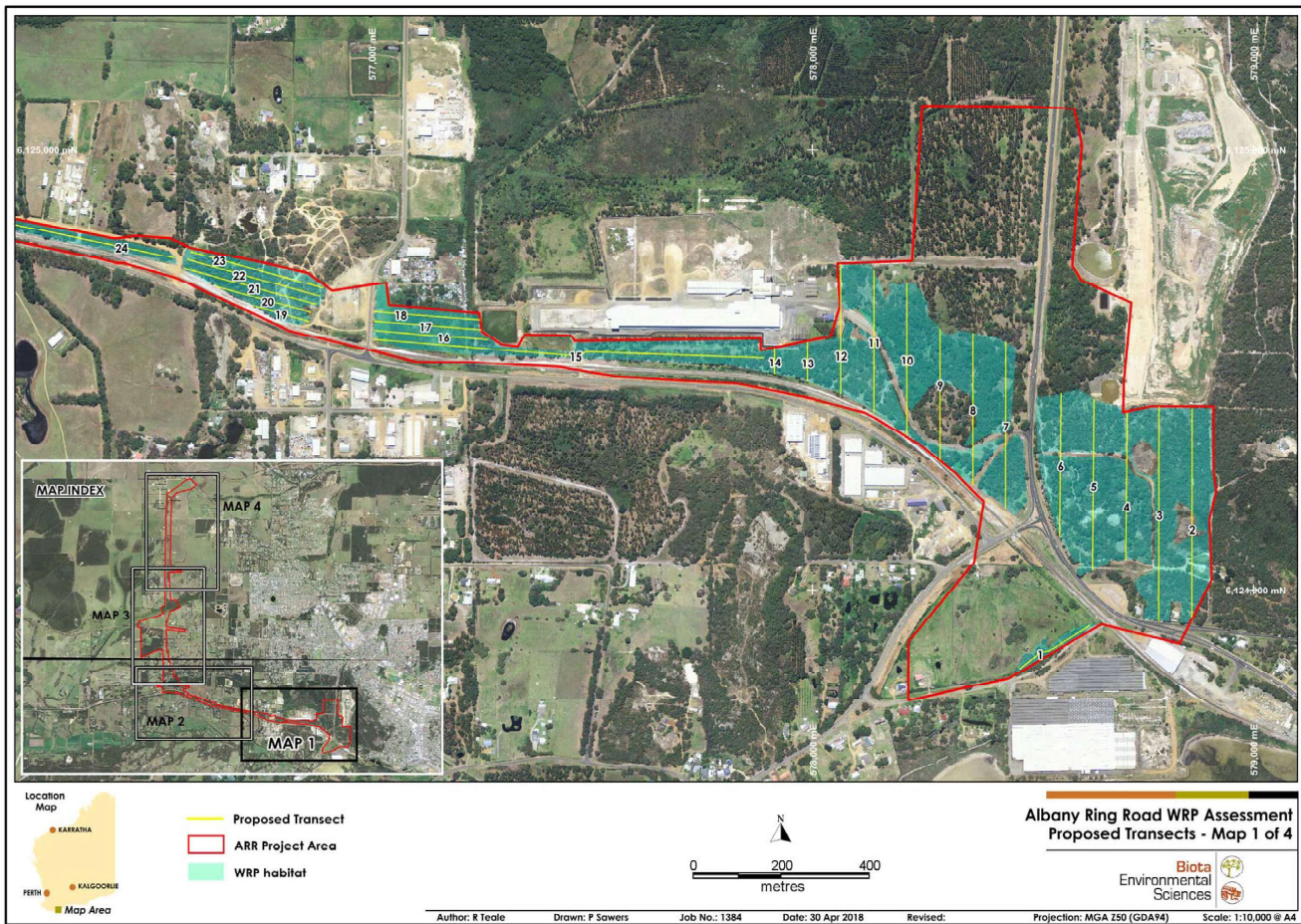


Figure 3.1: Distance sampling transects (Transects 2 – 14) within the CSBP site and strip transects (Transects 15 to 24) within the Albany Ring Road Project Area.

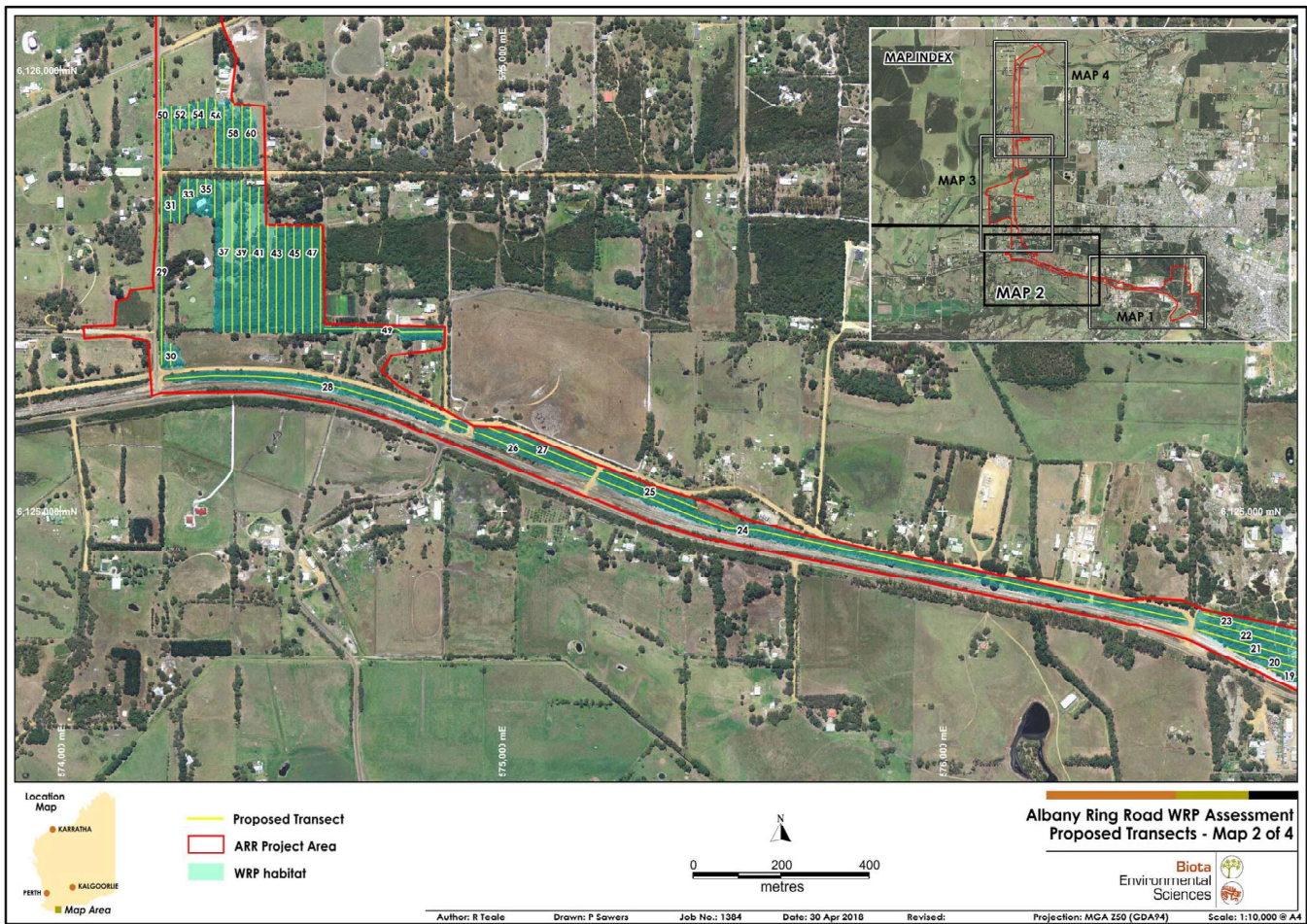


Figure 3.2: Strip transects (Transects 19 to 60) within the Albany Ring Road Project Area (continued).



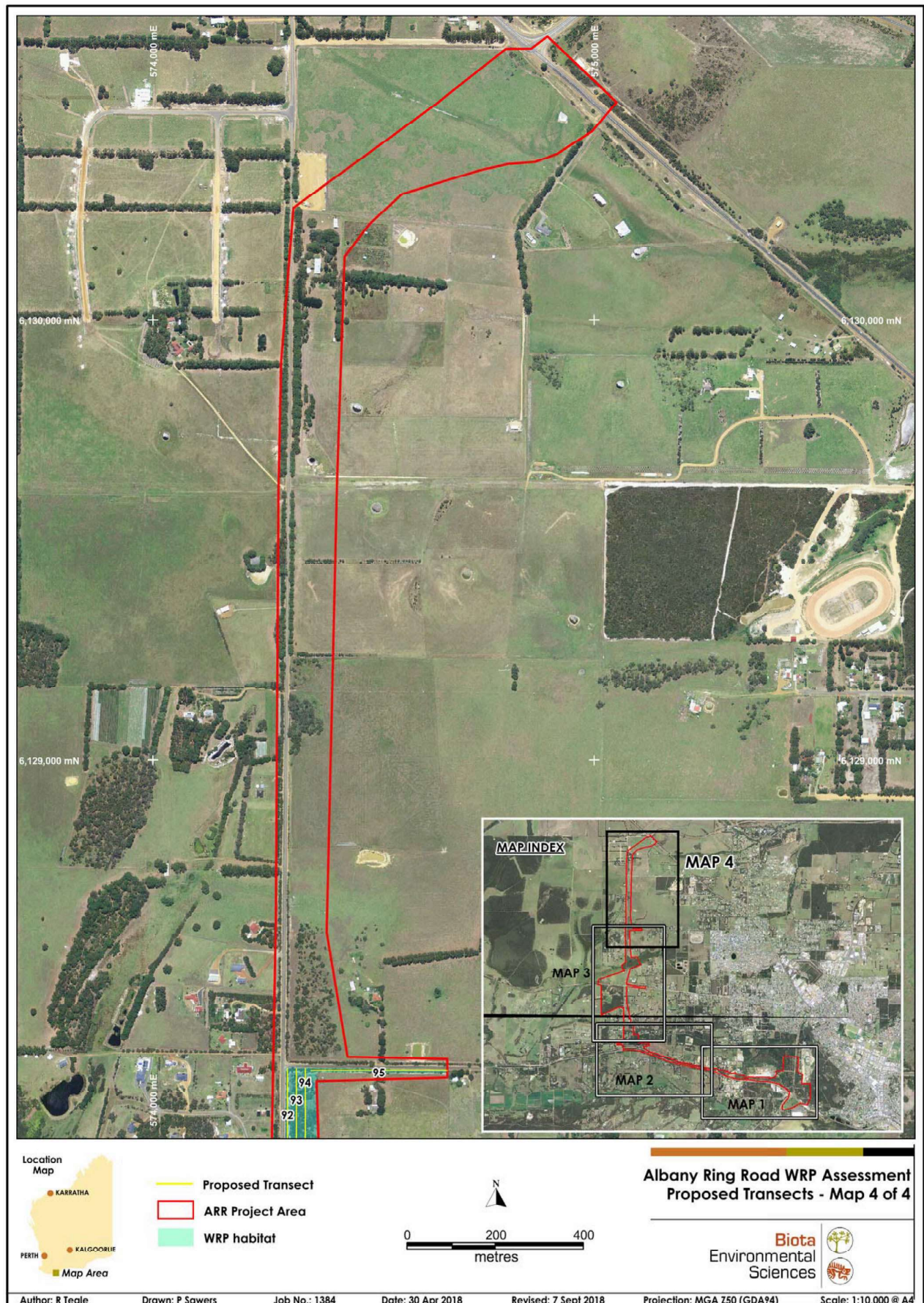


Figure 3.4: Strip transects (Transects 92 to 95) within the Albany Ring Road Project Area (continued).

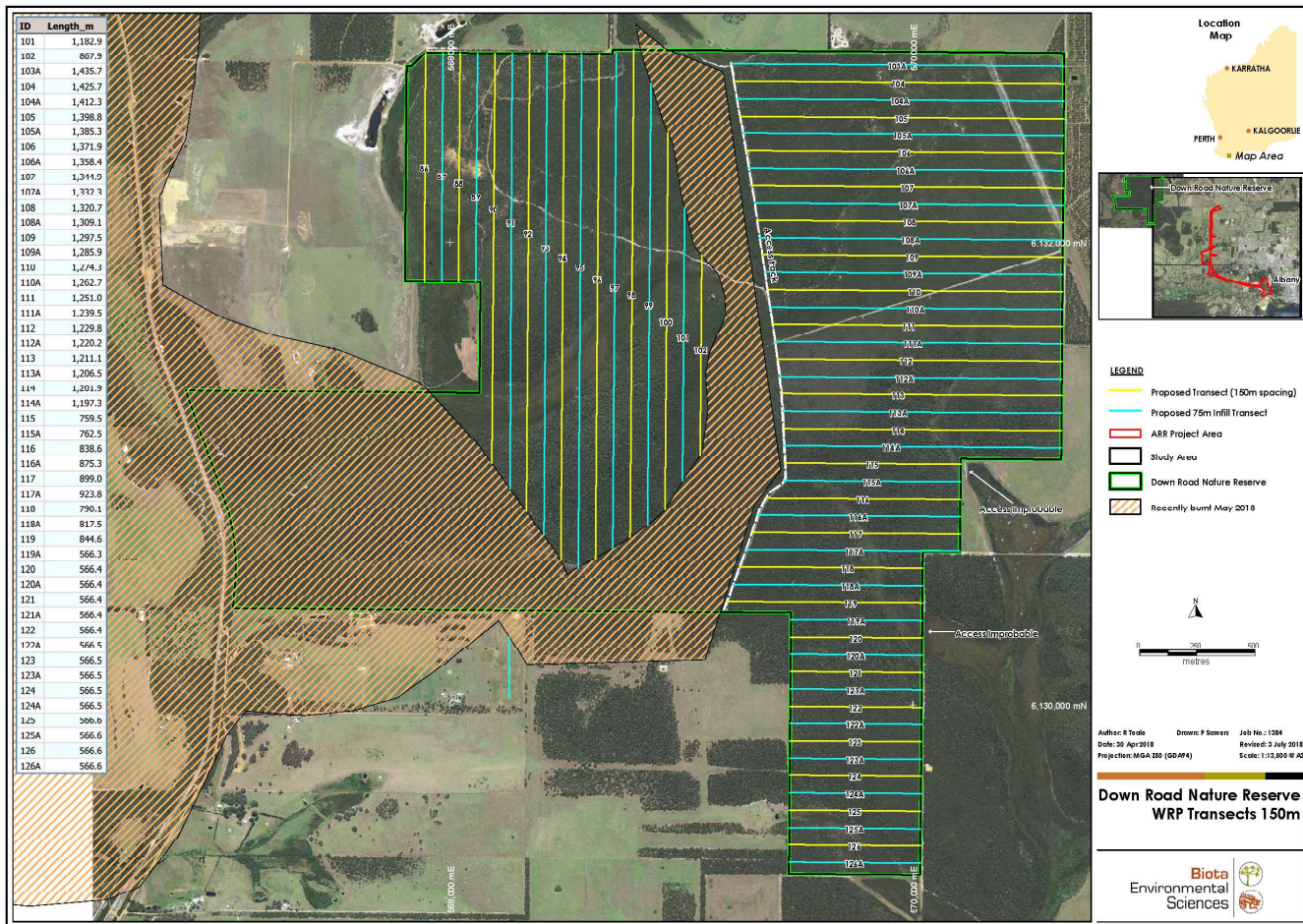


Figure 3.5: Proposed transects layout for the Western Ringtail Possum distance sampling program in the Down Road Nature Reserve study area.

4.0 Results

4.1 Project Area

The area of mapped Western Ringtail Possum habitat within the Project Area comprises approximately 92.2 ha (as per Rathbone and Gilfillan 2018), consisting of 30.89 ha of core Habitat, 31.95 ha of supporting habitat, 9.32 ha of linkage habitat and 20.04 ha of linkage likely habitat. Within this area, a total of 20 sightings of Western Ringtail Possums were recorded from 20 locations and records came from the entire length of the Project Area (Figure 4.5). The tally comprises 13 observations from the strip transects, four observations from the Old tip and three from the CSBP sites (within which distance sampling was conducted). Individuals were recorded from a variety of tree species including Sydney Wattle *Acacia longifolia*, Peppermint *Agonis flexuosa*, eucalypts, *Melaleuca* spp., and a Cypress Pine.

Within those areas sampled by strip transects, we are confident that most, if not all individuals present were recorded during the survey. This assertion is supported by the distance sampling program undertaken in the Down Road Nature Reserve (see Section 4.1.1) that yielded an average probability of detection of $p=0.99$ from the detection function at a truncation distance of 10 m (i.e. consistent with the 20 m strip transects used). The more open habitat of the road reserve areas likely afforded greater visibility than was possible in the larger vegetation fragments resulting in a higher probability of detection.

Population estimates for the two larger remnants (Old Tip site and the CSBP site) were derived using a distance sampling approach rather than being directly observed as was the case for the strip transects. As noted earlier (Section 3.3.2), the number of observations yielded by the distance sampling surveys within the CSBP and Old Tip sites ($n=7$) was too few to adequately model a stand-alone detection function and hence observations were combined across the Down Road and Bakers Junction Nature Reserves. The combined total of 63 transects across the four survey areas yielded 137 observations of Western Ringtail Possums prior to truncation, comprising 50 in Bakers Junction Reserve, 80 in the Down Road Nature Reserve, three in the CSBP site and four in the George Street Tip site.

4.1.1 Model Selection

The histogram of detection distances was indicative of Western Ringtail Possum movement away from the observer (Figure 4.1). An alternative explanation for the initial stepped increase in the number of observations is that insufficient attention was being spent observing along the transect, largely as a result of a requirement to navigate around trees and shrubs, removing the attention of the observer from along the transect. The consequence of the stepped increase is a negative bias in the estimate of Western Ringtail Possums (i.e. an underestimate). Methodological changes were developed to correct the observers' technique from the fifth night onwards and this markedly improved the histogram, supporting our suspicion that the cause of the spike was not animal movement away from the transect (and observer).

The best overall model fit was a hazard rate key with no adjustment terms and no covariate on the detection process (truncation = 20 m, $n = 117$, K-S $p = 0.80$, CvM $p = 0.96$) (Figure 4.2). Key summary statistics are presented in Table 4.1.

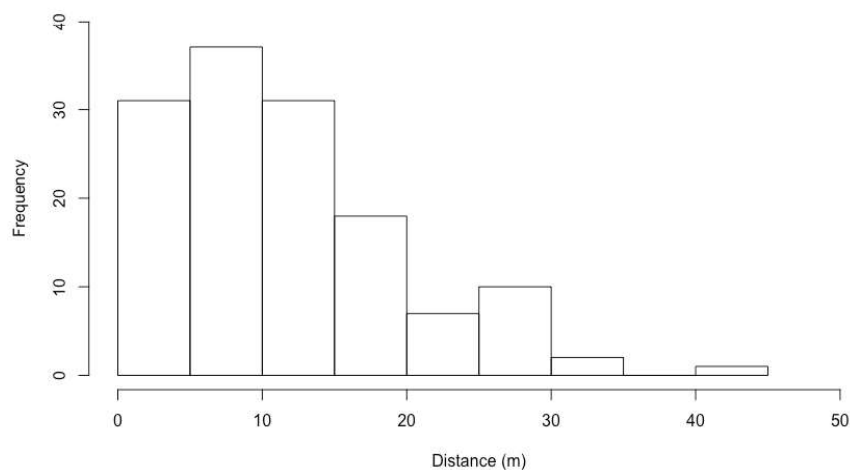


Figure 4.1: Histogram of all Western Ringtail Possum observations from Down Road Nature Reserve, Bakers Junction Nature Reserve, the Old Tip site and the CSBP site (n=137) (n.b. observations include occasions where two individuals were seen together. The tally of individuals was 156).

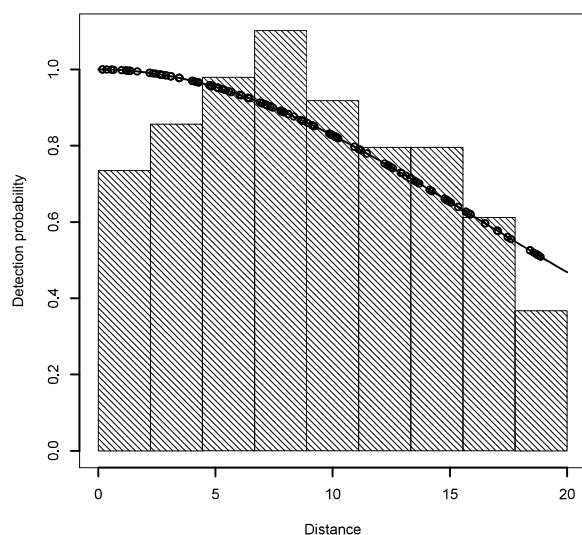


Figure 4.2: Histogram of Western Ringtail Possum observations from Down Road Nature Reserve, Bakers Junction Nature Reserve, the Old Tip site and the CSBP site with hazard-rate Probability Detection Function and truncation at 20 m.

Density estimates derived from the observation data were post-stratified by Reserve / Remnant to provide parameter estimates for the two remnants (namely the Old Tip site and the CSBP site) and then used to obtain abundance estimates. Density estimates of 0.36 ± 0.087 and 0.14 ± 0.101 Western Ringtail Possums per hectare were derived for the CSBP and Old Tip sites respectively (Table 4.2). The density estimates translate to abundance estimates of 6.1 ± 2.5 and 5.0 ± 3.6 individuals for the CSBP and Old Tip sites respectively (Table 4.3).

Table 4.1: Key summary statistics from the Distance Sampling program for Western Ringtail Possum observations (equals clusters) in the CSBP and Old Tip sites (ER = Encounter Rate, n = number of observations, k = number of transects, cv = coefficient of variation).

	Region Area (ha)	Covered Area (ha)	Effort (km)	n	k	ER km ⁻¹	se.ER Rate km ⁻¹	cv.ER
CSBP site	17	9.3	2.3	3	9	1.29	0.53	0.41
Old Tip site	35	15.6	3.9	2	10	0.51	0.36	0.71

Table 4.2: Density estimates for Western Ringtail Possums (individuals) in the CSBP and Old Tip sites (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).

	Estimate (per ha)	se (per ha)	cv	lcl (per ha)	ucl (per ha)
CSBP site	0.36	0.087	0.41	0.14	0.90
Old Tip site	0.14	0.101	0.71	0.03	0.61

Table 4.3: Abundance estimates for Western Ringtail Possums (individuals) in Bakers Junction Nature Reserve (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).

	Estimate	se	cv	lcl	ucl
CSBP site	6.1	2.5	0.42	2.4	15.3
Old Tip site	5.0	3.6	0.71	1.2	21.3

When the distance sampling abundance estimates (rather than the direct observations) from the Old Tip site and the CSBP site are added to the tally for the Project Area, then the number of expected individuals increases to 25 and ranges between 20 and 37 individuals, yielding a range of densities between 0.22 – 0.40 individuals per ha.

While the Project Area boundary may intersect the home ranges of more individual Western Ringtail Possums than the 20 to 37 estimated above (given that sections about larger contiguous habitat remnants), we believe it is reasonable to state that the Project Area encompasses habitat that could support the equivalent of 20 to 37 individuals. The local and regional significance of this habitat is in part understood by placing it into a local and regional context by direct comparison with habitat in other nearby remnants, in this case the Down Road Nature Reserve.

4.2 Local Context Area: Down Road Nature Reserve

The histogram of detection distances for the 80 observations (Figure 4.3) shows a clear “shoulder” out to 10 m indicating relatively even detectability to at least this distance from the transect. The best overall model fit for the observation data from the surveyed vegetation units of the Down Road Nature Reserve was a half-normal with no adjustment terms and no covariate on the detection process (truncation = 20 m, n = 75, K-S p = 0.99, CvM p = 0.98) (Figure 4.4). Key summary statistics derived from this model are presented in Table 4.4. An encounter rate of 3.45 ± 0.47 Western Ringtail Possums per kilometre of transect was estimated from a truncation distance of 20 m.

The Jarrah/Mari/Sheoak Laterite Forest and Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland vegetation units of the Down Road Nature Reserve yielded a density estimate of 1.246 ± 0.234 individuals per hectare (Table 4.5), which translates to approximately 452.3 ± 85 (95% CI 311.7 – 656.3) individuals for these vegetation units in the Reserve (Table 4.6).

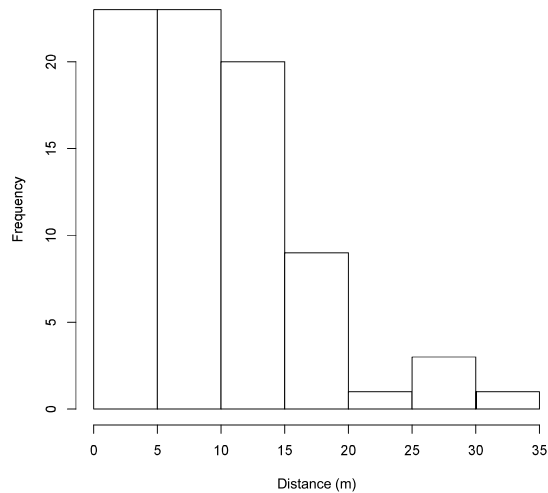


Figure 4.3: Histogram of all Western Ringtail Possum observations from the Down Road Nature Reserve (n=80) (note: observations include occasions where two individuals were seen together. The tally of individuals was 86).

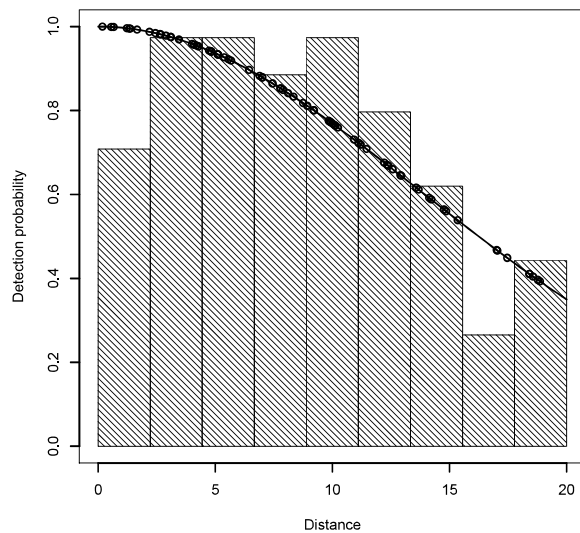


Figure 4.4: Histogram of Western Ringtail Possum observations from the Down Road Nature Reserve with half-normal Probability Detection Function and truncation at 20 m.

Table 4.4: Key summary statistics from the Distance Sampling program for Western Ringtail Possum observations (equals clusters) in Down Road Nature Reserve (ER = Encounter Rate, n = number of observations, k = number of transects, cv = coefficient of variation).

	Region Area (Ha)	Covered Area (Ha)	Effort (km)	n	k	ER km ⁻¹	se.ER Rate km ⁻¹	cv.ER
Down Road NR	363	87.1	21.8	75	29	3.45	0.47	0.136

Table 4.5: Density estimates for Western Ringtail Possums (individuals) in Down Road Nature Reserve (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).

	Estimate (per ha)	se (per ha)	cv	lcl (per ha)	ucl (per ha)
Down Road NR	1.246	0.234	0.19	0.858	1.808

Table 4.6: Abundance estimates for Western Ringtail Possums (individuals) in Down Road Nature Reserve (cv = coefficient of variation, lcl = lower confidence limit, ucl = upper confidence limit).

	Estimate	se	cv	lcl	ucl
Down Road NR	452.3	85.0	0.18	311.7	656.3

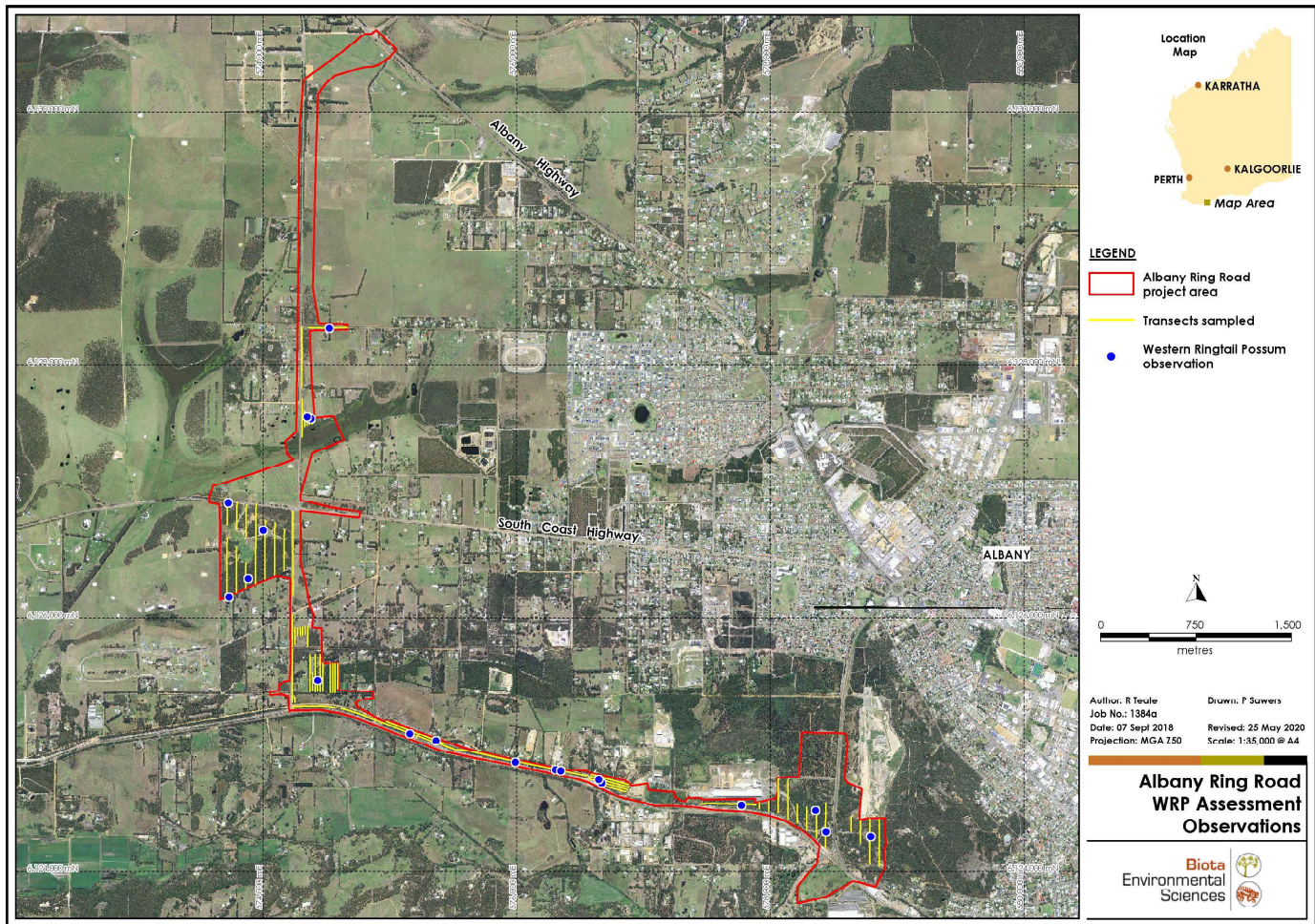


Figure 4.5: Observations of the Western Ringtail Possum within the Project Area from both Distance Sampling and Strip Sampling.

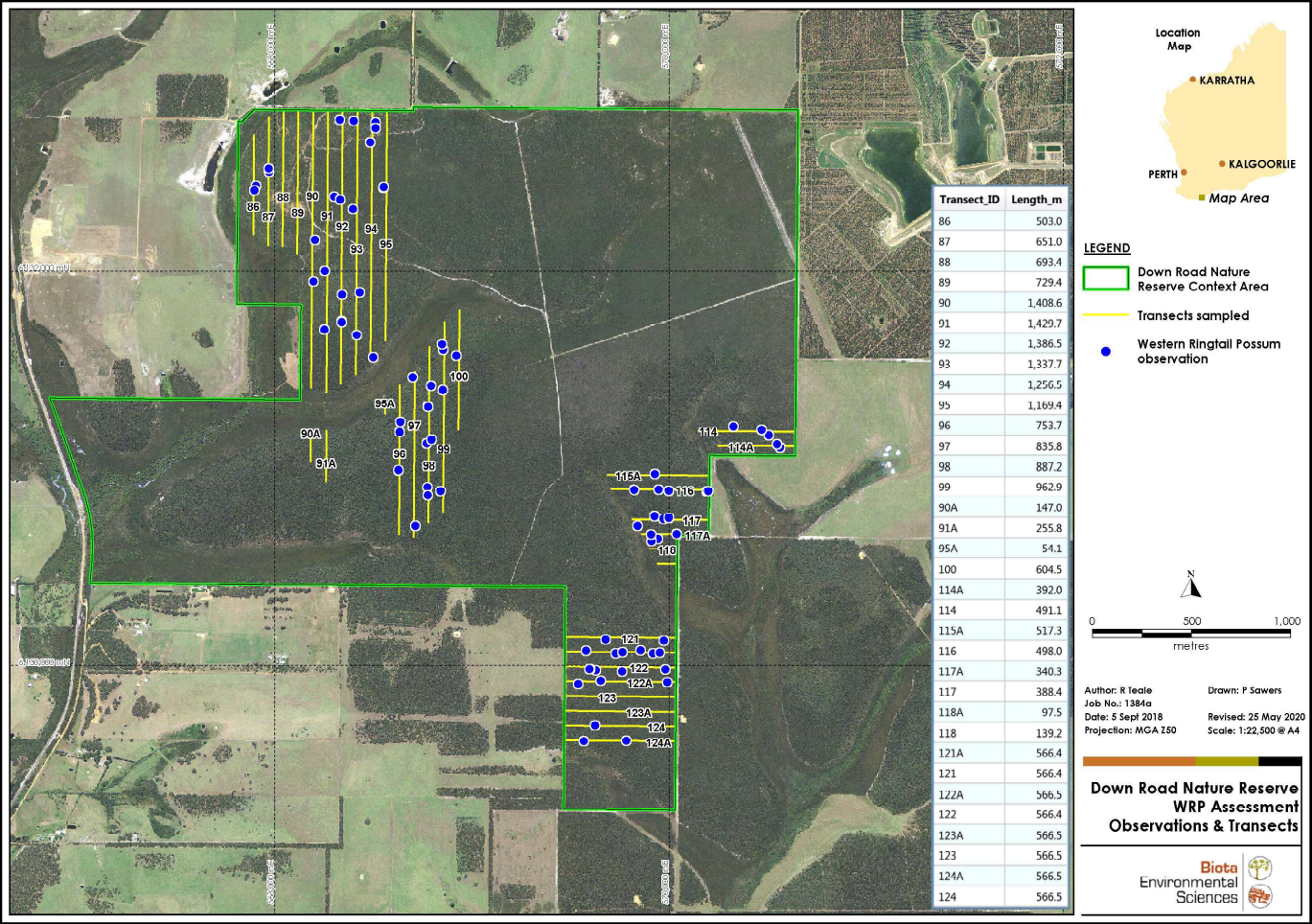


Figure 4.6: Locations from which Western Ringtail Possums were recorded within the Down Road Nature Reserve.

5.0 Discussion

The purpose of this study was to assess the importance of the identified Western Ringtail Possum habitat within the Albany Ring Road Project Area (as per Rathbone and Gilfillan 2018) by direct comparison with habitat in a local (the Down Road Nature Reserve) and wider contexts including the extent of the ARVS (Sandiford and Barrett 2010). Density was identified as the preferred metric for making such comparisons and was estimated using either strip transects or a distance sampling approach depending on the extent of habitat. Within the Albany Ring Road Project Area, Western Ringtail Possum habitat ranged from isolated individual habitat trees (both native and exotic), through remnant vegetation strips (between 10 and 80 m wide) surrounded by cleared land, to larger remnants; either isolated from or broadly contiguous with, much larger remnants. Narrow habitat corridors were not amenable to undertaking a distance sampling program and to obtain density estimates in such sections, the strip transect approach was adopted. Strip transects were considered a suitable method for estimating density given that the probability of detection was essentially 1.0 (see Section 3.1) and that in most instances the area of habitat was clearly demarcated. Distance sampling was used to estimate density within two larger remnants of the Project Area (Old Tip site and the CSBP site) as well as the Jarrah/Marri/Sheoak Laterite Forest and Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland vegetation units of the Down Road Nature Reserve.

The strip transects within the Project Area yielded 13 observations of Western Ringtail Possums and, when the expected number of individuals based on the distance sampling exercises in the Old Tip site and CSBP site were included, the estimate for the Project Area increased to between 20 and 37 individuals. The 20 to 37 individuals and an area of habitat of 92.2 ha (encompassed by the Project Area boundary and as mapped by Rathbone and Gilfillan (2018) yielded a density estimate ranging between 0.22 – 0.40 individuals per ha.

At the local scale, the estimate of 20 – 37 individuals supported by the 92.2 ha of mapped habitat within the Project Area compares to an estimate of 452.3 ± 85 individuals from the Jarrah/Marri/Sheoak Laterite Forest and Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland vegetation units (encompassing 363 ha) of the Down Road Nature Reserve for a density estimate of 1.246 ± 0.234 individuals per ha, more than three times that of the Project Area.

At a 'Around Albany' scale, an original estimate of approximately 500 individuals was ascribed to the 'Around Albany' sub-population as presented in the IUCN re-assessment of the conservation status of the Western Ringtail Possum (Burbidge and Zichy-Woinarski 2017). However, since the 2017 publication (initiated in 2014) (Burbidge and Zichy-Woinarski 2017), several programs (including this study) have been implemented in the Albany Region to more robustly estimate the density of Western Ringtail Possums using a distance sampling approach and these have provided additional data to re-evaluate the IUCN estimate.

The Down Road Nature Reserve study reported here was also run in conjunction with a distance sampling program within the Bakers Junction Nature Reserve (Biota 2018a). Neither reserve has previously been surveyed for Western Ringtail Possums and both were previously highlighted as regional gaps in determining the likely distribution of Western Ringtail Possums in the greater Albany region (Gilfillan 2008). The two programs involved walking a combined total of 51.7 km of transects across 13 nights, which yielded 130 individual Western Ringtail Possums (an encounter rate of 2.51 km^{-1}) and yielded population estimates of 306 ± 75 for Bakers Junction Nature Reserve and 452 ± 85 for Down Road Nature Reserve (Table 5.1).

A third program (with Natural Resource Management funding) implemented by the Oyster Harbour Catchment Group (OHGC) and using volunteers to collect the observation data, conducted distance sampling at Mt Clarence, Mt Adelaide and Mount Melville. This program involved repeated monthly sampling of six groups of four transects yielding a total effort of 51.8 km and has been in operation since 2016. The observation data were provided to Main Roads Western Australia for the purpose of providing additional regional context. These data were also analysed as part of the current study, and density for the Mt Clarence and Mt Adelaide sites was estimated to be 3.48 ± 0.91 individuals per ha yielding a population estimate of 767 ± 201 ,

whilst the density estimate for the Mt Melville site was 1.54 ± 0.38 individuals per ha, yielding a population estimate of 156 ± 39 (Table 5.1).

Table 5.1: Density and population estimates for four sites at which distance sampling has been undertaken in the Albany region.

Reserve / Remnant Bushland (Area of Surveyed habitat)	Number of individuals recorded	Density (ha)	CV	Abundance Estimate (95% CI)
Bakers Junction Nature Reserve (843 ha)	54	0.363 ± 0.088	24%	306 ± 75 (185 – 507)
Down Road Nature Reserve (363 ha)†	80	1.246 ± 0.234	17.9%	452 ± 85 (311 – 656)
Mt Clarence / Mt Adelaide (2,211.7 ha)	Repeat Sampling	3.478 ± 0.908	26.2%	767 ± 201 (441 – 1335)
Mt Melville (1,012.9 ha)	Repeat Sampling	1.54 ± 0.381	24.7%	156 ± 39 (92 – 263)

† Excludes habitat burnt in June 2018 fires. The area is an approximate estimate only as the exact area burnt was not known at the time of reporting.

The distance sampling campaigns at Bakers Junction Nature Reserve, Down Road Nature Reserve, Mt Clarence / Mt Adelaide and Mt Melville yielded in excess of 135 distinct Western Ringtail Possums. These three studies yielded a combined population estimate of 1,681 individuals from a combined area of approximately 4,400 ha. The population estimate for these areas alone is therefore three times the estimate provided for the 'Around Albany' sub-population in the IUCN assessment.

By drawing on the population estimates obtained from recent studies employing a systematic distance sampling approach in the Albany Region (i.e. 1. Biota: Bakers Junction Nature Reserve and Down Road Nature Reserve and 2. OHGC: Mt Clarence, Mt Adelaide and Mount Melville), and placing them in the context of regional vegetation mapping (Sandiford and Barrett 2010) of the same habitat sampled in these studies, it is possible to calculate an approximate population size for these vegetation units in the broader Albany region.

The ARVS (Sandiford and Barrett 2010) provides a description and extent of vegetation types that encompasses 124,415 ha in an area bounded to the east and west of the Albany town site by 30 km and to the north by 20 km (shown in Figure 2.1).

The distance sampling program within the two Bakers Junction Nature Reserve and Down Road Nature Reserve primarily sampled two vegetation Units:

- i) Jarrah/Marri Sheoak laterite forest (Unit 12); and
- ii) Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland (Unit 13).

Sandiford and Barrett (2010) mapped 13,144 ha of the Jarrah/Marri Sheoak laterite forest (Unit 12) within the ARVS boundary and noted that 1,273 ha was encompassed by IUCN I-IV reserves, a further 3,991 ha occurred on other Crown reserves and 7,879 ha was on non-reserve land. The mapped extent of Jarrah/Sheoak/*Eucalyptus staeri* Sandy Woodland (Unit 13) occurred on 5,148 ha including 1,334 ha on IUCN-IV reserves, 1,878 ha on other Crown Reserves and 1,936 ha on non-reserved land. The combined area of both vegetation units occurring on reserved land is 8,477 ha, with 9,815 ha on non-reserved land (at the time of mapping). The mean Western Ringtail Possum density across Bakers Junction Nature Reserve and Down Road Nature Reserve was estimated to be approximately 0.80 individuals per hectare. Using this density across the 8,477 ha of reserved land yields over 6,820 individuals and, if the entirety of the 2010 mapped extent is used, the estimate increases to over 14,600 individuals. Clearly not all of this habitat would currently be available either due to land clearing that has occurred since 2010, recent fires or degradation from a variety of pressures. Nor is it necessarily appropriate to apply a uniform density across the region encompassed by the mapping. However, there are a variety of other vegetation types considered likely to support Western Ringtail Possums occurring in the ARVS boundary but not surveyed as part of this study. Conservatively, these include *Hakea* spp. Shrubland/Woodland Complex (2,366 ha), *Banksia coccinea* Shrubland / *Eucalyptus staeri* / Sheoak Open Woodland (1,330 ha) and Peppermint Low Forest (1,232 ha). In addition, Western

Ringtail Possums have been documented to inhabit the urban environment within Albany utilising narrow road reserves and residential gardens (this study and Gilfillan 2008).

Further extrapolation can be obtained with a similar approach, including the additional vegetation units sampled during the studies at Mt Clarence / Mt Adelaide and Mt Melville, and applying the conservative density estimate of 0.8 individuals per hectare (lower than actually recorded during those studies). The vegetation units included in the surveys conducted at Mt Clarence / Mt Adelaide and Mt Melville were as follows:

- i) Coastal *Banksia ilicifolia* / Peppermint Low Woodland (Unit 4);
- ii) Marri / Jarrah Forest / Peppermint Woodland (Unit 10); and
- iii) Marri / Jarrah Coastal Hills Forest (Unit 17).

When an average density estimate of 0.8 individuals per hectare (as derived from the two Nature Reserves) is extrapolated to the mapped extent of all five vegetation units surveyed by distance sampling within the ARVS boundary (a combined area of 21,633 ha; Table 5.2), an estimate of 17,306 Western Ringtail Possums is yielded. Again, not all of this habitat would necessarily be utilised by Western Ringtail Possums and nor is it necessarily accurate to apply a uniform density across the region encompassed by the mapping. However, the approach does indicate that the population estimate for the 'Around Albany' sub-population is considerably larger than the 500 reported in the IUCN assessment, perhaps by an order of magnitude.

Table 5.2: Broader extent of the sampled vegetation units within the ARVS (Sandiford and Barret 2010) and the estimated abundance of Western Ringtail Possum given an average density of 0.5 ha⁻¹.

Vegetation Unit	ARVS Occurrence	Abundance Estimate at 0.8 ha ⁻¹
Coastal <i>Banksia ilicifolia</i> / Peppermint Low Woodland (Unit 4)	506 ha (411 ha in Reserves)	405 (329 in Reserves)
Marri / Jarrah Forest / Peppermint Woodland (Unit 10)	1,597 ha (516 ha in Reserves)	1,278 (413 in Reserves)
Jarrah/Marri Sheoak laterite forest (Unit 12)	13,144 ha (5,264 ha in Reserves)	10,515 (4,211 in Reserves)
Jarrah/Sheoak/ <i>Eucalyptus staeri</i> Sandy Woodland (Unit 13)	5,148 ha (3,212 ha in Reserves)	4,118 (2,570 in Reserves)
Marri / Jarrah Coastal Hills Forest (Unit 17)	1,238 ha (990 ha in Reserves)	990 (792 in Reserves)
All units	21,633 ha (10,393)	17,306 (8,314 in Reserves)

Reserve equates to IUCN I-IV Reserves and Other Crown Reserves after Sandiford and Barrett (2010).

This page intentionally blank.

6.0 References

- Biota (2018a). Albany Ring Road Western Ringtail Possum Context – A Desktop Assessment. Unpublished report for Main Roads Western Australia.
- Biota (2018b). Mead Road Project: Western Ringtail Possum Assessment. Unpublished report for Main Roads Western Australia.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas (2001). *Introduction to Distance Sampling*. Oxford University Press, Oxford, UK.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas (2004). *Advanced Distance Sampling. Estimating abundance of animal populations*. Oxford University Press, Oxford, UK.
- Buckland, S. T., E. A. Wrexstad, T. A. Marques and C.S. Oedekoven (2015). *Distance Sampling: Methods and Application*. Springer International Publishing, AG, Switzerland.
- Burbidge, A.A. & Zichy-Woinarski, J. 2017. *Pseudocheirus occidentalis*. The IUCN Red List of Threatened Species 2017: e.T18492A21963100. <http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T18492A21963100.en>.
- Clarke, J. R. (2011). Translocation outcomes for the western ringtail possum (*Pseudocheirus occidentalis*) in the presence of the common brushtail possum (*Trichosurus vulpecula*): health, survivorship and habitat use. Doctor of Philosophy, Murdoch University, Western Australia.
- Gilfillan, S (2008) Western Ringtail Possum (*Pseudocheirus occidentalis*) Survey and Data Collation in the Great Albany Area. Phase 1 Final Report. Prepared for the Department of Environment and Conservation, Albany Regional Office.
- How, R. A., and S. J. Hillcox (2000). Brushtail possum, *Trichosurus vulpecula*, populations in south-western Australia: demography, diet and conservation status. *Wildlife Research* 27:81–89.
- Laake, J., D. Borchers, L. Thomas, D. Miller, and J. Bishop (2013). *mrds: Mark-Recapture Distance Sampling (mrds)*. Retrieved from <http://CRAN.R-project.org/package=mrds>
- Miller, D. (2013). *Distance: A simple way to fit detection functions to distance sampling data and calculate abundance/density for biological populations*. Retrieved from <http://CRAN.R-project.org/package=Distance>.
- R Core Team (2013). *R: A Language and Environment for Statistical Computing*. R Development Core Team, R Foundation for Statistical Computing, Vienna, Austria. Retrieved from <http://www.R-project.org>.
- Rathbone, D. and S. Gilfillan (2017). Biological Assessment South Coast Highway King River to Kalgan River, 7.16 to 18.12 SLK. Unpublished report for Main Roads Western Australia.
- Sandiford, E. M. and S. Barrett (2010). Albany Regional Vegetation Survey: Extent, Type and Status. A project funded by the Western Australian Planning Commission, South Coast Natural Resource Management Inc., and City of Albany for the Department of Environment and Conservation. An unpublished report for the Department of Environment and Conservation, Western Australia.

Appendix 1

Raw Observation Data



Appendix A1: Distance Sampling Raw Data (Project Area and Down Road Nature Reserve)

Site	Abundance	Date	Time	Easting	Northing	Dominant Veg
ARR Strip sampling	1	20/7/18		574362	6127591	
ARR Strip sampling	1	20/7/18		574379	6127579	Jarrah/Marri
ARR Strip sampling	1	20/7/18		574347	6127595	Jarrah/Marri
ARR Strip sampling	1	16/7/18		574524	6128298	Cypress pine
ARR Strip sampling	1	16/7/18		577776	6124531	Jarrah/Marri
ARR Strip sampling	1	16/7/18		576673	6124705	Melaleuca
ARR Strip sampling	1	16/7/18		576650	6124735	Melaleuca
ARR Strip sampling	1	16/7/18		575989	6124871	Sydney Wattle
ARR Strip sampling	1	16/7/18		575366	6125041	Melaleuca
ARR Strip sampling	1	16/7/18		576309	6124811	Melaleuca
ARR Strip sampling	1	16/7/18		576350	6124802	Melaleuca
ARR Strip sampling	1	12/7/18		575158	6125098	Melaleuca
ARR Strip sampling	1	12/7/18		574432	6125514	
CSBP_ARR Distance sampling	1	16/7/18	21:41	578359	6124488	Melaleuca
CSBP_ARR Distance sampling	1	16/7/18	21:23	578443	6124319	Jarrah/Marri
CSBP_ARR Distance sampling	1	14/7/18	19:01	578795	6124282	
Tip_ARR Distance sampling	1	13/7/18	21:17	573733	6126174	
Tip_ARR Distance sampling	1	13/7/18	23:54	574001	6126704	Jarrah/Marri
Tip_ARR Distance sampling	1	13/7/18	22:35	573726	6126916	Allocasuarina
Tip_ARR Distance sampling	1	13/7/18	21:32	573883	6126322	Allocasuarina

Appendix A2: Down Road Nature Reserve Distance Sampling

Distance	Size	Person	Date	Time	Easting	Northing	Zone	Dominant_Veg
14.223	1	Stewart Ford	10/7/18	7:54	568205	6132162	50	Allocasuarina
14.766	1	Stewart Ford	15/7/18	10:46	568553	6132426	50	Allocasuarina
12.576	1	Stewart Ford	15/7/18	10:51	568555	6132431	50	Allocasuarina
17.046	1	Roy Teale	15/7/18	11:44	568512	6132759	50	Allocasuarina
18.412	1	Roy Teale	15/7/18	11:59	568513	6132730	50	Allocasuarina
8.749	1	Roy Teale	15/7/18	11:52	568485	6132656	50	Allocasuarina
2.667	1	Roy Teale	20/7/18	6:40	570565	6131108	50	Allocasuarina
12.902	1	Roy Teale	20/7/18	6:43	570550	6131124	50	Allocasuarina
20.571	1	Roy Teale	20/7/18	8:53	569928	6130761	50	Jarrah/Marri
7.789	1	Roy Teale	20/7/18	9	569974	6130748	50	Allocasuarina
12.34	1	Roy Teale	20/7/18	9:05	570001	6130752	50	Jarrah/Marri
7.007	1	Roy Teale	20/7/18	7:58	570041	6130672	50	Jarrah/Marri
18.566	1	Roy Teale	18/7/18	9:23	569763	6129973	50	Jarrah/Marri
13.684	1	Roy Teale	18/7/18	9:36	569629	6129979	50	Jarrah/Marri
7.789	1	Roy Teale	18/7/18	9:40	569602	6129985	50	Allocasuarina
7.889	1	Roy Teale	18/7/18	9:41	569597	6129985	50	Allocasuarina
12.939	1	Roy Teale	10/7/18	7:26	567906	6132436	50	Jarrah/Marri
5.564	1	Roy Teale	10/7/18	7:35	567899	6132413	50	Jarrah/Marri
4.831	1	Roy Teale	10/7/18	8:42	567973	6132508	50	Jarrah/Marri
2.189	1	Roy Teale	10/7/18	8:48	567971	6132524	50	Hakea
14.132	1	Roy Teale	15/7/18	6:53	568331	6132773	50	Jarrah/Marri
34.082	1	Roy Teale	15/7/18	7:38	568302	6132381	50	Allocasuarina
9.21	1	Roy Teale	15/7/18	7:49	568333	6132365	50	Jarrah/Marri
4.008	1	Roy Teale	15/7/18	8:32	568343	6131884	50	Jarrah/Marri

Distance	Size	Person	Date	Time	Easting	Northing	Zone	Dominant_Veg
2.642	1	Roy Teale	15/7/18	8:50	568340	6131748	50	Jarrah/Marri
4.099	1	Roy Teale	15/7/18	8:53	568342	6131744	50	Allocasuarina
14.856	1	Roy Teale	15/7/18	9:29	568501	6131564	50	Allocasuarina
5.383	1	Roy Teale	17/7/18	8:31	568778	6131316	50	Jarrah/Marri
3.095	1	Roy Teale	17/7/18	8:32	568780	6131312	50	Jarrah/Marri
13.58	1	Roy Teale	17/7/18	8:52	568796	6131151	50	Jarrah/Marri
9.202	1	Roy Teale	17/7/18	8:56	568773	6131129	50	Jarrah/Marri
4.823	2	Roy Teale	17/7/18	9:22	568775	6130906	50	Jarrah/Marri
1.366	1	Roy Teale	17/7/18	9:29	568779	6130865	50	Allocasuarina
10.93	1	Roy Teale	18/7/18	0:26	568795	6131422	50	Jarrah/Marri
12.395	1	Roy Teale	17/7/18	10:17	568843	6130889	50	Allocasuarina
5.103	1	Roy Teale	17/7/18	11:13	568854	6131398	50	Jarrah/Marri
4.831	1	Roy Teale	17/7/18	11:36	568856	6131603	50	Jarrah/Marri
9.934	1	Roy Teale	17/7/18	11:41	568851	6131632	50	Jarrah/Marri
12.214	1	Stewart Ford	17/7/18	11:00	568923	6131573	50	Jarrah/Marri
17.012	1	Stewart Ford	20/7/18	6:44	570508	6131169	50	Allocasuarina
11.458	1	Stewart Ford	20/7/18	6:51	570471	6131198	50	Melaleuca
25.232	1	Stewart Ford	20/7/18	7:01	570328	6131213	50	Allocasuarina
10.235	1	Stewart Ford	20/7/18	7:51	569929	6130976	50	Jarrah/Marri
3.108	1	Stewart Ford	20/7/18	8:26	569825	6130894	50	Allocasuarina
5.674	1	Stewart Ford	20/7/18	8:43	569949	6130896	50	Jarrah/Marri
0.662	1	Stewart Ford	20/7/18	8:47	569999	6130891	50	Allocasuarina
9.894	1	Stewart Ford	18/7/18	7:35	569580	6130078	50	Jarrah/Marri
1.223	2	Stewart Ford	18/7/18	7:48	569731	6130066	50	Jarrah/Marri
3.448	1	Stewart Ford	18/7/18	8:40	569993	6129919	50	Jarrah/Marri
8.341	1	Stewart Ford	18/7/18	9:13	569655	6129926	50	Allocasuarina
10.005	2	Stewart Ford	18/7/18	9:20	569542	6129909	50	Allocasuarina
8.107	1	Stewart Ford	10/7/18	8:16	568197	6131951	50	Allocasuarina
11.12	1	Stewart Ford	10/7/18	9:29	568254	6131705	50	Jarrah/Marri
18.412	1	Stewart Ford	15/7/18	7:28	568401	6132767	50	Jarrah/Marri
18.774	1	Stewart Ford	15/7/18	8:07	568398	6132319	50	Allocasuarina
18.865	2	Stewart Ford	15/7/18	8:37	568433	6131895	50	Jarrah/Marri
4.28	1	Stewart Ford	15/7/18	9:05	568417	6131679	50	Allocasuarina
4.741	1	Stewart Ford	17/7/18	7:38	568639	6131238	50	Jarrah/Marri
0.181	1	Stewart Ford	17/7/18	7:44	568634	6131187	50	Allocasuarina
4.198	1	Stewart Ford	17/7/18	8:13	568628	6130994	50	Allocasuarina
9.844	1	Stewart Ford	17/7/18	9:01	568714	6130712	50	Allocasuarina
8.93	1	Stewart Ford	17/7/18	10:06	568701	6131466	50	Jarrah/Marri
28.239	1	Roy Teale	20/7/18	8:36	569843	6130713	50	Jarrah/Marri
17.463	1	Roy Teale	20/7/18	8:09	569946	6130648	50	Jarrah/Marri
29.904	2	Roy Teale	20/7/18	8:15	569912	6130636	50	Allocasuarina
5.113	1	Roy Teale	20/7/18	8:19	569910	6130671	50	Allocasuarina
6.897	1	Roy Teale	18/7/18	7:44	569679	6130136	50	Jarrah/Marri
10.125	1	Roy Teale	18/7/18	8:14	569975	6130130	50	Allocasuarina
7.448	1	Roy Teale	18/7/18	8:39	569983	6129983	50	Allocasuarina
7.007	1	Roy Teale	18/7/18	11:31	569626	6129700	50	Allocasuarina
1.664	1	Stewart Ford	20/7/18	8:58	570193	6130887	50	Allocasuarina

Distance	Size	Person	Date	Time	Easting	Northing	Zone	Dominant_Veg
1.333	1	Stewart Ford	20/7/18	8:59	570200	6130887	50	Jarrah/Marri
5.113	1	Stewart Ford	18/7/18	7:55	569766	6130072	50	Allocasuarina
15.348	1	Stewart Ford	18/7/18	8:02	569858	6130081	50	Allocasuarina
0.561	2	Stewart Ford	18/7/18	8:08	569920	6130066	50	Allocasuarina
2.897	1	Stewart Ford	18/7/18	8:13	569955	6130068	50	Allocasuarina
6.446	1	Stewart Ford	18/7/18	11:09	569784	6129623	50	Allocasuarina
2.446	1	Stewart Ford	18/7/18	11:28	569568	6129621	50	Jarrah/Marri
11.21	1	Stewart Ford	10/7/18	9:57	568255	6132003	50	Jarrah/Marri
10.1	1	Roy Teale	15/7/18	-	-	-	50	-
21	1	Zoe Hamilton	13/7/18	9:17	-	-	50	-
25.1	1	Zoe Hamilton	13/7/18	11:54	-	-	50	Jarrah/Marri
2.33	1	Zoe Hamilton	13/7/18	10:35	-	-	50	Allocasuarina
7.34	1	Zoe Hamilton	13/7/18	9:32	-	-	50	Allocasuarina

Appendix G – Memorandum to Main Roads
Western Australia, Defining Possum in the South
Coast population (Southern Ecology, 2019)

Results

1. Core Habitats

Definition

- native vegetation with high canopy continuity (>3 canopy connections per tree) between trees >2 m high (Jones *et al.* 1994b; Van Helden *et al.* 2018)
- gardens with high cover of native and/or exotic plants/trees
- large enough to contain multiple home ranges
- long unburnt (if native vegetation)
- high densities (> 1/ha) OR high abundance >50
- breeding by a high % of individuals (if known)
- high recruitment (if known)
- can be connected OR isolated or largely isolated. However, poorly connected areas should be targeted for restoration work to restore connectivity, considering that the Effective Population Size for South Coast populations is not known.

Core Habitats within the South Coast population

Core Habitats occur within 20km of the coast in an area approximately from West Cape Howe NP in the west to Two Peoples Bay NR in the east (Van Helden, B. and Close, P. (*pers com.*)). At this point in time the east and west extent of this area is not as clear and requires further survey.

Habitats that should be considered Core Habitats, based on the above definition are:

- Any remnant with an established density of > 1/ha;
- OR
- Any remnant with an established abundance of >50.
- As a precautionary principal, any Jarrah, Marri or Sheoak forest or woodland, or Peppermint Low Forest remnant that is >50 ha in size until densities are established.
 - supporting information:*
 - Surveyed remnants that are largely comprised of these vegetation types and with these other characteristics have densities ranging from 0.36 – 17/ha (Table 1). Remnants with measured densities at the lower end of this range (Bakers Junction and Down Rd. NR's) are however large and contain estimated abundances of 306 +/-75 and 251 +/-45, respectively.
 - Average home range in Albany bushland (marri / jarrah communities is 0.88 (Van Helden *et al.* 2018); A population of 50 individuals is generally seen as large enough to avoid inbreeding (Franklin 20018) and with a estimate of 0.88ha home range 50 individuals would conservatively require 50ha to maintain viability, thus Core Habitats are defined as >50ha in size.
- Urban areas (core)
 - supporting information:* Urban areas with gardens generally having a high % of plant cover and higher densities (Van Helden, *pers com.*). Average home range in garden areas of Albany are 0.51ha (Van Helden unpub data) with evidence of overlapping HR. Average density within gardens of Albany (averaged across seasons) is 3.4 possums/ha (Van Helden unpub data).

2. Supporting Habitats

Definition

- any area with an established density of <1/ha;
- OR
- any area with an established abundance of <50.
- may be breeding occurring or not
- can be native or non-native vegetation, including urban gardens.

Supporting habitats within the South Coast Population

- Jarrah, Marri or Sheoak or Peppermint woodlands or forests that is < 50ha, or has an established density of <50.
- any remnant that has possums present.
- urban areas with gardens generally having a low % of plant cover and lower densities (Van Helden, pers com.)

3. Linkages

Definition

- any structure that allows movement of individuals at a small to medium scale (eg. street-scape/road-side non-native plantings, wind-breaks, plantations, fencelines)
- no resident individuals, movement of animals only
- do not need to be continuous, but can contain small gaps, as Western Ringtail Possums can come to the ground to move short distances.

Linkages within the South Coast Population

As linkages function on a local scale, they have not been identified at the scale of the population as a whole.

4. Primary Corridors

Definition

- provide major connectivity between areas of occupation,
- regional scale,
- containing multiple home ranges,
- breeding occurs,
- provides movements and habitat (residents)

Linkages within the South Coast Population

There are three primary corridors within the South Coast Population:

- King River
- Kalgan River
- Coastal Corridor (from West Cape Howe NP to Cheynes Beach – this may extend either east or west with new records).

Table 1: Densities determined by systematic methods of surveying WRP in various remnants and associated vegetation types.

Remnant/reserve and vegetation association (ARVS # in brackets)	Density	Source and method
Bakers Junction NR Jarrah/Marri Sheoak laterite forest (12) and Jarrah/Sheoak/Eucalyptus staeri Sandy Woodland (13)	0.483/ha, se = 1.182	Biota (in prep) Distance Sampling
Down Rd NR Jarrah/Marri Sheoak laterite forest (12) and Jarrah/Sheoak/Eucalyptus staeri Sandy Woodland (13)	0.795/ha, se = 1.145	Biota (in prep) Distance Sampling
Gull Rock	0.786/ha, se = 0.373	Biota (in prep) Distance Sampling
King River	0.115/ha, se = 0.213	Biota (in prep) Distance Sampling
Marbellup NR	0.106/ha, se = 0.223	Biota (in prep) Distance Sampling
Millbrook NR	0.142/ha, se = 0.451	Biota (in prep) Distance Sampling
Redmond West	0.000	Biota (in prep) Distance Sampling
Simpson Rd	0.400/ha, se = 0.700	Biota (in prep) Distance Sampling
Walmsley East	0.223/ha, se = 0.356	Biota (in prep) Distance Sampling
Walmsley South	0.175/ha, se = 0.339	Biota (in prep) Distance Sampling
Walmsley West	0.395/ha, se = 0.480	Biota (in prep) Distance Sampling
Mt Clarence and Adelaide 3 different vegetation types pooled; Marri/Jarrah Coastal Hills Forest (17), Jarrah Woodland Marri/Jarrah Forest/Peppermint Woodland (10) Coastal <i>Banksia ilicifolia</i> Peppermint Low Woodland (4)	1.60/ha - 2.25/ha (depending on season)	Gilfillan and Comer (2018) Distance Sampling
Mt Melville 3 different vegetation types pooled; Marri/Jarrah Coastal Hills Forest, (17) Jarrah/Sheoak/ <i>E. staeri</i> Sandy Woodland (13), Marri/Jarrah Forest/Peppermint Woodland (10)	2.90/ha - 3.16/ha (depending on season)	Gilfillan and Comer (2018) Distance Sampling

Remnant/reserve and vegetation association (ARVS # in brackets)	Density	Source and method
Mt Clarence and Adelaide Marri/Jarrah Coastal Hills Forest (17), Marri/Jarrah Forest/Peppermint Woodland (10) Jarrah Woodland (11)	4.13/ha (average density) – up to 5.5/ha in these vegetation types	Biota (2019) Distance Sampling
Remnant bushland in urban areas of Albany Marri, jarrah or Sheoak vegetation communities	4.5/ha (averaged across seasons):	Van Helden (unpub data) Based on Home Range size
Urban gardens of Albany Various (exotic and native)	3.4/ha (averaged across seasons)	(Van Helden unpub data) Based on Home Range size
Albany Ring Road Survey Area - CSBP site mix of exotics/Marri/ Jarrah/and Peppermint	0.36/ha	(Biota 2018) Distance Sampling
Albany Ring Road Survey Area - George st. tip site Jarrah/Marri Sheoak laterite forest (12)	0.14/ha	(Biota 2018) Distance Sampling
Albany Ring Road Survey Area - roadside vegetation all vegetation types combined	< 1/km (14 individuals in 19 km	Biota (2018) Strip transects
Albany remnants Peppermint (<i>Agonis flexuosa</i>) Woodland	1.6/ha (av); 8/ha (max)	(Mathiesen et al. in review) Systematic, exhaustive spotlight searches in multiple 20 m x 20 m quadrats over 20 days
Albany remnants Sheoak (<i>Allocasuarina fraseriana</i>) Woodland	7.0/ha(av); 12/ha (max)	(Mathiesen et al. in review) Systematic, exhaustive spotlight searches in multiple 20 m x 20 m quadrats over 20 days
Albany remnants Marri-eucalypt (<i>Corymbia calophylla</i> , <i>Eucalyptus marginanta</i> and <i>Eucalyptus staerii</i>) woodlands	6.5/ha (av); 17/ha (max)	(Mathiesen et al. in review) Systematic, exhaustive spotlight searches in multiple 20 m x 20 m quadrats over 20 days

References

- Biota (in prep.). A Regional Survey of the Western Ringtail Possum. Unpublished Report for Main Roads Western Australia, Biota Environmental Sciences.
- Biota (2019). Albany Mounts Western Ringtail Possum Population Assessment. Unpublished Report. Prepared for City of Albany, Biota Environmental Sciences, Perth, Western Australia.
- Biota (2018). Albany Ring Road Project Western Ringtail Possum Assessment. Unpublished report prepared for Main Roads Western Australia, Biota Environmental Sciences, Perth, Western Australia.
- Department of Environment, Water, Heritage and the Arts [DEWHA] (2009) Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, WA.
- Franklin, I. R. (1980). Evolutionary change in small populations. Pages 135–140 in: M. E. Soule and B. A. Wilcox (eds.), *Conservation Biology: An Evolutionary Ecological Perspective*. Sunderland, Mass.: Sinauer Associates.
- Gilfillan, S. and Comer, S. (2018). Western Ringtail Possums in Albany: Core Habitat, Abundance, and Distribution. Report prepared for the Oyster Harbour Catchment Group. Partners: City of Albany, Department of Biodiversity, Conservation and Attractions, and the Centre of Excellence in Natural Resource Management at UWA. Final Report. November 2018.
- Mathiesen, T., Close, P. Van Helden, B., Speldewinde, P. and Comer, C. (in review 2019) New evidence of unexpectedly high animal density and diet diversity for the critically endangered western ringtail possum. *Austral Ecology*, in review.
- Van Helden B. E., Speldewinde P. C., Close P. G. & Comer S. J. (2018) Use of urban bushland remnants by the western ringtail possum (*Pseudocheirus occidentalis*): short term home-range size and habitat use in Albany, Western Australia. *Aust. Mammal.* **40**, 563 173-80.
- Wilkins, P., Gilfillan, S., Watson, J. and Sanders, A. (ed). 2006. The Western Australian South Coast Macro Corridor Network – a bioregional strategy for nature conservation, Department of Conservation and Land Management (CALM) and South Coast Regional Initiative Planning Team (SCRIPT), Albany, Western Australia.

Memorandum to Main Roads Western Australia:

Defining habitat categories for Western Ringtail Possum in the South Coast population

31st October 2019

Dr Sandra Gilfillan (Southern Ecology)

Introduction

Current Environment Protection and Biodiversity Conservation (EPBC) Significant Impact Guidelines for the Western Ringtail Possum pertain only to the population occurring on the southern Swan Coastal Plain (DEWHA 2009). No guidelines have yet been developed for the South Coast population, which can be defined as a significant population under these guidelines (DEWHA, 2009). Recently a significant amount of work has been carried out on the South Coast population.

These recent data indicate that the South Coast population is quite different to the Swan Coastal Plain population in some aspects of its ecology. For example, the presence of Peppermint (*Agonis flexuosa*) is not necessary for the presence of the species; habitats with high densities are largely confined to Marri/Jarrah/Sheoak communities within 20 km of the coast; diet can be quite broad and a small percentage of individuals use refugia on the ground (Van Helden et al. 2018; Van Helden unpub. data; Van Helden and Close pers. com.; Mathieson et al. in review; Gilfillan 2008 and S.Gilfillan pers. obs.). The EPBC Significant Impact Guidelines for the Swan Coastal Plain may therefore have limited application to the South Coast population.

The EPBC Significant Impact Guidelines identified three areas as important for the Western Ringtail Possums within the southern Swan Coastal Plain: *Core habitat*, *Primary corridors* and *Supporting habitat*. As the definitions in themselves are not Swan Coastal Plain specific they can be used interchangeably to some degree. Using these habitat categories as a guide, plus current available data on Western Ringtail Possum ecology, habitat categories can be defined for the South Coast population and then identified within the Albany Ring Road project area. NB: the defined categories should be considered DRAFT and should be presented to the WRP Recovery Team for discussion and review.

Methods

Habitat category definitions were defined for the South Coast population by:

1. correlating available data on densities and home ranges of WRP with vegetation type (outlined in Table 1) and;
2. gathering expert opinion of what constitutes habitat categories.

Once habitat categories were defined the occurrence of these categories within the Albany Ring Road project area was mapped. In addition, the habitat categories were mapped (desktop assessment only) within a 5km buffer of the project area to give a regional context. This mapping is presented and summarised in a separate memo to Main Roads Western Australia. Details of methods will be provided in a final Biological Survey report for the Albany Ring Road Project (Southern Ecology December 2019).

Appendix I – *Phytophthora* Dieback Management Plan: Albany Ring Road (Southern Ecology, 2020b)

Phytophthora Dieback Management Plan: Albany Ring Road



**Report prepared for
Main Roads Western Australia
April 2020**

Damien Rathbone | Ecologist



Assessment for:

Main Roads Western Australia

Prepared by:

Southern Ecology

© DA Rathbone 2020. Reproduction of this report and maps in whole or in part is prohibited without the approval of the author or the client. The information provided within this report is accurate and correct to the best of the author's knowledge. No liability is accepted for loss, damage or injury arising from its use. The report should be read, distributed and referred to in its entirety.

Citation: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road. Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Rev. No.	Date	Author	File Name
Draft(RevA)	11/3/2020		
Final(Rev0)	15/04/2020		

REPORT CONTENTS

1	SUMMARY	5
2	INTRODUCTION.....	6
2.1	Background	6
2.2	Scope of Works	6
2.3	Physical and Biological Environment.....	7
2.3.1	Location and tenure	7
2.3.2	Biological Environment	7
2.3.3	Surface Water and Hydrology	8
2.3.4	Soil-Landscapes	8
2.3.5	Flora.....	8
2.3.6	Weeds.....	8
2.3.7	Existing Dieback Information.....	8
2.3.8	Weather.....	10
3	METHODS.....	11
3.1	Personnel	11
3.2	Desktop Assessment	11
3.3	Field Assessment	11
3.3.1	Schedule	11
3.3.2	Interpretation	11
3.3.3	Project Specific Considerations.....	12
3.3.4	Protectable Areas.....	12
3.3.5	Soil and Root Sampling	12
3.3.6	Demarcation	12
3.3.7	Survey Limitations	14
4	RESULTS & DISCUSSION.....	15
4.1	Vegetation Type and Condition	15
4.2	Soil and Root Sampling.....	17
4.3	Disease Status and Protectability	19
4.4	Hygiene Management Plan	21
4.4.1	Risk Assessment	21
4.4.2	Hygiene Management Strategies	21
4.5	Assessment Validity	24
5	REFERENCES	25
6	APPENDIX A – Map Series 1-8 (Attached).....	26

FIGURES

Figure 1. <i>Phytophthora</i> species record in the Study Area (5 km buffer around survey Area) derived from the Dieback Information Delivery System (DIDMS) (GAIA 2019).	9
Figure 2. Rainfall statistics for 8 months prior to the assessment period compared with historical averages (all years available) from the nearest weather station (Albany 9500) (BOM 2020).....	10

TABLES

Table 1. Vegetation condition scale (EPA 2016).....	13
Table 2. Assessment of potential survey limitations (EPA 2016).	14
Table 3. Susceptible species from the Survey Area considered useful indicators (likely to shown disease symptoms) for the presence of <i>Phytophthora cinnamomi</i>	15
Table 4. Results of soil and root samples from Vegetation Health Service (VHS). Sample locations are mapped in Appendix A: Map 1-8.	18
Table 5. Extent of disease status categories and protectability within the Survey Area.	19
Table 6. Protectable Areas 1 to 3.....	22

PLATES

Plate 1. Upland forest (Marri/Jarrah Coastal Hills Forest) on Mt Melville, with sufficeint indicator species for interpretation through symptomatic evidence of <i>Phytophthora</i>	16
Plate 2. Wetland vegetation (<i>Homalospermum firmum</i> / <i>Callistemon glaucus</i> Peat Thicket) dominated by species from the Myrtaceae and Cyperaceae that do not display obvious disease symtoms.	16
Plate 3. Degraded vegetation (Uninterpretable) in water gaining site where incipient pathogens are likely but asymptomatic.....	16
Plate 4. Uninfested and Protectable vegetation.	20
Plate 5. <i>Xanthorrhoea platyphylla</i> deaths associated with <i>Phytophthora cinnamomi</i>	20

1 SUMMARY

Main Roads Great Southern Region are proposing to construct stage two and three of the Albany Ring Road Project. Southern Ecology was engaged to assess the development envelope (232.8 ha) for presence of *Phytophthora* species in accordance with regulatory guidelines (Department of Parks and Wildlife 2015) and to recommend management strategies to reduce the spread of soil pathogens during construction.

The proposed soil disturbance activities associated with construction are considered to be complex and will require the use of heavy machinery and the introduction of basic raw materials. Due to the presence of putatively Uninfested areas in the Survey Area that supports Priority Flora that are moderately to highly susceptible, the Risk Rating for spreading of soil pathogens is considered 'High'. All of the roads and tracks within the Survey Area have uncontrolled hygiene and are open to the public, therefore introduction of pathogens may occur at any time.

The field interpretation combined with the soil and root sampling delineated the Survey Area into four disease status categories for the purposes of managing the spread of *Phytophthora cinnamomi*. A total of 1.05 ha was determined to be Uninfested from *Phytophthora cinnamomi* and is considered to be Protectable. However, the Protectability of these areas may change depending on activities undertaken and the extent of vegetation removed prior to construction.

Other parts of the Survey Area were Infested (17.3 ha), Uninterpretable (25.93 ha) or Excluded (191.7 ha).

A hygiene management plan has been provided with recommendations to reduce the risk of spreading *P. cinnamomi*, other soil pathogens and weeds during construction.

2 INTRODUCTION

2.1 Background

Main Roads Great Southern Region are proposing to construct a heavy haulage route around the City of Albany for the transport of materials to the City's port, called the Albany Ring Road Project. The project is a staged development to support freight growth and long-term transport needs of the City of Albany in Western Australia. The project will connect Albany Highway, South Western Highway, Lower Denmark Road and Hanrahan Road allowing access to the Southern Ports Authority Albany Port (Figure 1). Stage one of the project, the construction and upgrade of Menang Drive from Chester Pass Road to Albany Highway was completed in 2017. Stages two and three are proposed.

Phytophthora Dieback disease caused by the soil-born pathogen *Phytophthora cinnamomi* is a major threat to the biodiversity of south-western Australia and is recognised as a key threatening process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment (DotE) 2014). *Phytophthora cinnamomi* can be spread in water, soil or plant material that contains the pathogen or its spores and dispersal is often favoured under warm and moist conditions (Shearer and Tippet 1989). It can be carried in surface or sub-surface water flow and by the movement of infested soil or organic material by either anthropogenic or natural vectors. Consequently, knowledge of the pathogens occurrence within the landscape is essential to inform suitable hygiene management practices to mitigate its spread during soil-disturbance activities.

Southern Ecology was engaged to assess a Survey Area (232.8 ha) for the presence of *Phytophthora* species in accordance with regulatory guidelines (Department of Parks and Wildlife [DPAW] 2015) and to recommend management strategies to reduce the spread of soil pathogens during construction.

2.2 Scope of Works

The scope of works was to undertake the following:

1. Undertake a desktop assessment of known dieback locations, vegetation condition mapping and vegetation community mapping in the Study Area (5 km radius).
2. Undertake a dieback survey in accordance with relevant Department of Biodiversity, Conservation and Attractions (DBCA) guidelines (DPAW) 2015) to identify the presence (status) of *Phytophthora* dieback where native vegetation occurs within the Survey Area.
3. Prepare a Hygiene Management Plan for the project with details of appropriate management controls to prevent the spread of soil pathogens.

2.3 Physical and Biological Environment

2.3.1 Location and tenure

The Survey Area is located within the Southern Jarrah Forest subregion of the Jarrah Forest Interim Biogeographic Regionalisation of Australia (IBRA) Region (Department of Agriculture, Water and the Environment [DAWE] 2019). It intersects shire reserves, private property and road reserves mainly to the west of the City of Albany and is centred on Link Rd, South Coast Highway, George St, Lower Denmark Rd and Albany Port Rd (Figure 1).

The Survey Area includes one large City of Albany reserve with remnant vegetation (Res 28465, 28466 & 28467; corner of South Coast Highway and George St) that is vested for gravel extraction and rubbish purposes. Several smaller reserves within the Survey Area are vested for railway, drainage, public utilities or other purposes. One gazetted conservation reserve (Gledhow Nature Reserve) and one Public Park (Mt Melville) occur within the vicinity of the Survey Area (Appendix B).

2.3.2 Biological Environment

The Survey Area occurs along the western and southern interface between the urban and agricultural zones of Albany that was largely cleared for agricultural purposes in the 19th and 20th century. Three large patches of remnant vegetation remain within the Survey Area: Eucalypt and She-Oak Woodlands on George St Reserve (~30 ha), Forest and Granites on the lower southern slopes of Mt Melville (~12 ha) and a large wetland on Link Rd (6 ha). Other significant corridors of vegetation occur along Lower Denmark Rd and many narrow road reserves throughout the Survey Area continue to support native species. Large areas between Lower Denmark Rd and the Albany Port Rd have regenerated after clearing and/or have been planted with non-indigenous Eucalypts and Pine Trees.

Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) that overlies the Survey Area indicates the native vegetation is currently (or was previously) composed of three associations:

- Albany_3 - “Forest. Mainly jarrah and marri *Eucalyptus marginata*, *Corymbia calophylla*.”
- Albany_51 - “Sedgeland. *Cyperaceae*, *Restionaceae*, *Juncaceae*.”
- Albany_978 - “Low forest, woodland or low woodland with scattered trees *Eucalyptus marginata*, *Banksia* spp., *Allocasuarina* spp.”

The Survey Area also occurs within the zone mapped during the Albany Regional Vegetation Survey (Sandiford and Barrett 2010), which provides meso-scale vegetation information and provides a context for assessing the regional conservation significance of vegetation associations. Eleven mapping Units have previously been mapped within the Survey Area:

- *Evandra aristata* Sedgeland (Unit 46)
- *Gastrolobium bilobum*/*Hakea elliptica* Granite Shrubland/Yate Woodland (Unit 23)
- *Hakea* spp Shrubland/Woodland Complex (Unit 31)
- *Homalospermum firmum*/*Callistemon glaucus* Peat Thicket (Unit 47)
- Jarrah/Marri/Sheoak Laterite Forest (Unit 12)
- Jarrah/Sheoak/*E. staeri* Sandy Woodland (Unit 13)
- Marri/Jarrah Coastal Hills Forest (Unit 17)
- Marri/Jarrah Forest/Peppermint Woodland (Unit 10)
- Peppermint Low Forest (Unit 2)
- *Taxandria juniperina* Closed Forest (Unit 59)
- *Taxandria marginata* Granite Shrubland (Unit 24).

2.3.3 Surface Water and Hydrology

The northern section of the Survey Area (Link Rd) intersects a broad drainage channel that supports a large area of seasonally wet or inundated wetland vegetation, which sheds water westward into Five Mile Creek and eventually into Lake Powell. The hydrology of the southern section of the Survey Area (Lower George St, Lower Denmark Rd) is largely altered by artificial channels installed early in the late 19th to make the peaty swaps more suitable for agriculture. These drains divert water south of the Survey Area into Robinson and eventually empty into Princess Royal Harbour.

2.3.4 Soil-Landscapes

Seven soil-landscapes (Department of Primary Industries and Regional Development [DPIRD] 2019) are mapped within the Survey Area:

- Collis yellow duplex - “Gravelly yellow duplex soils; Jarrah-Marri forest.”
- Dempster crest - “Sands and laterite on elongate crests; Jarrah-Albany Blackbutt-Marri forest.”
- Dempster slope - “Sands and gravels on smooth slopes; Albany blackbutt-sheoak low forest.”
- Gardner granite - “Granite outcrop.”
- Mataband yellow duplex - “Gravelly yellow and yellow duplex soils; Jarrah-Marri-Yellow Tingle forest.”
- Minor Valleys S7 slope - “Broad valleys in sedimentary rocks; 30 m relief; smooth slopes. Deep sands and iron podzols on slopes; Albany Blackbutt-jarrah-sheoak woodland. Podzols and yellow duplex soils on floors; paperbark woodland, teatree heath.”
- Owingup Subsystem - “Plains with swamps, lunettes and dunes. Yellow solonchic soils, organic loams and diatomaceous earth. Wattle-Paperbark thickets, Teatree heath and reeds. Podzols on dunes; Banksia-Sheoak woodland.”

2.3.5 Flora

A previous biological survey covering part of the Survey Area (Rathbone and Gilfillan 2020) determined that five conservation significant flora occur within or closely adjacent to the Survey Area that are ‘Priority’-listed by the Department of Biodiversity Conservation and Attractions (DBCA):

- *Synaphea incurva* (P1),
- *Boronia crassipes* (P3),
- *Andersonia* sp. *Jamesii* (J. Liddelow 84) (P4)
- *Thysanotus isantherus* (P4).
- *Prasophyllum paulinae* (P1) (A previously recorded population of is known from the Survey Area; the potential exists for it to re- emerge following fire).

The susceptibility of these species to *Phytophthora cinnamomi* is considered in this hygiene management plan.

2.3.6 Weeds

Five Declared Pests and/or Weeds of National Significance (WONS) were previously recorded from the Survey Area: - Blackberry (**Rubus* species complex), Bridal Creeper (**Asparagus asparagoides*), Gorse (**Ulex europaeus*), Arum Lily (**Zantedeschia aethiopica*) and Lantana (**Lantana camara*).

2.3.7 Existing Dieback Information

No previous comprehensive *Phytophthora* Dieback mapping or sampling has been conducted within the Survey Area (Dieback Information Delivery System (DIDMS) (GAIA 2019). *Phytophthora cinnamomi* has been recovered from eighteen soil and root samples within the Study Area, collected between 1994

to 2018. One sample of *Phytophthora pseudocryptogea* is known from the Study Area. All *Phytophthora* records are greater than one km from the Survey Area and are hydrologically separated, therefore have a limited contribution to the disease interpretation in this assessment.



Figure 1. *Phytophthora* species record in the Study Area (5 km buffer around survey Area) derived from the Dieback Information Delivery System (DIDMS) (GAIA 2019).

2.3.8 Weather

Daily weather observations recorded from Albany were used to describe local rainfall and temperatures preceding the survey (Figure 2). Overall rainfall prior to the survey period was below average, counteracted by a closer to mean rainfall in the two months preceding the survey.

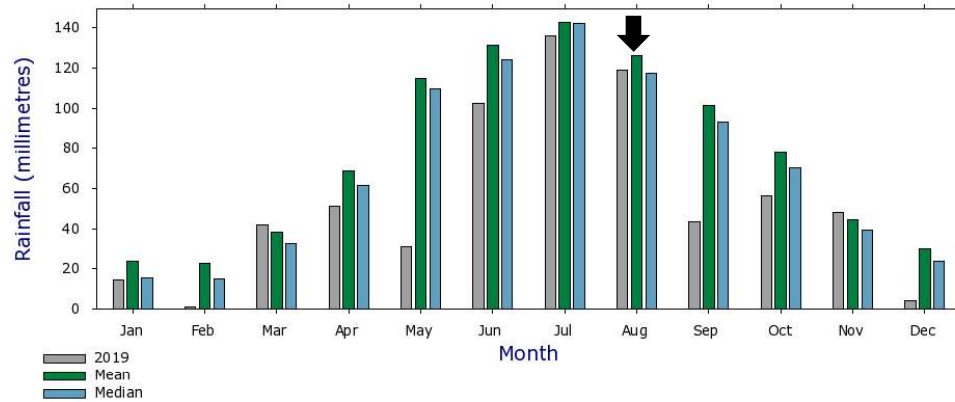


Figure 2. Rainfall statistics for 8 months prior to the assessment period compared with historical averages (all years available) from the nearest weather station (Albany 9500) (BOM 2020). Arrow indicates timing of field survey.

3 METHODS

3.1 Personnel

The survey (desktop and field assessment) was conducted by Damien Rathbone (BScHons Plant Science, Scientific License FB2000229). Damien has over 14 years of experience conducting biological surveys in southern Western Australia. Within the south coast region, he has previously undertaken DBCA regional surveys (Albany Regional Vegetation Survey, Fitzgerald River National Park Flora Survey, Ravensthorpe Range Flora Survey, Western Stirling Range Dieback Survey), threatened species survey and recovery implementation and has 10 scientific publications. Damien is also an accredited interpreter for dieback assessments on DBCA estate (Accreditation PDI-032).

3.2 Desktop Assessment

A desktop assessment of existing *Phytophthora* occurrence information and contextual vegetation and flora values within the Study Area (5 km radius of the Survey Area) was undertaken using the following sources:

- Dieback Information Delivery System (DIDMS) (GAIA 2019).
- NatureMap (Department of Biodiversity Conservations and Attractions [DBCA] 2007-).
- Previous biological reports (Rathbone and Gilfillan 2020, Sandiford and Barrett 2010).

3.3 Field Assessment

3.3.1 Schedule

The field assessment was undertaken over three days in 2019 (August 8, 9 and 13 2019).

3.3.2 Interpretation

Field interpretation was conducted following the standard operating procedures as described in the “*Phytophthora Dieback Interpreters Manual for Lands Managed by the Department*” (DPAW 2015). Most of the area was interpreted by foot or vehicle traverse, with particular emphasis on sites where pathogen vector pathways were present. The condition of the remnant vegetation was also considered using categories defined for Environmental Impact Assessments in Western Australia (Table 1, Environmental Protection Authority [EPA] 2016).

The potential occurrence of *Phytophthora* species in remnant vegetation was determined through observation of the symptomatic evidence of disease and supported by sampling of soil and roots of recently dead susceptible host plants. Areas were defined into six potential disease status categories relevant to *Phytophthora cinnamomi*:

- *infested* (disease symptoms present).
- *uninfested* (disease symptoms absent).
- *uninterpretable* (undisturbed areas where susceptible host plants are absent, or sparse).
- *temporarily uninterpretable* (indeterminate due to disturbance with anticipated short to medium term recovery e.g. fire or rehabilitation).
- *not yet resolved* (indeterminate due to inconsistent or incomplete evidence in low interpretability climatic zones (400mm to 600mm rainfall range).

- *disease risk roads* (potential incipient disease on road with apparent recent use under unknown hygiene conditions).

3.3.3 Project Specific Considerations

Large sections of the Survey Area are water gaining areas that are composed of Uninterpretable vegetation or Excluded areas with weeds and pasture. Inherently, these are sites where incipient pathogens are likely to occur and generally no indicator species for the detection of *Phytophthora* are present (i.e. pathogens can be present and asymptomatic). Due to the high level of historic disturbance and frequent incidence of *Phytophthora* in the Albany region, it is anticipated that many Uninterpretable or Excluded areas are likely to be infested with *Phytophthora* species.

All roads and tracks within the Survey Area are open to the public under all soil moisture conditions, therefore new introductions of *Phytophthora* (and other pathogens) may occur at any time. Many unauthorised tracks on the lower slopes of Mt Melville are frequented by 4WD vehicles, therefore vector pathways are present in some locations without gazetted roads.

3.3.4 Protectable Areas

Protectable Areas are generally defined as areas that will not be invaded by *Phytophthora* via autonomous spread in the short term (10 to 20 years) and anthropogenic spread can be mitigated by soil hygiene management. Regulatory guidance indicates the minimum patch size threshold for Protectable Areas is > 4 ha. However, where other high conservation or social values are present this threshold may be reduced (DPAW 2015).

All Protectable areas in this report are considered preliminary and may be subject to review depending on the activities proposed and the extent of vegetation remaining after disturbance activities.

3.3.5 Soil and Root Sampling

Soil and root samples associated with dead or dying susceptible host plants were taken to confirm the presence of *Phytophthora* species. Diagnostic baiting of the samples was conducted by the Department of Biodiversity Conservation and Attractions (DBCA), Vegetation Health Service (VHS), Kensington, Perth, which determined the potential presence and species identity of any *Phytophthora* isolated.

3.3.6 Demarcation

Any Protectable Areas were demarcated with management stop/start points to guide construction activities and temporarily marked with 25 mm fluorescent pink tape at the road edge with the knot facing into the infested area. Buffers applied to Infested areas were located 15 m upslope or 25 m (or greater) downslope from the active disease edge. The Clean on Entry management points, disease status boundaries (including buffers), soil and root samples and field observations were recorded with a non-differential, hand-held global positioning system (GPS) (Garmin Oregon 7000, ± 5 m accuracy) (MGA zone 50, GDA94).

Table 1. Vegetation condition scale (EPA 2016).

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

3.3.7 Survey Limitations

A consideration of potential limitations of the *Phytophthora* Dieback Survey was undertaken by adapting the regulatory guidance outlined in the document “*Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*” (EPA (2016)). No avoidable limitations were identified that can be expected to have affected the reliability of the results of the field survey (Table 2).

Table 2. Assessment of potential survey limitations (EPA 2016).

Potential for Limitation	Assessment
Availability of contextual information	No positive root and soil samples have previously been collected within the Survey Area. However, it was assumed that <i>Phytophthora</i> species would more widespread than records indicated. Some positive records occur within the Study Area. Regional vegetation mapping was available to allow for an appropriate level of contextual information prior to the field survey. The Albany Regional Vegetation Survey (Sandiford and Barret 2010) covers the Survey Area. Rathbone and Gilfillan (2020) have previously assessed the vegetation, flora and fauna values of the Survey Area.
Personnel experience	All personnel undertaking the survey have in excess of 10 years' experience within southern bioregions of WA.
Extent of survey and site access	The area of survey was adequately covered with sufficient intensity over multiple field days.
Seasonal conditions	Whilst below average rainfall has occurred for the year to date, this was counteracted by close to average rainfall preceding the survey, such that the seasonal conditions were considered ideal for dieback interpretation and recovery from soil and root samples (Figure 2).
Disturbances	The time since previous fire or disturbance within the majority of the Survey Area is considered suitable for interpretation. Some areas were very long unburnt (mapped as Uninterpretable), therefore were difficult to detect recent pathogen impacts.

4 RESULTS & DISCUSSION

4.1 Vegetation Type and Condition

The remnant vegetation within the Survey Area was composed of thirteen vegetation types (Rathbone and Gilfillan 2020) that closely align with Albany Regional Vegetation Survey regional mapping Units (Sandiford and Barrett 2010). Four occur exclusively in wetland habitats, three are associated with granite outcrops and six generally occur on uplands of sand or predominantly laterite. Vegetation condition graded from Completely Degraded (native understory very sparse or absent) to Excellent (no obvious disturbance). The condition of the majority of the remnant vegetation was classified as Very Good or Excellent.

The ability to detect *Phytophthora* through symptomatic evidence (interpretability) was highest in vegetation in upland or granite communities in Good to Excellent condition. This graded to low interpretability in Degraded native vegetation and to Uninterpretable in most wetland vegetation types (Plate 1-3). A list of susceptible host species present across the Survey Area is provided (Table 3). The incidence and pattern of disease symptoms in these taxa were considered an indication of the potential presence of *Phytophthora cinnamomi*.

Table 3. Susceptible species from the Survey Area considered useful indicators (likely to shown disease symptoms) for the presence of *Phytophthora cinnamomi*.

FAMILY	TAXON
Dasygongonaceae	<i>Dasygongon bromeliifolius</i>
Ericaceae	<i>Andersonia caerulea</i> subsp. <i>caerulea</i>
Ericaceae	<i>Leucopogon glabellus</i>
Ericaceae	<i>Leucopogon verticillatus</i>
Fabaceae	<i>Bossiaea linophylla</i>
Fabaceae	<i>Hovea chorizemifolia</i>
Fabaceae	<i>Hovea elliptica</i>
Fabaceae	<i>Jacksonia spinosa</i>
Fabaceae	<i>Sphaerolobium grandiflorum</i>
Iridaceae	<i>Patersonia umbrosa</i> var. <i>umbrosa</i>
Iridaceae	<i>Patersonia occidentalis</i>
Myrtaceae	<i>Melaleuca thymoides</i>
Proteaceae	<i>Adenanthos cuneatus</i>
Proteaceae	<i>Adenanthos obovatus</i>
Proteaceae	<i>Banksia grandis</i>
Proteaceae	<i>Grevillea occidentalis</i>
Proteaceae	<i>Hakea amplexicaulis</i>
Proteaceae	<i>Hakea ferruginea</i>
Proteaceae	<i>Hakea prostrata</i>
Proteaceae	<i>Persoonia elliptica</i>
Proteaceae	<i>Persoonia graminea</i>
Proteaceae	<i>Persoonia longifolia</i>
Xanthorrhoeaceae	<i>Xanthorrhoea platyphylla</i>



Plate 1. Upland forest (Marri/Jarrah Coastal Hills Forest) on Mt Melville, with sufficient indicator species for interpretation through symptomatic evidence of *Phytophthora*.



Plate 2. Wetland vegetation (*Homalospermum firmum*/*Callistemon glaucus* Peat Thicket) dominated by species from the Myrtaceae and Cyperaceae that do not display obvious disease symptoms.



Plate 3. Degraded vegetation (Uninterpretable) in water gaining site where incipient pathogens are likely to occur but are asymptomatic.

4.2 Soil and Root Sampling

Soil and root samples were collected to provide empirical evidence to support the disease interpretation of the Survey Area. Samples were taken from recently dead or dying susceptible plant species at eight locations. (Table 4., mapped in Appendix A).

Analysis by the Vegetation Health Service determined that of the eight samples taken, four samples returned positive for *Phytophthora cinnamomi*. The positive recoveries were strongly correlated with locations where multiple indicator species showed symptomatic evidence of *Phytophthora* pathogens.

Two of the samples that returned negative results occurred where *Phytophthora* impacts were observable (Samples 1 and 7), therefore are considered likely to be false negatives. False negatives are a relatively common occurrence using standard field sampling and laboratory techniques employed by the Vegetation Health Service. This can occur where diseased plant material may be too old (i.e. becomes infected with other fungi) or the baiting technique fails to break the dormancy of resting spores in the plant or soil sample. These samples occurred in areas rationalised as Infested due to the observed symptomatic evidence.

The two other negative samples were associated with isolated unhealthy indicator species, which may be attributable as non-*Phytophthora* related.

Table 4. Results of soil and root samples from Vegetation Health Service (VHS). Sample locations are mapped in Appendix A: Map 1-8.

Sample No.	Result	Comment	Collection ID	Host	Latitude	Longitude	Date
1	Negative	Potential false negative. Collected in site with very obvious disease symptoms. Dead <i>Xanthorrhoea</i> , <i>Banksia</i> and <i>Patersonia</i> .	Dar161	<i>Patersonia umbrosa</i>	-35.024082	117.865068	13/08/2019
2	<i>P. cinnamomi</i>	Subtle disease symptoms present. Vegetation is generally highly degraded.	Dar162	<i>Patersonia occidentalis</i>	-35.018033	117.840364	13/08/2019
3	<i>P. cinnamomi</i>	Obvious disease symptoms present that extend along tracks leading into the vegetation.	Dar163	<i>Patersonia umbrosa</i>	-35.000171	117.81327	13/08/2019
4	<i>P. cinnamomi</i>	Obvious disease symptoms present that extend along the edge of South Coast Highway.	Dar164	<i>Patersonia umbrosa</i>	-34.998081	117.81252	13/08/2019
5	Negative	Single unhealthy <i>Patersonia umbrosa</i> , potentially non- <i>Phytophthora</i> related.	Dar165	<i>Patersonia umbrosa</i>	-34.991253	117.814281	13/08/2019
6	<i>P. cinnamomi</i>	Obvious disease symptoms present that extend into wetland vegetation below.	Dar166	<i>Patersonia umbrosa</i>	-34.992121	117.814186	13/08/2019
7	Negative	Potential false negative. Collected in site with obvious disease symptoms. Dead <i>Xanthorrhoea</i> , <i>Andersonia</i> and <i>Persoonia</i> .	Dar167	<i>Xanthorrhoea platyphylla</i>	-34.96537	117.821931	13/08/2019
8	Negative	Single unhealthy <i>Patersonia occidentalis</i> , potentially non- <i>Phytophthora</i> related.	Dar168	<i>Patersonia occidentalis</i>	-34.966311	117.822699	13/08/2019

4.3 Disease Status and Protectability

The field interpretation combined with the soil and root sampling delineated the Survey Area into four disease status categories for the purposes of managing the spread of *Phytophthora cinnamomi* (Table 5, Plates 4 and 5). A total of 1.05 ha was determined to be Uninfested with *Phytophthora cinnamomi*, which occurred in three separate areas in the Survey Area. All Uninfested areas in the Survey Area are considered to be preliminary Protectable Areas. The Protectability of these areas may change depending on project activities and their recommended management is discussed in section 4.4.2.

A large proportion of the Survey Area was determined to be Infested (17.3 ha), which included areas with symptomatic disease evidence or where soil and roots samples returned positive for *Phytophthora cinnamomi* and includes all roadside drains and/or vegetated areas downslope of these locations (i.e. where water would naturally facilitate the dispersal of pathogens).

Areas were determined to be Uninterpretable (25.93 ha) either due to a low natural incidence of indicator species (i.e. very long unburnt or wetland type vegetation) or was where native vegetation was in Degraded to Good Condition (i.e. other disturbances may have removed indicator species). No Uninterpretable areas were considered as Protectable due the water gaining hydrology and high-level soil historic disturbance. Excluded areas (191.7 ha) consisted mainly of paddocks, agricultural areas or plantations, where *Phytophthora* species may be present but are asymptomatic.

Table 5. Extent of disease status categories and protectability within the Survey Area.

Status	Area (ha)	
	Unprotectable	Protectable
Infested	17.3	
Uninfested		1.05
Uninterpretable	22.8	
Excluded	191.7	
Total:	231.8	1.05



Plate 4. Uninfested and Protectable vegetation.



Plate 5. *Xanthorrhoea platyphylla* deaths associated with *Phytophthora cinnamomi*.

4.4 Hygiene Management Plan

4.4.1 Risk Assessment

A risk assessment for the proposed activities that determines the 'Likelihood' and 'Consequence' of introducing or spreading *Phytophthora* was undertaken in accordance with the Phytophthora Dieback Management Manual (DBCA 2017). The proposed soil disturbance activities associated with the Albany Ring Road construction are considered to be complex and will require heavy machinery and the introduction of basic raw materials. The 'Likelihood' of introducing or spreading *Phytophthora* during these activities is considered 'Almost Certain'. The potential 'Consequence' of introducing or spreading *Phytophthora* is dependent on the values of the biodiversity that may potentially be impacted. The 'Consequence' for the proposed activities is considered 'Significant' due to the presence of Uninfested areas and Priority Flora that are moderately to highly susceptible. The combined overall risk rating for the activities are considered 'High'.

4.4.2 Hygiene Management Strategies

The aim of hygiene management is to minimise the anthropogenic spread of *Phytophthora* species through the movement of contaminated soil or plant tissue. Best management principals include: demarcation of disease boundaries, minimising entry points, ensuring Clean on Entry (CoE) is applied to plant, equipment, vehicles and footwear and allowing only uninfested basic raw materials to enter (Department of Conservation and Land Management [CALM] 2003).

The proposed road construction has the potential to spread *Phytophthora* within the local area. Subsequently, the aim of the hygiene management recommendations is to reduce the risk of introducing *P. cinnamomi* into Uninfested/Protectable areas and to reduce the overall spread of weeds and other soil pathogens during construction.

Project Planning

1. Ensure all staff and contractors working within the project area have undertaken appropriate awareness training in Phytophthora Dieback.
2. Ensure all *Phytophthora* occurrence mapping is valid and up-to-date.
3. Timing of all operations and construction (particularly in Protectable Areas) should be conducted in dry soil conditions where possible (generally between November and April).
4. Engaging contractors with demonstrated experience in *Phytophthora* management should be preferentially weighted.
5. Contractors are required to demonstrate record keeping and standard operating procedures for hygiene relevant to all plant, equipment and vehicles (i.e. this includes a washdown checklist specific to each vehicle and plant).
6. Basic biosecurity hygiene management procedures are required for all operations and include consideration of weeds and other potential pathogens (including other isolates and species of *Phytophthora*) as follows:
 - a) All plant, equipment, vehicles and footwear should be free of soil and weed seeds prior to entering areas with remnant vegetation (particularly when moving from agricultural areas into remnant vegetation).
 - b) Strategies to further reduce the risk of spreading weeds and other pathogens is to operate from areas of high to low vegetation condition and to operate from areas of high to low elevation.
7. Main Roads will be responsible for supervision and evaluation of any environmental or hygiene breaches and non-compliance with this Management Plan by contractors.

8. After completion of operations a follow-up environmental audit is recommended, to ensure no clearing occurred outside the project envelope and to undertake a follow-up weed assessment (and weed control if required).

Management of Protectable Areas

Three areas have been delineated as preliminary Protectable Areas that require general Clean on Entry (CoE) soil hygiene standards (see below). These areas occur exclusively within the potential project footprint, therefore may be completely removed during construction. Subsequently, the CoE management recommendations provided apply only to operations (i.e. geo-tech survey) prior to approval and initiation of the removal of remnant vegetation.

Clean on Entry (CoE) Specifications for Protectable Areas:

1. Demarcation of Protectable Areas should be check/retaped after the approval of this Management Plan and shortly prior to construction.
2. Work in Protectable Areas should be scheduled for periods of low soil moisture.
3. All basic raw material imported into Protectable areas should be low risk for *Phytophthora* contamination.
4. Inspections of all plant, equipment, vehicles and footwear prior to entry into Protectable Areas must be undertaken and recorded.
5. Effective clean down prior to accessing the CoE point should be conducted at an appropriate facility to remove all soil and plant material (including weed seeds). The key components of a suitable washdown are:
 - a) All effluent is captured during washdown i.e. sump, for later transport and disposal, or diverted into excluded/infested areas.
 - b) Cleaned objects exit washdown area without becoming re-contaminated; and
 - c) Safe entry, departure of vehicles by operators is maintained.
6. Transportation of cleaned plant, equipment and vehicles to Protectable Areas should be undertaken via sealed roads where possible.
7. Once work is completed within a Protectable area, all plant, equipment and vehicles can continue to operate in other adjacent "Unprotectable Areas" areas without hygiene intervention.

Table 6. Protectable Areas 1 to 3.

Protectable Area No.	Area (ha)	Location	Map Reference (Appendix A)	Hygiene Strategies
1	0.23	Albany Highway (Eastern Side)	Map 1	<ul style="list-style-type: none"> - Clean On Entry off sealed road, Albany Highway - 100% of Protectable Area occurs in disturbance envelope.
2	0.13	Albany Highway (Western Side)	Map 1	<ul style="list-style-type: none"> - Clean On Entry off sealed road, Albany Highway. - 100% of Protectable Area occurs in disturbance envelope.
3	0.68	Link Road (Eastern side).	Map 4	<ul style="list-style-type: none"> - Clean On Entry off sealed road, Link Rd. - 100% of Protectable Area occurs in disturbance envelope.

Management of Unprotectable Areas

Operations within Unprotectable areas should generally occur after completion of work in Protectable Areas and can be scheduled for periods of moist or wet soil conditions. Basic biosecurity hygiene management for spreading soil pathogens and weeds should still be applied within Unprotectable areas (see point 5a and b). Once work is completed within Unprotectable Areas, all plant, equipment and vehicles are effectively contaminated with *Phytophthora*, therefore must be cleaned at an appropriate facility before continuing to operate in other areas.

General strategies for Vegetation Clearing and Earthmoving Operations

1. Any vegetation cleared and mulched can be reused within the same disease category. Preferably, as close to its origin as possible and within the micro-catchment (i.e. side of the road) that it originated.
2. Any mulch reused on site should be confined within the approval clearing area and not placed on intact vegetation.
3. Any cleared vegetation material that includes weeds should not be reused.
4. Any vegetation removed from the site should preferably be disposed as Class 2 Landfill.
5. Any soil removed from unprotectable area areas should preferably be disposed as Class 2 Landfill.
6. All vehicles, machinery, and personnel are to not to enter, or be stored in natural vegetation areas outside the development envelop.

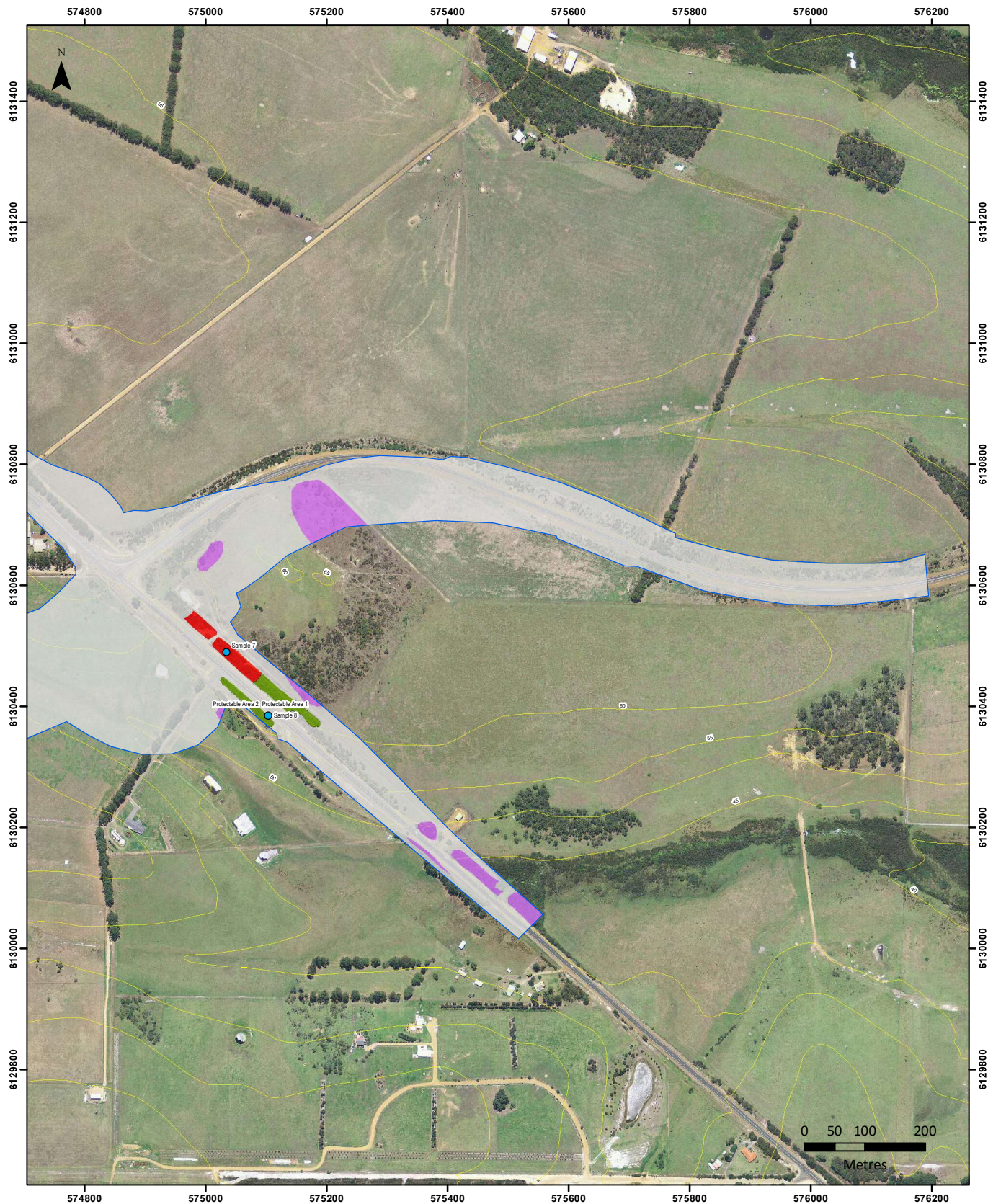
4.5 Assessment Validity

The *Phytophthora* occurrence information in this report is valid as of the 13rd August 2019. *Phytophthora* species can spread autonomously or by animals, bushwalkers and unauthorised vehicles, therefore the assessed boundaries within this report should be revalidated after one year. If continuing or new disturbance activities occur within the Survey Area, a full re-interpretation should be undertaken after three years.

5 REFERENCES

- Bureau of Meteorology (BOM) (2020) Climate Data Online. Commonwealth of Australia. URL: <http://www.bom.gov.au/climate/data/index.shtml>.
- Conservation and Land Management [CALM] (2003). *Phytophthora cinnamomi and disease caused by it, Volume 1, management guidelines*. Department of Conservation and Land Management, Perth.
- Department of Agriculture, Water and the Environment [DAWE] (2019) Interim Biogeographic Regionalisation of Australia, Version 7. Available from: <http://www.environment.gov.au/land/nrs/science/ibra>
- Department of Biodiversity Conservations and Attractions [DBCA] (2007 –) *NatureMap: Mapping Western Australia's Biodiversity*. Department of Biodiversity, Conservation and Attractions. URL: <https://naturemap.dbca.wa.gov.au/>
- Department of Biodiversity, Conservation and Attractions. (2017) *Phytophthora Dieback Management Manual. Forest and Ecosystem Management Branch*. Unpublished.
- Department of Parks and Wildlife [DPAW] (2015). *Phytophthora Dieback Interpreter's Manual for Lands Managed by the Department*. Forest and Ecosystem Management Branch. Perth, W.A.
- Department of Primary Industries and Regional Development [DPIRD] 2019 NRInfo. Natural Resource Information for Western Australia. Available at: <https://maps.agric.wa.gov.au/nrm-info/>
- Department of the Environment [DotE] (2014). *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi*. Commonwealth of Australia.
- Environmental Protection Agency [EPA] (2016) *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*.
- GAIA (2019). *Dieback Information Delivery and Management System*. Available from: <https://didms.gaiaresources.com.au/>
- Rathbone, D. A. and Gilfillan, S (2020). *Biological Survey: Albany Ring Road*. Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).
- Sandiford, E. M., & Barrett, S. (2010). Albany Regional Vegetation Survey, Extent Type and Status, A project funded by the Western Australian Planning Commission (EnviroPlanning "Integrating NRM into Land Use Planning" and State NRM Program), South Coast Natural Resource Management Inc. and City of Albany for the Department of Environment and Conservation. *Unpublished report. Department of Environment and Conservation, Western Australia*, 6.
- Shearer, BL, & Tippet, JT (1989). *Jarrah dieback: the dynamics and management of Phytophthora cinnamomi in the jarrah (Eucalyptus marginata) forest of south-western Australia*. Perth: Department of Conservation and Land Management.
- Shepherd, D. P., Beeston, G. R. & Hopkins, A. J. M. (2002) 'Native Vegetation in Western Australia: Extent, Type and Status', *Resource Management Technical Report 249*, Department of Agriculture, Western Australia.

6 APPENDIX A – Map Series 1-8 (Attached)



Map 1 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



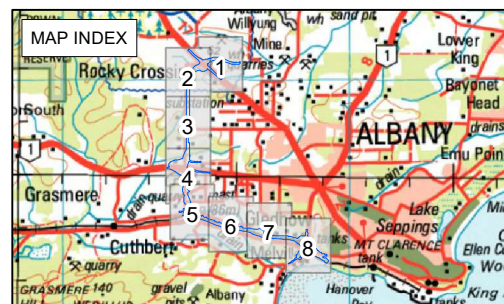
Damien Rathbone | Ecologist

Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- *P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 2 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



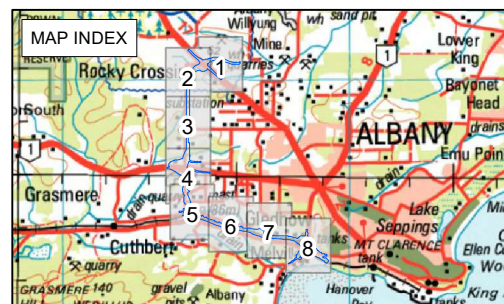
Damien Rathbone | Ecologist

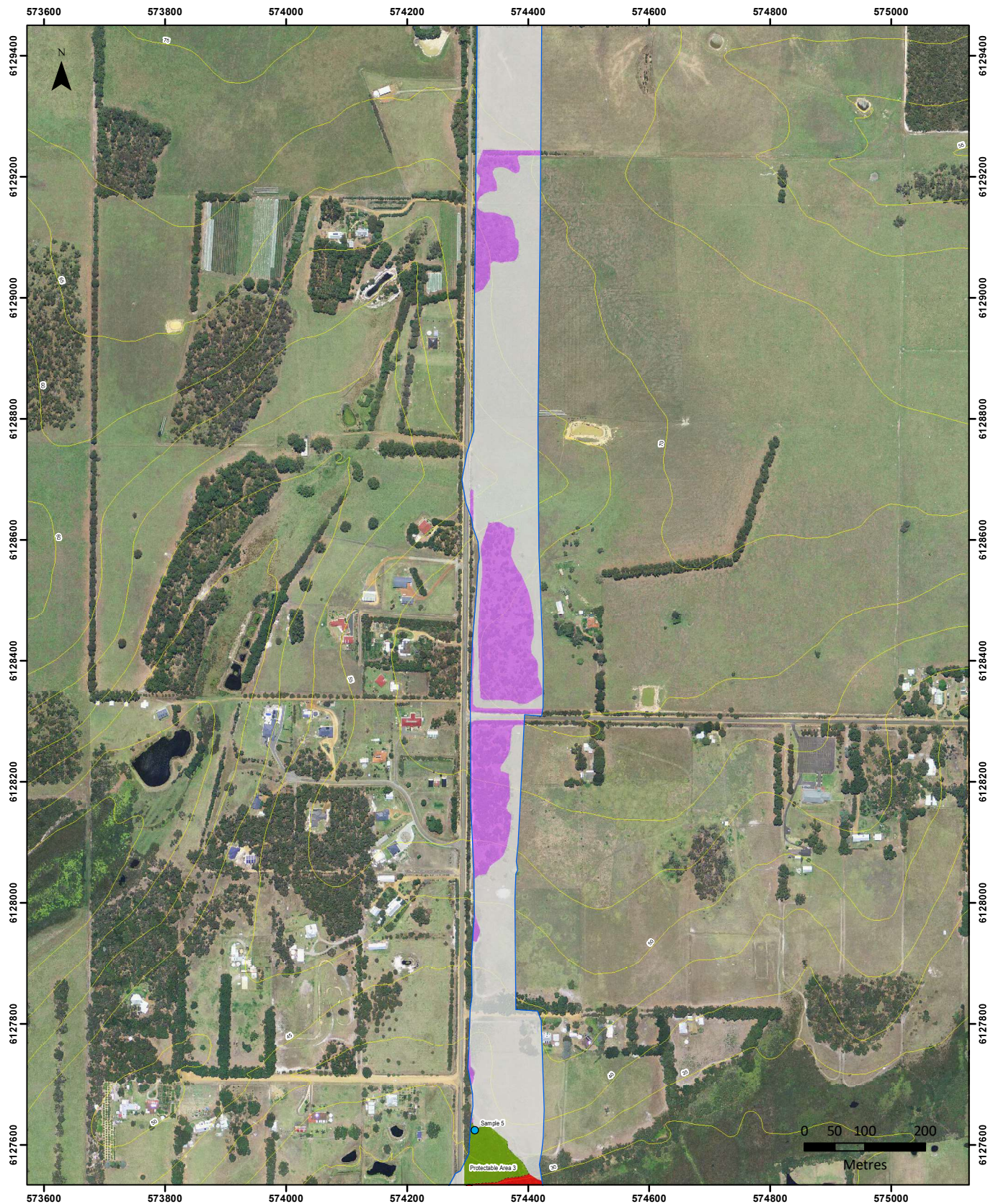
Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- *P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 3 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



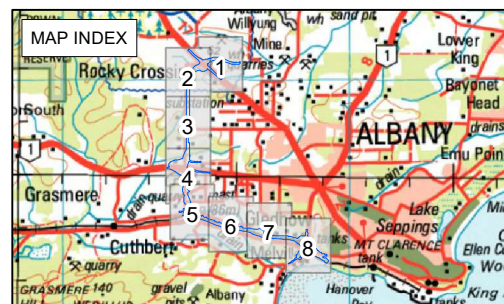
Damien Rathbone | Ecologist

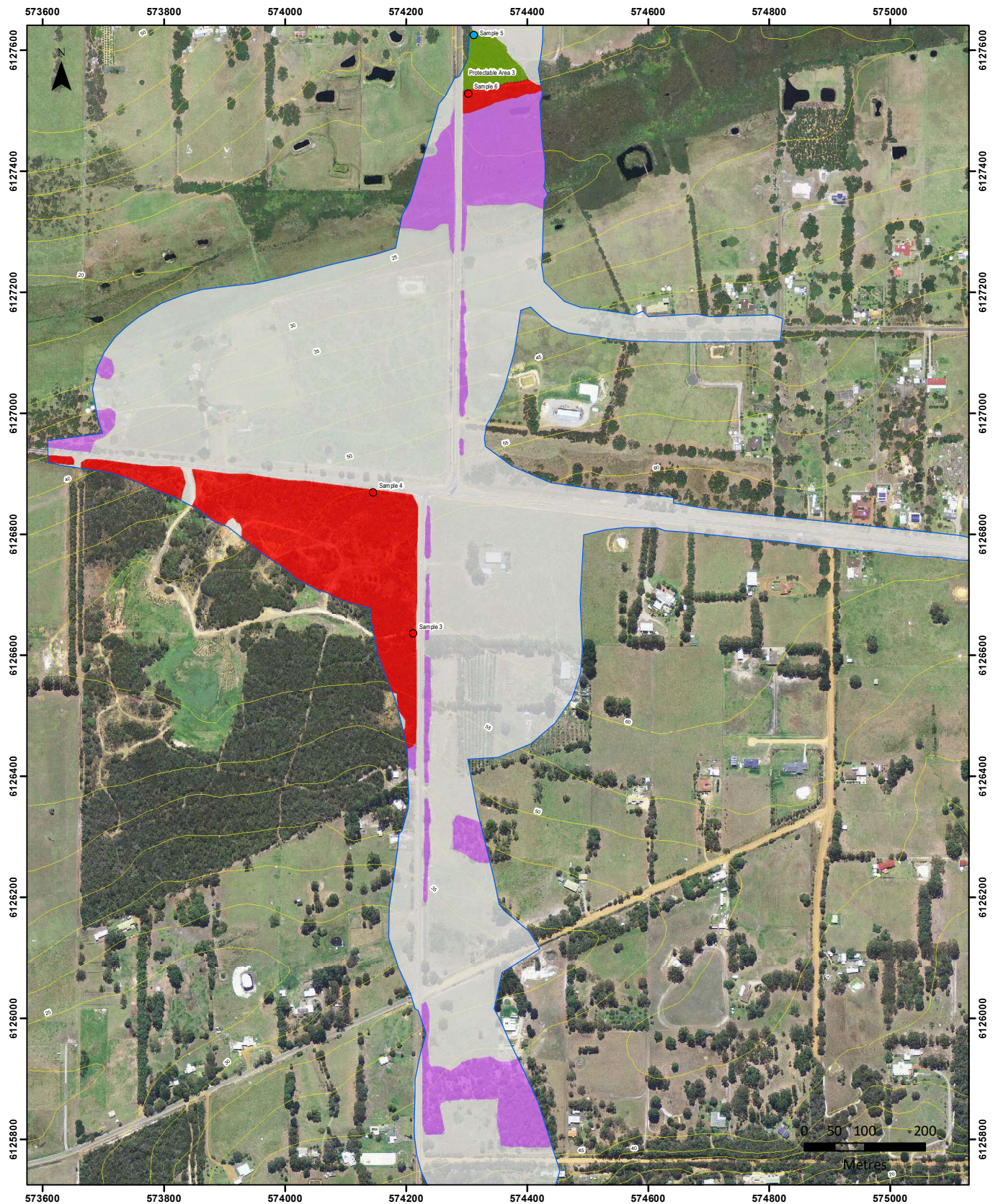
Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- *P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 4 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



Damien Rathbone | Ecologist

Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 5 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



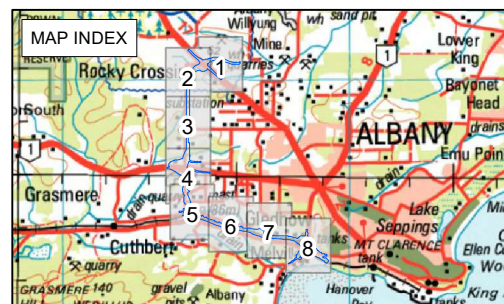
Damien Rathbone | Ecologist

Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- *P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 6 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



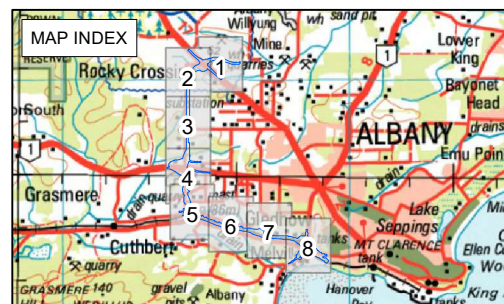
Damien Rathbone | Ecologist

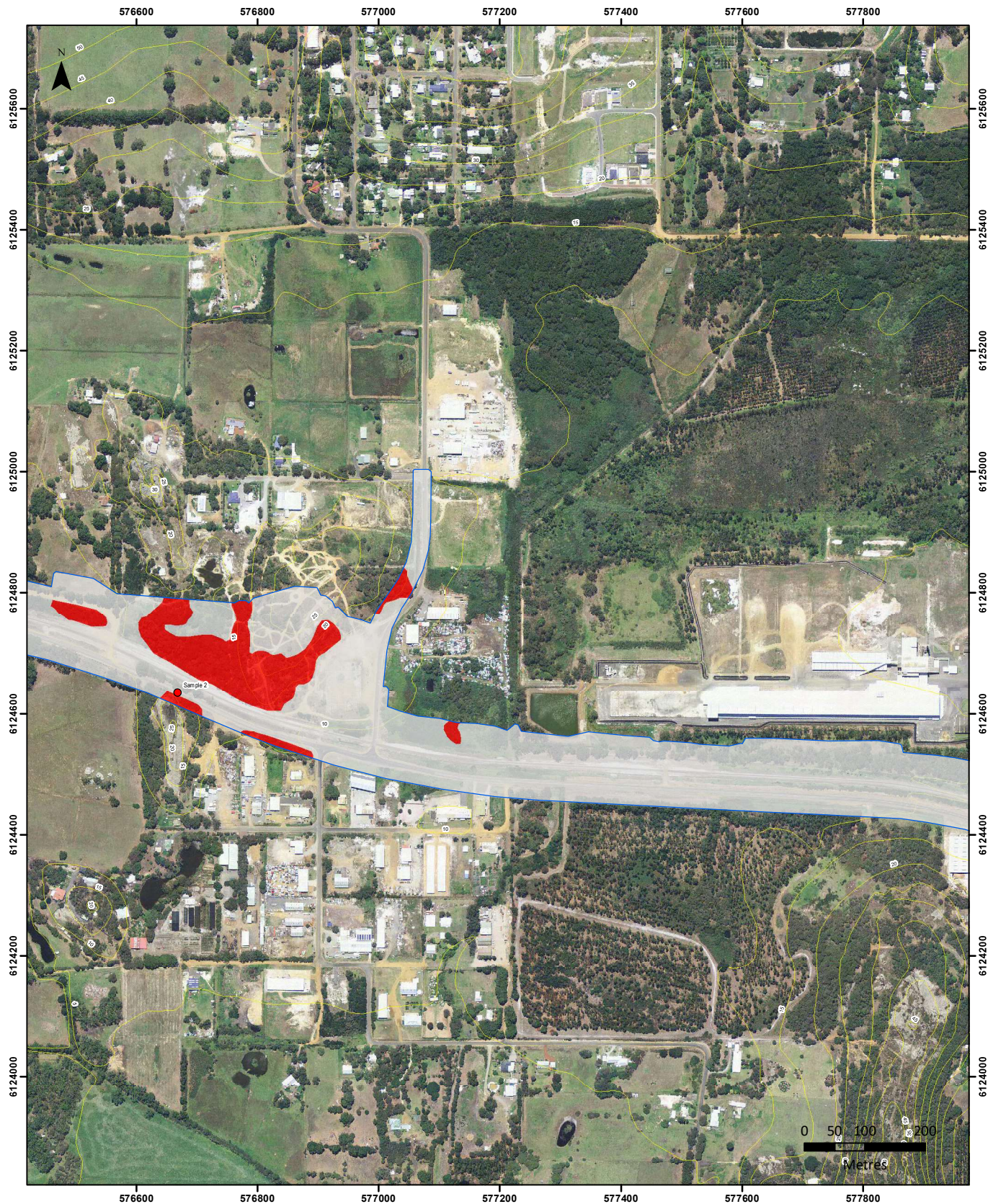
Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 7 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
 Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
 Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
 Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



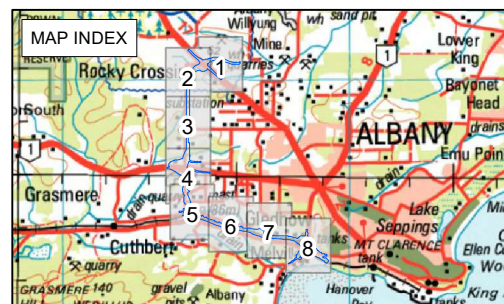
Damien Rathbone | Ecologist

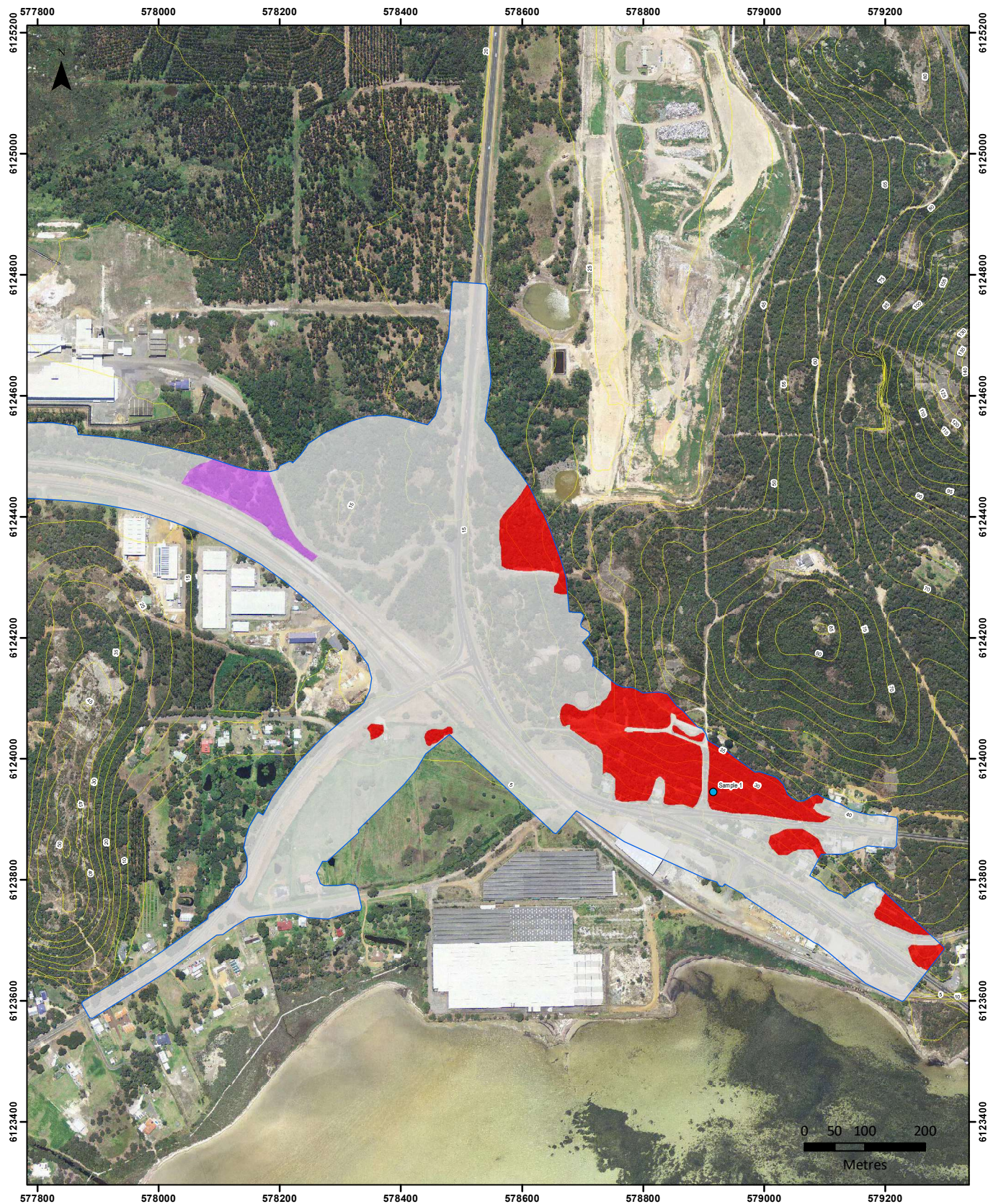
Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area





Map 8 of 8: Phytophthora Dieback Status, Albany Ring Road.

Mapping produced on 15/08/2019, see report for period of validity.
Report Reference: Rathbone, DA (2020). Phytophthora Dieback Management Plan: Albany Ring Road.
Unpublished report by Southern Ecology for Main Roads Western Australia (SE1810).

Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 50 Map Size: A3 Scale 1:6,000



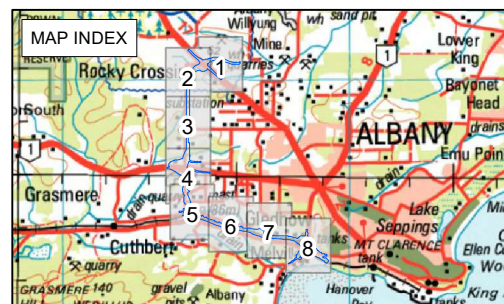
Damien Rathbone | Ecologist

Phytophthora Dieback Status

- Uninfested (Protectable Area 1-3)
- Infested
- Uninterpretable
- Excluded

Soil and Root Samples (Sample No.)

- P. cinnamomi*
- Negative
- Contours (5m)
- Survey Area



GHD

© GHD 2021

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

12533824-61756-

48/[https://projectsportal.ghd.com/sites/pp18_01/albanyringroadenviro/ProjectDocs/12533824-REP-0A_MRWA ARR Stage 2 & 3B Native Vegetation Clearing Permit Supporting Document](https://projectsportal.ghd.com/sites/pp18_01/albanyringroadenviro/ProjectDocs/12533824-REP-0A_MRWA_ARR_Stage_2_&_3B_Native_Vegetation_Clearing_Permit_Supporting_Document_20200921.docx)
20200921.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A						2/09/2020
Draft B						23/09/2020
Final 0						18/12/2020
Draft 0A						09-07-21

www.ghd.com

