Mt Cattlin Project

Clearing Assessment

KINGSTON RESOURCES

OCTOBER 2016

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1 INTRODUCTION

Kingston Resources (Kingston) is an ASX listed metals exploration company advancing four prospective lithium projects. Kingston has two prospects in Western Australian including Greenbushes and Ravensthorpe. The Mt Cattlin Project (Deep Purple Prospect) is located approximately 14 km south-west of the established Mt Cattlin lithium mine (Galaxy Resources) and 15 km south-west of Ravensthorpe. The Mt Cattlin Study Area (Study Area) covers a total area of 169.76 ha (Figure 1).

Kingston is seeking approval to drill pegmatite deposits within the Study Area during the 2016/17 period and have submitted a Program of Works (POW) to the Department of Mines and Petroleum (DMP). DMP responses to the POW application have identified the requirement for environmental studies and management actions along with the preparation of an application for a Native Vegetation Clearing Permit pursuant to the *Environmental Protection Clearing of Native Vegetation Regulations 2004*.

1.1 Studies conducted

The following studies have been conducted to provide supporting documentation for the Native Vegetation Clearing Permit:

- Level 1 Flora and Vegetation Assessment
- Fauna Assessment
- Dieback Management Program

2 ASSESSMENT AGAINST THE CLEARING PRINCIPLES

An assessment was made against the clearing principles under the *Environmental Protection Act 1986* utilising the flora and vegetation assessment by Woodman (2016 – Appendix A) and the fauna assessment by Bamford and Associates (2016- Appendix B).

Principle (a) – Native vegetation should not be cleared if it comprises a high level of biological diversity.

Proposal may be at variance to this Principle

The Survey Area lies in the Esperance Plains Bioregion and in the Fitzgerald subregion (at the transition between ESP01 and ESP02). The Fitzgerald subregion is broadly characterised by 'myrtaceous and proteaceous scrub and mallee heaths on sandplain overlying Eocene sediments; rich in endemics' with systems dominated by Eucalyptus. The sub-region is composed of 'variable relief, comprising subdued relief on sandplains of the coastal region, punctuated with metamorphosed granite and quartzite ranges both inland and on the coastal plain' (Woodman 2016a; Bamford 2016).

A total of 120 discrete vascular flora taxa, and one known hybrid, were recorded within the Study Area. This species richness is considered to be high given the relatively small size of the Study Area. Furthermore, as local rainfall far exceeded winter monthly averages preceding survey, it is considered that this survey of the Study Area captured a high number of ephemeral taxa and hence a high percentage of the flora potentially present in the Study Area.

No conservation significant flora taxa were recorded within the Study Area. No flora listed as Priority Flora (DPaW 2014b) are known from or were recorded in the Study Area.

No vegetation considered to represent TECs or PECs listed under the EPBC Act and DPaW-classified TECs or PECs were recorded in the Study Area ((DoE 2016, DPaW 2016a).

The condition of the majority of the vegetation in the Study Area was 'Excellent', indicating a pristine condition over the vast majority of the Study Area. One small area was ranked as 'Degraded' and has most likely been affected by historical human-clearing activities. However, it is considered that historical human-related disturbances have not had a significant impact on the vegetation in the Study Area as a whole.

No indication of the presence of Phytophthora Dieback (dieback) was observed during the survey. However, identification of infestation symptoms in the Mt Cattlin Study Area is difficult to determine due to very low presence of known indicator or susceptible species. This situation makes the vegetation uninterpretable for the presence and distribution of the pathogen (Woodman 2016b). A Dieback Management Program has been developed for the exploration program.

The desktop study (Bamford 2016) identified 250 vertebrate fauna species as potentially occurring in the Ravensthorpe survey area: four fish, ten frogs, 41 reptiles, 164 birds, 26 native and five introduced mammals. However, three of the bird species and three of the mammal species are considered locally extinct, and it is likely that several other mammal species that did not come up on the databases are also locally extinct, including the Quokka *Setonix brachyurus*, Woylie *Bettongia penicillata* and Gilbert's Potoroo *Potorous gilberti*. Therefore, the current vertebrate fauna assemblage is expected to include approximately 244 species.

The main processes affecting and maintaining the fauna assemblage are likely to be local hydrology, fire regimes and the presence and abundance of feral species. The survey area is part of a much broader area of native vegetation and this completeness contributes to the largely intact fauna assemblage.

As the proposed clearing is low impact and covers a small area within contiguous vegetation connecting to protected areas, it is unlikely that the exploration program and associated clearing will have an impact on the level of biodiversity of the region.

Principle (b) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Proposal may be at variance to this Principle

A large number of significant species are likely to occur as residents of the survey area, or at least as regular visitors. Many occur at the eastern edge of their range in the Ravensthorpe area, making their presence in the survey area more significant as populations on the edge of a species' range are often less abundant and more vulnerable to extinction than populations at the centre of the range (Curnutt et al. 1996). Significant species of note that are likely to occur in the survey area regularly include Carnaby's Black-Cockatoo, Malleefowl, Western Whipbird, Chuditch, Red-tailed Phascogale and Brush Wallaby.

Carnaby's Black-Cockatoo was observed mostly in areas of Salmon Gum where the species is very likely to breed, while several old Malleefowl mounds were found. Sightings of Malleefowl, Chuditch and the Western Whipbird were reported nearby in the last six months.

Recommendations regarding the avoidance of all large Salmon Gums and Malleefowl mounds to minimise impacts to these conservation significant species will be incorporated into the Conservation Management Plan for the Exploration Program that is a requirement of DPAW. These include:

- Retain large trees, particularly large Salmon Gums with nesting hollows as these are important for significant species – any large tree to be afforded a 10m buffer from machinery movement as a precaution to avoid disturbing black-cockatoo nests (August to December only);
- Disturbance outside the areas surveyed in detail (proposed access track) should be preceded by further inspections for active Malleefowl mounds;
- Personnel working in the area should be made aware of species such as the Malleefowl that are at risk of roadkill;
- Minimise vegetation clearance and disturbance footprint.

Principle (c) – Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

Proposal is not likely to be at variance to this Principle

No flora taxa listed as Threatened under either the WC Act or the EPBC Act was recorded during the survey of the Study Area. It is considered that this represents a relatively complete census of conservation significant flora in the Study Area.

Principle (d) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

Proposal is not at variance to this Principle

No TECs or PECs listed under the EPBC Act or DPaW-classified TECs or PECs were recorded in the Study Area (DoE 2016).

Principle (e) – Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Proposal is not at variance to this Principle

Ravensthorpe_352 has undergone considerable clearing with 27.79 % of the pre-European extent remaining. In addition, less than 1 % is currently reserved. In contrast, Qualup_516 has over 88 % of its pre-European extent remaining and is considered well protected, with more than 51 % of its current extent reserved.

Extent of Vegetation System Associations within the Study Area (Government of Western Australia 2015)

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent Protected for Conservation
Ravensthorpe_352	Medium woodland; York gum	5717.67	27.79	0.38
Qualup_516	Shrublands; mallee scrub, black marlock	145757.23	88.63	51.76

Given the small scale of the proposed clearing and large amount of connected native vegetation in the local area and region, the native vegetation under application is not considered to be a remnant in a highly cleared area.

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.

Proposal is not likely to be at variance to this Principle

Phillips River passes through the northern part of the survey area and minor watercourses occur in small valleys (Bamford 2016). The flora survey (Woodman 2016a) describes vegetation that occurs on the banks of the river and other damp areas. Given the relatively small scale and low impact nature of clearing activities, significant impacts to riparian vegetation are unlikely. Potential impacts to vegetation growing in association with a watercourse as a result of the proposed clearing will be minimised by the watercourse management actions to be described in a Conservation Management Plan.

Principle (g) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Proposal is not likely to be at variance to this Principle

The exploration program proposes to clear up to 5ha in an area of 168 ha. The study area is composed of undulating topography with flat to gently sloping crests to the ridges. Soils are chiefly sandy neutral yellow-mottled soils containing variable amounts of ironstone gravel, alternating with leached sands that sometimes contain ironstone gravel and are underlain by a clay substrate. Valleys have hard alkaline and neutral yellow-mottled soils (Woodman 2016a).

Given that disturbance activities (tracks, drill holes and costeans) are to be spread throughout the clearing permit boundary area, the proposed clearing is unlikely to cause appreciable land degradation.

Principle (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

Proposal is not likely to be at variance to this Principle

The Study Area is not located within a designation conservation reserve vested in the Conservation Commission. However, it is located in the Cocanarup Timber Reserve which is identified as an Environmentally Sensitive Area as it is listed on the Register of National Estate; Red Book Area, System 3.3 Cocanarup Reserve; and a Timber Reserve (Crown Reserve 30795).

The Cocanarup Timber Reserve is significant, as the salmon gum (*Eucalyptus salmonophloia*) woodland and jam (*Acacia acuminata*) woodland of this reserve are remnants of the vegetation communities which were widespread in the wheatbelt before clearing occurred. Many ecotypes that occur in this reserve are poorly reserved elsewhere in the region (SEWPAC, 2011).

Review of Redbook Areas in 1993 recommended that Timber Reserve C30795 retain its current vesting and also be managed for conservation of flora and fauna (EPA, 1993).

The Register of National Estate area covers 9000 hectares.

The Study Area is located in an area of continuous vegetation connecting to Fitzgerald River National Park located approximately 10km south and comprises more than 280,000 ha.

Given the relatively small scale and low impact nature of clearing activities and its proximity to extensive areas of remaining native vegetation, the proposed clearing is unlikely to result in significant impacts to adjacent or nearby conservation areas, or any areas used for the purpose of conservation.

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

Proposal is not likely to be at variance to this Principle

Several minor non-perennial watercourses intersect the application area and it is possible that some minor increases in sedimentation may occur within these watercourses, should they hold water following a rain event (Bamford 2016). Potential impacts to surface water quality as a result of the exploration will be minimised by management actions.

It is highly unlikely that clearing would cause deterioration in the quality of surface or underground water.

Principle (j) – Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Proposal is not likely to be at variance to this Principle

The Study Area is located within the Esperance Plains region in the Southwest Province of Western Australia. The Esperance Plains region is characterised by a warm Mediterranean climate with winter precipitation. There are 5-6 dry months per year (where evaporation exceeds precipitation), with the region generally receiving between 500-700 mm of precipitation annually (Beard 1990).

The average annual rainfall for this station is 430.5 mm (data from 1901-2016). Average monthly rainfall peaks from late autumn to early spring (May-September), with the highest rainfall on average received in July (47.3 mm). Rainfall received at Ravensthorpe prior to survey being conducted over the winter period (May-August), exceeded the long-term average, with 265.2 mm received compared to the average of 180.1 mm (Bureau of Meteorology 2016).

It is highly unlikely that clearing within the Study Area would cause or exacerbate the incidence of flooding in the area as only minor creeklines are present in the area. The Phillips River dissects the Study area in an east-west direction but the clearing will not impact the river and is therefore unlikely to increase the likelihood or incidence of flooding.

3 REFERENCES

Bamford Consulting Ecologists (2016) Kingston Resources Ravensthorpe Mt Cattlin Project Fauna Assessment. Prepared for Woodman Environmental.

EPA (1993) Red Book Status Report (1993) on the implementation of Conservation Reserves for Western Australia, as recommended by the Environmental Protection Authority (1976 – 1984).

SEWPAC (2011) Australian Heritage Database. Cocanarup Reserve, Jerramungup Ravensthorpe Rd, Ravensthorpe, WA, Australia. http://www.environment.gov.au/cgi-bin/ahdb/search.pl. Department of Sustainability, Environment, Water, Population and Communities.

Woodman Environmental Consulting (2016a) Mt Cattlin Project Level 1 Flora and Vegetation Assessment. Report prepared for Kingston Resources.

Woodman Environmental Consulting (2016b) Mt Cattlin Project Dieback Management Program. Report prepared for Kingston Resources.

Appendix A: Woodman Level 1 Flora and Vegetation Assessment

Mt Cattlin Project

Level 1 Flora and Vegetation Assessment

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OCTOBER 2016

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Mt Cattlin Project, Level 1 Flora and Vegetation Assessment

Prepared for: Kingston Resources

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Cover Photograph: Image 102-0212 - Phillips River, Site KR001, Mt Cattlin Study Area (Woodman Environmental Pty Ltd)

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A	Draft report	AS/SC	DT	19/10/16	AP	21/10/2016
0	Final report	AS/SC	DT	21/10/2016		

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DEFINITIONS

Term	Definition
aff.	Affinitive
AWC	Australian Weeds Committee
BAM	Biosecurity and Agriculture Management
CALM	Department of Conservation and Land Management (now DPaW)
DAF	Department of Agriculture and Food
DEC	Department of Environment and Conservation (now DPaW)
DoEE	Department of the Environment and Energy
DMP	Department of Mines and Petroleum
DPaW	Department of Parks and Wildlife
DEWHA	Department of the Environment, Water, Heritage and the Arts (now DoEE)
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
ESCAVI	Executive Steering Committee for Australian Vegetation Information
GDA	Geocentric Datum of Australia
GIS	Geographic Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
NVIS	National Vegetation Information System
PEC	Priority Ecological Community
Pty Ltd	Proprietary Limited
sp.	Species
TEC	Threatened Ecological Community
TSSC	Threatened Species Scientific Committee
UCL	Unallocated Crown Land
VT	Vegetation Type
WA	Western Australia
WA Herb.	Western Australian Herbarium
Woodman Environmental	Woodman Environmental Pty Ltd

EXECUTIVE SUMMARY

Kingston Resources (Kingston) is an ASX listed metals exploration company advancing four prospective lithium projects. Kingston has two prospects in Western Australian including Greenbushes and Ravensthorpe. The Mt Cattlin Project (Deep Purple Prospect) is located approximately 14 km south-west of the established Mt Cattlin lithium mine (Galaxy Resources) and 15 km south-west of Ravensthorpe. The Mt Cattlin Study Area (Study Area) covers a total area of 169.76 ha.

Kingston is seeking approval to drill pegmatite deposits and have submitted a Program of Works to the Department of Mines and Petroleum The Department responses to the POW application have identified the requirement for environmental studies and management actions along with the preparation of an application for a Native Vegetation Clearing Permit pursuant to the *Environmental Protection Clearing of Native Vegetation Regulations 2004*. Woodman Environmental Consulting Pty Ltd (Woodman Environmental) was commissioned by Kingston to undertake a Level 1 flora and vegetation survey in order to support approval of the proposed exploration program.

The flora and vegetation survey of the Study Area was conducted over one visit in spring of 2016, which is within the optimal time during which the majority of taxa in the Esperance Plains Bioregion are considered most likely to flower. A total of 31 non-permanent relevés were established in each major vegetation unit in the Study Area.

A total of 120 vascular flora taxa, and one known hybrid, were recorded within the Study Area. These taxa represent 37 families and 76 genera. No conservation significant flora taxa were recorded within the Study Area by this survey.

A total of 27 vegetation types were mapped based upon data collected from 31 vegetation relevés. The number and diversity of structural vegetation types in the Study Area is a reflection of the relatively high variety of habitat types owing to the varied geology and soils in the Study Area, as well as a relatively long, narrow Study Area crossing a variety of structural delineations. It is unlikely that these vegetation units have the potential to be restricted. No Threatened Ecological Communities or Priority Ecological Communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* or by the Department of Parks and Wildlife were recorded in the Study Area.

Sixteen introduced flora taxa were recorded in the survey of the Study Area; none of which are Declared Pests under the *Biosecurity and Agriculture Management Act 2007*. However, one taxon, *Lycium ferocissimum* (African Boxthorn), is listed as a Weed of National Significance. Individuals of this taxon were very broadly scattered throughout the Study Area, occurred at very low density and did not alter the vegetation structure and composition.

The condition of the majority of the vegetation in the Study Area was ranked as 'Excellent', indicating a pristine condition over the vast majority of the Study Area. One small area was ranked as 'Degraded' and has most likely been affected by historical human-clearing activities. However, it is considered that historical human-related disturbances have not had a significant impact on the vegetation in the Study Area as a whole.

Detecting pathogen infestation in the Mt Cattlin Study Area through field observations was difficult, as susceptible species were limited. No indication of the presence of Phytophthora Dieback was observed during the 2016 survey. However, infestation symptoms in the Mt Cattlin Study Area were difficult to determine during field observations making the result uninterpretable.

1 INTRODUCTION

1.1 Project and Assessment Description

Kingston Resources (Kingston) is an ASX listed metals exploration company advancing four prospective lithium projects. Kingston has two prospects in Western Australian including Greenbushes and Ravensthorpe. The Mt Cattlin Project (Deep Purple Prospect) is located approximately 14 km south-west of the established Mt Cattlin lithium mine (Galaxy Resources) and 15 km south-west of Ravensthorpe. The Mt Cattlin Study Area (Study Area) covers a total area of 169.76 ha (Figure 1).

Kingston is seeking approval to drill pegmatite deposits within the Study Area during the 2016/17 period and have submitted a Program of Works (POW) to the Department of Mines and Petroleum (DMP). DMP responses to the POW application have identified the requirement for environmental studies and management actions along with the preparation of an application for a Native Vegetation Clearing Permit pursuant to the *Environmental Protection Clearing of Native Vegetation Regulations 2004*.

Woodman Environmental Consulting Pty Ltd (Woodman Environmental) was commissioned by Kingston to undertake a Level 1 flora and vegetation survey in order to support approval of the proposed exploration program. This report presents the results of both the desktop and field survey components of the Level 1 survey.

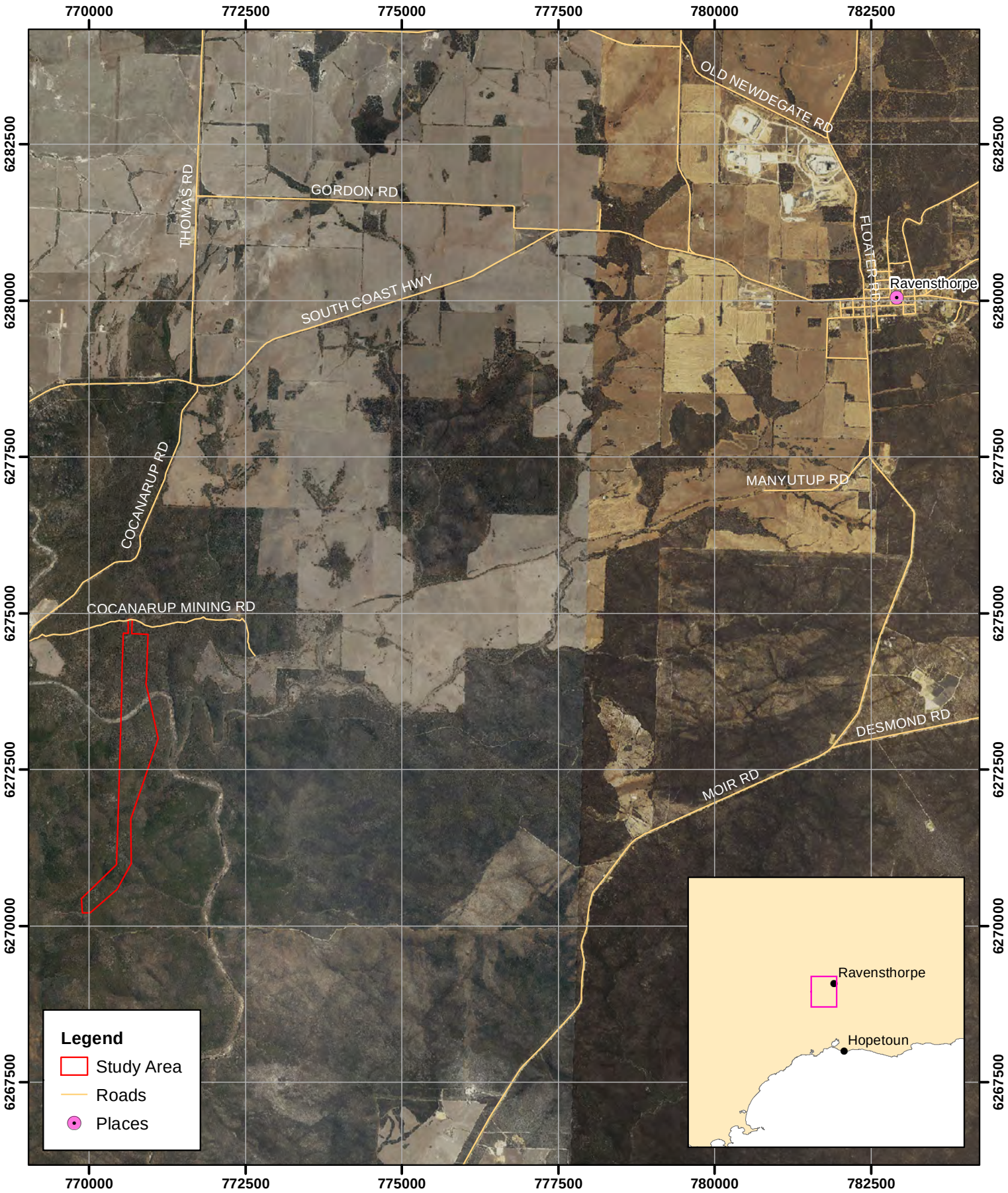
1.2 Level of Assessment

A Level 1 flora and vegetation assessment of the Study Area as defined by the Environmental Protection Authority's (EPA) Guidance Statement No. 51 (EPA 2004a), and Position Statement No. 3 (EPA 2002). The level of survey was determined to be appropriate using Table 2 of Guidance Statement No. 51, where the Bioregion Group is defined as Group 1 and scale and nature of impact is considered Low (EPA 2004a).

1.3 Aims and Objectives

The aim of the flora and vegetation assessment was to determine the flora and vegetation values of the Study Area, and to provide baseline information to support approval of the proposed exploration program. The objectives of the assessment were to:

- Determine the vegetation communities including assessment of the likelihood of Threatened Ecological Communities (TEC) listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and TEC or Priority Ecological Communities (PEC) listed by the Department of Parks and Wildlife.
- Document the presence and/or likelihood of Threatened and Priority listed flora.
- Quantify the area and condition of each vegetation community
- Quantify areas of weed infestation.
- Document the ecological values.



Mt Cattlin Study Area Location	Author: Alison Saligari	N
	WEC Ref: KR16-34-01	
WOODMAN ENVIRONMENTAL	Filename: KR16-34-01-f01.mxd	**Figure**
	Scale: 1:80,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report KR16-34-01.	Revision: A - 09 September 2016	

The survey and reporting works were conducted to comply with the following legislation, guidance statements (GS), environmental assessment guidelines (EAG) and policies:

Legislative requirements

- EPBC Act
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act)
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004; Environmental Protection (Clearing of Native Vegetation) Amendment Regulations 2007*

EPA Guidance Statements and Environmental Assessment Guidelines

- GS 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a)

EPA Environmental Protection Bulletins

- EPB 20 Protection of Naturally Vegetated Areas through Planning and Development

EPA Position Statements

- EPA PS 2 Environmental Protection of Native Vegetation in Western Australia (EPA 2000)
- EPA PS 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002)
- EPA PS 4 Environmental Protection of Wetlands (EPA 2004b)

Technical Guides

- Technical Guide on Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment (EPA and DEC 2015)

2 BACKGROUND AND LITERATURE REVIEW

2.1 Climate

The Study Area is located within the Esperance Plains region in the Southwest Province of Western Australia. The Esperance Plains region is characterised by a warm Mediterranean climate with winter precipitation. There are 5-6 dry months per year (where evaporation exceeds precipitation), with the region generally receiving between 500-700 mm of precipitation annually (Beard 1990). Figure 2 displays average monthly maximum and minimum temperatures, and average monthly rainfall, recorded for Ravensthorpe, the nearest long-term meteorological station to the Study Area (Bureau of Meteorology 2016).

The highest average daily maximum temperature at Ravensthorpe occurs in January (29.0 °C) with the lowest average minimum temperature experienced in August (both 6.7 °C) (data from 1962-2014). The average annual rainfall for this station is 430.5 mm (data from 1901-2016). Average monthly rainfall peaks from late autumn to early spring (May-September), with the highest rainfall on average received in July (47.3 mm). Rainfall received at Ravensthorpe prior to survey being conducted over the winter period (May-August), exceeded the long-term average, with 265.2 mm received compared to the average of 180.1 mm (Bureau of Meteorology 2016).

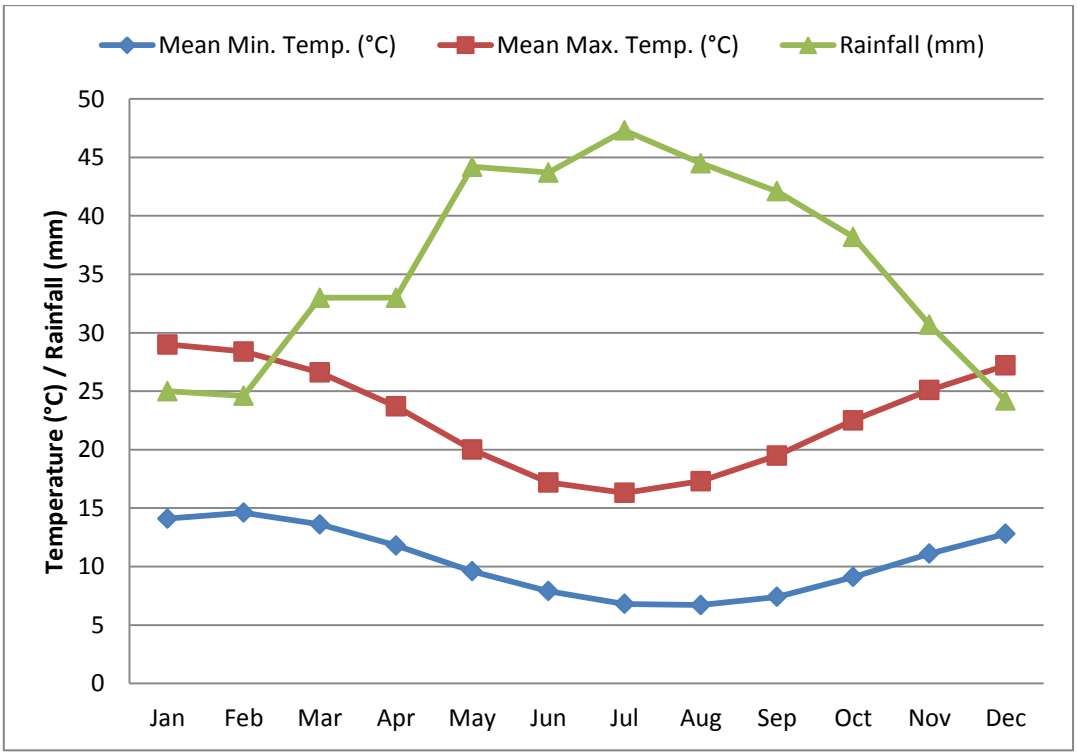


Figure 2: Mean Maximum and Minimum Temperatures (° Celsius) and Mean Rainfall (mm) for Ravensthorpe (Bureau of Meteorology 2016)

2.2 Geology, Soils and Landforms

The Esperance Plains region consists of a relatively flat and monotonous plain rising gently from near sea level at the coast to about 100 m, which is broken by quartzite ranges and granite domes. The plain is formed from Tertiary sediments from the Plantagenet Group, which are Eocene sands and siltstones. Soils are chiefly sandy neutral yellow-mottled soils containing variable amounts of

ironstone gravel, alternating with leached sands that sometimes contain ironstone gravel and are underlain by a clay substrate. Valleys have hard alkaline and neutral yellow-mottled soils (Beard 1990).

The geology in the vicinity of the Study Area is largely mapped as basaltic pyroclastics. There are also significant areas mapped as porphyritic metadacite, pegmatite sheets and dykes, medium to coarse grained metadolerite and metagabbro and metamorphosed basalt (Thom et al 1984).

2.3 Regional Vegetation

The Study Area is located within the Esperance Plains IBRA (Interim Biogeographic Regionalisation for Australia) Region (Commonwealth of Australia 2012), specifically within the ESP01 (Fitzgerald) Subregion. The Fitzgerald subregion has a high diversity of vegetation types, which are often cryptic and endemically localised in nature (Comer *et al.* 2001). Eucalypt species dominate most vegetation types, with a high diversity of Eucalypt species present in many types (Comer *et al.* 2001). Broad vegetation types include the following (from Comer *et al.* 2001):

- coastal dune woodlands of *Eucalyptus utilis* and *E. cornuta*;
- coastal shrublands and heathlands dominated by *Agonis flexuosa*, *Eucalyptus angulosa* and *E. notactites*;
- mallee shrubland and heath (rich in endemics) dominated by *Eucalyptus captiosa*, *E. decipiens* subsp. *chalara* and subsp. *adesmophloia*, *E. falcata*, *E. flocktoniae*, *E. lehmannii*, *E. phaenophylla*, *E. pleurocarpa*, *E. sporadica*, *E. tetraptera*, E. *thamnoides* and *E. uncinata*;
- mallet and moort woodlands on gravel rises, clay sheets and colluvial slopes and greenstone (rich in endemics), with typical dominants including *Eucalyptus astringens* subsp. *redacta*, *E. cernua*, *E. clivicola*, *E. megacornuta*, *E. platypus* subsp. *platypus*, and *E. praetermissa*;
- Yate and York Gum (in the Pallinup system) woodlands on alluvials;
- Jarrah/Marri woodlands in the west; and
- Goldfields woodland and mallee systems mixing with south coast and wheatbelt taxa on greenstone in the east with *Eucalyptus annulata*, *E. brachycalyx*, *E. cernua*, *E. desmondensis*, *E. gardneri* subsp. *ravensthorpensis*, *E. occidentalis*, *E. oleosa* subsp. *corvina*, and *E. salmonophloia*.

Beard (1973) mapped vegetation of the Ravensthorpe area (including the Study Area) related to physiognomy, at a scale of 1:250,000. The Study Area coincides with two vegetation systems described by Beard (1973), being Qualup and Ravensthorpe. The vegetation mapping by Beard (1973) was used by Shepherd *et al.* (2002) to describe vegetation system associations for the purpose of estimating remaining vegetation types.

Two vegetation system associations occur in the Study Area, as summarised in Table 1. Table 1 also presents the extent of each vegetation system association in relation to its pre-European extent (Government of Western Australia 2015), and the percentage of the extent of each vegetation system association currently protected for conservation (in DPaW-managed land). Ravensthorpe_352 has undergone considerable clearing with 27.79 % of the pre-European extent remaining. In addition, less than 1 % is currently reserved. In contrast, Qualup_516 has over 88 % of its pre-European extent remaining and is considered well protected, with more than 51 % of its current extent reserved.

Table 1: Extent of Vegetation System Associations within the Study Area (Government of Western Australia 2015)

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent Protected for Conservation
Ravensthorpe_352	Medium woodland; York gum	5717.67	27.79	0.38
Qualup_516	Shrublands; mallee scrub, black marlock	145757.23	88.63	51.76

A search of the Commonwealth Department of the Environment and Energy (DoEE) database with regard to Matters of National Environmental Significance (MNES) listed under the EPBC Act was performed for the Study Area (DoEE 2016). The results of this search indicate that one federally listed Threatened Ecological Community (TEC) is likely to occur within the Study Area. The Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia TEC is listed as 'Endangered'. The TEC is described as *generally kwongkan shrubland, ranging from sparse to dense, thicket-forming, where Proteaceaeous species form a significant component, primarily occurring on sandplains, marine plains, lower to upper slopes and ridges, as well as uplands* (Threatened Species Scientific Committee (TSSC) (2014)). The results of this search are presented in Appendix A.

A search of DPaW's TEC and PEC database was undertaken for an area encompassing the Study Area with a buffer of 10 km, to identify the presence of any DPaW-classified TECs and/or DPaW-classified PECs that coincide with the search area (DPaW 2016a). No TECs as listed by DPaW (DPaW 2015a) coincide with the search area. The buffer of the DPaW-classified PEC 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia' (Priority 3) overlaps Study Area (Figure 3). This community is federally listed as a TEC as discussed above. Appendix B presents the key features of this conservation significant ecological community (DoE 2014). Appendix C presents definitions, categories and criteria for TECs and PECs (Department of Environment and Conservation (DEC) 2013).

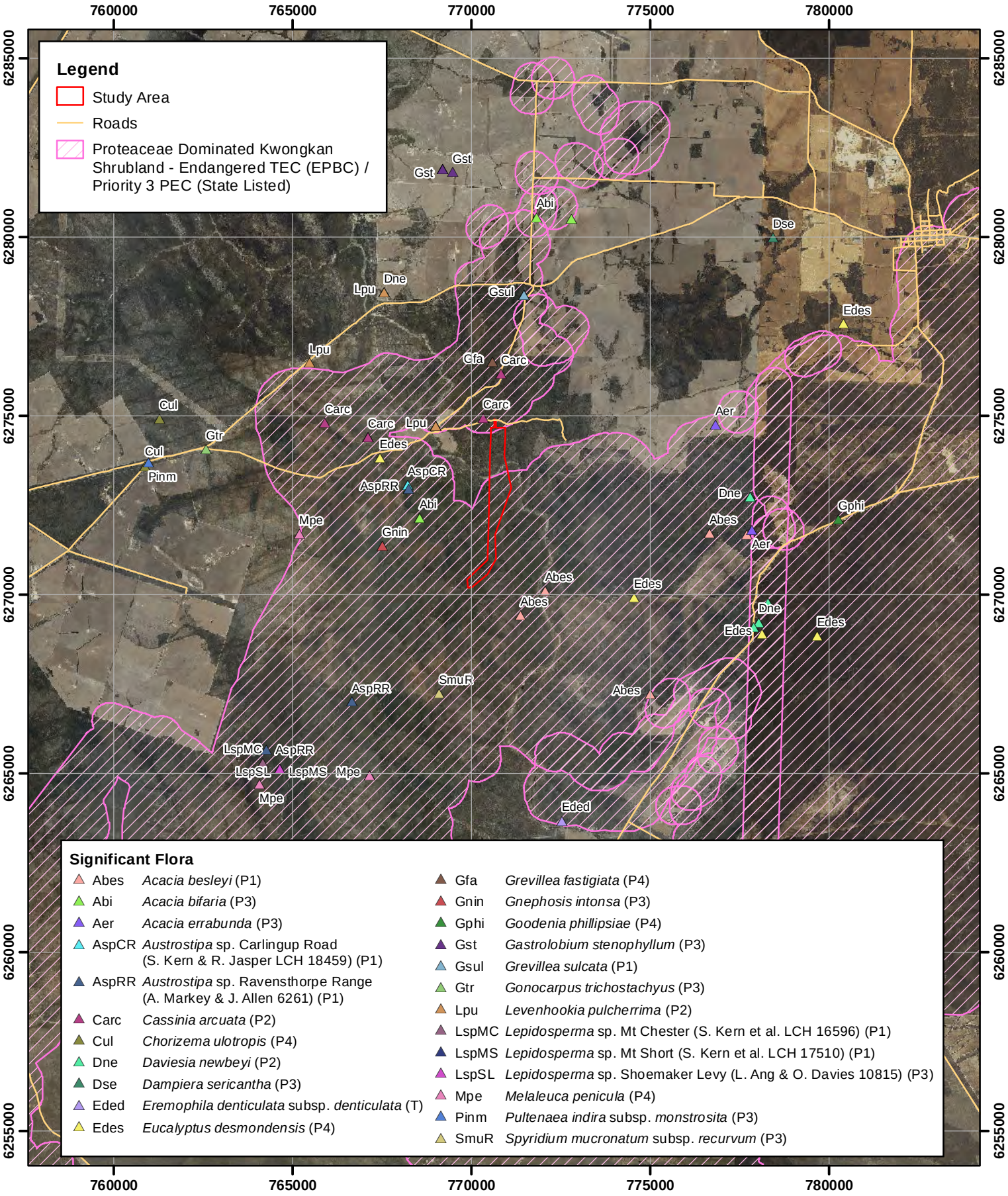
2.4 Regional Flora

A search of DPaW's threatened flora databases was undertaken for an area encompassing the Study Area with a buffer of 10 km, including the Western Australian Herbarium (WAHerb.) specimen database, Threatened and Priority Flora database, and Threatened and Priority Flora List (DPaW 2016b). A total of 158 conservation significant flora taxa were returned from the database search, including 21 taxa listed as Threatened under the WC Act and 137 comprising DPaW-classified Priority flora taxa. These taxa are presented in Appendix D. Of these taxa, there are no records known from within the Study Area. There are records of 24 taxa in close proximity (approximately 5 –10 km) of the Study Area (DPaW 2016b) (Figure 3) including the Threatened taxon - *Eremophila denticulata* subsp. *denticulata*. These 24 taxa are listed below:

- *Acacia besleyi* (P1)
- *Acacia bifaria* (P3)
- *Acacia errabunda* (P3)
- *Austrostipa* sp. Carlingup Road(S. Kern & R. Jasper LCH 18459) (P1)
- *Austrostipa* sp. Ravensthorpe Range(A. Markey & J. Allen 6261) (P1)
- *Cassinia arcuata* (P2)

- *Chorizema ulotropis* (P4)
- *Daviesia newbeyi* (P2)
- *Dampiera sericantha* (P3)
- *Eremophila denticulata* subsp. *denticulata* (T)
- *Eucalyptus desmondensis* (P4)
- *Grevillea fastigiata* (P4)
- *Gnephosis intonsa* (P3)
- *Goodenia phillipsiae* (P4)
- *Gastrolobium stenophyllum* (P3)
- *Grevillea sulcata* (P1)
- *Gonocarpus trichostachyus* (P3)
- *Levenhookia pulcherrima* (P2)
- *Lepidosperma* sp. Mt Chester (S. Kern et al. LCH 16596) (P1)
- *Lepidosperma* sp. Mt Short (S. Kern et al. LCH 17510) (P1)
- *Lepidosperma* sp. Shoemaker Levy (L. Ang & O. Davies 10815) (P3)
- *Melaleuca penicula* (P4)
- *Pultenaea indira* subsp. *monstrosita* (P3)
- *Spyridium mucronatum* subsp. *recurvum* (P3)

Appendix E presents conservation codes for Western Australia flora (DPaW 2015b).



Mt Cattlin Threatened and Priority Ecological Community and Conservation Significant Flora Locations

Author: Alison Saligari

WEC Ref: KR16-34-01

WOODMAN ENVIRONMENTAL

Filename: KR16-34-01-f03.mxd

Scale: 1:140,000 (A4)

Projection: GDA 1994 MGA Zone 50

Revision: A - 09 September 2016

Figure 3

This map should only be used in conjunction with WEC report KR16-34-01.

The search of the DoEE database with regard to MNES listed under the EPBC Act (Appendix A) identified 10 taxa, or habitat for the taxa as likely to occur within the Study Area (Table 2). The majority of these taxa are unlikely to occur within the Study Area as there are no known DPaW records within close proximity to the Study Area, with the exception of *Acacia rhamphophylla, Daviesia megacalyx* and *Eremophila denticulata* subsp*. denticulata*.

Table 2: EPBC listed Threatened Flora Taxa (DoEE 2016)

Taxon	Status	Comments
Acacia rhamphophylla	Endangered	Nearest record just over 10 km to the south-east of the Study Area (DPaW 2016d)
Adenanthos pungens subsp. *effusus*	Endangered	Nearest record is approximately 200 km west of the Study Area (DPaW 2016d)
Anigozanthos bicolor subsp. *minor*	Endangered	Nearest record is approximately 20 km from the Study Area (DPaW 2016d)
Darwinia oxylepis	Endangered	Nearest record is approximately 50 km from the Study Area with the majority of records located approximately 160 km to the west of the Study Area (DPaW 2016d)
Daviesia megacalyx	Endangered	Nearest record just over 10 km to the south-east of the Study Area (DPaW 2016d)
Eremophila denticulata subsp. *denticulata*	Vulnerable	Recorded in close proximity to the Study Area (DPaW 2016d)
Eremophila subteretifolia	Endangered	Nearest record is over 30 km north of the Study Area (DPaW 2016d)
Ricinocarpos trichophorus	Endangered	Nearest record is over 50 km east of the Study Area (DPaW 2016d)
Roycea pycnophylloides	Endangered	Nearest record is over 70 km north-west of the Study Area (DPaW 2016d)
Thelymitra psammophila	Vulnerable	Nearest record is over 60 km east of the Study Area (DPaW 2016d)

The DoEE database search identified four significant invasive flora taxa likely to occur within the Study Area and surrounds including *Asparagus asparagoides*, *Lycium ferocissimum*, *Rubus fruticosus* aggregate and *Tamarix aphylla*. Of these taxa, three are listed as Declared Pests in Western Australia under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (Department of Agriculture and Food (DAF) 2016), and all four are Weeds of National Significance (WoNS) (Australian Weeds Committee (AWC) 2016) (Table 3). Although *Lycium ferocissimum* is not listed as Declared Pest, it is a WoNS and is considered by the States and Territories to pose a particularly significant threat to biodiversity (DoEE 2016).

The Department of Conservation and Land Management (CALM) (now DPaW) developed an Environmental Weed Strategy for Western Australia which assessed and rated environmental weeds in terms of their environmental impact on biodiversity according to invasiveness, distribution and environmental impact, assigning a score of 'High', 'Moderate', 'Mild' or 'Low' (CALM 1999). Two of the introduced taxa were ranked as 'High' for environmental impact including *Asparagus asparagoides* and *Lycium ferocissimum* (Table 3). Appendix E provides descriptions of each rating from CALM (1999).

A search for records of introduced taxa within the Study Area and surrounds was performed using the online tool NatureMap (DPaW 2016d). A total of five introduced taxa were returned including *Cotula coronopifolia*, *Crassula natans* var. *minus*, *Ehrharta longiflora*, *Lysimachia arvensis* and *Malva*

pseudolavatera. None of these are listed as Declared Pests or WoNS or are rated as 'High' for environmental impact (Table 3).

2.5 Local Flora and Vegetation Surveys

There is limited publicly available information in regard to previous flora and vegetation surveys within or in close proximity to the Study Area.

Thompson *et al* (2013) undertook a flora and vegetation survey of the Ravensthorpe Greenstone Belt in October and November in 2009. Part of the Greenstone Belt survey area overlaps the Mt Cattlin Study Area. The survey included the assessment of 50 quadrats measuring 20 x 20 m. A total of six community types were derived from statistical classification of the 50 quadrats. A brief overview of the floristic community results is as follows:

- Community type 1: *Eucalyptus myriadena* or *E. salmonophloia* dominated woodlands with typical shrubland taxa including *Dodonaea ptarmicaefolia*, *Enchylaena tomentosa* var. *tomentosa*, *Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia*, *Senna artemisioides* subsp. *filifolia* and the grass *Austrostipa* sp. Ravensthorpe Range (A Markey & J Allen 6261) (P1) on principally red-brown sandy clay loams.
- Community type 2: Typically mallee *Eucalyptus pleurocarpa* with a rich shrub layer including *Acacia mimica* var. *angusta*, *Calothamnus quadrifidus* subsp. *quadrifidus*, *Calytrix leschenaultii*, *Daviesia pachyphylla*, *Hakea verrucosa*, *Leptospermum spinescens*, *Leucopogon cuneifolius*, *Melaleuca villosisepala*, *Petrophile seminuda*, *Platysace deflexa*, plus *Conostylis argentea* and *Mesomelaena stygia* subsp. *stygia* on yellow-brown loamy sands or sandy loams.
- Community type 3: Typically *Eucalyptus extensa*, *E. oleosa* subsp. *corvina* with *Melaleuca cucullata* over *Acacia glaucoptera* and the *Senna artemisioides* subsp. × *artemisioides* group on sandy loams and sandy clay loams.
- Community type 4: Typically *Eucalyptus pluricaulis* subsp. *pluricaulis* and E. *suggrandis* subsp. *suggrandis* over *Melaleuca hamata*, *Daviesia incrassata* subsp. *incrassata*, *Dianella revoluta* var. *revoluta* and *Gastrolobium musaceum* with *Lepidosperma sanguinolentum*, *Lepidosperma* sp. Ravensthorpe (GF Craig 5188) and *Cassytha melantha* occurring on orange-brown sandy clay loams and loamy sands.
- Community type 5: mallee woodland dominated by *Eucalyptus flocktoniae* subsp. *flocktoniae* and *E. phenax* subsp. *phenax*, with a typical understorey of *Acacia glaucoptera*, *A. ingrata*, *Boronia inornata* subsp. *inornata* and *Dodonaea* sp. on typically red-brown sandy loams and sandy clay loams or light brown sandy clay loams and sandy loam.

A total of 313 vascular plant taxa, representing 49 plant families and 131 genera were recorded during the flora and vegetation survey of the Ravensthorpe Greenstone Belt (Thompson *et al* 2013). No Threatened Flora (T) taxa were recorded during the survey. A total of six priority flora taxa were recorded during the survey:

- *Austrostipa* sp. Carlingup Road (S. Kern & R. Jasper LCH 18459) (P1)
- *Austrostipa* sp. Ravensthorpe Range (A. Markey & J. Allen 6261) (P1)
- *Cassinia arcuata* (P2)
- *Acacia bifaria* (P3)
- *Eucalyptus desmondensis* (P4)

- *Melaleuca penicula* (P4)

A total of five introduced taxa were recorded over the Ravensthorpe Greenstone Belt survey area including *Asparagus asparagoides*, *Malva parviflora*, *Ehrharta longiflora*, *Pentameris airoides* subsp. *airoides* and *Lysimachia arvensis* (Thompson *et al* 2013). Of these *Asparagus asparagoides* is a declared pest (DAF 2016) and a WoNS (AWC 2016).

Keith Lindbeck and Associates conducted a Level 1 flora and vegetation survey of the Mt Cattlin lithium mine, located approximately 14 km north of the Study Area (Keith Lindbeck and Associates 2010 as referenced in Department of Mines and Petroleum (DMP) 2016). The survey was undertaken in 2010, during August to October 2010. The survey included two areas with deposits 'Quarry' and 'Horseshoe' (located approximately 600 metres apart). The flora and vegetation survey identified five vegetation types within the Horseshoe area and nine vegetation types within the Quarry area. No TECs or PECs were identified during the survey (DMP 2016).

The flora and vegetation survey undertaken by Keith Lindbeck and Associates did not identify any Threatened or currently listed Priority flora taxa. However, the survey was undertaken two years after a fire event and was noted as a limitation within the flora survey report. Few introduced flora taxa were recorded during the survey, with taxa recorded including *Lysimachia arvensis* and *Arctotheca calendula* (DMP 2016).

2.6 Phytophthora Dieback

Phytophthora dieback is caused by the plant pathogen, *Phytophthora cinnamomi*, which kills susceptible species with more than 40 per cent of Western Australian native plants being susceptible to the disease, particularly those in Sate's south-west (DPaW 2016c). Although not previously assessed or mapped, susceptibility and vulnerability to Phytophthora Dieback is considered to be high in the vicinity of the Study Area. Nearby Cocanarup Road is an all-weather access route utilised regularly by the public and as such is regarded as potentially infested with *P. cinnamomi* (Woodman Environmental 2016).

2.7 Summary of Environmental Factors

The desktop review of flora and vegetation within the Study Area identified the following key issues:

- One threatened ecological community (the Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province) buffer overlaps the Study Area which is federally listed (under the EPBC Act) as an 'Endangered' TEC and listed on a State level (by DPaW) as Priority 3 PEC;
- A total of 162 conservation significant flora taxa are known from the vicinity of the Study Area, including 25 taxa listed as Threatened and 137 Priority Flora taxa (Appendix D);
- A total of 12 introduced taxa are known to occur or have the potential to occur within or in the vicinity of the Study Area, including three taxa listed as Declared Pests in Western Australia under the BAM Act (DAF 2016), and four taxa listed as WoNS (AWC 2016).

Table 3: Introduced Flora Taxa Known from within or in the vicinity of the Study Area

Taxon	Comments	Source		
		DoEE	DPaW	Thompson et al (2013)
Arctotheca calendula (Cape Weed)	Environmental impact 'Moderate' (CALM 1999)			
Asparagus asparagoides (Bridal Creeper)	Declared Pest (DAF 2016) WoNS (AWC 2016) Environmental impact 'High' (CALM 1999)	X		X
Cotula coronopifolia (Waterbuttons)	Environmental impact not assessed (CALM 1999)		X	
Crassula natans var. *minus*	Environmental impact 'Moderate' (CALM 1999)		X	
Ehrharta longiflora (Annual Veldt Grass)	Environmental impact 'Moderate' (CALM 1999)		X	X
Lycium ferocissimum (African Boxthorn)	WoNS (AWC 2016) Environmental impact 'High' (CALM 1999)	X		
Lysimachia arvensis (Pimpernel)	Environmental impact not assessed (CALM 1999)		X	X
Malva parviflora (Marshmallow)	Environmental impact 'Low' (CALM 1999)			X
Malva pseudolavatera	Environmental impact not assessed (CALM 1999)		X	
Pentameris airoides subsp. *airoides* (False Hairgrass)	Environmental impact 'Moderate' (CALM 1999)			X
Rubus fruticosus aggregate (Blackberry)	Declared Pest (DAF 2016) WoNS (AWC 2016) Environmental impact 'Low' (CALM 1999)	X		
Tamarix aphylla	Declared Pest (DAF 2016) WoNS (AWC 2016) Environmental impact 'Moderate' (CALM 1999)	X		

3 METHODS

3.1 Personnel and Licensing

Table 4 lists the personnel involved in both fieldwork and plant identifications for the survey of the Study Area. The field team members have previous field experience in areas similar to the Study Area, with personnel involved in plant identifications having many years' experience in taxonomic identifications and/or several years of taxonomic experience with the flora of the Esperance Plains region. All plant material was collected under the scientific licences pursuant to the WC Act Section 23C and Section 23F.

Table 4: Personnel and Licensing Information

Personnel	Role	Flora Collecting Permit (WC Act)
Bethea Loudon	Fieldwork (team leader) / Plant identification QA	SL011773 (Section 23C) 123-1516 (Section 23F)
Samuel Coultas	Fieldwork	2016: SL011775 (Section 23C) 124-1516 (Section 23F)
Sharnya Thomson	Plant identifications	NA

3.2 Field Survey Methods

The field survey was conducted over one visit in Spring from the 5th – 9th September. The survey was conducted following the season which normally contributes the most rainfall in the bioregion, to ensure that the majority of the plant species are flowering, fruiting and have foliage (in response to sufficient rainfall for growth and reproductive purposes) that allows for correct identification (EPA 2004a). The Study Area was traversed on foot.

3.3 Plant Collection and Identification

Specimens of any unknown taxa that were collected were pressed for later identification at the WA Herbarium. Identifications were undertaken by experienced botanist Sharnya Thomson and reviewed by Bethea Loudon. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest, such as, the Eucalypts were determined by Nathan McQuoid.

Taxon nomenclature generally follows *FloraBase* (DPaW 2016e) with all names checked against the current DPaW Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not been adopted on *FloraBase* (DPaW 2016e), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the WA Herbarium for consideration for vouchering as soon as practicable. However, this process is via donation, and the WA Herbarium may not voucher all specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms submitted to DPaW (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority flora taxa).

3.4 Vegetation Mapping

The vegetation was assessed through site relevés as well as observations recorded while traversing the Study Area. Non-permanent relevés were established in each major vegetation unit discernible through aerial photograph interpretation prior to the field survey, with extra relevés included where additional vegetation types were observed during the survey. Quadrats (where all vascular taxa are recorded) were not established during this survey.

The following information was recorded at each relevé location:

- Unique identifying number;
- Relevé location (including GPS co-ordinates);
- Total cover and dominant taxa within each stratum;
- Soil type/colour and presence of outcropping;
- Position of relevé in the landscape (topography/landform type);
- Vegetation condition, including fire history and presence of any disturbance (adapted from Keighery 1994) (presented in Appendix G);
- Height, percentage foliage cover and stratum of dominant taxa present within a 50m radius; and
- Photograph of representative vegetation.

Additional taxa were recorded while traversing the Study Area to assist in the development of a basic species list for the area, along with changes in vegetation types (i.e. the physical location of boundaries) to assist with mapping.

Species composition, density and occurrence in structural layers were used to identify and describe the structural vegetation types (VT) present. Aerial photography interpretation and field notes taken during the survey were used to develop VT polygon boundaries within the Study Area. These were then digitised using Geographic Information System (GIS) software and displayed on figures.

The VT descriptions have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI 2003), a system of describing structural vegetation units preferred by the DPaW. This model follows nationally-agreed guidelines to describe and represent vegetation types, so that comparable and consistent data is produced nation-wide. For the purposes of this report, it is considered that a VT is equivalent to a NVIS sub-association as described in ESCAVI (2003).

3.5 Vegetation Condition Mapping

Vegetation condition was recorded at relevés, and opportunistically within the Study Area where significant areas of disturbance to vegetation were noted (e.g. weed infestations, areas of clearing, soil disturbance). Vegetation condition was described using the Vegetation Condition Scale for the South-West Botanical Province from Keighery (1994) (Table 5).

Table 5: Vegetation Condition Scale for the South-West Botanical Province (Keighery 1994)

Condition Ranking	Description	Example
1	Pristine or nearly so; no obvious signs of disturbance.	
2	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.
3	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.
4	Good. Vegetation structure significantly altered by very obvious signs of multiple disturbance. 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.
5	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.
6	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 composing of weed or crop species with isolated native trees and shrubs.

3.6 Significant Flora and Vegetation

Visual interpretation of aerial photography and review of the desktop study results for the Study Area was undertaken prior to the site visit to gain an understanding of the flora and vegetation and that may encountered.

The habitat requirements or preferences of conservation significant flora, and the composition of significant vegetation communities were investigated using available resources (e.g. DPaW 2015a, 2016e, 2016f) to determine the likelihood of their occurrence in the Study Area, and to be able to identify potential habitat and the occurrence of these taxa and communities during the field survey.

3.7 Phytophthora Dieback

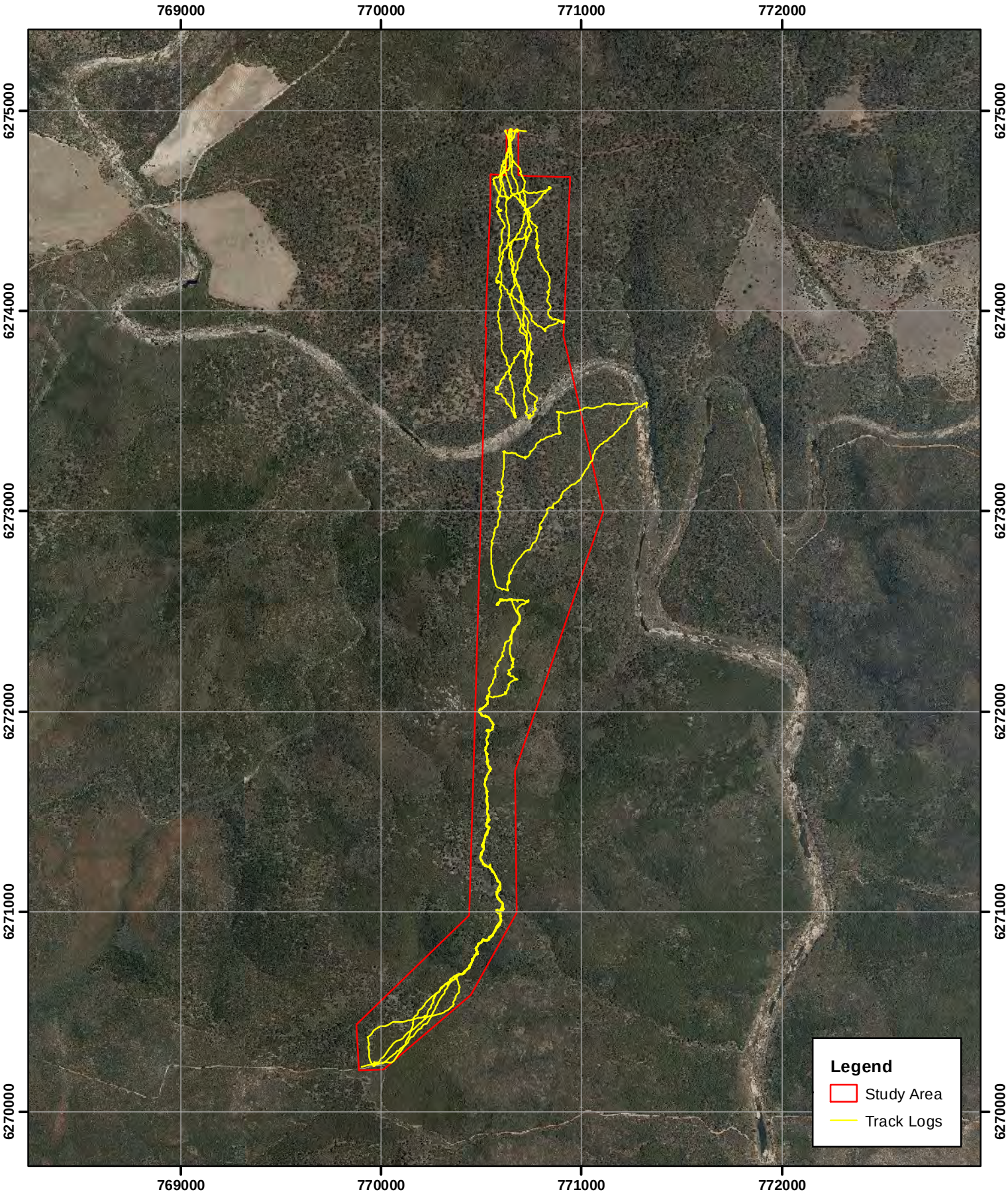
Visual interpretation of aerial photography and review of vegetation assemblages and recorded taxa from previous studies (Thompson *et al* (2013); DMP (2016)) in the vicinity of the Study Area was undertaken prior to the site visit to gain an understanding of the susceptible indicator species that may encountered during the field survey to interpret Phytophthora Dieback expression.

4 LIMITATIONS OF SURVEY

Table 6 presents the limitations of the flora and vegetation survey of the Study Area in accordance with EPA Guidance Statement No. 51 (EPA 2004a).

Table 6: Limitations of the Flora and Vegetation Assessment of the Study Area

Potential Limitation	Limitation of Survey	Comment
Level of Survey	No	Level 1 survey is considered appropriate as Study Area occurs in the Bioregion Group is defined as Group 1 and the scale and nature of the impact is considered Low.
Competency/experience of the consultant conducting the survey	No	Botanists with extensive experience undertaking flora and vegetation surveys, in particular on the Esperance Plains, conducted the survey and undertook QA of plant identifications.
Scope	No	All vascular groups that were present during the survey were sampled. There were no constraints that prevented appropriate sampling techniques from being employed.
Proportion of flora identified	No	Moderate proportion of perennial vascular taxa recorded base on complexity of vegetation and level of survey/survey method. Vascular taxa recorded that were not known to the botanists had at least one reference specimen collected, with specimens identified at the WAHerb.
Sources of information (historic/recent/new data or anecdotal)	No	Sources of information used included government databases (DPaW, DoE) and unpublished data from the vicinity of the Study Area. Good contextual information for the Study Area was available prior to the survey.
Proportion of the task achieved and further work that may be need to be undertaken	No	All objectives of the task achieved and the Level 1 survey completed, no further survey required.
Timing/weather/season/ cycle	No	The survey was undertaken in Spring, within the optimal flowering period for flora in the south-west of Western Australia (Spring). Sufficient features (e.g. fruit) were present to accurately identify the majority of taxa present.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	No	No recent fires have affected the vegetation within the Study Area, with all observations suggesting the time since last fire exceeds 20 years. No other recent disturbances affected the results of the survey.
Intensity of survey (e.g. in retrospect was the intensity of the survey adequate)	No	The Study Area was searched adequately with the entire site traversed on foot. The survey intensity was considered adequate to identify flora taxa present.
Completeness and mapping reliability	No	The entire Study Area was surveyed adequately.
Resources (e.g. degree of expertise available for plant identification)	No	Botanists with extensive plant identification skills and knowledge of taxa and vegetation of the Esperance Plain, in addition to knowledge of cultivated and introduced taxa, undertook the plant identifications using relevant plant identification resources
Remoteness and/or access problems	No	Entire site was accessible on foot, with no restrictions to any areas



Mt Cattlin Study Area **Survey Track Logs**	Author: Alison Saligari	N
	WEC Ref: KR16-34-01	
WOODMAN ENVIRONMENTAL	Filename: KR16-34-01-f04.mxd	**Figure**
	Scale: 1:25,000 (A4)	4
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report KR16-34-01.	Revision: A - 09 September 2016	

5 RESULTS

5.1 Vegetation

A total of 27 VTs Vegetation Types (VTs) were described for the Study Area. Figure 5 presents the locations of the VTs in the Study Area and they are described as:

- VT 1 is dominated by *Acacia binata* and *Eremophila decipiens* subsp. *decipiens* over **Arctotheca calendula*, **Centaurea melitensis*, **Lysimachia arvensis*, *Maireana trichoptera* and *Vittadinia gracilis* on brown clay loam gentle slopes;
- VTs 2, 5, 9 and 12 are dominated by *Eucalyptus salmonophloia*, occasionally with *Eucalyptus brachycalyx*, over *Acacia acuminata*, occasionally with *Dodonaea ptarmicaefolia* and *Santalum spicatum*, over *Eremophila decipiens* subsp. *decipiens* and *Rhagodia crassifolia* on brown clay loam with granite, dolerite and quartz surface stones with occasional outcropping on gentle to steep slopes and hills;
- VTs 3, 4, 14 and 15 are dominated by *Eucalyptus salmonophloia*, occasionally with *Eucalyptus oleosa* subsp. *corvina*, *Eucalyptus celastroides* subsp. *virella* and *Eucalyptus extensa*, over *Acacia binata* and *Dodonaea ptarmicaefolia* over *Eremophila decipiens* subsp. *decipiens* and *Rhagodia crassifolia*, occasionally with *Olearia muelleri*, on brown sandy clay loam with granite, dolerite and quartz surface stones with occasional outcropping on gentle to steep slopes and gullies/minor drainage lines;
- VTs 6 and 13 are dominated by *Eucalyptus oleosa* subsp. *corvina and Eucalyptus brachycalyx*, occasionally over *Dodonaea ptarmicaefolia*, *over Rhagodia crassifolia*, *Olearia muelleri*, *Sclerolaena diacantha*, *Senna artemisioides* subsp. *filifolia*, occasionally with *Acacia erinacea*, *Maireana erioclada*, *Maireana suaedifolia* and *Rhagodia preissii* subsp. *preissii*, on grey/brown sandy clay/clay loam with granite, dolerite and quartz surface stones on gentle lower and simple slopes;
- VTs 7 and 8 are dominated by *Eucalyptus salmonophloia* over *Eucalyptus brachycalyx*, occasionally over *Acacia cyclops* and *Santalum acuminatum*, *over Senna artemisioides* subsp. *filifolia*, occasionally with *Acacia binata* and *Olearia* ?*cassiniae*, over *Rhagodia crassifolia* and *Olearia muelleri*, occasionally with *Acacia erinacea*, *Eremophila decipiens* subsp. *decipiens*, *Enchylaena tomentosa Maireana erioclada* and *Maireana suaedifolia*, occasionally over grasses and forbs on grey/brown sandy clay loam/light clay with granite and quartz surface stones on gentle slopes;
- VT 10 is dominated by *Acacia acuminata* and *Dodonaea ptarmicaefolia* over *Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia* and *Senna artemisioides* subsp. *x artemisioides* and/or *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *filifolia* over forbs on lower slopes of red-brown or brown light clay/sandy clay loam with granite surface stones;
- VT 11 is dominated by **Lycium ferocissimum*, *Melaleuca hamulosa*, *Melaleuca incana* subsp. *tenella*, *Melaleuca torquata* over *Acacia patagiata*, *Beyeria* ?*sulcata*, *Dodonaea ptarmicaefolia*, *Melaleuca halmaturorum* over *Gahnia* sp. L (K.R. Newbey 7888) over **Cotula bipinnata*, *Disphyma crassifolium*, **Ehrharta longiflora*, **Lysimachia arvensis*, *Tecticornia indica* subsp. *bidens* in drainage lines of cream river sand with granite outcropping and granite and quartz surface stones;
- VT's 16 and 18 are dominated by *Eucalyptus extensa* over *Dodonaea ptarmicaefolia* and *Templetonia retusa* and/or *Acacia binata* and *Daviesia nematophylla* over *Enchylaena tomentosa* and/or *Acacia erinacea*, *Acacia glaucoptera* and *Senna artemisioides* subsp. *x*

artemisioides occasionally over forbs on moderate to steep slopes and hillocks with brown sandy clay loam/clay loam/light clay with granite, quartz and dolerite surface stones;

- VT 17 is dominated by *Eucalyptus salmonophloia* over *Acacia acuminata* and *Melaleuca acuminata* subsp. *acuminata* over *Lepidosperma diurnum* over forbs on upper slopes of red-brown clay loam with dolerite surface stones;
- VT 19 is dominated by *Eucalyptus extensa* and *Eucalyptus celastroides* subsp. *virella* over *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Templetonia retusa* over *Acacia glaucoptera* and *Daviesia nematophylla* over *Lepidosperma diurnum* over forbs in steep gullies/minor drainage lines with red-brown clay loam and dolerite and quartz surface stones;
- VT 20 is dominated by *Eucalyptus celastroides* subsp. *virella* over *Templetonia retusa* over *Acacia glaucoptera*, *Dodonaea ptarmicaefolia*, *Exocarpos aphyllus* and *Grevillea oligantha* over *Acacia erinacea* over forbs on gently sloped valley-tops/upper slopes with brown clay loam and dolerite and granite surface stones;
- VT 21 is dominated by *Eucalyptus phenax* subsp. *phenax* over *Acacia acuminata*, *Allocasuarina campestris* and *Dodonaea ptarmicaefolia* over *Lepidosperma diurnum* and *Spartochloa scirpoidea* over forbs on moderate mid slopes with dark brown clay loam and granite surface stones;
- VT 22 is dominated by *Eucalyptus cernua* and *Eucalyptus celastroides* subsp. *virella* over *Acacia acuminata* over forbs on moderate mid slopes with brown clay loam and granite outcropping and granite and dolerite surface stones;
- VT's 23 and 27 are dominated by *Eucalyptus cernua*, occasionally with *Eucalyptus extensa*, over *Exocarpos aphyllus*, occasionally with *Hakea commutata* or *Templetonia retusa*, over *Acacia glaucoptera* and *Senna artemisioides* subsp. *x artemisioides*, occasionally with *Rhagodia preissii* subsp. *preissii*, *Carpobrotus modestus* and *Enchylaena tomentosa*, on steep slopes and hillocks with dark brown clay loam/light clay and granite and quartz surface stones and occasional granite outcropping;
- VT's 24 and 25 are dominated by *Eucalyptus oleosa* subsp. *corvina*, occasionally with *Eucalyptus cernua*, over *Templetonia retusa*, occasionally with *Daviesia nematophylla*, *Santalum acuminatum* or *Exocarpos aphyllus*, occasionally over *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *x artemisioides* over *Acacia glaucoptera*, *Carpobrotus modestus* and *Sclerolaena diacantha*, occasionally with *Enchylaena tomentosa* and *Rhagodia preissii* subsp. *preissii*, occasionally over forbs on hill crests and upper slopes with brown/grey-brown clay loam/light clay and dolerite, granite and quartz surface stones;
- VT's 24 and 25 are dominated by *Eucalyptus oleosa* subsp. *corvina*, occasionally with *Eucalyptus cernua*, over *Templetonia retusa* and occasionally *Daviesia nematophylla*, *Santalum acuminatum* and *Exocarpos aphyllus*, occasionally over *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *x artemisioides* over *Acacia glaucoptera*, *Carpobrotus modestus* and *Sclerolaena diacantha*, over *Enchylaena tomentosa* and *Rhagodia preissii* subsp. *preissii* occasionally over forbs on hill crests and upper slopes with brown/grey-brown clay loam/light clay and dolerite, granite and quartz surface stones.

The full list of the defined Structural Vegetation Types in the Mt Cattlin Study Area is presented in Appendix G, and includes vegetation description, condition, representative site and a representative photo.

770000
770500
771000
6275000
6274500
6274000
6273500
1
6
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2
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2
4
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2
7
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14

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area
Vegetation Types

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon

WEC Ref: KR16-34-01

Filename: KR16-34-01-f05.mxd

Projection: GDA 1994 MGA Zone 50

Figure

5.1

770000
770500
771000
6273000
6272500
6272000
6271500

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12
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WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area
Vegetation Types

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon
WEC Ref: KR16-34-01
Filename: KR16-34-01-f05.mxd
Projection: GDA 1994 MGA Zone 50

Figure
5.2

769500
770000
770500
6271000
6270500
6270000
6269500

25
23
16
16/21/26
21/26
26
21
27

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area
Vegetation Types

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon

WEC Ref: KR16-34-01

Filename: KR16-34-01-f05.mxd

Projection: GDA 1994 MGA Zone 50

Figure

5.3

Legend

Vegetation Types

1 — Low to mid isolated clumps of shrubs of *Acacia binata* and *Eremophila decipiens* subsp. *decipiens* over low closed forbland of **Arctotheca calendula*, **Centaurea melitensis*, **Lysimachia arvensis*, *Maireana trichoptera* and *Vittadinia gracilis* on gentle simple slopes of brown clay loam

2 — Mid isolated clumps of trees to open woodland of *Eucalyptus salmonophloia* over tall shrubland of *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Santalum spicatum* (occasionally with *Allocasuarina huegeliana*) over low open shrubland of *Eremophila decipiens* subsp. *decipiens* and *Rhagodia crassifolia* over low forbland of *Cheilanthes sieberi* subsp. *sieberi*, *Gonocarpus nodulosus*, *Lawrencella rosea* and *Waitzia suaveolens* var. *flava* on hill crests of moderate slope with dark brown clay loam and granite surface stones and outcropping

3 — Mid open woodland of *Eucalyptus salmonophloia* over low isolated clumps of mallees of *Eucalyptus celastroides* subsp. *virella* or *Eucalyptus oleosa* subsp. *corvina* over tall shrubland of *Acacia binata* and *Dodonaea ptarmicaefolia* (occasionally with *Olearia ?cassiniae*) over low open shrubland *Enchylaena tomentosa*, *Eremophila decipiens* subsp. *decipiens*, *Maireana trichoptera*, *Olearia muelleri* and *Rhagodia crassifolia* in gullies/minor drainage lines of moderate slope with brown sandy clay loam and surface stones of granite, dolerite and quartz

4 — Mid woodland of *Eucalyptus salmonophloia* over tall open shrubland of *Acacia binata*, *Daviesia nematophylla*, *Santalum acuminatum* and *Templetonia retusa* over low open shrubland of *Eremophila decipiens* subsp. *decipiens* and *Rhagodia crassifolia* on steep slopes of brown sandy clay loam with surface stones of dolerite and quartz

5 — Mid woodland of *Eucalyptus salmonophloia* over tall shrubland of *Acacia acuminata*, *Santalum spicatum* and *Templetonia retusa* over low open shrubland of *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri*, *Rhagodia crassifolia* and *Senna artemisioides* subsp. *filifolia* on steep slopes of brown clay loam with dolerite surface stones and outcropping

6 — Mid mallee woodland of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus brachycalyx* over low shrubland of *Olearia muelleri*, *Rhagodia crassifolia*, *Sclerolaena diacantha* and *Senna artemisioides* subsp. *filifolia* on gentle lower slopes of grey-brown sandy clay with surface stones of dolerite and quartz

7 — Mid open woodland of *Eucalyptus salmonophloia* over low open mallee woodland of *Eucalyptus brachycalyx* over tall open shrubland of *Acacia cyclops* and *Santalum acuminatum* over mid shrubland of *Senna artemisioides* subsp. *filifolia* over low sparse shrubland of *Maireana erioclada*, *Olearia muelleri* and *Rhagodia crassifolia* over low isolated clumps of grasses of *BLSC-opp05 Austro straight up* and *020-06 Austro rough* over low closed forbland of *Asteridea athrixioides*, **Lysimachia arvensis*, *Omphalolappula concava* and *Vittadinia australasica* var. *australasica* on gentle mid slopes of grey-brown light clay with granite and quartz surface stones

8 — Mid woodland of *Eucalyptus salmonophloia* over low isolated clumps of mallees of *Eucalyptus brachycalyx* over mid open shrubland of *Acacia binata*, *Senna artemisioides* subsp. *filifolia* and *Olearia ?cassiniae* over low shrubland of *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri*, *Rhagodia crassifolia*, *Enchylaena tomentosa* and *Acacia erinacea* on gentle simple slopes of light brown sandy clay loam with granite and quartz surface stones

9 — Mid woodland of *Eucalyptus salmophloia* over low mallee woodland of *Eucalyptus brachycalyx* over tall shrubland of *Acacia acuminata* and *Callitris roei* over mid open shrubland of *Daviesia nematophylla* and *Dodonaea ptarmicaefolia* over low open shrubland of *Eremophila decipiens* subsp. *decipiens*, *Grevillea oligantha* and *Rhagodia crassifolia* on moderately sloped mid slopes of red-brown clay loam with dolerite, granite and quartz surface stones

10 — Tall closed shrubland of *Acacia acuminata* and *Dodonaea ptarmicaefolia* over low sparse shrubland or isolated clumps of shrubs of *Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia* and *Senna artemisioides* subsp. *x artemisioides* and/or *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *filifolia* over low forbland or isolated clumps of forbs of *Cheilanthes sieberi* subsp. *sieberi*, **Ehrharta longiflora*, *Lawrencella rosea*, *Oxalis perennans*, *Pterostylis* sp. inland (A.C. Beauglehole 11880), *Trachymene ornata*, **Ursinia anthemoides* and *Waitzia suaveolens* var. *flava* and/or *Nicotiana rotundifolia* on moderately or gently sloped lower slopes of red-brown or brown light clay or sandy clay loam with granite surface stones

11 — Tall open shrubland of **Lycium ferocissimum*, *Melaleuca hamulosa*, *Melaleuca incana* subsp. *tenella*, *Melaleuca torquata* over mid sparse shrubland of *Acacia patagiata*, *Beyeria ?sulcata*, *Dodonaea ptarmicaefolia*, *Melaleuca halmaturorum* over tall sparse sedgeland of *Gahnia* sp. L (K.R. Newbey 7888) over low isolated clumps of forbs and grasses of **Cotula bipinnata*, *Disphyma crassifolium*, **Ehrharta longiflora*, **Lysimachia arvensis*, *Tecticornia indica* subsp. *bidens* in very gently slope drainage lines of cream river sand with granite outcropping and granite and quartz surface stones

12 — Mid open woodland of *Eucalyptus salmonphloia* over tall closed shrubland of *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Santalum spicatum* over low sparse shrubland of *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri* and *Rhagodia crassifolia* on gentle mid slopes of brown sandy clay with granite surface stones

13 — Low mallee forest of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus brachycalyx* over mid open shrubland of *Dodonaea ptarmicaefolia* and *Senna artemisioides* subsp. *filifolia* over low open shrubland ofÂ *Acacia erinacea*, *Maireana erioclada*, *Maireana suaedifolia*, *Olearia muelleri*, *Rhagodia crassifolia*, *Rhagodia preissii* subsp. *preissii* and *Sclerolaena diacantha* on gentle simple slopes of brown clay loam with dolerite, granite and quartz surface stones

14 — Mid woodland of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus salmonophloia* over mid open shrubland of *Dodonaea concinna*, *Dodonaea ptarmicaefolia* and *Senna artemisioides* subsp. *filifolia* over low shrubland of *Eremophila decipiens* subsp. *decipiens*, *Maireana radiata*, *Rhagodia crassifolia* and *Sclerolaena diacantha* over low isolated clumps of forbs and grasses of **Centaurea melitensis*, *Crassula colorata* var. *acuminata* **Lysimachia arvensis* and **Schismus barbatus* on gentle upper slopes of brown clay loam with dolerite outcropping surface stones

15 — Mid woodland of *Eucalyptus salmonophloia* over low mallee open woodland of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus extensa* over mid sparse shrubland of *Acacia binata* and *Dodonaea ptarmicaefolia* over low sparse shrubland of *Acacia erinacea*, *Maireana suaedifolia*, *Olearia muelleri*, *Rhagodia crassifolia* and *Sclerolaena diacantha* on moderately sloped upper slopes of brown sandy clay loam with dolerite and granite surface stones

16 — Low mallee closed forest of *Eucalyptus extensa* over mid to tall isolated shrubs or tall open shrubland of *Dodonaea ptarmicaefolia* and *Templetonia retusa* over low isolated clumps of forbs and shrubs of *Enchylaena tomentosa*, *Hydrocotyle rugulosa* and **Lysimachia arvensis* on moderate to steep slopes or hillocks with dark brown clay loam and dolerite, quartz and granite surface stones

17 — Low isolated mallees of *Eucalyptus salmonophloia* over tall closed shrubland of *Acacia acuminata* and *Melaleuca acuminata* subsp. *acuminata* over mid open sedgleand of *Lepidosperma diurnum* over low isolated forbs of *Hydrocotyle rugulosa* and *Trachymene ornata* on moderately sloped upper slopes of red-brown clay loam with dolerite surface stones

18 — Low closed forest of *Eucalyptus extensa* over tall shrubland of *Acacia binata* and *Daviesia nematophylla* over low sparse shrubland of *Enchylaena tomentosa* and *Rhagodia preissii* subsp. *preissii* and/or *Acacia erinacea*, *Acacia glaucoptera* and *Senna artemisioides* subsp. *x artemisioides* on moderate to steep slopes and hillocks with brown sandy clay loam or light clay with granite and dolerite surface stones

19 — Low mallee forest of *Eucalyptus extensa* and *Eucalyptus celastroides* subsp. *virella* over tall open shrubland of *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Templetonia retusa* over mid sparse shrubland of *Acacia glaucoptera* and *Daviesia nematophylla* over mid sparse sedgeland of *Lepidosperma diurnum* over low isolated forbes of *Daucus glochidiatus*, *Goodenia affinis*, *Hydrocotyle rugulosa*, **Lysimachia arvensis*, *Oxalis perennans* and *Waitzia suaveolens* var. *flava* in steep gullies/minor drainage lines with red-brown clay loam and dolerite and quartz surface stones

20 — Low mallee woodland of *Eucalyptus celastroides* subsp. *virella* over tall isolated clumps of *Templetonia retusa* over mid shrubland of *Acacia glaucoptera*, *Dodonaea ptarmicaefolia*, *Exocarpos aphyllus* and *Grevillea oligantha* over low isolated clumps of *Acacia erinacea* over low isolated forbs of *Daucus glochidiatus*, *Hydrocotyle rugulosa*, **Lysimachia arvensis* and *Senecio glossanthus* on gently sloped valley-tops/upper slopes with brown clay loam and dolerite and granite surface stones

21 — Low isolated mallees of *Eucalyptus phenax* subsp. *phenax* over tall closed shrubland of *Acacia acuminata*, *Allocasuarina campestris* and *Dodonaea ptarmicaefolia* over mid open sedgeland of *Lepidosperma diurnum* and *Spartochloa scirpoidea* over low isolated forbs of *Cheilanthes sieberi* subsp. *sieberi*, *Goodenia affinis*, *Hydrocotyle rugulosa*, *Trachymene ornata* and *Waitzia suaveolens* var. *flava* on moderate mid slopes with dark brown clay loam and granite surface stones

22 — Low isolated mallees of *Eucalyptus cernua* and *Eucalyptus celastroides* subsp. *virella* over tall closed shrubland of *Acacia acuminata* over low isolated shrubs and forbs of *Cheilanthes sieberi* subsp. *sieberi*, *Phyllanthus calycinus*, *Senna artemisioides* subsp. *x artemisioides* and *Trachymene ornata* on moderate mid slopes with brown clay loam and granite outcropping and granite and dolerite surface stones

23 — Low closed mallee forest of *Eucalyptus cernua* over tall sparse shrubland of *Exocarpos aphyllus* and *Hakea commutata* or *Templetonia retusa* over low sparse shrubland of *Acacia glaucoptera*, *Senna artemisioides* subsp. *x artemisioides* on hillocks or steep slopes with brown light clay and granite surface stones and outcropping

24 — Low mallee woodland of *Eucalyptus oleosa* subsp. *corvina* over tall shrubland of *Daviesia nematophylla*, *Santalum acuminatum* and *Templetonia retusa* over mid open shrubland of *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *x artemisioides* over low open shrubland of *Acacia glaucoptera*, *Carpobrotus modestus* and *Sclerolaena diacantha* over low isolated grasses and forbs of *Crassula colorata* var. *acuminata*, **Hypochaeris glabra*, **Schismus barbatus* on hill crests of very gentle slope with brown sandy clay loam and granite surface stones

25 — Low open mallee woodland of *Eucalyptus cernua* and *Eucalyptus oleosa* subsp. *corvina* over tall shrubland of *Exocarpos aphyllus* and *Templetonia retusa* over mid shrubland of *Acacia glaucoptera* over low isolated clumps of shrubs of *Carpobrotus modestus*, *Enchylaena tomentosa*, *Rhagodia preissii* subsp. *preissii* and *Sclerolaena diacantha* on gentle upper slopes with grey-brown light clay and dolerite, granite and quartz surface stones

26 — Mid mallee forest of *Eucalyptus occidentalis*, *Eucalyptus extensa* and *Eucalyptus salmonophloia* over tall shrubland of *Hakea commutata* and *Templetonia retusa* over low isolated sedges of *Lepidosperma diurnum* and *Lepidosperma tenue* over low isolated clumps of forbs and grasses of **Ehrharta longiflora*, **Galium murale*, *Hydrocotyle rugulosa*, **Hypochaeris glabra*, **Lysimachia arvensis* and *Oxalis perennans* on very steep slopes and hillocks with brown light clay and dolerite and granite surface stones

27 — Low closed mallee forest of *Eucalyptus cernua* and *Eucalyptus extensa* over tall isolated shrubs of *Exocarpos aphyllus* over mid isolated to mid sparse shrubland of *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *x artemisioides* over low sparse shrubland of *Acacia glaucoptera*, *Carpobrotus modestus* and *Enchylaena tomentosa* on steep slopes and hillocks with dark brown clay loam and granite and quartz surface stones

Mosaics

16/21/26 — Mosaic of VT16, VT21 and VT26

21/26 — Mosaic of VT21 and VT26

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area
Vegetation Types Legend

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon

WEC Ref: KR16-34-01

Filename: KR16-34-01-f05.mxd

Projection: GDA 1994 MGA Zone 50

Figure

5.0

5.2 Vegetation Condition

The vegetation of the Study Area was predominantly in 'Excellent' condition, with minimal disturbance and patchy occurrences of non-aggressive introduced flora taxa (mostly *Lysimachia arvensis*). Figure 6 presents the vegetation condition of the Study Area, along with locations of introduced flora taxa in the Study Area.

One small area (VT1, KR031), at the northern end of the Study Area, had a lower condition score of 'Degraded'. This area intersects with the Cocanarup Mining Road and appeared to be historically cleared and disturbed with high weed loads containing 7 introduced flora taxa at 38.2% cover. The rest of the vegetation was given a 'Pristine' condition, with minor occasional patches of *Lysimachia arvensis* scattered throughout the vegetation.

Thirty-six individuals at eight locations of *Lycium ferocissimum* (African boxthorn), listed as a WoNS (AWC 2016), were recorded throughout the Study Area (section 5.3.3). However, individuals were broadly scattered, occurred at very low density and did not alter the vegetation structure, composition and condition. A number of other non-aggressive introduced flora taxa were recorded throughout the Study Area (section 5.3.3), occurring at low density scattered throughout the Study Area.

Previous fire scars were partially discernible from aerial photography and may have had a minor short-term effect on structure and species composition (i.e. presence of typical fire responsive of taxa and heights of shrubs). However, fire appears to have not affected the majority of the area for greater than 20 years and has not resulted in loss of vegetation (unnatural bare areas) or weed introduction.

5.3 Flora

A total of 120 vascular flora taxa, and one known hybrid, were recorded within the Study Area from 31 relevés and opportunistic records, representing 37 families and 76 genera. The complete vascular plant species list recorded in the Study Area is presented in Appendix H, the raw relevé data is presented in Appendix I and the site by species data recorded in the Study Area is presented in Appendix J.

5.3.1 Conservation Significant Flora

No conservation significant flora taxa were recorded in the Study Area.

5.3.2 Distribution Extension and Gaps

As the flora of the Fitzgerald subregion has previously been relatively well surveyed and collected, only a small number of taxa recorded in the Study Area during the 2016 survey correlate to range extensions, fill locality holes or represent taxa with few vouchered collections at the WAHerb, and are therefore of scientific interest.

Table 7 presents taxa where the collections from the Study Area represent extensions to the known distribution, or otherwise fill gaps within the known distribution of such taxa. Where adequate representative material is available, specimens will be submitted to the WA Herbarium to increase the knowledge and known extent of these taxa.

770000
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771000
6275000
6274500
6274000
6273500

Arc, Caa, Cem, Lya, Mei, Pea, Tce
Lyf
Lyf
Lya
Lyf
Lyf
Ehl
Ura
Ehl
Gam
Sol
Lya
Lyf
Ehl
Lya
Ura
Cobi
Coc
Ehl
Lya
Lyf
Ura

Legend

Vegetation Condition

- 1 Pristine
- 1/2 Pristine/Excellent
- 2 Excellent
- 5 Degraded

Intoduced Flora

- Arc **Arctotheca* calendula
- Caa **Carrichtera* annua
- Cem **Centaurea* melitensis
- Cobi **Cotula* bipinnata
- Coc **Cotula* coronopifolia
- Ehl **Ehrharta* longiflora
- Gam **Galium* murale
- Hyg **Hypochaeris* glabra
- Lya **Lysimachia* arvensis
- Lyf **Lycium* ferocissimum
- Mei **Melilotus* indicus
- Pea **Pentameris* airoides
- Scb **Schismus* barbatus
- Sol **Sonchus* oleraceus
- Tce **Trifolium*
- Ura **Ursinia* anthemoides

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area Vegetation Condition with Locations of Introduced Flora Taxa

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon

WEC Ref: KR16-34-01

Filename: KR16-34-01-f06.mxd

Projection: GDA 1994 MGA Zone 50

Figure

6.1

770000
770500
771000
6273000
6272500
6272000
6271500

Lyf
Cem
Hyg
Lya
Scb
Lyf
Lya
Lya
Hyg
Lya
Scb

Legend

Vegetation Condition

- 1 Pristine
- 1/2 Pristine/Excellent
- 2 Excellent
- 5 Degraded

Intoduced Flora

- Arc **Arctotheca* calendula
- Caa **Carrichtera* annua
- Cem **Centaurea* melitensis
- Cobi **Cotula* bipinnata
- Coc **Cotula* coronopifolia
- Ehl **Ehrharta* longiflora
- Gam **Galium* murale
- Hyg **Hypochaeris* glabra
- Lya **Lysimachia* arvensis
- Lyf **Lycium* ferocissimum
- Mei **Melilotus* indicus
- Pea **Pentameris* airoides
- Scb **Schismus* barbatus
- Sol **Sonchus* oleraceus
- Tce **Trifolium*
- Ura **Ursinia* anthemoides

N

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area Vegetation Condition with Locations of Introduced Flora Taxa

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon

WEC Ref: KR16-34-01

Filename: KR16-34-01-f06.mxd

Projection: GDA 1994 MGA Zone 50

Figure

6.2

769500 770000 770500

6271000 6270500 6270000 6269500

Hyg

Ehl
Gam
Hyg
Lya

Lya
Scb

Legend

Vegetation Condition

- 1 Pristine
- 1/2 Pristine/Excellent
- 2 Excellent
- 5 Degraded

Intoduced Flora

- Arc **Arctotheca* calendula
- Caa **Carrichtera* annua
- Cem **Centaurea* melitensis
- Cobi **Cotula* bipinnata
- Coc **Cotula* coronopifolia
- Ehl **Ehrharta* longiflora
- Gam **Galium* murale
- Hyg **Hypochaeris* glabra
- Lya **Lysimachia* arvensis
- Lyf **Lycium* ferocissimum
- Mei **Melilotus* indicus
- Pea **Pentameris* airoides
- Scb **Schismus* barbatus
- Sol **Sonchus* oleraceus
- Tce **Trifolium*
- Ura **Ursinia* anthemoides

769500 770000 770500

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report KR16-34-01.

Mt Cattlin Study Area Vegetation Condition with Locations of Introduced Flora Taxa

Revision: A - 05 October 2016 Scale: 1:5,000

Author: Bethea Loudon

WEC Ref: KR16-34-01

Filename: KR16-34-01-f06.mxd

Projection: GDA 1994 MGA Zone 50

Figure

6.3

Table 7: Taxa Where Collections Represent Significant Range Extensions to the Known Ranges of these Taxa, or Fill Distribution Gaps (DPaW 2016d)

Taxon	Description
Pterostylis sp. inland (A.C. Beauglehole 11880)	Slight range extension to the south/southwest (approx. 70km)
Vittadinia dissecta var. *hirta*	Significant locality hole

5.3.3 Conservation Significant Ecological Communities

No TECs or PECs listed under the EPBC Act were recorded in the Study Area (DoE 2016). No DPaW-classified TECs or PECs listed under the EPBC Act were recorded in the Study Area (DoE 2016)

5.3.4 Introduced Taxa

A total of 16 introduced flora taxa were recorded in the Study Area, as listed in Table 8, which also presents ratings for each under the Environmental Weed Strategy for Western Australia (CALM 1999) (Appendix F). 1 taxa, *Lycium ferocissimum* (African boxthorn), is listed as a Weed of National Significance (WoNS) (AWC 2016). Locations of these flora taxa are presented in Table 8, Appendix J and in Figure 6 (above). As well as records from the 31 relevés conducted within the Study Area, populations or occurrences of introduced flora taxa were recorded opportunistically during the survey.

Table 8: Introduced Flora Taxa Recorded in the Study Area

Taxon	No. of Locations	Vegetation Type	Environmental Weeds Rating (CALM 1999)	Control
**Arctotheca calendula*	1	VT01,	Moderate	S-11 Permitted
**Carrichtera annua*	2	VT01	High	S-11 Permitted
**Centaurea melitensis*	2	VT01, VT14,	Moderate	S-11 Permitted
**Cotula bipinnata*	1	VT11,	Low	S-11 Permitted
**Cotula coronopifolia*	1	VT11,		S-11 Permitted
**Ehrharta longiflora*	5	VT02, VT04, VT10, VT11, VT26,	Moderate	S-11 Permitted
**Galium murale*	2	VT04, VT26,	Moderate	S-11 Permitted
**Hypochaeris glabra*	4	VT14, VT24, VT25, VT26,	Moderate	S-11 Permitted
**Lycium ferocissimum*	8	VT11 and opportunistically (not in defined VTs)	High	S-11 Permitted; WoNS (AWC 2016)
**Lysimachia arvensis*	12	VT01, VT03, VT07, VT10, VT11, VT14, VT16, VT19, VT20, VT24, VT26, VT27,		S-11 Permitted
**Melilotus indicus*	1	VT01	Moderate	S-11 Permitted
**Pentameris airoides*	1	VT01		S-11 Permitted
**Schismus barbatus*	3	VT14, VT24, VT27,	Moderate	S-11 Permitted
**Sonchus oleraceus*	1	VT04	Moderate	S-11 Permitted
**Trifolium cernuum*	1	VT01	Moderate	S-11 Permitted
**Ursinia anthemoides*	3	VT02, VT10, VT11	Moderate	S-11 Permitted

The majority of the introduced flora locations were small patches of *Lysimachia arvensis* scattered throughout the majority of the Study Area. Other minor occurrences of non-aggressive/invasive introduced flora taxa, mainly *Hypochaeris glabra* and *Ehrharta longiflora*, occurred in a few locations throughout the Study Area. These occurrences were generally associated with alternating levels of water-retaining clay, rocky outcropping at the soil surface or position in the landscape (ie. close to a drainage line), all of which had negligible impact on vegetation structure, composition and condition (section 5.2). The majority of the polygons within the Study Area were ranked 'Excellent' due to these occurrences.

One small area (VT1, KR031) (section 5.2) had significant weed cover, containing seven introduced flora at 38.2% cover, as a direct result of historical disturbance.

Thirty-six individuals of *Lycium ferocissimum* at eight locations were recorded scattered throughout the Study Area (section 5.3.3). This taxon is listed as a WoNS (AWC 2016).

5.3.5 Phytophthora Dieback

No indication of the presence of Phytophthora Dieback was observed. However, infestation symptoms in the Mt Cattlin Study Area were difficult to determine during field observations making the result uninterpretable.

6 DISCUSSION

6.1 Vegetation

A total of 27 vegetation types (VTs) were mapped within the Study Area. The relatively high number of VTs recorded for the area is due to the VT determination being primarily driven by vegetation structure, rather than holistic floristic composition and statistical analysis. The diversity of structural vegetation types in the Study Area is a reflection of the relatively high variety of habitat types owing to the varied geology and soil in the Study Area, as well as a relatively long, narrow Study Area crossing a variety of structural delineations.

The VTs recorded by this survey is significantly higher than the six community types recorded by Thompson *et al* (2013). However, this does not necessarily indicate a higher level of complexity and diversity as the results of these surveys cannot be directly compared, when differing methods of vegetation unit determination were utilised, was over a larger scale geographically, and mapped at a broader scale. While several of the vegetation types recorded by this survey are relatively common and widespread, it is not possible to infer their distributions at a regional scale. It is considered that these none of these vegetation units have the potential to be restricted.

6.2 Vegetation Condition

The condition of the majority of the vegetation in the Study Area was 'Excellent', indicating a pristine condition over the vast majority of the Study Area. One small area was ranked as 'Degraded' and has most likely been affected by historical human-clearing activities. However, it is considered that historical human-related disturbances have not had a significant impact on the vegetation in the Study Area as a whole.

6.3 Flora

A total of 120 discrete vascular flora taxa, and one known hybrid, were recorded within the Study Area. This species richness is considered to be high given the relatively small size of the Study Area. Furthermore, as local rainfall far exceeded winter monthly averages preceding survey, it is considered that this survey of the Study Area captured a high number of ephemeral taxa present in the Study Area.

No conservation significant flora taxa were recorded within the Study Area. It is considered that this represents a relatively complete census of conservation significant flora in the Study Area.

Whilst it is possible that this survey may not have located some individuals of conservation significant taxa occurring in the Study Area, such as the 24 conservation significant flora recorded in close proximity (approximately 5 –10 km) to the Study Area (DPaW 2016b), given the habitat, it is considered unlikely that these species occur in the Study Area. The relatively small width and area of the Study Area allowed for detailed mapping of Vegetation Types and geology precluding the likelihood of these conservation significant taxa occurring within the Study Area.

No vegetation considered to represent TECs or PECs listed under the EPBC Act and DPaW-classified TECs or PECs were recorded in the Study Area ((DoE 2016, DPaW 2016a).

Although the pre-field search revealed an overlap of the defined 10 km buffer of the federally listed 'Endangered' TEC and State listed Priority 3 PEC - Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province; none of the defined VT's contain enough of the key features

to suggest that is represented within the Study Area. The majority of the vegetation within the Study Area was typically dominated by Eucalypts species in the overstorey, forming mid woodlands and low mallee forests, over dense to sparse mixed height shrublands of mostly Fabaceous shrubs. Only three Proteaceous species (*Hakea commutata*, *Grevillea oligantha* and *G. pectinata*) within two genera were recorded within the Study Area; none of which are defined as typical "widespread and characteristic" taxa of the Proteaceous Kwongkan Shrublands community and none of which form widespread dominant structural shrublands or heaths.

Sixteen introduced flora taxa were recorded in the survey of the Study Area. Records of such taxa were often associated with environmental factors and not unnatural disturbances. All taxa were generally present at low levels. None of the introduced flora taxa found within the Study Area are Declared Pests under the Biosecurity and Agriculture Management Act 2007 (BAM Act) (WA) (DAF 2016); however, one taxon, *Lycium ferocissimum* (African Boxthorn), is listed as a Weed of National Significance (AWC 2016). However, individuals of this taxon were very broadly scattered throughout the Study Area, occurred at very low density and did not alter the vegetation structure and composition. As this is a fast growing and spreading invasive species (Agriculture Victoria 2016) and poses a particularly significant threat to biodiversity (DoEE 2016), it is recommended that the small number of individuals present be removed and destroyed to prevent further spread.

The introduction and spread of introduced flora taxa can be managed in accordance with standard hygiene practices, such as inspection and cleaning of machinery and vehicles prior to entering or leaving areas known or suspected to have infestations of introduced flora, and weed control through targeted spraying.

6.4 Phytophthora Dieback

Detecting pathogen infestation in the Mt Cattlin Study Area through field observations was difficult, as susceptible species were limited. The Mt Cattlin Study Area vegetation was mapped as primarily mid Eucalypt woodlands and low mallee Eucalypt forests over dense to sparse mixed height shrublands of mostly Fabaceous shrubs. Few susceptible species were recorded in the Study Area, with greatest known susceptibility existing in *Proteaceae*, *Epacridaceae*, *Dilleniaceae*, *Xanthorrhoeaceae* and non-Eucalypt *Myrtaceae* species.

No indication of the presence of Phytophthora Dieback (dieback) was observed during the survey. However, infestation symptoms in the Mt Cattlin Study Area were difficult to determine during field observations making the result uninterpretable.

Susceptibility and vulnerability to dieback is still considered to be high in the Study Area as nearby Cocanarup Road is an all-weather access route utilised regularly by the public and as such is regarded as potentially infested with *P. cinnamomi* (Woodman ENV 2016). The introduction and spread of dieback can be managed in accordance with a Dieback Management Program (Woodman Environmental 2016).

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Appendix A: Results of Search of the Department of the Environment and Energy Database with Regard to Environmental Matters of National Significance (DoEE 2016)

Australian Government

Department of the Environment

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.

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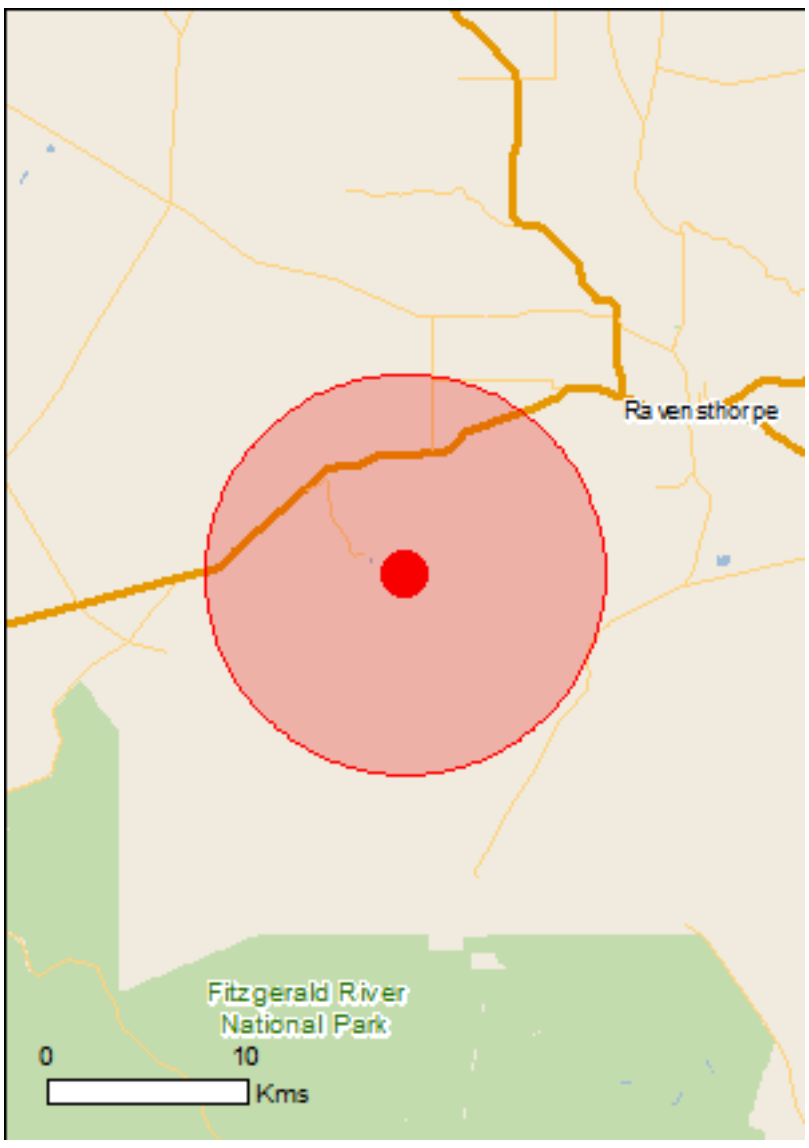

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

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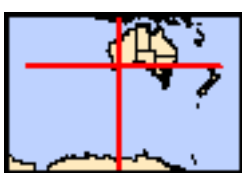

Summary

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:	1
Listed Threatened Species:	19
Listed Migratory Species:	3

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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	7
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	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:	None
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
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 Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	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 may occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Breeding likely to occur within area
Dasyornis longirostris Western Bristlebird [515]	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Pezoporus flaviventris Western Ground Parrot, Kyloring [84650]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
Myrmecobius fasciatus Numbat [294]	Vulnerable	Species or species habitat known to occur within area
Phascogale calura Red-tailed Phascogale [316]	Endangered	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Vulnerable	Species or species habitat may occur within area
Plants		
Acacia rhamphophylla Kundip Wattle [64659]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Adenanthos pungens subsp. effusus Sprawling Spiky Adenanthos [10742]	Endangered	Species or species habitat likely to occur within area
Anigozanthos bicolor subsp. minor Little Kangaroo Paw, Two-coloured Kangaroo Paw, Small Two-colour Kangaroo Paw [21241]	Endangered	Species or species habitat likely to occur within area
Darwinia oxylepis Gillam's Bell [13188]	Endangered	Species or species habitat may occur within area
Daviesia megacalyx Long-sepalled Daviesia [56785]	Endangered	Species or species habitat likely to occur within area
Eremophila denticulata subsp. denticulata Fitzgerald Eremophila [64569]	Vulnerable	Species or species habitat likely to occur within area
Eremophila subteretifolia Lake King Eremophila [56702]	Endangered	Species or species habitat may occur within area
Ricinocarpos trichophorus Barrens Wedding Bush [19931]	Endangered	Species or species habitat likely to occur within area
Roycea pycnophylloides Saltmat [21161]	Endangered	Species or species habitat may occur within area
Thelymitra psammophila Sandplain Sun-orchid [4908]	Vulnerable	Species or species habitat likely to 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
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

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		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to 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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Extra Information

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 Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
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
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		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
Mus musculus House Mouse [120]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		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 asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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

-33.64296 119.91507

Acknowledgements

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-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
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-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-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, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

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Please feel free to provide feedback via the Contact Us page.

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Appendix B: Guide to Proteaceae Dominated Kwongkan Shrubland (DoE 2014)

Proteaceae Dominated Kwongkan Shrubland: a nationally-protected ecological community

This guide is intended to help the public understand what the Proteaceae Dominated Kwongkan Shrubland ecological community is, why it is nationally protected, what the listing aims to achieve, and what the listing means for people in the region.

In summary:

- The Proteaceae Dominated Kwongkan Shrubland ecological community is now listed as endangered and protected under Australia's national environment law, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- The ecological community is found within the south coast region of Western Australia, and is dominated by flowering shrub species from the Proteaceae family (e.g. Banksias, Grevilleas, Hakeas).
- The national Threatened Species Scientific Committee found that the ecological community has undergone a severe reduction in integrity, and has a fragmented geographic distribution that means it is under a severe level of threat over the near future.
- The intent of the listing is to prevent its decline and to provide support to on-ground efforts that ensure its long-term survival and recovery. The Threatened Species Scientific Committee's **conservation advice** outlines a range of priority research and management actions that provide guidance on how to manage, restore and protect the ecological community.
- The listing promotes a co-ordinated, ecosystem-scale approach to threat abatement in the region and supports existing national protection of many threatened species that are found within the ecological community.
- Listing under the EPBC Act means that an activity that is likely to have a significant impact on the ecological community will need to be referred for an environmental impact assessment and approval.
- Routine property maintenance and land management practices carried out in line with laws and guidelines covering native vegetation are typically unlikely to require referral under national environment law. This includes most farming activities.
- The national environment law is triggered by activities that are likely to have a significant adverse impact on a listed ecological community; activities such as large new developments, works or infrastructures. For example, activities that involve permanently clearing large areas of intact and high-quality native vegetation.

Background

Australia's national environmental law, the EPBC Act, protects what are known as Matters of National Environmental Significance. The Act is only triggered if a particular activity is likely to have a significant impact on any of these matters.

Threatened species and ecological communities are Matters of National Environmental Significance. The EPBC Act defines an ecological community as an assemblage of native species that inhabits a particular area in nature. They often correspond with types of native vegetation, such as a certain kind of woodland or forest or shrubland.

The native plants and animals within an ecological community have different roles and relationships that, together, contribute to the healthy functioning of the environment. Protecting native communities also protects ecosystem services such as good quality air and water; healthy soils; natural prevention or control of erosion and salinity; shelter for stock; and carbon storage. These all contribute to better productivity of our land and water, which benefits people and society.

Human settlements and infrastructures where an ecological community formerly occurred do not form part of the natural environment and are therefore not part of the ecological community. This also applies to sites that have been replaced by crops and exotic pastures, or where the ecological community exists in a highly-degraded or unnatural state.

Kwongkan shrublands near Hopetoun (Department of the Environment)

Banksia speciosa (showy banksia), a key species in some parts of the ecological community (Department of the Environment)

What is the Proteaceae Dominated Kwongkan Shrubland ecological community?

The full name of the ecological community is the *Proteaceae dominated kwongkan shrublands of the southeast coastal floristic province of Western Australia*. Kwongkan (also known as kwongan) is a type of heathland found on the coastal plains of Western Australia. The name is derived from language of the Nyungar/Noongar people.

The key features of the ecological community are:

- The ecological community is mainly found within the Esperance Sandplains and Mallee bioregions with some patches occurring in the adjoining bioregions of south-west Western Australia (see Figure 1). Local government areas across this region are Albany City, Cranbrook Shire, Dundas Shire, Esperance Shire, Gnowangerup Shire, Jerramungup Shire, Kent Shire, Lake Grace Shire, Plantagenet Shire and Ravensthorpe Shire.
- The ecological community is typical of vegetation within some of the reserves across the region, such as Stirling Range National Park, Fitzgerald River National Park and Cape Le Grand National Park.
- The ecological community typically occurs on sandplains, occupying lower and upper slopes and ridges, as well as uplands across its range, where rainfall ranges from approximately 400 to 800 millimetres a year. It typically occurs on:
  - duplex soils and deep to shallow soils on the sandplains
  - sandy soils to clay loam, gravelly loam and loam on quartzite (e.g. The Barrens, Stirlings and Russell Range)
  - greenstone ranges (e.g. Ravensthorpe Range).
- Structurally, the ecological community may be described as proteaceous kwongkan shrubland and heath, or mallee heath.
- Typically for this ecological community, plants from the family Proteaceae make up a large component of the flora, including plants from the genera *Adenanthos, Banksia, Grevillea,*

Hakea, Isopogon and Lambertia. The actual Proteaceae species present in the ecological community is variable across its range.

- Widespread and characteristic species within the ecological community include:
  - *Banksia alliacea*
  - *B. armata* (prickly dryandra)
  - *B. cirsioides*
  - *B. media* (southern plains banksia)
  - *B. nutans* (nodding banskia)
  - *B. obovata* (wedge-leaved dryandra)
  - *B. sessilis* (parrot bush)
  - *B. speciosa* (showy banksia)
  - *B. tenuis*
  - *Hakea cucculata* (hood-leaved or scallop hakea)
  - *H. corymbosa* (cauliflower hakea)
  - *H. denticulata*
  - *H. drupacea*
  - *H. ferruginea*
  - *H. obliqua* (needles and corks)
  - *H. pandanicarpa*
  - *H. victoria* (royal hakea)
  - *Lambertia inermis*
  - *Beaufortia empetrifolia* (Myrtaceae)
  - *Xanthorrhoea platyphylla* (Xanthorrhoeaceae)
  - *Melaleuca striata* (Myrtaceae).
- Mallee eucalypt trees may be present at varying densities, but providing the vegetation is dominated by Proteaceae species, it is still classified as the ecological community.

The ecological community provides habitat for 45 plant and 15 animal species that are listed as nationally threatened, including:

- critically endangered plant species, such as: *Daviesia glossosema* (maroon-flowered daviesia), *Gastrolobium luteifolium* (yellow-leafed gastrolobium) and *Scaevola macrophylla* (large-flowered scaevola)

- threatened animals include the dibbler, heath mouse, Carnaby's black cockatoo, western bristlebird, western ground parrot, and western whipbird.

Why is the Proteaceae Dominated Kwongkan Shrubland ecological community important?

The region where the ecological community occurs has been identified as a global hotspot of biodiversity and is home to many unique plant species. The ecological community also provides habitat for a range of native birds, mammals, reptiles and other animals. Fifty-four plant and eighteen animal species that are listed as threatened, either nationally or in Western Australia, are known to occur in this ecological community.

The country of the Nyungar/Noongar and Ngadju Aboriginal people, and their sub-groups or dialectal groups, cover the region where the ecological community occurs. These groups have a strong cultural connection to the ecological community and surrounding environment. The ecological community provides an important resource for Aboriginal people in the form of bush foods, medicines and materials for tools and other significant items. Many patches contain important sites such as ceremonial areas and law grounds.

A large portion of the ecological community has already been lost and remaining areas are vulnerable to the impacts of threats such as dieback due to *Phytophthora cinnamomi*, changing fire regimes, land clearing, invasive species, and climate change. Some of these threats are also affecting areas of the ecological community that occur in reserves. In many areas it now mostly exists as small and fragmented patches. Protection will contribute to a region that is better able to cope with environmental fluctuations and changes.

Fitzgerald River National Park and surrounding lands (Department of the Environment)

Figure 1: Location of the Proteaceae Dominated Kwongkan Shrubland ecological community, showing indicative current and pre-European distribution.

Degraded roadside, showing loss of the ecological community on the left (Department of the Environment)

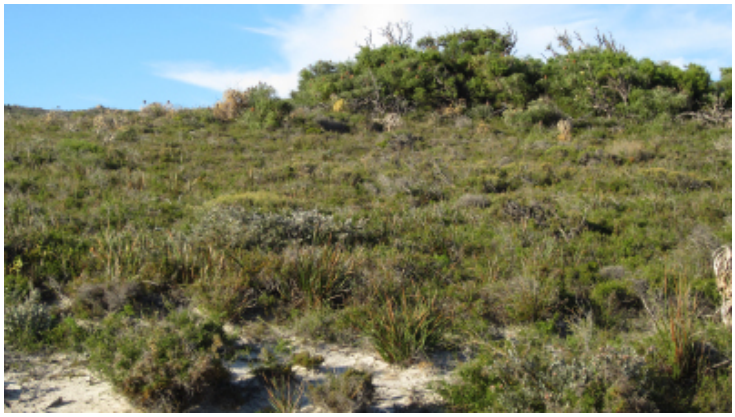
Why does it need national protection?

In January 2014, the Australian Government Minister for the Environment listed the Proteaceae Dominated Kwongkan Shrubland ecological community after considering the advice of the Threatened Species Scientific Committee.

During a rigorous assessment, the scientific evidence supported as it met the eligibility criteria for listing as endangered under national environment law.

Across its range the ecological community has been grouped on a biological basis, bringing together vegetation across the region of similar structure that is dominated by proteaceous species. This forms a nationally unique ecological community that has common threats and management practices. Whilst the ecological community is likely to be present in several shires, it is all included within the South Coast Natural Resource Management (NRM) region, which allows for a co-ordinated NRM approach.

The ecological community is intolerant of frequent disturbance due to land modification and clearance. A reduction in the integrity of the ecological community is evident from observations of dieback due to plant pathogens, effects of altered fire regimes, weed invasion, fragmentation and the subsequent decline or changes to flora and fauna within the ecological community. A reduction in community integrity results in changes to both the species composition and ecological processes that maintain the ecological community. If these changes are ongoing, some native species may persist, but it could lead to the eventual loss of a naturally functioning ecological community overall.



Loss of dominant tall structure due to dieback of *Banksia speciosa* (showy banksia), Cape Le Grand National Park (Department of the Environment)

The overall aim of listing is to prevent its decline and to provide support to on-ground efforts that ensure its long-term survival. The **conservation advice** outlines a range of priority research and management actions that provide guidance on how to manage, restore and protect the ecological community.

What are the benefits of listing an ecological community as nationally threatened?

There are a number of benefits to listing ecological communities under Australia's national environment law:

- Listing an ecological community can help to protect the landscapes that provide connectivity, corridors and refuge essential to protect and improve the ecological function, health and biodiversity of the region. It can protect habitat critical for refuge and recruitment for threatened species and for other species that are under pressure in the region. In turn, this helps foster the ecosystem services associated with an ecological community.
- Listing threatened ecological communities helps protect them from future significant human impacts that may cause further decline. The aim of the national environment law is to ensure the matters of national environmental significance are given due consideration, along with broader economic, social and other issues in the planning of any large projects. Where possible, significant adverse impacts to the environment should be avoided, or the impacts mitigated, reduced or offset, when unavoidable.
- National listing encourages agencies and community/Landcare groups to access environmental funding opportunities for conservation and recovery works. The Australian Government has a variety of funding programs to encourage land managers to continue to conserve biodiversity and ecosystem services on their properties.
- A **conservation advice**, published at the time of listing, provides guidance and options for environmental decision-making, including rehabilitation and conservation initiatives in the region.

- In the case of the Proteaceae Dominated Kwongkan Shrubland ecological community, the listing will:
  - provide landscape-scale protection that complements existing national protection for threatened species that are found within the ecological community (e.g. the Fitzgerald Biosphere Recovery Plan)
  - protect the environmental values, including the ecosystem functions and services associated with the ecological community, which contributes to the long-term productivity of the landscape
  - provide a range of environmental amenity benefits that support tourism and recreation activities.

Regeneration following fire, Fitzgerald River National Park (Department of the Environment)

What does the listing mean for landholders?

The national environment law is triggered if an action is likely to have a significant impact on the Proteaceae Dominated Kwongkan Shrubland ecological community. If a proposed action is likely to have such an impact, it would require:

- referral (determining if the action may have a significant impact on the ecological community)
- assessment (the scope of the assessment depends on the complexity of the proposed action and impacts)
- a decision on approval from the Minister (who considers the environmental, social and economic factors involved).

Social and economic matters may be taken into account for individual projects that may have a significant impact on the ecological community, through the EPBC Act approvals process. Strict timeframes apply to assessments to ensure decisions are made as quickly as possible.

The normal activities of individual landholders and residents will typically not be affected by a listing. Routine property maintenance, land management and other established practices are unlikely to have

a significant impact and so do not typically require referral under national environment law, particularly if carried out in line with other national and state laws covering native vegetation.

For instance, the following actions are unlikely to trigger national environment law:

- ongoing grazing, horticultural or cropping activities
- maintaining existing fences, roads, internal access tracks and firebreaks
- maintaining existing farm gardens and orchards
- maintaining existing farm dams or water storages
- maintaining existing pumps and clearing drainage lines
- replacing and maintaining sheds, yards and other farm buildings
- controlling weeds and spraying for pests on individual properties
- small scale extraction of gypsum and lime for on farm use, as well as small scale gravel extraction for road works.

In all these cases impacts on important patches of the ecological community (e.g. high quality, important corridor for wildlife) should be avoided.

One of the major concerns with some activities is the spread of *Phytophthora* dieback, which has the potential for broader detrimental impacts to the ecological community. Activities in the region should therefore continue to be carried out with appropriate hygiene measures in place to prevent the introduction and spread of dieback (e.g. by cleaning boots, vehicles and machinery).

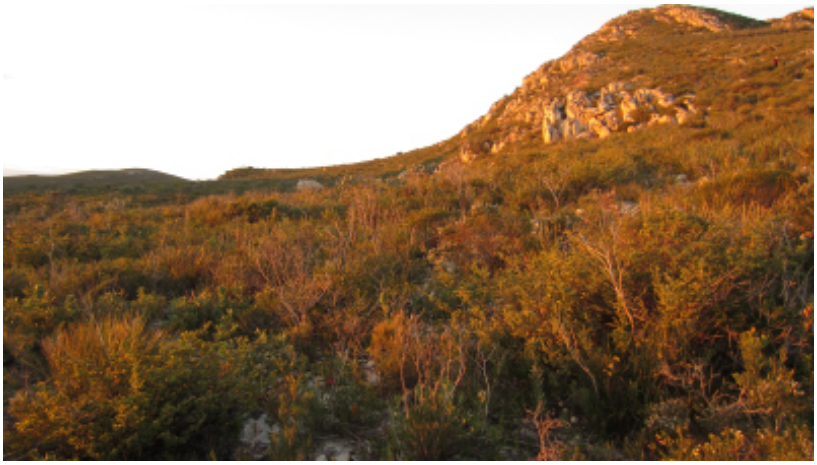
Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. The major activity that is likely to have a significant impact on the ecological community is permanently clearing large or otherwise important areas of intact or high-quality native vegetation. This might include, for example, major mining, residential, commercial or other industrial development, developing wind farms, building new roads or widening existing roads, or converting large areas into new pastures or cropping fields. To help reduce the significance of actions, the EPBC Act promotes the avoidance and mitigation of impacts from the early planning stage, wherever that is possible.

Have activities previously been referred under the EPBC Act for this area?

Within the area of the Proteaceae Dominated Kwongkan Shrubland ecological community some developments and activities have previously been referred for consideration under the EPBC Act due to possible impacts on threatened species that are already nationally protected. No activity has been rejected outright, although some were approved with conditions to take better account of significant environmental impacts.

Where can I get further information?

- The listing process: **www.environment.gov.au/topics/threatened-species-ecological-communities**
- The EPBC referral and approval process: **www.environment.gov.au/topics/environment-protection**
- Australian Government natural resource management initiatives: **www.nrm.gov.au**/
- The Department's Community Information Unit: by phone on **1800 803 772** (freecall), or email at **ciu@environment.gov.au**
- The EPBC liaison officer with the National Farmers Federation: by email at **environment@nff.org.au**



Department of the Environment (2014)
Kwongkan shrublands at East Mount Barren, Fitzgerald River National Park. Sourced October, 2016. Available: www.environment.gov.au

Appendix C: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (DPaW 2013)

1. GENERAL DEFINITIONS

Ecological Community: A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:
Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a direct or indirect

result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)
An ecological community that has been 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.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been 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. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities:

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral

leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities:

Communities that are 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) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities:

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) Communities 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) Communities 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.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities:

Communities that are 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.

(i) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands.

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities:

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Current as of January 2013

Department of Environment and Conservation (2013)
Definitions, Categories and Criteria for Threatened and Priority Ecological Communities. January 2013. Available: www.dpaw.wa.gov.au

Appendix D: Taxa Returned from the Search of DPaW's Threatened Flora Databases (DPaW 2016b)

Taxon	Status	Source				
		DPaW (2016B)			DoEE (2016)	Thompson et al (2013)
		TP List	TPFL	WA Herb		
Acacia argutifolia	P4	X				
Acacia besleyi	P1	X		X		
Acacia bifaria	P3	X		X		X
Acacia dictyoneura	P4	X				
Acacia errabunda	P3	X		X		
Acacia grisea	P4	X				
Acacia improcera	P3	X				
Acacia leioderma var. Fitzgerald River N.P. variant (A.S.George 9922)	P2	X				
Acacia newbeyi	P3	X				
Acacia papulosa	P2	X				
Acacia rhamphophylla	T	X			X	
Acacia simulans	P4	X				
Acacia sp. Ravensthorpe Range (B.R. Maslin 5463)	P1	X				
Acrotriche orbicularis	T	X				
Adenanthos cacomorphus	P2	X				
Adenanthos dobagii	T	X				
Adenanthos ellipticus	T	X				
Adenanthos pungens subsp. *effusus*	T	X			X	
Allocasuarina hystricosa	P4	X				
Andersonia echinocephala	P4	X				
Anigozanthos bicolor subsp. *minor*	T	X			X	
Anthocercis fasciculata	P4	X				
Anticoryne ovalifolia	P2	X				
Astartea decemcostata	P2	X				
Astartea reticulata	P3	X				
Astroloma sp. Dumbleyung (A.J.G. Wilson 146)	P3	X				
Austrostipa sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)	P1	X		X		X
Austrostipa sp. Ravensthorpe Range (A. Markey & J. Allen 6261)	P1	X		X		X
Banksia corvijuga	P3	X				
Banksia foliosissima	P4	X				
Banksia laevigata subsp. *laevigata*	P4	X				
Banksia lullfitzii	P3	X				
Banksia meganotia	P3	X				
Banksia rufa subsp. *chelomacarpa*	P3	X				
Banksia rufa subsp. *flavescens*	P3	X				
Beyeria sulcata var. *truncata*	P3	X				
Beyeria villosa	P4	X				
Boronia oxyantha var. *oxyantha*	P2	X				
Bossiaea oxyclada	P2	X				
Calectasia keigheryi	P2	X				
Calectasia obtusa	P3	X				
Calothamnus roseus	P1	X				
Calycopeplus marginatus	P3	X				

Taxon	Status	Source				
		DPaW (2016B)			DoEE (2016)	Thompson et al (2013)
		TP List	TPFL	WA Herb		
Cassinia arcuata	P2	X		X		X
Chorizema ulotropis	P4	X		X		
Commersonia rotundifolia	P3	X				
Conostephium prolatum	P2	X				
Conostylis seorsiflora subsp. *longissima*	P2	X				
Coopernookia georgei	T	X				
Cryptandra inconspicua	P2	X				
Cryptandra polyclada subsp. *polyclada*	P3	X				
Cyathostemon gracilis	P2	X				
Dampiera deltoidea	P4	X				
Dampiera fitzgeraldensis	P2	X				
Dampiera orchardii	P2	X				
Dampiera sericantha	P3			X		
Dampiera sp. Ravensthorpe (G.F. Craig 8277)	P3	X				
Darwinia oxylepis	T				X	
Daviesia megacalyx	T	X			X	
Daviesia newbeyi	P3	X	X	X		
Daviesia obovata	T	X				
Daviesia pauciflora	P3	X				
Eremophila denticulata subsp. *denticulata*	T	X	X		X	
Eremophila serpens	P4	X				
Eremophila subteretifolia	T				X	
Eremophila verticillata	T	X				
Eremophila youngii subsp. *lepidota*	P4	X				
Eucalyptus arborella	P3	X				
Eucalyptus brandiana	P2	X				
Eucalyptus burdettiana	T	X				
Eucalyptus coronata	T	X				
Eucalyptus desmondensis	P4	X		X		X
Eucalyptus dielsii x *platypus*	P1	X				
Eucalyptus mcquoidii	P2	X				
Eucalyptus praetermissa	P4	X				
Eucalyptus quaerenda	P3	X				
Eucalyptus sinuosa	P2	X				
Eucalyptus x bennettiae	P4	X				
Gastrolobium spectabile	P3	X				
Gastrolobium stenophyllum	P3	X	X	X		
Gnephosis intonsa	P3			X		
Gonocarpus hispidus	P2	X				
Gonocarpus trichostachyus	P3	X		X		
Goodenia phillipsiae	P4	X	X			
Goodenia stenophylla	P4	X				
Grevillea coccinea subsp. *lanata*	P3	X				
Grevillea fastigiata	P4	X		X		
Grevillea infundibularis	T	X				
Grevillea prostrata	P4	X				
Grevillea punctata	P3	X				
Grevillea sulcata	P1	X	X	X		
Guichenotia anota	P1	X				
Gyrostemon ditrigynus	P4	X				
Hakea acuminata	P2	X				

Taxon	Status	Source				
		DPaW (2016B)			DoEE (2016)	Thompson et al (2013)
		TP List	TPFL	WA Herb		
Hakea brachyptera	P3	X				
Hibbertia abyssa	T	X				
Hibbertia acrotrichion	P2	X				
Hibbertia atrichosepala	P1	X				
Hibbertia fitzgeraldensis	P3	X				
Hibbertia papillata	P2	X				
Hydrocotyle sp. Decipiens (G.J. Keighery 463)	P2	X				
Hypocalymma melaleucoides	P2	X				
Jacksonia intricata	P2	X				
Kunzea acicularis	T	X				
Kunzea eriocalyx	P2	X				
Kunzea similis subsp. *similis*	T	X				
Lasiopetalum adenotrichum	P2	X				
Lasiopetalum parvuliflorum	P3	X				
Lasiopetalum sp. Desmond (N. McQuoid 653)	P1	X				
Lechenaultia acutiloba	P3	X				
Lepidosperma sp. Archer Drive (S. Kern & R. Jasper LCH 18300)	P1	X				
Lepidosperma sp. Hopetoun Road (S. Kern et al. LCH 16552)	P1	X				
Lepidosperma sp. Maydon (S. Kern, R. Jasper, H. Hughes LCH 17844)	P1	X				
Lepidosperma sp. Mt Chester (S. Kern et al. LCH 16596)	P1	X		X		
Lepidosperma sp. Mt Short (S. Kern et al. LCH 17510)	P1	X		X		
Lepidosperma sp. Shoemaker Levy (L. Ang & O. Davies 10815)	P3	X		X		
Leucopogon blepharolepis	P4	X				
Leucopogon compactus	P4	X				
Leucopogon sp. Barren Range (A.S. George 10092)	P2	X				
Levenhookia pulcherrima	P2	X		X		
Marianthus aquilonaris	T	X				
Marianthus mollis	P4	X				
Melaleuca coccinea	P3	X				
Melaleuca penicula	P4	X	X	X		X
Melaleuca pritzelii	P3	X				
Melaleuca sculponeata	P3	X				
Melaleuca similis	P1	X				
Melaleuca sophisma	P1	X				
Micromyrtus navicularis	P3	X				
Monotoca aristata	P2	X				
Opercularia hirsuta	P2	X				
Persoonia brevirhachis	P3	X				
Philotheca cymbiformis	P2	X				
Pimelea longiflora subsp. *eyrei*	P2	X				
Poa billardierei	P3	X				
Pultenaea brachyphylla	P2	X				
Pultenaea calycina subsp. *calycina*	P3	X				

Taxon	Status	Source				
		DPaW (2016B)			DoEE (2016)	Thompson et al (2013)
		TP List	TPFL	WA Herb		
Pultenaea calycina subsp. *proxena*	P4	X				
Pultenaea craigiana	P3	X				
Pultenaea indira subsp. *monstrosita*	P3	X		X		
Pultenaea vestita	P3	X				
Pultenaea wudjariensis	P1	X				
Ricinocarpos trichophorus	T	X			X	
Rinzia affinis	P4	X				
Roycea pycnophylloides	T				X	
Senecio pinnatifolius var. *leucocarpus*	P2	X				
Sphaerolobium validum	P3	X				
Spyridium mucronatum subsp. *recurvum*	P3	X		X		
Spyridium oligocephalum	P3	X				
Stenanthemum cristatum	P2	X				
Stylidium pseudohirsutum	P3	X				
Synaphea sp. flat canaliculata (M. Bennett 794)	P1	X				
Tetratheca applanata	P1	X				
Thelymitra psammophila	T	X			X	
Thomasia pygmaea	P3	X				
Thomasia sp. Hopetoun (K.R. Newbey 4896)	P2	X				
Thysanotus brachiatus	P2	X				
Verticordia crebra	T	X				
Verticordia helichrysantha	T	X				
Verticordia integra	P4	X				
Verticordia longistylis	P3	X				
Westringia fitzgeraldensis	P2	X				

*Note: Sources of records are:

- TP List – DPaW Threatened and Priority Flora List
- TPFL – DPaW Threatened and Priority Flora Database
- WA Herb. – WA Herb. specimen database

Appendix E: Conservation Codes for Western Australian Flora and Fauna (DPaW 2015b)

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

Categories of specially protected fauna and flora are:

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

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

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

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

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

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

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

EX Presumed extinct species
Listed as Specially Protected under the *Wildlife Conservation Act 1950,* published under Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed

Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora (which may also be referred to as Declared Rare Flora).

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.

IA Migratory birds protected under an international agreement
Listed as Specially Protected under the Wildlife Conservation Act 1950, listed under Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice.

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), relating to the protection of migratory birds.

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

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

P Priority species

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

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

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

1: Priority One: Poorly-known species
Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well

known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2: Priority Two: Poorly-known species

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

3: Priority Three: Poorly-known species

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

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

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies, variety or forma).

Current as of 11th November 2015

Appendix F: Environmental Weed Strategy - Criteria for the Assessment and Rating of Weeds in Terms of their Environmental Impact on Biodiversity (CALM 1999)

ENVIRONMENTAL WEEDS RATING

- **Invasiveness-** ability to invade bushland in good to excellent condition or ability to invade waterways (Score as yes or no).
- **Distribution** – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world (Score as yes or no).
- **Environmental Impacts** – ability to change the structure, composition and function of ecosystems; in particular an ability to form a monoculture in a vegetation community (Score as yes or no).

The Rating System used in the Environmental Weed Strategy for Western Australia

High	A weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritising this weed for control and/or research.
Moderate	A weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control or research effort should be directed to it if funds are available; however it should be monitored (possibly a reasonably high level of monitoring).
Mild	A weed species scoring one of the criteria. A mild rating would indicate monitoring of the weed and control where appropriate.
Low	A weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

Appendix G: Structural Vegetation Types Defined in the Study Area

VT	Description	Condition	Representative Site	Representative Photo
VT1	Low to mid isolated clumps of shrubs of *Acacia binata* and *Eremophila decipiens* subsp. *decipiens* over low closed forbland of **Arctotheca calendula*, **Centaurea melitensis*, **Lysimachia arvensis*, *Maireana trichoptera* and *Vittadinia gracilis* on gentle simple slopes of brown clay loam	Degraded (historical clearing?, non-aggressive weeds)	KR031	

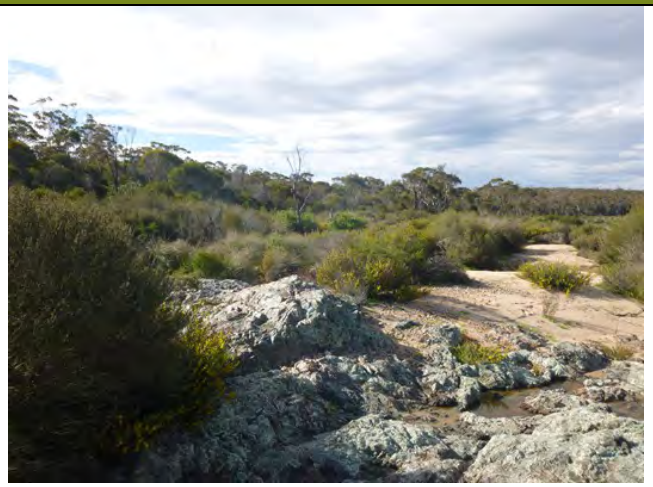
VT	Description	Condition	Representative Site	Representative Photo
VT2	Mid isolated clumps of trees to open woodland of *Eucalyptus salmonophloia* over tall shrubland of *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Santalum spicatum* (occasionally with *Allocasuarina huegeliana*) over low open shrubland of *Eremophila decipiens* subsp. *decipiens* and *Rhagodia crassifolia* over low forbland of *Cheilanthes sieberi* subsp. *sieberi*, *Gonocarpus nodulosus*, *Lawrencella rosea* and *Waitzia suaveolens* var. *flava* on hill crests of moderate slope with dark brown clay loam and granite surface stones and outcropping	Excellent-Pristine (patches of non-aggressive weeds)	KR029	
VT3	Mid open woodland of *Eucalyptus salmonophloia* over low isolated clumps of mallees of *Eucalyptus celastroides* subsp. *virella* or *Eucalyptus oleosa* subsp. *corvina* over tall shrubland of *Acacia binata* and *Dodonaea ptarmicaefolia* (occasionally with *Olearia* ?*cassiniae*) over low open shrubland *Enchylaena tomentosa*, *Eremophila decipiens* subsp. *decipiens*, *Maireana trichoptera*, *Olearia muelleri* and *Rhagodia crassifolia* in gullies/minor drainage lines of moderate slope with brown sandy clay loam and surface stones of granite, dolerite and quartz	Excellent-Pristine (patches of non-aggressive weeds)	KR030	

VT	Description	Condition	Representative Site	Representative Photo
VT4	Mid woodland of *Eucalyptus salmonophloia* over tall open shrubland of *Acacia binata*, *Daviesia nematophylla*, *Santalum acuminatum* and *Templetonia retusa* over low open shrubland of *Eremophila decipiens* subsp. *decipiens* and *Rhagodia crassifolia* on steep slopes of brown sandy clay loam with surface stones of dolerite and quartz	Excellent-Pristine (patches of non-aggressive weeds)	KR028	
VT5	Mid woodland of *Eucalyptus salmonophloia* over tall shrubland of *Acacia acuminata*, *Santalum spicatum* and *Templetonia retusa* over low open shrubland of *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri*, *Rhagodia crassifolia* and *Senna artemisioides* subsp. *filifolia* on steep slopes of brown clay loam with dolerite surface stones and outcropping	Excellent-Pristine (patches of non-aggressive weeds)	KR026	

VT	Description	Condition	Representative Site	Representative Photo
VT6	Mid mallee woodland of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus brachycalyx* over low shrubland of *Olearia muelleri*, *Rhagodia crassifolia*, *Sclerolaena diacantha* and *Senna artemisioides* subsp. *filifolia* on gentle lower slopes of grey-brown sandy clay with surface stones of dolerite and quartz	Excellent-Pristine (patches of non-aggressive weeds)	KR027	
VT7	Mid open woodland of *Eucalyptus salmonophloia* over low open mallee woodland of *Eucalyptus brachycalyx* over tall open shrubland of *Acacia cyclops* and *Santalum acuminatum* over mid shrubland of *Senna artemisioides* subsp. *filifolia* over low sparse shrubland of *Maireana erioclada*, *Olearia muelleri* and *Rhagodia crassifolia* over low isolated clumps of grasses of *Austrostipa exilis* over low closed forbland of *Asteridea athrixioides*, **Lysimachia arvensis*, *Omphalolappula concava* and *Vittadinia australasica* var. *australasica* on gentle mid slopes of grey-brown light clay with granite and quartz surface stones	Excellent (non-aggressive weeds)	KR020	

VT	Description	Condition	Representative Site	Representative Photo
VT8	Mid woodland of *Eucalyptus salmonophloia* over low isolated clumps of mallees of *Eucalyptus brachycalyx* over mid open shrubland of *Acacia binata*, *Senna artemisioides* subsp. *filifolia* and *Olearia* ?*cassiniae* over low shrubland of *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri*, *Rhagodia crassifolia*, *Enchylaena tomentosa* and *Acacia erinacea* on gentle simple slopes of light brown sandy clay loam with granite and quartz surface stones	Pristine	KR018	
VT9	Mid woodland of *Eucalyptus salmophloia* over low mallee woodland of *Eucalyptus brachycalyx* over tall shrubland of *Acacia acuminata* and *Callitris roei* over mid open shrubland of *Daviesia nematophylla* and *Dodonaea ptarmicaefolia* over low open shrubland of *Eremophila decipiens* subsp. *decipiens*, *Grevillea oligantha* and *Rhagodia crassifolia* on moderately sloped mid slopes of red-brown clay loam with dolerite, granite and quartz surface stones	Pristine	KR002	

VT	Description	Condition	Representative Site	Representative Photo
VT10	Tall closed shrubland of *Acacia acuminata* and *Dodonaea ptarmicaefolia* over low sparse shrubland or isolated clumps of shrubs of *Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia* and *Senna artemisioides* subsp. *x artemisioides* and/or *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *filifolia* over low forbland or isolated clumps of forbs of *Cheilanthes sieberi* subsp. *sieberi*, **Ehrharta longiflora*, *Lawrencella rosea*, *Oxalis perennans*, *Pterostylis* sp. inland (A.C. Beauglehole 11880), *Trachymene ornata*, **Ursinia anthemoides* and *Waitzia suaveolens* var. *flava* and/or *Nicotiana rotundifolia* on moderately or gently sloped lower slopes of red-brown or brown light clay or sandy clay loam with granite surface stones	Excellent-Pristine (non-aggressive weeds)	KR017, KR023	

VT	Description	Condition	Representative Site	Representative Photo
VT11	Tall open shrubland of **Lycium ferocissimum*, *Melaleuca hamulosa*, *Melaleuca incana* subsp. *tenella*, *Melaleuca torquata* over mid sparse shrubland of *Acacia patagiata*, *Beyeria* ?*sulcata*, *Dodonaea ptarmicaefolia*, *Melaleuca halmaturorum* over tall sparse sedgeland of *Gahnia* sp. L (K.R. Newbey 7888) over low isolated clumps of forbs and grasses of **Cotula bipinnata*, *Disphyma crassifolium*, **Ehrharta longiflora*, **Lysimachia arvensis*, *Tecticornia indica* subsp. *bidens* in very gently slope drainage lines of cream river sand with granite outcropping and granite and quartz surface stones	Excellent (non-aggressive weeds)	KR001	
VT12	Mid open woodland of *Eucalyptus salmonphloia* over tall closed shrubland of *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Santalum spicatum* over low sparse shrubland of *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri* and *Rhagodia crassifolia* on gentle mid slopes of brown sandy clay with granite surface stones	Pristine	KR022	

VT	Description	Condition	Representative Site	Representative Photo
VT13	Low mallee forest of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus brachycalyx* over mid open shrubland of *Dodonaea ptarmicaefolia* and *Senna artemisioides* subsp. *filifolia* over low open shrubland of *Acacia erinacea*, *Maireana erioclada*, *Maireana suaedifolia*, *Olearia muelleri*, *Rhagodia crassifolia*, *Rhagodia preissii* subsp. *preissii* and *Sclerolaena diacantha* on gentle simple slopes of brown clay loam with dolerite, granite and quartz surface stones	Pristine	KR021	
VT14	Mid woodland of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus salmonophloia* over mid open shrubland of *Dodonaea concinna*, *Dodonaea ptarmicaefolia* and *Senna artemisioides* subsp. *filifolia* over low shrubland of *Eremophila decipiens* subsp. *decipiens*, *Maireana radiata*, *Rhagodia crassifolia* and *Sclerolaena diacantha* over low isolated clumps of forbs and grasses of **Centaurea melitensis*, *Crassula colorata* var. *acuminata* **Lysimachia arvensis* and **Schismus barbatus* on gentle upper slopes of brown clay loam with dolerite outcropping surface stones	Excellent	KR024	

VT	Description	Condition	Representative Site	Representative Photo
VT15	Mid woodland of *Eucalyptus salmonophloia* over low mallee open woodland of *Eucalyptus oleosa* subsp. *corvina* and *Eucalyptus extensa* over mid sparse shrubland of *Acacia binata* and *Dodonaea ptarmicaefolia* over low sparse shrubland of *Acacia erinacea*, *Maireana suaedifolia*, *Olearia muelleri*, *Rhagodia crassifolia* and *Sclerolaena diacantha* on moderately sloped upper slopes of brown sandy clay loam with dolerite and granite surface stones	Pristine	KR025	
VT16	Low mallee closed forest of *Eucalyptus extensa* over mid to tall isolated shrubs or tall open shrubland of *Dodonaea ptarmicaefolia* and *Templetonia retusa* over low isolated clumps of forbs and shrubs of *Enchylaena tomentosa*, *Hydrocotyle rugulosa* and **Lysimachia arvensis* on moderate to steep slopes or hillocks with dark brown clay loam and dolerite, quartz and granite surface stones	Excellent (non-aggressive weeds)	KR003	

VT	Description	Condition	Representative Site	Representative Photo
VT17	Low isolated mallees of *Eucalyptus salmonophloia* over tall closed shrubland of *Acacia acuminata* and *Melaleuca acuminata* subsp. *acuminata* over mid open sedgleand of *Lepidosperma diurnum* over low isolated forbs of *Hydrocotyle rugulosa* and *Trachymene ornata* on moderately sloped upper slopes of red-brown clay loam with dolerite surface stones	Pristine	KR005	
VT18	Low closed forest of *Eucalyptus extensa* over tall shrubland of *Acacia binata* and *Daviesia nematophylla* over low sparse shrubland of *Enchylaena tomentosa* and *Rhagodia preissii* subsp. *preissii* and/or *Acacia erinacea*, *Acacia glaucoptera* and *Senna artemisioides* subsp. *x artemisioides* on moderate to steep slopes and hillocks with brown sandy clay loam or light clay with granite and dolerite surface stones	Pristine	KR004, KR009	

VT	Description	Condition	Representative Site	Representative Photo
VT19	Low mallee forest of *Eucalyptus extensa* and *Eucalyptus celastroides* subsp. *virella* over tall open shrubland of *Acacia acuminata*, *Dodonaea ptarmicaefolia* and *Templetonia retusa* over mid sparse shrubland of *Acacia glaucoptera* and *Daviesia nematophylla* over mid sparse sedgeland of *Lepidosperma diurnum* over low isolated forbes of *Daucus glochidiatus*, *Goodenia affinis*, *Hydrocotyle rugulosa*, **Lysimachia arvensis*, *Oxalis perennans* and *Waitzia suaveolens* var. *flava* in steep gullies/minor drainage lines with red-brown clay loam and dolerite and quartz surface stones	Excellent (non-aggressive weeds)	KR006	
VT20	Low mallee woodland of *Eucalyptus celastroides* subsp. *virella* over tall isolated clumps of *Templetonia retusa* over mid shrubland of *Acacia glaucoptera*, *Dodonaea ptarmicaefolia*, *Exocarpos aphyllus* and *Grevillea oligantha* over low isolated clumps of *Acacia erinacea* over low isolated forbs of *Daucus glochidiatus*, *Hydrocotyle rugulosa*, **Lysimachia arvensis* and *Senecio glossanthus* on gently sloped valley-tops/upper slopes with brown clay loam and dolerite and granite surface stones	Excellent (non-aggressive weeds)	KR007	

VT	Description	Condition	Representative Site	Representative Photo
VT21	Low isolated mallees of *Eucalyptus phenax* subsp. *phenax* over tall closed shrubland of *Acacia acuminata*, *Allocasuarina campestris* and *Dodonaea ptarmicaefolia* over mid open sedgeland of *Lepidosperma diurnum* and *Spartochloa scirpoidea* over low isolated forbs of *Cheilanthes sieberi* subsp. *sieberi*, *Goodenia affinis*, *Hydrocotyle rugulosa*, *Trachymene ornata* and *Waitzia suaveolens* var. *flava* on moderate mid slopes with dark brown clay loam and granite surface stones	Pristine	KR008	
VT22	Low isolated mallees of *Eucalyptus cernua* and *Eucalyptus celastroides* subsp. *virella* over tall closed shrubland of *Acacia acuminata* over low isolated shrubs and forbs of *Cheilanthes sieberi* subsp. *sieberi*, *Phyllanthus calycinus*, *Senna artemisioides* subsp. *x artemisioides* and *Trachymene ornata* on moderate mid slopes with brown clay loam and granite outcropping and granite and dolerite surface stones	Pristine	KR010	

VT	Description	Condition	Representative Site	Representative Photo
VT23	Low closed mallee forest of *Eucalyptus cernua* over tall sparse shrubland of *Exocarpos aphyllus* and *Hakea commutata* or *Templetonia retusa* over low sparse shrubland of *Acacia glaucoptera*, *Senna artemisioides* subsp. *x artemisioides* on hillocks or steep slopes with brown light clay and granite surface stones and outcropping	Pristine	KR011	
VT24	Low mallee woodland of *Eucalyptus oleosa* subsp. *corvina* over tall shrubland of *Daviesia nematophylla*, *Santalum acuminatum* and *Templetonia retusa* over mid open shrubland of *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *x artemisioides* over low open shrubland of *Acacia glaucoptera*, *Carpobrotus modestus* and *Sclerolaena diacantha* over low isolated grasses and forbs of *Crassula colorata* var. *acuminata*, **Hypochaeris glabra*, **Schismus barbatus* on hill crests of very gentle slope with brown sandy clay loam and granite surface stones	Excellent (non-aggressive weeds)	KR012	

WOODMAN ENVIRONMENTAL

VT	Description	Condition	Representative Site	Representative Photo
VT25	Low open mallee woodland of *Eucalyptus cernua* and *Eucalyptus oleosa* subsp. *corvina* over tall shrubland of *Exocarpos aphyllus* and *Templetonia retusa* over mid shrubland of *Acacia glaucoptera* over low isolated clumps of shrubs of *Carpobrotus modestus*, *Enchylaena tomentosa*, *Rhagodia preissii* subsp. *preissii* and *Sclerolaena diacantha* on gentle upper slopes with grey-brown light clay and dolerite, granite and quartz surface stones	Excellent (non-aggressive weeds)	KR013	
VT26	Mid mallee forest of *Eucalyptus occidentalis*, *Eucalyptus extensa* and *Eucalyptus salmonophloia* over tall shrubland of *Hakea commutata* and *Templetonia retusa* over low isolated sedges of *Lepidosperma diurnum* and *Lepidosperma tenue* over low isolated clumps of forbs and grasses of **Ehrharta longiflora*, **Galium murale*, *Hydrocotyle rugulosa*, **Hypochaeris glabra*, **Lysimachia arvensis* and *Oxalis perennans* on very steep slopes and hillocks with brown light clay and dolerite and granite surface stones	Excellent (non-aggressive weeds)	KR015	

VT	Description	Condition	Representative Site	Representative Photo
VT27	Low closed mallee forest of *Eucalyptus cernua* and *Eucalyptus extensa* over tall isolated shrubs of *Exocarpos aphyllus* over mid isolated to mid sparse shrubland of *Rhagodia preissii* subsp. *preissii* and *Senna artemisioides* subsp. *x artemisioides* over low sparse shrubland of *Acacia glaucoptera*, *Carpobrotus modestus* and *Enchylaena tomentosa* on steep slopes and hillocks with dark brown clay loam and granite and quartz surface stones	Excellent (non-aggressive weeds)	KR016	

Appendix H: Vascular Plant Taxa Recorded in the Study Area

Note: * denotes introduced taxon

FAMILY	TAXON
Aizoaceae	*Carpobrotus modestus* *Disphyma crassifolium*
Amaranthaceae	*Ptilotus holosericeus* *Ptilotus spathulatus*
Apiaceae	*Daucus glochidiatus*
Apocynaceae	*Alyxia buxifolia*
Araliaceae	*Hydrocotyle rugulosa* *Trachymene ornata*
Asparagaceae	*Thysanotus patersonii*
Asteraceae	**Arctotheca calendula* *Asteridea athrixioides* **Centaurea melitensis* **Cotula bipinnata* **Cotula coronopifolia* **Hypochaeris glabra* *Lagenophora huegelii* *Lawrencella rosea* *Olearia ?cassiniae* *Olearia muelleri* *Podolepis rugata* subsp. *rugata* *Senecio glossanthus* **Sonchus oleraceus* **Ursinia anthemoides* *Vittadinia australasica* var. *australasica* *Vittadinia dissecta* var. *hirta* *Vittadinia gracilis* *Waitzia suaveolens* var. *flava*
Boraginaceae	*Omphalolappula concava*
Brassicaceae	**Carrichtera annua*
Casuarinaceae	*Allocasuarina campestris* *Allocasuarina huegeliana*
Chenopodiaceae	*Chenopodium desertorum* subsp. *desertorum* *Enchylaena tomentosa* *Maireana erioclada*

	Maireana radiata *Maireana suaedifolia* *Maireana trichoptera* *Rhagodia crassifolia* *Rhagodia preissii* subsp. *preissii* *Sclerolaena diacantha* *Tecticornia indica* subsp. *bidens*
Crassulaceae	*Crassula colorata* var. *acuminata*
Cupressaceae	*Callitris roei*
Cyperaceae	*Gahnia* sp. L (K.R. Newbey 7888) *Lepidosperma diurnum* *Lepidosperma fimbriatum* *Lepidosperma tenue*
Dilleniaceae	*Hibbertia exasperata*
Euphorbiaceae	*Beyeria* ?*sulcata*
Fabaceae	*Acacia acuminata* *Acacia binata* *Acacia cyclops* *Acacia eremophila* var. *eremophila* *Acacia erinacea* *Acacia glaucoptera* *Acacia lachnophylla* *Acacia lasiocalyx* *Acacia patagiata* *Daviesia nematophylla* **Melilotus indicus* *Senna artemisioides* subsp. *filifolia* *Senna artemisioides* subsp. *x artemisioides* *Templetonia battii* *Templetonia retusa* **Trifolium cernuum*
Goodeniaceae	*Goodenia affinis* *Scaevola spinescens*
Haloragaceae	*Gonocarpus nodulosus*
Lamiaceae	*Teucrium sessiliflorum*
Malvaceae	*Guichenotia ledifolia* *Thomasia foliosa*
Myrtaceae	*Callistemon phoeniceus* *Eucalyptus brachycalyx* *Eucalyptus calycogona* subsp. *calycogona*

	Eucalyptus celastroides subsp. *virella*
	Eucalyptus cernua
	Eucalyptus extensa
	Eucalyptus occidentalis
	Eucalyptus oleosa subsp. *corvina*
	Eucalyptus phenax subsp. *phenax*
	Eucalyptus salmonophloia
	Eucalyptus sp.
	Melaleuca acuminata subsp. *acuminata*
	Melaleuca halmaturorum
	Melaleuca hamulosa
	Melaleuca incana subsp. *tenella*
	Melaleuca torquata
	Melaleuca undulata
Orchidaceae	*Caladenia attingens* subsp. *gracillima*
	Caladenia hirta subsp. *rosea*
	Caladenia horistes
	Caladenia microchila
	Pterostylis sp. inland (A.C. Beauglehole 11880)
Oxalidaceae	*Oxalis perennans*
Phyllanthaceae	*Phyllanthus calycinus*
Plantaginaceae	*Plantago hispida*
Poaceae	*Austrostipa elegantissima*
	Austrostipa exilis
	Austrostipa flavescens
	**Ehrharta longiflora*
	Neurachne alopecuroidea
	**Pentameris airoides*
	**Schismus barbatus*
	Spartochloa scirpoidea
Primulaceae	**Lysimachia arvensis*
Proteaceae	*Grevillea oligantha*
	Grevillea pectinata
	Hakea commutata
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*
Ranunculaceae	*Clematis delicata*
Rubiaceae	**Galium murale*
Santalaceae	*Exocarpos aphyllus*
	Santalum acuminatum
	Santalum spicatum

Sapindaceae	*Dodonaea concinna*
	Dodonaea ptarmicaefolia
Scrophulariaceae	*Eremophila decipiens* subsp. *decipiens*
	Eremophila subfloccosa subsp. *glandulosa*
Solanaceae	**Lycium ferocissimum*
	Nicotiana rotundifolia
Violaceae	*Hybanthus floribundus*

Conservation Significant Taxa	=	0
Native Taxa	=	105
Introduced Taxa	=	16
Total Taxa	=	**121**

Appendix I: Raw Relevé Data Recorded in the Study Area

Site Name:	KR-001
Site Type:	AREA
Vegetation Type:	VT11
Survey Date:	05/09/2016
GPS Location:	GDA94 Zone 50 770740E 6273469N
Landform Type:	Drainage Line
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	N
Soil Type:	River sand (other)
Soil Colour:	Cream (other)
Rock Outcrop:	Granite, >50% bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	**Lycium ferocissimum*, *Melaleuca hamulosa*, *Melaleuca incana* subsp. *tenella*, *Melaleuca torquata*
Mid Stratum 1:	*Acacia patagiata*, *Beyeria* ?*sulcata*, *Dodonaea ptarmicaefolia*, *Melaleuca halmaturorum*
Mid Stratum 2:	*Gahnia* sp. L (K.R. Newbey 7888)
Lower Stratum 1:	**Cotula bipinnata*, *Disphyma crassifolium*, **Ehrharta longiflora*, **Lysimachia arvensis*, *Tecticornia indica* subsp. *bidens*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia lasiocalyx	0.7	0.2
Acacia patagiata	1	5
Beyeria ?sulcata	1.5	1
Callistemon phoeniceus	1.5	0.5
**Cotula bipinnata*	0.1	1
**Cotula coronopifolia*	0.1	0.1
Disphyma crassifolium	1	1
Dodonaea ptarmicaefolia	1	2

**Ehrharta longiflora*	0.4	0.5
Gahnia sp. L (K.R. Newbey 7888)	1.5	5
**Lycium ferocissimum*	1.7	2
**Lysimachia arvensis*	0.1	1
Melaleuca halmaturorum	1	2
Melaleuca hamulosa	2.5	2
Melaleuca incana subsp. *tenella*	2.5	10
Melaleuca torquata	2	2
Tecticornia indica subsp. *bidens*	0.5	0.5
**Ursinia anthemoides*	0.1	0.1

PHOTO

Site Name:	KR-002
Site Type:	AREA
Vegetation Type:	VT09
Survey Date:	05/09/2016
GPS Location:	GDA94 Zone 50 770750E 6273750N
Landform Type:	Mid Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	SW
Soil Type:	Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Upper Stratum 2:	*Eucalyptus brachycalyx*
Mid Stratum 1:	*Acacia acuminata*, *Callitris roei*
Mid Stratum 2:	*Daviesia nematophylla*, *Dodonaea ptarmicaefolia*
Lower Stratum 1:	*Eremophila decipiens* subsp. *decipiens*, *Grevillea oligantha*, *Rhagodia crassifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	5	35
Acacia erinacea	0.5	0.1
Alyxia buxifolia	1.2	0.2
Austrostipa elegantissima	0.6	0.1
Callitris roei	3	4
Clematis delicata		0.1
Daviesia nematophylla	2	15
Dodonaea ptarmicaefolia	2	5
Eremophila decipiens subsp. *decipiens*	0.5	15
Eucalyptus brachycalyx	8	15

Eucalyptus salmonophloia	14	15
Grevillea oligantha	0.7	4
Rhagodia crassifolia	0.5	4
Teucrium sessiliflorum	0.1	0.2

PHOTO

Site Name:	KR-003
Site Type:	AREA
Vegetation Type:	VT16
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770584E 6272541N
Landform Type:	Lower Slope
Slope Class:	Steep (23 degrees)
Aspect:	SE
Soil Type:	Clay Loam
Soil Colour:	Dark Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus extensa*
Mid Stratum 1:	*Dodonaea ptarmicaefolia*, *Templetonia retusa*
Lower Stratum 1:	*Enchylaena tomentosa*, *Hydrocotyle rugulosa*, **Lysimachia arvensis*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia glaucoptera	0.5	0.2
Dodonaea ptarmicaefolia	2.5	4
Enchylaena tomentosa	0.2	0.5
Eucalyptus extensa	8	80
Hydrocotyle rugulosa	0.1	1
**Lysimachia arvensis*	0.1	2
Oxalis perennans	0.1	0.1
Senecio glossanthus	0.1	0.1
Templetonia retusa	3	10

PHOTO

Site Name:	KR-004
Site Type:	AREA
Vegetation Type:	VT18
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770727E 6272552N
Landform Type:	Mid Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	N
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	20-50%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Dolerite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus extensa*
Mid Stratum 1:	*Acacia binata*
Lower Stratum 1:	*Enchylaena tomentosa*, *Rhagodia preissii* subsp. *preissii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia binata	2	30
Enchylaena tomentosa	0.5	5
Eucalyptus extensa	7	75
Rhagodia preissii subsp. *preissii*	0.5	1

PHOTO

Site Name:	KR-005
Site Type:	AREA
Vegetation Type:	VT17
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770661E 6272412N
Landform Type:	Upper Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	E
Soil Type:	Clay Loam
Soil Colour:	Red Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Dolerite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Mid Stratum 1:	*Acacia acuminata*, *Melaleuca acuminata* subsp. *acuminata*
Lower Stratum 1:	*Lepidosperma diurnum*
Lower Stratum 2:	*Hydrocotyle rugulosa*, *Trachymene ornata*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	7	80
Eucalyptus salmonophloia	9	4
Goodenia affinis	0.1	0.1
Hydrocotyle rugulosa	0.1	2
Lepidosperma diurnum	0.9	25
Melaleuca acuminata subsp. *acuminata*	2.5	1
Oxalis perennans	0.1	0.1
Senna artemisioides subsp. *x artemisioides*	0.7	0.5
Trachymene ornata	0.2	0.5
Waitzia suaveolens var. *flava*	0.2	0.1

PHOTO

Site Name:	KR-006
Site Type:	AREA
Vegetation Type:	VT19
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770655E 6272257N
Landform Type:	Gully/minor drainage line (other)
Slope Class:	Steep (23 degrees)
Aspect:	NE
Soil Type:	Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus celastroides* subsp. *virella*, *Eucalyptus extensa*
Mid Stratum 1:	*Acacia acuminata*, *Dodonaea ptarmicaefolia*, *Templetonia retusa*
Mid Stratum 2:	*Acacia glaucoptera*, *Daviesia nematophylla*
Lower Stratum 1:	*Lepidosperma diurnum*
Lower Stratum 2:	*Daucus glochidiatus*, *Goodenia affinis*, *Hydrocotyle rugulosa*, **Lysimachia arvensis*, *Oxalis perennans*, *Waitzia suaveolens* var. *flava*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	4	5
Acacia glaucoptera	1	5
Daucus glochidiatus	0.2	0.1
Daviesia nematophylla	1.4	2
Dodonaea ptarmicaefolia	3	8
Eucalyptus celastroides subsp. *virella*	8	20
Eucalyptus extensa	9	30
Goodenia affinis	0.1	0.2
Hydrocotyle rugulosa	0.1	1.5
Lepidosperma diurnum	0.7	4

**Lysimachia arvensis*	0.1	1
Oxalis perennans	0.1	0.2
Templetonia retusa	3	4
Waitzia suaveolens var. *flava*	0.1	0.2

PHOTO

Site Name:	KR-007
Site Type:	AREA
Vegetation Type:	VT20
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770622E 6272094N
Landform Type:	Top of valley/slope (other)
Slope Class:	Gently Inclined (3 degrees)
Aspect:	S
Soil Type:	Clay Loam
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Dolerite
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus celastroides* subsp. *virella*
Mid Stratum 1:	*Templetonia retusa*
Mid Stratum 2:	*Acacia glaucoptera*, *Dodonaea ptarmicaefolia*, *Exocarpos aphyllus*, *Grevillea oligantha*
Lower Stratum 1:	*Acacia erinacea*
Lower Stratum 2:	*Daucus glochidiatus*, *Hydrocotyle rugulosa*, **Lysimachia arvensis*, *Senecio glossanthus*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia erinacea	0.7	2
Acacia glaucoptera	1.2	25
Daucus glochidiatus	0.2	0.1
Dodonaea ptarmicaefolia	1.5	5
Eucalyptus celastroides subsp. *virella*	7	25
Exocarpos aphyllus	1.5	3
Grevillea oligantha	1.8	7
Hydrocotyle rugulosa	0.1	0.5
**Lysimachia arvensis*	0.1	0.5
Senecio glossanthus	0.1	0.1

Templetonia retusa	2.5	2

PHOTO

Site Name:	KR-008
Site Type:	AREA
Vegetation Type:	VT21
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770523E 6271977N
Landform Type:	Mid Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	S
Soil Type:	Clay Loam
Soil Colour:	Dark Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus phenax* subsp. *phenax*
Mid Stratum 1:	*Acacia acuminata*, *Allocasuarina campestris*, *Dodonaea ptarmicaefolia*
Mid Stratum 2:	*Lepidosperma diurnum*, *Spartochloa scirpoidea*
Lower Stratum 1:	*Cheilanthes sieberi* subsp. *sieberi*, *Goodenia affinis*, *Hydrocotyle rugulosa*, *Trachymene ornata*, *Waitzia suaveolens* var. *flava*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	5	80
Allocasuarina campestris	5	2
Cheilanthes sieberi subsp. *sieberi*	0.1	2
Dodonaea ptarmicaefolia	3	2
Eucalyptus phenax subsp. *phenax*	5	4
Goodenia affinis	0.1	0.1
Guichenotia ledifolia	1	0.5
Hibbertia exasperata	0.3	0.1
Hydrocotyle rugulosa	0.1	0.2
Lawrencella rosea	0.2	0.1
Lepidosperma diurnum	0.7	25
Phyllanthus calycinus	0.6	0.2

Spartochloa scirpoidea	0.9	2
Thomasia foliosa	0.2	0.1
Trachymene ornata	0.2	0.2
Waitzia suaveolens var. *flava*	0.1	0.1

PHOTO

Site Name:	KR-009
Site Type:	AREA
Vegetation Type:	VT18
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770534E 6271842N
Landform Type:	Hillock
Slope Class:	Steep (23 degrees)
Aspect:	N
Soil Type:	Light Clay
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus extensa*
Mid Stratum 1:	*Acacia binata*, *Daviesia nematophylla*
Lower Stratum 1:	*Acacia erinacea*, *Acacia glaucoptera*, *Enchylaena tomentosa*, *Rhagodia preissii* subsp. *preissii*, *Senna artemisioides* subsp. *x artemisioides*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia binata	1.8	25
Acacia erinacea	0.3	2
Acacia glaucoptera	0.4	4
Daviesia nematophylla	1.5	20
Enchylaena tomentosa	0.2	1
Eucalyptus extensa	7	45
Oxalis perennans	0.1	0.1
Rhagodia preissii subsp. *preissii*	0.4	1
Senna artemisioides subsp. *x artemisioides*	0.5	2

PHOTO

Site Name:	KR-010
Site Type:	AREA
Vegetation Type:	VT22
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770542E 6271719N
Landform Type:	Mid Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	N
Soil Type:	Clay Loam
Soil Colour:	Brown
Rock Outcrop:	Granite, <2% bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Dolerite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus celastroides* subsp. *virella*, *Eucalyptus cernua*
Mid Stratum 1:	*Acacia acuminata*
Lower Stratum 1:	*Cheilanthes sieberi* subsp. *sieberi*, *Phyllanthus calycinus*, *Senna artemisioides* subsp. *x artemisioides*, *Trachymene ornata*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	4	80
Cheilanthes sieberi subsp. *sieberi*	0.1	0.1
Eucalyptus celastroides subsp. *virella*	7	3
Eucalyptus cernua	7	2
Phyllanthus calycinus	0.4	0.1
Senna artemisioides subsp. *x artemisioides*	0.5	0.5
Trachymene ornata	0.1	0.1

PHOTO

Site Name:	KR-011
Site Type:	AREA
Vegetation Type:	VT23
Survey Date:	06/09/2016
GPS Location:	GDA94 Zone 50 770530E 6271606N
Landform Type:	Hillock
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	E
Soil Type:	Light Clay
Soil Colour:	Brown
Rock Outcrop:	Granite, <2% bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus cernua*
Mid Stratum 1:	*Exocarpos aphyllus*, *Hakea commutata*
Lower Stratum 1:	*Acacia glaucoptera*, *Senna artemisioides* subsp. *x artemisioides*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia glaucoptera	0.4	5
Eucalyptus cernua	6.5	80
Exocarpos aphyllus	2.5	5
Hakea commutata	2.2	1
Senna artemisioides subsp. *x artemisioides*	0.3	2

PHOTO

Site Name:	KR-012
Site Type:	AREA
Vegetation Type:	VT24
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770536E 6271462N
Landform Type:	Hillock
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	E
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus oleosa* subsp. *corvina*
Mid Stratum 1:	*Daviesia nematophylla*, *Santalum acuminatum*, *Templetonia retusa*
Mid Stratum 2:	*Rhagodia preissii* subsp. *preissii*, *Senna artemisioides* subsp. *x artemisioides*
Lower Stratum 1:	*Acacia glaucoptera*, *Carpobrotus modestus*, *Sclerolaena diacantha*
Lower Stratum 2:	*Crassula colorata* var. *acuminata*, **Hypochaeris glabra*, **Schismus barbatus*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
012-op05 Austro straight up	0.2	0.1
Acacia glaucoptera	0.4	3
Carpobrotus modestus		3
Crassula colorata var. *acuminata*	0.1	0.2
Daviesia nematophylla	3	20
Eucalyptus oleosa subsp. *corvina*	7	30
**Hypochaeris glabra*	0.1	0.2
**Lysimachia arvensis*	0.1	0.1
Plantago hispida	0.1	0.1
Rhagodia preissii subsp. *preissii*	1.2	10

Santalum acuminatum	2.5	1
**Schismus barbatus*	0.1	0.2
Sclerolaena diacantha	0.2	8
Senna artemisioides subsp. *x artemisioides*	1.1	5
Templetonia retusa	2.5	12

PHOTO

Site Name:	KR-013
Site Type:	AREA
Vegetation Type:	VT25
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770503E 6271333N
Landform Type:	Upper Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	SE
Soil Type:	Light Clay
Soil Colour:	Grey Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus cernua*, *Eucalyptus oleosa* subsp. *corvina*
Mid Stratum 1:	*Exocarpos aphyllus*, *Templetonia retusa*
Lower Stratum 1:	*Acacia glaucoptera*
Lower Stratum 2:	*Carpobrotus modestus*, *Enchylaena tomentosa*, *Rhagodia preissii* subsp. *preissii*, *Sclerolaena diacantha*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia glaucoptera	1.2	55
Carpobrotus modestus		1.5
Crassula colorata var. *acuminata*	0.1	0.5
Enchylaena tomentosa	0.6	2
Eremophila subfloccosa subsp. *glandulosa*	1.1	0.5
Eucalyptus cernua	8	5
Eucalyptus oleosa subsp. *corvina*	8	5
Exocarpos aphyllus	1.2	3
**Hypochaeris glabra*	0.1	0.1
Oxalis perennans	0.1	0.1
Plantago hispida	0.1	0.1
Rhagodia preissii subsp. *preissii*	0.5	2

Sclerolaena diacantha	0.2	2
Templetonia retusa	2.5	35

PHOTO

Site Name:	KR-014
Site Type:	AREA
Vegetation Type:	Ecotone of VT16/21/26
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770516E 6270859N
Landform Type:	Upper Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	S
Soil Type:	Light Clay
Soil Colour:	Grey Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	20-50%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus calycogona* subsp. *calycogona*, *Eucalyptus celastroides* subsp. *virella*, *Eucalyptus extensa*, *Eucalyptus occidentalis*, *Eucalyptus phenax* subsp. *phenax*
Mid Stratum 1:	*Templetonia retusa*
Mid Stratum 2:	*Hakea commutata*
Lower Stratum 1:	*Lepidosperma diurnum*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Eucalyptus calycogona subsp. *calycogona*	4.5	1
Eucalyptus celastroides subsp. *virella*	5	2
Eucalyptus extensa	8	1
Eucalyptus occidentalis	7	3
Eucalyptus phenax subsp. *phenax*	4	2
Hakea commutata	1.7	15
Lepidosperma diurnum	0.5	2
Templetonia retusa	2.5	40

PHOTO

Site Name:	KR-015
Site Type:	AREA
Vegetation Type:	VT26
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770458E 6270764N
Landform Type:	Mid Slope
Slope Class:	Very Steep (37 degrees)
Aspect:	S
Soil Type:	Light Clay
Soil Colour:	Brown
Rock Outcrop:	Granite, 2-10% bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Dolerite
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus extensa*, *Eucalyptus occidentalis*, *Eucalyptus salmonophloia*
Mid Stratum 1:	*Hakea commutata*, *Templetonia retusa*
Lower Stratum 1:	*Lepidosperma diurnum*, *Lepidosperma tenue*
Lower Stratum 2:	**Ehrharta longiflora*, **Galium murale*, *Hydrocotyle rugulosa*, **Hypochaeris glabra*, **Lysimachia arvensis*, *Oxalis perennans*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
**Ehrharta longiflora*	0.2	0.2
Eucalyptus extensa	12	20
Eucalyptus occidentalis	12	30
Eucalyptus salmonophloia	12	10
**Galium murale*	0.1	2
Hakea commutata	2.5	20
Hydrocotyle rugulosa	0.1	0.2
**Hypochaeris glabra*	0.1	0.2
Lepidosperma diurnum	0.3	1.5
Lepidosperma tenue	0.3	2.5
**Lysimachia arvensis*	0.1	2
Oxalis perennans	0.1	0.2

Templetonia retusa	3	12

PHOTO

Site Name:	KR-016
Site Type:	AREA
Vegetation Type:	VT27
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770220E 6270477N
Landform Type:	Hillock
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	N
Soil Type:	Clay Loam
Soil Colour:	Dark Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus cernua*, *Eucalyptus extensa*
Mid Stratum 1:	*Exocarpos aphyllus*
Mid Stratum 2:	*Rhagodia preissii* subsp. *preissii*, *Senna artemisioides* subsp. *x artemisioides*
Lower Stratum 1:	*Acacia glaucoptera*, *Carpobrotus modestus*, *Enchylaena tomentosa*, *Sclerolaena diacantha*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia glaucoptera	0.6	1
Carpobrotus modestus		1
Chenopodium desertorum subsp. *desertorum*	0.1	0.2
Crassula colorata var. *acuminata*	0.1	0.1
Enchylaena tomentosa	0.4	2.5
Eremophila subfloccosa subsp. *glandulosa*	1	0.1
Eucalyptus cernua	7	37
Eucalyptus extensa	7	37
Exocarpos aphyllus	2.2	2.5
**Lysimachia arvensis*	0.1	0.5

Oxalis perennans	0.1	0.1
Plantago hispida	0.1	0.1
Ptilotus spathulatus		0.1
Rhagodia preissii subsp. *preissii*	1	3.5
**Schismus barbatus*	0.1	0.1
Sclerolaena diacantha	0.1	0.5
Senecio glossanthus	0.2	0.1
Senna artemisioides subsp. *x artemisioides*	1.1	4

PHOTO

Site Name:	KR-017
Site Type:	AREA
Vegetation Type:	VT10
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770668E 6273475N
Landform Type:	Lower Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	S
Soil Type:	Light Clay
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia acuminata*, *Dodonaea ptarmicaefolia*
Mid Stratum 1:	*Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia*, *Senna artemisioides* subsp. *x artemisioides*
Lower Stratum 1:	*Cheilanthes sieberi* subsp. *sieberi*, **Ehrharta longiflora*, *Lawrencella rosea*, *Oxalis perennans*, *Pterostylis* sp. inland (A.C. Beauglehole 11880), *Trachymene ornata*, **Ursinia anthemoides*, *Waitzia suaveolens* var. *flava*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	5.5	55
Cheilanthes sieberi subsp. *sieberi*	0.1	0.1
Daucus glochidiatus	0.1	0.1
Dodonaea ptarmicaefolia	3	25
**Ehrharta longiflora*	0.2	0.2
Eremophila decipiens subsp. *decipiens*	0.3	3
Lagenophora huegelii	0.1	0.1
Lawrencella rosea	0.2	0.2
**Lysimachia arvensis*	0.1	0.1
Neurachne alopecuroidea	0.1	0.1
Oxalis perennans	0.1	0.2

Pterostylis sp. inland (A.C. Beauglehole 11880)	0.1	0.1
Rhagodia crassifolia	0.7	4
Senna artemisioides subsp. *x artemisioides*	0.3	1
Trachymene ornata	0.1	0.1
**Ursinia anthemoides*	0.1	0.1
Waitzia suaveolens var. *flava*	0.2	0.2

PHOTO

Site Name:	KR-018
Site Type:	AREA
Vegetation Type:	VT08
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770575E 6273625N
Landform Type:	Simple Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	SE
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Light Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm, 6-20mm
CF Types:	Granite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Upper Stratum 2:	*Eucalyptus brachycalyx*
Mid Stratum 1:	*Acacia binata*, *Olearia* ?*cassiniae*, *Senna artemisioides* subsp. *filifolia*
Lower Stratum 1:	*Acacia erinacea*, *Enchylaena tomentosa*, *Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri*, *Rhagodia crassifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
012-op05 Austro straight up	0.3	0.5
Acacia binata	1.8	8
Acacia erinacea	0.3	2
Austrostipa flavescens	0.8	0.1
Enchylaena tomentosa	0.3	3
Eremophila decipiens subsp. *decipiens*	0.4	2
Eucalyptus brachycalyx	6	4
Eucalyptus salmonophloia	16	20
Olearia ?*cassiniae*	1.9	1.5
Olearia muelleri	0.9	20
Rhagodia crassifolia	0.8	6
Senna artemisioides subsp. *filifolia*	1.8	5

Vittadinia dissecta var. *hirta*	0.1	0.1

PHOTO

Site Name:	KR-019
Site Type:	AREA
Vegetation Type:	Ecotone between VT 5 and VT9
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770717E 6273768N
Landform Type:	Mid Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	S
Soil Type:	Clay Loam
Soil Colour:	Dark Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm, 6-20mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Upper Stratum 2:	*Eucalyptus brachycalyx*
Mid Stratum 1:	*Acacia acuminata*, *Dodonaea ptarmicaefolia*
Lower Stratum 1:	*Eremophila decipiens* subsp. *decipiens*, *Grevillea oligantha*, *Rhagodia crassifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	4.5	72
Alyxia buxifolia	2	0.1
Austrostipa flavescens	0.5	0.1
Dodonaea ptarmicaefolia	2.2	10
Eremophila decipiens subsp. *decipiens*	0.6	15
Eucalyptus brachycalyx	5	4
Eucalyptus salmonophloia	11	4
Grevillea oligantha	0.9	2
Lepidosperma diurnum	0.4	0.5
Oxalis perennans	0.1	0.1
Rhagodia crassifolia	0.8	8
Waitzia suaveolens var. *flava*	0.1	0.1

PHOTO

Site Name:	KR-020
Site Type:	AREA
Vegetation Type:	VT07
Survey Date:	07/09/2016
GPS Location:	GDA94 Zone 50 770726E 6273878N
Landform Type:	Mid Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	SE
Soil Type:	Light Clay
Soil Colour:	Grey Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Upper Stratum 2:	*Eucalyptus brachycalyx*
Mid Stratum 1:	*Acacia cyclops*, *Santalum acuminatum*
Mid Stratum 2:	*Senna artemisioides* subsp. *filifolia*
Lower Stratum 1:	*Maireana erioclada*, *Olearia muelleri*, *Rhagodia crassifolia*
Lower Stratum 2:	*012-op05 Austro straight up*, *020-06 Astro rough*, *Asteridea athrixioides*, **Lysimachia arvensis*, *Omphalolappula concava*, *Vittadinia australasica* var. *australasica*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
012-op05 Austro straight up	0.2	1
020-06 Astro rough	0.2	2
Acacia cyclops	4	5
Acacia lachnophylla	0.5	0.1
Asteridea athrixioides	0.1	4
Daucus glochidiatus	0.1	0.1
Eucalyptus brachycalyx	9	8
Eucalyptus salmonophloia	18	9

**Lysimachia arvensis*	0.1	70
Maireana erioclada	0.3	1
Maireana radiata	0.3	0.1
Olearia muelleri	0.5	2
Omphalolappula concava	0.1	0.5
Oxalis perennans	0.1	0.1
Rhagodia crassifolia	0.7	4
Santalum acuminatum	4	8
Senna artemisioides subsp. *filifolia*	1.5	35
Vittadinia australasica var. *australasica*	0.1	1

PHOTO

Site Name:	KR-021
Site Type:	AREA
Vegetation Type:	VT13
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770894E 6273395N
Landform Type:	Simple Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	N
Soil Type:	Clay Loam
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus brachycalyx*, *Eucalyptus oleosa* subsp. *corvina*
Mid Stratum 1:	*Dodonaea ptarmicaefolia*, *Senna artemisioides* subsp. *filifolia*
Lower Stratum 1:	*020-06 Astro rough*, *Acacia erinacea*, *Maireana erioclada*, *Maireana suaedifolia*, *Olearia muelleri*, *Rhagodia crassifolia*, *Rhagodia preissii* subsp. *preissii*, *Sclerolaena diacantha*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
020-06 Astro rough	0.2	1
Acacia erinacea	0.5	8
Alyxia buxifolia	1.7	0.2
Dodonaea ptarmicaefolia	1.3	2
Eucalyptus brachycalyx	8	45
Eucalyptus oleosa subsp. *corvina*	8	23
Maireana erioclada	0.2	1
Maireana suaedifolia	0.5	2
Olearia muelleri	0.8	20
Oxalis perennans	0.1	0.5
Ptilotus holosericeus		0.2
Rhagodia crassifolia	0.6	1

Rhagodia preissii subsp. *preissii*	0.4	3
Sclerolaena diacantha	0.1	1
Senna artemisioides subsp. *filifolia*	1.5	7

PHOTO

Site Name:	KR-022
Site Type:	AREA
Vegetation Type:	VT12
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770718E 6273269N
Landform Type:	Mid Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	NW
Soil Type:	Sandy Clay (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Mid Stratum 1:	*Acacia acuminata*, *Dodonaea ptarmicaefolia*, *Santalum spicatum*
Lower Stratum 1:	*Eremophila decipiens* subsp. *decipiens*, *Olearia muelleri*, *Rhagodia crassifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
012-op05 Austro straight up	0.2	0.5
Acacia acuminata	5	75
Dodonaea ptarmicaefolia	2.5	7
Eremophila decipiens subsp. *decipiens*	0.3	3
Eucalyptus salmonophloia	20	8
Olearia muelleri	0.6	1
Rhagodia crassifolia	0.8	5
Santalum spicatum	3.5	5
Waitzia suaveolens var. *flava*	0.1	0.2

PHOTO

Site Name:	KR-023
Site Type:	AREA
Vegetation Type:	VT10
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770617E 6273297N
Landform Type:	Lower Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	NW
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia acuminata*, *Dodonaea ptarmicaefolia*
Mid Stratum 1:	*Senna artemisioides* subsp. *filifolia*
Lower Stratum 1:	*Enchylaena tomentosa*, *Rhagodia crassifolia*, *Rhagodia preissii* subsp. *preissii*
Lower Stratum 2:	*Cheilanthes sieberi* subsp. *sieberi*, *Nicotiana rotundifolia*, *Trachymene ornata*, *Waitzia suaveolens* var. *flava*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia acuminata	5.5	80
Cheilanthes sieberi subsp. *sieberi*	0.1	2
Dodonaea ptarmicaefolia	3	5
Enchylaena tomentosa	0.2	1
Gonocarpus nodulosus	0.1	25
Nicotiana rotundifolia	0.2	2
Rhagodia crassifolia	0.4	1
Rhagodia preissii subsp. *preissii*	0.4	1
Senna artemisioides subsp. *filifolia*	0.5	1
Trachymene ornata	0.1	0.1
Waitzia suaveolens var. *flava*	0.2	0.5

PHOTO

Site Name:	KR-024
Site Type:	AREA
Vegetation Type:	VT14
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770592E 6273052N
Landform Type:	Upper Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	N
Soil Type:	Clay Loam
Soil Colour:	Brown
Rock Outcrop:	Dolerite, <2% bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Dolerite
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus oleosa* subsp. *corvina*, *Eucalyptus salmonophloia*
Mid Stratum 1:	*Dodonaea concinna*, *Dodonaea ptarmicaefolia*, *Senna artemisioides* subsp. *filifolia*
Lower Stratum 1:	*Eremophila decipiens* subsp. *decipiens*, *Maireana radiata*, *Rhagodia crassifolia*, *Sclerolaena diacantha*
Lower Stratum 2:	**Centaurea melitensis*, *Crassula colorata* var. *acuminata*, **Lysimachia arvensis*, **Schismus barbatus*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Alyxia buxifolia	1.8	0.5
Asteridea athrixioides	0.1	0.1
**Centaurea melitensis*	0.2	1
Crassula colorata var. *acuminata*	0.1	1
Dodonaea concinna	1.7	4
Dodonaea ptarmicaefolia	1.8	2
Eremophila decipiens subsp. *decipiens*	0.6	3
Eucalyptus oleosa subsp. *corvina*	14	20
Eucalyptus salmonophloia	20	5
**Hypochaeris glabra*	0.1	0.1

**Lysimachia arvensis*	0.2	1
Maireana radiata	0.3	60
Oxalis perennans	0.1	0.1
Ptilotus holosericeus		0.2
Rhagodia crassifolia	0.6	5
Scaevola spinescens	0.9	0.5
**Schismus barbatus*	0.1	5
Sclerolaena diacantha	0.3	60
Senna artemisioides subsp. *filifolia*	1.6	20

PHOTO

Site Name:	KR-025
Site Type:	AREA
Vegetation Type:	VT15
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770797E 6272915N
Landform Type:	Upper Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	SE
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Dolerite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Upper Stratum 2:	*Eucalyptus extensa*, *Eucalyptus oleosa* subsp. *corvina*
Mid Stratum 1:	*Acacia binata*, *Dodonaea ptarmicaefolia*
Lower Stratum 1:	*Acacia erinacea*, *Maireana suaedifolia*, *Olearia muelleri*, *Rhagodia crassifolia*, *Sclerolaena diacantha*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia binata	1.1	3
Acacia erinacea	0.4	7
Dodonaea ptarmicaefolia	1.5	5
Enchylaena tomentosa	0.2	0.5
Eucalyptus extensa	9	7
Eucalyptus oleosa subsp. *corvina*	9	3
Eucalyptus salmonophloia	25	20
Maireana suaedifolia	0.3	1
Olearia muelleri	0.6	2
Ptilotus holosericeus		0.1
Rhagodia crassifolia	0.3	1
Sclerolaena diacantha	0.1	0.5

PHOTO

Site Name:	KR-026
Site Type:	AREA
Vegetation Type:	VT05
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770777E 6274317N
Landform Type:	Upper Slope
Slope Class:	Steep (23 degrees)
Aspect:	S
Soil Type:	Clay Loam
Soil Colour:	Brown
Rock Outcrop:	Dolerite, 2-10% bedrock exposed
CF Abundance:	10-20%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Dolerite
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Mid Stratum 1:	*Acacia acuminata*, *Eremophila decipiens* subsp. *decipiens*, *Santalum spicatum*, *Templetonia retusa*
Lower Stratum 1:	*Olearia muelleri*, *Rhagodia crassifolia*, *Senna artemisioides* subsp. *filifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
020-06 Astro rough	0.2	0.5
Acacia acuminata	4.5	25
Eremophila decipiens subsp. *decipiens*	0.3	10
Eucalyptus salmonophloia	25	25
Hybanthus floribundus	1	0.5
Lepidosperma diurnum	0.5	0.2
Olearia muelleri	0.5	2
Rhagodia crassifolia	0.3	1
Santalum spicatum	2.5	2
Senna artemisioides subsp. *filifolia*	0.5	1
Templetonia retusa	2.5	20
Teucrium sessiliflorum	0.1	0.1
Thysanotus patersonii		0.1

PHOTO

Site Name:	KR-027
Site Type:	AREA
Vegetation Type:	VT06
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770913E 6273947N
Landform Type:	Lower Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	S
Soil Type:	Sandy Clay (other)
Soil Colour:	Grey Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 1 - Pristine
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus brachycalyx*, *Eucalyptus oleosa* subsp. *corvina*
Lower Stratum 1:	*Olearia muelleri*, *Rhagodia crassifolia*, *Sclerolaena diacantha*, *Senna artemisioides* subsp. *filifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
012-op05 Austro straight up	0.2	0.7
Asteridea athrixioides	0.1	0.2
Eucalyptus brachycalyx	10	12
Eucalyptus oleosa subsp. *corvina*	10	25
Olearia muelleri	0.7	30
Ptilotus holosericeus		0.1
Rhagodia crassifolia	0.5	2
Sclerolaena diacantha	0.8	5
Senna artemisioides subsp. *filifolia*	0.8	3
Vittadinia australasica var. *australasica*	0.2	0.1

PHOTO

Site Name:	KR-028
Site Type:	AREA
Vegetation Type:	VT04
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770575E 6274150N
Landform Type:	Mid Slope
Slope Class:	Steep (23 degrees)
Aspect:	S
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Mid Stratum 1:	*Acacia binata*, *Daviesia nematophylla*, *Santalum acuminatum*, *Templetonia retusa*
Lower Stratum 1:	*Disphyma crassifolium*, *Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia*, *Senna artemisioides* subsp. *filifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia binata	2.5	15
Daviesia nematophylla	2.1	2
Disphyma crassifolium	0.1	1
**Ehrharta longiflora*	0.2	0.5
Eremophila decipiens subsp. *decipiens*	0.3	7
Eucalyptus salmonophloia	28	28
**Galium murale*	0.1	0.2
Maireana suaedifolia	0.3	0.1
Oxalis perennans	0.1	0.2
Plantago hispida	0.1	0.1
Rhagodia crassifolia	6	3
Santalum acuminatum	3	1

Senecio glossanthus	0.2	0.1
Senna artemisioides subsp. *filifolia*	0.5	1
**Sonchus oleraceus*	0.1	0.1
Templetonia battii	0.3	0.2
Templetonia retusa	2.5	2

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Site Name:	KR-029
Site Type:	AREA
Vegetation Type:	VT02
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770725E 6274357N
Landform Type:	Crest
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	S
Soil Type:	Clay Loam
Soil Colour:	Dark Brown (other)
Rock Outcrop:	Granite, 2-10% bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Granite
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Mid Stratum 1:	*Allocasuarina huegeliana*, *Dodonaea ptarmicaefolia*
Lower Stratum 1:	*Eremophila decipiens* subsp. *decipiens*, *Rhagodia crassifolia*, *Thomasia foliosa*
Lower Stratum 2:	*Cheilanthes sieberi* subsp. *sieberi*, *Gonocarpus nodulosus*, *Lawrencella rosea*, *Waitzia suaveolens* var. *flava*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
020-06 Astro rough	0.2	0.2
Acacia acuminata	8	30
Allocasuarina huegeliana	5	5
Cheilanthes sieberi subsp. *sieberi*	0.1	5
Dodonaea ptarmicaefolia	3.5	3
**Ehrharta longiflora*	0.2	0.1
Enchylaena tomentosa	0.4	0.3
Eremophila decipiens subsp. *decipiens*	0.7	7
Eucalyptus salmonophloia	18	4
Gonocarpus nodulosus	0.1	30
Lawrencella rosea	0.2	2

Neurachne alopecuroidea	0.2	0.2
Nicotiana rotundifolia	0.1	0.1
Rhagodia crassifolia	0.5	2
Thomasia foliosa	0.3	1
Trachymene ornata	0.1	0.2
**Ursinia anthemoides*	0.1	
Waitzia suaveolens var. *flava*	0.2	5

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Site Name:	KR-030
Site Type:	AREA
Vegetation Type:	VT03
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770842E 6274618N
Landform Type:	Minor gully (other)
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	E
Soil Type:	Sandy Clay Loam (other)
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Dolerite, Quartz (other)
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus salmonophloia*
Mid Stratum 1:	*Eucalyptus oleosa* subsp. *corvina*
Mid Stratum 2:	*Acacia binata*, *Dodonaea ptarmicaefolia*
Lower Stratum 1:	*Enchylaena tomentosa*, *Eremophila decipiens* subsp. *decipiens*, *Maireana trichoptera*, *Olearia muelleri*, *Rhagodia crassifolia*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
020-06 Astro rough	0.1	0.1
Acacia binata	2.1	4
Crassula colorata var. *acuminata*	0.1	0.1
Disphyma crassifolium		2
Dodonaea ptarmicaefolia	2.5	7
Enchylaena tomentosa	0.3	1
Eremophila decipiens subsp. *decipiens*	0.4	1
Eucalyptus oleosa subsp. *corvina*	9	2
Eucalyptus salmonophloia	25	9
**Lysimachia arvensis*	0.1	0.1
Maireana trichoptera	0.2	2
Olearia muelleri	0.5	6

Oxalis perennans	0.1	0.1
Podolepis rugata subsp. *rugata*	0.3	0.1
Rhagodia crassifolia	0.4	4
Sclerolaena diacantha	0.1	2

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Site Name:	KR-031
Site Type:	AREA
Vegetation Type:	VT01
Survey Date:	08/09/2016
GPS Location:	GDA94 Zone 50 770651E 6274879N
Landform Type:	Simple Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	E
Soil Type:	Clay Loam
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 5 - Degraded
Fire:	>5 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia binata*
Lower Stratum 1:	*Eremophila decipiens* subsp. *decipiens*
Lower Stratum 2:	**Arctotheca calendula*, **Centaurea melitensis*, *Crassula colorata* var. *acuminata*, **Lysimachia arvensis*, *Maireana trichoptera*, **Melilotus indicus*, *Sclerolaena diacantha*, **Trifolium cernuum*, *Vittadinia gracilis*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia binata	0.7	2
**Arctotheca calendula*	0.2	15
**Carrichtera annua*	0.2	0.1
**Centaurea melitensis*	0.4	10
Crassula colorata var. *acuminata*	0.1	3
Eremophila decipiens subsp. *decipiens*	0.4	2
**Lysimachia arvensis*	0.2	10
Maireana trichoptera	0.2	20
**Melilotus indicus*	0.1	2
**Pentameris airoides*	0.1	0.1
Sclerolaena diacantha	0.1	1
Senecio glossanthus	0.1	0.1
Trachymene ornata	0.1	0.1
**Trifolium cernuum*	0.1	1
Vittadinia gracilis	0.3	40

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Appendix J: Site by Species Recorded in the Study Area

Taxon	KR-001	KR-002	KR-003	KR-004	KR-005	KR-006	KR-007	KR-008	KR-009	KR-010	KR-011	KR-012	KR-013	KR-014	KR-015	KR-016
Acacia acuminata		X			X	X		X		X						
Acacia binata				X					X							
Acacia cyclops																
Acacia erinacea		X					X		X							
Acacia glaucoptera			X			X	X		X		X	X	X			X
Acacia lachnophylla																
Acacia lasiocalyx	X															
Acacia patagiata	X															
Allocasuarina campestris								X								
Allocasuarina huegeliana																
Alyxia buxifolia		X														
**Arctotheca calendula*																
Asteridea athrixioides																
Austrostipa elegantissima		X														
Austrostipa exilis												X				
Austrostipa flavescens																
Beyeria ?sulcata	X															
Callistemon phoeniceus	X															
Callitris roei		X														
Carpobrotus modestus												X	X			X
**Carrichtera annua*																
**Centaurea melitensis*																
Cheilanthes sieberi subsp. *sieberi*								X		X						
Chenopodium desertorum subsp.																X

Taxon	KR-001	KR-002	KR-003	KR-004	KR-005	KR-006	KR-007	KR-008	KR-009	KR-010	KR-011	KR-012	KR-013	KR-014	KR-015	KR-016
desertorum																
Clematis delicata		X														
**Cotula bipinnata*	X															
**Cotula coronopifolia*	X															
Crassula colorata var. *acuminata*												X	X			X
Daucus glochidiatus						X	X									
Daviesia nematophylla		X				X			X			X				
Disphyma crassifolium	X															
Dodonaea concinna																
Dodonaea ptarmicaefolia	X	X	X			X	X	X								
**Ehrharta longiflora*	X														X	
Enchylaena tomentosa			X	X					X				X			X
Eremophila decipiens subsp. *decipiens*		X														
Eremophila subfloccosa subsp. *glandulosa*													X			X
Eucalyptus brachycalyx		X														
Eucalyptus calycogona subsp. *calycogona*														X		
Eucalyptus celastroides subsp. *virella*						X	X			X				X		
Eucalyptus cernua										X	X		X			X
Eucalyptus extensa			X	X		X			X					X	X	X
Eucalyptus occidentalis														X	X	
Eucalyptus oleosa subsp. *corvina*												X	X			
Eucalyptus phenax subsp. *phenax*								X						X		
Eucalyptus salmonophloia		X			X										X	
Exocarpos aphyllus							X				X		X			X
Gahnia sp. L (K.R. Newbey 7888)	X															

Taxon	KR-001	KR-002	KR-003	KR-004	KR-005	KR-006	KR-007	KR-008	KR-009	KR-010	KR-011	KR-012	KR-013	KR-014	KR-015	KR-016
**Galium murale*															X	
Gonocarpus nodulosus																
Goodenia affinis					X	X		X								
Grevillea oligantha		X					X									
Guichenotia ledifolia								X								
Hakea commutata											X			X	X	
Hibbertia exasperata								X								
Hybanthus floribundus																
Hydrocotyle rugulosa			X		X	X	X	X							X	
**Hypochaeris glabra*												X	X		X	
Lagenophora huegelii																
Lawrencella rosea								X								
Lepidosperma diurnum					X	X		X						X	X	
Lepidosperma tenue															X	
**Lycium ferocissimum*	X															
**Lysimachia arvensis*	X		X			X	X					X			X	X
Maireana erioclada																
Maireana radiata																
Maireana suaedifolia																
Maireana trichoptera																
Melaleuca acuminata subsp. *acuminata*					X											
Melaleuca halmaturorum	X															
Melaleuca hamulosa	X															
Melaleuca incana subsp. *tenella*	X															
Melaleuca torquata	X															
**Melilotus indicus*																

Taxon	KR-001	KR-002	KR-003	KR-004	KR-005	KR-006	KR-007	KR-008	KR-009	KR-010	KR-011	KR-012	KR-013	KR-014	KR-015	KR-016
Neurachne alopecuroidea																
Nicotiana rotundifolia																
Olearia ?cassiniae																
Olearia muelleri																
Omphalolappula concava																
Oxalis perennans			X		X	X			X				X		X	X
**Pentameris airoides*																
Phyllanthus calycinus								X		X						
Plantago hispida												X	X			X
Podolepis rugata subsp. *rugata*																
Pterostylis sp. inland (A.C. Beauglehole 11880)																
Ptilotus holosericeus																
Ptilotus spathulatus																X
Rhagodia crassifolia		X														
Rhagodia preissii subsp. *preissii*				X					X			X	X			X
Santalum acuminatum												X				
Santalum spicatum																
Scaevola spinescens																
**Schismus barbatus*												X				X
Sclerolaena diacantha												X	X			X
Senecio glossanthus			X				X									X
Senna artemisioides subsp. *filifolia*																
Senna artemisioides subsp. *x artemisioides*					X				X	X	X	X				X
**Sonchus oleraceus*																
Spartochloa scirpoidea								X								

Taxon	KR-001	KR-002	KR-003	KR-004	KR-005	KR-006	KR-007	KR-008	KR-009	KR-010	KR-011	KR-012	KR-013	KR-014	KR-015	KR-016
Tecticornia indica subsp. *bidens*	X															
Templetonia battii																
Templetonia retusa			X			X	X					X	X	X	X	
Teucrium sessiliflorum		X														
Thomasia foliosa								X								
Thysanotus patersonii																
Trachymene ornata					X			X		X						
**Trifolium cernuum*																
**Ursinia anthemoides*	X															
Vittadinia australasica var. *australasica*																
Vittadinia dissecta var. *hirta*																
Vittadinia gracilis																
Waitzia suaveolens var. *flava*					X	X		X								

Taxon	KR-017	KR-018	KR-019	KR-020	KR-021	KR-022	KR-023	KR-024	KR-025	KR-026	KR-027	KR-028	KR-029	KR-030	KR-031
Acacia acuminata	X		X			X	X			X			X		
Acacia binata		X							X			X		X	X
Acacia cyclops				X											
Acacia erinacea		X			X				X						
Acacia glaucoptera															
Acacia lachnophylla				X											
Acacia lasiocalyx															
Acacia patagiata															
Allocasuarina campestris															
Allocasuarina huegeliana													X		
Alyxia buxifolia			X		X			X							
**Arctotheca calendula*															X
Asteridea athrixioides				X				X			X				
Austrostipa elegantissima															
Austrostipa exilis		X		X	X	X				X	X		X	X	
Austrostipa flavescens		X	X												
Beyeria ?sulcata															
Callistemon phoeniceus															
Callitris roei															
Carpobrotus modestus															
**Carrichtera annua*															X
**Centaurea melitensis*								X							X
Cheilanthes sieberi subsp. *sieberi*	X						X						X		
Chenopodium desertorum subsp. *desertorum*															
Clematis delicata															
**Cotula bipinnata*															

**Cotula coronopifolia*															
Crassula colorata var. *acuminata*								X						X	X
Daucus glochidiatus	X			X											
Daviesia nematophylla												X			
Disphyma crassifolium												X		X	
Dodonaea concinna								X							
Dodonaea ptarmicaefolia	X		X		X	X	X	X	X				X	X	
**Ehrharta longiflora*	X											X	X		
Enchylaena tomentosa		X					X		X				X	X	
Eremophila decipiens subsp. *decipiens*	X	X	X			X		X		X		X	X	X	X
Eremophila subfloccosa subsp. *glandulosa*															
Eucalyptus brachycalyx		X	X	X	X						X				
Eucalyptus calycogona subsp. *calycogona*															
Eucalyptus celastroides subsp. *virella*															
Eucalyptus cernua															
Eucalyptus extensa									X						
Eucalyptus occidentalis															
Eucalyptus oleosa subsp. *corvina*					X			X	X		X			X	
Eucalyptus phenax subsp. *phenax*															
Eucalyptus salmonophloia		X	X	X		X		X	X	X		X	X	X	
Exocarpos aphyllus															
Gahnia sp. L (K.R. Newbey 7888)															
**Galium murale*												X			
Gonocarpus nodulosus							X						X		
Goodenia affinis															
Grevillea oligantha			X												
Guichenotia ledifolia															
Hakea commutata															

Hibbertia exasperata															
Hybanthus floribundus										X					
Hydrocotyle rugulosa															
**Hypochaeris glabra*								X							
Lagenophora huegelii	X														
Lawrencella rosea	X												X		
Lepidosperma diurnum			X							X					
Lepidosperma tenue															
**Lycium ferocissimum*															
**Lysimachia arvensis*	X			X				X						X	X
Maireana erioclada				X	X										
Maireana radiata				X				X							
Maireana suaedifolia					X				X			X			
Maireana trichoptera														X	X
Melaleuca acuminata subsp. *acuminata*															
Melaleuca halmaturorum															
Melaleuca hamulosa															
Melaleuca incana subsp. *tenella*															
Melaleuca torquata															
**Melilotus indicus*															X
Neurachne alopecuroidea	X												X		
Nicotiana rotundifolia							X						X		
Olearia ?cassiniae		X													
Olearia muelleri		X		X	X	X			X	X	X			X	
Omphalolappula concava				X											
Oxalis perennans	X		X	X	X			X				X		X	
**Pentameris airoides*															X
Phyllanthus calycinus															

Plantago hispida												X			
Podolepis rugata subsp. *rugata*														X	
Pterostylis sp. inland (A.C. Beauglehole 11880)	X														
Ptilotus holosericeus					X			X	X		X				
Ptilotus spathulatus															
Rhagodia crassifolia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Rhagodia preissii subsp. *preissii*					X		X								
Santalum acuminatum				X								X			
Santalum spicatum						X				X					
Scaevola spinescens								X							
**Schismus barbatus*								X							
Sclerolaena diacantha					X			X	X		X			X	X
Senecio glossanthus												X			X
Senna artemisioides subsp. *filifolia*		X		X	X		X	X		X	X	X			
Senna artemisioides subsp. *x artemisioides*	X														
**Sonchus oleraceus*												X			
Spartochloa scirpoidea															
Tecticornia indica subsp. *bidens*															
Templetonia battii												X			
Templetonia retusa										X		X			
Teucrium sessiliflorum										X					
Thomasia foliosa													X		
Thysanotus patersonii										X					
Trachymene ornata	X						X						X		X
**Trifolium cernuum*															X
**Ursinia anthemoides*	X												X		
Vittadinia australasica var. *australasica*				X							X				

Vittadinia dissecta var. *hirta*		X													
Vittadinia gracilis															X
Waitzia suaveolens var. *flava*	X		X			X	X						X		

Appendix B: Bamford Consulting Ecologists Fauna Assessment 2016

Kingston Resources Ravensthorpe
Mt Cattlin Project
Fauna Assessment

View towards the Fitzgeralds from south of project area (photo: Mike Bamford)

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Prepared by: Mike Bamford, Natalia Huang and Joys Tan.
M.J. & A.R. Bamford Consulting Ecologists,
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21st October 2016

Executive summary

Bamford Consulting Ecologists (BCE) was commissioned by Woodman Environmental for Kingston Resources Ltd to conduct a Level 1 fauna impact assessment (desktop review and site inspection) for proposed lithium exploration in the Ravensthorpe area (Mt Cattlin Project). BCE uses an impact assessment process with the following components:

- The identification of **fauna values**:
    - Assemblage characteristics: uniqueness, completeness and richness;
    - Species of conservation significance;
    - Recognition of vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
    - Patterns of biodiversity across the landscape;
    - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
    - Habitat loss leading to population decline;
    - Habitat loss leading to population fragmentation;
    - Degradation of habitat due to weed invasion leading to population decline;
    - Ongoing mortality from operations;
    - Species interactions including feral and overabundant native species;
    - Hydrological change;
    - Altered fire regimes; and
    - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts.

The fauna investigations were based on a desktop assessment and field surveys in September 2016. The desktop assessment identified 250 vertebrate fauna species as potentially occurring in the site: four fish, ten frogs, 41 reptiles, 164 birds, 26 native and five introduced mammals. However, three bird and three mammal species are considered locally extinct, leaving a current vertebrate assemblage of 244 species. A total of 68 vertebrate species were recorded during the field survey: one fish, four reptiles, 52 birds and five native mammals. The vertebrate assemblage includes up to 45 species of conservation significance.

Key fauna values are:

Fauna assemblage. Largely intact but with some mammals and birds locally extinct. The assemblage is likely to be typical of the Esperance Plains Bioregion, but of note is the presence of many south-western species at the eastern edge of their range.

Species of conservation significance. A large number of significant species likely to occur as residents of the survey area, or at least as regular visitors. Many occur at the eastern edge of their range in the Ravensthorpe area, making their presence in the survey area more significant as populations on the edge of a species' range are often less abundant and more vulnerable to extinction than populations at the centre of the range (Curnutt *et al.* 1996). Significant species of note that are likely to occur in the survey area regularly include Carnaby's Black-Cockatoo, Malleefowl, Western Whipbird, Chuditch, Red-tailed Phascogale and Brush Wallaby. Carnaby's Black-Cockatoo was observed mostly in areas of Salmon Gum where the species is very likely to breed, while several old Malleefowl mounds were found. Sightings of Malleefowl, Chuditch and the Western Whipbird were reported nearby in the last six

months. There is the possibility of short range endemic invertebrates along drainage lines and in VSA 5 which appears to have persistently moist soils on a southward facing slope.

Vegetation and Substrate Associations (VSAs). The project area supports intact native vegetation across a landscape of undulating hills and valleys, and five VSAs were identified. Most of the survey area contains mallee eucalypt woodland over a sparse understorey on brown loam (VSA 3), and low Acacia forest over sparse understorey on red-brown loam (VSA 4). There are areas of open Salmon Gum woodland over dense Acacia on brown loam (VSA 1) on hills and valleys, with large Salmon Gums a feature of the northernmost part of the survey area (mostly north of Phillips River). Phillips River and associated intact riparian vegetation (VSA 2), comprising of Melaleuca and samphire, passes west-east through the northern part of the survey area. This VSA includes minor, seasonal drainage lines. Minor drainage lines are fresh but the river itself is brackish, and all waters are gilvin stained and thus probably acidic. A small area of Acacia and mixed shrub thickets on brown loam with some exposed rock (granite) and moist soils (VSA 5) occurs in the south, on a southward facing slope. All VSAs are considered important for fauna, with large Salmon Gums providing important nesting opportunities for fauna such as Carnaby's Black-Cockatoo and the Red-tailed Phascogale. The project area does not include sandplain heaths that are an important feature of the nearby Fitzgerald River National Park.

Patterns of biodiversity. Detailed patterns of biodiversity could not be examined but can be predicted on the basis of VSA structure and composition. VSA 1, with large Salmon Gums and multiple vegetation strata, is likely to be species rich. VSA 2 (river and other drainage lines) and VSA 5 are likely to be important in providing dense cover and there is potential for a distinctive invertebrate assemblage in mesic refugia.

Key ecological processes. The main processes affecting and maintaining the fauna assemblage are likely to be local hydrology, fire regimes and the presence and abundance of feral species. The survey area is part of a much broader area of native vegetation and this completeness contributes to the largely intact fauna assemblage.

Potential Impacts upon fauna include:

- Altered local hydrology which could impact distinct mesic refugia;
- Loss and fragmentation of habitat, particularly aquatic-associated habitats;
- Change in fire regime which could impact fire-sensitive species; and
- Increased abundance of feral species which could impact mammal populations in particular.

Recommendations relate to impacts and include:

- Minimise disturbance to the Phillips River and associated riparian vegetation as this provides aquatic connectivity through the landscape. Any impacts to the river and local hydrology could affect fauna populations further upstream or downstream far from the survey area. Such impacts could include runoff from construction activities and topographic modifications such as backfilling valleys.
- Retain large trees, particularly large Salmon Gums with nesting hollows as these are important for significant species – any large tree to be afforded a 10m buffer from machinery movement as a precaution to avoid disturbing black-cockatoo nests (August to December only);
- Personnel working in the area should be informed of the appearance of Malleefowl mounds to reduce the risk of direct impacts upon mounds and particularly active mounds;

- Disturbance outside the areas surveyed in detail (proposed access track) should be preceded by further inspections for active Malleefowl mounds;
- Personnel working in the area should be made aware of species such as the Malleefowl that are at risk of roadkill;
- Minimise vegetation clearance and disturbance footprint;
- Implement feral species management plan for cats and foxes;
- Implement a fire management plan during construction activities to ensure wildfires do not occur as a result of activities and appropriate responses are in place should a wildfire occur;
- Rehabilitation should be carried out post-disturbance.

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1 Introduction

1.1 Introduction

Bamford Consulting Ecologists (BCE) was commissioned by Woodman Environmental to conduct a Level 1 fauna impact assessment (desktop review and site inspection) for proposed lithium exploration by Kingston Resources Limited in the Ravensthorpe area (Mt Cattlin Project). The purpose of this report is to provide information on the fauna values of the project area, particularly for significant species, an overview of the ecological function of the site within the local and regional context, and to provide discussion on the interaction of the proposal on these fauna values and functions.

1.2 General Approach to Fauna Impact Assessment

The purpose of impact assessment is to provide government agencies with the information they need to decide upon the significance of impacts of a proposed development. BCE uses an impact assessment process with the following components:

- The identification of **fauna values**:
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape;
  - Ecological processes upon which the fauna depend.
- The review of **impacting processes** such as:
  - Habitat loss leading to population decline;
  - Habitat loss leading to population fragmentation;
  - Degradation of habitat due to weed invasion leading to population decline;
  - Ongoing mortality from operations;
  - Species interactions including feral and overabundant native species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- The **recommendation** of actions to mitigate impacts.

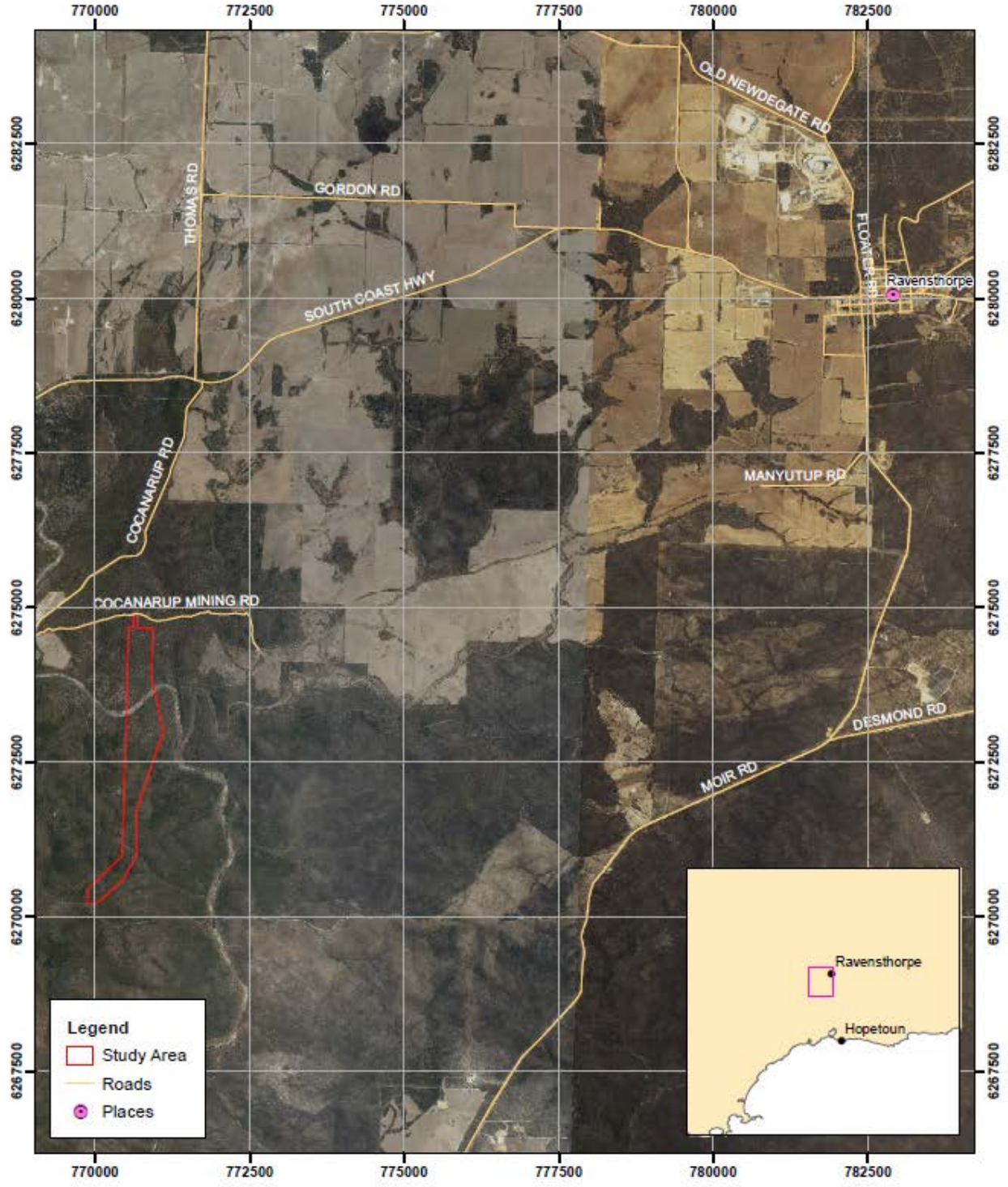
Descriptions and background information on these values and processes can be found in Appendices 1 to 4. Based on this impact assessment process, the objectives of investigations are to: identify fauna values; review impacting processes with respect to these values and the proposed development; and provide recommendations to mitigate these impacts.

1.3 Description of Survey Area

The survey area is located approximately 15 kilometres southwest of the township of Ravensthorpe, on the southern edge of the Ravensthorpe Range (known for its high biodiversity values; e.g. Craig 2008) and the Esperance Plains, and approximately 35 kilometres northwest of the Southern Ocean (see Figure 1). It lies in a region of undulating hills with shallow, generally loamy soils over rock (mostly granite), with Phillips River passing through the northern part of the survey area and minor watercourses in small valleys. The landscape is more abrupt to the south of the Phillips River, with steep

hills and valleys and exposed rock on slopes. Phillips River flows west-east through the area before heading south into the Fitzgerald River National Park, and discharging into the Culham Inlet and finally into the Southern Ocean. The project area is approximately 4.8 kilometres in length and varies in width around 500 metres.

The survey area supports largely intact native vegetation dominated by eucalypts and Salmon Gum woodland to the north and thickets of eucalypt or acacia to the south. There has been some localised historical agricultural and mining disturbance. Some cleared farmland lies to the north-east and north-west, but to the south native vegetation continues uninterrupted into the Fitzgerald River National Park.



Mt Cattlin Study Area Location	Author: Alison Saligari	
	WEC Ref: KR16-34-01	
WOODMAN ENVIRONMENTAL	Filename: KR16-34-01-f01.mxd	**Figure**
	Scale: 1:80,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report KR16-34-01.	Revision: A - 09 September 2016	

Figure 1. Location of survey area.

2 Background

2.1 Regional Description

The Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia, 2000) has identified 26 bioregions in Western Australia that are further divided into subregions (Figure 2). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell, 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA, 2004). The Survey Area lies in the Esperance Plains Bioregion (DSEWPaC 2012) and in the Fitzgerald subregion (at the transition between ESP01 and ESP02) as shown in Figure 2.

The Fitzgerald subregion is broadly characterised by 'myrtaceous and proteaceous scrub and mallee heaths on sandplain overlying Eocene sediments; rich in endemics' with systems dominated by *Eucalyptus* (Comer *et al.* 2001). The sub-region is composed of 'variable relief, comprising subdued relief on sandplains of the coastal region, punctuated with metamorphosed granite and quartzite ranges both inland and on the coastal plain' (Comer *et al.* 2001).

About half of the Esperance Plains Bioregion is occupied by areas of grazing and agriculture, with many areas having experienced previous disturbance from early agricultural clearance. The survey area is entirely comprised of native vegetation, and is dominated by mallet eucalypts with some areas of low acacia forest and mixed shrub thickets, and some large trees in the area north of the Phillips River.

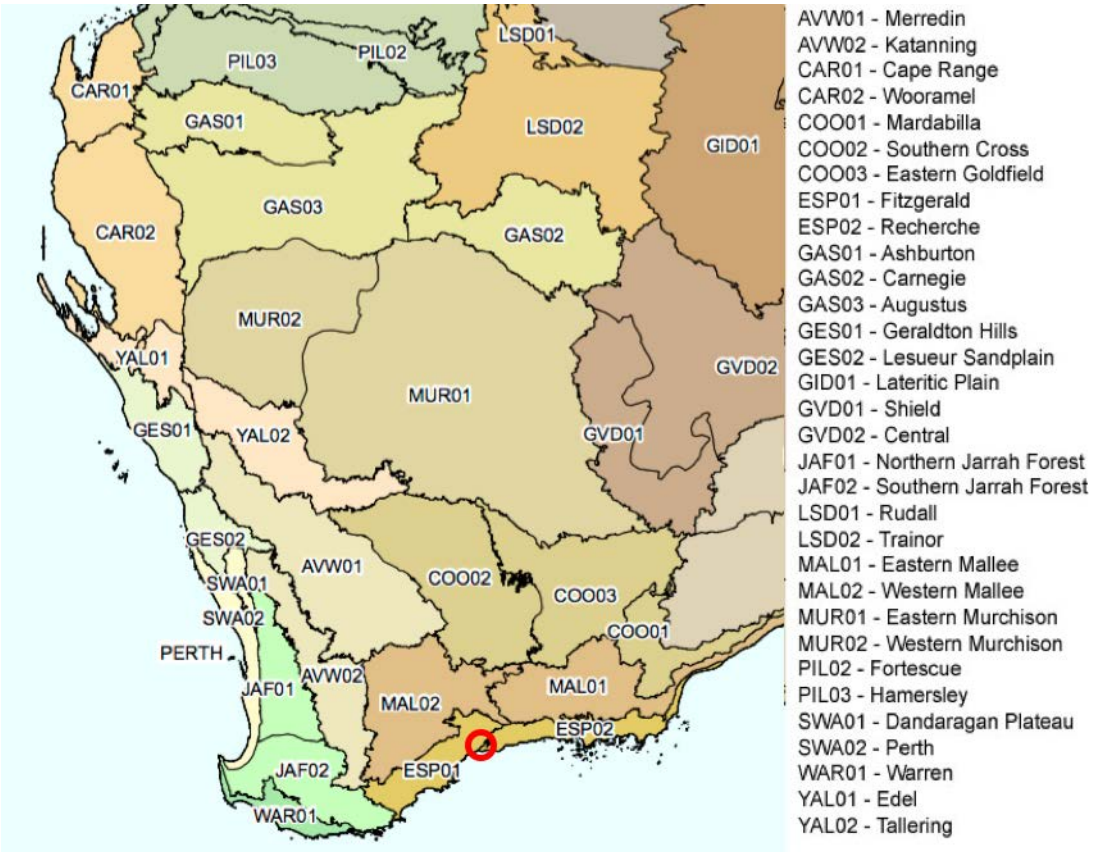


Figure 2. IBRA Subregions in Western Australia. Note the survey area (indicated by red circle) lies in the ESP01 Fitzgerald IBRA subregion.

3 Methods

3.1 Overview

The methods used for this assessment are based upon the general approach to fauna investigations for impact assessment as outlined in Section 1.2 and with reference to Appendices 1 to 4. Thus, the impact assessment process involves the identification of fauna values, review of impacting processes and preparation of mitigation recommendations.

This approach to fauna impact assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA 2002; EPA 2004). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 being a review of data and a site reconnaissance to place data into the perspective of the site, and Level 2 being a literature review and intensive field investigations (e.g. trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data.

The following approach and methods is divided into three groupings that relate to the stages and the objectives of impact assessment:

- Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the project area based on unpublished and published data using a precautionary approach.
- Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the project area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the project area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage, or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in an intensive trapping study, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford et al. (2010) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a set of sites only defines the assemblage of those sites at the time of sampling.
- Impact assessment. Determine how the fauna assemblage may be affected by the proposed development based on the interaction of the project with a suite of ecological and threatening processes.

3.2 Desktop Assessment

3.2.1 Sources of information

Information on the fauna assemblage of the survey area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), DPaW NatureMap (incorporating the Western Australian Museum's FaunaBase and the DPaW Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA), the EPBC Protected Matters Search Tool and the BCE database (Table 3-1). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

- Fish: Allan *et al.* (2002);
- Frogs: Tyler *et al.* (2000) and Anstis (2013);
- Reptiles: Storr *et al.* (1983); Storr *et al*. (1990); Storr *et al*. (1999); Storr *et al.* (2002) and Wilson and Swan (2013);
- Birds: Blakers *et al*. (1984); Johnstone and Storr (1998, 2004) and Barrett *et al*. (2003); and
- Mammals: Menkhorst & Knight (2004); Churchill (2008); and Van Dyck and Strahan (2008).

Table 3-1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia	Records of biodiversity data from multiple sources across Australia.	Point search: 33.5831°S, 120.0489°E plus 20 km buffer. Searched 5/09/2016
NatureMap (DPaW 2016)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	Point search: 33.5831°S, 120.0489°E plus 20 km buffer. Searched 5/09/2016
BirdLife Australia Atlas Database (Birdlife Australia 2016)	Records of bird observations in Australia, 1998-2014.	Point search: 33.5831°S, 120.0489°E plus 20 km buffer. Searched 5/09/2016
EPBC Protected Matters (DEE 2016)	Records on matters of national environmental significance protected under the EPBC Act.	Point search: 33.5831°S, 120.0489°E plus 20 km buffer. Searched 5/09/2016
Birdlife Australia Great Cocky Count roost data 2010 to 2014 (Byrne *et al.* 2015)	Black Cockatoo roost sites (confirmed, potential, and unconfirmed)	Data search for any roost sites known in the Ravensthorpe region

3.2.2 Previous fauna surveys

The desktop assessment included a review of fauna monitoring surveys conducted by Coffey Environments Australia Pte Ltd. in 2010 and Terrestrial Ecosystem 2013; both reports provide data for the BHP Ravensthorpe Nickel Operations, located approximately 40 km east of the present survey area. The reports provide data on conservation significant species recorded in vegetation soil associations (VSAs) in some cases similar to those found in the current fauna assessment. VSAs observed at the survey area are presented in Section 4.1.

3.2.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) *Checklist of the Fauna of Western Australia 2016*. The authorities used for each vertebrate group were: amphibians (Doughty *et al*. 2016), reptiles (Doughty *et al.* 2016), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (eg. the BirdLife Australia working list of names for Australian Birds). English names of species, where available, are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.2.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the site is of no importance. Species returned from databases but excluded from species lists are presented in Appendix 5.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

- Resident: species with a population permanently present in the survey area;
- Regular migrant or visitor: species that occur within the survey area regularly in at least moderate numbers, such as part of annual cycle;

- Irregular Visitor: species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the survey area in at least moderate numbers and for some time;
- Vagrant: species that occur within the survey area unpredictably, in small numbers and/or for very brief periods. Therefore, the survey area is unlikely to be of importance for the species; and
- Locally extinct: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the survey area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation sense, and species which use the site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals.

3.3 Field survey

3.3.1 Overview

The field survey included several components:

- identification of VSAs;
- targeted searching for conservation significant fauna, particularly the Carnaby's Black-Cockatoo and Western Ground Parrot;
- searching of the site for black-cockatoo habitat and habitat for other conservation significant fauna; and
- opportunistic fauna observations.

3.3.2 Dates and Personnel

The survey area was visited on the 6th to 8th September 2016 by Dr Mike Bamford (B.Sc. Hons. Ph.D.) and Mrs Mandy Bamford (B.Sc. Hons.). Mr Robert Browne-Cooper (B.Sc.), Ms Natalia Huang (B.Sc. Hons.), Ms Joys Tan (B.Sc. Hons.) and Dr Mike Bamford prepared the fauna assessment report.

The field investigations were carried out under Regulation 17 permit No. 01-000031-1.

3.3.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) in the survey area were assessed during the desktop review and as part of the field investigations. Within the survey area, all major VSAs were visited to

develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area.

3.3.4 Targeted Surveys

Carnaby's Black-Cockatoo

Ravensthorpe town is located at the eastern edge of the known range of the Carnaby's Black-Cockatoo (see Figure 3). The survey area was searched for ecological values for the species and these were based on the definitions of breeding, foraging and roosting habitat as per the EPBC Act referral guidelines for black-cockatoos (DSEWPaC, 2012), with foraging and nesting values assessed using systems developed by Bamford Consulting Ecologists.

Black-cockatoos are known to forage in suitable vegetation in the Southern and Southwest regions, leaving distinctive marks on dropped feeding material such as eucalypt fruit, and foraging signs on trees. Targeted searches were made for these signs around potential foraging habitat within the survey area. The areas of remnant vegetation within the site were assessed for foraging value based on the method outlined in Appendix 6.

Trees observed throughout the survey area were assessed for their suitability in supporting black-cockatoo breeding and nesting activities. Along the proposed access track (see Figure 4), all potential nesting trees were recorded; these were generally trees with a trunk diameter (DBH) greater than 40 cm (Salmon Gum). The following data were recorded for these trees:

- Tree species;
- GPS waypoint location;
- DBH;
- Tree status (alive or dead); and
- Tree class in terms of black-cockatoo nest potential (refer to Appendix 6).

Outside the access track, the general area of large trees was noted on the basis of VSA description, and some individual trees were recorded in the smaller priority 1 areas. This approach was taken so that individual trees along the proposed access track could be avoided, while in larger areas it would have been very time-consuming to record the location and description of every large tree, but the general advice is that any tree with a DBH >40cm should be avoided.

Figure 3. Distribution of Carnaby's Black-Cockatoo (taken from Johnston and Storr 1998).

Western Ground Parrot

Targeted surveys were conducted for the Western Ground Parrot at two points adjacent to the survey area - near Moir Road and Cocanarup Road; GPS coordinates and notes are given in Table 3-2. This involved listening for the calls of the parrot in the evening.

Table 3-2 GPS coordinates and notes at Western Ground Parrot listening locations

X coordinate	Y coordinate	Notes
-33.67435	119.99754	Evening listen off Moir Road. Sunset 17:45. Listened from 17:40 to 18:20. Lots of birds calling in general but no WGP. Vegetation a tall heath with small trees in valley, not classic low heath.
-33.64574	119.85573	Evening listen along Cocanarup Road. Listened 17:35 to 18:20. Lots of birds calling including Rufous Fieldwren and Tawny-crowned Honeyeater, i.e. assemblage correct for WGP to be present. Vegetation low heath. No WGP.

Malleefowl

Searching for Malleefowl mounds was undertaken along the proposed access track from the south, and at all times when walking throughout the project area. The BCE team walked from the north as far as Phillips River twice, following different routes, and walked the proposed access track from the south with diversions through the priority areas indicated on Figure 4. In addition, the Woodmans team walked throughout the project area and recorded mounds when encountered. This did not constitute a total search of the entire project area for Malleefowl mounds, but was intended to identify mounds along the proposed access track. Because of the density of vegetation, a team of about five people would need a week to reliably survey the entire project area for Malleefowl mounds.

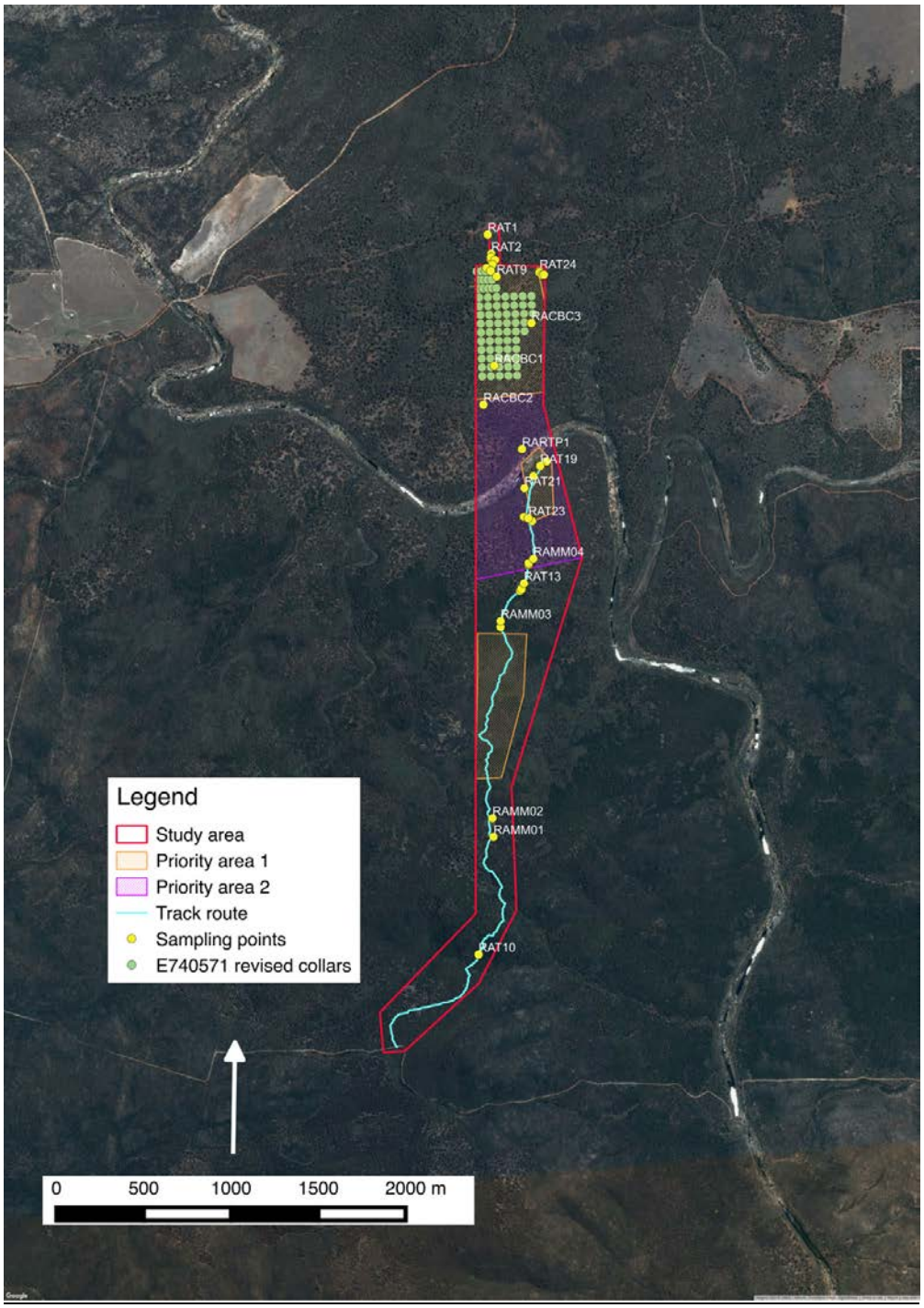


Figure 4. Location of the survey area (red boundary), including survey route taken (proposed access track) and GPS points of key features. RACB=Carnaby's Black-Cockatoo records/evidence; RARTP=Potential old drey of Western Ringtail Possum; RAMM=Malleefowl mounds; RAT=Large trees (suitable nesting trees for black-cockatoos).

3.3.5 Opportunistic observations

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included such casual observations as birds or reptiles seen while walking through the study area. Opportunistic searching for potential short range endemic invertebrates was conducted, including turning over logs and rocks, particularly in moist areas.

3.4 Survey limitations

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE fauna survey at the survey area in Table 3-3.

Table 3-3. Survey limitations as outlined by EPA (2004).

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study with a reconnaissance survey to follow). Survey intensity was deemed adequate due to the small area and availability of previous studies in the region.
Competency/experience of the consultant(s) carrying out the survey.	The authors have had extensive experience in conducting desktop reviews and have conducted multiple fauna surveys in the Esperance Plains bioregion with surveys focussed on relevant local species including black-cockatoos and ground parrots.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The site investigation targeted descriptions of the environment and fauna values for the significant species potentially occurring to occur.
Proportion of fauna identified, recorded and/or collected.	Key significant species were identified and the desktop provided information on other species.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Sources include previous fauna monitoring surveys in the Ravensthorpe area (Coffey Environments Australia Pte Ltd 2010 and Terrestrial Ecosystems 2014) and databases (BA, DPaW, EPBC, BCE, ALA, NatureMap, Bird Data database)
The proportion of the task achieved and further work which might be needed.	This report provides fauna values for significant species.
Timing/weather/season/cycle.	There were no constraints from the weather and conditions allowed personnel to move around readily.
Disturbances (e.g. fire, flood, accidental human intervention etc.) that affected results of survey.	None

Intensity. (In retrospect, was the intensity adequate?)	All major VSAs were visited and significant species habitat and traces were identified.
Completeness (e.g. was relevant area fully surveyed).	Site was fully surveyed to the level appropriate for a level 1 assessment and for the proposed impact. For example, potential nest trees for black-cockatoos were recorded only along the proposed access route and in priority areas, but not in areas where no direct impact is expected from the proposed drilling program.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna in the region.
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. biogeographic) information on the region.	Extensive regional information was available and was consulted.

3.5 Presentation of results for Impact Assessment

While some impacts are unavoidable during a development, of concern are long-term, deleterious impacts upon biodiversity. This is reflected in documents such as the Significant Impact Guidelines provided by DSEWPaC (see Appendix 3). Significant impacts may occur if:

- There is direct impact upon a VSA and the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna.
- There is direct impact upon conservation significant fauna.
- Ecological processes are altered and this affects large numbers of species or large proportions of populations, including significant species.

The impact assessment process therefore involves reviewing the fauna values identified through the desktop assessment and field investigations with respect to the project and impacting processes. The severity of impacts on the fauna assemblage and conservation significant fauna can then be quantified on the basis of predicted population change.

The presentation of this assessment follows the general approach to impact assessment as given in Section 1.2, but modified to suit the characteristics of the site. Key components to the general approach to impact assessment are addressed as follows:

<u>Fauna values</u>

This section presents the results of the desktop and field investigations in terms of key fauna values (described in detail in Appendix 1):

- Assemblage characteristics (uniqueness, completeness and richness) - based upon desktop assessment and information from the site inspection;
- Species of conservation significance – based upon desktop assessment and site inspection;
- Recognition of ecotypes or vegetation/substrate associations (VSAs) - based upon desktop assessment and site inspection;

- Patterns of biodiversity across the landscape - based upon desktop assessment and site inspection;
- Ecological processes upon which the fauna depend - based upon desktop assessment and site inspection.

Impact assessment

This section reviews impacting processes (as described in detail in Appendix 1) with respect to the proposed lithium exploration project and examines the potential effect of these impacts upon biodiversity of the survey area. It thus expands upon Section 1.2 and discusses the contribution of the project to impacting processes, and the consequences of this with respect to biodiversity. A major component of impact assessment is consideration of threats to species of conservation significance as these are a major and sensitive element of biodiversity. Therefore, the impact assessment includes the following:

- Review of impacting processes; will the proposal result in:
  - Habitat loss leading to population decline, especially for significant species;
  - Habitat loss leading to population fragmentation, especially for significant species;
  - Weed invasion that leads to habitat degradation;
  - Ongoing mortality;
  - Species interactions that adversely affect native fauna, particularly significant species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).
- Summary of impacts upon significant species, and other fauna values.

The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

3.5.1 Criteria for impact assessment

Impact assessment criteria are based on the severity of impacts on the fauna assemblage and conservation significant fauna, and were quantified on the basis of predicted population change (Table 3-4). Population change can be the result of direct habitat loss and/or impacts upon ecological processes.

The significance of population change is contextual. The EPA (2004) suggests that the availability of fauna habitats within a radius of 15km can be used as a basis to predict low, moderate or high impacts. In this case, a high impact is where the impacted environment and its component fauna is rare (<5% of the landscape within a 15km radius or within the Bioregion), whereas a low impact is where the environment is widespread (10% of the local landscape). Under the Ramsar Convention, a wetland that regularly supports 1% of a population of a waterbird species is considered to be significant. These provide some guidance for impact assessment criteria, but are really only appropriate when considering very large proposed developments. In the case of the current project area of approximately 300ha within a greater landscape, a 15km radius is considered appropriate for context. In the following criteria (Table 3-4), the significance of impacts is based upon estimated percentage fauna population decline within the immediate area of the surroundings, and upon the effect of the decline upon the conservation status of a recognised taxon (recognisably discrete

genetic population, sub-species or species). Note that percentage declines can usually only be estimated on the basis of distribution of a species derived from the extent of available habitat.

Note that for a few species, such as the black-cockatoos, there is guidance for the assessment of impact significance (DSEWPaC 2012) and this is referred to as necessary.

The impact assessment concludes with recommendations based upon predicted impacts and designed to mitigate these.

Table 3-4. Assessment criteria of impacts upon fauna.

Impact Category	Observed Impact
Negligible	Effectively no population decline; at most few individuals impacted and any decline in population size within the normal range of annual variability.
Minor	Population decline temporary (recovery after end of project such as through rehabilitation) or permanent, but <1% within the immediate area. No change in viability or conservation status of taxon.
Moderate	Permanent population decline 1-10% within the immediate area. No change in viability or conservation status of taxon.
Major	Permanent population decline >10% within the immediate area. No change in viability or conservation status of taxon.
Critical	Taxon extinction within the immediate area and/or change in viability or conservation status of taxon.

4 Fauna Values

4.1 Vegetation Soil Associations

Five key Vegetation Soil Associations (VSAs) were identified across the survey area and are illustrated in Plates 1 to 5. They include:

1. **Open Salmon Gum woodland over dense Acacia and mixed shrubs on brown or grey loam.** This is comprised of Acacia midstorey over a mixed shrub understorey, with the understorey dominated by *Eremophila sp.* and shrubby acacias, and the soil with scattered small granite rocks. Salmon Gums are not continuous and other eucalypts occasionally present. The Salmon Gums in the north of the survey area are large with abundant hollows which are important for fauna. This VSA is located on hills and valleys mostly in the north and in the small priority area adjacent to and south of Phillips River. Includes Vegetation types 1 to 9, and 12 to 15.

2. **Phillips River and associated vegetation on exposed rock.** This is comprised of dense Acacia over mixed shrub thickets of stunted *Melaleuca sp.* and samphire along margins of the Phillips River. The river contains moderately fast-flowing, tannin-stained and brackish water. It appears to be eroding through Greenstone and/or granite. This VSA extends into minor tributaries that flow seasonally between hills in the area. Includes Vegetation Type 11 and minor drainage lines.

3. **Dense mallet eucalypt woodland over sparse understorey on grey loam.** This is comprised of dense mallet, or thickets of eucalypts in some places, and soil with scattered rocks throughout. This VSA is located high on the hills in the far south of the survey area and in part of the southern priority area. Includes Vegetation Types 20, 22 to 25 and 27.

4. **Closed low forest over sparse understorey on red-brown loam**. This is comprised of tall *Acacia acuminata* and occasionally eucalypts forming a canopy over clumps of *Lepidosperma diurnum* and scattered low shrubs. This VSA is located along and south of Phillips River, generally low in the landscape and on slopes. This occurs over much of the southern priority area. Includes Vegetation Types 10, 16 to 19 and 21.

5. **Acacia and mixed shrub thickets.** This VSA is located on one south-facing slopes in the south of the survey area. The vegetation is dense with a variety of shrubs and there is exposed rock at the surface in places. Ferns are a conspicuous component of the herb layer, suggesting persistent mesic conditions. Includes Vegetation Types 26 and mosaics that include 26.

The distribution of VSAs, based upon interpretation of vegetation mapping, is presented in Figure 5.

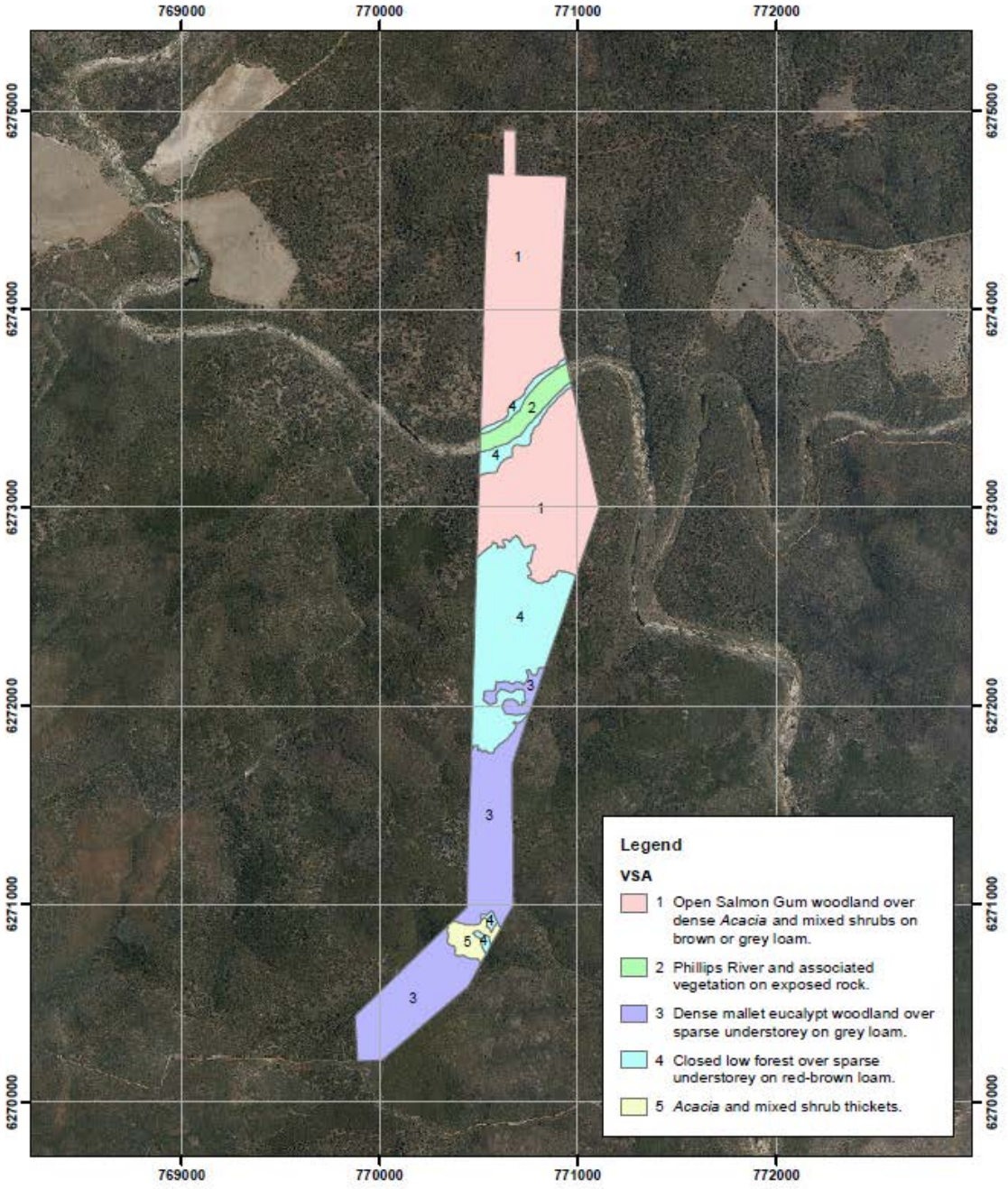
Plate 1. VSA 1 – Open Salmon Gum woodland

Plate 2. VSA 2 – Phillips River and associated vegetation

Plate 3. VSA 3 - Dense mallet eucalypt woodland

Plate 4. VSA 4 – Closed low forest; in this case an area of dense *Acacia acuminata*

Plate 5. VSA 5 – Acacia and mixed shrub thickets (Vegetation Type 26).



Mt Cattlin Study Area The Distribution of VSAs	Author: Mike Bamford	N
	WEC Ref: KR16-34-01	
WOODMAN ENVIRONMENTAL	Filename: KR16-34-Fauna-f05.mxd	Figure 5
	Scale: 1:25,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: A - 19 October 2016	

Figure 5. The distribution of VSAs across the project area.

4.2 Vertebrate Fauna

4.2.1 Overview of fauna assemblage

The desktop study identified 250 vertebrate fauna species as potentially occurring in the Ravensthorpe survey area (see Table 4-1 and Appendix 4): four fish, ten frogs, 41 reptiles, 164 birds, 26 native and five introduced mammals. However, three of the bird species and three of the mammal species are considered locally extinct, and it is likely that several other mammal species that did not come up on the databases are also locally extinct, including the Quokka *Setonix brachyurus*, Woylie *Bettongia penicillata* and Gilbert's Potoroo *Potorous gilberti*. Therefore, the current vertebrate fauna assemblage is expected to include 244 species and these are assigned a status as outlined in Section 3.2.4 (see Table 4-1). An annotated list of fauna species recorded during field investigations is included in Appendix 10. Species returned from databases but which are not considered to be part of the survey area's fauna assemblage are presented in Appendix 5.

The four fish species expected are all considered to be resident in the Phillips River and one was confirmed. This list does not include marine/estuarine species that may occasionally invade the river from Culham Inlet.

The 10 frog species (four confirmed) are all locally common, considered resident and are regionally widespread, and three of the species were breeding in flooded borrow pits along Moir Road. All the frog species can be expected to breed in seasonal wetlands in the region including tributaries of the Phillips River, although the river itself is probably too brackish to support breeding.

The 41 reptile species are all considered resident and are probably regionally widespread, but the most comprehensive reptile surveys from the region are from 40km to the east where soils, vegetation and climate are not the same as in the survey area, so information on the reptile assemblage is uncertain. As an example of this uncertainty, one of the six species confirmed as present, the Crowned Snake, was not present in any of the available databases, while the South-West Carpet Python was also missing from databases but is almost certainly present (based on experience with the species in the Fitzgerald region; M. Bamford pers. obs).

The extant bird assemblage of 136 species includes 81 classed as residents, of which 47 (58%) were observed in two days in the field. Only a small proportion of migrants and regular visitors were observed, but many are expected only in summer. The bird assemblage is a biogeographic mixture of south-west species (e.g. Western Whipbird, Red-eared Firetail, Southern Emu-wren, Red-capped Parrot), Wheatbelt species (e.g. Yellow-plumed Honeyeater, Yellow-throated Miner, Blue-breasted Fairy-wren) and widespread species (e.g. Australian Ringneck, Galah). The locally extinct bird species (Bush Stone-curlew, Western Ground Parrot and Western Bristlebird) have suffered from land clearing, changed fire regimes and introduced predators and are further discussed in the section on significant species.

The extant mammal fauna of 24 native and four introduced species was poorly documented by the field investigations (only four species confirmed), as many mammals can be difficult to detect without extensive fieldwork. Even introduced species were difficult to confirm as the hard and uneven ground made it difficult to find tracks, but the apparent scarcity of species such as Rabbits may reflect the presence of some toxic native vegetation. The mammal assemblage includes a high proportion of species of conservation significance (discussed below) and at least three species may be locally extinct.

The overall fauna assemblage is almost complete. Key features of the fauna assemblage expected in the survey area are:

- Uniqueness: The assemblage is typical of eucalypt and acacia woodland, and associated waterway, located throughout the Esperance Plains Bioregion. It is notable for the blending of bioregion fauna from the south and wheatbelt, and the presence (assumed in some cases) of a suite of significant species discussed in the following section.
- Completeness: The assemblage of species from the survey area is mostly complete, with many species of mammals that are usually not found in other parts of Western Australia.
- Richness: The assemblage contains a high level of richness to be expected in relatively undisturbed intact woodland vegetation.

Table 4-1. Composition of vertebrate fauna assemblage of the survey area.

Taxon	Number of species	Number of species in each status category (number in parenthesis is number confirmed present)				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Fish	4	4 (1)	-	-	-	-
Frogs	10	10 (4)	-	-	-	-
Reptiles	41	41 (6)	-	-	-	-
Birds	164 (1 introduced)	81 (46)	25 (6)	25	28	3
Native Mammals	26	22 (4)	-	2	-	2
Introduced Mammals	5	4	-	-	-	1
Total	**250**	**162**	**25**	**27**	**28**	**6**

4.2.2 Species of conservation significance

The current vertebrate assemblage potentially includes 40 species of conservation significance, with a further five conservation significant species considered to be locally extinct (Table 4-2). The overall list of significant species includes 18 CS1 species, eight CS2 species and 20 CS3 species, but some of these are locally extinct. Numbers and classes of significant species broken down by major taxonomic group and still expected to be present are:

Taxon	CS1	CS2	CS3	
Fish	0	0	1	
Frogs	0	0	0	
Reptiles	0	2	1	
Birds	13	2	17	(excludes two locally extinct CS1 species and one locally extinct CS3 species)
Mammals	5	4	1	(excludes two locally extinct CS1 species)

As outlined in Appendix 1, species classed as CS1 are those listed under legislation, while those classed as CS2 are listed as Priority by the Department of Parks and Wildlife. The CS3 class is more subjective, but includes species that have declined extensively across the Wheatbelt due to land clearing, and species that occur at the edge of their range in the Ravensthorpe region. This makes their presence in the survey area significant as populations on the edge of a species' range are often less abundant and more vulnerable to extinction than populations at the centre of the range (Curnutt *et al.* 1996). The CS3 class also includes potential short range endemic (SRE) invertebrates and the potential for these is discussed with other CS3 species below.

Table 4-2. Details on the conservation significant fauna species of the survey area.

This list is based on desktop review and their expected status within the site. Species recorded are indicated as confirmed.

Common Name	Latin Name	Conservation Status			Expected status in project area
		CS1	CS2	CS3	
Fish					
GALAXIIDAE					
Common Jollytail	*Galaxias maculatus*			CS3	Resident
Reptiles					
SCINCIDAE					
Ravensthorpe Range Slider	*Lerista viduata*		P1		Resident
BOIDAE					
South-West Carpet Python	*Morelia spilota imbricata*			CS3	
ELAPIDAE					
Common Death Adder	*Acanthophis antarcticus*		P3		Resident
Birds					
Anatidae					
Blue-billed Duck	*Oxyura australis*		P4		Vagrant
MEGAPODIIDAE					
Malleefowl	*Leipoa ocellata*	V S3			*Likely resident
ARDEIDAE					
Cattle Egret	*Ardea ibis*	M S5			Vagrant
Eastern Great Egret	*Ardea modesta*	S5			Irregular visitor

Common Name	Latin Name	Conservation Status			Expected status in project area
BURHINIDAE					
Bush Stone-curlew	*Burhinus grallarius*			CS3	Locally extinct
SCOLOPACIDAE					
Common Greenshank	*Tringa nebularia*	M S5			Irregular visitor
Red-necked Stint	*Calidris ruficollis*	M S5			Irregular visitor
Sharp-tailed Sandpiper	*Calidris acuminata*	M S5			Irregular visitor
APODIDAE					
Fork-tailed Swift	*Apus pacificus*	M S5			Migrant, occasional visitor
MEROPIDAE					
Rainbow Bee-eater	*Merops ornatus*	M S5			Migrant
FALCONIDAE					
Peregrine Falcon	*Falco peregrinus*	S7			Resident
CACATUIDAE					
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2			Confirmed regular visitor
PSITTACIDAE					
Western Rosella (Inland)	*Platycercus icterotis xanthogenys*		P4		Irregular visitor
Western Ground Parrot	*Pezoporus flaviventris*	C S1			Locally extinct
MALURIDAE					
Blue-breasted Fairy-wren	*Malurus pulcherrimus*			CS3	Confirmed resident
Southern Emu-wren	*Stipiturus malachurus*			CS3	Resident
DASYORNITHIDAE					
Western Bristlebird	*Dasyornis longirostris*	V S3			Probably locally extinct
ACANTHIZIDAE					
Shy Heathwren	*Calamanthus cautus*			CS3	Confirmed resident
Rufous Fieldwren	*Calamanthus campestris*			CS3	Confirmed resident
Redthroat	*Pyrrholaemus brunneus*			CS3	Irregular visitor
POMATOSTOMIDAE					
White-browed Babbler	*Pomatostomus superciliosus*			CS3	Confirmed resident
PSOPHODIDAE					
Western Whipbird	*Psophodes nigrogularis*	E S2			Resident
OREOICIDAE					
Crested Bellbird	*Oreoica gutturalis*			CS3	Resident
PACHYCEPHALIDAE					
Gilbert's Whistler	*Pachycephala inornata*			CS3	Resident
Grey Shrike-thrush	*Colluricincla harmonica*			CS3	Confirmed resident
PETROICIDAE					
Western Yellow Robin	*Eopsaltria australis*			CS3	Confirmed resident
Hooded Robin	*Melanodryas cucullata*			CS3	Resident

Common Name	Latin Name	Conservation Status			Expected status in project area
Jacky Winter	*Microeca fascinans*			CS3	irregular visitor
Scarlet Robin	*Petroica boodang*			CS3	Resident
Red-capped Robin	*Petroica goodenovii*			CS3	Resident
Southern Scrub-robin	*Drymodes brunneopygia*			CS3	Confirmed resident
ESTRILDIDAE					
Red-eared Firetail	*Stagonopleura oculata*			CS3	Resident
Mammals					
DASYURIDAE					
Chuditch	*Dasyurus geoffroii fortis*	V S3			Confirmed resident
Red-tailed Phascogale	*Phascogale calura*	E S6			Resident
MYRMECOBIIDAE					
Numbat, Walpurti	*Myrmecobius fasciatus*	V S2			Locally extinct
PERAMELIDAE					
Quenda, Southern Brown Bandicoot	*Isoodon obesculus fusciventer*		P4		Resident
MACROPODIDAE					
Tammar Wallaby	*Macropus eugenii derbianus*		P4		Possibly locally extinct
Brush Wallaby	*Notamacropus Irma*		P4		Confirmed resident
PSEUDOCHEIRIDAE					
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S2			*Likely resident
MURIDAE					
Mitchell's Hopping-mouse	*Notomys mitchellii*			CS3	Resident
Western Mouse	*Pseudomys occidentalis*		P4		Resident
Heath Mouse	*Pseudomys shortridgei*	V S3			Resident

*Presence inferred from old mounds or drey.

See Appendix 2 for descriptions of conservation significance levels. Species recorded are indicated and the predicted status of each species in the survey area is also given.

EPBC Act listed species: V = Vulnerable, E = Endangered, C = Critically Endangered, M = Migratory.

WC Act listed species: S1 – S7 = Schedule 1 - 7; DEC Priority Species: P1 - P5 = Priority 1 - 5.

4.2.2.1 Species of Conservation Significance level 1

Malleefowl

The Malleefowl is known from mallee eucalypt woodlands, environments typical of those found in the survey area. Very old mounds (>10 years) of the species were recorded within the survey area (GPS coordinates provided in Appendix 10). While no Malleefowl were directly seen during the present survey, recent sightings in the region have been reported by the Ravensthorpe caravan park owner and an independent zoologist (J. Turpin pers. comm.). Given suitable habitat is present, the presence of old mounds and the recent sightings nearby, the Malleefowl is likely to be a resident in the area.

There were no active or recently active mounds along the proposed access road and none was found elsewhere despite both the BCE team and the Woodmans team walking across much of the project area. However, the vegetation is very dense in places and thus there is potentially an active mound within the project area.

Rainbow Bee-eater and Fork-tailed Swift

Both these species are of high conservation significance because they are listed as migratory under the EPBC Act and Wildlife Conservation Act, but they are widespread. The Rainbow Bee-eater nests in burrows often in cleared land, and is likely to be a summer breeding migrant resident in the survey area. The Fork-tailed Swift is less predictable but could be a regular, non-breeding summer visitor.

Migratory Waterbirds

This group includes two egret species and ten waders (shorebirds) listed as Migratory under federal and/or state legislation and known to occur in the region. However, the survey area lacks suitable environments such as shallow wetlands and tidal flats and therefore these species are expected only as irregular visitors or vagrants in small numbers, most likely along the Phillips River.

Peregrine Falcon

This species is known to occur over a wide range of environments across Australia. Preferred nesting locations include a range of elevated locations with steep topography such as rocky hills, breakaways, cliffs and high artificial structures. It will also nest in very large, horizontally-aligned tree hollows, and in old Raven nests in tall trees (M. Bamford pers. obs.). While the hills in the survey area do not provide clifflines suitable for nesting, the large Salmon Gums may do so.

Carnaby's Black-Cockatoo

The Carnaby's Black-Cockatoo is Endangered at the federal and state level. The Ravensthorpe area is at the edge of the range of the species, but it is known to breed in the region (Johnstone and Storr 1998), and its presence was confirmed during the site inspection. Regular sightings were made, particularly north of the Phillips River where birds were mostly in pairs amongst the large Salmon Gum and were almost certainly prospecting for nest sites. One trio was also present, consisting of adult birds and a young bird from the last breeding season. There was also foraging evidence where the birds had been feeding on the fruit of mallet eucalypts (Plate 6). Locations of foraging evidence and sightings are given in Figure 4, and coordinates and information relevant to each location is given in Appendix 9.

VSA 1 with large Salmon Gums is almost certainly being used for breeding and potential nest trees were recorded and assigned a nesting value score along the proposed access road south of Phillips River, and in the priority survey areas. More potential nest trees can be expected throughout VSA 1. In the targeted areas, 28 trees with at least some potential as nest trees for black-cockatoos were scored, and six of these were considered of high potential with suitable hollows visible (Appendix 8).

The vegetation through the survey area is of low to moderate foraging value for Carnaby's Black-Cockatoo, with the more proteaceous heaths of the Fitzgeralds to the south being of greater value. The Mallet and Salmon Gum woodlands would have a foraging value score of 3 on a scale from 0 to 6 (see Appendix 6) and can be used for the calculation of offsets if necessary.

Plate 6. Foraging signs by Carnaby's Black Cockatoos in mallet eucalypts.

Western Ground Parrot

The Western Ground Parrot is Critically Endangered at the federal and state levels. It is known to inhabit coastal heathlands with low-growing shrubs that have been unburnt for more than 40 years. Although it was not recorded during the survey, it is considered a possible resident or visitor to the survey area and until recently (2012) it was known to occur in nearby areas of the Fitzgerald River National Park (A. Burbidge pers. comm.). The actual survey area contains little of the species' favoured environment, but major threats are fire and feral species and any activity in the general region can affect these threatening processes.

Western Bristlebird

The Western Bristlebird occurs in dense thickets and heaths and is restricted to a small area in south-western Western Australia. The survey area lies just beyond the current eastern edge of its range, but suitable environments are present and as with the Western Ground, the major threatening processes of fire and feral species are not site-specific.

Western Whipbird

The subspecies which occurs in Western Australia is restricted to a small area east of Albany where the population is comprised of c.500 adults and declining, probably due to wildfires (Garnett *et al.* 2011). They are known to occur in mallee eucalypts, heath, shrubland and acacia vegetation, and the survey area is within the species' range.

Chuditch

The Chuditch was recorded by Coffey Environments in the Ravensthorpe Nickel Operations mine site 40km from the present survey area (Coffey Environments, 2010), and a sighting was reported by the Ravensthorpe caravan park operator on Hopetoun Road in early 2016. It is therefore considered likely that the species is resident in the survey area. This species suffers from habitat loss and predation by Foxes.

Red-tailed Phascogale

Ravensthorpe represents the eastern edge of the Red-tailed Phascogale's range in south-western Western Australia, and it was recorded in the Fitzgerald National Park in a 2004 survey by DPaW. The species is arboreal, preferring long-unburnt *Allocasuarina* woodlands with hollow-containing eucalypts, although Short and Hide (2011) stress the importance of hollow-bearing eucalypts. The survey area lacks extensive stands of *Allocasuarina* but does have suitable eucalypt woodlands so the species is considered likely to be a resident. Short and Hide (2011) note that there are recent records from the Ravensthorpe region of the Esperance Plains, but are unsure of the persistence and security of this population.

Numbat

Formerly widespread across southern Australia excluding high rainfall areas, the Numbat is now restricted to a few areas in the south-west of Western Australia, in eucalypts woodlands where hollow logs provide shelter, there is an abundance of food (termites) and where some control of feral predators is in effect. With no recent records from around Ravensthorpe the Numbat is almost certainly locally extinct, but VSA 1 in particular would provide suitable habitat.

Western Ringtail Possum

The Western Ringtail Possum is now restricted to south-western Western Australia in near-coastal forests and woodlands from Mandurah to slightly east of Albany, but was formerly more widespread. If it occurs in the survey area, it is past the edge of its currently known range. A possible old drey of the species was recorded in the survey area (location indicated in Figure 4 and coordinates given in Appendix 9), so it is considered to be a possible resident in the survey area.

Heath Mouse

The Heath Mouse has a preference for mature stands of scrub mallee and mixed scrub with Banksia and in Western Australia is currently known only from the nearby Ravensthorpe Range (including the Ravensthorpe Nickel Operations mine site (Coffey Environments, 2010)), and Fitzgerald River National Park. However, the Heath Mouse has been declining dramatically in the last ten years. Given the

presence of suitable environments in and around the survey area, it is considered a likely resident, although its presence cannot be confirmed without intensive sampling.

4.2.2.2 Species of Conservation Significance level 2

Ravensthorpe Range Slider

The Ravensthorpe Range Slider is endemic to the Ravensthorpe area. Little is known about this species, but like other *Lerista* species its habitat is likely to be leaf litter in woodland areas and it therefore has to be expected as a resident in the survey area.

Common Death Adder

The Common Death Adder in Western Australia is restricted to a near-coastal belt in the south and a narrow region along the Darling Escarpment south-east of Perth. It can be expected as a resident throughout the survey area.

Blue-billed Duck

The Blue-billed Duck is a species of deep, usually freshwater wetlands wetlands in south-western and south-eastern Australia. It may be an irregular visitor in only small numbers to the Phillips River.

Western Rosella

The inland subspecies of the Western Rosella is restricted to the Wheatbelt region and adjacent Great Western Woodlands of southern Western Australia. The survey area may be too far south and lack the open, semi-arid eucalypt woodlands favoured by the species, but it could occur irregularly.

Quenda

The Quenda occurs in the south-west coast from Guilderton north of Perth to east of Esperance. It is usually found within dense and often swampy vegetation. Some of the vegetation in the survey area would provide the species with adequate cover, and while no evidence of the Quenda was recorded, it is considered likely to be resident.

Tammar Wallaby

The Tammar Wallaby would have occurred in the survey area prior to the invasion of the south-west by the Fox, but it is now probably locally extinct.

Brush Wallaby

The Brush Wallaby occurs in a range of shrublands and woodlands across much of the south-west, but is at risk from clearing and Foxes. It is almost certainly resident in the survey area and was recorded (tracks) along Moir Road just to the east.

Western Mouse

The Western Mouse is restricted to the protected areas of southwest Western Australia, including the Ravensthorpe Range and Fitzgerald River National Park. As it is usually found in unburnt

shrublands and those in the survey area may be suitable, so the species is considered a likely resident. However, its presence cannot be confirmed without intensive sampling.

4.2.2.3 Species of Conservation Significance level 3

Spotted Jollytail

This species is widespread in rivers and stream of south-eastern Australia, but in Western Australia is confined to a few drainage systems from Denmark to Esperance. It is presumably present in Phillips River and this population should be considered locally significant.

Carpet Python

The south-west race of the Carpet Python was until recently listed as Priority by DPaW and a population in the survey area would be locally significant as the species is still at risk from feral species and clearing.

Conservation Significance level 3 birds

Seventeen bird species are considered to be of local significance because their populations have declined dramatically across much of their range due to clearing for agriculture. These species also show poor persistence in fragmented landscapes, and therefore populations in large tracts of native vegetation are important for their long-term conservation.

Mitchell's Hopping-Mouse

The Mitchell's Hopping Mouse is listed as CS3 as it is at the south-western end of its range in the Ravensthorpe area. It is known from mallee and dry woodlands across southern Australia and while the survey area may not be suitable for it (rainfall too high), it is considered likely to be a resident on the basis of available information.

Short Range Endemic (SRE) Invertebrates

Detailed searching for potential SRE invertebrates is beyond the scope of a site inspection, but the presence of one large land snail, probably *Bothriembryon dux*, was confirmed. This is not an SRE and occurs from near Albany across to the South Australian Border (ALA). The survey area does not generally support the sort of isolated and distinctive landscapes that are conducive to the evolution of SRE invertebrates, but drainage lines in the greater region may have a distinctive aquatic and riparian invertebrate assemblage. VSA 5 is of interest with respect to potential SRE invertebrates as the presence of ferns in the understorey suggests high soil moisture levels for an extended period. Such conditions can be important for SRE invertebrates and this VSA may be more or less isolated as it appears to occur only on a south-facing slope with granite just below the surface.

4.3 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations. However, the presence of a mixture of VSAs, including Phillips River and associated riparian vegetation, are factors in patterns of biodiversity. Within the survey area, the VSAs are considered to be mostly intact with some historical agricultural disturbance. Fauna that occur in eucalypt woodlands throughout the region are likely to occur in or move through the survey area for foraging, resting, and nesting. Most areas have intact understoreys that are important for understorey-dependent species such as some invertebrates, birds and reptiles. Areas with dense thickets are important for species that prefer dense cover such as some birds and wallabies.

Any waterway is usually of significance as it provides a unique environment for aquatic and riparian species such as waterbirds. The river within the survey area also provides connectivity along the river system through the landscape. The presence of large Salmon Gums containing large hollows is likely to influence patterns of distribution of fauna that rely on such hollows for breeding, such as phascogales and black-cockatoos. As the entire landscape is underlain by rock - mostly granite and some greenstone - rainfall flows down even minor valleys, which creates distinct mesic refugia along small to large watercourses. This may also affect the nature of VSA 5. These areas are likely to contain high levels of biodiversity or unique species.

4.4 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix 3 for descriptions and other ecological processes). These include:

Local hydrology. The entire landscape of the survey area is underlain by rock which facilitates water to flow down minor valleys. This allows the creation of distinct mesic refugia that may be important for fauna. In addition, Phillips River passes through the survey area, providing connectivity for aquatic-associated species. Maintaining local hydrology is considered to be of high importance to fauna in the present project.

Fire. Woodlands of the Esperance Plains Bioregion are fire-adapted but the flora and fauna assemblages can be altered by too-frequent fires; and even by fire exclusion. Some species are particularly sensitive to wildfires and altered fire regimes. Fire season may also be important in seed germination. As the site consists of open woodland to dense eucalypts and thickets, fire is expected to occur at the site. Fire could further reduce recruitment of the remnant woodland vegetation and hence the biodiversity and resilience of the area in the absence of remedial action.

Feral species and interactions with over-abundant native species. Feral species occur throughout Western Australia and it is expected that the fauna assemblage within the survey areas has been impacted by feral species (particularly foxes and cats), which has resulted in the loss of some mammal and bird species. Rabbits and introduced rodents may cause further degradation to the

native vegetation and, in combination with introduced predators (cats, dogs and foxes), reduce the capacity of the area to support native fauna diversity.

Connectivity and landscape permeability. The survey area is part of a much greater area of native vegetation. The eucalypt woodlands in the survey area provide connectivity between the surrounding woodlands, including west to Fitzgerald National Park and north-east to Ravensthorpe Range, with fauna, such as birds and mammals, likely to move across the landscape. The Phillips River provides aquatic connectivity across the Bioregion, allowing species associated with waterways and riparian vegetation to move north or south through the landscape.

4.5 Summary of fauna values

The desktop study identified 249 vertebrate fauna species as potentially occurring in the Ravensthorpe survey area: three fish, ten frogs, 41 reptiles, 164 birds, 26 native and five introduced mammals, but with local extinction of some species (three birds and three mammals). The vertebrate assemblage includes 45 species of conservation significance, including the Carnaby's Black-Cockatoo and Chuditch.

Fauna values within the study area can be summarised as follows:

Fauna assemblage. Largely intact and rich, and broadly typical of the Esperance Plains Bioregion. Several south-western species at the eastern edge of their range and the assemblage also has elements from adjacent biogeographic zones.

Species of conservation significance. A large number of significant species likely to occur as residents of the survey area, or at least as regular visitors. Many occur at the eastern edge of their range in the Ravensthorpe area, making their presence in the survey area significant. Carnaby's Black-Cockatoo is probably the significant species of greatest note, as the area is on the edge of the species' range and eucalypt woodlands (VSA 1) are likely to support breeding.

Vegetation and Substrate Associations (VSAs). There are five VSAs identified. Most of the survey area contains intact mallee eucalypt woodland over a sparse understorey (VSA 3) and intact low Acacia forest over sparse understorey (VSA 4). There are areas of open Salmon Gum woodland over dense Acacia (VSA 1) on hills and valleys, mostly north of the Phillips River. Phillips River and associated intact riparian vegetation (VSA 2), comprising of Melaleuca and samphire, passes west-east through the northern part of the survey area. A small area of Acacia and mixed shrub thickets (VSA 5) occurs in the south and is of interest as its hydrology may be unusual (indicted by growth of ferns). All VSAs are considered important for fauna, with large Salmon Gums providing important nesting opportunities for fauna such as the Carnaby's Black-Cockatoo and the Red-tailed Phascogale.

Patterns of biodiversity. Detailed patterns of biodiversity could not be examined, but it can be predicted that important features for biodiversity will be the structural complexity and presence of

large, hollow-bearing trees in VSA 1, the presence of dense cover and seasonal water along drainage lines (VSA 2) and the persistent high soil moisture in VSA 5.

Key ecological processes. The main process which may affect the fauna assemblage is likely to be local hydrology, the fire regime and the presence of feral predators. Phillips River and tributaries provide dispersal corridors for some fauna. The survey area is part of a much greater extent of native vegetation and this contributes to the near-completeness of the fauna assemblage.

5 Impact Assessment

Impacting processes have to be considered in the context of fauna values and the nature of the proposed action, and are examined below. Predicted impacts need to be considered in the light of recommendations made in Section 6.

Habitat loss leading to population decline.
The proposed action of a drilling program has a small disturbance footprint in a contiguous landscape and therefore the impact upon fauna biodiversity is predicted to be negligible. However, VSA 5 may be vulnerable and large eucalypts need to be avoided (see recommendations).

Habitat loss leading to population fragmentation.
The small proposed disturbance footprint in a contiguous landscape means that the effect upon population fragmentation is likely to be negligible. Drainage lines may be vulnerable (see recommendations).

Degradation of habitat due to weed invasion.
This impact should be negligible assuming standard hygiene procedures (see recommendations).

Ongoing mortality from operations.
Some fauna may be at risk from roadkill (e.g. Malleefowl, Chuditch) but this will depend upon levels of vehicle activity and if drilling is proposed for night (when there could be disruption of fauna attracted to lights). There is also a slight risk of direct impact upon an active Malleefowl mound. Impact can be assumed to be minor (see recommendations).

Species interactions.
Some of the fauna is sensitive to feral species such as Foxes and Cats. These are likely to be present already, but new tracks through previously intact native vegetation allows increased access to feral species. Feral species can also be attracted to areas of human activity and personnel in remote locations will occasionally feed feral Cats. Impact can be kept to minor subject to recommendations.

Hydrological change
The drainage system and VSA 5 may be sensitive to hydrological change. The access route from the south passes through VSA 5 and crosses a number of minor drainage lines. These is a risk of a major impact if, for example, the access track greatly altered hydrology of VSA 5 or diverted water movement along drainage lines, but the impact risk can be reduced to minor subject to recommendations.

Altered fire regimes

The vegetation in general is fire-dependent and many of the fauna species are reliant on particular fire regimes, and therefore sensitive to any alteration to the fire regime. Fire regime and feral species can interact to increase pressure on a species. The proposed drilling program represents a source of fire that could affect fauna outside the survey area, including the adjacent Fitzgerald National Park. The impact of altered fire regimes in the Fitzgerald River National Park could be major and therefore a strict fire management plan needs to be developed to keep this risk low (see recommendations).

Disturbance (dust, noise, light).

The level of dust, noise and light from the proposed action is uncertain but impacts would be localised and therefore unlikely to be more than minor. An exception to this might be if exploration works take place during the breeding season for Carnaby's Black-Cockatoo (approximately August to December in the Ravensthorpe area). See recommendations below.

6 Recommendations

Section 5 (Impact Assessment) identified several potential adverse impacts upon fauna that may occur from the disturbance to the site from the proposed lithium exploration project. Although impacts are mostly expected to be Minor or less, any reduction in impacts is desirable, and some assessments of minor or negligible impacts are reliant on recommendations. Management strategies are recommended below to reduce the potential impacts of this development on fauna species.

Hydrological changes

- Ensure local hydrology is not affected, including alterations of runoff through stream diversions or topography modifications such as backfilling valleys or low points in the landscape.
- Care may need to be taken in placement of the access track through VSA 5 where granite is close to the surface and high levels of soil moisture appear to be present for at least part of the year.
- Avoid runoff from operations to ensure sediment or any chemicals do not enter waterways or minor valleys through installation of appropriate erosion control methods.

Loss of habitat

- Minimise the disturbance footprint and maintain large trees. The large Salmon Gums are important for fauna, including providing nesting hollows for significant species. Therefore, any large eucalypt tree should be avoided during movement of machinery. A 10m buffer is recommended around large trees as a precaution for the presence of nesting black-cockatoos.
- Clearly delineate areas to be cleared to minimise unnecessary vegetation loss.
- Rehabilitate as soon as practical.

Habitat fragmentation

- Minimise disturbance to the Phillips River and associated minor drainage lines.
- Rehabilitation post-disturbance.

Weed invasion

- Employ industry standard hygiene to avoid introducing weeds and dieback into the project area.

Ongoing mortality

- Educate employees on the vulnerability of some species to roadkill.
- Educate employees and contractors on the appearance of Malleefowl mounds so they can be avoided during movement of machinery off the access track.
- Conduct further surveys for Malleefowl mounds should impact areas expand.

Species interactions

- Rehabilitate access tracks as soon as possible to discourage access by feral fauna. In the long term, it may be necessary to develop a feral fauna management plan in conjunction with the Department of Parks and Wildlife.
- Ensure appropriate waste disposal during construction activities to avoid attracting feral species to the area.
- Educate personnel not to feed (deliberately or inadvertently) feral species.

Changes in fire regime

- Implement a fire management plan during construction activities to ensure wildfires do not occur as a result of activities and appropriate responses are in place should a wildfire occur.
- In the long term, discuss fire management with the Department of Parks and Wildlife due to the juxtaposition of the Fitzgerald River National Park.

Dust, noise, light and disturbance

- Minimise disturbance to small areas at a time.
- While it is recommended that all large trees be avoided (see above), the Department of Parks and Wildlife has suggested that active nests of Carnaby's Black-Cockatoo be given a 10m buffer from machinery movements. Finding active nests is very time-consuming, and therefore it is recommended that if activities are taking place in the August to December breeding period, any large eucalypt tree be afforded a 10m buffer from vehicle movements.

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8 Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species rich site is more valuable than a species poor site, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should

automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950* (Wildlife Conservation Act). In addition, the Western Australian Department of Environment and Conservation (DEC) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in **Appendix** 2.

Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Wildlife Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) 2: Species listed as Priority by the DEC but not listed under State or Commonwealth Acts.

In Western Australia, the DEC has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Wildlife Conservation Act but for which the DEC feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DPaW, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Wildlife Conservation Act 1950*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

Schedules used in the WA *Wildlife Conservation Act 1950*

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Environment and Conservation Priority species (species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4. (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 3. Ecological and threatening processes identified under legislation and in the literature.

Ecological processes are processes that maintain ecosystems and biodiversity. They are important for the assessment of impacts of development proposals, because ecological processes make ecosystems sensitive to change. The issue of ecological processes, impacts and conservation of biodiversity has an extensive literature. Following are examples of the sorts of ecological processes that need to be considered.

Ecological processes relevant to the conservation of biodiversity in Australia (Soule *et al.* 2004):

- Critical species interactions (highly interactive species);
- Long distance biological movement;
- Disturbance at local and regional scales;
- Global climate change;
- Hydroecology;
- Coastal zone fluxes;
- Spatially-dependent evolutionary processes (range expansion and gene flow); and
- Geographic and temporal variation of plant productivity across Australia.

Threatening processes (EPBC Act)

Under the EPBC Act, a key threatening process is an ecological interaction that threatens or may threaten the survival, abundance or evolutionary development of a threatened species or ecological community. There are currently 20 key threatening processes listed by the federal Department of the Environment (DotE 2014b):

- Competition and land degradation by rabbits.
- Competition and land degradation by unmanaged goats.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*).
- Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South.
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.
- Invasion of northern Australia by Gamba Grass and other introduced grasses.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.

- Predation by European red fox.
- Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha).
- Predation by feral cats.
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant).

General processes that threaten biodiversity across Australia (The National Land and Water Resources Audit):

- Vegetation clearing;
- Increasing fragmentation, loss of remnants and lack of recruitment;
- Firewood collection;
- Grazing pressure;
- Feral animals;
- Exotic weeds;
- Changed fire regimes;
- Pathogens;
- Changed hydrology—dryland salinity and salt water intrusion;
- Changed hydrology— such as altered flow regimes affecting riparian vegetation; and
- Pollution.

In addition to the above processes, DSEWPaC has produced Significant Impact Guidelines that provide criteria for the assessment of the significance of impacts. These criteria provide a framework for the assessment of significant impacts. The criteria are listed below.

- Will the proposed action lead to a long-term decrease in the size of a population?
- Will the proposed action reduce the area of occupancy of the species?
- Will the proposed action fragment an existing population?
- Will the proposed action adversely affect habitat critical to the survival of a species?
- Will the proposed action disrupt the breeding cycle of a population?
- Will the proposed action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?
- Will the proposed action result in introducing invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?
- Will the proposed action introduce disease that may cause the species to decline?
- Will the proposed action interfere with the recovery of the species?

Appendix 4. Vertebrate fauna expected to occur in the survey area.

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. These are:

- ALA = Atlas of Living Australia, searched September 2016;
- Nat Map = Naturemap Database, searched September 2016;
- Bird Data = Birdlife Australia's Birdata database, searched September 2016;
- RNO = Ravensthorpe Nickel
- BCE 2016 = Site inspection September 2016.

Status codes:

- CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 2 for full explanation.
- EPBC Act listings: E = Endangered, V = Vulnerable, M = Migratory (see Appendix 2).
- Wildlife Conservation Act listings: for all CS1 species S1 to 7 = Schedules 1 to 7 respectively, (see Appendix 2) with rankings shown in square parentheses: [e] = endangered, [v] = vulnerable.
- DEC Priority species: P1 to P5 = Priority 1 to 5 (see Appendix 2).
- LS = considered to be of local significance by Bamford Consulting Ecologists (see Appendix 2).

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Fish													
GALAXIIDAE													
Common Jollytail	*Galaxias maculatus*			X		Resident	X	X					
ATHERINIDAE													
Western Hardyhead	*Leptatherina wallacei*					Resident	X						
NANNOPERCIDAE													
Wester Pygmy-perch	*Edelia vittata*					Resident							
GOBIIDAE													
Bluespot Goby	*Pseudogobius olorum*					Confirmed resident	X						X

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Frogs													
HYLIDAE													
Slender Tree Frog	*Litoria adelaidensis*					Resident	X	X					
Spotted-thighed Frog	*Litoria cyclorhyncha*					Confirmed resident	X	X		X			X
LIMNODYNASTIDAE													
Western Spotted Frog	*Heleioporus albopunctatus*					Resident	X	X		X			
Moaning Frog	*Heleioporus eyrei*					Resident	X	X					
Pobblebonk, Western Banjo Frog	*Limnodynastes dorsalis*					Confirmed resident	X	X		X			X
White-footed Trilling Frog	*Neobatrachus albipes*					Confirmed resident						X	X
MYOBATRACHIDAE													
Kunapalari Frog	*Neobatrachus kunapalari*					Resident	X	X					
Bleating Froglet	*Crinia pseudinsignifera*					Confirmed resident	X	X					X
Crawling Toadlet	*Pseudophryne guentheri*					Resident	X	X					
Western Toadlet	*Pseudophryne occidentalis*					Resident	X	X					
Reptiles													
CARPHODACTYLIDAE													
Southern Barking Gecko	*Nephrurus milii*					Resident	X	X		X			
DIPLODACTYLIDAE													
Clawless Gecko	*Crenadactylus ocellatus ocellatus*					Resident	X	X		X			
South Coast Gecko	*Diplodactylus calcicolus*					Resident	X	X					
	Diplodactylus granariensis					Resident				X			
Spiny-tailed Gecko	*Strophurus spinigerus inornatus*					Resident	X	X		X			
GEKKONIDAE													
Marbled Gecko	*Christinus marmoratus*					Resident	X	X					

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
PYGOPODIDAE													
Sand-plain Worm-lizard	*Aprasia repens*					Resident	X	X		X			
Lined Worm-lizard	*Aprasia striolata*					Resident	X	X					
Marble-faced Delma	*Delma australis*					Resident	X	X		X			
Fraser's Delma	*Delma fraseri*					Resident	X	X		X			
Common Scaly-foot	*Pygopus lepidopodus*					Resident	X	X		X			
AGAMIDAE													
	Amphibolurus norrisi					Possible resident				X			
Western Heath Dragon	*Ctenophorus adelaidensis*					Resident				X			
Spotted Dragon	*Ctenophorus maculatus griseus*					Resident	X	X		X			
Western Bearded Dragon	*Pogona minor minor*					Resident	X	X		X			
SCINCIDAE													
Western Three-lined Skink	*Acritoscincus trilineatus*					resident	X	X		X			
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*					resident	X	X					
Chain-striped South-west Ctenotus	*Ctenotus catenifer*					resident	X	X					
Jewelled Sandplain Ctenotus	*Ctenotus gemmula*					resident	X	X		X			
Odd-striped Ctenotus	*Ctenotus impar*					resident	X	X		X			
King's Skink	*Egernia kingii*					resident	X	X					
Earless Skink Sp.	*Hemiergis initialis*					resident	X	X		X			
Lowlands Earless Skink	*Hemiergis peronii peronii*					resident	X	X		X			
South-western Orange-tailed Slider	*Lerista distinguenda*					resident	X	X		X			
Ravensthorpe Range Slider	*Lerista viduata*		P1			resident	X	X					
Common Dwarf Skink	*Menetia greyii*					Confirmed resident	X	X		X			X

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Shrubland Morethia Skink	*Morethia obscura*					Confirmed resident	X	X		X			X
Western Blue-tongue	*Tiliqua occipitalis*					Confirmed resident	X	X		X			X
Bobtail	*Tiliqua rugosa rugosa*					Confirmed resident	X	X		X			X
VARANIDAE													
Heath Monitor	*Varanus rosenbergi*					Confirmed resident	X	X		X			X
TYPHLOPIDAE													
Southern Blind Snake	*Anilios australis*					resident	X			X			
Prong-snouted Blind Snake	*Anilios bituberculatus*					resident	X						
BOIDAE													
South-West Carpet Python	*Morelia spilota imbricata*			X									
ELAPIDAE													
Common Death Adder	*Acanthophis antarcticus*		P3			resident	X	X					
Bardick	*Echiopsis curta*					resident	X	X					
Crowned Snake	*Elapognathus coronatus*					Confirmed resident				X		X	X
Tiger Snake	*Notechis scutatus*					resident	X	X		X			
Gould's Hooded Snake	*Parasuta gouldii*					resident	X	X		X			
	Parasuta nigriceps					resident							
Dugite	*Pseudonaja affinis affinis*					resident	X	X		X			
Mueller's Snake	*Rhinoplocephalus bicolor*					resident	X	X					
Birds													
DROMAIIDAE													
Emu	*Dromaius novaehollandiae*					Confirmed resident	X	X	X	X	X		X
Anatidae													
Black Swan	*Cygnus atratus*					Vagrant	X	X	X				
Freckled Duck	*Stictonetta naevosa*					Vagrant			X				
Australian Shelduck	*Tadorna tadornoides*					Vagrant	X	X	X				
Pink-eared Duck	*Malacorhynchus*					Vagrant	X		X				

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
	membranaceus												
Australian Wood Duck	*Chenonetta jubata*					Vagrant	X	X	X				
Pacific Black Duck	*Anas superciliosa*					regular visitor	X	X	X				
Australasian Shoveler	*Anas rhynchotis*					Vagrant	X		X				
Grey Teal	*Anas gracilis*					regular visitor	X	X	X				
Chestnut Teal	*Anas castanea*					Confirmed regular visitor	X	X	X				X
Hardhead	*Aythya australis*					Vagrant	X		X				
Blue-billed Duck	*Oxyura australis*		P4			Vagrant			X				
Musk Duck	*Biziura lobata*					Vagrant			X				
MEGAPODIIDAE													
Malleefowl	*Leipoa ocellata*	V S3				Confirmed resident	X		X	X	X		X old mounds
PHASIANIDAE													
Stubble Quail	*Coturnix pectoralis*					irregular visitor	X						
PODICIPEDIDAE													
Australasian Grebe	*Tachybaptus novaehollandiae*					regular visitor	X	X	X				
Hoary-headed Grebe	*Poliocephalus poliocephalus*					regular visitor	X	X	X				
Great Crested Grebe	*Podiceps cristatus*					irregular visitor			X				
THRESKIORNITHIDAE													
Australian White Ibis	*Threskiornis moluccus*					Vagrant			X				
Straw-necked Ibis	*Threskiornis spinicollis*					Vagrant	X		X				
Yellow-billed Spoonbill	*Platalea flavipes*					Vagrant			X				
ARDEIDAE													
Nankeen Night-Heron	*Nycticorax caledonicus*					regular visitor	X	X	X				
Cattle Egret	*Ardea ibis*	M S5				Vagrant	X						
White-necked Heron	*Ardea pacifica*					irregular visitor	X		X				
Eastern Great Egret	*Ardea modesta*	M				irregular visitor			X				

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
		S5											
White-faced Heron	*Ardea novaehollandiae*					Confirmed regular visitor	X						X
PELECANIDAE													
Australian Pelican	*Pelecanus conspicillatus*					Vagrant			X				
PHALACROCORACIDAE													
Little Pied Cormorant	*Phalacrocorax melanoleucos*					regular visitor	X		X		X		
Little Black Cormorant	*Phalacrocorax sulcirostris*					Vagrant	X	X	X				
Pied Cormorant	*Phalacrocorax varius*					Vagrant	X						
Great Cormorant	*Phalacrocorax carbo*					Vagrant	X		X				
ACCIPITRIDAE													
Black-shouldered Kite	*Elanus caeruleus*					regular visitor	X	X	X				
Square-tailed Kite	*Hamirostra isura*					regular visitor	X		X				
Little Eagle	*Hieraaetus morphnoides*					Resident	X		X				
Wedge-tailed Eagle	*Aquila audax*					Resident	X	X	X		X		
Brown Goshawk	*Accipiter fasciatus*					Resident	X	X	X				
Collared Sparrowhawk	*Accipiter cirrocephalus*					Resident	X	X	X				
Swamp Harrier	*Circus approximans*					rregular visitor			X				
Spotted Harrier	*Circus assimilis*					irregular visitor		X	X				
Whistling Kite	*Haliastur sphenurus*					Resident	X		X				
OTIDIDAE													
Australian Bustard	*Ardeotis australis*					Vagrant	X						
RALLIDAE													
Black-tailed Native-hen	*Tribonyx ventralis*					Vagrant	X		X				
Eurasian Coot	*Fulica atra*					Vagrant	X		X				
TURNICIDAE													
Painted Button-quail	*Turnix varius*					Confirmed resident	X	X	X		X		X
BURHINIDAE													
Bush Stone-curlew	*Burhinus grallarius*			X		locally extinct			X				
RECURVIROSTRIDAE													

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Black-winged Stilt	*Himantopus himantopus*					regular visitor			X				
Banded Stilt	*Cladorhynchus leucocephalus*					Vagrant			X				
Red-necked Avocet	*Recurvirostra novaehollandiae*					Vagrant			X				
CHARADRIIDAE													
Banded Lapwing	*Vanellus tricolor*					Vagrant	X	X	X				
Red-kneed Dotterel	*Erythrogonys cinctus*					irregular visitor			X				
Red-capped Plover	*Charadrius ruficapillus*					regular visitor			X				
Black-fronted Dotterel	*Elseyornis melanops*					regular visitor	X		X				
SCOLOPACIDAE													
Common Greenshank	*Tringa nebularia*	M S5				irregular visitor			X				
Red-necked Stint	*Calidris ruficollis*	M S5				irregular visitor			X				
Sharp-tailed Sandpiper	*Calidris acuminata*	M S5				irregular visitor							
COLUMBIDAE													
Common Bronzewing	*Phaps chalcoptera*					Confirmed resident	X	X	X		X		X
Brush Bronzewing	*Phaps elegans*					Resident	X	X	X		X		
Crested Pigeon	*Ocyphaps lophotes*					Confirmed resident	X	X	X		X		X
CUCULIDAE													
Horsfield's Bronze-Cuckoo	*Chalcites basalis*					Confirmed resident	X		X		X		X
Black-eared Cuckoo	*Chrysococcyx osculans*					Migrant	X		X				
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*					Migrant	X		X				
Pallid Cuckoo	*Cacomantis pallidus*					Confirmed migrant	X		X				X
Fan-tailed Cuckoo	*Cacomantis flabelliformis*					Confirmed migrant	X	X	X		X		X
TYTONIDAE													
Eastern Barn Owl	*Tyto alba delicatula*					irregular visitor	X	X	X				
STRIGIDAE													

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Southern Boobook	*Ninox boobook boobook*					Confirmed resident	X	X	X				X
PODARGIDAE													
Tawny Frogmouth	*Podargus strigoides*					Confirmed resident	X	X	X				X
CAPRIMULGIDAE													
Spotted Nightjar	*Eurostopodus argus*					Confirmed migrant	X		X				X
AEGOTHELIDAE													
Australian Owlet-nightjar	*Aegotheles cristatus*					Resident	X	X	X				
APODIDAE													
Fork-tailed Swift	*Apus pacificus*	M S5				Migrant, occasional visitor	X		X				
ALCEDINIDAE													
Laughing Kookaburra	*Dacelo novaeguineae*				int	Confirmed resident	X	X	X				X
Sacred Kingfisher	*Todiramphus sanctus*					Migrant	X		X				
MEROPIDAE													
Rainbow Bee-eater	*Merops ornatus*	M S5				Migrant	X	X	X				
FALCONIDAE													
Nankeen Kestrel	*Falco cenchroides*					Confirmed resident	X	X	X		X		X
Australian Hobby	*Falco longipennis*					Resident	X	X	X				
Brown Falcon	*Falco berigora*					Resident	X	X	X				
Peregrine Falcon	*Falco peregrinus*	S7				Resident	X	X	X				
CACATUIDAE													
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2				Confirmed regular visitor	X	X	X	X	X		X
Galah	*Cacatua roseicapilla*					Confirmed resident	X	X	X		X		X
Cockatiel	*Nymphicus hollandicus*					Vagrant	X						
PSITTACIDAE													
Purple-crowned Lorikeet	*Parvipsitta porphyrocephala*					Confirmed resident	X	X	X		X		X
Red-capped Parrot	*Platycercus spurius*					Confirmed resident			X		X		X

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Australian Ringneck	*Platycercus zonarius*					Confirmed resident	X	X	X		X		X
Western Rosella (Inland)	*Platycercus icterotis xanthogenys*		P4			irregular visitor	X	X	X				
Mulga Parrot	*Platycercus varius*					Vagrant			X				
Elegant Parrot	*Neophema elegans*					Confirmed resident			X				X
Budgerigar	*Melopsittacus undulatus*					Vagrant	X	X	X				
Western Ground Parrot	*Pezoporus wallicus flaviventris*	C S1				locally extinct	X	X	X				
Regent Parrot	*Polytelis anthopeplus*					Confirmed resident	X	X	X				X
CLIMACTERIDAE													
Rufous Treecreeper	*Climacteris rufus*					Resident	X	X	X				
MALURIDAE													
Blue-breasted Fairy-wren	*Malurus pulcherrimus*			X		Confirmed resident	X	X	X				X
Splendid Fairy-wren	*Malurus splendens*					Confirmed resident	X	X	X				X
Southern Emu-wren	*Stipiturus malachurus*			X		Resident			X		X		
MELIPHAGIDAE													
Black Honeyeater	*Sugomel niger*					irregular visitor	X	X					
Tawny-crowned Honeyeater	*Glyciphila melanops*					Confirmed resident	X	X	X		X		X
Western Spinebill	*Acanthorhynchus superciliosus*					Resident	X	X	X				
Pied Honeyeater	*Certhionyx variegatus*					irregular visitor			X				
Brown Honeyeater	*Lichmera indistincta*					Confirmed resident	X	X	X		X		X
New Holland Honeyeater	*Phylidonyris novaehollandiae*					Confirmed resident	X	X	X		X		X
White-cheeked Honeyeater	*Phylidonyris niger*					Resident	X	X	X		X		
Brown-headed Honeyeater	*Melithreptus brevirostris*					Confirmed resident	X	X	X		X		X

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Western White-naped (Gilbert's) Honeyeater	*Melithreptus chloropsis*					Resident	X	X	X				
White-fronted Chat	*Epthianura albifrons*					regular visitor	X	X	X				
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*					Resident	X	X	X				
Western Wattlebird	*Anthochaera lunulata*					Confirmed resident	X	X	X		X		X
Red Wattlebird	*Anthochaera carunculata*					Resident	X	X	X		X		
White-eared Honeyeater	*Lichenostomus leucotis*					Confirmed resident	X	X	X		X		X
Purple-gaped Honeyeater	*Lichenostomus cratitius*					Resident	X	X	X		X		
Yellow-throated Miner	*Manorina flavigula*					Confirmed resident	X		X		X		X
White-fronted Honeyeater	*Purnella albifrons*					Vagrant	X	X	X				
Singing Honeyeater	*Gavicalis virescens*					Resident	X	X	X				
Yellow-plumed Honeyeater	*Ptilotula ornata*					confirmed resident		X	X				X
DASYORNITHIDAE													
Western Bristlebird	*Dasyornis longirostris*	V S3				probably locally extinct		X	X				
PARDALOTIDAE													
Spotted Pardalote	*Pardalotus punctatus*					Confirmed resident	X	X	X		X		X
Striated Pardalote	*Pardalotus striatus*					Confirmed resident	X	X	X				X
ACANTHIZIDAE													
Shy Heathwren	*Calamanthus cautus*			X		Confirmed resident	X	X	X		X		X
Rufous Fieldwren	*Calamanthus campestris*			X		Confirmed resident	X		X		X		X
Redthroat	*Pyrrholaemus brunneus*			X		irregular visitor	X		X				
White-browed Scrubwren	*Sericornis frontalis*					Confirmed resident	X	X	X		X		X
Weebill	*Smicrornis brevirostris*					Confirmed resident	X	X	X		X		X
Western Gerygone	*Gerygone fusca*					Resident	X	X	X				
Inland Thornbill	*Acanthiza apicalis*					Resident		X	X		X		

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Chestnut-rumped Thornbill	*Acanthiza uropygialis*					irregular visitor			X				
Western Thornbill	*Acanthiza inornata*					irregular visitor	X		X				
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*					Resident	X	X	X				
POMATOSTOMIDAE													
White-browed Babbler	*Pomatostomus superciliosus*			X		Confirmed resident	X		X		X		X
PSOPHODIDAE													
Western Whipbird	*Psophodes nigrogularis nigrogularis*	E S2				Resident	X	X	X		X		
ARTAMIDAE													
Black-faced Woodswallow	*Artamus cinereus*					Resident	X		X				
Dusky Woodswallow	*Artamus cyanopterus*					Resident	X	X	X				
CRACTICIDAE													
Grey Butcherbird	*Cracticus torquatus*					Confirmed resident	X	X	X		X		X
Pied Butcherbird	*Cracticus nigrogularis*					irregular visitor	X	X	X				
Australian Magpie	*Cracticus tibicen*					Confirmed resident	X	X	X		X		X
Grey Currawong	*Strepera versicolor*					Confirmed resident	X	X	X		X		X
CAMPEPHAGIDAE													
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*					Confirmed resident	X	X	X		X		X
White-winged Triller	*Lalage tricolor*					Migrant	X		X				
NEOSITTIDAE													
Varied Sittella	*Daphoenositta chrysoptera*					Resident	X	X	X				
OREOICIDAE													
Crested Bellbird	*Oreoica gutturalis*			X		Resident	X	X	X		X		
PACHYCEPHALIDAE													
Crested Shriketit	*Falcunculus frontatus*					Resident	X		X				

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Gilbert's Whistler	*Pachycephala inornata*			X		Resident			X				
Western Golden Whistler	*Pachycephala occidentalis*					Confirmed resident	X	X	X		X		X
Rufous Whistler	*Pachycephala rufiventris*					Resident	X	X	X				
Grey Shrike-thrush	*Colluricincla harmonica*			X		Confirmed resident	X	X	X		X		X
RHIPIDURIDAE													
Willie Wagtail	*Rhipidura leucophrys*					Confirmed resident	X	X	X		X		X
Grey Fantail	*Rhipidura albiscapa*					Confirmed resident	X	X	X		X		X
MONARCHIDAE													
Magpie-lark	*Grallina cyanoleuca*					Confirmed resident	X	X	X		X		X
Restless Flycatcher	*Myiagra inquieta*					irregular visitor	X	X	X				
CORVIDAE													
Little Crow	*Corvus bennetti*					irregular visitor	X	X	X				
Australian Raven	*Corvus coronoides*					Confirmed resident	X	X	X		X		X
PETROICIDAE													
Western Yellow Robin	*Eopsaltria australis griseogularis*			X		Confirmed resident	X	X	X				X
Hooded Robin	*Melanodryas cucullata*			X		Resident		X	X				
Jacky Winter	*Microeca fascinans*			X		irregular visitor			X				
Scarlet Robin	*Petroica boodang*			X		Resident		X					
Red-capped Robin	*Petroica goodenovii*			X		Resident	X	X	X				
Southern Scrub-robin	*Drymodes brunneopygia*			X		Confirmed resident	X	X	X		X		X
HIRUNDINIDAE													
Welcome Swallow	*Hirundo neoxena*					resident to regular migrant	X	X	X		X		
Fairy Martin	*Petrochelidon ariel*					Vagrant			X				
Tree Martin	*Petrochelidon nigricans*					resident to regular migrant		X	X				
LOCUSTELLIDAE													
Rufous Songlark	*Megalurus mathewsi*					regular visitor	X	X	X				
Brown Songlark	*Megalurus cruralis*					Vagrant		X	X				

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
ZOSTEROPIDAE													
Silvereye	*Zosterops lateralis*					Confirmed resident	X	X	X		X		X
DICAEIDAE													
Mistletoebird	*Dicaeum hirundinaceum*					Resident			X				
ESTRILDIDAE													
Red-eared Firetail	*Stagonopleura oculata*			X		Resident	X	X	X				
MOTACILLIDAE													
Australasian Pipit	*Anthus australis*					irregular visitor		X	X		X		
Mammals													
TACHYGLOSSIDAE													
Short-beaked Echidna	*Tachyglossus aculeatus*					Confirmed resident	X	X			X		X
DASYURIDAE													
Chuditch	*Dasyurus geoffroii fortis*	V S3				Confirmed resident	X	X		X			X
Fat-tailed Dunnart	*Sminthopsis crassicaudata*					irregular visitor	X	X					
Grey-bellied Dunnart	*Sminthopsis fuliginosus fuliginosus*					Resident	X			X	X		
Gilbert's Dunnart	*Sminthopsis gilberti*					Resident	X	X					
White-tailed Dunnart	*Sminthopsis granulipes*					Resident	X	X		X			
Red-tailed Phascogale	*Phascogale calura*	E S6				Resident	X						
MYRMECOBIIDAE													
Numbat, Walpurti	*Myrmecobius fasciatus*	V S2				locally extinct		X					
PERAMELIDAE													
Quenda, Southern Brown Bandicoot	*Isoodon obesculus fusciventer*		P4			Resident	X	X					
BURRAMYIDAE													
Western Pygmy-possum	*Cercartetus concinnus*					Resident	X	X		X			
TARSIPEDIDAE													

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
Honey Possum	*Tarsipes rostratus*					Resident	X	X		X			
MACROPODIDAE													
Western Grey Kangaroo	*Macropus fuliginosus melanops*					Confirmed resident	X	X		X			X
Tammar Wallaby	*Macropus eugenii derbianus*		P4			Possibly locally extinct		X					
Brush Wallaby	*Notamacropus irma*		P4			Confirmed resident		X		X			X
PSEUDOCHEIRIDAE													
Western Ringtail Possum	*Pseudocheirus occidentalis*	V S2				Possible resident							old drey?
MURIDAE													
Mitchell's Hopping-mouse	*Notomys mitchellii*			X		Resident				X	X		
Ash-grey Mouse	*Pseudomys albocinereus*					irregular visitor	X	X		X	X		
Western Mouse	*Pseudomys occidentails*		P4			Resident	X	X		X			
Heath Mouse	*Pseudomys shortridgei*	V S3				Resident		X		X			
Moodit, Western Bush Rat	*Rattus fuscipes*					Resident	X	X		X	X		
MOLLOSIDAE													
White-striped Bat	*Tadarida (Austronomus?) australis*					Resident							
	Mormopterus ?pumilis					Resident							
VESPERTILIONIDAE													
Gould's Wattled Bat	*Chalinolobus gouldii*					Resident	X	X					
Lesser Long-eared Bat	*Nyctophilus geoffroyi geoffroyi*					Resident	X	X					
	Nyctophilus major					Resident							
Southern Forest-bat	*Vespadelus regulus*					Resident	X	X					
Introduced Mammals													
Dog/Dingo	*Canis lupus*				Int	locally extinct	X						
Cat	*Felis catus*				Int	Resident	X	X		X	X		

Common Name	Latin Name	Conservation Status			Int	Expected status in project area	Presence in Previous Literature and Present Survey						
		CS1	CS2	CS3	Int		ALA	Nat. Map	Bird Data	RNO 2010	RNO 2013/4	BCE 2016	Present survey
House Mouse	*Mus musculus*				Int	Resident	X	X		X	X		
Rabbit	*Oryctolagus cuniculus*				Int	Resident	X	X					
Red Fox	*Vulpes vulpes*				Int	Resident	X	X					
Total Number of Species	**250**	**18**	**8**	**21**	**6**								**67**

Appendix 5. Vertebrate species returned in database searches but unlikely to occur in survey area.

Database searches often return found nearby but that are unlikely to be present in the survey area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors, out-of-date Latin names, zoo specimens and subtleties of distribution that are not recognised in databases. The species listed below are considered highly unlikely to be found in the survey area (although some species could occur as very rare vagrants).

Table 7-1. Species returned in database searches which are unlikely to occur in the Ravensthorpe survey area.

Common name	Latin name
REPTILES	
Ornate Crevice Dragon	*Ctenophorus ornatus*
BIRDS	
Letter-winged Kite	*Elanus scriptus*
Yellow-nosed Albatross	Thalassarche chlororhynchos
Little Penguin	*Eudyptula minor*
Australasian Gannet	*Morus serrator*
Australian Pied Oystercatcher	*Haomatopus longirostris*
Sooty Oystercatcher	*Haematopus fuliginosus*
Hooded Plover	*Thinornis rubricollis*
Caspian Tern	*Hydroprogne caspia*
Crested Tern	*Thalasseus bergii*
Silver Gull	*Chroicocephalus novaehollandiae*
Pacific Gull	*Larus pacificus*
Australasian Bittern	*Botaurus poiciloptilus*
Eastern Ground Parrot	*Pezoporus wallicus*
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*
Rainbow Lorikeet	*Trichoglossus haematodus*
Rock Dove	*Columba livia*
Laughing Dove	*Streptopelia senegalensis*
Red-winged Fairy-wren	*Malurus elegans*

Appendix 6. Scoring system for the assessment of Black Cockatoo foraging values.

Site Score	Vegetation Description
	Carnaby's Black-Cockatoo
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples would be salt lakes and bare ground.
1	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <2%. Could include urban areas with scattered foraging trees. Blue Gum plantations are considered to have a score of 1 as foraging by Black-Cockatoos has been reported but appears to be unusual.
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with <10% projected foliage cover. • Open eucalypt woodland/mallee of small-fruited species. • Paddocks with melons or other weeds (a short-term, seasonal food source).
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with 10-20% projected foliage cover. • Woodland with tree banksias 2-10% projected foliage cover. • Eucalypt woodland/mallee of small-fruited species; Marri, if present, <10% project foliage cover.
4	Moderate foraging value. Examples: • Woodland with tree banksias 20-40% projected foliage cover. • Eucalypt woodland/forest with Marri 20-40% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia woodlands with tree banksias >40%. Vegetation condition moderate due to weed invasion and some tree deaths.
6	High foraging value. Example: • Banksia woodlands of key species (e.g. *B. attenuata, B. menziesii*) with projected foliage cover >60%. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.

Proteaceous plants include species such as *Banksia*, *Hakea* and *Grevillea.*

Appendix 7. Grading system used to assess potential nest trees for Black-Cockatoos.

Class	Description of tree and hollows /activity
1	Active nest observed; adult (or immature) bird seen entering or emerging from hollow.
2	Hollow of suitable size and angle (i.e. near-vertical) visible with chew marks around entrance.
3	Potentially suitable hollow visible but no chew marks present; or potentially suitable hollow present (as suggested by structure of tree, such as large, vertical trunk broken off at a height of >10m).
4	Tree with large hollows or broken branches that might contain large hollows but hollows or potential hollows are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by Black-Cockatoos.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

Appendix 8. Large trees recorded in survey area; these are potential black-cockatoo nesting trees. The tree rating is the likelihood the tree could provide a nesting site for black-cockatoos as described in Appendix 7.

Waypoint	Longitude	Latitude	Tree species	DBH (mm)	Tree rating	Tree status
RAT01	119.91741	-33.63173	'Woollybutt' eucalypt	1000	4	Alive
RAT02	119.91763	-33.63272	Salmon Gum	600	5	Alive
RAT03	119.91759	-33.63299	Salmon Gum	500	5	Alive
RAT04	119.91761	-33.63289	Salmon Gum	500	5	Alive
RAT05	119.91787	-33.63304	Salmon Gum	700	4	Alive
RAT06	119.91771	-33.63327	Salmon Gum	900	4	Alive
RAT07	119.91735	-33.63345	Salmon Gum	1000	3	Alive
RAT08	119.91760	-33.63360	Salmon Gum	800	4	Alive
RAT09	119.91796	-33.63389	Salmon Gum	1100	4	Alive
RAT10	119.91685	-33.66876	Eucalypt	1000	3	Dead
RAT11	119.91942	-33.65005	Woollybutt	400	3	Alive
RAT12	119.91950	-33.64997	Salmon Gum	400	5	Alive
RAT13	119.91965	-33.64968	Salmon Gum	800	5	Alive
RAT14	119.91992	-33.64872	Salmon Gum	500	3	Alive
RAT15	119.91994	-33.64869	Salmon Gum	500	5	Alive
RAT16	119.91994	-33.64863	Salmon Gum	600	3	Alive
RAT17	119.92015	-33.64647	Salmon Gum	700	5	Alive
RAT18	119.92105	-33.64340	Salmon Gum	800	5	Alive
RAT19	119.92066	-33.64363	Salmon Gum	400	3	Alive
RAT20	119.92024	-33.64416	Woollybutt	400	4	Alive
RAT21	119.91968	-33.64478	Salmon Gum	600	5	Alive
RAT22	119.91965	-33.64625	Salmon Gum	600	5	Alive
RAT23	119.91991	-33.64632	Salmon Gum	600	5	Alive
RAT24	119.92061	-33.63363	Salmon Gum	400	5	Alive
RAT25	119.92061	-33.63369	Salmon Gum	500	5	Alive
RAT26	119.92077	-33.63381	Salmon Gum	500	5	Alive
RAT27	119.92089	-33.63380	Salmon Gum	500	5	Alive
RAT27	119.92089	-33.63380	Salmon Gum	500	5	Alive

Appendix 9. Coordinates of records of Carnaby's Black-Cockatoos, Malleefowl mounds, and a possible old drey of the Western Ringtail Possum.

Waypoint	Longitude	Latitude	Remarks
RACBC01	119.91782	-33.63847	A female and male Carnaby's Black-Cockatoos foraging in Salmon Gum about 150m apart but keeping in contact with calls (1pm).
RACBC02	119.91714	-33.64048	A trio of Carnaby's Black-Cockatoos in the top of a Salmon Gum. Male and female were very close and making odd calls; hard to tell which was making the calls. Sounds were like a begging call. Third bird below the pair possibly young from previous year (1:15pm). Another bird flew in from the south and landed west of the project area near RACBC02 and a second bird was heard in this area (1:30pm).
RACBC03	119.92012	-33.63629	Pair of Carnaby's Black-Cockatoos flew in from the east about 3pm.
RACBC04	119.91821	-33.65191	Fresh foraging signs of Carnaby's Black-Cockatoos in mallet eucalypts.
RAMM01	119.91777	-33.66270	Old mallefowl mound about 2m cross, 0.3m high and 0.1m deep in centre. Mound is of clayey-loam ad covered with weeds but no large shrubs. No plant material or shell fragments; last used 10-20 years ago?
RAMM02	119.91771	-33.66175	Very old mallefowl mound with just a slight rise about 10m across.
RAMM03	119.91821	-33.65161	Old malleefowl mound
RAMM04	119.92023	-33.64841	Very old malleefowl mound about 3m across and 0.1m high, with 0.1m deep central depression.
RARTP1	119.91953	-33.64277	Possible old drey of Western Ringtail Possum in a dead acacia.

Malleefowl mounds recorded by Woodman personnel

Easting	Northing	Zone	Description
770546	6271237	50H	Very old Malleefowl mound
770527	6271906	50H	Old Malleefowl mound

Appendix 10. Annotated list of fauna recorded during the field survey.

No.	Species	Observational Notes
	Fish	
1	Bluespot Goby	Lots in shallows of Phillips River.
	Frogs	
2	Bleating Froglet	Calling from around pools along Moir Road.
3	White-footed Trilling Frog	Calling from around pools along Moir Road. Pale tadpoles probably of this species present.
4	Pobblebonk, Western Banjo Frog	Calling from around pools along Moir Road; also calling near Ravensthorpe Caravan Park.
5	Spotted-thighed Frog	One seen along Phillips River by botanists.
	Reptiles	
6	Common Dwarf Skink	Many seen active in sunshine.
7	Shrubland Morethia Skink	Seen regularly.
8	Bobtail	Several along highway including year 1 specimens that seem very small. One found in project area.
9	Western Blue-tongue	One crossing highway near Coracarup Road.
10	Crowned Snake	One active in south of project area mid-morning.
	Birds	
11	Emu	Several seen, including two separate parties of an adult male with small chicks.
12	Malleefowl	Reported in general area by caravan park owner and several old mounds found.
13	Chestnut Teal	Pair along minor creek just west of project area.
14	White-faced Heron	Two along Phillips Creek.
15	Common Bronzewing	Few along highway nearby.
16	Crested Pigeon	Few along highway near Ravensthorpe.
17	Spotted Nightjar	Several calling near Ground Parrot listening point along Moir Road.
18	Painted Button-quail	Foraging platelets in south of project area.
19	Brown Falcon	One over project area.
20	Carnaby's Black-Cockatoo	Pairs and small groups in areas of large eucalypts. Probably preparing to breed. Some foraging signs south of Phillips River.
21	Galah	Pairs in woodland areas inspecting hollows.
22	Australian Ringneck	Pairs and small groups throughout; some checking hollows.
23	Regent Parrot	Pairs throughout woodland areas; some checking hollows.
24	Red-capped Parrot	One at Ground Parrot listening site off Moir Road and one in south of project area.
25	Elegant Parrot	One along Peart Track south-west of project area.

No.	Species	Observational Notes
26	Purple-crowned Lorikeet	Flock of about 15 in Ravensthorpe and small groups throughout project area.
27	Laughing Kookaburra	Several pairs in woodland areas and along highway.
28	Pallid Cuckoo	One heard in project area.
29	Fan-tailed Cuckoo	Several calling.
30	Horsfield's Bronze-Cuckoo	One heard.
31	Southern Boobook	One heard along Moir Road.
32	Tawny Frogmouth	Two in south of project area.
33	Blue-breasted Fairy-wren	Several parties in woodland areas.
34	Splendid Fairy-wren	Party in dense vegetation along Phillips River.
35	White-browed Scrubwren	Parties in understory throughout woodland.
36	Shy Heathwren	One in north of project area in patch of scattered shrubs.
37	Rufous Fieldwren	Heard at ground parrot listening point along Cocanarup Road.
38	Weebill	Abundant in eucalypts.
39	Striated Pardalote	Many calling amongst eucalypts.
40	Spotted Pardalote	Heard in Ravensthorpe and a few in south of project area.
41	Red Wattlebird	Throughout woodland areas.
42	Yellow-throated Miner	Several along highway near project area.
43	White-eared Honeyeater	Throughout woodland areas.
44	New Holland Honeyeater	In thicket along Phillips River and in thickets near ground parrot listening point off Moir Road.
45	Tawny-crowned Honeyeater	Calling at ground parrot listening point off Moir Road and Cocanarup Road.
46	Brown Honeyeater	Few in dense thickets along Phillips River.
47	Brown-headed Honeyeater	Few parties in woodland areas.
48	White-plumed Honeyeater	Several amongst tall eucalypts in project area.
49	Grey Shrike-thrush	Calling from dense thickets along drainage lines.
50	Western (Golden) Whistler	Calling in woodland.
51	Southern Scrub-robin	At least three birds calling around ground parrot listening point off Moir Road and two birds calling around ground parrot listening point along Cocanarup Road.
52	Western Yellow Robin	Several in thickets in south of project area.
53	White-browed Babbler	Party heard in south of project area.
54	Black-faced Cuckoo-shrike	One in woodland area north of Phillips River.
55	Willie Wagtail	Regular along highway.
56	Grey Fantail	One in project area north of Phillips River and one to south.

No.	Species	Observational Notes
57	Grey Butcherbird	Several heard in project area.
58	Grey Currawong	Single bids and pairs seen regularly throughout.
59	Australian Raven	Few seen.
60	Australian Magpie	One heard in project area north of Phillips River, and common along highway. Group of three in south of project area.
61	Magpie-lark	Several along highway near Ravensthorpe.
62	Silvereye	Small groups throughout.
	Mammals	
63	Echidna	Diggings throughout project area and reported in region by caravan park owner.
64	Chuditch	One seen on Hopetoun Road by Caravan Park owner in early 2016.
65	Western Grey Kangaroo	Scats throughout and seen occasionally.
66	Brush Wallaby	Tracks at ground parrot listening point off Moir Road.
67	Western Ring-tailed Possum	Possible old drey in dense tall thicket along Phillips River

Appendix C: Dieback Management Program – Woodman Environmental 2016

Mt Cattlin Project
Dieback Hygiene Management Program

KINGSTON RESOURCES

OCTOBER 2016

WOODMAN ENVIRONMENTAL

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MT CATTLIN PROJECT - Dieback Hygiene Management Program

Prepared for: Kingston Resources

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O	Final	GW	DT	21/10/16	AP	

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DEFINITIONS

Term	Definition
Cleandown	The removal of soil, soil slurry and mud, vegetation material from vehicles, plant or machinery using either compressed air or a brush for dry material or a high pressure water washdown unit for wet material.
Clean on Entry Point	Positioned at designated management boundaries for the project area at which a hygiene procedure must be conducted.
DMP	Department of Mines and Petroleum
DPaW	Department of Parks and Wildlife
Dry soil conditions	When soil moisture content of open ground or on unsealed roads is not high enough to allow soil materials to adhere to vehicles, machinery equipment and footwear.
Hygiene Boundary	Boundary between Protectable Native Vegetation and other Hygiene Categories.
Hygiene Procedures	Tasks (e.g. Cleandown) that must be completed to ensure that plant pathogen (*P. cinnamomi*) is not spread into native vegetation.
Uninterpretable	Areas in which indicator plants are absent or too few to determine the presence or absence of disease caused by *P. cinnamomi*. These areas will include agricultural areas, areas that have been significantly disturbed and some native vegetation areas with few or no indicator species such as wetlands.
Protectable Area	Defines DPaW managed land over which the hygiene rule, for the plant pathogen *Phytophthora cinnamomi*, of clean on entry will apply (CALM 2003). For the purposes of the Exploration Project, Protectable areas include: • all areas of native vegetation in good condition; and • constitute an area that can be protected from the spread of *P. cinnamomi* by human vectoring during the exploration works.
Unprotectable Area	Consist of all areas not classed as Protectable (CALM 2003).
VCC	Vegetation Clearing Contractor
Dry Soil Conditions	Ground is too dry for soil to adhere to vehicle parts
Wet soil conditions	A general rule commonly applied is that greater than 5mm of rainfall over a 24 hour period will result in moist soil conditions high enough to allow soil materials to adhere to vehicles, machinery equipment and footwear.

EXECUTIVE SUMMARY

Kingston Resources (Kingston) is an ASX listed metals exploration company advancing four prospective lithium projects. Kingston has two prospects in Western Australian including Greenbushes and Ravensthorpe. The Mt Cattlin Project (Deep Purple Prospect) is located approximately 14 km south-west of the established Mt Cattlin lithium mine (Galaxy Resources) and 15 km south-west of Ravensthorpe. The Mt Cattlin Project Area (the Project Area) covers a total area of 169.76 ha (Figure 1).

Kingston is drilling pegmatite deposits within the Project Area during the 2016/17 period and has submitted a Program of Works (POW) to the Department of Mines and Petroleum (DMP). DMP responses to the POW application have identified the requirement for environmental studies and management actions along with the preparation of a dieback management program. This document fulfils the requirements of the request by DMP and provides the framework and procedures that Kingston will employ to minimise the risk of spreading dieback disease caused by *Phytophthora cinnamomi* during the planned operations.

1 INTRODUCTION

Kingston Resources (Kingston) is an ASX listed metals exploration company advancing four prospective lithium projects. Kingston has two prospects in Western Australian including Greenbushes and Ravensthorpe. The Mt Cattlin Project (Deep Purple Prospect) is located approximately 14 km south-west of the established Mt Cattlin lithium mine (Galaxy Resources) and 15 km south-west of Ravensthorpe. The Mt Cattlin Project Area (the Project Area) covers a total area of 169.76 ha (Figure 1).

The vegetation of the Project Area including the Deep Purple deposits was assessed by Woodman Environmental Consulting during September 2016 and found to be generally in excellent condition with some small areas showing evidence of disturbance and degradation. The survey indicated that the vegetation has very few flora species present known to be indicators of the presence of *Phytophthora cinnamomi* dieback. The vegetation therefore is considered to be uninterpretable for the disease and this management program considers all native vegetation in the Project Area to be protectable uninterpretable vegetation.

1.1 Aim and Objectives

The main objective of this Dieback Hygiene Management Program is:

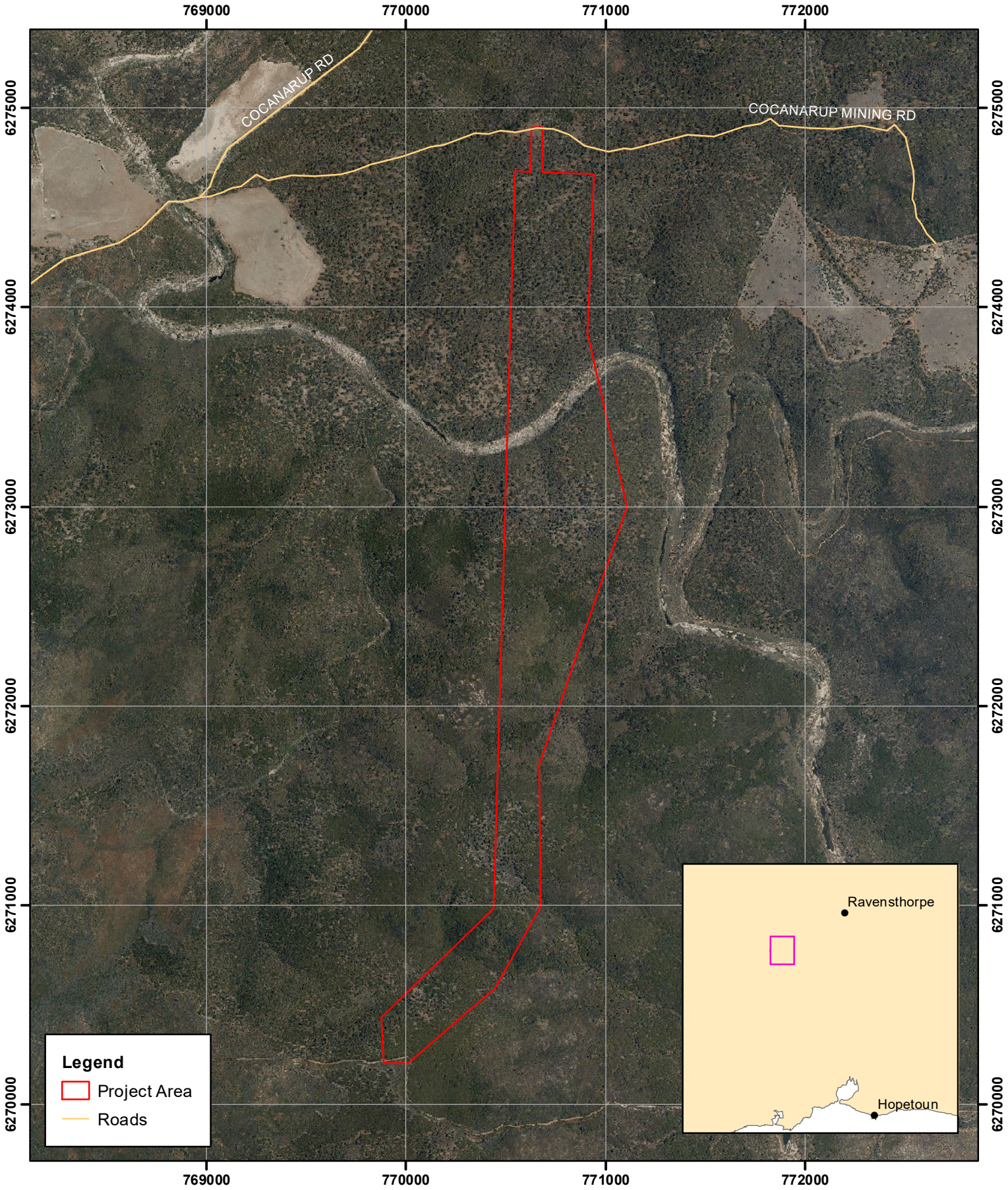
- to control the human-vectored spread of *Phytophthora cinnamomi* resulting from activities associated with the project.

Specific objectives include:

- provide information to project personnel that will enable them to effectively manage their activities to prevent the spread of dieback;
- provide a system of documentation and field controls to enable this issue to be managed effectively and ensure Kingston's commitments with regard to dieback hygiene are met;

This management program applies to the following proposed order of operations:

- Vegetation clearing
- Exploration drilling
- Site reinstatement



Mt Cattlin Project Area Location	Author: Greg Woodman	
	WEC Ref: KR16-34-02	
WOODMAN ENVIRONMENTAL	Filename: KR16-34-02-f01.mxd	**Figure**
	Scale: 1:25,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report KR16-34-02.	Revision: A - 04 October 2016	

2 BACKGROUND

P. cinnamomi is a largely soil-borne pathogen that invades and destroys the root and root collar cells of susceptible species primarily from the plant families Proteaceae, Epacridaceae, Dilleniaceae, Fabaceae, Xanthorrhoeaceae and Myrtaceae. This pathogen is a microscopic, fungus – like organism requiring warm moist conditions to survive and spread. The pathogen is commonly spread in infested soil material during road construction and other soil disturbing activities, and in water via both surface and sub-surface drainage. *P. cinnamomi* has been identified as the single most destructive plant pathogen in native plant communities in Western Australia.

Research conducted by a number of authors has shown that infestation by *P. cinnamomi* has significant detrimental impacts to vegetation communities in the Southwest of Western Australia. Impacts include significant reductions in canopy cover and ground cover (Crane and Shearer 2007) and reductions in species richness and plant density, particularly in the Proteaceae (Wills and Keighery 1994: Shearer and Dillon 1996: Shearer et. al. 2009: Shearer and Tippett 1989). Ongoing impacts include loss of biodiversity, habitat modification and altered local hydrology.

The Dieback Hygiene Management Program focuses on protecting good quality vegetation by preventing the introduction of *P. cinnamomi* from outside the site, or spread from other areas within the site through the use of "Clean on Entry" (COE) points and good exploration hygiene practices. The Department of Mines and Petroleum have produced a guidance document for the *Management of Dieback Disease in Mineral Exploration* (Government of WA 2006). The guidance states "exploration activities, in some circumstances, may only be permitted under dry soil conditions. Operations shall not be permitted:

- during wet months (late Autumn to Spring),
- immediately after sufficient rain has fallen to leave the surface wet or damp, and
- in swampy or other permanently moist areas."

Consultation with the DPaW Ravensthorpe District office (Peter Masters pers.comm.), indicated that the Cocanarup Road is an all-weather access route utilised regularly by the public and as such is regarded as potentially infested with *P. cinnamomi*. All other tracks in the vicinity of the Project Area are considered to be uninfested due to the intermittent nature of their use and trafficability. Access to the Project Area from Cocanarup Road will therefore be subject to hygiene measures to protect the native vegetation of the Project Area and vegetation along the subsidiary tracks.

The Dieback Hygiene Management Program has been developed for use during exploration drilling within the Project Area (Figure 1).

3 MANAGEMENT TASKS

A hygiene map showing areas protectable against the introduction of *P. cinnamomi*, areas non-protectable against the introduction of *P. cinnamomi*, and Clean on Entry point locations are presented in Attachment 1. The hygiene map forms the operational basis for this management program.

3.1 Training

1. Training will be given to all personnel involved in the drilling program during an initial safety and environment induction. This will include an explanation of the Project, and specific requirements with regard to dieback hygiene management.

   Training will also include inspection and cleandown procedures to be conducted at Clean on Entry points and will be provided to all personnel during project induction sessions by Kingston personnel.

3.2 Access

2. Access to the Project Area will be restricted to Dry Soil Conditions only. Kingston Resources will coordinate all contractor access to the Project Area and will utilise Bureau of Meteorology data and liaise with Ravensthorpe District DPaW personnel to confirm Dry Soil Conditions prior to each planned access.

3. Entry to the Project Area must be via established COE (Attachment 1) points to ensure hygienic entry. COE Point 1 will be the main point of entry off Cocanarup Road for exploration drilling of targets north of the Phillips River. COE Point 2 has been identified as the appropriate hygiene control point for accessing drilling targets south of the Phillips River.

4. Access will be unrestricted within the Project Area utilising existing roads and tracks identified as “approved access” as shown on the attached hygiene map (Attachment 1).

5. Kingston Resources shall establish the designated Clean on Entry points at the locations indicated on the attached Hygiene Map (Attachment 1).

6. Soil and vegetation material must not be transported across hygiene boundaries at any time.

7. Rock, limestone or fill material must not be introduced to the Project Area unless first classified as Phytophthora and weed free and approved by Kingston Resources. Suppliers of material should be audited by a qualified environmental scientist in consultation with DPaW to determine classification as weed and Phytophthora free.

8. All vehicles, plant and machinery must be clean prior to entering the Project Area on commencement of works.

9. The Vegetation Clearing Contractor and Drilling Contractor will supply documentary evidence to Kingston Resources in the form of an Initial Vehicle/Plant Hygiene Register (Attachment 2) that equipment has been cleaned of soil and vegetation material and inspected prior to commencement of work.

3.3 Clean on Entry Points

The locations of Clean on Entry points are shown on the Hygiene Map (Attachment 1).

10. Kingston Resources will ensure construction of designated Clean on Entry points, as shown in the Hygiene Maps (Attachment 1), are completed prior to access. An example layout for a Clean on Entry Point is provided in Attachment 3.

    Clean on Entry points will include:

    - a pad for inspecting and cleaning vehicles, plant and equipment if required. The pad is to be lined with either limestone (to a minimum depth of 20cm) or heavy-duty rubber matting (conveyor material) or other surface such as ramps constructed from wooden sleepers to allow equipment to be cleaned without resting in potentially contaminated mud. The pad is to be sloped away from native vegetation and not into existing drains or other vegetation and runoff from washdowns is to be directed to a shallow earthen sump;
    - a compressor for cleaning tracked equipment under dry soil conditions is to be provided when necessary;
    - a stiff bristled brush and broom for brushing soil material from equipment under dry conditions;
    - a high pressure water washdown unit for use during unexpected wet conditions. Note that should the washdown water be sourced from a secure source (town water supply or a bore drawing from a deep aquifer), then no dosing will be required. However, should washdown water be sourced from open waterbodies, rivers, dams or shallow bores the water for washdowns must be dosed with sodium hypochlorite (or equivalent product such as Phytoclean) to a minimum of 7 parts per million active chlorine or as directed on product directions to remove spores of *P. cinnamomi*.

11. Vehicles, plant and equipment will stop on the inspection pad at each Clean on Entry point prior to entering the Project Area and inspected for soil, soil slurry or vegetation material. Inspections will include tyres/wheels, undercarriage, belly plates, buckets and tracks of all equipment.

12. Should any of the mentioned materials be present, the equipment must be cleaned. Dry conditions will require a brushdown to remove dirt clods or vegetation. Dust does not have to be cleaned from the vehicle. Wet conditions with mud present will require a washdown with high pressure water.

13. Complete and fill out the Vehicle Washdown Register before proceeding and passing through the Clean on Entry point.

14. Prior to exiting the Clean on Entry point, the inspection pad must be cleaned of soil, mud or vegetation (deposit in sump). The driver of the vehicle/operator of plant will be responsible for the inspection and clean down.

15. Kingston Resources shall ensure that washdown units are supplied with appropriately dosed water at all times.

16. Clean on Entry points will be inspected daily by Kingston Resources and maintained as required.

3.4 Drilling Hygiene

17. Drill rigs will be inspected for adhered soil at the end of each hole and cleaned to minimise the potential for transport of disease within the Project Area.

18. Rig parts will be brushed down unless material is moist. Mud debris will be washed from the drill bits etc., and the effluent directed down-hole before moving the rig to the next hole location.

3.5 Reinstatement

19. During post-drilling reinstatement of the site the Clean on Entry points identified on Attachment 1 will be removed and the sumps backfilled by the Drilling Contractor.

20. All removed material is to be disposed of at an appropriate waste management facility.

3.6 Hygiene Breach Management

21. A hygiene breach is any breach of the hygiene procedures listed above. This includes such incidents as failing to inspect vehicle at designated Clean on Entry points, failing to washdown or clean vehicle if needed, and failing to adhere to authorised access routes.

22. All hygiene breaches must be reported to Kingston Resources immediately.

23. An incident investigation will be undertaken by Kingston Resources and the company will manage the situation in accordance with the following:

- Removal from site of personnel will occur after such incidents as passing through Hygiene Inspection Points without stopping and checking the vehicle; using non-approved access routes to or from site; and use of water on site from non-Phytophthora-free sources.
- Further training of Hygiene requirements will be undertaken by personnel who do not fill out the Hygiene Inspection Register; and for improper maintenance and use of the washdown units.

3.7 Inspections and Auditing

24. The site, Clean on Entry points and documentation will be monitored daily for compliance with hygiene procedures by Kingston Resources. Daily inspections of the active work site will include:
- the condition of inspection points and washdown equipment (washdown water levels, chlorine dose, cleanliness of site etc.);
- evidence of vehicles or machinery leaving the agreed access route or entering native vegetation without permission; and
- evidence of inspections or cleandowns not being completed.

25. On completion of drilling and site reinstatement a final audit of the site will be conducted by Kingston Resources.

26. Further training of personnel into dieback hygiene management will be provided if problems implementing hygiene are encountered.

4 PROJECT ACCOUNTABILITY AND SCHEDULE

TASK	SCHEDULE	ACCOUNTABLE PERSONNEL
	Training	
1	Prior to Initial Vegetation Clearing and ongoing	KR
	Access	
2	Prior to Initial Vegetation Clearing	KR
3	During Vegetation Clearing and Drilling	All
4	During Vegetation Clearing and Drilling	All
5	Prior to Initial Vegetation Clearing	KR
6	During Vegetation Clearing and Drilling	All
7	During Vegetation Clearing and Drilling	All
8	During Vegetation Clearing and Drilling	All
9	Prior to accessing the Site	VCC; DC
	Clean on Entry points	
10	Prior to Initial Vegetation Clearing	KR
11	During Vegetation Clearing and Drilling	All
12	During Vegetation Clearing and Drilling	All
13	During Vegetation Clearing and Drilling	All
14	During Vegetation Clearing and Drilling	All
15	During Vegetation Clearing and Drilling	All
16	During Vegetation Clearing and Drilling	All
	Drilling Hygiene	
17	During Drilling	DC
18	During Drilling	DC
	Reinstatement	
19	At Completion of Drilling	DC
20	At Completion of Drilling	DC
	Hygiene Breach Management	
21	During Vegetation Clearing and Drilling	All
22	During Vegetation Clearing and Drilling	DC
23	During Vegetation Clearing and Drilling	KR
	Inspections and Auditing	
24	During Vegetation Clearing and Drilling	KR
25	Post Site Reinstatement	KR
26	During Vegetation Clearing and Drilling	KR

VCC: Vegetation Clearing Contractor

DC: Drilling Contractor

KR: Kingston Resources

All: All Personnel

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Attachment 1: Hygiene Map

767500

770000

6275000

6272500

6270000

Legend

- Project Area
- Proposed Drilling Area
- Roads
- COE — Clean on Entry
  Kingston Resources Hygiene Point
- Approved Access

Dieback Hygiene Category

- Uninterpretable — UNINTERPRETABLE (PROTECTABLE)
  Where susceptible plants are absent or too few to enable the interpretation of *P. cinnamomi* presence or absence.

COCANARUP RD

COCANARUP MINING RD

COE 1

COE 2

COCANARUP RD

PHILLIPS RIVER

FUTURE ACCESS TRACK

PEART TRACK

767500

770000

WOODMAN ENVIRONMENTAL This map should only be used in conjunction with WEC report KR16-34-02.	***Phytophthora cinnamomi* Hygiene Map**	Author: Greg Woodman	**Attachment**
		WEC Ref: KR16-34-02	1
		Filename: KR16-34-02-a01.mxd	
	Revision: A - 04 October 2016 Scale: 1:20,000 (A3)	Projection: GDA 1994 MGA Zone 50	

Attachment 2: Initial Vehicle/Plant Hygiene Register

HYGIENE POINT INSPECTION REGISTER HYGIENE POINT # _____

REGISTRATION NUMBER/ PLANT NUMBER	TYPE OF EQUIPMENT	DATE	ACTIONS UNDERTAKEN (I=inspection; B=brush or blow down; W=wash down)	INSPECTION SIGNATURE

Attachment 3: Clean on Entry Point Layout

CLEAN ON ENTRY POINT LAYOUT – GENERAL