

**Flora & Fauna Assessment
Albany Highway, South of Kojonup Townsite
254.9-266 SLK
Main Roads Western Australia**



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REPORT CONTENTS

1	SUMMARY	4
2	INTRODUCTION.....	6
2.1	<i>Background.....</i>	6
3	METHODS	7
3.1	<i>Desktop Assessment</i>	7
3.2	<i>Vegetation Assessment</i>	7
3.1	<i>Targeted Rare and Priority Flora Search.....</i>	8
3.2	<i>Fauna Habitat Assessment</i>	8
3.1	<i>Legislation and Conservation Significance</i>	9
4	FLORA RESULTS & DISCUSSION	10
4.1	<i>Vegetation</i>	10
4.2	<i>Threatened Ecological Communities</i>	15
4.1	<i>Other Conservation Significant Vegetation</i>	16
4.1	<i>Flora.....</i>	17
4.1	<i>Flora Likelihood of Occurrence Assessment.....</i>	18
4.2	<i>Weeds.....</i>	18
5	FAUNA RESULTS & DISCUSSION	19
5.1	<i>Fauna Assessment</i>	19
5.2	<i>Threatened Fauna</i>	19
5.3	<i>Significant Fauna Habitat Trees</i>	20
5.1	<i>Ecological linkages.....</i>	21
6	SURVEY TIMING & LIMITATIONS.....	22
7	REFERENCES.....	24
8	APPENDIX A - Maps 1-2 - Vegetation, Flora and Fauna Habitat.	27
9	APPENDIX B – PLANT TAXA INVENTORY	32
10	APPENDIX C – LIKELIHOOD OF OCCURENCE (FLORA).....	37
11	APPENDIX D – LIKELIHOOD OF OCCURENCE (FAUNA)	39
12	APPENDIX E – Quadrat Photos and Locations (see attachment).....	41
13	APPENDIX F – GIS Data (see attachment).....	41
14	APPENDIX G – Protected Matters Report (see attachment)	41

FIGURES, TABLES AND PLATES

Table 1. Relevant Acts and conservation status definitions used in environmental impact assessment.	9
Table 1. Extent (hectares) and condition (Keighery 1994) of native remnant and non-native vegetation within the Albany Highway Survey Area.	10
Plate 1. <i>Corymbia calophylla</i> Woodland in good (above) and degraded (below) condition.	11
Plate 2. <i>Eucalyptus rudis</i> Woodland in good (above) and degraded (below) condition.	12
Plate 3. <i>Eucalyptus wandoo</i> Woodland in good (above) and degraded (below) condition.	13
Plate 4. <i>Eucalyptus</i> revegetation.	14
Table 2. Occurrences of the Wheatbelt Woodlands TEC within the Survey Area. Occurrence number relevant to vegetation mapping in Appendix A: Map 1A-D.	15
Table 3. Extent of Pre-European vegetation within state jurisdictions (GoWA 2015) for vegetation association 4 (Medium woodland; Marri & Wandoo) and vegetation association 968 (Medium woodland; jarrah, marri & wandoo).	16
Figure 1. Species accumulation curve; the accumulative average, min and maximum number of species recorded in 22 quadrats (n=103, excluding species outside quadrats) using 100 random permutations. The logarithmic function of $y = 30.925\ln(x) + 1.2487$	17
Table 4. Species, average diameter and presence of hollows in the significant trees within the Survey Area... ..	20
Plate 5. Exceptional fauna habitat tree: Large <i>Eucalyptus wandoo</i> (above) with close up of six easily visible hollows (below).	21
Figure 2. Climate statistics for 12 months prior to the assessment compared with historical averages (all years available) from the nearest weather stations (Kojonup for rainfall only, Katanning for temperature only) (BOM 2016). Total rainfall in Kojonup for the 12 month period prior to the survey was 690 mm compared to the historic average of 533 mm.	23

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1 SUMMARY

Main Roads Western Australia (Main Roads) is proposing to conduct widening and reconstruction of the Albany Highway, south of Kojonup townsite between straight line kilometres (SLK) 254.9 to 266. A biological assessment of vegetation, flora and fauna values was undertaken to inform the environmental impact and approval process. The Survey Area included the full width of the road reserve and some areas of adjacent private property that together comprised 46.39 hectares (ha).

Vegetation:

- Three native vegetation types that occurred on specific landforms were defined: *Corymbia calophylla* Woodlands on hillslopes (12.86ha), *Eucalyptus rudis* Woodlands in broad, shallowly incised drainage channels (9.49ha) and *Eucalyptus wandoo* Woodlands on uplands of laterite and granite (3.00ha).
- Vegetation condition varied from degraded (native understory very sparse or absent) to good (native understory present but obvious disturbance or low-moderate cover of agricultural weeds present) or as a mosaic of both categories.
- Revegetated (with native Eucalypts) and cleared areas accounted for 21.04ha of the Survey Area.
- The Threatened Ecological Community “*Eucalypt Woodlands of the Western Australian Wheatbelt*” was mapped in five occurrences (total of 3.49ha) where floristic and condition thresholds were met.
- The broad pre-European vegetation types (Association 4 & 968) mapped in the Survey Area fall below the 30% extent threshold for most levels of jurisdiction.
- *Eucalyptus rudis* Woodland (9.49ha) occurs in broad drainage channels and is intersected by watercourses in two locations, therefore is recognised as riparian vegetation.
- Overall only 15% remnant vegetation remains in the Shire of Kojonup therefore all remnant vegetation could be considered significant due to the history of land clearing.

Flora:

- A total of 146 taxa from 41 families (including 47 weed species) were recorded from the Survey Area. No Priority or Threatened flora were recorded in the Survey Area. One weed species, Bridal creeper (*Asparagus asparagoides*) is listed as a Weed of National Significance (WONS).
- A desktop assessment identified that two Threatened flora were considered to possibly occur and seven Priority flora were considered possibly or likely to occur in the Survey Area. However, the field survey did not identify the presence of any conservation significant flora species. Survey limitations included flowering period for one Priority 4 orchid (*Caladenia integra*) and a high cover of agricultural grasses that reduced the detectability of low native shrubs.

Fauna:

- Four conservation significant fauna species were either present or considered very likely to occur; Forest Red-tailed Black Cockatoo (T;Vu), Baudin's Black Cockatoo (T;Vu), Carnaby's Black Cockatoo (T;E) and Western Rosella (Inland) (P4).

- All the native remnant *Eucalyptus* and *Allocasuarina* woodlands and areas revegetated with Eucalypts (30.12ha) are considered foraging habitat for the three Threatened Black Cockatoo species.
- Six hundred and sixty individual trees of four taxa were considered as significant fauna habitat within the Survey Area (Table 4). Hollows were uncommon, occurring in only 2.3% of three tree species. However, some individual trees contained multiple hollows, representing a significant habitat resource.
- The Eucalypt woodland within the road reserve constitutes a large proportion of the remnant vegetation within the region and importantly represents one of the last connections between Tunney and Kojonup townsite reserves, which are known breeding sites for Black Cockatoo.

2 INTRODUCTION

2.1 Background

Main Roads is proposing to conduct widening and reconstruction of a section of the Albany Highway, south of Kojonup townsite. A biological assessment of vegetation, flora and fauna values was undertaken to inform the environmental impact and approval process. The Survey Area includes the full width of the road reserve over 11 km, between SLK 254.9 to 266. Some small areas of adjacent private property were also included to encompass the footprint of potential road designs. The total area of the Survey Area is 46.39 ha.

The Survey Area is located in the southern half of the Jarrah Forest Interim Biogeographic Regionalisation of Australia (IBRA) Region (Department of the Environment [DotE] 2014). Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) indicates that the native vegetation of the area is composed of woodlands of Marri (*Corymbia calophylla*) and Wandoo (*Eucalyptus wandoo*) (Vegetation Association 4) or Jarrah (*Eucalyptus marginata*), Marri & Wandoo (Vegetation Association 968).

The Survey Area is intersected by two drainage channels including Mandalup Brook and an upper tributary of the Balgarup River. The Survey Area occurs within two soil-landscapes mapped in South West Western Australia (Department of Agriculture and Food Western Australia [DAFWA] 2014):

- Farrar 2 Subsystem - Undulating rises and low hills with mainly grey deep sandy duplex soils.
- Farrar 3 Subsystem - Rocky undulating rises and low hills with mainly grey deep sandy duplex, red sandy and loamy duplex formed on weathered bedrock.

3 METHODS

The assessments were conducted by Damien Rathbone (SL 011605), an ecologist with over 13 years of experience in southwest Western Australia. All vegetation assessments, locations of significant flora, weeds and faunal habitat were identified using a handheld GPS (Garmin 60).

3.1 Desktop Assessment

A desktop assessment of known or potential conservation significant vegetation, flora and fauna within a 20 km radius around the Survey Area was undertaken using the following sources:

- Previous reports: A Survey of Roadside Conservation Values in the Shire of Kojonup and Roadside Management Guidelines (Roadside Conservation Committee [RCC] 2003), Harold Road Passing Lanes (Albany Highway SLK 240.4 – 243.25) Biological Assessment (GHD 2016).
- Protected Matters Search Tool (PMST) (Department of the Environment and Energy [DotEE] 2016a) to identify potential flora and fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- NatureMap (Department of Parks and Wildlife [DPaW] 2016a) to identify potential flora and fauna species listed under State and Federal legislation.
- DPaW database of Priority Ecological Communities (PECs) and Threatened Ecological Communities (TECs) (DPaW 2016b) to determine known occurrences in the vicinity of the assessment area.

3.2 Vegetation Assessment

A vegetation assessment using floristic quadrats was conducted to identify the vegetation type and condition. The following information was recorded in quadrats with dimensions of 100 m² in accordance with the Technical Guide for Flora and Vegetation Surveys for Environmental Impact Assessment (Environmental Protection Agency and Department of Parks and Wildlife [EPA & DPaW] 2015):

- Location – coordinates of the Northwest corner of the quadrat.
- Recorder and date – personnel involved in sampling that location and survey date.
- Species – all vascular plant species present, including weed species. Species that were not confidently identified during the field survey were collected for later identification in the Albany regional herbarium, or at the WA Herbarium where required.
- Foliar cover – the estimated percentage cover for each dominant species in each stratum.
- Vegetation description – according to the National Vegetation Information System (Executive Steering Committee for Australian Vegetation Information [ESCAVI] 2003).
- Vegetation condition – according to the most current vegetation condition classification.
- Disturbance – records of any obvious disturbances such as symptoms of plant disease (i.e. caused by the presence of *Phytophthora* Dieback, aerial canker or *Armillaria* sp.), recent fire, tracks, weed infestation etc.

- Photographs – several photographs were taken overlooking the quadrat from various corners.

Quadrat information was used to define vegetation communities based on a comprehensive quadrat sampling regime (minimum of three quadrats per community). Species accumulation curves were assessed according to Drozd *et al.* (2010) to determine the adequacy of the overall number of quadrats within the Survey Area. Quadrat similarity was assessed using two way tables and field observations, no cladistics analysis was conducted.

3.1 Targeted Rare and Priority Flora Search

A targeted search for potential Threatened and Priority flora identified from the desktop assessment was conducted across the Survey Area. The search was conducted in the appropriate season to detect most of the Threatened or Priority species with a high likelihood of occurrence. The assessment area was initially surveyed via a meandering traverse to identify vegetation types and condition. Where vegetation types were identified as potential habitat for Threatened or Priority flora, an intensive grid of suitably spaced transects was surveyed. Population census and site information of any Threatened or Priority flora 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 within population boundaries.

3.2 Fauna Habitat Assessment

A fauna habitat assessment was undertaken in accordance with Guidance Statement No. 56, Assessment of Environmental Factors for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The fauna assessment primarily focused on the identification of fauna habitat based on vegetation type and structure and the likelihood of occurrence determined from the desktop analysis. Opportunistic recording of faunal evidence (sightings, bird calls, tracks, scats, bones and feeding signs) was undertaken during the concurrent vegetation survey.

Identification and quantification of habitat for Black Cockatoo species was specifically undertaken within the Survey Area. Breeding, foraging and roosting habitat was assessed in accordance with the EPBC Act Referral guidelines for the three threatened Black Cockatoo species (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 trees above a threshold diameter at breast height (DBH) and notes on whether they contain hollows; and the presence and extent of foraging habitat other than tree species (e.g. Proteaceous Shrubland). Trees were recognised as significant when DBH was below the threshold size and hollows were present. The timing potentially coincided with the use of hollows by nesting cockatoo, however the assessment was made only from ground level therefore limiting the detectability of active, or recently active hollows.

3.1 Legislation and Conservation Significance

Flora, fauna and vegetation can be considered as conservation significant under Federal or State legislation or through listing by State Government Authorities. These are explained below with the definitions of conservation status relevant to the different Acts provided (Table 1).

The EPBC Act 1999 is administered by the Federal Government and provides protection to Threatened flora, fauna or vegetation communities that are recognised as Matters of National Environmental Significance (MNES). Impacts to MNES require approval from the Federal Minister for the Environment.

State Government legislation includes the *Wildlife Conservation Act 1950* (WC Act), which recognises Threatened flora, fauna and vegetation in need of special protection within Western Australia. The recently proclaimed *Biodiversity Conservation Act 2016* (BC Act) will eventually replace the WC Act. The DPaW also maintain a list of Priority flora, fauna and ecological communities that warrant monitoring or protection.

The *Environmental Protection Act 1986* (EP Act) provides regulations for clearing of vegetation or habitats through ten clearing principles (Schedule Five of the EP Act) relevant to the biological and environmental aspects of native vegetation. The EP Act also recognises Environmentally Sensitive Areas (ESA) that have specific values such as threatened species, certain conservation estate and wetlands.

Other State level measures of conservation significance other than statutory listing for vegetation and species, subspecies, varieties, hybrids or ecotypes relate to local distribution, range extensions, relictual characteristics, novel assemblages, degree of impact from threatening processes and the level of reservation (EPA & DPaW 2015). Conservation targets also exist for the protection of certain vegetation above thresholds of pre-European extent (EPA 2000). Six overarching criteria relate to the assessment of regional conservation significance including representation of ecological communities, diversity, rarity, maintaining ecological process, evolutionary importance and wetlands (EPA 2006).

Table 1. Relevant Acts and conservation status definitions used in environmental impact assessment.

<i>Environment Protection and Biodiversity Conservation Act 1999</i>	http://www.environment.gov.au/epbc http://www.environment.gov.au/epbc/about/epbc-act-lists#species
<i>Wildlife Conservation Act 1950</i>	https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf (Also includes DPaW Priority species)
<i>Environmental Protection Act 1986</i>	https://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_304_homepage.html
<i>Biodiversity Conservation Act 2016</i>	https://www.dpaw.wa.gov.au/plants-and-animals/468-biodiversity-conservation-act-2016
Environmentally Sensitive Areas	https://www.der.wa.gov.au/your-environment/environmentally-sensitive-areas

4 FLORA RESULTS & DISCUSSION

4.1 Vegetation

Twenty-two floristic quadrats were established to identify the type and condition of the vegetation within the Survey Area. The condition of the vegetation was predominantly degraded due to a sparse or absent understory of native shrubs and a high cover of agricultural grasses and herbs. A tall shrub layer of *Allocasuarina huegeliana* or *Acacia acuminata* was present at various densities across most landforms within the Survey Area. Consequently, the vegetation type was primarily delineated by the dominant Eucalypt present. Three landform specific vegetation types were defined: *Corymbia calophylla* Woodlands on hillslopes, *Eucalyptus rudis* Woodlands in broad, shallowly incised drainage channels and *Eucalyptus wandoo* Woodlands on uplands of laterite and granite. Each vegetation type was represented in condition scales grading from degraded (native understory very sparse or absent) to good (native understory present but obvious disturbance or low-moderate cover of agricultural weeds present) or as a mosaic of both categories (Appendix A).

A species inventory for each vegetation type is listed in Appendix B. Vegetation descriptions and the area of extent (Table 1) for each condition scale is provided below.

Table 1. Extent (hectares) and condition (Keighery 1994) of native remnant and non-native vegetation within the Albany Highway Survey Area.

Vegetation Type	Condition			total:
	Degraded	Degraded/Good	Good	
<i>Corymbia calophylla</i> Woodland	7.42	5.20	0.24	12.86
<i>Eucalyptus rudis</i> Woodland	6.43	2.52	0.54	9.49
<i>Eucalyptus wandoo</i> Woodland	1.16		1.84	3.00
<i>Eucalyptus species</i> Revegetation				4.76
Completely cleared				16.28
<i>sub-total:</i>	15.01	7.72	2.62	46.39

Corymbia calophylla Woodland

Woodlands dominated by *Corymbia calophylla* occurred throughout the Survey Area on mid to upper hillslopes in dark brown sandy loam soils with occasional lateritic gravel (Plate 1).

Areas in good condition are described as an open forest to woodland of *Corymbia calophylla* over a tall open to closed shrubland of *Allocasuarina huegeliana* and *Acacia acuminata* over a low sparse shrubland of *Gastrolobium praemorsum*, *Acacia lasiocarpa* var. *sedifolia*, *Bossiaea eriocarpa* and *Dodonaea humifusa* with an open grassland of *Neurachne alopecuroides* and various agricultural grasses.

Areas in degraded condition typically had a weed cover > 50 % and very sparse or absent native shrub understory.

This vegetation type was represented in quadrat 3, 4, 9, 12, 13, 14, 18, 19 and 22.



Plate 1. *Corymbia calophylla* Woodland in good (above) and degraded (below) condition.

Eucalyptus rudis Woodland

Woodlands dominated by *Eucalyptus rudis* occurred on lower slopes and in broad, shallowly incised drainage channels across the Survey Area in alluvial dark brown sand or clay soils (Plate 2). Exposed granite occurred occasionally in channel basins or as outcropping boulders on lower slopes.

Areas in good condition are described as a woodland or open woodland of *Eucalyptus rudis* over a tall open to closed shrubland of *Allocasuarina huegeliana* and *Acacia acuminata* over a low sparse shrubland of *Xanthorrhoea gracilis* and *Gastrolobium praemorsum*, with a grassland and or sedgeland of *Patersonia occidentalis*, *Neurachne alopecuroides* and various agricultural grasses. *Melaleuca raphiophylla*, *Melaleuca cuticularis* and *Melaleuca viminea* occurred along water courses within this vegetation type. Most low lying areas of this vegetation were in degraded condition due to a grass weed cover > 75 %.

This vegetation type was represented in quadrat 5, 7, 8, 14 and 17



Plate 2. *Eucalyptus rudis* Woodland in good (above) and degraded (below) condition.

Eucalyptus wandoo Woodland

Woodlands dominated by *Eucalyptus wandoo* occurred on upper slopes and hilltops across the Survey Area in dark brown or orange clay soils with occasional lateritic gravel or outcropping granite (Plate 3).

Areas in good condition are described as a woodland or open woodland of *Eucalyptus wandoo* over a tall sparse shrubland of *Allocasuarina huegeliana* and *Acacia acuminata* over a low sparse shrubland of *Gastrolobium praemorsum*, *Mirbelia ovata*, *Acacia lasiocarpa* var. *sedifolia* and *Tetratheca virgata* with a grassland of *Neurachne alopecuroides*, *Themeda triandra*, *Austrostipa* spp. and a herbland of *Ptilotus* spp. Most of this community occurred on dry upper slopes so was less susceptible to invasion of agricultural weeds compared to other lowland vegetation. Some areas of this vegetation were in degraded condition as they were confined to narrow road reserves with grass weed cover > 50 %.

This vegetation type was represented in quadrat 1, 2, 10, 11, 20 and 21.



Plate 3. *Eucalyptus wandoo* Woodland in good (above) and degraded (below) condition.

Eucalyptus revegetation

This vegetation was not considered as a component of remnant vegetation relevant to formal guidelines (EPA & DPaW 2015) for impact assessment, although is considered in relation to habitat for Threatened fauna. The revegetation was composed of mallees (i.e. *Eucalyptus megacornuta*) or small to medium trees (i.e. *Eucalyptus accedens*), typically with a sparse understory and low weed cover (Plate 4). No hollows suitable for Threatened Fauna were present.



Plate 4. *Eucalyptus* revegetation.

4.2 Threatened Ecological Communities

Several components of the vegetation within the Survey Area are recognised as conservation significant under State and Federal legislation.

Several areas within the Survey Area meet the floristic, size and condition thresholds that identify the Eucalypt Woodlands of the Western Australian Wheatbelt Threatened Ecological Community (Wheatbelt Woodlands TEC) (DotEE 2016b). This Federally recognised community encompasses the *Eucalyptus wandoo* Woodlands on low rises and *Eucalyptus rudis* Woodlands in drainage lines that occur within the Survey Area. *Corymbia calophylla* Woodlands are a common component of Jarrah Forest IBRA region and are not recognised as part of the Wheatbelt Woodlands TEC.

Specific size and condition thresholds were applied to vegetation patches on road side reserves within the Survey Area and occurrences of the Wheatbelt Woodlands TEC were mapped when the following thresholds were met:

- reserve width >5 m AND,
- vegetation condition is \geq good AND
- weed cover \leq 50% OR
- weed cover \leq 70% and mature tree density is \leq 10/ha

Vegetation condition was described as “good” according to Keighery (1994): “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”. It was interpreted that at least some understory species were present to meet the rating of “good”. Where vegetation in the road reserve was contiguous with vegetation in similar condition on adjacent tenure the overall width was considered. Five occurrences (total area 3.49 hectares) of the Wheatbelt Woodlands TEC were mapped and numbered consecutively north to south within the Survey Area (Appendix A: Map 1A-D) and are described in Table 2.

Table 2. Occurrences of the Wheatbelt Woodlands TEC within the Survey Area. Occurrence number relevant to vegetation mapping in Appendix A: Map 1A-D.

Occurrence Number	SLK	Area (ha)	Description
1	256.2	0.49	Hillcrest with <i>Eucalyptus wandoo</i> Woodland. Intact understory, good condition and contiguous with good to very good <i>Eucalyptus wandoo</i> woodland in adjacent shire water reserve.
2	258.2	0.54	Drainage channel with <i>Eucalyptus rudis</i> Woodland. Condition is variable, but native understory mostly present and is contiguous with large woodland to the east and a narrow vegetation corridor to west along the Mandalup Brook (tributary of Balgarup River).
3	259.5	0.81	Hillcrest with <i>Eucalyptus wandoo</i> Woodland. Sparse understory but generally low agricultural grass cover. Some connectively with adjacent degraded woodland in private property.
4	263.8	1.1	Lower hill slope with outcropping granite. Mosaic of good to degraded <i>Eucalyptus rudis</i> Woodland. Limited connectively to other vegetation, but road reserve is relatively wide compared to other sections.
5	265.4	0.54	Upper hillslope with <i>Eucalyptus wandoo</i> Woodland. Small contiguous area of Woodland in adjacent private property.

4.1 Other Conservation Significant Vegetation

Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) is used in south west Western Australia to determine the significance of remnant vegetation. There is a presumption against clearing vegetation associations with less than 30% pre-European extent remaining and vegetation with less than 10% of their pre-European extent remaining are considered endangered (EPA 2000).

Within the Survey Area, approximately 94% of the vegetation corresponds with Medium Woodland; Marri (*Corymbia calophylla*) and Wandoo (*Eucalyptus wandoo*) (Vegetation Association 4) and the remaining 6% corresponds with Medium Woodland; Jarrah (*Eucalyptus marginata*), Marri & Wandoo (Vegetation Association 968) (GoWA 2015). These broad vegetation associations subsume all three native remnant vegetation types mapped within the Survey Area. The current extent of vegetation Association 4 falls below the threshold level (30%) at all levels of jurisdiction and vegetation Association 968 falls below the threshold level (30%) in two jurisdictions; Southern Jarrah Forest IBRA Sub-Region and the shire of Kojonup (Table 3). No vegetation was identified that falls below 10% of pre-European extent in any jurisdiction and therefore considered endangered (EPA 2000).

Table 3. Extent of Pre-European vegetation within state jurisdictions (GoWA 2015) for vegetation association 4 (Medium woodland; Marri & Wandoo) and vegetation association 968 (Medium woodland; jarrah, marri & wandoo).

	Vegetation Association	Pre-European Extent (ha)	Current Extent (ha)	% Remaining
State	4	1,054,279.89	293,916.91	27.88
	968	296,877.84	95,732.25	32.25
IBRA Region: Jarrah Forest	4	1,022,712.70	286,845.32	28.05
	968	140,823.45	68,796.35	48.85
IBRA Sub-Region: Southern Jarrah Forest	4	408,511.88	87,631.16	21.45
	968	68,816.02	15,587.88	22.65
Local Government Authority: Shire of Kojonup	4	213,813.59	41,807.12	19.55
	968	8,173.42	2,104.94	25.75

Several additional factors may be used to determine the significance of vegetation in addition to statutory listing or because the extent is below a minimum threshold (EPA & DPaW 2015). These include the following:

- restricted distribution;
- degree of historical impact from threatening processes;
- local endemism in restricted habitats;
- novel combinations of taxa;
- a role as a refuge;
- being representative of a vegetation unit in 'pristine' condition in a highly cleared landscape, recently discovered range extensions, or isolated outliers of the main range; and
- being poorly reserved.

When broadly considered the vegetation can be considered significant in relation to the “degree of historical impact from threatening processes” due to the extensive land clearing within the region. The total remnant vegetation remaining within the Shire of Kojonup is 15% (RCC 2003).

Vegetation clearing principals in the EP Act (No. 6 of schedule five) state that “native vegetation should not be cleared if it is growing in, or in association with an environment associated with a watercourse or wetland”. The *Eucalyptus rudis* Woodland mapped within the Survey Area (9.49ha) occurs in broad drainage channels and is intersected by watercourses in two locations (Mandalup Brook and an upper tributary of the Balgarup River). Despite their generally degraded condition these areas are riparian vegetation that is protected under the EP Act. Riparian areas with *E. rudis* Woodland in good condition are concordant with the specially protected Wheatbelt Woodlands TEC.

4.1 Flora

A total of 146 taxa from 41 families (including 47 weeds) was recorded from the Survey Area (Appendix B). No Priority or Threatened flora were recorded in the Survey Area.

A species accumulation curve according to Drozd *et al.* (2010) was used to determine the adequacy of the quadrat sampling. From 22 quadrats, 103 species (excluding adjacent collections) were detected, which represents 70% of total inventory for the Survey Area. The species accumulation curve is beginning to plateau at approximately 20 quadrats (Figure 1). According to a natural logarithmic relationship between the number of quadrats (x) and unique species (y), greater than 110 quadrats would theoretically be required to detect ≥ 146 species.

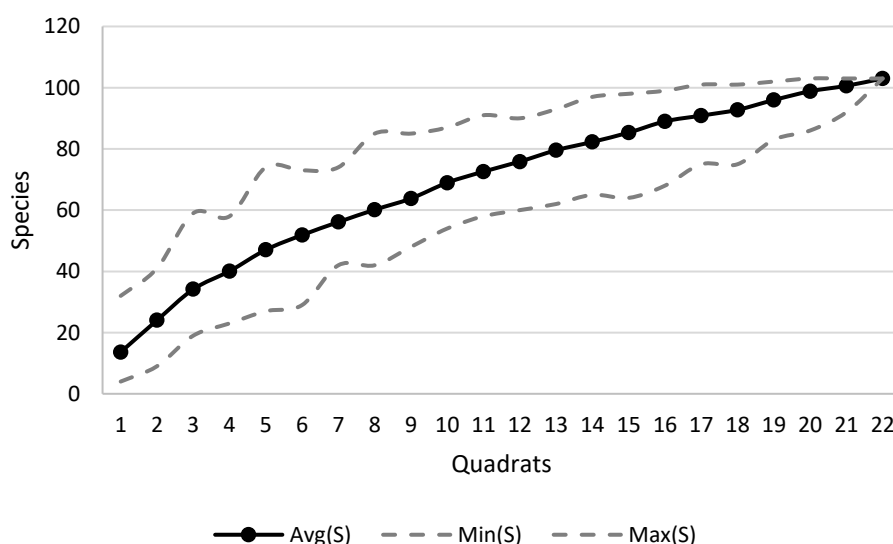


Figure 1. Species accumulation curve; the accumulative average, min and maximum number of species recorded in 22 quadrats (n=103, excluding species outside quadrats) using 100 random permutations. The logarithmic function of $y = 30.925\ln(x) + 1.2487$.

4.1 Flora Likelihood of Occurrence Assessment

The desktop assessment identified 26 conservation significant flora species that may occur in the Survey Area (Appendix C). A likelihood of occurrence was determined using reported habitat information in herbarium voucher labels, published descriptions, distribution records and knowledge from the author. Two Threatened flora were considered to possibly occur and seven Priority flora were considered to either possibly or likely to occur. However, none of these species were recorded during the survey.

Two Threatened flora (*Conostylis drummondii* and *Conostylis setigera* subsp. *dasy*) are known from the vicinity and from habitats represented in the Survey Area (*Eucalyptus wandoo* and *E. marginata* woodland). The habitats identified in the Survey Area were floristically similar, but in poorer condition than known populations of these species. A dense cover of agricultural grasses was prevalent that could easily obscure a small number of individuals if present and represented a limitation in the survey method. However, the tolerance to weed competition of these Threatened flora may also be low and a contributing factor to their rarity. Several plants of *Conostylis setigera* were observed in the Survey Area, which all had distinctively glabrous leaf lamina that is diagnostic of the non-threatened subspecies (subsp. *setigera*).

Four Priority flora that were considered to possibly occur are known in the vicinity (>20 km) and habitats are represented in the Survey Area (woodlands and drainage lines). Most habitats in the Survey Area were in poor condition, which may have contributed to the absence of these species.

Three other Priority flora were considered likely to occur as they are known in close proximity and habitats are represented in the Survey Area. *Acacia grisea* (P4) and *Gastrolobium ovalifolium* (P4) are both perennial shrubs that occur in woodlands of *Eucalyptus wandoo* in small nature reserves near Kojonup Townsite. The survey was theoretically aligned with the flowering period of these species, although the prevalent, dense cover of agricultural grasses could have easily obscured a low number of individuals. One Priority 4 orchid (*Caladenia integra*) is considered likely to occur and the field survey timing was inadequate as it was not aligned with the flowering period (September) (Western Australian Herbarium [WAH] 2016). The likelihood of occurrence of these three Priority flora is considered probable and limitations in the method could have impeded their detection. However, they are relatively abundant (26-44 records) and widespread (range = 350-450km) (WAH 2016), therefore a low number of individuals within the potential project footprint (given that the surveyed area is much greater than the proposed clearing area) would be unlikely to constitute a significant impact to these species, should they actually occur.

4.2 Weeds

Forty seven weed species were recorded from the Survey Area (Appendix B). One species, Bridal creeper (*Asparagus asparagoides*) is listed as a WONS (Weeds Australia 2012). It was abundant in both road reserves in the vicinity of the Kojonup townsite between SLK 254.9 to 256.

5 FAUNA RESULTS & DISCUSSION

5.1 Fauna Assessment

The fauna assessment combined opportunistic field observations and the identification of habitats based on vegetation type, structure and the likelihood of occurrence. The likelihood of occurrence assessment is listed in Appendix D, which determined four conservation significant fauna species were present or likely to occur in the Survey Area, including Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)(T), Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)(T), Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)(T) and Western Rosella (inland) (*Platycercus icterotis* subsp. *xanthogenys*)(P4). Field assessments confirmed that habitats within the Survey Area are currently utilized by conservation significant fauna.

5.2 Threatened Fauna

Carnaby's Black Cockatoo

Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) is listed under Schedule 1 of the WC Act as Endangered and under the EPBC Act as Endangered. The Survey Area occurs within the known distribution and predicted breeding range. No individuals were observed during the field survey, which was conducted in the cockatoo breeding season. Foraging and potential breeding habitat was recorded within the Survey Area.

Baudin's Black Cockatoo

Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) is listed under Schedule 1 of the WC Act as Vulnerable and under the EPBC Act as Vulnerable. The Survey Area occurs within the known distribution and known breeding range of Baudin's Black Cockatoo. No individuals were observed during the field survey, which was conducted in the cockatoo breeding season. Foraging and potential breeding habitat was recorded within the Survey Area.

Forest Red-tailed Black Cockatoo

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) is listed under Schedule 1 of the WC Act as Vulnerable and under the EPBC Act as Vulnerable. The survey area occurs within the modelled distribution of the species occurrence range (DSEWPac 2012). The breeding range has not been modelled although it is recognised that it may breed anywhere within its occurrence range (DSEWPac 2012). Several flocks were observed perching or flying in the vicinity during the field survey, which was conducted in the cockatoo breeding season. Destructive foraging on Marri capsules diagnostic of Forest Red-tailed Black Cockatoo was also observed frequently across the entire Survey Area. Foraging and potential breeding habitat was recorded within the Survey Area.

All three species of cockatoo may utilise similar habitat types for foraging within the Survey Area. All the native remnant *Eucalyptus* and *Allocasuarina* woodlands and areas revegetated with Eucalypts are considered foraging habitat, which comprises a total of 30.12 ha within the Survey Area.

5.3 Significant Fauna Habitat Trees

Significant trees were considered as potential breeding habitat for Black Cockatoo species. Significant trees are those greater than 500 mm DBH for *Eucalyptus marginata*, *E. rudis* and *Corymbia calophylla* or >300 mm DBH for *E. wandoo* (DSEWPaC 2012). Six hundred and sixty individual trees of four taxa were considered as significant within the Survey Area (Table 4). Hollows were uncommon, occurring in only 2.3% of three tree species. However, some individual significant trees contained several hollows, representing a highly valuable resource for Threatened, Priority and other fauna (Plate 5).

Table 4. Species, average diameter and presence of hollows in the significant trees within the Survey Area.

Taxon	Average DBH (mm)	Count	Hollows present
<i>Corymbia calophylla</i>	720	268	2
<i>Eucalyptus marginata</i>	610	8	-
<i>Eucalyptus rudis</i>	740	61	8
<i>Eucalyptus wandoo</i>	460	323	5
		660	15 (2.3%)



Plate 5. Exceptional fauna habitat tree: Large *Eucalyptus wandoo* (above) with close up of six easily visible hollows (below).

5.1 Ecological linkages

In agricultural landscapes largely cleared of native vegetation, roadside remnants can represent a significant proportion of the remaining native habitat for fauna. In some cases road side reserves may form the only remaining vegetation linkage between other areas of native vegetation. The Eucalypt woodland within the Survey Area exemplify this as one the major areas of native vegetation within the Shire of Kojonup (15% native vegetation remaining). Most importantly the road reserve forms one of the last vegetation corridors between Tunney Hill and Kojonup townsite reserves (Farr reserve and Myrtle Benn Sanctuary), which are known breeding sites for Black Cockatoo.

6 SURVEY TIMING & LIMITATIONS

The assessment was conducted during November, 2016. Climatic characteristics of the site and the seasonal conditions preceding the field work may have favourably influenced the emergence of annual species and the flowering of perennial species. The Survey Area occurs within a moderate rainfall zone and the assessment was conducted in spring after good rainfall in the preceding year (Figure 2). Total rainfall for the 12 months prior to the survey was 690 mm, above the historic average of 533 mm; monthly rainfall was also above average in August and October prior to the survey. Consequently, soil moisture conditions were not considered as a limitation for the emergence and flowering of Threatened or Priority species (particularly orchids) within the Survey Area. However, the high rainfall did result in a very high cover of agricultural grasses and herb throughout the Survey Area. Even areas where some understory was present, grass cover was dense. Consequently, this is noted as a potential limitation to the survey by reducing the detectability of low shrubs and herbs of conservation significance.

The survey timing was not aligned with the flowering period (most collections are from last week in September) of one Priority 4 orchid (*Caladenia integra*) that is considered likely to occur, based on the presence of suitable habitat.

Eleven introduced or roadside planted taxa were not identified to species level. Four native grasses or sedges could not be identified confidently to species level due to the absence of reproductive material. One orchid, present as leaf only was identified to the genus *Thelymitra*. No unidentified taxa are considered likely to be Threatened or Priority flora.

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. The report was prepared for Main Roads Western Australia and should be read, distributed and referred to in its entirety.

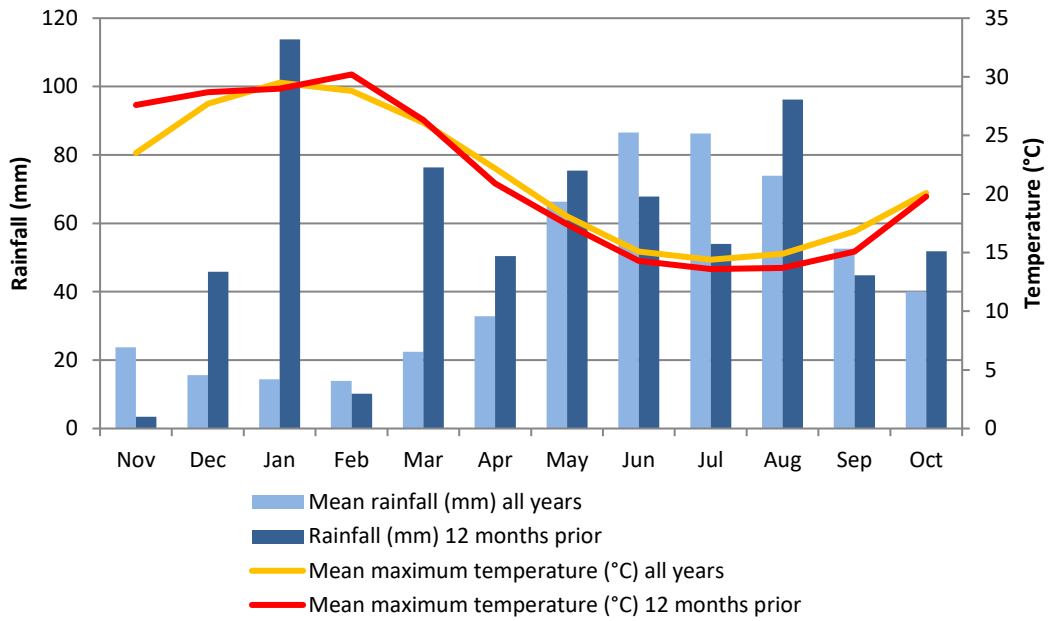


Figure 2. Climate statistics for 12 months prior to the assessment compared with historical averages (all years available) from the nearest weather stations (Kojonup for rainfall only, Katanning for temperature only) (BOM 2016). Total rainfall in Kojonup for the 12 month period prior to the survey was 690 mm compared to the historic average of 533 mm.

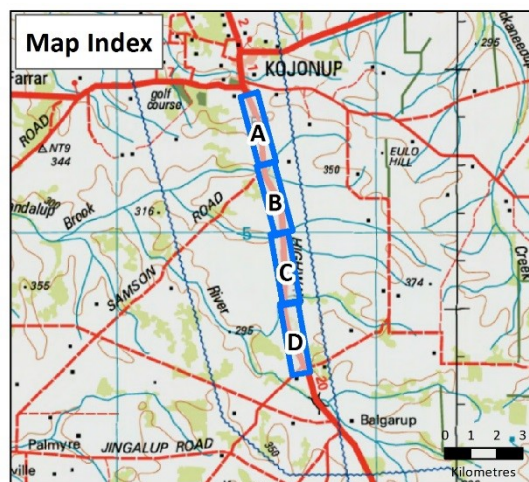
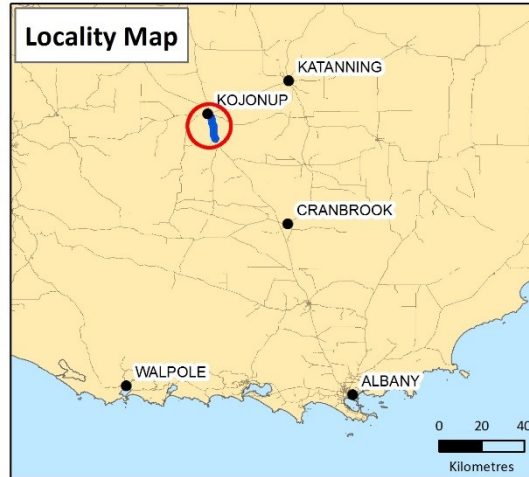
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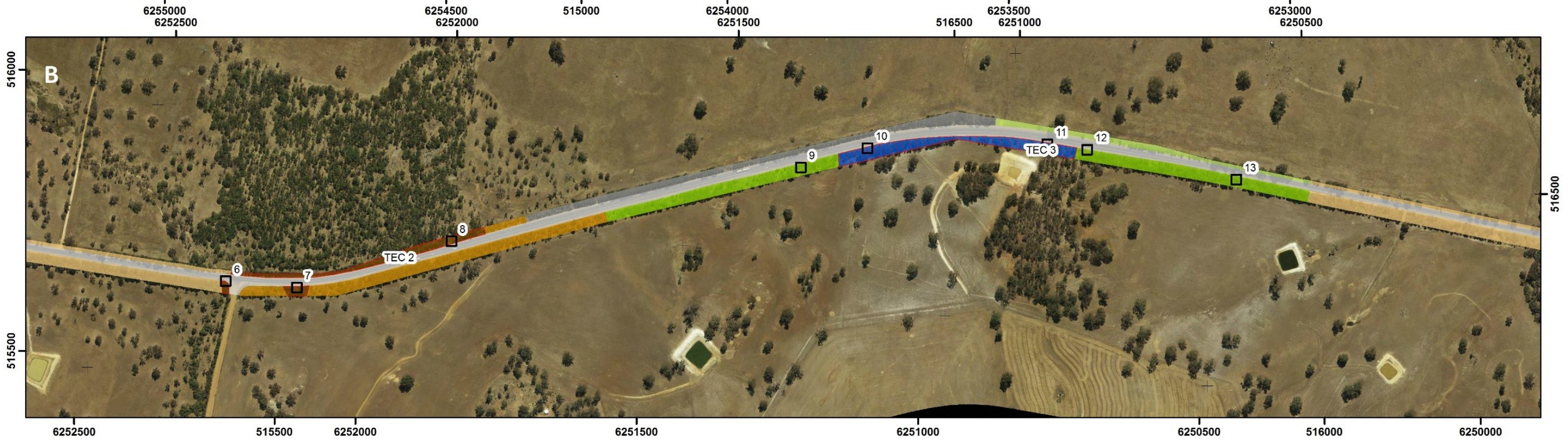
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8 APPENDIX A - MAPS 1-2 - Vegetation, Flora and Fauna Habitat.



**Locality & Index to Report Maps:
Flora and Fauna Assessment
Albany Highway, South of
Kojonup Townsite.**



Vegetation Type & Condition

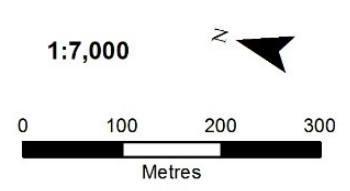
- Corymbia calophylla* Woodland, Good
- Corymbia calophylla* Woodland, Degraded/Good
- Corymbia calophylla* Woodland, Degraded
- Eucalyptus rudis* Woodland, Good
- Eucalyptus rudis* Woodland, Degraded/Good

- Eucalyptus rudis* Woodland, Degraded
- Eucalyptus wandoo* Woodland, Good
- Eucalyptus wandoo* Woodland, Degraded
- Eucalyptus* species Revegetation, NA
- Cleared, NA

Threatened Ecological Communities (Occurrence No.)

- Eucalypt Woodlands of the WA Wheatbelt
- Vegetation Quadrat (No.)

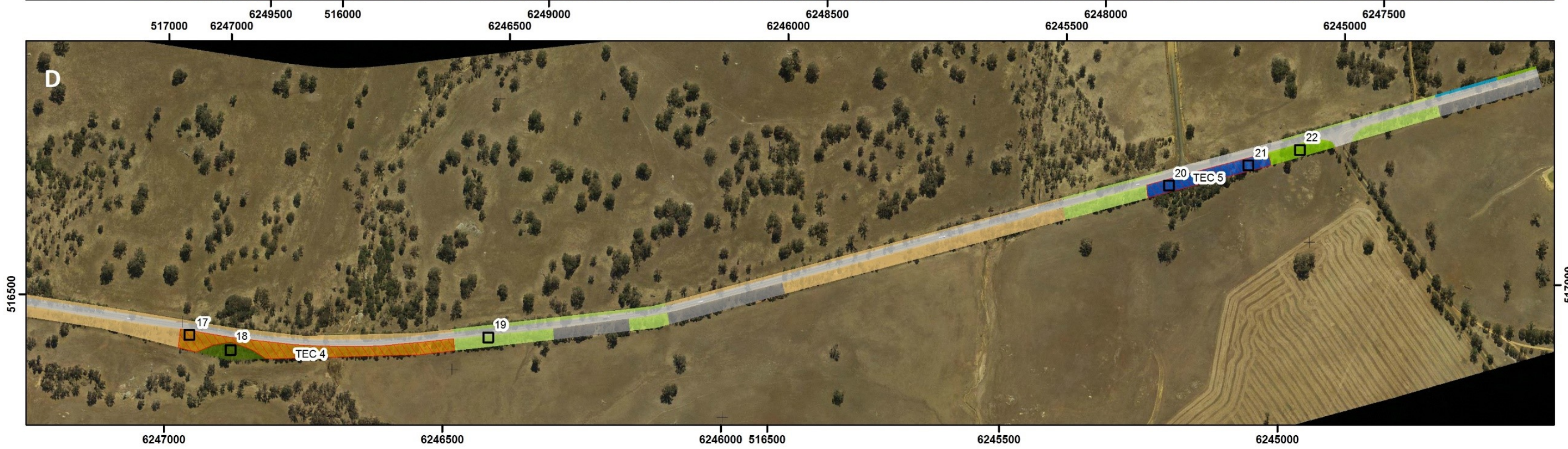
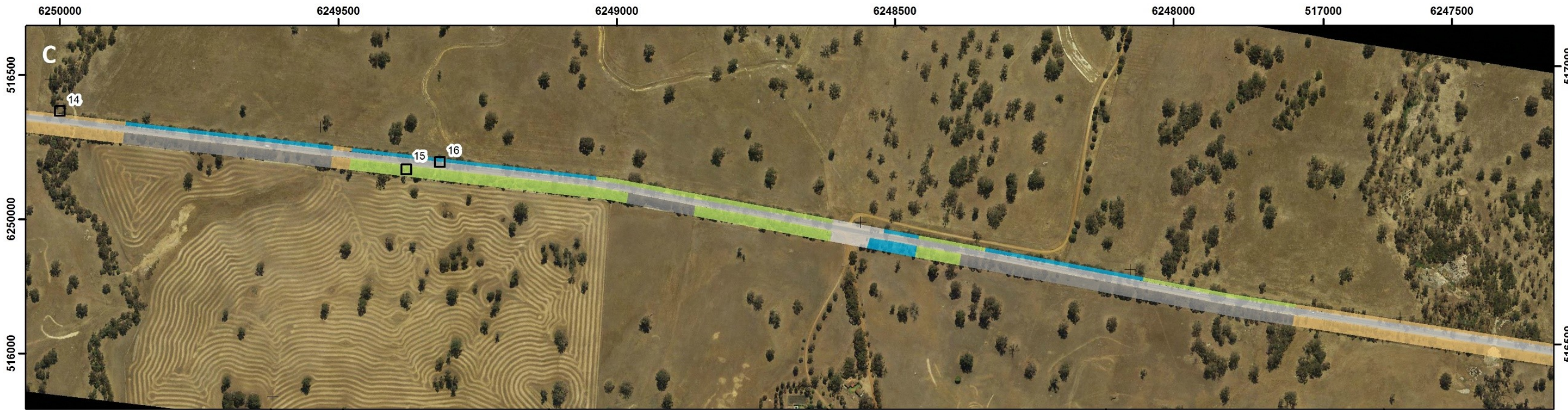
Map 1A&B: Vegetation Type and Condition, Threatened Ecological Communities, Albany Highway, South of Kojonup Townsite.



Map produced by Damien Rathbone on 16/02/2017 for Main Roads Western Australia. Field information valid at 30th November, 2016.

Project Reference: DR1616_Flora2cFaunaAssessmentAlbanyHwySouthofKojonupTownsite_20170220

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50
Map size = A3



Vegetation Type & Condition

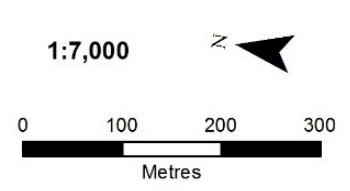
- Corymbia calophylla* Woodland, Good
- Corymbia calophylla* Woodland, Degraded/Good
- Corymbia calophylla* Woodland, Degraded
- Eucalyptus rudis* Woodland, Good
- Eucalyptus rudis* Woodland, Degraded/Good

- Eucalyptus rudis* Woodland, Degraded
- Eucalyptus wandoo* Woodland, Good
- Eucalyptus wandoo* Woodland, Degraded
- Eucalyptus* species Revegetation, NA
- Cleared, NA

Threatened Ecological Communities (Occurrence No.)

- Eucalypt Woodlands of the WA Wheatbelt
- Vegetation Quadrat (No.)

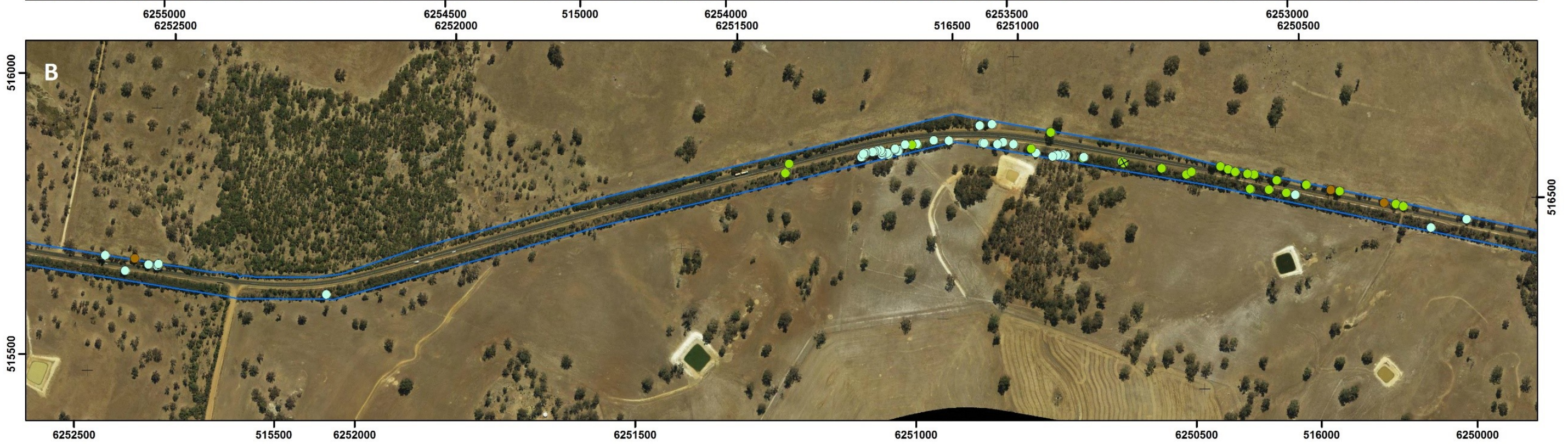
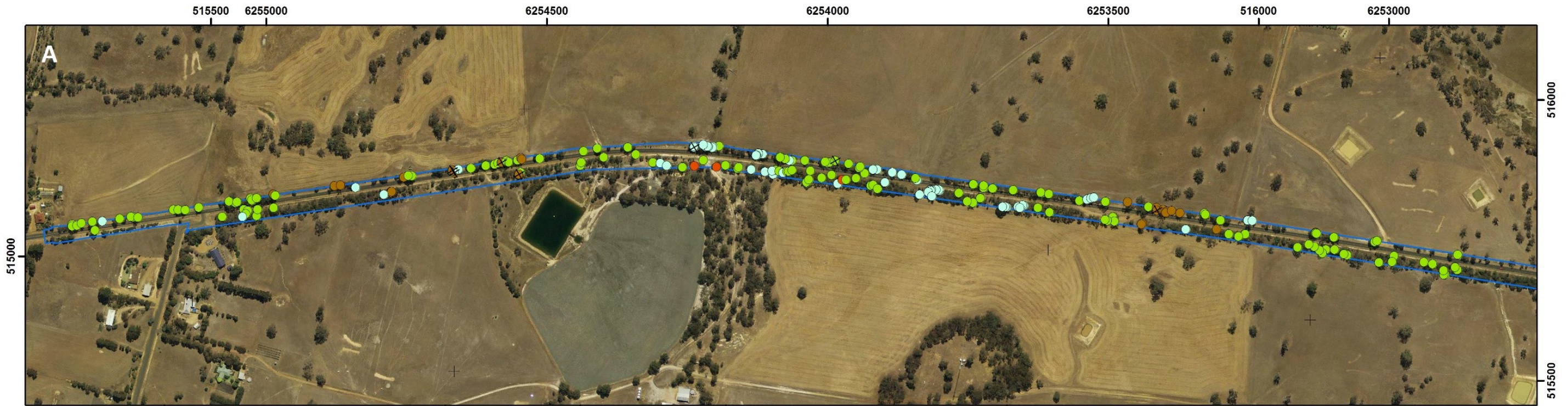
Map 1C&D: Vegetation Type and Condition, Threatened Ecological Communities, Albany Highway, South of Kojonup Townsite.



Map produced by Damien Rathbone on 16/02/2017 for Main Roads Western Australia. Field information valid at 30th November, 2016.

Project Reference: DR1616_Flora2cFaunaAssessmentAlbanyHwySouthofKojonupTownsite_20170220

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50
Map size = A3 Map rotation = 80 degrees



Significant Fauna Habitat Trees

- *Corymbia calophylla* (DBH>500mm)
- *Eucalyptus marginata* (DBH>500mm)
- *Eucalyptus rudis* (DBH>500mm)
- *Eucalyptus wandoo* (DBH>300mm)

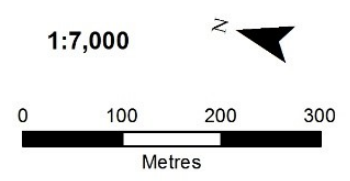
Fauna Habitat Type

- ⊗ Current or potential nesting habitat for Cockatoo (T) or Western Rosella (P4)

Other Features

- Survey Area

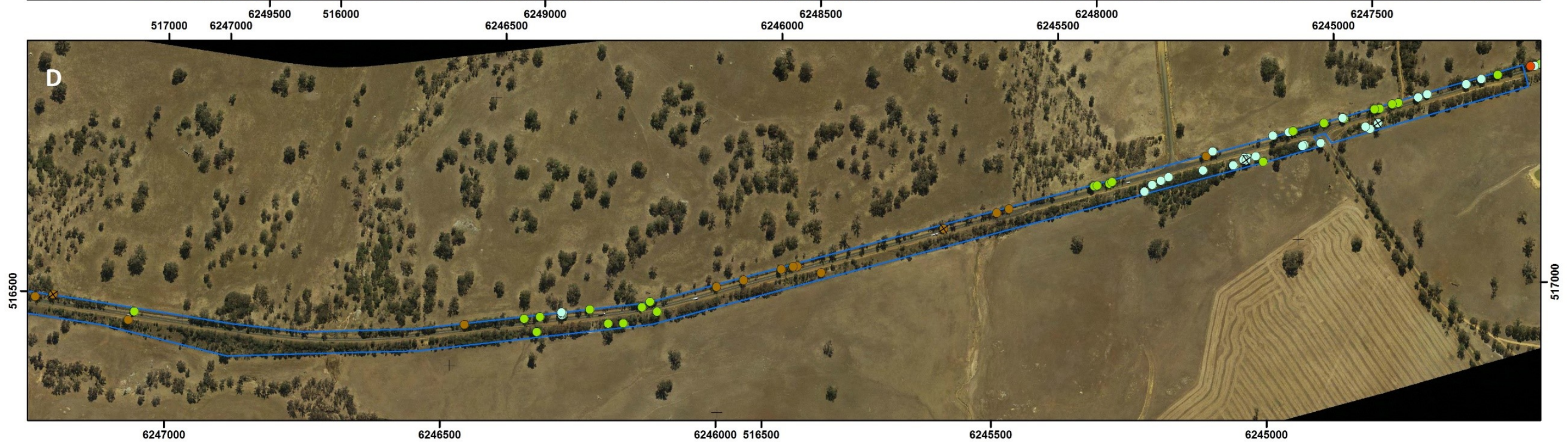
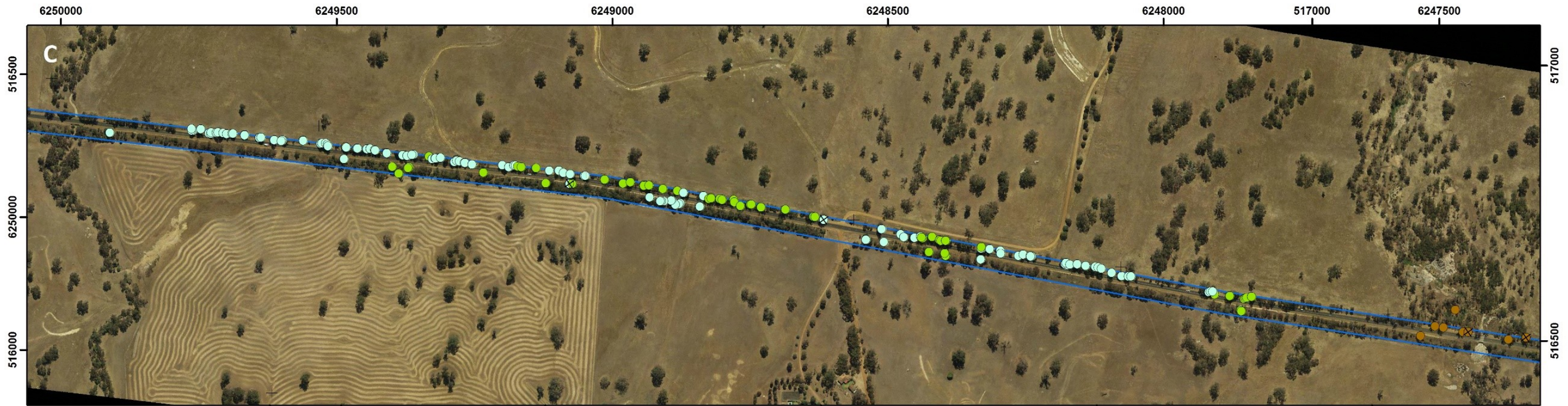
Map 2A&B: Significant Fauna Habitat Trees and Fauna Habitat Type Albany Highway, South of Kojonup Townsite.



Map produced by Damien Rathbone on 16/02/2017 for Main Roads Western Australia. Field information valid at 30th November, 2016.

Project Reference: DR1616_Flora2cFaunaAssessmentAlbanyHwySouthofKojonupTownsite_20170220

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50
Map size = A3 Map rotation = 75 degrees



Significant Fauna Habitat Trees

- *Corymbia calophylla* (DBH>500mm)
- *Eucalyptus marginata* (DBH>500mm)
- *Eucalyptus rudis* (DBH>500mm)
- *Eucalyptus wandoo* (DBH>300mm)

Fauna Habitat Type

- ⊗ Current or potential nesting habitat for Cockatoo (T) or Inland Western Rosella (P4)

Other Features

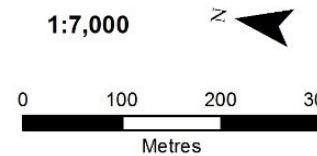
- Survey Area

Map 2A&B: Significant Fauna Habitat Trees and Fauna Habitat Type Albany Highway, South of Kojonup Townsite.

Map produced by Damien Rathbone on 16/02/2017 for Main Roads Western Australia. Field information valid at 30th November, 2016.

Project Reference: DR1616_Flora2cFaunaAssessmentAlbanyHwySouthofKojonupTownsite_20170220

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50
Map size = A3 Map rotation = 80 degrees



9 APPENDIX B – PLANT TAXA INVENTORY

Vascular plant taxa recorded the Survey Area from 22 floristic quadrats and opportunistic collections (outside). Plant nomenclature and status according WAH (1998-). *denotes weed taxon. Weeds of National Significance (WoNS) according to Weeds Australia (2012).

FAMILY	TAXON	QUADRAT NO.																						Outside
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Amaranthaceae	<i>Ptilotus declinatus</i>																							x
	<i>Ptilotus drummondii</i>																							x
	<i>Ptilotus manglesii</i>																							x
Asparagaceae	* <i>Asparagus asparagoides</i> (WoNS)																							x
	* <i>Asparagus officinalis</i>																							x
	<i>Lomandra nutans</i>	x																						x
	<i>Thysanotus patersonii</i>																							x
Asteraceae	* <i>Arctotheca calendula</i>																							x
	* <i>Conyza bonariensis</i>																							x
	* <i>Cotula coronopifolia</i>																							x
	* <i>Sonchus asper</i>																							x
	* <i>Sonchus oleraceus</i>																							x
	* <i>Taraxacum khatoonae</i>	x																						x
	* <i>Ursinia anthemoides</i>																							x
	* <i>Vellereophyton dealbatum</i>																							x
	<i>Podotheca gnaphalioides</i>																							x
	<i>Rhodanthe manglesii</i>																							x
	<i>Waitzia corymbosa</i>	x																						x
		<i>Waitzia suaveolens</i> var. <i>suaveolens</i>																						x
Brassicaceae	* <i>Brassica tournefortii</i>																							x
	* <i>Raphanus raphanistrum</i>																							x
Campanulaceae	<i>Isotoma hypocrateriformis</i>																							x
Caryophyllaceae	* <i>Spergula arvensis</i>																							x
Casuarinaceae	<i>Allocasuarina huegeliana</i>																							x
Celastraceae	<i>Stackhousia pubescens</i>	x																						x
Chenopodiaceae	* <i>Chenopodium album</i>																							x
Convolvulaceae	<i>Convolvulus angustissimus</i> subsp. <i>angustissimus</i>																							x

FAMILY	TAXON	QUADRAT NO.																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Outside
Crassulaceae	<i>Crassula colorata</i>																x							x
Cyperaceae	* <i>Cyperus tenellus</i>						x																	
	<i>Chorizandra enodis</i>																							x
	<i>Isolepis cernua</i> var. <i>cernua</i>						x																	
	<i>Lepidosperma</i> sp. 1 (aff. <i>squamatum</i>)	x																						
	<i>Lepidosperma</i> sp. 2 (aff. <i>leptostachyum</i>)																					x	x	
	<i>Schoenus curvifolius</i>									x														
	<i>Schoenus</i> sp.										x													
	<i>Schoenus subflavus</i>																					x	x	
	<i>Tetragia octandra</i>									x		x		x										
	<i>Tetragia</i> sp. Jarrah Forest (R. Davis 7391)	x	x	x				x		x				x										
Dilleniaceae	<i>Hibbertia commutata</i>	x		x								x												
Droseraceae	<i>Drosera menziesii</i>	x								x														
Elaeocarpaceae	<i>Tetragia virgata</i>	x																		x				
Ericaceae	<i>Astroloma pallidum</i>	x																						
Fabaceae	* <i>Acacia decurrens</i>																						x	
	* <i>Acacia iteaphylla</i>																							x
	* <i>Chamaecytisus palmensis</i>																							x
	* <i>Lotus</i> sp.									x														
	* <i>Trifolium</i> sp. 1		x									x											x	
	* <i>Trifolium</i> sp. 2						x																	
	* <i>Trifolium subterraneum</i>									x														
	<i>Acacia acuminata</i>				x		x	x	x							x								x
	<i>Acacia lasiocarpa</i> var. <i>sedifolia</i>	x								x	x	x												
	<i>Acacia pulchella</i> var. <i>goadbyi</i>																							x
	<i>Acacia saligna</i>														x				x					x
	<i>Bossiaea eriocarpa</i>	x	x							x		x	x	x										
	<i>Bossiaea spinescens</i>	x	x																					
	<i>Daviesia hakeoides</i> subsp. <i>subnuda</i>																							x
	<i>Dillwynia laxiflora</i>	x																						
	<i>Gastrolobium calycinum</i>								x				x											x
	<i>Gastrolobium praemorsum</i>	x	x						x	x		x	x			x	x			x				
	<i>Hovea chorizemifolia</i>												x											

FAMILY	TAXON	QUADRAT NO.																						Outside	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
	<i>Jacksonia furcellata</i> (roadside introduction)																								x
	<i>Jacksonia sternbergiana</i>							x	x					x					x		x				x
	<i>Kennedia prostrata</i>		x			x		x						x											
	<i>Mirbelia ovata</i>	x											x												
Goodeniaceae	<i>Dampiera sacculata</i>	x																							
	<i>Goodenia coerulea</i>																								x
	<i>Goodenia pulchella</i> subsp. <i>Wheatbelt</i> (L.W. Sage & F. Hort 795)																								x
	<i>Lechenaultia formosa</i>																								x
Haemodoraceae	<i>Conostylis aculeata</i> subsp. <i>aculeata</i>												x												x
	<i>Conostylis setigera</i> subsp. <i>setigera</i>																								x
	<i>Haemodorum laxum</i>							x																	x
Haloragaceae	<i>Glischrocaryon aureum</i>																								x
Hemerocallidaceae	<i>Agrostocrinum scabrum</i> subsp. <i>scabrum</i>								x																
	<i>Caesia occidentalis</i>	x								x													x		
	<i>Dianella revoluta</i>	x		x			x	x	x				x		x				x	x		x	x	x	
	<i>Stypandra glauca</i>					x		x	x					x					x					x	
	<i>Tricoryne elatior</i>								x					x					x				x		
IRIDACEAE	* <i>Gadiolus</i> sp.																								x
	* <i>Romulea rosea</i>	x	x	x					x		x					x							x		
	<i>Patersonia occidentalis</i>								x							x									
Juncaceae	* <i>Juncus acutus</i> subsp. <i>acutus</i>																								x
	<i>Juncus kraussii</i>								x																
Loranthaceae	<i>Amyema</i> sp.																								x
Lythraceae	* <i>Lythrum hyssopifolia</i>																								x
Malvaceae	<i>Thomasia angustifolia</i>																								
	<i>Thomasia foliosa</i>																								x
Myrtaceae	<i>Callistemon phoeniceus</i> (planted)																								x
	<i>Calothamnus quadrifidus</i> (planted)																								x
	<i>Corymbia calophylla</i>	x	x		x	x				x				x		x				x				x	
	<i>Eucalyptus accedens</i> (planted)																								x
	<i>Eucalyptus megacornuta</i> (planted)																								x
	<i>Eucalyptus rudis</i>						x	x	x						x					x			x	x	

FAMILY	TAXON	QUADRAT NO.																						Outside	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
	<i>Eucalyptus sp. red flowers (planted)</i>																							x	
	<i>Eucalyptus sp. rough bark (planted)</i>																							x	
	<i>Eucalyptus wandoo</i>	x	x							x	x	x					x					x	x		
	<i>Leptospermum erubescens</i>	x																							
	<i>Melaleuca cuticularis</i>								x																
	<i>Melaleuca raphiophylla</i>								x						x									x	
	<i>Melaleuca viminea</i>							x																	
Orchidaceae	<i>*Disa bracteata</i>		x			x			x	x							x								
	<i>Thelymitra sp. (leaf only)</i>																							x	
Oxalidaceae	<i>*Oxalis sp.</i>												x	x										x	x
Phyllanthaceae	<i>Poranthera microphylla</i>														x										
Pittosporaceae	<i>Billardiera heterophylla</i>												x											x	
	<i>Billardiera lehmanniana</i>																						x		
Poaceae	<i>*Aira caryophyllea</i>		x																						
	<i>*Avena barbata</i>		x		x		x				x					x		x	x	x					
	<i>*Briza maxima</i>	x	x					x		x		x	x			x		x	x			x	x	x	
	<i>*Briza minor</i>		x			x																			
	<i>*Bromus diandrus</i>							x									x								
	<i>*Bromus hordeaceus</i>							x														x			
	<i>*Cenchrus clandestinus</i>																							x	
	<i>*Dactylis glomerata</i>							x																	
	<i>*Ehrharta calycina</i>	x	x		x							x		x			x	x			x	x	x	x	
	<i>*Ehrharta longiflora</i>							x	x	x	x			x		x							x		
	<i>*Eragrostis curvula</i>																x								
	<i>*Lolium sp.</i>					x	x								x			x							
	<i>*Phalaris paradoxa</i>																							x	
	<i>*Poaceae sp. (putative weed)</i>																							x	
	<i>*Sporobolus africanus</i>																x								
	<i>*Triticum aestivum</i>							x																	
	<i>Amphipogon strictus</i>												x										x		
	<i>Austrostipa elegantissima</i>	x	x						x		x					x						x			
	<i>Austrostipa mollis</i>										x	x													
	<i>Neurachne alopecuroidea</i>	x		x		x		x		x	x	x			x		x	x				x	x	x	

FAMILY	TAXON	QUADRAT NO.																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Outside
	<i>Rytidosperma caespitosum</i>	x																						
	<i>Rytidosperma setaceum</i>										x	x												
	<i>Rytidosperma sp.</i>											x												
	<i>Themeda triandra</i>																							x
Polygalaceae	<i>Comesperma calymega</i>	x		x																				
Polygonaceae	* <i>Rumex crispus</i>																							x
Primulaceae	* <i>Lysimachia arvensis</i>																						x	
Proteaceae	<i>Hakea laurina (planted)</i>																							x
	<i>Hakea lissocarpha</i>																							x
	<i>Hakea prostrata</i>					x		x		x						x					x			
	<i>Hakea varia</i>																							x
Restionaceae	<i>Desmocladus asper</i>			x																x				x
	<i>Desmocladus fasciculatus</i>																							x
Rhamnaceae	<i>Trymalium ledifolium var. ledifolium</i>												x											x
Rubiaceae	* <i>Galium sp.</i>																							x
	<i>Opercularia vaginata</i>	x	x					x		x												x		x
Sapindaceae	<i>Dodonaea humifusa</i>							x		x					x									
Stylidiaceae	<i>Stylidium caricifolium</i>	x																						
	<i>Stylidium uniflorum</i>	x																						
Thymelaeaceae	<i>Pimelea angustifolia</i>																							x
Xanthorrhoeaceae	<i>Xanthorrhoea gracilis</i>			x				x				x	x	x						x				

10 APPENDIX C – LIKELIHOOD OF OCCURENCE (FLORA)

Likelihood of occurrence and survey limitations for conservation significant flora recorded in the vicinity of the Survey Area (<20 km). Plant nomenclature, status, description and habitat according to WAH (1998-).

Taxon	Plant Description & Habitat	Likelihood of Occurrence
<i>Adenanthos pungens</i> subsp. <i>pungens</i> [Proteaceae] (T)	Erect shrub, 0.5-3 m high. Fl. pink/red, Aug to Nov. White/grey or pink sand, rocky soils, gypsum. Sand dunes, hillsides.	Unlikely: No records in vicinity and no suitable habitat in Survey Area.
<i>Banksia oligantha</i> [Proteaceae] (T)	Non-lignotuberous shrub, to 3 m high. Fl. red & cream/orange-brown, Oct to Nov. Proteaceous heath in yellow or yellow-brown sand.	Unlikely: No records in vicinity and no suitable habitat in Survey Area.
<i>Caladenia dorrienii</i> [Orchidaceae] (T)	Tuberous, perennial, herb, 0.1-0.2 m high. Fl. white-cream-yellow, Sep to Nov. Clayey loam. Moist sites adjacent to rivers and seasonal creeks.	Unlikely: No records in vicinity and limited habitat in Survey Area.
<i>Commersonia erythrogyna</i> [Malvaceae] (T)	Shrub. Stems glabrous. Leaves 12-35 mm long, 8-20 mm wide, margins entire or serrate; indumentum of stellate hairs. Flowering time Aug, Sep or Oct.	Unlikely: No records in vicinity and known only from a few locations. Limited suitable habitat in Survey Area.
<i>Conostylis drummondii</i> [Haemodoraceae] (T)	Rhizomatous, tufted perennial, grass-like or herb, 0.1-0.3 m high. Fl. yellow, Oct to Nov. White, grey or yellow sand, gravel. Heath or woodlands of <i>Eucalyptus marginata</i> or <i>E. wandoo</i> .	Possible: Known from very few locations north of Kojonup. Some potential habitat in Survey Area, although mostly disturbed. Survey limitations: Small, inconspicuous plant easily obscured by weedy grasses that were prevalent in Survey Area.
<i>Conostylis setigera</i> subsp. <i>dasys</i> [Haemodoraceae] (T)	Rhizomatous, tufted perennial, grass-like or herb, 0.15-0.3 m high. Fl. yellow/red, Oct to Nov. Sand, gravel, laterite.	Possible: Known from very few locations north of Kojonup. Some potential habitat in Survey Area although mostly disturbed. All plants of <i>C. setigera</i> within Survey Area had distinctly glabrous leaf lamina diagnostic of subsp. <i>setigera</i> . Survey limitations: Small, inconspicuous plant easily obscured by weedy grasses that were prevalent in Survey Area.
<i>Diuris micrantha</i> [Orchidaceae] (T)	Tuberous, perennial, herb, 0.3-0.6 m high. Fl. yellow & brown, Sep to Oct. Brown loamy clay. Winter-wet swamps, in shallow water.	Unlikely: No contemporary records in vicinity of the Survey Area. Limited habitat within Survey Area. All wet habitats were associated with open drainage channels rather than closed depressions. Survey limitations: Survey not aligned with flowering time.
<i>Diuris micrantha</i> [Orchidaceae] (T)	Tuberous, perennial, herb, 0.3-0.6 m high. Fl. yellow & brown, Sep to Oct. Brown loamy clay. Winter-wet swamps, in shallow water.	Unlikely: No contemporary records in vicinity of the Survey Area. Limited habitat within Survey Area. All wet habitats were associated with open drainage channels rather than closed depressions.
<i>Eleocharis keigheryi</i> [Cyperaceae] (T)	Rhizomatous, clumped perennial, grass-like or herb (sedge), to 0.4 m high. Fl. green, Aug to Nov. Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Unlikely: Fairly widely disturbed in a variety of wet habitat within SWWA. All wet habitats Survey Area were associated with open drainage channels rather than closed depressions so limited habitat present. Survey limitations: Potential seasonally wet habitats were mainly dry during assessment, therefore may have obscured plants.
<i>Gastrolobium lehmannii</i> [Fabaceae] (T)	Erect, domed shrub, to 1.5 m high. Fl. orange-yellow-red-purple, Sep to Oct. Red clay, laterite. <i>Eucalyptus marginata</i> woodland on hilltops or breakaways. Rarely in Wandoo	Unlikely: More commonly found in <i>E. marginata</i> that was very limited within Survey Area.
<i>Hemigenia ramosissima</i> [Lamiaceae] (T)	Slender shrub, to 0.5 m high. Fl. blue-purple, Nov to Dec or Jan. Lateritic soils, clay. Seasonally wet areas near the Beaufort River.	Unlikely: Known from a very restricted distribution south of the Survey Area. Known habitat is within a large drainage system not replicated within the Survey Area.
<i>Verticordia fimbrilepis</i> subsp. <i>fimbrilepis</i> [Myrtaceae] (T)	Shrub, 0.3-0.7 m high. Fl. pink-white, Oct to Dec or Jan. Heath in gravelly sandy or clayey soils on granite fringes, flats and occasionally road verges.	Unlikely: Known mainly from north of Survey Area near granite outcrops and occasionally road verges. Limited granite habitat and often disturbed within Survey Area.
<i>Melaleuca ordinifolia</i>	Compact, spreading shrub, 0.3-1.5 m high. Fl. white-cream, Aug to Oct. Sandy loam or clay.	Possible: Known mainly from south of the Survey Area. Some potential habitat in drainage lines within the

[Myrtaceae] (P2)	Drainage lines or depressions.	Survey Area. Survey limitations: None identified.
<i>Synaphea flexuosa</i> [Proteaceae] (P2)	Much-branched, tangled shrub, ca. 0.2 m high. Fl. yellow, Sep to Oct. Sandy loam, brown sand. Heath or Allocasuarina woodlands on laterite.	Possible: Extensive potential habitat (<i>Allocasuarina huegeliana</i>) in Survey Area, although highly disturbed. Survey limitations: Small shrub easily obscured by weedy grasses. Survey not aligned with flowering time.
<i>Acacia ataxiphylla</i> subsp. <i>ataxiphylla</i> [Fabaceae] (P3)	Prostrate, sprawling shrub, 0.15-0.5 m high, to 1 m wide. Fl. yellow, Nov to Dec or Jan. Gravelly clay loam, white/grey sand. Sometime in wandoo. Variety of soil types.	Possible: Some potential habitat in Survey Area, although mainly disturbed. Survey limitations: Small shrub easily obscured by weedy grasses.
<i>Brachyloma mogin</i> [Ericaceae] (P3)	Compact shrub, 0.4 m high. Fl. red/pink/white, Jun. Grey clayey sand. Swamp flats.	Unlikely: Limited habitat within Survey Area. All wet habitats associated with open drainage channels rather than closed depressions.
<i>Calectasia obtusa</i> [Dasyopogonaceae] (P3)	Erect, low herb, 0.25-0.4 m high, to 0.2; with aerial roots. Fl. blue, Aug to Sep. Sand, clay loam, gravel, laterite. Flats. Heath and mallee.	Unlikely: No suitable habitat (heath or mallee) within the Survey Area.
<i>Hakea lasiocarpa</i> [Proteaceae] (P3)	Erect shrub, to 6 m high. Fl. white, May to Jul. Sandy loam soils, organic litter over sand, clay or gravel. Hill tops, valleys.	Unlikely: Known mainly from south of Survey Area. Record in vicinity of Survey Area has low geographic accuracy.
<i>Laxmannia grandiflora</i> subsp. <i>stirlingensis</i> [Asparagaceae] (P3)	Tall, slender, rambling, stilt-rooted perennial, herb, to 0.22 m high. Fl. white, Sep to Nov. White sand, sandy clay. Winter-wet locations. Heath and mallee	Unlikely: Known mainly from south of Survey Area. Record in vicinity of Survey Area has low geographic accuracy. Known from habitats not represented in the Survey Area.
<i>Stylidium lepidum</i> [Stylidiaceae] (P3)	Spreading, rosetted perennial, herb, ca 0.05 m high, forming densely packed colonies. Fl. pink-orange, Oct to Nov. Gravelly sand or loam, clay. Winter-wet depressions. Heath and <i>Melaleuca</i> shrublands	Unlikely: Known from habitats not represented or in very poor condition in the Survey Area.
<i>Acacia grisea</i> [Fabaceae] (P4)	Spreading or compact shrub, 0.1-0.6 m high. Fl. yellow, Jun to Aug. Lateritic gravelly loamy soils. Undulating plains, slopes. Known from Wandoo and heath.	Likely: Known in close proximity and in similar habitats to Survey Area. Survey limitations: Small, inconspicuous shrub easily obscured by weedy grasses and survey timing not aligned with flowering time. Known from 28 records over range of 400km, therefore low potential impact if present in low numbers.
<i>Banksia acuminata</i> [Proteaceae] (P4)	Prostrate, lignotuberous shrub, to 0.2 m high, to 1 m wide. Fl. yellow-orange, Oct. Gravelly soils. Usually in heath or <i>E. marginata</i> woodland, occasionally with <i>E. wandoo</i>	Possible: Some potential habitat (<i>E. wandoo</i>) in Survey Area, although highly disturbed. Survey limitations: Small shrub easily obscured by weedy grasses and survey not aligned with flowering time.
<i>Caladenia integra</i> [Orchidaceae] (P4)	Tuberous, perennial, herb, 0.2-0.5 m high. Fl. green & red, Sep to Oct. Clayey loam. Wandoo and <i>Allocasuarina huegeliana</i> woodland with outcropping granite.	Likely: Known in close proximity and in similar habitats to Survey Area. Survey limitations: Small, inconspicuous shrub easily obscured by weedy grasses and survey not aligned with flowering time. Known from 44 records across a range of 450km, therefore low potential impact if present in low numbers.
<i>Gastrolobium ovalifolium</i> [Fabaceae] (P4)	Prostrate, spreading shrub, to 0.1 m high. Fl. orange & purple & yellow & red, Aug to Sep. Sandy clay. Gravelly hills. wandoo	Likely: Known in close proximity and in similar habitats to Survey Area. Survey limitations: Small, inconspicuous shrub easily obscured by weedy grasses and survey timing not aligned with flowering time. Known from 26 populations over range of 350km, therefore low potential impact if present in low numbers.
<i>Gastrolobium tomentosum</i> [Fabaceae] (P4)	Weak, decumbent, often clumped shrub, to 1 m high. Fl. orange & purple & red, Aug to Nov. Gravelly loam or clay, sometimes over sandier substrates. Hills, road verges.	Unlikely: Known mainly north of Survey Area. Record in vicinity of Survey Area has low geographic accuracy.
<i>Schoenus natans</i> [Cyperaceae] (P4)	Aquatic annual, grass-like or herb (sedge), 0.3 m high. Fl. brown, Oct. Winter-wet depressions.	Unlikely: Aquatic plant that occurs in standing water habitats not known from in Survey Area.

11 APPENDIX D – LIKELIHOOD OF OCCURENCE (FAUNA)

Likelihood of occurrence assessment for conservation significant fauna recorded or with potential habitat known in the vicinity (<20 km) of the Survey Area.

Taxon	Habitat	Likelihood of Occurrence
Birds		
<i>Botaurus poiciloptilus</i> Australasian Bittern (T)	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 <i>Baumea</i> , <i>Lignum</i> , Canegrass, <i>Eragrostis</i> sp. 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).	Unlikely: Most drainage lines within the survey area are sparsely vegetated and would rarely hold suitable fresh water pools at the surface.
<i>Calyptorhynchus banksii naso</i> Forest Red-tailed Black-Cockatoo (T)	Typically dense Jarrah (<i>Eucalyptus marginata</i>), Karri (<i>E. diversicolor</i>) and Marri (<i>Corymbia calophylla</i>) forests, however the species also occurs in a range of other forest and woodland types, including Blackbutt (<i>E. patens</i>), Wandoo (<i>E. wandoo</i>), Tuart (<i>E. gomphocephala</i>), Albany Blackbutt (<i>E. staeri</i>), Yate (<i>E. cornuta</i>), and Flooded Gum (<i>E. rudis</i>) (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 species of tree during breeding periods (Johnstone et al. 2013). Other foraging trees include Blackbutt, Albany Blackbutt, Forest sheoak (<i>Allocasuarina torulosa</i>), Snottygobble (<i>Persoonia</i> spp.) and Karri (<i>E. diversicolor</i>). A realistic minimum age for <i>Eucalyptus marginata</i> bearing hollows used by FRTBC is ~120–150 years (trees diameters of 50–60 cm). Most nest hollows occur in intermediate-sized trees (Whitford et al. 2015).	Present: Multiple small flocks (3-8 birds) observed and extensive foraging evidence on Marri throughout the Survey Area. Foraging habitat abundant, limited breeding habitat present. Survey Area within possible breeding range.
<i>Calyptorhynchus baudinii</i> Baudin's Black Cockatoo (T)	This species occurs in high-rainfall areas, usually at sites that are heavily forested and dominated by Marri (<i>Corymbia calophylla</i>) and <i>Eucalyptus</i> species, especially Karri (<i>E. diversicolor</i>) and Jarrah (<i>E. marginata</i>). The species also occurs in woodlands of Wandoo (<i>E. wandoo</i>), Blackbutt (<i>E. patens</i>), Flooded Gum (<i>E. rudis</i>), and Yate (<i>E. cornuta</i>) (DSEWPaC, 2012). During the non-breeding season, Baudin's Cockatoo feeds on Marri (Saunders 1979). Outside the breeding season, the species feeds on <i>Banksia</i> , <i>Hakea</i> and <i>Erodium</i> . They also feed on invertebrate larvae and in fruit orchards (apple, pear and persimmon) (Chapman 2008). Trees with hollows suitable for Baudin's Cockatoo are likely to be 500 mm or greater diameter at breast height (DBH). Trees thinner than 500 mm DBH have the potential to develop hollows and are therefore also an important resource for Baudin's Cockatoos. Nests, which comprise a layer of wood-chips, are built in large hollows in tall eucalypts, 30-40 cm in diameter and more than 30 cm deep, especially Karri, Marri and Wandoo (Johnstone & Storr 1998; Higgins 1999; Saunders 1974, 1979).	Very Likely: Foraging habitat abundant, limited breeding habitat present. Survey Area occurs in vicinity of known breeding area and is within the known breeding range.
<i>Calyptorhynchus latirostris</i> Carnaby's Black Cockatoo (T)	This species mainly occurs in uncleared or remnant native eucalypt woodlands and in shrubland or kwongan heathland dominated by <i>Banksia</i> , <i>Grevillea</i> and <i>Hakea</i> . The species also occurs in forests containing <i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i> or <i>E. diversicolor</i> (Groom 2011; DSEWPaC 2012). A large variety of food plants are consumed. On the south coast they feed on Jarrah and Marri seeds and a wide variety of mainly proteaceous species. Hollows suitable for breeding generally have an entrance diameter >20cm and occur in trees that are 120–150 years old (Pittman et al. 2007). Trees approaching 680 mm DBH are close to developing suitable hollows (Whitford 2002).	Very Likely: Foraging habitat abundant, limited breeding habitat present. Survey Area occurs within modelled breeding range.
<i>Numenius madagascariensis</i> Eastern Curlew (T)	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 International 2015).	Unlikely: Possible migrant in Survey Area.
<i>Platycercus icterotis</i>	Open forest woodlands and agricultural areas (Simpson and Day	Likely: Foraging habitat and suitable

Taxon	Habitat	Likelihood of Occurrence
subsp. <i>xanthogenys</i> Western Rosella (inland) (P4)	2004). Subspecies <i>xanthogenys</i> occurs in drier woodland, with a heath understorey. Survey area occurs on distribution boundary of the two subspecies.	breeding hollows present in the Survey Area.
<i>Leipoa ocellata</i> Malleefowl (T)	Shrublands, woodlands and mallee vegetation. Distinctive large mound nest of sand or soil and organic matter (Jones and Goth 2008; Morcombe, 2004).	Unlikely: Limited suitable habitat present due to the fragmented landscape, proximity to the highway and the presence of Cats and Foxes.
<i>Merops ornatus</i> Rainbow Bee-eater (IA)	Open forests and woodlands, cleared or semi-cleared habitats, including farmland and areas of human habitation. It also inhabits sand dune systems in coastal areas and at inland sites in close proximity to water.	Possible: Rainbow Bee-eater may be a migratory visitor within the Survey Area.
Mammals		
<i>Dasyurus geoffroii</i> Chuditch (T)	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 (DSEWPC 2012-SPRAT).	Unlikely: Limited suitable habitat present due to the proximity to the highway and the presence of Cats and Foxes.
<i>Macrotis lagotis</i> Bilby (T)	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)	Unlikely: Limited suitable habitat present within the Survey Area due to the proximity to the highway and the presence of Cats and Foxes. Only one inaccurate record exists in the vicinity of Survey Area.
<i>Myrmecobius fasciatus</i> Numbat (T)	The Numbat's distribution once encompassed a number of habitat types, including eucalypt forest, Acacia woodland and Triodia grasslands. Currently there are only two remnant native populations at Dryandra and Perup, WA and several reintroduced populations including Boyagin Nature Reserve, Tutanning Nature Reserve, Batalling block and Karroun Hill Nature Reserve (DPaW 2015, Van Dyck and Strahan, 2008).	Unlikely: No recent records within the vicinity of the Survey Area. Limited suitable habitat present due to the proximity to the highway and the presence of Cats and Foxes.
<i>Phascogale calura</i> Red-tailed Phascogale (T)	The Red-tailed Phascogale inhabits Wandoo(<i>Eucalyptus wandoo</i>) and dense Sheoak (<i>Allocasuarina huegeliana</i>) woodland associations, with populations being most dense in the latter vegetation type. The species prefers vegetation that is unburnt for a long time, which provides continuous canopy cover to assist their arboreal habits. Trees need to be of a sufficient age to provide hollows for nesting in limbs or logs, and grass trees need to have ample skirts to provide cover. Small, scattered populations still occur in remnant vegetation in the Wheatbelt (DEC 2007b).	Possible: Some suitable habitat present, although all contemporary records are from extensive bushland approx. 20 km north of Survey Area. There is very limited vegetated connectivity between known locations and the Survey Area.
<i>Phascogale tapoatafa</i> subsp. <i>tapoatafa</i> Southern Brush-tailed Phascogale (T)	Woodland and open forests, less commonly in wetter forests. The species has an arboreal foraging habit and a preference for mature trees for nesting hollows, although smaller trees have the potential to provide nesting hollows (Abbott & Whitford 2002). Trees with suitable hollows for this species in Victoria range 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 (Gillfillan pers. com. 2016). Phascogales did not discriminate between canopy tree species in selecting nest trees, but showed highly significant selection for trees in the largest size class. Dry sclerophyll forests and open woodlands with a generally sparse ground-storey, which contain suitable nesting resources such as tree hollows, rotted stumps and tree cavities (Van Dyck and Strahan, 2008).	Unlikely: The species has not been recorded in the vicinity since 1994. Limited suitable habitat present due to the fragmented landscape, the proximity to the highway and the presence of Cats and Foxes.
<i>Hydromys chrysogaster</i> Water-rat (P4)	River banks, estuaries and around dams and creeks.	Unlikely: The species has not been recorded in the vicinity since 1993. Most drainage lines within the survey area are sparsely vegetated and would rarely hold water at the surface to provide suitable habitat.
<i>Macropus Irma</i> Western Brush	Habitat includes open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby	Unlikely: Most recent record (2005) was 20 km from survey area limited suitable

Taxon	Habitat	Likelihood of Occurrence
Wallaby (P4)	thickets. It is also found in some areas of mallee and heathland, and is uncommon in karri forest.	habitat due to fragmented landscape and proximity to the highway.
<i>Isoodon obesulus fusciventer</i> Quenda (P5)	Wet or dry sclerophyll forest through to open woodland and scrubby vegetation on sandy soils. Dense scrubby, often swampy, vegetation with dense cover up to one metre high, 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.	Unlikely: Not recorded in vicinity since 1992. Limited suitable habitat present due to the open understory, the fragmented landscape and the presence of Cats and Foxes.
<i>Onychogalea lunata</i> Crescent Nailtail Wallaby (X)	Extinct taxon therefore a paucity of habitat information exist.	Very Unlikely: Not recorded in Western Australia since 1908 (Van Dyck and Strahan, 2008).

12 APPENDIX E – Quadrat Photos and Locations (see attachment)

13 APPENDIX F – GIS Data (see attachment)

14 APPENDIX G – Protected Matters Report (see attachment)
