



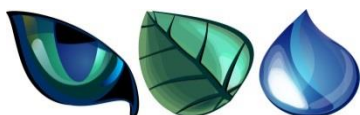
**November  
2018**

# **RAVENSTHORPE GOLD PROJECT Biological Survey**

## **Ravensthorpe, WA**



**Prepared on behalf of ACH Minerals Pty Ltd by:**



**Animal Plant Mineral Pty Ltd**

**Kundip Mine Site:**

M74/41, M74/51, M74/53, M74/135, M74/180,  
L74/34, L74/45

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## EXECUTIVE SUMMARY

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ACH Minerals Pty Ltd (ACH) proposes to develop the Ravensthorpe Gold Project (RGP) (the Project), located in the Fitzgerald subregion of the Esperance Interim Biogeographic region (IBRA) of Western Australia (WA), approximately 550 km southeast of Perth within the local government area of Ravensthorpe.

Animal Plant Mineral Pty Ltd (APM) was engaged by ACH to design and execute the requisite flora, vegetation, fauna and fauna habitat surveys of the Project area, to inform the referral of the RGP to the Office of the Environmental Protection Authority (OEPA), to enable the OEPA to determine if the Project requires formal assessment. Upon the determination that the RGP would be assessed as an Environmental Review Document, APM was commissioned to augment the survey work completed for the Referral. The guidance for the additional biological survey work came from comments received by the regulators on the Referral document.

This Biological Assessment Survey report is a synopsis of all biological survey work that has been undertaken for the RGP and for the same project area that was formerly known as the Phillips River Gold Project. Reporting on the flora and vegetation of the RGP focusses primarily on the work undertaken by APM with specific reference and comparison to the work of Craig *et al.* 2008 where appropriate locally, and reference to Markey *et al.* 2012 and Craig *et al.* 2008 where appropriate regionally. Reporting on the fauna and fauna habitat for the RGP is based on the consideration of all fauna data collected by Biota in 2003/4 and all fauna data collected by APM during 2016 and 2017.

Within the Kundip Mine Site there is longstanding legacy of mining practice stemming from the early 19<sup>th</sup> century to present day exploration projects. Subsequently, the vegetation within the 2016 and 2017 survey areas proposed to be impacted, reflects a mosaic of conditions from 'Completely Degraded' to 'Very Good' (Keighery 1994) or higher. One Weed of National Significance, the Bridal creeper *\*Asparagus asparagoides*, listed under the *Biosecurity and Agriculture Management Act 2007*, has been recorded within the Project area.

A total of 243 taxa (species, subspecies and varieties) belonging to 126 genera and 49 families were recorded within and adjacent to the 95 quadrats. The quadrats surveyed captured an average of 25, maximum of 48 and minimum of 4 species. The average richness recorded appears consistent with that detected by Markey *et al.* (2012). The compositional turnover (Whittaker's beta diversity; Whittaker 1965) was high at 0.83. The analysis of quadrats within vegetation units described by Craig *et al.* (2008) has allowed APM to update vegetation units within the Project area as Communities 1 through to 12.

Communities 2, 5, 7 and 9 (APM) were determined to be representative of the following conservation significant communities: 'Very Open Mallee over Melaleuca sp. Kundip Dense Heath' a Priority 1, Priority Ecological Community; and 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA' a Threatened Ecological Community (TEC/PEC). A small percentage of the vegetation consistent with the 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA' TEC will be cleared, and other parts lie adjacent to proposed disturbance areas. The proposed clearing is unlikely to have a significant residual impact on these communities, as any impacts will be temporary and reversible upon completion of mining.

The Department of Biodiversity Conservation and Attractions (DBCA) Threatened (Declared Rare) and Priority Flora Database, Threatened and Priority Flora List and the WA Herbarium Specimen Database found 11 Threatened flora and 63 Priority Flora species that could potentially occur within the Project area. PMST returned 11 botanical Matters of National Environmental Significance (MNES). Of these species 16 Priority flora have been previously recorded within the Project area according to the DBCA databases. APM's 2016 and 2017 surveys confirmed the presence of 7 Priority flora within the Project area including; *Calothamnus roseus*, *Hydrocotyle* sp. *Decipiens*, *Marianthus mollis*, *Melaleuca sophisma*, *Pultenaea craigiana*, *Stachystemon vinosus* and *Thysanotus parviflorus*. While some local populations will be directly impacted by the Project, the majority

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of Priority flora populations occur outside of the proposed disturbance footprint. The RGP is unlikely to have a significant impact on the occurrence of these species in the Ravensthorpe Range.

Collectively, database searches indicate that a total of 297 fauna species are expected to occur within 10 km of the Project area: the total of 297 species comprise 133 birds, 27 mammals, 7 amphibians, 33 reptiles and 97 invertebrates. NatureMap lists records for 5 amphibians, 29 reptiles, 14 mammals and 69 birds. The Atlas of Living Australia lists records for 7 amphibians, 26 reptiles, 13 mammals, 77 birds and 94 invertebrates.

A search of the EPBC Act list of protected species and Threatened Ecological Communities considered to be MNES indicated 15 fauna species of conservation significance (comprising of 11 birds and 4 mammals) have the potential to occur in habitats that may be present within 10 km of the Project area. While the DBCA database search returned historical records of 34 Conservation Significant fauna (comprising of 20 birds, 11 mammals, 2 reptiles and 1 insect).

Three fauna habitats were identified as occurring within the Project area and include; 'Low Dense Forest / Forest', 'Damplands and Drainage Lines' and 'Low Woodland Mallee and Heath'. Fauna trapping and opportunistic collection recorded a total of 101 terrestrial vertebrate fauna species in the Project area, including 54 bird species, 12 mammals (9 native and 3 introduced), 29 reptiles and 6 amphibians. Bat acoustic recordings undertaken in Biota (2004) and APM surveys returned acoustic signatures for 4 species.

Conservation significant fauna recorded during fauna surveys within the Project Area include the following:

- Birds – Carnaby's Black Cockatoo, Peregrine Falcon, Malleefowl, and Western Whipbird (Mallee).
- Mammals – Chuditch/Western Quoll, Quenda/Southern Brown Bandicoot and Western Brush Wallaby.
- Reptiles – Ravensthorpe Range Slider Skink.

It is unlikely that the RGP will have a significant impact on any of the above listed species, particularly given the occurrence of similar and undisturbed habitat immediately outside of the Project area and throughout the Ravensthorpe Range. Species such as the Peregrine Falcon and Carnaby's Cockatoo have a large foraging territory and APM has confirmed an absence of suitable natural breeding habitat within the Project area due to the lack of hollow-bearing trees and cliff recesses.

ACH are committed to supporting a Masters Research project for Chuditch and Malleefowl in conjunction with Edith Cowan University.

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## CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>11</b>
1.1	Project and Location .....	11
1.2	Scope of Work.....	15
<b>2</b>	<b>BACKGROUND AND SUPPORTING INFORMATION .....</b>	<b>18</b>
2.1	Relevant Legislation .....	18
2.2	Land Use .....	18
2.3	Climate.....	18
2.4	Biogeographic Regionalisation.....	20
<b>3</b>	<b>METHODOLOGY.....</b>	<b>27</b>
3.1	Contributing Authors .....	27
3.2	Database Searches .....	27
3.3	Field Survey.....	28
<b>4</b>	<b>FLORA AND VEGETATION RESULTS .....</b>	<b>40</b>
4.1	Desktop Survey .....	40
4.2	Field Survey.....	55
<b>5</b>	<b>TERRESTRIAL VERTEBRATE FAUNA RESULTS .....</b>	<b>76</b>
5.1	Desktop Survey .....	76
5.2	Field Survey.....	85
<b>6</b>	<b>DISCUSSION AND CONCLUSION .....</b>	<b>109</b>
6.1	Impacts to Flora of Conservation Significance.....	109
6.2	Impacts to Vegetation of Conservation Significance .....	110
6.3	Impacts to Fauna of Conservation Significance .....	111
<b>7</b>	<b>REFERENCES .....</b>	<b>123</b>
	<b>APPENDICES.....</b>	<b>130</b>

## APPENDICES

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Appendix 1: Conservation Codes for Western Australia Flora and Fauna.....	131
Appendix 2: Ravensthorpe and Cocanarup Geology Map .....	132
Appendix 3: 2004 Biota Biological Survey Report.....	133
Appendix 4: 2005 Biota Biological Survey Report.....	134
Appendix 5: EPBC Act Protected Matters Search .....	135
Appendix 6: NatureMap Search – 10 km buffer .....	136
Appendix 7: Atlas of Living Australia Database Search – 10 km buffer .....	137
Appendix 8: DBCA Threatened (Declared Rare) and Priority Flora Database Search.....	138
Appendix 9: DBCA Fauna Database Search .....	139
Appendix 10: NatureMap Search – 6 km buffer .....	140

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Appendix 11: Atlas of Living Australia Database Search – 5 km buffer .....	141
Appendix 12: Vegetation Condition Scale (Keighery 1994) .....	142
Appendix 13: Fire Scars in the vicinity of the Ravensthorpe Gold Project .....	143
Appendix 14: Ard Patrick Survey 2017 .....	144
Appendix 15: Vegetation Community Profiles .....	145
Appendix 16: Flora taxa recorded by APM within the Ravensthorpe Gold Project area .....	146

## FIGURES

---

Figure 1-1: Regional Location of the Ravensthorpe Gold Project.....	12
Figure 1-2: Ravensthorpe Gold Project Disturbance Footprint .....	14
Figure 2-1: Ravensthorpe Weather Station Meteorological Data (BoM, 2017). Data is gained from BoM Site Number 010633, with rainfall data from 117 years and temperature data from 56 years.....	19
Figure 3-1: APM (2018) Permanent Flora Quadrats within the Ravensthorpe Gold Project Area .....	30
Figure 3-2: APM Fauna Data Collection Points at the Ravensthorpe Gold Project Area .....	34
Figure 4-1: Monthly rainfall for Ravensthorpe in 2017. BoM Site Number 010633.....	40
Figure 4-2: Conservation Significant Flora Identified by Department of Biodiversity Conservation and Attractions Database Search as Occurring within the Ravensthorpe Gold Project Region .....	51
Figure 4-3: Department of Biodiversity Conservation and Attractions Threatened and Priority Ecological Communities of the Ravensthorpe Range .....	54
Figure 4-4: APM (2018) Vegetation Communities of the Ravensthorpe Gold Project Area.....	57
Figure 4-5: Vegetation Representative of Priority and Threatened Ecological Communities at the Ravensthorpe Gold Project Area.....	68
Figure 4-6: Vegetation Condition at the Ravensthorpe Gold Project Area .....	70
Figure 4-7: Records of Priority Flora collected by APM at the Ravensthorpe Gold Project Area .....	72
Figure 4-8: Location of <i>Asparagus asparagoides</i> and other Annual Weeds (Buffer Zone) and Eradication Zone at the Ravensthorpe Gold Project Area .....	75
Figure 5-1: Capture Rates for Honey Possum in the Scott River National Park (Bradshaw in prep.) .....	85
Figure 5-2: Fauna Habitats and Conservation Significant Fauna Records within the Ravensthorpe Gold Project Area .....	97
Figure 5-3: APM (2018) Survey Tracks within the Ravensthorpe Gold Project Area .....	103

## TABLES

---

Table 1-1: Disturbance at the Ravensthorpe Gold Project .....	13
Table 2-1: Rainfall and Temperature Averages for Ravensthorpe Weather Station (BoM, 2017a). Data is gained from BoM Site Number 010633, with rainfall data from 117 years and temperature data from 56 years. ....	19
Table 2-2: Geological units intersecting with the Project area at a resolution of 1:100 000 (Witt 1997). ....	21

---

Table 2-3: Existing Flora and Fauna Surveys and Investigations of the Ravensthorpe Gold Project and Surrounds.....	23
Table 3-1: Black Cockatoo Nesting Tree Assessment .....	33
Table 3-2: Target Conservation Significant Fauna Species and Method of Trapping .....	33
Table 3-3: Funnel Trap Survey Effort .....	35
Table 3-4: Pit Trap Survey Effort.....	35
Table 3-5: Frog Acoustic Monitoring Survey Effort.....	36
Table 3-6: Bat Acoustic Monitoring Survey Effort .....	36
Table 3-7: Bird Monitoring Survey Effort.....	36
Table 3-8: Thermal Trigger Camera Survey Effort .....	37
Table 3-9: Aluminium Box Trap Survey Effort.....	38
Table 3-10: Cage Trap Survey Effort .....	39
Table 3-11: Turtle Trap Survey Effort .....	39
Table 4-1: Conservation Significant Flora Potentially Occurring in the Ravensthorpe Gold Project Area .....	43
Table 4-2: Priority and Threatened Ecological Communities of the Ravensthorpe Gold Project Region .....	53
Table 4-3: Relationship between Craig <i>et al.</i> 's (2008) and APM (2017) New Floristic Communities in the Ravensthorpe Gold Project Area (with exception of Completely Degraded areas). .....	56
Table 4-4: Full Description of the Craig <i>et al.</i> (2008) Vegetation Communities that Could be Representative of Local TECs and PECs.....	59
Table 4-5: Species Recorded in 1 Quadrat Intersecting with Craig <i>et al.</i> 's (2008) Dcir ( <i>Dryandra cirsoides</i> ) Polygon (bold and shaded taxa are those identified as characteristic floristic elements of the Kwongan TEC). .....	61
Table 4-6: Species Recorded in 12 quadrats Intersecting with Craig <i>et al.</i> 's (2008) Efal/Eple Polygons (bold and shaded taxa are those identified as characteristic floristic elements - singleton species were removed unless determined as a characteristic floristic element). .....	63
Table 4-7: Species recorded in 5 quadrats intersecting with Craig <i>et al.</i> 's (2008) Eple/Bmed polygons. Bold and shaded taxa are those identified as characteristic floristic elements. Singleton species were removed unless determined as a characteristic floristic element. ....	65
Table 4-8: Species Recorded in 1 Quadrat Intersecting with Craig <i>et al.</i> 's (2008) Mx polygon (bold and shaded taxa are those identified as characteristic floristic elements).....	66
Table 4-9: Threatened and Priority Ecological Community Impacts .....	67
Table 4-10: Flora of Conservation Significance Recorded within the Ravensthorpe Gold Project Area .....	71
Table 5-1: Conservation Significant Fauna Potentially Occurring and those Recorded During the Surveys in the Ravensthorpe Gold Project Area .....	77
Table 5-2: Avifauna Census Data .....	86
Table 5-3: Fauna Captured or Recorded in the Ravensthorpe Gold Project Area .....	91
Table 5-4: Bat Species Recorded in the Ravensthorpe Gold Project Area.....	94
Table 5-5: Conservation Significant fauna expected or recorded in the Ravensthorpe Gold Project area .....	99
Table 6-1: Black Cockatoo Nesting Tree Assessment .....	112

## PLATES

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Plate 1: The old Kundip battery .....	11
Plate 2: Unstable shafts in the Kundip mining area.....	11
Plate 3: Abandoned building in the Kundip mining area .....	11
Plate 4: * <i>Asparagus asparagoides</i> Weed Patch (APM, 2016) .....	74



## ABBREVIATIONS

Symbols and Units	Meaning
%	Percentage
*	Introduced plant species
DBH	Diameter at Base Height
°C	Degrees Celsius
ha	Hectare
km	Kilometre
m	Metre
mm	Millimetre

Abbreviation	Meaning
ACH	ACH Minerals Pty Ltd
ANZECC	Australian and New Zealand Environment Conservation Council
AoLA	Atlas of Living Australia
APM	Animal Plant Mineral Pty Ltd
BAM Act	<i>Biosecurity and Agriculture Management Act 2007 (WA)</i>
Biota	Biota Environmental Sciences Pty Ltd
BoM	Bureau of Meteorology
CAMBA	China and Australian Migratory Bird Agreement 1986
Cth	Commonwealth
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DPaW	Department of Parks and Wildlife
DoE	Department of Environment
DoEE	Department of the Environment and Energy
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i>
FRNP	Fitzgerald River National Park
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
JAMBA	Japan and Australian Migratory Bird Agreement 1974
L	Miscellaneous tenement
M	Mining tenement
MNES	Matters of National Environmental Significance
MS	Ministerial Statement
OEPA	Office of the Environmental Protection Authority
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
PRP	Phillips River Project
RGP	Ravensthorpe Gold Project
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement 2007
sp.	Species (Unspecified)
spp.	Multiple species (Unspecified)
subsp.	Sub-species
SRNP	Stirling Range National Park
TEC	Threatened Ecological Community
var.	Variety
WA	Western Australia

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WC Act	<i>Wildlife Conservation Act 1950 (WA)</i>
WONS	Weeds of National Significance

## 1 INTRODUCTION

### 1.1 PROJECT AND LOCATION

ACH Minerals Pty Ltd (**ACH**) proposes to develop the Ravensthorpe Gold Project (RGP) (the Project), located in the Fitzgerald subregion of the Esperance Interim Biogeographic region (IBRA) of Western Australia (WA), approximately 550 km southeast of Perth and 17 km southeast of the town of Ravensthorpe (Figure 1-1).

ACH purchased the Project from Silver Lake Resources Ltd (**Silver Lake**) on 15 July 2016, with settlement occurring in August 2016. Originally titled the Phillips River Project (**PRP**), the Project was referred to the Environmental Protection Authority of Western Australia (**EPA**) and the Commonwealth Department of Environment and Energy (**DoEE**) in 2005. The DoEE determined the PRP to be “Not a Controlled Action”. The State Minister for the Environment approved the PRP in 2006 (by Ministerial Statement 716), with approval lapsing in 2011 after the proponents failed to make a substantive commencement on the Project and declined to request an extension to the approval. As a consequence, the Project was referred by new proponents ACH (the **Proponent**) to the EPA on 13 December 2016 for consideration.

The RGP will comprise the Kundip Mine Site (Figure 1-1). The site has a long history of mining, containing both native vegetation and historic mining legacies (see Plates 1 to 3). Both sites are accessible from the Hopetoun-Ravensthorpe Road.



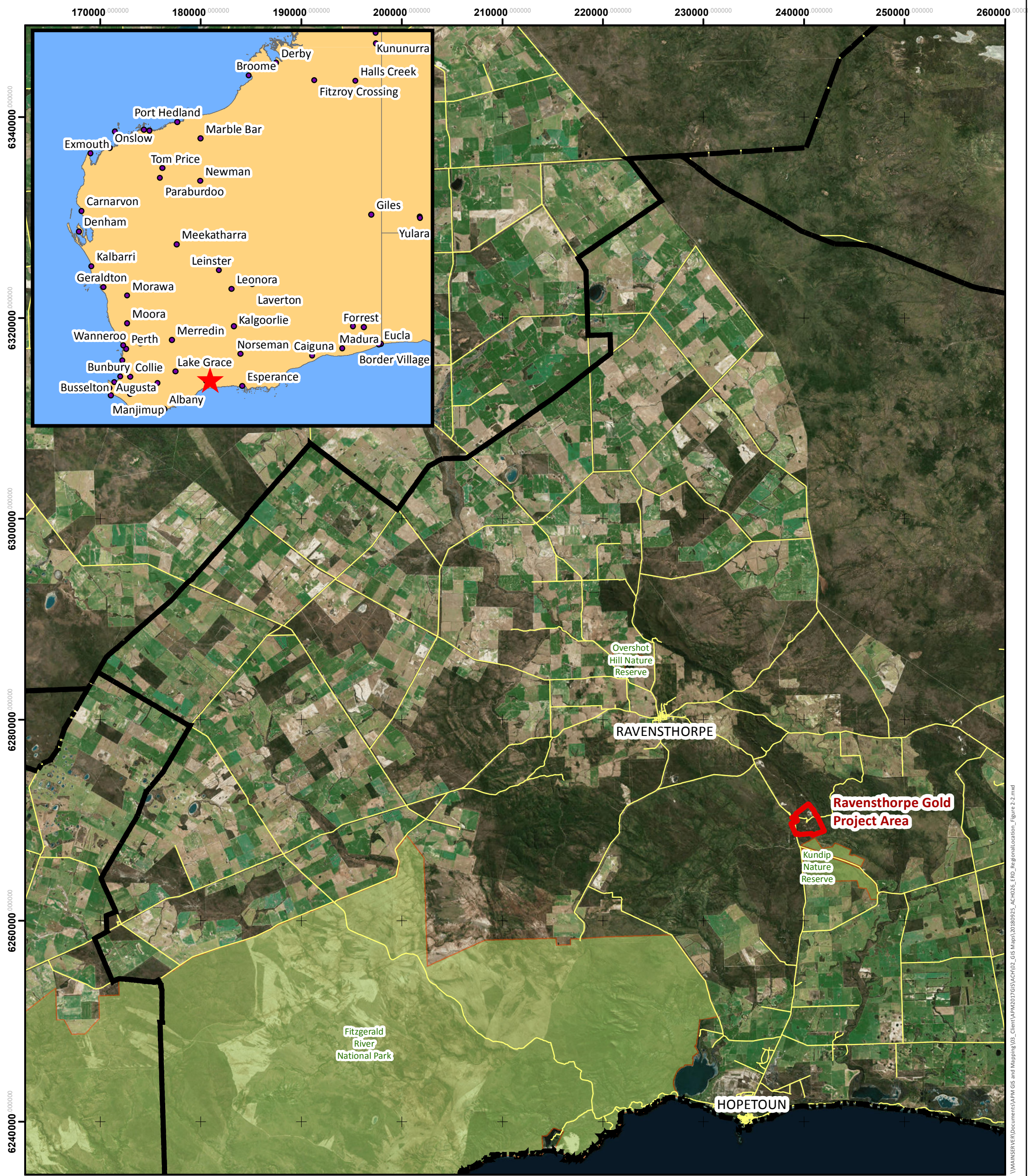
Plate 1: The old Kundip battery



Plate 2: Unstable shafts in the Kundip mining area



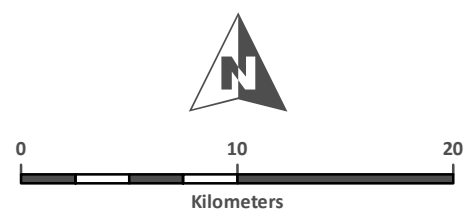
Plate 3: Abandoned building in the Kundip mining area



**Figure 1-1: Regional Location of the Ravensthorpe Gold Project**

**LEGEND**

- Ravensthorpe Gold Project Area
- Nature Reserves
- Ravensthorpe Shire Boundary
- Major Roads



Date: 25/09/2018  
 Scale: 1:350,000  
 GDA 1994 MGA Zone 51  
 Author: sarah@animalplantmineral.com.au



The expected life of mine (**LOM**) at Kundip is approximately 8 years and includes the following elements:

- Open pit mining of the Kaolin, Harbour View and Flag deposits and subsequent underground mining of the Harbour View and Flag deposits;
- Construction and operation of mineral processing facilities;
- Construction of a Tailings Storage Facility (**TSF**);
- Construction of water storage facilities and surface water diversion structures;
- Construction of two waste rock landforms (**WRL**) and a run of mine (**ROM**) pad;
- Construction of an access road from Hopetoun – Ravensthorpe Road to Kundip Mine Site and various internal roads within the site; and
- Construction of ancillary support infrastructure (e.g. offices, workshops, ablutionary facilities).

The Mine Site contains a Disturbance Footprint of 244.7 ha within a 428.4 ha Development Envelope (Table 1-1, Figure 1-2). Historic disturbance has led to the condition of 70.9 ha of vegetation in the site to be classified as 'Completely Degraded' (Keighery, 1994). There is 49.3 ha of existing disturbance in the Project area.

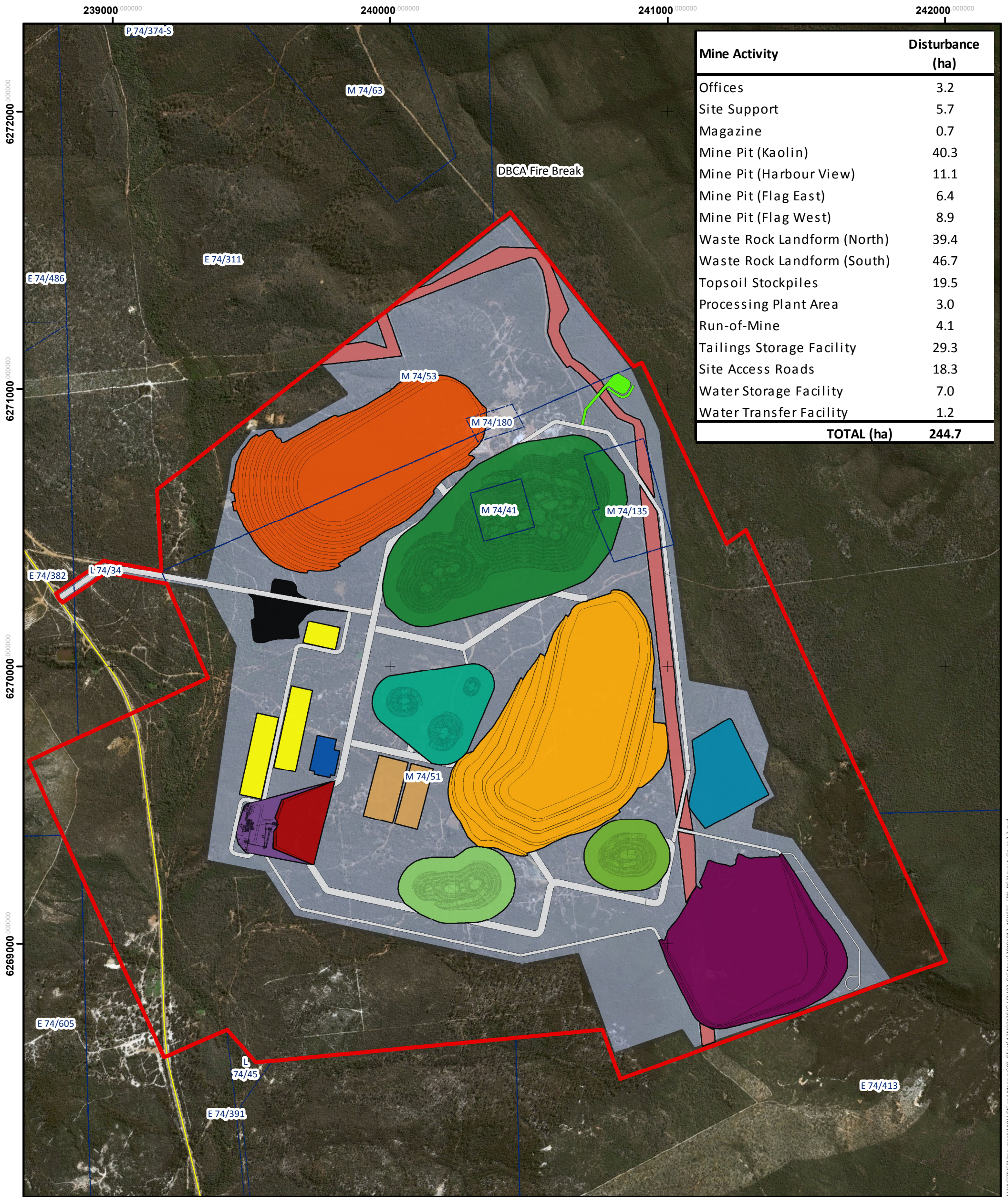
**Table 1-1: Disturbance at the Ravensthorpe Gold Project**

Mine Site	Proposed Development Envelope (ha)	Proposed Disturbance Footprint (ha)	Existing Disturbance (ha)
Kundip	428.4	244.7	49.3

The Project is a revision of the previously approved PRP. Since Ministerial Approval was received for the PRP in March 2006, a number of changes have occurred that directly and indirectly impact the Project resulting in key differences between the PRP and this proposal. Of most significance, the PRP contemplated trucking Kundip ore to the RAV8 Nickel Project (**RAV8**) for treatment in a pre-existing processing facility. RAV8 ceased production in 2007 and the site has largely been rehabilitated. In this revised proposal processing will be undertaken at the Kundip Mine Site, removing the requirement for a 17 km haul road to traverse a proposed Nature Reserve to the east and adjacent to the Project. As processing will occur on-site it will be a requirement to construct a TSF at the Kundip Mine Site. In all other respects, the basic elements of the Kundip Mine Site are unchanged from what was approved in 2006, being open pit and underground mines, WRLs and associated surface infrastructure.

Myamba Mine Site has been removed from the Project. This removes the requirement to truck ore between Myamba Mine Site and Kundip Mine Site for processing. No disturbance will occur at Myamba Mine Site, there will be no impacts to ground water and there will be no requirement to construct a power-water corridor within a road reserve immediately adjacent to the Kundip Nature Reserve. Myamba Mine Site was previously approved in 2006 as part of the PRP.

*This document reports on the biological attributes of the Project area that may be influenced by the development of the RGP.*

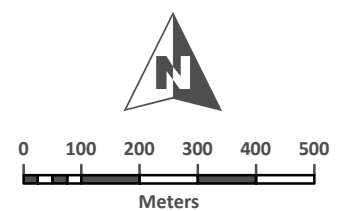


**Figure 1-2: Ravensthorpe Gold Project Disturbance Footprint**

**LEGEND**

**RGP Mine Activities**

- Offices
- Site Support
- Magazine
- Mine Pit (Kaolin)
- Mine Pit (Harbour View)
- Mine Pit (Flag East)
- Mine Pit (Flag West)
- Waste Rock Landform (North)
- Waste Rock Landform (South)
- Topsoil Stockpile
- Topsoil Stockpile (DBCA Fire Break)
- Processing Plant Area
- Run-of-Mine
- Tailings Storage Facility
- Roads
- Water Storage Facility
- Water Transfer Facility
- RGP Development Envelope
- Ravensthorpe Gold Project Area
- Mining Tenements
- Major Roads



Date: 12/10/2018  
 Scale: 1:13,000  
 GDA 1994 MGA Zone 51  
 Author: sarah@animalplantmineral.com.au

## 1.2 SCOPE OF WORK

Animal Plant Mineral Pty Ltd (**APM**) was engaged by ACH to design and execute the requisite flora, vegetation, fauna and fauna habitat surveys to inform the referral to the Office of the Environmental Protection Authority (**OEPA**) to enable the OEPA to determine if the Project requires formal assessment. The methodology for the biological survey was determined by an assessment of the proposed and current disturbance, the location of the site and the context of the proposed development relative to the surrounding land use, and the previous biological survey work that had been undertaken as part of a previous environmental assessment process. The survey scope was then discussed in liaison with the OEPA and the Department of Biodiversity Conservation and Attractions (**DBCA**).

Upon the determination that the RGP would be assessed as an Environmental Review Document, APM was commissioned to augment the survey work completed for the Referral. The guidance for the additional biological survey work came from comments received by the regulators on the Referral document.

Generally, the scope included an on-ground assessment of the Kundip Mine Site and included the then power and water corridor adjacent to the Kundip Nature Reserve. It also included a reconnaissance and desktop assessment for the cleared pastoral land that was initially the proposed Myamba Mine Site, which has since been removed from the Project layout (Figure 1-2).

This Biological Assessment Survey report is a synopsis of all biological survey work that has been undertaken for the RGP and PRP, as relevant.

Reporting on the flora and vegetation of the RGP focusses primarily on the work undertaken by APM in 2016 through to 2018, with specific reference and comparison to the work of Craig *et al.* (2008) where appropriate locally and regionally, and reference to Markey *et al.* (2012) where appropriate regionally.

Reporting on the fauna and fauna habitat for the RGP is based on the consideration of all fauna data collected by Biota in 2003/4 and all fauna data collected by APM during 2016 and 2017.

### 1.2.1 Flora and Vegetation

1. APM undertook a Reconnaissance level survey in August 2016 within the Project Area. The survey was aimed at gathering broad information about the Project Area. To achieve this aim vegetation mapping (Craig *et al.* 2008) was ground-truthed, the extent of current disturbances quantified, a targeted flora survey was commenced, and opportunistic flora sampling conducted;
2. In May 2017, a targeted search for the Priority Ecological Community (PEC) '*Heath on Komatiite of the Ravensthorpe Range Area*' was undertaken. An initial desktop investigation of finer scale geological units (1:100 000) revealed that the 'komatiite' geology type did not occur in the RGP sites within the Project area. Nevertheless, an on-ground survey (21 person days active in the field) was undertaken where all possible geology types (and their associated vegetation) were searched for the presence of indicator species;
3. In July 2017 a flora and vegetation field survey comprising 21 person days active in the field was undertaken focussing on the collection of flora samples from quadrats representative of all vegetation types. The work was to enable the confirmation of the presence/absence of the Threatened Ecological Community (TEC) '*Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA*'. This survey also marked the commencement of broader vegetation sampling to refine the mapping boundaries of the existing vegetation map of the Ravensthorpe Range (Craig *et al.* 2008);

4. In October 2017, a spring flora and vegetation survey comprising 14 person days active in the field was undertaken comprising a grid search of the proposed Disturbance Footprint to determine the presence/absence of species of conservation significance that were difficult to detect at other times of the year. This survey also included the continuation of broader vegetation sampling to refine the mapping boundaries of the existing vegetation map of the Ravensthorpe Range (Craig *et al.* 2008). In addition, a targeted Priority flora search (2 person days active in the field) along the proposed drill lines at the Ard Patrick exploration lease just north of the Project Area was undertaken for a Vegetation Clearing Permit application (**VCP**);
5. During all of the above-mentioned surveys, opportunistic observations of the patterns and identity of weed species occurring on the Project were collected;
6. In August 2018 a targeted survey for proteaceous and myrtaceous flora and the Priority *Hydrocotyle* sp. *Decipiens* was undertaken within the rehabilitated RAV8 site and the disturbed low-grade stockpiles at Kundip; and
7. In September 2018, a reconnaissance survey was undertaken (3 person days active in the field) to support a VCP application at the Welcome Stranger exploration lease.

This biological assessment survey report does not cover *Phytophthora Dieback*, which has been historically established through numerous surveys (Glevan, 2006, NRG Consultancy (2010) and Terratree, 2012) of the Project Area.

### 1.2.2 Terrestrial Fauna

A summary of the work undertaken to address specific impacts to terrestrial fauna is provided:

1. The 2016 Spring Fauna Surveys (August and September) targeted Conservation Significant fauna with a high likelihood of occurrence in the area based on the suitability of habitat present and previous historical species records (Biota 2004, 2005). The targeted survey utilised aluminium box traps, cage traps, pit traps, funnel traps, turtle traps and camera traps and acoustic recording devices. All opportunistic observations of other species were recorded.
2. In July 2017 a second targeted fauna survey (14 person days active in the field and more than 500 trapping nights) was undertaken to more confidently determine the presence/absence of the Heath Mouse (*Pseudomys shortridgei*), across the RGP following a possible record of one individual on the north-eastern boundary of the Project area. Other data collection that took place during this survey included:
  - 70 cage trapping nights targeting the Chuditch (*Dasyurus geoffroii*) following the recording of one individual on a motion sensitive camera during the fauna survey of 2016.
  - Call playback for the Western Whipbird (Mallee) (*Psophodes nigrogularis* subsp. *oberon*) to augment records collected during the 2004 biological survey work for the PRP.
3. In October 2017 a third targeted survey, comprising 10 person days active in the field and more than 400 trapping nights was initiated to:
  - Resolve the absence of the Heath Mouse in the RGP;
  - Contribute to records of the Chuditch in the RGP; and
  - Detect the presence of Western Whip Bird (*Psophodes nigrogularis* subsp. *oberon*), the Western Bristlebird (*Dasyornis longirostris*) and Western Ground Parrot (*Pezoporus flaviventris*) comprising call play back and acoustic monitoring pre-dawn and post-dusk.



This survey comprised over 400 aluminium box trap nights, 40 cage trap nights, 8 predawn and 8 post-dusk, one-hour acoustic survey sessions.

During this survey further attempts were made to find trees suitable for Carnaby's Black-Cockatoo. 4 trees of suitable Diameter at Base Height (DBH) were identified, none of which contained hollows. GPS records and measurements of these trees were recorded (refer to section 3.3.3).

The mention of the Dibbler (EN) (*Parantechinus apicalis*) in the methodology section of the original biological survey led to it being included in the list of targeted fauna for additional work. However, this species was not recorded in the original survey (verified by Tony Start from DBCA), and therefore no further investigation of the Dibbler was undertaken.

## 2 BACKGROUND AND SUPPORTING INFORMATION

### 2.1 RELEVANT LEGISLATION

Species considered to be of National conservation significance are protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under this Act, activities that may have a significant impact on a species of National conservation significance must be referred to the Department of Environment (DoE) for assessment. In WA, all native flora and fauna species are protected under the *Wildlife Conservation Act 1950* (WC Act). Flora species that are considered likely to become Rare, Threatened with extinction or are presumed to be Extinct are specially protected by four schedules in the WC Act. Fauna are protected by seven schedules in the WC Act which accommodate all fauna species in need of special protection, that are rare (likely to become extinct) or that are presumed extinct, as well as birds subject to International Agreements relating to the protection of migratory birds. The Department of Biodiversity Conservation and Attractions (DBCA) classifies specially protected flora and fauna into eight categories as listed in Appendix 1. The lists also include potentially threatened species that do not meet survey criteria or are otherwise data deficient, these species are listed as Priority 1, 2 or 3. While species that are adequately known, are rare but not threatened, are listed as Priority 4.

Some species are protected under the *Australian and New Zealand Environment Conservation Council* (ANZECC, 1991) Convention (Cth). Migratory birds are further protected under the following agreements:

- 1974 Japan and Australian Migratory Bird Agreement (JAMBA) (Cth);
- 1975 RAMSAR Convention on Wetlands;
- 1983 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
- 1986 China and Australian Migratory Bird Agreement (CAMBA) (Cth);
- 2004 Agreement on the Conservation of Albatrosses and Petrels (ACAP);
- 2007 Republic of Korea-Australian Migratory Bird Agreement (ROKAMBA); and
- 2006 East Asian - Australasian Flyway Partnership.

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as Matters of National Environmental Significance (MNES) under the EPBC Act.

### 2.2 LAND USE

The Project lies within the Shire of Ravensthorpe. Historical and current land use activities within the Shire of Ravensthorpe are pastoralism focused towards grazing and cereal crop cultivation. Some conservation areas are present along with unallocated crown land, crown reserves and forestry plantations (Comer *et al.*, 2003).

### 2.3 CLIMATE

The RGP is in the Goldfields-Esperance region of WA which experiences a Mediterranean-type climate characterised by mild summers and cool wet winters.

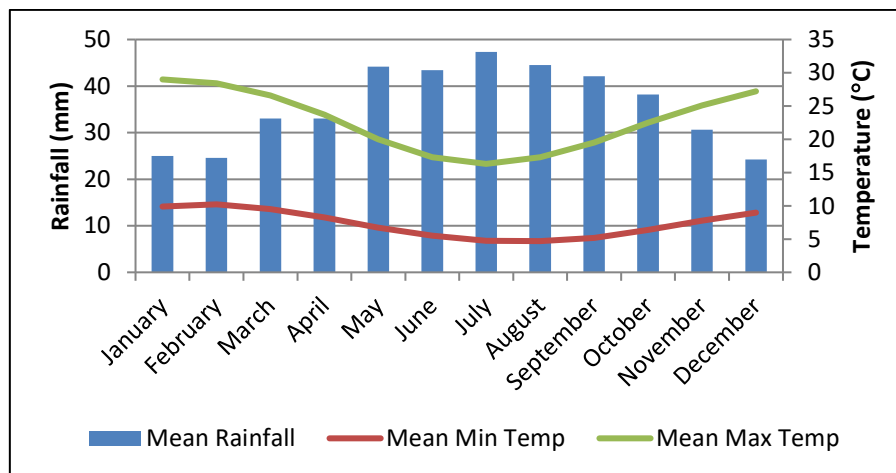
The nearest Bureau of Meteorology (BoM) weather station is at Ravensthorpe (BoM Site Number: 010633), less than 5 km north of the Kundip mine site. The Ravensthorpe station has been recording rainfall and

temperature since 1901. Average monthly and annual rainfall, temperature and evaporation is presented in Table 2-1.

**Table 2-1: Rainfall and Temperature Averages for Ravensthorpe Weather Station (BoM, 2017a). Data is gained from BoM Site Number 010633, with rainfall data from 117 years and temperature data from 56 years.**

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Rainfall (mm)	24.8	26.5	32.8	32.8	44.1	43.6	47.3	45.1	42.3	38.0	30.5	24.1	427.2
Mean Max Temp (°C)	29.0	28.3	26.6	23.7	20.0	17.3	16.3	17.3	19.5	22.5	25.1	27.2	22.8
Mean Min Temp (°C)	14.1	14.6	13.6	11.8	9.6	7.9	6.7	6.7	7.4	9.1	11.1	12.8	10.5

Recorded data suggests that the Project area receives 427 mm of rain on an annual basis and experiences temperatures ranging between 2.2°C and 40.8°C (the lowest and highest monthly averages recorded) (BoM, 2017a). January is the hottest month with a mean maximum temperature of 29.0°C and mean minimum of 14.1°C. July is the coolest month with a mean maximum temperature of 16.3°C and mean minimum of 6.7°C (BoM, 2017a) (Table 2-1). Figure 2-1 illustrates the Project area is subject to climate typical of the region, with mild summers and wet winters. These observations are consistent with the description attributed to Ravensthorpe under the *Regional Development Commissions Act 1993* (see Mediterranean climate in Goldfields-Esperance region), IBRA regionalisation (see Mediterranean climate in the ESP01 subregion, DoE 2017).



**Figure 2-1: Ravensthorpe Weather Station Meteorological Data (BoM, 2017). Data is gained from BoM Site Number 010633, with rainfall data from 117 years and temperature data from 56 years.**

## 2.4 BIOGEOGRAPHIC REGIONALISATION

The IBRA (version 7.1; DoE 2017) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (Thackway and Cresswell, 1995). The mapping completed by Beard in 1975 provides the basis for the IBRA bioregions. IBRA mapping (Version 7.1; DoE 2017), places the Project within the Esperance Plains Bioregion.

The Esperance Plains Bioregion is characterised by a plain broken by quartzite ranges and granite domes/outcrops. These inselbergs provide habitat diversity and unique microclimates compared to regional conditions, supporting a high species diversity and level of endemism (Hopper *et al.* 1997; Keppel *et al.* 2016). Dominant vegetation of the region is predominantly proteaceous scrub and mallee heaths on sandplain. Other vegetation types include herbfields and heaths, which are rich in endemics. Eucalypt woodlands also occur in gullies and foot-slopes (Thackway and Cresswell, 1995).

The Esperance Plains Bioregion is further subdivided into the Fitzgerald (ESP01) and Recherche (ESP02) sub-regions. The Project lies entirely within the Fitzgerald (ESP01) sub-region. Topography of the Fitzgerald subregion is variable, ranging from sandplains on the coast to granite and quartzite ranges on both the coastal plain and inland (Comer *et al.*, 2003). Soils are predominantly duplex, deep and yellow sands on the plains with shallow sandy soils on mountain ranges (Comer *et al.*, 2003). Herein, the vegetation is presumed diverse (species and endemic-rich), with *Eucalyptus* the most prevalent genera. The most prominent vegetation types include coastal dune woodlands, coastal shrublands and heathlands, mallee shrubland and heath. Herbfields and heaths can be found on granite tors, quartzite ranges and greenstone heath and shrublands (Comer *et al.*, 2003).

### 2.4.1 Land Systems

The land system approach to the management of rangelands results from the identification of recurring patterns of topography, soil and vegetation and involves their use in land use and catchment planning. The Project area falls into an area which has not been surveyed in the context of land systems. For this reason, information for this report is limited to IBRA and soil-landscape characterisation.

Soil-landscape mapping delineates repeating patterns of soils and landscapes across WA's rangelands and arid interior (Tille, 2006). Mapping completed by the Department of Agriculture places the Project within the Ravensthorpe Zone of the Stirling Province (Government of Western Australia, 2016). The Stirling Province is broadly described as a gently undulating plain in the northeast, occasionally broken by small valleys, low narrow rocky hills and ridges, and granitic tors and bosses. In the northwest a gently undulating plain occurs, dissected by short rivers. In the western half of the Stirling Province, hills and ranges are noticeable features (Tille, 2006).

Soils of the Ravensthorpe Range are mostly shallow gravels and red/brown non-cracking clays (Tille, 2006). Witt's (1997) 1: 100 000 geological series places the Project area between two major geological units, including; the Ravensthorpe Terrene spanning the northern section, and to the south the Mount Barren Group. For detailed breakdown of the corresponding geological formations see Table 2-2 and Appendix 2. The Ravensthorpe Zone itself is characterised as rolling low hills on greenstone (mafic and ultramafic). South-flowing rivers moderately dissect the zone and soils are red fine-textured (Government of Western Australia, 2016).

Vegetation in the Stirling Province is highly complex, however can be summarised broadly as a transitional vegetation type dominated by open mallee scrub and woodlands in the northeast, to mallee scrub and salmon gum-yate woodlands on the Ravensthorpe Range (Tille, 2006). Accompanying these Myrtaceous mosaics is a presumed rich and highly endemic 'kwonganoid' vegetation type characterised by proteoid scrub patches.

**Table 2-2: Geological units intersecting with the Project area at a resolution of 1:100 000 (Witt 1997).**

Geological code	Description
AAv	Mafic to intermediate tuff and agglomerate, and related epiclastic rocks (mainly andesite), subordinate dacite; metamorphosed.
ACc	Chert; metamorphosed
Czf	Ferruginous deposits—undifferentiated; mainly ferruginous quartz sand and granules, and angular rock fragments with ferruginous cement
Czi	Sand with limonitic pisoliths and gravel
Czl	Lateritic deposits—laterite, ferruginous duricrust, and ferricrete; massive
Czsr	Undulating sandplain, Reworked Czs; sandplain deposit—unconsolidated sand; remnants of peneplain.
PLBk	Kundip quartzite; quartzite, massive to coarsely bedded; minor pelitic rocks.
PLBsc	Dolomite; metamorphosed; massive to finely bedded; locally ?stromatolitic.
PLBy	Pelitic schist and phyllite with minor psammitic layers
Qa	Quaternary alluvium
Qcb	Colluvium—rubble of boulders and sand derived from MOUNT BARREN GROUP; minor outcrops of MOUNT BARREN GROUP
TPp	White to yellow to brown siltstone, silty sandstone, and spongolite; mainly deeply weathered.

#### 2.4.2 Surface Water

The Kundip mine site is characterised by moderate slopes of 5 - 10%. Landscape elevation is highest in the north-eastern corner of the site at 228 m Average Heights Datum (AHD), falling to 127 m AHD in the south-western corner. Surface drainage in the region trends north to south from the Ravensthorpe Range towards the Southern Ocean. The main drainage channels in the Kundip area are the Phillips River, Steere River and Jerdacuttup River. Stream channels within the Kundip mine site are moderately spaced forming an integrated network of convergent creeks. The divide between the Steere River sub-catchments and Jerdacuttup River catchment to the east varies in elevation from 232 at the divide to 80 m AHD at the river. The primary channel of the Steere River falls from 145 to 117 m AHD over a 2.75 km north-to-south stretch adjacent the western extent of the site.

#### 2.4.3 Wetlands

The Project Area does not include and is not near any wetlands listed as Ramsar sites (Landgate, 2016). Towards the western boundary of the Project there are patches of habitat dominated by myrtaceous species strongly associated with natural drainage lines.

#### 2.4.4 Previous Surveys

The Phillips River Gold Project (PRP) was referred to the Federal Department of Environment (DoE) for assessment in 2005 where it was determined to be “Not a Controlled Action”.

The PRP was also assessed based on proponent information by the EPA in 2006. Following the recommendations of the EPA, the Minister for Environment approved the project (Ministerial Statement (MS) 0716). This approval is no longer valid due to the time that has elapsed without substantial commencement on the Project.

Survey work was done to underpin the environmental approvals at the time of assessment. The Kundip site specific vegetation survey work done by G.F Craig in 2004 and local vegetation mapping completed for the Ravensthorpe Ranges by the South Coast Natural Resource Management Group provides a wealth of background information to give context to the 2016 flora survey work. In 2004 a fauna survey consultant (Biota Environmental Sciences) executed a comprehensive baseline biological assessment over two seasons. The first survey was done at a sub-optimal time of the year, but the second survey was done in ideal conditions in spring (Biota 2004). This work provides a valuable baseline for the 2016 fauna survey work and the data are included herein as capture records for the Project.

A summary of biological surveys previously undertaken within the Project Area and regionally, are provided in Table 2-3 and these data have been used to guide 2016-2018 biological survey methodology.

**Table 2-3: Existing Flora and Fauna Surveys and Investigations of the Ravensthorpe Gold Project and Surrounds**

Report Title	Consultant	Year	Scale	Survey Type	Purpose
<b>Flora and Vegetation</b>					
Kundip Mining Leases M74/41, 51, 53, & 135 and P74/153 – Vegetation and Flora Survey.	G.F Craig	2004	Local	Declared Rare, Priority Flora and Vegetation Mapping Survey.	Kundip mining leases M74/41, 51, 53 & 135 and P74/153. Delineate vegetation community boundaries.
Kundip Mining Leases – Pultenaea and Melaleuca.	G.F Craig	2004	Local	Targeted Declared Rare Flora Survey.	Declared Rare and Priority Flora listed Pultenaea sp. Kundip and Melaleuca sp. Kundip. Estimation of population density confirming P1 status.
Kundip Haul Road – Declared Rare and Priority Flora Survey.	G.F Craig	2004	Local	Declared Rare and Priority Flora Survey.	Proposed haul road between Kundip and the RAV8 mine sites.
Kundip Mining Leases – Waste Dumps and Haul Road – Declared Rare and Priority Flora Surveys.	G.F Craig	2005	Local	Declared Rare and Priority Flora Survey.	Northern and Southern Waste Dumps and Haul Road. Add to known taxa records and estimate potential disturbance of mine design.
Kundip Mining Leases Monitoring Quadrat Survey	E. Hickman	2007	Local	Vegetation Mapping Survey.	Collect baseline data for the monitoring of potential impacts of mining activities on the vegetation communities within the mining leases at Kundip.
Vegetation of the Ravensthorpe Range: Mt Short to South Coast Highway.	Craig et al.	2007	Regional	Vegetation Mapping Survey.	Ravensthorpe Range between Mt Short and South Coast Highway. Pilot study, mapping the entirety of the Range's vegetation and delineate community boundaries undertaken for the Biodiversity Inventory Program of South Coast NRM.
Vegetation of the Ravensthorpe Range, Western Australia: Mt Short to Kundip, 1: 10,000 scale	Craig et al.	2008	Regional	Vegetation Mapping Survey.	Ravensthorpe Range between Mt Short and Kundip. Determining extent and occurrence of representative vegetation units to support conservation and land use planning.
Power and Water Easement, Trilogy to Kundip Mine Site. Declared Rare and Priority Flora Survey	E. Hickman	2008	Local	Declared Rare and Priority Flora Survey.	Clearing Permit and Permit to Take for construction of power and water easement between the Trilogy mine site and the Kundip mine site.
Floristic Survey of the Ravensthorpe Range 2007	Kern et al.	2008	Regional	Vegetation Mapping Survey.	Document conservation values and assess regional context in the Ravensthorpe Range for future proposed developments. Commissioned by Department of Environment and

Report Title	Consultant	Year	Scale	Survey Type	Purpose
					Conservation (DEC).
Kundip Mining Leases Additional Monitoring Quadrat Survey	E. Hickman	2009	Local	Declared Rare and Priority Flora Survey.	Additional survey areas from 2008 survey. Impact Assessment for the Kundip Mining Leases.
Targeted and Regional Survey for Melaleuca sp. Kundip and Melaleuca stramentosa.	N. McQuoid	2009	Regional	Targeted Priority Flora Survey.	Estimate distribution patterns and population estimates for Melaleuca sp. Kundip and Melaleuca stramentosa for revisal of conservation status.
Survey for Declared Rare and Priority Flora, and Exotic Weeds of Proposed Drill Grids at the Lonestar and the Gift Prospects, Kundip Mining Centre.	N. McQuoid	2009	Local	Declared Rare and Priority Flora survey and Weed Survey.	To meet approval for test drilling along grid lines within Lonestar and Gift prospects of the Kundip leases.
Survey for Dieback Disease caused by Phytophthora cinnamomi on Mining Leases within the Southern Ravensthorpe Range known as the Kundip Mining Centre Spring 2010 for Tectonic Resources N.L.	NRG Consultancy	2011	Local	Phytophthora Dieback Assessment.	Determine Dieback status (mapping areas of absense and those uninterpretable) in the Kundip Mining Centre and assessing potential impact from mining development.
Floristic communities of the Ravensthorpe Range, Western Australia.	Markey et al.	2012	Regional	Vegetation Mapping Survey.	Provide regional context with consistency and repeatability for proposed developments in the Ravensthorpe Range.
Kundip Mining Centre and Proposed Kundip – RAV8 Haul Road. Phytophthora Dieback Assessment.	Terratree Pty Ltd	2012	Local	Phytophthora Dieback Assessment.	Determine Dieback status (mapping areas of absense and those uninterpretable) Kundip Mining Centre and proposed Kundip to RAV8 haul road assessing potential impact from mining development.
Level 1 Flora Assessment of the Kundip Exploration Leases – Targeted Search of Tenements P74/352, 349, 350, 351, E74/537, E74/311, P74/290, E74/486, P74/259 and E74/392	MWH Global	2013	Local	Level 1 Flora Survey.	Assessing prospecting and exploration leases at the Kundip Mining Centre as part of approvals process.
Ravensthorpe Gold Project Biological Survey, Ravensthorpe, WA.	APM	2016	Local	Vegetation Mapping and Declared Rare and Priority Flora Survey.	Reassess and remap (where required) the vegetation boundaries identified by the South Coast Natural Resource Management Group.



Report Title	Consultant	Year	Scale	Survey Type	Purpose
Ravensthorpe Gold Project Biological Survey, Ravensthorpe, WA.	APM	2017	Local	Level 1 Targeted Threatened and Priority Flora Survey.	Declared Rare Flora and Priority Flora search across the Project Disturbance Footprint as part of approvals process.
Targeted Survey for Declared conservation significant Flora and Ecological Communities to Support Exploration Drilling within the Ravensthorpe Copper / Gold Project Area	APM	2017	Local	Targeted Threatened and Priority Flora and Ecological Communities.	Monitoring existing disturbance areas and searching in new disturbance areas.
Ravensthorpe Gold Project Biological Survey, Ravensthorpe, WA.	APM	2018	Local	Targeted Flora Survey.	Early August survey for <i>Hydrocotyle</i> sp. Decipiens and proteaceous and myrtaceous species within rehabilitated RAV8 and disturbed low-grade stockpiles at Kundip.  September survey to support Welcome Stranger exploration lease and Vegetation Clearing Permit.
<b>Fauna</b>					
Fauna and Fauna Assemblages of the Kundip and Trilogy Study Sites.	Biota Environmental Sciences Pty Ltd	2004	Local	Level 2 Fauna Survey: Detailed Survey	Phase 1 of a two phase (two seasons) baseline survey as per EAG56 to assess the potential for impacts from the Phillips River Project.
Kundip Phase II Fauna Survey – Summary of Findings.	Biota Environmental Sciences Pty Ltd	2004	Local	Level 2 Fauna Survey: Detailed Survey	Phase II of the two phase (two season) baseline survey as per EAG56 to assess the potential for impacts from the Phillips River Project.
Subterranean fauna desktop risk assessment.	Outback Ecology	2010	Local	Level 1 Fauna Survey: Desktop Study	Desktop assessment of the risk to subterranean fauna from the Phillips River Project.
Gem Restored Flora and Fauna Reconnaissance Survey	Outback Ecology	2013	Local	Level 1 Fauna Survey: Reconnaissance Survey	Priority 1 "Gem Restored" survey to determine types of significant fauna and fauna habitat present in the area.
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2016 (August)	Local	Level 1 Fauna Survey: Reconnaissance Survey	Spring survey targeting fauna of conservation significance previously recorded or highly likely to occur within the Project Area based on the baseline survey work undertaken by Biota in 2004 to assess presence and estimate likely impact.

Report Title	Consultant	Year	Scale	Survey Type	Purpose
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2016 (September)	Local	Level 2 Fauna Survey: Detailed Survey	Spring survey targeting fauna of conservation significance previously recorded or highly likely to occur within the Project Area based on the baseline survey work undertaken by Biota in 2004 to assess presence and estimate likely impact.
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2017 (June)	Local	Level 1 Fauna Survey: Reconnaissance Survey	Targeted survey focussed primarily on assessing the presence/absence of Heath Mouse ( <i>Pseudomys shortridgei</i> ), Malleefowl ( <i>Leipoa ocellata</i> ), Chuditch ( <i>Dasyurus geoffroi</i> ), Western Whip Bird (Mallee) ( <i>Psophodes nigrogularis</i> subsp. <i>oberon</i> ) and Western Bristlebird ( <i>Dasyornis longirostris</i> ).
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2017 (October)	Local	Level 1 Fauna Survey: Reconnaissance Survey	Targeted survey focussed primarily on assessing the presence/absence of Heath Mouse ( <i>Pseudomys shortridgei</i> ), Malleefowl ( <i>Leipoa ocellata</i> ), Chuditch ( <i>Dasyurus geoffroi</i> ), Western Whip Bird (Mallee) ( <i>Psophodes nigrogularis</i> subsp. <i>oberon</i> ), Western Bristlebird ( <i>Dasyornis longirostris</i> ) and Western Ground Parrot ( <i>Pezoporus flaviventris</i> ).  Site wide assessment to locate trees of a suitable diameter and/or containing hollows suitable for significant Black Cockatoo breeding.

## 3 METHODOLOGY

### 3.1 CONTRIBUTING AUTHORS

The Project survey scope was designed by APM Principal Biologist Dr Mitch Ladyman. The flora and vegetation survey was refined and executed by APM Botanist, James Tsakalos, with field assistance by environmental biologists Loren Kavanagh, Sarah Isbister and Crystal Heydenrych, Graduate Biologist Sarah Flemington and Taxonomist Shibi Ullas Chandran. The field fauna survey work was executed by Dr Mitch Ladyman and assisted by Sarah Flemington and Joshua Keen.

Data captured by Biota Environmental Sciences Pty Ltd (Biota) in May and November 2004 are incorporated into the results of this report. Those data are the property of ACH Minerals and can be utilised herein. Credit is given to Roy Teale and the team at Biota who undertook the field surveys and collected the data. The Biota reports are provided in Appendix 3 and Appendix 4.

### 3.2 DATABASE SEARCHES

A search of the EPBC listed protected species was undertaken using the Protected Matters Search Tool (PMST) (DoE, 2016) to identify Flora, Fauna and Threatened Ecological Communities considered to be Matters of National Environmental Significance. This search covered an area within 10 km of the centre of the Project Area (-33.67 S, 120.20 E). The results of the database search are presented in Appendix 5.

The NatureMap database (DPaW, 2016) was searched to produce a list of potentially occurring species within 10 km of the Project area using centre coordinates (-33.67° S, 120.20° E). This database has the most up to date species list based on flora and fauna licence returns from numerous surveys conducted in the area. The results of the database search are presented in Appendix 6.

A search of the Atlas of Living Australia (AoLA) (AoLA, 2016) was also undertaken to produce a list of fauna potentially occurring within a 10 km buffer of the Project Area using coordinates -33.67° S, 120.20° E. The results of the database search are presented in Appendix 7.

A request was made for a search of the DBCA databases for Threatened and Priority flora and fauna and the presence of Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs). This search was conducted based on a single point approximately centrally located in the Project Area (-33.67° S, 120.20° E) and included a 10 km buffer for flora and Threatened/Priority communities and a 30 km buffer for fauna. The results of the DBCA flora database searches are presented Appendix 8, results of the fauna database search are presented in Appendix 9.

Additional searches for fauna focussing more intensively on the Kundip Mine Site and immediate area, including the Kundip Nature Reserve, were undertaken to enable a comparison of the results of an extensive field survey undertaken by Biota in 2004 (Biota, 2004a; Biota, 2005). The searches comprised the NatureMap search (Appendix 10) which included a 6 km buffer, AoLA search which included a predefined buffer of 5 km (Appendix 11) and the PMST, also a buffer of 5 km (Appendix 5).

### 3.3 FIELD SURVEY

#### 3.3.1 Flora and Vegetation Survey Methodology

APM undertook a Targeted survey (EPA, 2016) in August 2016, a Detailed survey in May of 2016. In July 2017 a Detailed Survey was undertaken, followed by a Targeted survey in October 2017. Survey work was also undertaken more recently in early August and September 2018 within the Project Area and various exploration leases. Surveys were undertaken in accordance with:

- EPA (2016) Environmental Factor Guideline: *Flora and Vegetation*; and
- EPA (2016) Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment*.

The 2016 survey was aimed at gathering broad information about the Project Area. To achieve this, Craig *et al.* 2004; Craig *et al.* 2008 vegetation mapping was ground-truthed, the extent of historic and recent disturbances quantified, a targeted flora survey commenced for conservation significant flora species most likely to occur in habitats within the Project Area and opportunistic flora sampling was conducted.

The data obtained from the 2016 survey was presented to the EPA in 'Biological Assessment of Ravensthorpe Gold Project, WA' (2016). Following the formal review of this document and insights gained from the survey, APM developed a strategy to augment the 2016 survey by undertaking both Targeted and Detailed surveys. The Targeted surveys were used to gather comprehensive information on conservation significant flora and vegetation within the Project Area, while the Detailed surveys were used to collect sufficient information to update the general flora and vegetation attributes of the Project Area, and to accurately assess the value of flora and vegetation in both a local and regional context. Surveys undertaken in 2017 were conducted during May and July (out-of-season) and August (in-season).

The Targeted survey(s) consisted of a gridded search bounded by the proposed Disturbance Footprint, as identified at the time of the survey, to determine the presence/absence of conservation significant species, TECs and PECs. Surveyors involved in the searches first familiarised themselves with the locally occurring records of conservation significant taxa and vegetation communities which were used to assist in the field identification. The gridded search was conducted by two botanists and one environmental scientist. Each person was spaced ~10 metres apart with the environmental scientist remaining along the central track. Both botanists were holding a global positioning system (GPS). Track logs were recorded on the GPS to ensure maximum coverage of the areas and minimum overlap of search effort. The locations of all potential conservation significant flora identified were recorded with the GPS unit. Plants with uncertain identities were recorded with the GPS, collected and later identified to species level. Identifications were conducted by; James Tsakalos, Shibi Chandran and Mike Hislop (contracted through the State Herbarium by APM). Opportunistic observations as well as plot-less surveys with the aim of capturing vegetation condition as well as the occurrence/identity of weed species was also conducted during the Targeted surveys. Additional opportunistic observations were made on transit to and from quadrats.

Vegetation condition was described using the Vegetation Condition Scale adapted from Keighery (1994) as presented in Appendix 12 from within the EPA *Technical Guidance for Flora and Vegetation Surveys* (2016). Condition mapping undertaken by Craig *et al.* 2004; 2008, as well as ground-truthing by APM enabled the confirmation of the condition of vegetation in all the areas that have historically received or will receive disturbance in the future, within the Kundip Mine Site from the proposed RGP. A condition of 'Completely Degraded' vegetation was denoted to those areas that have been historically mined in the Kundip Mine Site, including large infrastructural elements and access tracks and roads. Areas with both historical drill lines and historically cleared areas that have not been disturbed recently, as well as the areas targeted for controlled burning over several years by the DBCA, are denoted a 'Very Good' condition, as the vegetation structure has been altered through repeated or significant disturbance but has been able to regenerate or is in the process

of regeneration (Keighery, 1994). More recently disturbed areas such as the latest drill lines created, are considered to be areas of a mosaic of 'Good' to 'Degraded' condition, as vegetation has been recently removed and fragmented and has either retained some basic structure or requires intensive management and rehabilitation to bring it back to 'Good' condition (Keighery, 1994). Vegetation condition is only an estimation and each area has not been denoted a specific condition due to physical limitations, priorities and time limitations in the field. Only a general description can therefore be provided. It has been estimated that the Kundip Mine Site contains a mosaic of conditions (Keighery, 1994) that range across the entirety of the Condition Scale. Areas that have not been mapped and represented in figures, are being assumed (based on Craig *et al.* mapping and APM field observation and survey for vegetation communities) that they are of 'Very good' condition or higher on the Condition Scale.

The Detailed survey(s) were designed to capture the vegetation and environmental heterogeneity (of the mature vegetation) in the Project area. Fire scar mapping (spanning back to 2007) was created and utilised to ensure that the placement of the quadrats was in vegetation considered mature (See EPA 2016). To create the fire scar mapping, Landsat 7 imagery (spanning 10 years, accessed from USGS earth explorer) was collected and raster bands 7, 4 and 1 used to emphasise the extent of potentially burnt areas. These areas were manually digitised into a polygon shape file using QGIS software. The reasons for the selection of matured vegetation over recovering / recently disturbed are manifold (Bond & van Wilgen 1996, Bowman *et al.* 2009), however in terms of community assembly and disassembly, the primary factors are likely the regeneration of nutrient pools and reconstruction of ecological niches. The age selected here (9 years), we consider conservative, since in putatively similar mediterranean-type fire prone shrublands, the recovery of species composition appears to range from 2 (Van der Merwe & Rooyen 2011) to 8 years (Herath *et al.* 2009). Nonetheless, the Project area appears largely uninfluenced by fire with records along the eastern and southern boundaries occurring during 2007 and 2008 (representing 9 and 10-year-old regeneration, respectively). See Appendix 12 and Appendix 13 to query the spatial extent of the fire scar mapping near the Project Area.

#### *Vegetation and environmental data collection and collation*

Ninety-five permanent quadrats, each sized 10 m x 10 m were established within the Project Area between August 2016 and October 2017 (Figure 3-1). The sampling grain (i.e. 100 m<sup>2</sup>) is consistent with that recommended as optimal by Bennett's (1987) species area curve analysis within the Ravensthorpe Range. To capture the habitat heterogeneity of the Project area a minimum of three quadrats were placed in each of the vegetation types (presumed to intersect with potential impacts) mapped by Craig *et al.* (2004). Within each of these quadrats the projected cover (%) and height (m) of all plants was recorded. Additionally, a 5 m buffer was added to the perimeter of the quadrat and all additional species encountered were recorded. The inclusion of buffer species is consistent with survey methods applied by Kern *et al.* (2008) and Markey *et al.* (2012) within the Ravensthorpe Range. The nomenclature of the plant taxa follows FloraBase (WA Herbarium, 2017).

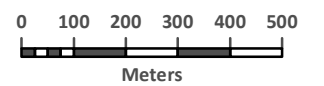
At each of the ninety-five permanent quadrats we collected 52 soil and 3 topographical data variables. Soil data was sourced from CSIRO Terrestrial Ecosystem Research Network (TERN) and the 1:100 000 geological map of Ravensthorpe (2930). Soil data from TERN included modelled; Total Nitrogen, Total Phosphorus, Bulk Density, Clay, Sand, Silt, Organic Carbon, pH, CaCl<sub>2</sub>, Plant Available Water (PAW), and Effective Cation Exchange Capacity (CEC). Soil data from the geological map included qualitative spatial descriptions of the underlying surface geology. Topographic data included slope, aspect and elevation determined using Earth Explorer's non-void-filled satellite radar topographic mission series (SRTM) captured at 1 arc second resolution (Farr *et al.* 2007). Climate data was not included because the spatial distribution of the quadrats was small, hence we would not expect to see any major changes as a product of modelled climatic variation. Fire data was not included because all surveyed areas were from matured vegetation (> 9-years-old).



**Figure 3-1: APM (2018) Permanent Flora Quadrats within the Ravensthorpe Gold Project Area**

**LEGEND**

- APM Quadrats
- Ravensthorpe Gold Project Area
- Mining Tenements



Date: 25/09/2018

Scale: 1:14,500

WGS 1984 Web Mercator Auxiliary Sphere

Author: sarah@animalplantmineral.com.au



### 3.3.2 Flora and Vegetation Data Analyses

#### **Classification and post-classification procedures**

OptimClass 1 (Tichy *et al.* 2010) was used to evaluate the performance of commonly applied data-analytical combinations representing resemblance measures and clustering algorithm used for classifications. Specifically, we evaluated space-conserving and space-dilating resemblance measures (see Strauss & Maltitz 2017 for review) of unweighted pair group method with arithmetic mean (UPGMA) (Sokal & Michener 1958) and Ward's method (Ward 1963) respectively. These clustering algorithms were paired with Bray-Curtis and relative Euclidean distances respectively. The OptimClass 1 method has been used extensively (e.g. Tichý *et al.* 2010; Wisser *et al.* 2011; Eliáš *et al.* 2013; Lötter *et al.* 2013; Vymazalová *et al.* 2016) to evaluate the ability of classifications to translate dendrograms (hierarchical classification patterns) into non-hierarchical vegetation classification systems. OptimClass 1 identifies the classification that yields the highest number of faithful species across the classes (clusters, communities) as 'optimal'. The number of faithful species for each cluster is determined using Fisher's Exact Test (Chytrý *et al.* 2002). According to the peaks in the 'faithful species to cluster number' trend line from OptimClass 1, the different nested hierarchical levels (i.e. communities, community groups and major community groups) were determined. JUICE version 7.0.187 (Tichý 2002) was used to carry out the OptimClass 1 procedure (Tichý *et al.* 2010).

Post-classification analyses involved extraction of 'diagnostic community profiles' and synoptic table of association. The diagnostic community profiles were comprised of; Diagnostic, Constant, and Dominant taxa. JUICE offers identification of diagnostic species based, in this case we used the phi coefficient > 30. Constant species were those which occur across 50% of the quadrats within a community. Dominant species were those with projected cover values greater than 20%. Diagnostic community profiles are included as Appendix 15. The synoptic table was populated by the species constancy (%) values and was sorted according to the JUICE routine based on fidelity (a sorting of the species according to Fisher's exact test scores).

#### **Comparison between Markey *et al.* 2012 and new APM classification**

Despite the substantial number of quantitative methods available for direct formal comparison between classification systems (for example; non-metric multidimensional scaling of fused constancy (%) tables) we were only able to provide qualitative comparisons. The reason for qualitative over quantitative comparison emanate from our inability to attain or reproduce their complete synoptic table for comparison purposes. Specifically, Markey *et al.* (2012) provided only a redacted (with species which frequencies were > 20%) synoptic table, and the source data published online (DPaW, 2012) was missing 64 quadrats and there was not any attribute data which could potentially serve to link between Markey *et al.*'s (2012) communities and the published quadrat data. Since the original classification was conducted on qualitative data (1/0), purportedly high in beta diversity (Markey *et al.* 2012) species combinations would have driven the community patterns. These combinations, through omission of species with frequencies < 20% are missing in the redacted synoptic table.

#### **Identification of environmental drivers**

We used distance-based redundancy analysis (db-RDA) (Legendre & Anderson 1998; ter Braak & Šmilauer 2012), as offered by *vegan* (Oksanen *et al.* 2017) in the R Statistical Environment (R Core Team, 2017), to identify the potential drivers of compositional patterns. This method allows flexible selection of any resemblance function to be used to analyse the relationship between environmental and community composition data (Legendre & Anderson 1999; Legendre & Gallaher 2001). The number of explanatory variables was reduced through formation of a consensus derived according to two techniques; (1) the 'ordistep' function from *vegan* (Oksanen *et al.* 2017) where variables are included if their inclusion into the model leads to a significant increase of explained variance, and if the AIC of the new model is lower than the

AIC of the simpler model, and (3) by removing variables if they introduced linear dependencies determined using 'vif.cca' from *vegan* (Oksanen *et al.* 2017).

### 3.3.3 Terrestrial Vertebrate Fauna Survey Methodology

The field fauna surveys were executed by Dr Mitch Ladyman (Principal Biologist), assisted by Sarah Flemington and Joshua Keen. The surveys were designed in accordance with:

- EPA (2016) Environmental Factor Guideline: *Terrestrial Fauna*;
- EPA (2016) Technical Guidance: *Terrestrial Fauna Surveys*;
- EPA (2016) Technical Guidance: *Sampling Methods for Terrestrial Vertebrate Fauna*; and
- EPA (2002) Position Statement 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection*.

Project specific liaison was undertaken with the DBCA to further tailor the survey design.

The 2016 spring fauna survey, undertaken from 20 - 26 September, targeted conservation significant fauna with a high likelihood of occurrence in the area based on the habitat present and previous historical records (Biota 2004, 2005). The targeted survey utilised aluminium box traps, cage traps, pit traps, funnel traps, turtle traps and camera traps and acoustic recording devices. All opportunistic observations of other species were recorded.

The 2017 surveys were undertaken from 14 - 19 July and 12 – 27 October. In July 2017 a second targeted fauna survey (14 person days active in the field and more than 500 trapping nights) was undertaken to more confidently determine the presence / absence of the Heath Mouse across the RGP following a possible record of one individual on the north-eastern boundary of the Project area. Other data collection that took place during this survey included:

- 70 cage trapping nights targeting the Chuditch following the recording of one individual on a motion sensitive camera during the fauna survey of 2016.
- Call playback for the Western Whipbird (Mallee) to augment records collected during the 2004 biological survey work for the PRP.

In October 2017 a third targeted survey, comprising 10 person days active in the field and more than 400 trapping nights was initiated to:

- Resolve the absence of the Heath Mouse in the RGP;
- Contribute to records of the Chuditch in the RGP; and
- Detect the presence of the Western Whip Bird, the Western Bristlebird and the Western Ground Parrot, comprising call play back and acoustic monitoring pre-dawn and post-dusk.

The October 2017 survey comprised over 400 aluminium box trap nights, 40 cage trap nights, eight (8) predawn and eight (8) post-dusk one-hour acoustic survey sessions. During this survey further attempts were made to find hollow-bearing trees suitable for Carnaby's nesting, however none were found. GPS records and measurements of a number of large trees, 4 of which were suitably sized to facilitate hollows, as stipulated in the habitat assessment guidelines (EPBC, 2012), however, none of these trees contained any hollows as outlined in Table 3-1.



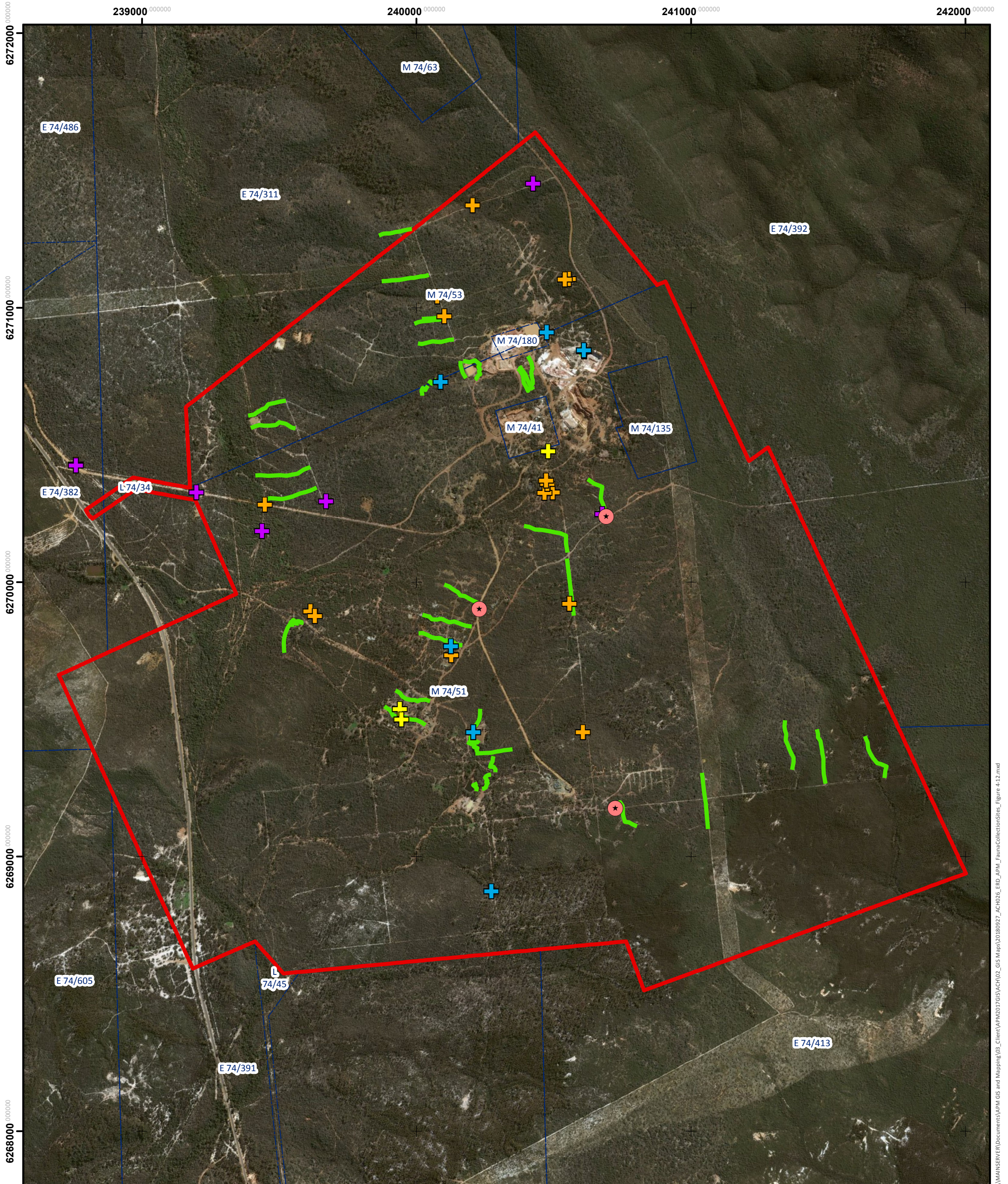
**Table 3-1: Black Cockatoo Nesting Tree Assessment**

Tree ID	Diameter Breast Height (mm)	Height (m)	Hollows	Fire (Years since)
1	570	18	None	>10
2	510	16	None	>10
3	490	16	None	>10
4	720	15	None	>10

Table 3-2 outlines the target fauna species and the method of trapping employed to determine presence / absence. The location of trap lines is illustrated in Figure 3-2.

**Table 3-2: Target Conservation Significant Fauna Species and Method of Trapping**

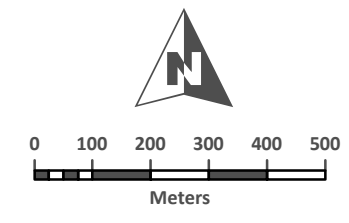
Fauna Species	Transect Observation	Funnel and Pit Trapping	Call Play-back	Thermal Trigger Fauna Cameras	Aluminium Box Traps	Cage traps	Opportunistic Hand Searching
<i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo (short-billed black-cockatoo))	x		x				
<i>Dasyornis longirostris</i> (Western Bristlebird)	x		x				
<i>Dasyurus geoffroyi</i> (Chuditch, Western Quoll)				x		x	
<i>Falco peregrinus</i> (Peregrine Falcon)	x		x				
<i>Hydromys chrysogaster</i> (Water-rat, Rakali)	x			x	x	x	
<i>Isodon fusciventer</i> (Quenda, Southern Brown Bandicoot)	x			x	x	x	
<i>Leipoa ocellata</i> (Malleefowl)	x			x			
<i>Lerista viduata</i> (Ravensthorpe Range Slider skink)		x					x
<i>Notamacropus eugenii derbianus</i> (Tammar Wallaby (WA subsp))	x			x			
<i>Notamacropus irma</i> (Western Brush Wallaby)	x			x			
<i>Merops ornatus</i> (Rainbow Bee-eater)	x						
<i>Myrmecobius fasciatus</i> (Numbat Walpurti)	x			x	x	x	
<i>Parantechinus apicalis</i> (Dibbler)	x			x	x		
<i>Phascogale calura</i> (Red-tailed Phascogale, Kenngoor)	x			x	x		
<i>Pseudomys occidentalis</i> (Western Mouse)	x			x	x		
<i>Pseudomys shortridgei</i> (Heath Mouse, Dayang)	x			x	x		
<i>Psophodes nigrogularis oberon</i> (Western Whipbird (Mallee))	x		x				



**Figure 3-2: APM Fauna Data Collection Points at the Ravensthorpe Gold Project Area**

**LEGEND**

- Fauna Trap Lines
- + Thermal Trigger Camera Sites
- + Bat
- + Frog
- Mining Tenements
- Ravensthorpe Gold Project Area
- + Bird Monitoring Site
- \* Opportunistic Record - Western Whipbird



Date: 27/09/2018  
 Scale: 1:13,000  
 GDA 1994 MGA Zone 51  
 Author: sarah@animalplantmineral.com.au

\\MAINSERVER\Documents\APM GIS and Mapping\03\_Client\APM2017\GIS\ACH\02\_GIS Maps\20180927\_ACH026\_ERD\_APM\_FaunaCollectionSites\_Figure 4-12.mxd

### 3.3.3.1 Transect Observation

Transect observations were made in many ways with each increasing the likelihood of an encounter with a particular species or suite of species.

#### Nocturnal Transects

Nocturnal searching comprised vehicle-based searches of all roads and tracks throughout the Project area. Searches commenced after sunset (approximately 7 pm) and typically lasted for more than one hour. On all occasions hand held spotlights were used to detect arboreal or volant nocturnal fauna, including possums and owls, and vehicle headlights and spotlights were used to detect ground dwelling reptiles and amphibians and hawking nocturnal birds that are often found roosting on the track.

#### Diurnal Transects

As a function of the botanical survey protocol, biologists were able to actively search for Malleefowl nests during grid searches for Priority flora species. Over the course of the botanical survey five persons walked a total of more than 35 km searching a ~10 metre swath width for Malleefowl mounds.

Movement between traps and sites on foot increases the likelihood of detection of scats and secondary evidence of fauna. All evidence observed during daily systematic trap clearing was recorded.

### 3.3.3.2 Funnel and Pit Trapping

A total of 40 funnel traps were set up in two different habitats. The first site comprised sandy gentle slopes in vegetation Community 6 '*Taxandria spathulata* - *Melaleuca rigidifolia*' (APM 2017). The object was to sample for the Ravensthorpe Slider and funnel traps were augmented by small cup pit traps with four funnel traps and four cups set up per 10 m drift fence.

The second site was in a small patch of vegetation mapped as Community 10 '*Melaleuca stramentosa* - *Taxandria spathulata*' (APM 2017), to sample species that had persisted in this remnant patch of vegetation between Western Gem, Two Boys and Kaolin Pit and the Tailings Storage Facility. Funnel traps were set up in conjunction with deep 20 L bucket pit traps with three-way traversing wire drift fences (Table 3-3 and Table 3-4).

**Table 3-3: Funnel Trap Survey Effort**

Trap Location	No. of Traps	No. of Trap Nights	Total
F29	20	4	80
F30	20	4	80
<b>Total</b>	<b>40</b>	<b>4</b>	<b>160</b>

**Table 3-4: Pit Trap Survey Effort**

Trap Location	No. of Traps	No. of Trap Nights	Total
P30	5	5	25
<b>Total</b>	<b>5</b>	<b>5</b>	<b>25</b>

### 3.3.3.3 Call Play-back

A Marantz acoustic recorder was set up over many nights adjacent to a small permanent water body at the foot of an historic heap leach pit at the point of out flow (Table 3-5).

The objective here was to establish a list of common frog species that give an indication of overall water quality and environmental health.

**Table 3-5: Frog Acoustic Monitoring Survey Effort**

Trap Location	No. of Traps	No. of Trap Nights	Total
ACHS8Ac Outflow	1	1	1
ACHS8Ac Heap leach dam	1	1	1
ACHS8Ac Two boys	1	1	1
<b>Total</b>	<b>3</b>	<b>3</b>	<b>3</b>

### 3.3.3.4 Acoustic Monitoring

A total of four full spectrum lossless WACO format with Wildlife Acoustics SM2BAT bat detectors (sampling rate 384 kHz, trigger 6 dB above background; 48 dB gain) were set to record the acoustic signatures of the microbats across the Project area. Detectors were set up in strategic locations where the likelihood of detecting bats was significantly increased near water bodies and mine shafts. Detectors were set to turn on automatically at sunset and off at sunrise (Table 3-6).

**Table 3-6: Bat Acoustic Monitoring Survey Effort**

Trap Location	No. of Traps	No. of Trap Nights	Total
A23 - 7014	1	5	5
A24 - 8066	1	5	5
A31 - 6066	1	4	4
A33 - 8048	1	3	3
<b>Total</b>	<b>4</b>	<b>17</b>	<b>17</b>

### 3.3.3.5 Bird Monitoring

Bird monitoring was undertaken at the sites indicated in Figure 3-2. Each site was monitored by 1 person for 1 hour in the morning and evening, with monitoring commencing 15 minutes prior to sunrise and 15 minutes prior to sunset. A schedule of monitoring undertaken is present in Table 3-7.

**Table 3-7: Bird Monitoring Survey Effort**

Date	Time of Day	No. people	Sites Monitored	Person Hours (total)
20/10/2017	Evening	2	1 & 2	2
21/10/2017	Morning	2	1 & 2	2
21/10/2017	Evening	2	3 & 4	2
22/10/2017	Morning	2	3 & 4	2
22/10/2017	Evening	2	5 & 6	2
23/10/2017	Morning	2	5 & 6	2
<b>Total:</b>				<b>16</b>

### 3.3.3.6 Thermal Trigger Fauna Cameras

Scout Guard SG560K-14mHD white light and Reconyx HC500 HyperFire™ Semi-Covert IR were set up at several locations across the Project area (Table 3-8). The principal focus was on mine shafts set at angles that would encourage occupation by both native and introduced fauna of assorted sizes from small dasyurids and rodents to larger animals including; foxes, cats and the Chuditch.

**Table 3-8: Thermal Trigger Camera Survey Effort**

Trap Location	No. of traps	No. of trap nights	Total
ACHS3TC004	1	3	3
ACHS5TC003	1	3	3
ACHS5TC004	1	3	3
ACHS6 - Camera 005 & 006	2	3	6
ACHS7TC001	1	3	3
ACHS7TC002	1	3	3
C25 - Camera 25	1	4	4
E34 - Camera 29	1	4	4
E35 - Camera 30	1	4	4
DpaW10 - bridge	1	4	4
DPaW21 - NW hill	1	4	4
DPaW24 - NW creek	1	4	4
DPaW25	1	4	4
DPaW25	1	4	4
DPaW26	1	4	4
DPaW27	1	4	4
DPaW35	1	4	4
TC003	1	3	3
TC005	1	3	3
TC006	1	2	2
<b>Total</b>	<b>21</b>	<b>70</b>	<b>73</b>

### 3.3.3.7 Aluminium Box Traps

A total of 80 aluminium box traps were set up along linear transects in close proximity to each other to concentrate trapping in limited habitats (Table 3-9). Trap spacing was at least 10 m, with the average spacing around 20 m. Many of the box traps were set in habitats likely to support the Conservation Significant mammalian fauna of the Project area. Many grids were established along drainage lines starting at or perpendicular to artificially constructed dam walls. Saturation trapping of 20 traps around one shaft was employed after it the detection of a Dibbler on a remote sensing camera was speculated, but later discounted as a capture (refer to section 5.2.9.1).

**Table 3-9: Aluminium Box Trap Survey Effort**

Trap Location	No. of traps	No. of trap nights	Total
ACHS1	12	3	36
ACHS2	8	3	24
ACHS3	20	3	60
ACHS4	20	3	60
C25	20	5	100
E22	22	10	220
E26	20	4	80
E28	8	4	32
E32	40	3	120
E21	20	9	180
E36	20	8	160
E35	29	11	319
E34	19	9	114
E19	20	3	60
E20	10	3	30
E25	20	8	160
E18	5	3	15
E16	10	3	30
E15	10	3	30
E23	20	10	200
E30	10	5	50
E33	10	5	50
E29	10	5	50
E24	10	5	50
<b>Total</b>	<b>393</b>	<b>128</b>	<b>2230</b>

### 3.3.3.8 Cage Traps

Twelve cage traps were established in sets of four in association with the aluminium box traps (Table 3-10). The primary focus was on habitat likely to support Chuditch or Rakali/Water Rats (*Hydromys chrysogaster*). Though the Water Rat may be captured in the larger aluminium box traps used in this survey, cage traps have a higher capture success rate. Cage traps are the only traps of a sufficient size to catch Chuditch.

**Table 3-10: Cage Trap Survey Effort**

Trap Location	No. of traps	No. of trap nights	Total
ACHS1	4	3	12
ACHS2	4	3	12
ACHS3	4	3	12
C20	5	5	25
C27	5	4	20
C36	3	8	24
C21	2	5	10
C24	1	8	8
C25	2	5	10
C15	1	3	3
C22	1	5	5
C23	1	5	5
C24	1	5	5
C25	1	5	5
C26	1	5	5
C28	1	5	5
<b>Total</b>	<b>37</b>	<b>77</b>	<b>166</b>

### 3.3.3.9 Turtle traps

Seven turtle traps were set along the banks of more established rehabilitated water bodies (Table 3-11).

**Table 3-11: Turtle Trap Survey Effort**

Trap Location	No. of Traps	No. of Trap Nights	Total
T21	7	4	28
<b>Total</b>	<b>7</b>	<b>4</b>	<b>28</b>

### 3.3.3.10 Opportunistic Hand Searching

Historic mine workings, processing areas and settlement sites provided an array of material including; tin sheets, concrete slabs, and timber which serve as fauna habitat and have the potential to preserve fossorial remains. In addition, roadside vegetation spoil heaps were searched, and micro-refuges in standing and fallen timber were investigated. More than 30-person hours were invested in opportunistic searching across the site, the majority of which was undertaken by Principal Biologist Dr Mitch Ladyman.

## 4 FLORA AND VEGETATION RESULTS

### 4.1 DESKTOP SURVEY

#### 4.1.1.1 Climate

Leading up to the 2017 surveys, monthly total rainfall was above average for February, August and September (Figure 4-1), particularly in February when the average was exceeded by 222.7 mm (BoM 2017a; BoM 2017b).

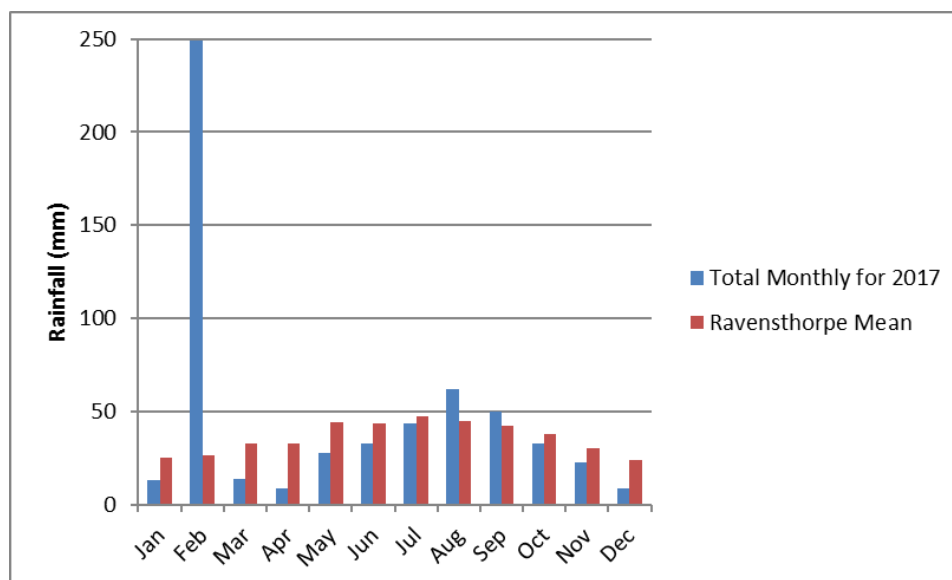


Figure 4-1: Monthly rainfall for Ravensthorpe in 2017. BoM Site Number 010633.

#### 4.1.1.2 Previous Surveys

The Ravensthorpe Range is situated within the Esperance Plains Bioregion (Department of Environment and Water Resources, 2007). The vegetation was first described by Beard (1972, 1973) and this is where the Ravensthorpe-, Oldfield- and Esperance-vegetation systems were formalised. Additional vegetation surveys within the Project Area have been undertaken by Craig *et al.* (2008; 2004) where qualitative assessment of vegetation enabled the creation of digitally available mapping units; Kern *et al.* (2008) who established 200 permanent quadrats; and Markey *et al.* (2012) who revisited as well as established an additional 66 quadrats during 2008-09. Combined, only nine of the 266 quadrats established by Kern *et al.* (2008) and Markey *et al.* (2012) across the Ravensthorpe Range were positioned in the Project area. The study of Markey *et al.* (2012) focused on quantitatively defining the vegetation patterns as well as comparing these newly defined patterns to those described and mapped by Craig *et al.* (2008).

According to the Craig *et al.* (2008) mapping a total of 25 vegetation units fall within the Project area, many of which (63%) have been described as dominated by obligate re-seeding taxa. In general, Craig *et al.* (2008; 2004) found that the vegetation was in 'Excellent' condition, with weed invasion minimal. This holds true for those areas away from historical and recent disturbance. Unfortunately, for practical purposes it is not possible to determine from the Markey *et al.* (2012) analyses how many of the newly derived vegetation units fall within the Project area. There are multiple reasons for this; (1) there was a mismatch between Craig's described vegetation units and the newly derived classification; and (2) spatial information provided to the TERN network lacked reference on how the 266 established quadrats were assigned to floristic communities.



Combined, we have found that the vegetation mapping of the Ravensthorpe Range in general, is requiring an update with the newest system of vegetation units.

#### 4.1.1.3 Conservation Significant Flora

The DBCA Threatened (Declared Rare) and Priority Flora Database, Threatened and Priority Flora List and the WA Herbarium Specimen Database identified 11 Threatened and 63 Priority flora species which have the potential to occur within the Project Area. The PMST returned 11 botanical Matters of National Environmental Significance (MNES). Of these, 16 conservation significant flora have been recorded as occurring within the Project Area. These are:

- *Acacia argutifolia* (P4) (3 individuals);
- *Acacia* sp. Ravensthorpe Range (P1) (1 individual);
- *Calothamnus roseus* (P1) (8 individuals);
- *Dampiera* sp. Ravensthorpe (G. F. Craig 8277) (P3) (1 individual);
- *Eucalyptus desmondensis* (P4) (2 individuals);
- *Eucalyptus stoatei* (P4) (2 individuals);
- *Grevillea fulgens* (P3) (1 individual);
- *Hydrocotyle* sp. *decipiens* (G.J. Keighery 463) (P2) (3 individuals);
- *Lepidosperma* sp. Elverdton (R. Jasper *et al.* LCH 16844) (P1) (1 individual);
- *Lepidosperma* sp. Mt Short (S. Kern *et al.* LCH 17510) (P1) (1 individual);
- *Marianthus mollis* (P4) (7 individuals);
- *Melaleuca sophisma* (P1) (6 individuals);
- *Pultanaea brachyphylla* (P2) (1 individual);
- *Pultanaea calycina* subsp. *proxena* (P4) (1 individual);
- *Pultanaea craigiana* (P3) (12 individuals); and
- *Thomasia* sp. Hopetoun (K.R. Newbey 4896) (P2) (1 individual).

Priority Flora within the Project Area identified by APM (2018) during surveys (not recorded by DBCA) include:

##### APM 2016

- *Stachystemon vinosus* (P4) (1 individual).

##### APM 2017

- *Thysanotus parviflorus* (P4) (4 individuals).

Priority Flora identified by APM during surveys outside of the Project Area, additional to existing DBCA records, include:

##### APM 2017 (Ard Patrick Exploration Survey) (Appendix 14)

- *Hibbertia hamata* (P3) (2 individuals);
- *Hydrocotyle* sp. *Deciapiens* (P2) (35 individuals); and
- *Melaleuca sophisma* (P1) (2 individuals).

**APM 2018 (Welcome Stranger Exploration Survey)**

- *Eucalyptus desmondensis* (P4) (average cover of 8.5% over seventeen quadrats containing the species).

All flora identified by the database searches, and augmented by APM and other consultant's survey work have been assimilated into Table 4-1 below to provide a comprehensive list flora that have the potential to occur and those that are known to occur within the Project Area. The results of the DBCA flora search are presented in Figure 4-2.

**Table 4-1: Conservation Significant Flora Potentially Occurring in the Ravensthorpe Gold Project Area**

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
<i>Acacia argutifolia</i>	Low spreading shrub. Shallow sand over quartzite, rocky hills & ridges	High, flowering in spring		Recorded in 1985 & 2010 (DBCA & WA Herbarium records)			P4
<i>Acacia besleyi</i>	Resinous shrub with stringy and fibrous bark.	High, flowering in spring					P1
<i>Acacia bifaria</i>	Prostrate or semi-prostrate shrub. Rocky loam, sandy soils. Plains, roadsides, low lying areas	High, flowering in spring					P3
<i>Acacia dictyoneura</i>	Shrub. Loamy soils, River banks, gentle slopes.	High, flowering in spring					P4
<i>Acacia disticha</i>	Spreading shrub. Sand, rocky loam, limestone soils. Watercourses within rocks.	High, flowering in spring	Craig 2004a, 2005		P2		Not Threatened
<i>Acacia durabilis</i>	Slender, open spinescent shrub. Rocky or lateritic clay, sandy clay. Stony ridges and hills.	High, flowering in spring	Craig 2004a, 2005; Hickman 2007		P3		Not Threatened
<i>Acacia errabunda</i>	Dense, bushy, spreading shrub. Clay loam, gravelly loam, sand. Plains, clay flats.	High, flowering in spring		Recorded in 2002 (DBCA & WA Herbarium records)			P3
<i>Acacia grisea</i>	Spreading or compact shrub. Lateritic gravelly loamy soils. Plains & slopes.	Medium, flowering in winter		Recorded in 1992 and 2007 (DBCA & WA Herbarium records)			P4
<i>Acacia improcera</i>	Spreading, spiny shrub. Sand, loamy clay, clay. Undulating plains, flats	High, flowering in spring	K. Newbey 4.8 km SE of Ravensthorpe				P3
<i>Acacia loricina</i> var. <sup>1</sup> <i>crassifolia</i>	Domed, dense, spreading shrub. Loamy stony shallow sand, lateritic soils. Ridges.	High, flowering in spring	Craig 2004a, 2004b, 2005; Hickman 2007; APM 2017		P2		Not Threatened
<i>Acacia nitidula</i>	Spreading shrub. Granitic sandy gravelly soils. Amongst granite boulders.	Low, few, if any granite protruding granite boulders.		Naturemap WA, Herbarium record 40 km east of Site.			P3
<i>Acacia ophiolithica</i>	Dense, bushy & rounded shrub. Clay loam, loam. Rocky areas, river banks.	High, flowering in spring	Craig 2004b		P3		Not Threatened

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
<i>Acacia papulosa</i>	Bushy shrub. Spongolitic loam.	High, flowering in spring		Recorded 2003 and 2010 (DBCA & WA Herbarium records)			P2
<i>Acacia pinguiculosa</i>	Shrub. Gravelly or loamy sand, loam, clay, laterite, granite, outcrops, risen plains.	High, flowering in spring	Craig 2004a; APM 2017		P4		Not Threatened
<i>Acacia rhamphophylla</i>	Low spreading shrub. Rocky or sandy clay. Upper sloped of low ranges.	High, flowering in spring		Recorded 2006, 2008, 2009, 1992 and 1995 (DBCA & WA Herbarium records)		EN	T
<i>Acacia sp.</i> Ravensthorpe Range (B.R. Maslin 5463)	Low spreading shrub. Rocky clay, clayey loam.	High, flowering in spring		Recorded in 1975, 1980, 83, 2001 and 2003 (WA Herbarium record)			P1
<i>Acrotriche parviflora</i>	Erect, spreading/compact shrub. Rocky grey loam, white-grey sandy or clay loam.	High, flowering in spring	Hickman 2009; APM 2017		P4		Not Threatened
<i>Allocasuarina hystricosa</i>	Dioecious tree. Orange, red or brown loam with limestone or granite outcropping. Plains, lower slopes, hilltops.	Medium, flowering in summer	MWH 2013	Recorded 2004-05, 2007 (DBCA & WA Herbarium)	P4		P4
<i>Allocasuarina scleroclada</i>	Dioecious straggling shrub. Granitic/lateritic soils. Rocky hillsides and limestone pavements.	Medium, flowering in winter	Craig 2004b		T		Not Threatened
<i>Anigozanthos bicolor subsp. minor</i>	Rhizomatous, perennial herb. Sand. Well-watered sites.	High, flowering in spring		Naturemap WA, Recorded 1987, 2004 (WA Herbarium record)		EN	T
<i>Anticoryne ovalifolia</i>	Shrub. Quartzite rocky slopes & granite.	High, flowering in spring		Recorded 1983 (DBCA & WA Herbarium)			P2
<i>Banksia corvijuga</i>	Dense, rounded shrub. Gravelly lateritic soils. Hillslopes.	High, flowering in spring	MWH 2013	Recorded 1960, 1979, 1993, 2004 & 2007 (DBCA & WA Herbarium)	T		P3
<i>Banksia corvijuga x heliantha</i>	Dense, rounded shrub. Gravelly lateritic soils. Hillslopes.	High, flowering in spring		Recorded DBCA & WA Herbarium [Unknown]			P3

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
				year]			
<i>Banksia foliosissima</i>	Dense erect, non-lignotuberous shrub. Gravelly sand or sandy clay over laterite. Hill top & upper slopes.	High, summer flowerer with distinctive perennial morphology.		Recorded 1960-64, 1993,98 (DBCA & WA Herbarium)			P4
<i>Banksia laevigata subsp. laevigata</i>	Shrub. Rocky soils. Hill, top of breakaways.	High, flowering in spring	MWH 2013	Recorded 1925,1959, 1962-63, 1978, 2005-2009 (DBCA & WA Herbarium)	P4		P4
<i>Beyeria sulcata var. truncata</i>	Straggly shrub.			Recorded 2004 (DBCA & WA Herbarium)			P3
<i>Beyeria villosa</i> (Previously <i>Beyeria</i> sp. A Ravensthorpe)	Upright spreading perennial shrub.	Medium, flowering in winter	Craig 2004b	Recorded 1987, 2004, 2007 (DBCA & WA Herbarium)	P1		P4
<i>Boronia oxyantha var. brevicalyx</i>	Spreading shrub. Gravel, clay, loam. Ironstone slopes.	High, flowering in spring	Craig 2004a, 2005; APM 2017		P3		Not Threatened
<i>Calothamnus roseus</i>	Dense shrub. Sandy loam, quartzite soil. Upper-slopes and hilltops.	High, flowering in spring	APM 2017	Recorded in 2004, 2007-2010 (WA Herbarium record)	P1		P1
<i>Conostylis lepidospermoides</i>	Rhizomatous, tufted perennial, grass-like or herb. Grey or yellow-brown sand over laterite.	High, flowering in spring		Naturemap WA, Recorded in 1968 (WA Herbarium)		EN	T
<i>Cryptandra craigiae</i>	Erect to spreading shrub. Sand. Low-lying sand dunes, low rises between or adjacent to swampy areas, gutter on disturbed road verge.	Medium, flowering in winter		Recorded in 2005 (DBCA & WA Herbarium)			P1
<i>Dampiera deltoidea</i>	Erect perennial herb. Sand, sandy clay, loam. Sandplains around quartzite rocks	High, flowering in spring	MWH 2013	Recorded in 1963, 1998, 2004, 2005 (DBCA & WA Herbarium)	P4		P4

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
<i>Dampiera sp.</i> <i>Ravensthorpe</i> (G.F. Craig 8277)	Erect perennial herb. Orange loam, rocky outcrops & hillcrest.	High, flowering in spring		Recorded in 2009,2010 (WA Herbarium record)			P3
<i>Darwinia oxylepis</i>	Upright, dense shrub. Occurs on stony, peaty sand and rocky gullies.	High, flowering in spring		Naturemap record (WA Herbarium) ~140 km SW of site.		EN	T
<i>Daviesia megacalyx</i>	Erect shrub. Gravelly laterite. Ridges. Hillslopes.	High, flowering in spring	MWH 2013	Recorded 1995, 2004-2007 (DBCA & WA Herbarium)	T	EN	T
<i>Daviesia newbeyi</i>	Bushy, multi-stemmed, broom-like shrub. Sand or sandy clay over granite. Rocky slopes.	High, flowering in spring		Recorded 2010 and 2005 (DBCA & WA Herbarium)			P3
<i>Dodonaea trifida</i>	Shrub. Sandy/gravelly soils. Coastal areas.	High, flowering in spring	Craig, 2004a; Craig, 2005; Hickman, 2007; APM 2017		P3		Not Threatened
<i>Eremophila chamaeophila</i>	Low, dome-shaped shrub. White sand, clay. Sandplains, disturbed road verges.	High, flowering in spring		Naturemap record in 2005 (WA Herbarium) 40 km SW of site.			P3
<i>Eremophila denticulata subsp. denticulata</i>	Erect, open shrub. Alluvium, sand, sandy clay loam. River beds & plains, laterite breakaways.	High, flowering in spring		Naturemap record in 2015 (WA Herbarium) 20km SW of site.		VU	T
<i>Eucalyptus desmondensis</i>	Mallee. Stony loam or sand, clay, granitic soils. Rocky hillsides, sandplains.	High, flowering in spring	MWH 2013; APM 2018	Recorded in 1950-1980, 2002, 2005-2007 (WA Herbarium record)	P4		P4
<i>Eucalyptus famelica</i>	Mallee. White / grey sand. Wet areas, sometimes slightly brackish.	High, flowering in winter - long lived perennial structures can be used for identification		Recorded in 1989 (WA Herbarium record)			P3
<i>Eucalyptus proxima</i>	Mallee. Smooth bark, grey over coppery stems, strippy. Gravelly loam, red brown, red-yellow sand, sandy clays, ironstone.	Medium, flowering in summer	Hickman 2009; APM 2017		P4		Not Threatened
<i>Eucalyptus purpurata</i>	Tree (mallette). White powdery loam, magnesite.	High, flowering in spring		Recorded in 1970 (WA Herbarium).			T

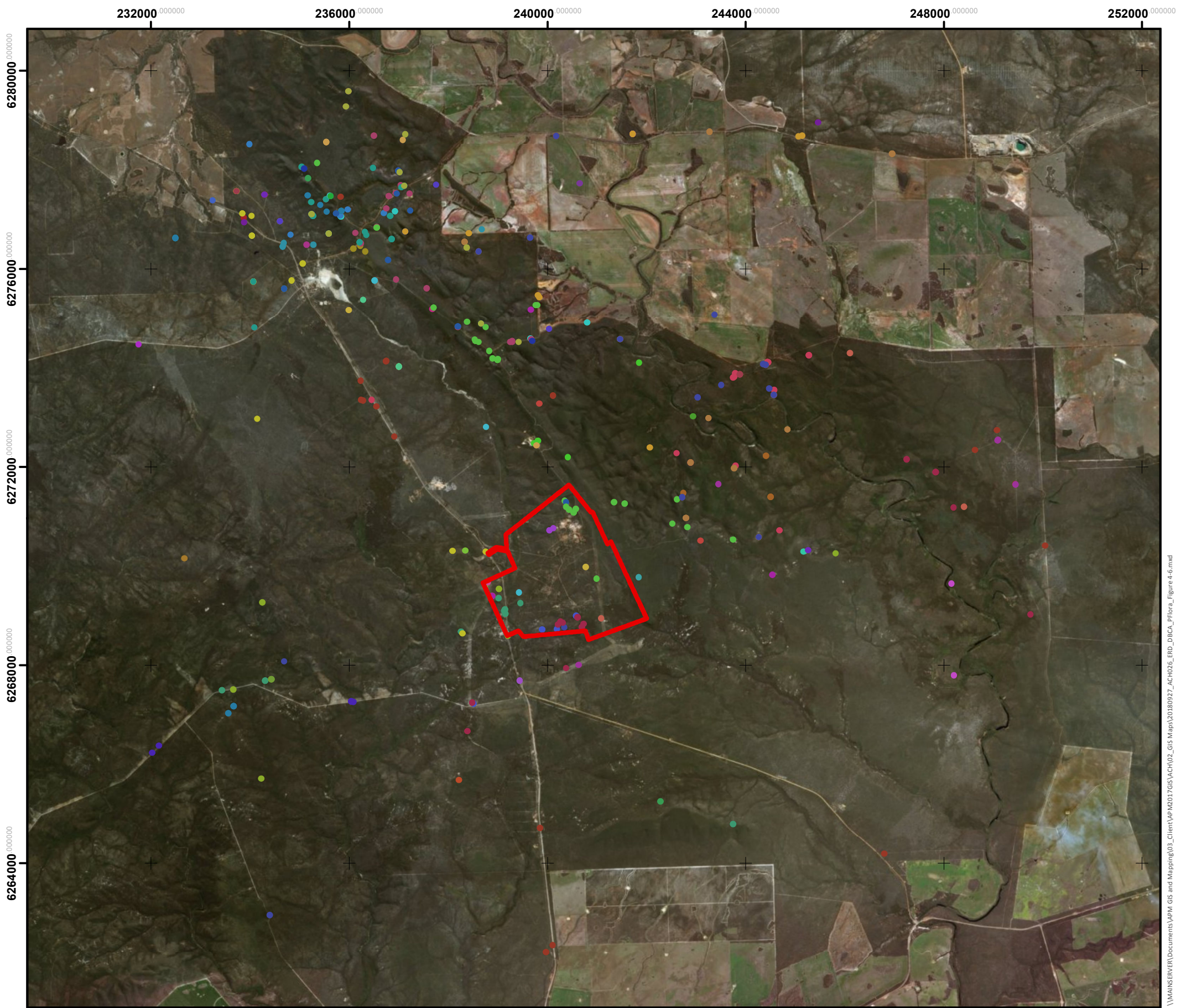
Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
<i>Eucalyptus stoatei</i>	Slender tree. Gravelly sand or clay, sandy loam. Flats, rises.	High, flowering in spring		Recorded in 1981 (WA Herbarium record)			P4
<i>Eucalyptus x bennettiae</i>	Mallee. Red quartzite rubble, red loam. Slopes.	High, flowering in spring		Recorded in 1979, 1981, 1991, 2000-01 (DBCA & WA Herbarium)			P4
<i>Goodenia phillipsiae</i>	Low shrub. Sandy soils.	High, flowering in spring		Recorded in 2002-08 (DBCA & WA Herbarium)			P4
<i>Goodenia stenophylla</i>	Erect shrub. Rocky soils. Granite or quartzite rocks. Steep slopes.	High, flowering in spring		Recorded in 1987-88, 2007 and 2010 (WA Herbarium)			P4
<i>Grevillea fastigiata</i>	Shrub. Red clay, granite.	High, flowering in summer - long lived perennial structures can be used for identification.		Recorded in 1990,91,99 and 2006 and 2007 (WA Herbarium)			P4
<i>Grevillea fulgens</i>	Spreading to straggling, shrub. Gravel over laterite. Hillsides.	High, flowering in spring	MWH 2013	Recorded in 1960-1990, 2004-2007 (DBCA & WA Herbarium)	P3		P3
<i>Grevillea punctata</i>	Shrub. Stony red loam, red clay.	High, flowering in spring	MWH 2013	Recorded in 1991-98 and 2000, 2007 and 2010 (WA Herbarium)	P3		P3
<i>Grevillea sulcata</i>	Spreading shrub. Loam.	Medium, flowering in winter	MWH 2013		P1		P1
<i>Guichenotia apetala</i>	Compact, much branched shrub. Gravel, laterite.	High, flowering in spring	MWH 2013	Recorded in 2002-2007 (DBCA & WA Herbarium)	P1		P1
<i>Gyrostemon sessilis</i> (Previously <i>Gyrostemon</i> sp. Ravensthorpe)	Slender shrub. Sand, loam. Sandplains.	Medium, flowering in winter		Recorded in 2008 (WA Herbarium record)	P1		Not Threatened

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
<i>Hakea acuminata</i>	Shrub. Deep white sand, grey sand over granite, loam. Undulating plain.	Medium, flowering in winter		Recorded in 2003 (DBCA & WA Herbarium record)			P2
<i>Hibbertia hamata</i>	Erect shrub. Granite. Inland outcrops.	High, flowering in spring	APM 2017		P3		P3
<i>Hydrocotyle</i> sp. <i>Decipiens</i> (G.J. Keighery 463)	Prostrate annual herb. Clay / loam soils. Riverbeds & banks.	Medium, flowering in spring	APM 2017	Recorded in 2005 (DBCA & WA Herbarium)	P2		P2
<i>Lasiopetalum</i> sp. <i>Desmond</i> (N. McQuoid 653)	Shrub. Brown laterite. Ridges.	High, flowering in spring		Recorded in 2008 (WA Herbarium)			P1
<i>Lepidosperma</i> sp. <i>Archer Drive</i> (S. Kern & R. Jasper LCH 18300)	Sedge. Grey clayey sand. Outcrops.			Recorded in 2007 (WA Herbarium)			P1
<i>Lepidosperma</i> sp. <i>Elverdton</i> (R. Jasper <i>et al.</i> LCH 16844)	Sedge. Sandy loam, red-brown clay. Tonalite on surface.	Underlying geology matches the site		Recorded in 2007 (WA Herbarium record)			P1
<i>Lepidosperma</i> sp. <i>Hopetoun Road</i> (S. Kern <i>et al.</i> LCH 16552)	Sedge. Grey clayey-sand. Lateritic outcrop.			Recorded in 2007 (WA Herbarium record)			P1
<i>Lepidosperma</i> sp. <i>Maydon</i> (S. Kern, R. Jasper, H. Hughes LCH 17844)	Sedge. Clayey sand. Tonalite on surface.			Recorded in 2007 (WA Herbarium record)			P1
<i>Lepidosperma</i> sp. <i>Mt Chester</i> (S. Kern <i>et al.</i> LCH 16596)	Sedge. Sandy loam. Tonalite on surface.			Recorded in 2007 (WA Herbarium record)			P1
<i>Lepidosperma</i> sp. <i>Mt Short</i> (S. Kern <i>et al.</i> LCH 17510)	Sedge. Clayey sand. Tonalite on surface.	Underlying geology matches the site		Recorded in 2007 (WA Herbarium record)			P1
<i>Lepidosperma</i> sp. <i>Shoemaker Levy</i> (L. Ang & O. Davies 10815)				Recorded in 2005 (WA Herbarium record)			P3



Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
<i>Lepidosperma</i> sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764)	Sedge. Sandy loam.			Recorded in 2007 (WA Herbarium record)			P1
<i>Marianthus mollis</i>	Low branching, spreading, silky hairy shrub. Laterite soils. Hills and ridges.	High, flowering in spring	Hickman, 2007; MWH, 2013; APM 2016	Recorded in 2003-2010 (WA Herbarium record)	T; P4		P4
<i>Marianthus tenuis</i> (Previously <i>M. villosus</i> ).	Slender twining shrub. Red-brown sandy clay or loam. Slopes, rock outcrops, valleys.	High, flowering in spring	Craig, 2004a; Craig, 2004b; 2005		T		Not Threatened.
<i>Melaleuca penicula</i>	Spreading shrub. Red, brown loamy sand or red sandy clay. Granite outcrops, valley slopes.	Medium, perennial summer flowerer. Some structures would be intact for identification.	MWH, 2013-	Recorded in 2007, 2008. (WA Herbarium record)	P4		P4
<i>Melaleuca similis</i>	Shrub. Grey sand. Margins of saline drainage lines.	High, flowering in spring.		Naturemap record in 2003 (Threatened Flora Seed Centre Collections) 25 km E, NE of site.			P1
<i>Melaleuca stramentosa</i>	Compact shrub. Yellow sand, lateritic gravel. Plains, heath and thicket.	High, flowering in spring.	Craig 2004a, 2004b, 2005; Hickman 2007; APM 2016, 2017.		P1		Not Threatened
<i>Melaleuca sophisma</i>	Short, dense/compact shrub.	High, flowering in spring	APM 2016	Recorded in 2003-2005 (DBCA & WA Herbarium record)			P1
<i>Micromyrtus navicularis</i>	Spindly, erect shrub. Sand with gravel, laterite, granite. Hill slopes.	High, flowering all year	MWH 2013	Recorded in 2007 (WA Herbarium record)	P3		P3
<i>Pultenaea brachyphylla</i>	Erect shrub. Pale brown sandy loam, sandy clay, gravel, granite, quartz, laterite.	High, flowering in spring		Recorded in 2008 (WA Herbarium record)			P2
<i>Pultenaea calycina</i> subsp. <i>proxena</i>	Many-branched, compact shrub. Sand, clay, sandy clay or loam with gravel, over magnesite. Moderate	High, flowering in spring	Craig 2004b	Recorded in 2002-2010 (WA Herbarium record)	P1		P4

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
	slopes, adjacent to creek beds.						
<i>Pultenaea craigiana</i> (Previously <i>Pultenaea</i> sp. Kundip)	Branching, erect shrub.	High, flowering in spring	Craig 2004a; Hickman 2007, 2009; APM 2017.	Recorded in 2003 - 2010 (DBCA & WA Herbarium record)	P1		P3
<i>Pultenaea vestita</i>	Erect or procumbent shrub. Sandy soils. Coastal cliffs, granite.	High, flowering in spring		Recorded in 1951 (WA Herbarium) and in 1999 Naturemap (Salinity Action Plan Flora Survey Data)			P3
<i>Ricinocarpos trichophorus</i>	Erect, openly branching shrub. Occurs on sandy clay and loam on breakaways and among sandstone rocks	High, flowering in spring		Naturemap record in 2014 (DBCA TPFL) 30 km E of site.		EN	T
<i>Siegfriedia darwinioides</i>	Much-branched, spreading shrub. Gravelly loam or sandy soils, clay.	High, flowering in spring	Craig 2004a, 2005; Hickman 2007; APM 2016		P4		Not Threatened
<i>Spyridium glaucum</i>	Erect or spreading shrub. Clay.	High, flowering in spring	Craig 2004a, 2004b; Hickman 2007		P3; P4		Not Threatened
<i>Stachystemon vinosus</i>	Compact shrub. Fine loamy sand, stony soils. Sandplains, rock crevices on breakaways.	High, flowering in spring	Hickman 2007; APM 2016	Recorded in 2005 & 2010 (Wa Herbarium record)	T		P4
<i>Thomasia</i> sp. Hopetoun (K.R. Newbey 4896)	Erect slender shrub	High, flowering in spring	MWH 2013	Recorded in 1969, 74,98 (WA Herbarium record)	P2		P2
<i>Thysanotus parviflorus</i>	Perennial herb. Grey sand	High, flowering in spring	APM 2017	Recorded in 1987 (WA Herbarium record)			P4
<i>Xanthoparmelia subimitatrix</i>	Lichen. Granite. Sheltered/exposed outcrops.	High, flowering in spring		Recorded in 2004 (WA Herbarium record)			P3
<i>Xanthoparmelia xanthomelanoides</i>	Lichen. Granite. Sheltered/exposed outcrops.	High, flowering in spring		Recorded in 2007 (WA Herbarium record)			P2



**Figure 4-2: Conservation Significant Flora Identified by Department of Biodiversity Conservation and Attractions Database Search as Occurring within the Ravensthorpe Gold Project Region**

**LEGEND**

Ravensthorpe Gold Project Area

**DBCRA Records of Priority Flora**

- |  |   |   |
|--|---|---|
| <i>Acacia argutifolia</i>                        | <i>Dampiera deltoidea</i>                   | <i>Lepidosperma</i> sp. Elverdton...            |
| <i>Acacia besleyi</i>                            | <i>Dampiera</i> sp. Ravensthorpe...         | <i>Lepidosperma</i> sp. Hopetoun Road...        |
| <i>Acacia bifaria</i>                            | <i>Daviesia megacalyx</i>                   | <i>Lepidosperma</i> sp. Maydon...               |
| <i>Acacia dictyoneura</i>                        | <i>Daviesia newbeyi</i>                     | <i>Lepidosperma</i> sp. Mt Chester...           |
| <i>Acacia errabunda</i>                          | <i>Eucalyptus desmondensis</i>              | <i>Lepidosperma</i> sp. Mt Short...             |
| <i>Acacia grisea</i>                             | <i>Eucalyptus famelica</i>                  | <i>Lepidosperma</i> sp. Shoemaker Levy...       |
| <i>Acacia papulosa</i>                           | <i>Eucalyptus purpurata</i>                 | <i>Lepidosperma</i> sp. Steere River...         |
| <i>Acacia rhamphophylla</i>                      | <i>Eucalyptus stoatei</i>                   | <i>Marianthus mollis</i>                        |
| <i>Acacia</i> sp. Ravensthorpe Range...          | <i>Eucalyptus</i> x <i>bennettiae</i>       | <i>Melaleuca penicula</i>                       |
| <i>Allocasuarina hystricosa</i>                  | <i>Goodenia phillipsiae</i>                 | <i>Melaleuca sophisma</i>                       |
| <i>Anticoryne ovalifolia</i>                     | <i>Goodenia stenophylla</i>                 | <i>Micromyrtus navicularis</i>                  |
| <i>Banksia corvijuga</i>                         | <i>Grevillea fastigiata</i>                 | <i>Pultenaea brachyphylla</i>                   |
| <i>Banksia corvijuga</i> x <i>heliantha</i>      | <i>Grevillea fulgens</i>                    | <i>Pultenaea calycina</i> subsp. <i>proxena</i> |
| <i>Banksia foliosissima</i>                      | <i>Grevillea punctata</i>                   | <i>Pultenaea craigiana</i>                      |
| <i>Banksia laevigata</i> subsp. <i>laevigata</i> | <i>Guichenotia apetala</i>                  | <i>Pultenaea vestita</i>                        |
| <i>Beyeria sulcata</i> var. <i>truncata</i>      | <i>Gyrostemon</i> sp. Ravensthorpe...       | <i>Stachystemon vinosus</i>                     |
| <i>Beyeria villosa</i>                           | <i>Hakea acuminata</i>                      | <i>Thomasia</i> sp. Hopetoun...                 |
| <i>Calothamnus roseus</i>                        | <i>Hydrocotyle</i> sp. <i>Decipiens</i> ... | <i>Thysanotus parviflorus</i>                   |
| <i>Cryptandra craigiae</i>                       | <i>Lasiopetalum</i> sp. <i>Desmond</i> ...  | <i>Xanthoparmelia subimitatrix</i>              |
|  | <i>Lepidosperma</i> sp. Archer Drive...     | <i>Xanthoparmelia xanthomelanoides</i>          |

0 5½  
 Kilometers

Date: 27/09/2018  
 Scale: 1:84,421  
 GDA 1994 MGA Zone 51  
 Author: sarah@animalplantmineral.com.au

**ACHMINERALS**

#### 4.1.1.4 Threatened and Priority Ecological Communities

Two Threatened Ecological Communities (**TEC**) listed under the EPBC Act were identified as potentially occurring in the Project Area through a search of the Protected Matters Search Tool:

- Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA; and
- *Banksia laevigata* – *Banksia lemniiana* proteaceous thicket.

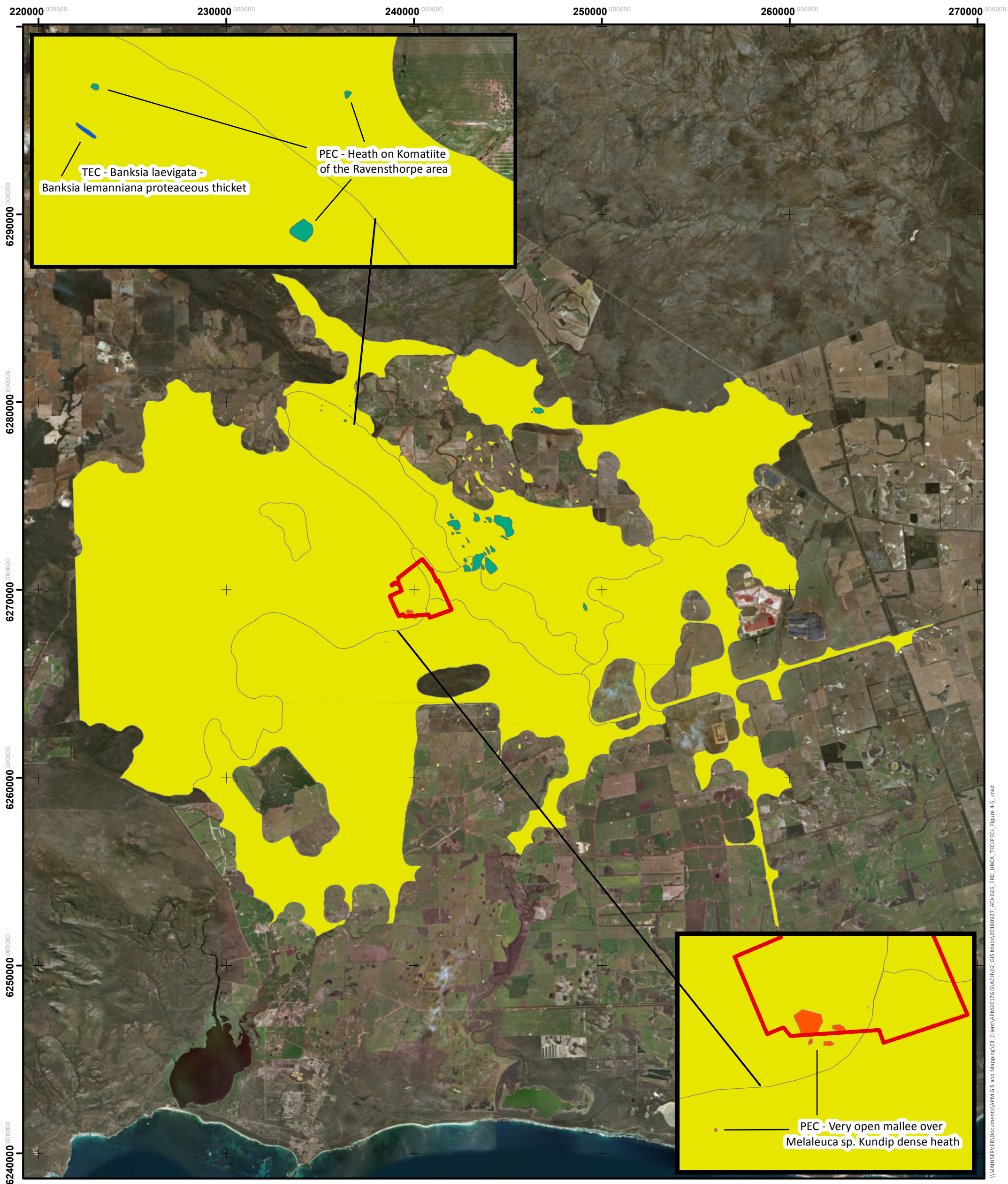
Three Priority Ecological Communities (**PEC**) listed under the WC Act were also identified as potentially occurring in the Project Area by searches of the DBCA databases:

- Very open Mallee over Melaleuca sp. Kundip dense heath (P1);
- Heath on Komatiite of the Ravensthorpe area (P3); and
- Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA (P3).

Descriptions for these communities are provided in Table 4-2 and their representative distributions (by DBCA as of 2016) shown in Figure 4-3.

**Table 4-2: Priority and Threatened Ecological Communities of the Ravensthorpe Gold Project Region**

Community	Description	Conservation Status
Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA	Consists of predominantly obligate seeding proteaceous shrubland and heath (Kwongkan) and Mallee heath on sandplain, duplex sand/clay and gravels overlying Eocene sediments, quartzite, schist, Yilgarn and Albany Fraser granite and greenstone ranges. Its flora is characterised by high species diversity and a high degree of endemism, particularly in the Stirling Range, Fitzgerald River National Park, Ravensthorpe Range and Russell Ranges. Due to the high levels of endemism, there are few species that exist across the entire range of the dense, obligate seeding Proteaceae dominated shrublands and Kwongkan of the Esperance Sandplains, however particular species have been identified as common dominant species in each of its ecodistricts.	TEC, EPBC Act; PEC (Priority 3), WC Act
<i>Banksia laevigata</i> – <i>Banksia lemanniana</i> proteaceous thicket	This community occurs on laterised ridges and breakaways. Associated species generally include <i>Eucalyptus pleurocarpa</i> , <i>Adenanthos oreophilus</i> , <i>Leptospermum maxwellii</i> , <i>Beaufortia orbifolia</i> , <i>Taxandria spathulata</i> and <i>Stylidium albomontis</i> .	TEC, EPBC Act
Very open Mallee over <i>Melaleuca</i> sp. Kundip dense heath	Very open Mallee over <i>Melaleuca</i> sp. Kundip (Collection number GF Craig 6020) dense heath. Open Mallee over dense shrub heath (1.0-1.5) dominated by <i>Melaleuca sophisma</i> on pale grey loamy sand with quartz rubble, occupies hill slopes. Associated species include <i>Melaleuca sophisma</i> (prev. <i>Melaleuca</i> sp. Kundip (GF Craig 6020) (P1) (dominant), <i>M. haplantha</i> , <i>M. stramentosa</i> , <i>M. rigidifolia</i> , <i>M. bracteosa</i> , <i>Melaleuca ulicoides</i> (prev. <i>Melaleuca</i> sp. Gorse), <i>Pultenaea craigiana</i> (prev. <i>Pultenaea</i> sp. Kundip (GF Craig 6008)) (P3), <i>Eucalyptus cernua</i> , <i>E. phaenophylla</i> , <i>E. pileata</i> , <i>Dodonaea trifida</i> , <i>Acacia durabilis</i> , <i>Leucopogon infuscatus</i> and <i>Hibbertia psilocarpa</i> ms. On its eastern boundary, the community abuts <i>Eucalyptus astringens</i> open low woodland and in this area, there is an intergrade community.	PEC (Priority 1), WC Act
Heath on Komatiite of the Ravensthorpe area	Dense heath on alkaline red clay over komatiite (ultra-mafic rock) and associated carbonates. Note: very open tree Mallee over heath B in Hale Bopp orebody area. Dominant species: <i>Beyeria cockertonii</i> (T), <i>Acacia ophiolithica</i> , <i>Hakea verrucosa</i> , <i>Grevillea fastigiata</i> (P4), <i>Melaleuca ulicoides</i> , <i>Allocasuarina hystricosa</i> (P4), <i>Verticordia oxylepis</i> , <i>Grevillea oligantha</i> , <i>Hybanthus floribundus</i> , <i>Pomaderris brevifolia</i> , <i>Pultenaea Xwudjariensis</i> (P1), <i>Melaleuca pomphostoma</i> , <i>Nematolepis phebalioides</i> , <i>Philothea gardneri</i> subsp. <i>gardneri</i> , <i>Gyrostemon sessilis</i> , <i>Calothamnus quadrifidus</i> , <i>Calytrix tetragona</i> , <i>Halgania anagaloides</i> , <i>Coleanthera myrtoides</i> , <i>Beyeria cockertonii</i> (T), <i>Pultenaea Xwudjariensis</i> , <i>Grevillea fastigiata</i> (P4) and <i>Gyrostemon sessilis</i> are narrow range endemics.	PEC (Priority 3), WC Act



**Figure 4-3: Department of Biodiversity Conservation and Attractions Threatened and Priority Ecological Communities of the Ravensthorpe Range**

**LEGEND**

- Ravensthorpe Gold Project Area
- PEC - Heath on Komatiite of the Ravensthorpe area.
- TEC - Banksia laevigata - Banksia lemanniana proteaceous thicket.
- PEC - Very open mallee over Melaleuca sp. Kundip dense heath.
- TEC/PEC - Proteaceae dominated kwongan shrublands of the southeast coastal floristic province of WA.



Date: 27/09/2018

Scale: 1:188,937

GDA 1994 MGA Zone 51

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\\WAINSERVER\Documents\APM GIS and Mapping\03\_Client\APM2017\GIS\ACH\02\_GIS Maps\20180927\_ACH026\_ERD\_DBCA\_TECPECS\_Figure 4-5\_.mxd

#### 4.1.1.5 Introduced Flora

Three invasive plant taxa listed as MNES were identified as likely to occur near the Project area; *Asparagus asparagoides*, *Lycium ferocissimum* and *Tamarix aphylla*. Interestingly, Florabase occurrence records indicate that *Tamarix aphylla*, unlike *Asparagus asparagoides* and *Lycium ferocissimum*, does not occur within the same IBRA region as the Project, and is therefore unlikely to occur.

Bridal creeper *Asparagus asparagoides* is classified as a Weed of National Significance (**WONS**) and a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) characterised as 'no control' (Department of Primary Industries and Regional Development, 2017) and will require active management.

African Boxthorn *Lycium ferocissimum* is broadly distributed over the Eremaean Province and South-West Botanical Provinces. Often introduced on islands and near-coastal areas as a wind break this species is highly invasive and, once established, is difficult to control. Broken stem and root pieces can remain alive for several months before flowering, fruiting or taking root. Disturbance results in mass seed germination within one year. Over the life of the Project the spread of this species must be curtailed and provisions for active removal should be put in place.

Athel Pine *Tamarix aphylla* is a WONS. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts. This species, if detected, will require active management.

## 4.2 FIELD SURVEY

### 4.2.1 Summary of the quadrat data

A total of 243 taxa (species, subspecies and varieties) belonging to 126 genera and 49 families were recorded within and adjacent to the 95 quadrats (Appendix 16). The 95 quadrats surveyed captured an average of 25, maximum of 48 and minimum of 4 species. The average richness recorded appears consistent with that detected by Markey *et al.* (2012). The compositional turnover (Whittaker's beta diversity; Whittaker 1965) was high, at 0.83.

### 4.2.2 Flora and Vegetation Associations

The Craig (2008) vegetation communities were ground-truthed with a focus on structural changes during the survey conducted in Spring 2016. During this time disturbed areas were updated. Only very minor changes were made to the boundaries of these vegetation units. After the establishment and analyses of the 95 quadrats within these vegetation units, the vegetation units have been updated. A description of each vegetation community as described by Craig *et al.* (2008) are presented in Table 4-3 and Figure 4-4 shows where those vegetation communities occur within the Project Area.

Relative Euclidean distance combined with Ward's clustering was identified by OptimClass as the optimal classification. This is not surprising given that normalisation of the data is known to decrease unbalanced species distribution across relevés, as is the case with APM data (See section 4.2.1). According to peaks in the number of diagnostic species to cluster number, we identified 12 floristic communities belonging to two major groups (MG). Detailed descriptions of the Communities were summarised in the form of community profiles and their position established along gradients of variables from the environmental data in Appendix 15. A low (%) of the compositional variance (at quadrat level) was explained by the environmental variables with a total of 13.57 along the first two db-RDA axis. With exception of Community 12 (*Eucalyptus asperatilis* – *Eucalyptus*

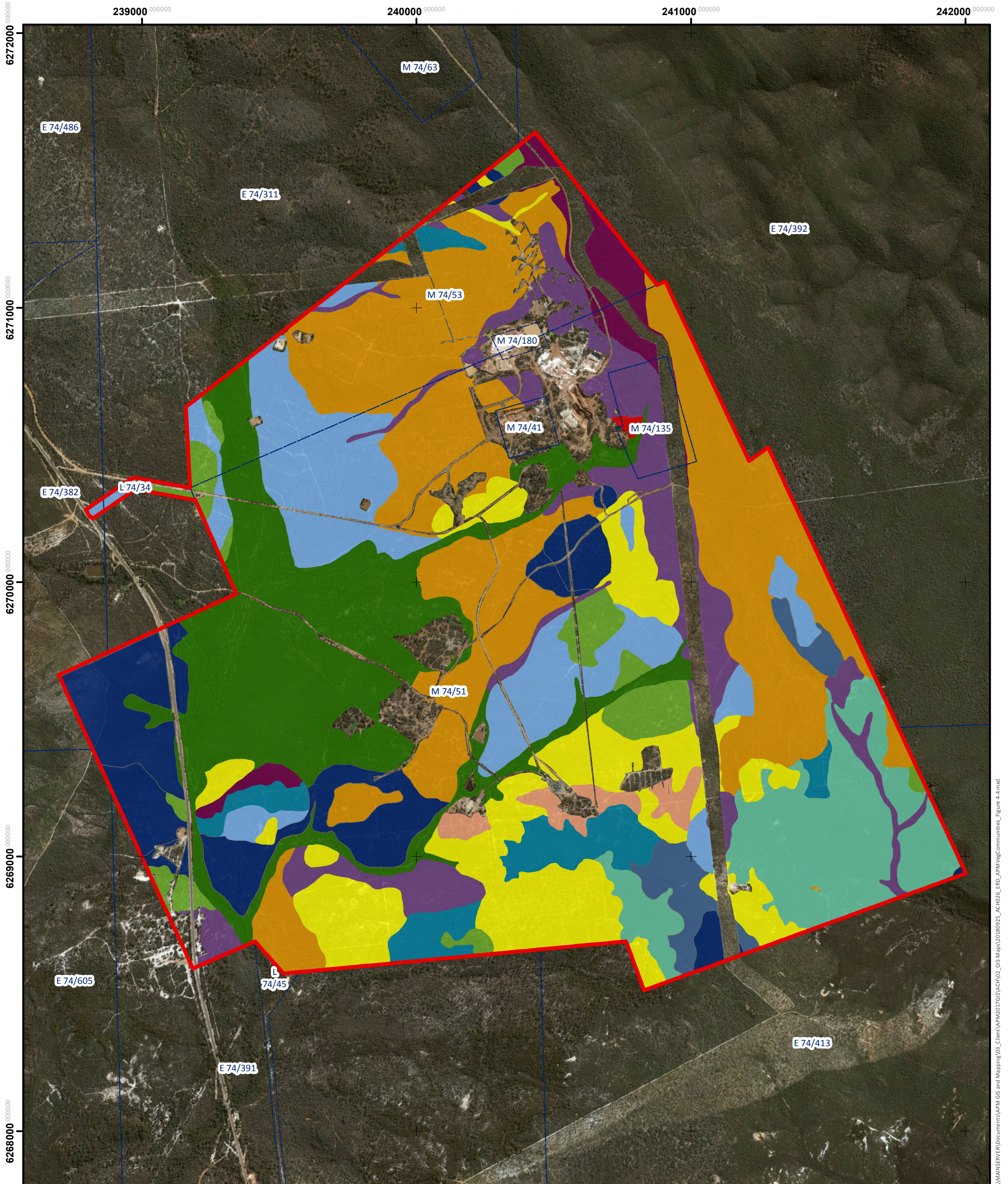
*cernua*) which occurs primarily on shallow regolith with higher Total Nitrogen and Organic Carbon, the remainder of the Communities appear to have overlapping environmental niches.

**Table 4-3: Relationship between Craig *et al.*'s (2008) and APM (2017) New Floristic Communities in the Ravensthorpe Gold Project Area (with exception of Completely Degraded areas).**

New Community Number	Craig <i>et al.</i> 's (2008) Code	APM Community Name	Total Occurrence in the RGP (ha)
1	Efal/Eple	<i>Taxandria spathulata</i> - <i>Banksia heliantha</i>	10.7
2	Ecli; Mx; East; Efal/Eple/ Mallee/Mspp	<i>Eucalyptus clivicola</i> - <i>Eucalyptus astringens</i>	18.1
3	Ecli;	<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>	0.6
4	Efal/Eple; Eole/Mpau	<i>Eucalyptus flocktoniae</i> - <i>Calothamnus quadrifidus</i>	6.7
5	Eflo/Espp; Eple/Bmed; Mallee/Mspp	<i>Eucalyptus leptocalyx</i> - <i>Tetrapora verrucosa</i>	56.6
6	Dcir; Efal/Eple; Eflo/Espp; Mallee/Mspp	<i>Taxandria spathulata</i> - <i>Melaleuca rigidifolia</i>	134.5
7	Ecli; Efal; Efal/Eple; Eflo/Mbra; Mstr	<i>Banksia cirsioides</i> - <i>Eucalyptus pleurocarpa</i>	20.0
8	Efal/Eple; Eflo/Mgor; Mallee/mspp; Mstr	<i>Melaleuca glaberrima</i> - <i>Melaleuca rigidifolia</i>	46.0
9	East; Eflo/Espp; Eflo/Esug; Eflo/Mgor; Mcau	<i>Melaleuca stramentosa</i> - <i>Eucalyptus flocktoniae</i>	64.5
10	Epil; Epla; Epro/Mspp; Espo; Mstr	<i>Melaleuca stramentosa</i> - <i>Taxandria spathulata</i>	44.1
11	Eflo/Mcuc; Eflo/Mgor; Eocc; Epro/Mspp; Espo	<i>Melaleuca cucullata</i> - <i>Melaleuca acuminata</i>	90.5
12	Mosaic Ecer and Ecli	<i>Eucalyptus aspratilis</i> - <i>Eucalyptus cernua</i>	43.7
n/a <sup>1</sup>	Elep/Mrig	<i>Eucalyptus leptocalyx</i> - <i>Melaleuca rigidifolia</i>	9.5
<b>TOTAL:</b>			<b>545.4</b>

<sup>1</sup> Not surveyed as the mapped extent of this community does not intersect with the proposed RGP layout.





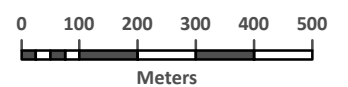
**Figure 4-4: APM (2018) Vegetation Communities of the Ravensthorpe Gold Project Area**

**LEGEND**

**APM Vegetation Communities**

- |   |                                |
|---|--------------------------------|
| 1 | 7                              |
| 2 | 8                              |
| 3 | 9                              |
| 4 | 10                             |
| 5 | 11                             |
| 6 | 12                             |
|   | Elep/Mrig (Craig 2008 Mapping) |

- Ravensthorpe Gold Project Area
- Mining Tenements



Date: 27/09/2018

Scale: 1:13,000

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### 4.2.3 Threatened and Priority Ecological Communities

During the ground-truthing of Craig's mapping (Craig *et al.* 2008) each community was assessed to determine whether it was representative of any one of the TECs or PECs that have the potential to occur in the Project area based on the databases search (Table 4-2). To achieve this goal; (1) the descriptions of the TECs/PECs were compared with those from Craig *et al.* (2008) mapped vegetation units, (2) detailed field observations were made during the on-ground surveys, and (3) formal comparison (especially regarding proteaceous species) was made during the surveys.

Initial desktop survey has identified four of Craig *et al.* (2008) communities as potentially representing one or more of the TECs or PECs. The full description of these communities by Craig *et al.* (2008) is presented in Table 4-4. The status of these communities as belonging to one of the TECs was then further assessed on a per case basis which involved use of quadrat data, the communities produced from the new numerical Classification as well as from field observations.

**Table 4-4: Full Description of the Craig *et al.* (2008) Vegetation Communities that Could be Representative of Local TECs and PECs**

Craig <i>et al.</i> (2008) Vegetation Unit Code	Craig <i>et al.</i> (2008) Vegetation Unit Name	Geology	Vegetation description
Dcir	<i>Banksia cirsioides</i> : Proteaceous mallee-heaths	Colluvium of deeply eroded surfaces - Qrg (228.8 ha); Sandplain - Czs (101.9 ha), Cemented ironstone gravel and laterite - Czl (67.6 ha); Gravel plain - Czg (64.1 ha); Colluvium and minor alluvium - Qrt (21.5 ha); Ultramafic rock, altered - Ae (6.9 ha); Pelitic metasediments - Alp (3.5 ha)	<p><b>Mallees:</b> <i>Eucalyptus pleurocarpa</i>, <i>Eucalyptus incrassata</i>, <i>Eucalyptus tetraptera</i>, <i>Eucalyptus uncinata</i></p> <p><b>Tall shrubs:</b> <i>Allocasuarina acutivalvis</i> subsp. <i>acutivalvis</i>, <i>Banksia lemanniana</i>, <i>Hakea pandanica</i> subsp. <i>crassifolia</i>, <i>Melaleuca hamata</i></p> <p><b>Mid shrubs:</b> <i>Banksia cirsioides</i>, <i>Banksia pallida</i>, <i>Gastrolobium parviflorum</i> forma 'broad', <i>Petrophile seminuda</i>, <i>Taxandria spathulata</i></p> <p><b>Low shrubs:</b> <i>Allocasuarina humilis</i>, <i>Beaufortia schaueri</i>, <i>Beaufortia micrantha</i> var. <i>micrantha</i>, <i>Melaleuca rigidifolia</i>, <i>Melaleuca subtrigona</i>, <i>Petrophile glauca</i></p> <p><b>Dwarf shrubs:</b> <i>Hibbertia pungens</i>, <i>Leucopogon conostephioides</i></p> <p><b>Sedges:</b> <i>Gahnia ancistrophylla</i>, <i>Mesomelaena stygia</i> subsp. <i>stygia</i></p> <p><b>Landform:</b> Lower and simple slopes and flat</p>
Efal/Eple	<i>Eucalyptus falcata</i> / <i>E. pleurocarpa</i> : Proteaceous mallee-heath	Colluvium of deeply eroded surfaces; contains rock fragments and minor outcrops - Qrg (1135.6 ha); Cemented ironstone gravel and laterite - Czl (779.2 ha); Metamorphosed sedimentary rock - As (405.1 ha); Fine-grained mafic rock - Ab (144.1 ha); Serpentinite - Au (81.3 ha); Pelitic metasediments - Alp (79.7 ha); Colluvium and minor alluvium - Qrt (78.0 ha); Gravel plain - Czg (52.2 ha)	<p><b>Mallees:</b> <i>Eucalyptus pleurocarpa</i>, <i>Eucalyptus falcata</i> subsp. <i>falcata</i>, <i>Eucalyptus uncinata</i>, <i>Eucalyptus incrassata</i>, <i>Eucalyptus phaenophylla</i></p> <p><b>Tall shrubs:</b> <i>Banksia lemanniana</i>, <i>Banksia laevigata</i> subsp. <i>laevigata</i>, <i>Beaufortia orbifolia</i>, <i>Banksia quercifolia</i>, <i>Grevillea coccinea</i> subsp. <i>coccinea</i>, <i>Melaleuca hamata</i></p> <p><b>Mid shrubs:</b> <i>Acacia fragilis</i>, <i>Acacia heterochroa</i> subsp. <i>heterochroa</i>, <i>Allocasuarina humilis</i>, <i>Beyeria brevifolia</i> var. <i>brevifolia</i>, <i>Calothamnus quadrifidus</i>, <i>Banksia cirsioides</i>, <i>Banksia pallida</i>, <i>Gastrolobium parviflorum</i> forma 'broad', <i>Hakea lissocarpha</i>, <i>Hakea obtusa</i>, <i>Hakea verrucosa</i>, <i>Isopogon polycephalus</i>, <i>Jacksonia viscosa</i>, <i>Kunzea cincinnata</i>, <i>Leptospermum spinescens</i>, <i>Melaleuca rigidifolia</i>, <i>Melaleuca subtrigona</i>, <i>Petrophile seminuda</i>, <i>Taxandria spathulata</i></p> <p><b>Low shrubs:</b> <i>Beaufortia schaueri</i>, <i>Hibbertia mucronata</i>, <i>Lasiopetalum compactum</i>, <i>Leucopogon cuneifolius</i>, <i>Petrophile glauca</i>, <i>Petrophile fastigiata</i>, <i>Philotheca gardneri</i> subsp. <i>Ravensthorpe</i> (G.F. Craig 6902)</p> <p><b>Dwarf shrubs:</b> <i>Hibbertia pungens</i>, <i>Leucopogon conostephioides</i>, <i>Rinzia communis</i></p> <p><b>Sedges:</b> <i>Gahnia ancistrophylla</i>, <i>Lepidosperma</i> sp. <i>Mt Benson</i> (RL Barrett 3553), <i>Lepidosperma</i> sp. <i>Cordingup</i> (GF Craig 6138), <i>Mesomelaena stygia</i> subsp. <i>stygia</i></p> <p><b>Landform:</b> Crest, upper to lower slope, flat, and open depression</p>

Craig <i>et al.</i> (2008) Vegetation Unit Code	Craig <i>et al.</i> (2008) Vegetation Unit Name	Geology	Vegetation description
Eple/Bmed	<i>Eucalyptus pleurocarpa</i> / <i>Banksia media</i>	Sandplain - mostly loam/ clay, with ironstone pebbles and limonite nodules - Czc (95.9 ha); Sandplain - Czs (61.9 ha); Drainage/ Alluvium of mature drainage - Qpv (59.2 ha); Colluvium of deeply eroded surfaces; contains rock fragments and minor outcrops - Qrg (59.2 ha); Colluvium and minor alluvium - Qrt (57.8 ha); Fine-grained mafic rock - Ab (18.8 ha); Felsic extrusives, mainly dacite - Al (11.0 ha)	<p><b>Mallees:</b> <i>Eucalyptus falcata</i> subsp. <i>falcata</i>, <i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>, <i>Eucalyptus incrassata</i>, <i>Eucalyptus pleurocarpa</i>, <i>Eucalyptus phaenophylla</i>, <i>Eucalyptus proxima</i>, <i>Eucalyptus suggrandis</i> subsp. <i>suggrandis</i>, <i>Eucalyptus uncinata</i></p> <p><b>Tall shrubs:</b> <i>Banksia media</i>, <i>Melaleuca hamata</i>, <i>Hakea laurina</i>, <i>Hakea pandanicarpa</i> subsp. <i>crassifolia</i>, <i>Hakea pandanicarpa</i> subsp. <i>pandanicarpa</i></p> <p><b>Mid shrubs:</b> <i>Allocasuarina humilis</i>, <i>Calothamnus gibbosus</i>, <i>Calothamnus gracilis</i>, <i>Banksia cirsioides</i>, <i>Grevillea oligantha</i>, <i>Hakea corymbosa</i>, <i>Melaleuca bracteosa</i>, <i>Melaleuca glaberrima</i>, <i>Melaleuca rigidifolia</i>, <i>Melaleuca lateriflora</i> subsp. <i>lateriflora</i>, <i>Melaleuca subfalcata</i>, <i>Melaleuca subtrigona</i>, <i>Taxandria spathulata</i></p> <p><b>Low shrubs:</b> <i>Acacia gonophylla</i>, <i>Baeckea corynophylla</i>, <i>Beaufortia micrantha</i> var. <i>micrantha</i>, <i>Beaufortia schaueri</i>, <i>Boronia inornata</i>, <i>Hakea marginata</i>, <i>Isopogon</i> sp. <i>Fitzgerald River</i> (DB Foreman 813), <i>Leucopogon fimbriatus</i>, <i>Lysinema ciliatum</i>, <i>Petrophile squamata</i> subsp. <i>northern</i> (J Monks 40)</p> <p><b>Dwarf shrubs:</b> <i>Acacia ingrata</i>, <i>Hibbertia pungens</i>, <i>Rinzia communis</i></p> <p><b>Sedges:</b> <i>Gahnia ancistrophylla</i></p> <p><b>Landform:</b> Simple lower slopes and flats</p>
Mx	Mx	Colluvium of deeply eroded surfaces; contains rock fragments and minor outcrops - Qrg (10.6 ha)	<p><b>Mallets:</b> <i>Eucalyptus cernua</i></p> <p><b>Mallees:</b> <i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>, <i>Eucalyptus phaenophylla</i></p> <p><b>Mid shrubs:</b> <i>Baeckea corynophylla</i>, <i>Melaleuca bracteosa</i>, <i>Melaleuca haplantha</i>, <i>Melaleuca</i> sp. <i>Kundip</i> (GF Craig 6020), <i>Melaleuca stramentosa</i></p> <p><b>Low shrubs:</b> <i>Pultenaea craigiana</i></p> <p><b>Dwarf shrubs:</b> <i>Andersonia parvifolia</i>, <i>Cooperookia polygalacea</i>, <i>Hibbertia psilocarpa</i>, <i>Leucopogon infuscatus</i></p> <p><b>Sedges:</b> <i>Gahnia aristata</i></p> <p><b>Landform:</b> Gently undulating, lower slopes</p>

## Dcir

The *Banksia cirsioides*: Proteaceous mallee-heaths are a vegetation community representative of the Proteaceae Dominated Kwongan Shrublands of the Southeast Coastal Floristic Province of WA TEC/PEC. *Banksia cirsioides* and *Hakea pandanica* are species known to occur in the TEC and have been detected within the Dcir vegetation community described by Craig *et al.* (2008). In support of Craig *et al.*'s (2008) description both species have been detected during our field survey with *B. cirsioides* (Projected cover (%);  $\bar{x}$  = 30) and *H. pandanica* (Projected cover (%);  $\bar{x}$  = 1). Further, since *B. cirsioides* occurs with cover  $\geq$  30% the vegetation triggers one of the criteria for referral under the EPBC Act (EPA 1999a). Additionally, pursuant to the new vegetation classification Community 7, consisting of 7 quadrats and named *Banksia cirsioides* – *Eucalyptus pleurocarpa* is considered as the TEC/PEC. Table 4-5 provides a complete list of species recorded in a single quadrat intersecting with the initial mapping of the Dcir community (Craig *et al.* 2008).

Throughout the Ravensthorpe Range this vegetation community is present as 37 discrete units (Craig *et al.* 2008). Following the new mapping within the Project area, Community 7 occurs within a total of 11 polygons (7 within the Kundip area and 4 along the vegetation corridor) covering a total area of 21.6 ha. Based on the current Disturbance Footprint approximately 3.2 ha (15%) of Community 7 will be directly impacted.

**Table 4-5: Species Recorded in 1 Quadrat Intersecting with Craig *et al.*'s (2008) Dcir (*Dryandra cirsioides*) Polygon (bold and shaded taxa are those identified as characteristic floristic elements of the Kwongan TEC).**

Species	Number of Observations	Average Projected Cover (%)
<b><i>Banksia cirsioides</i></b>	<b>1</b>	<b>30.00</b>
<i>Allocasuarina thuyoides</i>	1	5.00
<i>Beaufortia micrantha</i>	1	3.00
<i>Lepidosperma diurnum</i>	1	3.00
<i>Leucopogon</i> sp. Newdegate (M. Hislop 3585)	1	3.00
<i>Conostylis bealiana</i>	1	2.00
<i>Melaleuca rigidifolia</i>	1	2.00
<i>Amphipogon turbinatus</i>	1	1.50
<i>Billardiera venusta</i>	1	1.00
<i>Chorizema glycinifolium</i>	1	1.00
<i>Eucalyptus goniocarpa</i>	1	1.00
<i>Eucalyptus pleurocarpa</i>	1	1.00
<i>Gompholobium knightianum</i>	1	1.00
<b><i>Hakea pandanica</i> subsp. <i>pandanica</i></b>	<b>1</b>	<b>1.00</b>
<i>Hibbertia gracilipes</i>	1	1.00
<i>Lepidosperma gahnioides</i>	1	1.00
<i>Leptospermum</i> sp. Bandalup Hill (G. Cockerton 11001)	1	1.00
<i>Lysinema pentapetalum</i>	1	1.00
<i>Mesomelaena stygia</i> subsp. <i>stygia</i>	1	1.00
<i>Neurachne alopecuroidea</i>	1	1.00
<i>Petrophile squamata</i> subsp. <i>northern</i> (J. Monks 40)	1	1.00
<i>Schoenus pleiostemoneus</i>	1	1.00
<i>Stylidium piliferum</i>	1	1.00
<i>Tetrapora verrucosa</i>	1	1.00
<i>Xanthorrhoea platyphylla</i>	1	1.00

## Efal/Eple

*Eucalyptus falcata* / *E. pleurocarpa*: Proteaceous mallee-heath vegetation community has elements of TECs; (1) Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA and (2) *Banksia laevigata* - *Banksia lemniiana* proteaceous thicket.

The floristic element reported by Craig *et al.* (2008) within Efal/Eple and belonging to 'Proteaceae Dominated Kwongkan Shrublands TEC' is *B. cirsioides*.

The floristic elements reported by Craig *et al.* (2008) within Efal/Eple and belonging to '*Banksia laevigata* - *Banksia lemniiana* proteaceous thicket TEC' are; *B. laevigata* subsp. *laevigata*, *B. lemniiana*, *Adenanthos oreophilus*, *Leptospermum maxwellii*, *Beaufortia orbifolia*, *Taxandria spathulata* and *Stylidium albomontis*.

Based on field observations (Table 4-6), within the Efal/Eple vegetation units (mapped by Craig *et al.*, 2008), occurring within the Project area, the main floristic elements of this vegetation was highly variable, and included; Myrtoid, Ericoid and Restiod dominating taxa (in terms of projected cover as well as high incidence records); with only two records of *B. cirsioides* (Projected cover (%);  $\bar{x} = 6$ , Sd  $\pm 5.6$ ), 7 records of *B. lemniiana* (Projected cover (%);  $\bar{x} = 5.7$ , Sd  $\pm 4.2$ ), 8 records of *T. spathulata* (Projected cover (%);  $\bar{x} = 26.1$ , Sd  $\pm 26.5$ ) and 4 records of *S. albomontis* (Projected cover (%);  $\bar{x} = 1$ , Sd  $\pm 0$ ). At no point was *B. laevigata* detected.

The Efal/Eple community is represented within 99 discrete units in the Ravensthorpe Range area. The Efal/Eple vegetation as described by Craig *et al.* (2008) should not be considered as the '*Banksia laevigata* - *Banksia lemniiana* proteaceous thicket' and only marginal sections have the potential for consideration for referral under the EPBC Act for EPBC as 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province'.

Our reasons are manifold and include; (1) field data (Table 4-6) indicate that the dominant strata are not Proteaceous species (instead co-dominating myrtaceous, ericoid, restiod and proteoid only at low strata levels): *sensu stricto* to be considered for listing the vegetation patches must have Proteaceous projected cover values of > 30% across all layers where the shrubs occur (EPA 1999a), and (2) as was the case here, and likely throughout the extent of Efal/Eple across the Ravensthorpe range, fine scale survey effort (capturing the large variability contained within the unit) has/will elucidate patches of vegetation (new Community 7 which is considered a TEC/PEC) contained within Efal/Eple. This re-assignment is not surprising considering that the study of Markey *et al.* (2012) also found that the Efal/Eple community was highly variable.

The vegetation type Efal/Eple (as mapped by Craig *et al.* 2008), represents 151 ha the Project Area, of which 3.3 ha of its original extent falls into the newly delineated Community 7, a small portion of which will be directly impacted based on the current Disturbance Footprint.

**Table 4-6: Species Recorded in 12 quadrats Intersecting with Craig *et al.*'s (2008) Efal/Eple Polygons (bold and shaded taxa are those identified as characteristic floristic elements - singleton species were removed unless determined as a characteristic floristic element).**

Species	Number of observations	Average projected cover (%)
<i>Eucalyptus pleurocarpa</i>	11	7.82
<i>Petrophile squamata</i> subsp. northern (J. Monks 40)	11	6.91
<i>Hibbertia gracilipes</i>	9	1.11
<b><i>Taxandria spathulata</i></b>	<b>8</b>	<b>26.13</b>
<i>Eucalyptus falcata</i>	8	8.63
<i>Leucopogon</i> sp. Newdegate (M. Hislop 3585)	8	4.75
<i>Melaleuca rigidifolia</i>	8	2.44
<b><i>Banksia lemniiana</i></b>	<b>7</b>	<b>5.71</b>
<i>Lepidosperma gahnioides</i>	7	3.36
<i>Hakea lissocarpha</i>	7	2.57
<i>Lepidosperma carphoides</i>	7	1.50
<i>Mesomelaena stygia</i> subsp. <i>stygia</i>	7	1.29
<i>Tetrapora verrucosa</i>	6	6.83
<i>Beaufortia micrantha</i>	6	3.00
<i>Neurachne alopecuroidea</i>	6	1.67
<i>Lepidosperma viscidum</i>	5	2.40
<i>Lepidosperma diurnum</i>	5	1.80
<i>Isopogon</i> sp. Fitzgerald River (D.B. Foreman 813)	5	1.70
<i>Cassytha melantha</i>	5	1.00
<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>	4	13.00
<i>Eucalyptus incrassata</i>	4	3.00
<i>Allocasuarina humilis</i>	4	2.25
<i>Calothamnus pinifolius</i>	4	2.25
<i>Chorizema glycinifolium</i>	4	1.63
<i>Lepidosperma tuberculatum</i>	4	1.25
<i>Amphipogon turbinatus</i>	4	1.00
<i>Hibbertia exasperata</i>	4	1.00
<i>Lomandra mucronata</i>	4	1.00
<b><i>Stylidium albomontis</i></b>	<b>4</b>	<b>1.00</b>
<i>Hakea laurina</i>	3	10.33
<i>Banksia heliantha</i>	3	6.67
<i>Eucalyptus leptocalyx</i>	3	5.00
<i>Grevillea patentiloba</i> subsp. <i>patentiloba</i>	3	3.00
<i>Melaleuca hamata</i>	3	2.67
<i>Eucalyptus uncinata</i>	3	2.33
<i>Eutaxia cuneata</i>	3	1.33
<i>Acacia gonophylla</i>	3	1.00
<i>Acacia subcaerulea</i>	3	1.00
<i>Dampiera lavandulacea</i>	3	1.00
<i>Leptospermum</i> sp. Bandalup Hill (G. Cockerton 11001)	3	1.00
<i>Pterostylis sanguinea</i>	3	1.00

Species	Number of observations	Average projected cover (%)
<i>Pultenaea indira</i> subsp. <i>indira</i>	3	1.00
<i>Stylidium piliferum</i>	3	1.00
<i>Verticordia acerosa</i> var. <i>preissii</i>	3	1.00
<i>Acacia heterochroa</i> subsp. <i>heterochroa</i>	2	15.50
<i>Beaufortia schaueri</i>	2	9.50
<i>Acacia pinguiculosa</i> subsp. <i>pinguiculosa</i>	2	8.00
<i>Jacksonia viscosa</i>	2	7.00
<b><i>Banksia cirsioides</i></b>	<b>2</b>	<b>6.00</b>
<i>Hibbertia mucronata</i>	2	6.00
<i>Leucopogon carinatus</i>	2	3.50
<i>Grevillea oligantha</i>	2	3.00
<i>Boronia crassifolia</i>	2	2.00
<i>Leucopogon fimbriatus</i>	2	1.50
<i>Lysinema ciliatum</i>	2	1.50
<i>Acacia crispula</i>	2	1.00
<i>Allocasuarina microstachya</i>	2	1.00
<i>Calothamnus roseus</i>	2	1.00
<i>Cassutha glabella</i>	2	1.00
<i>Cassutha racemosa</i>	2	1.00
<i>Conostylis bealiana</i>	2	1.00
<i>Cooperookia strophiolata</i>	2	1.00
<i>Daviesia anceps</i>	2	1.00
<i>Desmocladus lateriflorus</i>	2	1.00
<i>Dodonaea pinifolia</i>	2	1.00
<i>Gastrolobium venulosum</i>	2	1.00
<i>Gompholobium knightianum</i>	2	1.00
<i>Lasiopetalum rosmarinifolium</i>	2	1.00
<i>Leucopogon opponens</i>	2	1.00
<i>Olearia imbricata</i>	2	1.00
<i>Schoenus racemosus</i>	2	1.00
<i>Thelymitra graminea</i>	2	1.00
<i>Xanthorrhoea platyphylla</i>	2	1.00

### Eple/Bmed

The floristic elements reported by Craig *et al.* (2008) within the *Eucalyptus pleurocarpa* / *Banksia media* vegetation suggests that it is representative of the Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA TEC. Characteristic of the Kwongkan TEC are many subordinate (constant) obligate re-seeding species (another characteristic of the TEC) including; *Banksia media*, *B. cirsioides*, *Hakea corymbosa* and *H. pandanicarpa*.

Our field data (Table 4-7), partially support Craig *et al.*'s (2008) vegetation descriptions with the detection of *B. media* (Projected cover (%);  $\bar{x}$  = 6.7, Sd  $\pm$  9.0), *H. corymbosa* (Projected cover (%);  $\bar{x}$  = 2, Sd  $\pm$  2) and *H. pandanicarpa* (Projected cover (%);  $\bar{x}$  = 2, Sd  $\pm$  2). Further, we also identified; *Petrophile squamata* subsp. *northern* (J. Monks 40) and *B. lemmaniana*—additional diagnostic species of the Kwongkan TEC—occurring



within the Eple/Bmed unit mapped by Craig *et al.* (2008). Of these, *B. media* was distributed amongst four quadrats and *B. lemanniana* over two quadrats.

The *Eucalyptus pleurocarpa* / *Banksia media* vegetation is represented within 31 discrete units within the Ravensthorpe Range (Craig *et al.* 2008). Following the new classification, the unit was re-assigned to Community 5 (*Eucalyptus leptocalyx* – *Tetraphora verrucosa*) consisting of 14 polygons, which we consider as the Kwongkan TEC. The new area covers 56.6 ha within the Project area of which 22.7 ha will be directly impacted based on the current disturbance footprint.

**Table 4-7: Species recorded in 5 quadrats intersecting with Craig *et al.*'s (2008) Eple/Bmed polygons. Bold and shaded taxa are those identified as characteristic floristic elements. Singleton species were removed unless determined as a characteristic floristic element.**

Species	Number of observations	Average projected cover (%)
<i>Lepidosperma gahnioides</i>	5	3.40
<i>Lepidosperma fairallianum</i>	5	3.20
<i>Cassytha glabella</i>	5	1.10
<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>	4	11.25
<i>Melaleuca rigidifolia</i>	4	9.00
<b><i>Banksia media</i></b>	<b>4</b>	<b>6.75</b>
<b><i>Petrophile squamata</i> subsp. Northern (J. Monks 40)</b>	<b>4</b>	<b>6.25</b>
<i>Amphipogon turbinatus</i>	4	6.00
<i>Schoenus racemosus</i>	3	14.33
<i>Eucalyptus leptocalyx</i>	3	11.00
<i>Tetrapora verrucosa</i>	3	9.33
<i>Leucopogon</i> sp. Newdegate (M. Hislop 3585)	3	3.00
<i>Hakea laurina</i>	3	2.67
<i>Mesomelaena stygia</i> subsp. <i>stygia</i>	3	2.33
<i>Melaleuca stramentosa</i>	3	2.00
<i>Acacia gonophylla</i>	3	1.33
<i>Acacia ingrata</i>	3	1.33
<i>Calytrix leschenaultii</i>	3	1.33
<i>Hibbertia gracilipes</i>	3	1.33
<i>Neurachne alopecuroidea</i>	3	0.70
<b><i>Banksia lemanniana</i></b>	<b>2</b>	<b>21.00</b>
<i>Hakea lissocarpha</i>	2	2.50
<i>Daviesia teretifolia</i>	2	2.00
<i>Grevillea oligantha</i>	2	2.00
<i>Stachystemon virgatus</i>	2	2.00
<i>Leptospermum</i> sp. Bandalup Hill (G. Cockerton 11001)	2	1.50
<i>Conostylis bealiana</i>	2	1.00
<i>Coopernookia polygalacea</i>	2	1.00
<i>Isopogon</i> sp. Fitzgerald River (D.B. Foreman 813)	2	1.00
<b><i>Hakea corymbosa</i></b>	<b>1</b>	<b>2.00</b>
<b><i>Hakea pandanica</i> subsp. <i>pandanica</i></b>	<b>1</b>	<b>2.00</b>

## Mx

The floristic elements reported by Craig *et al.* (2008) within the *Melaleuca sp. Kundip* vegetation (Mx) suggests that it is representative of the PEC 'Very open mallee over *Melaleuca sp. Kundip* dense heath (P1)'. Characteristic species recorded by Craig *et al.* (2008) include; *Acacia durabilis*, *Dodonaea trifida*, *Eucalyptus cernua*, *Eucalyptus phaenophylla*, *Eucalyptus pileata*, *Leucopogon infuscatus*, *Hibbertia psilocarpa*, *Melaleuca bracteosa*, *Melaleuca sp. Kundip (Melaleuca sophisma)*, *Melaleuca haplantha*, *Melaleuca rigidifolia*, *Melaleuca stramentosa*, *Melaleuca ulicoides*. Additionally, the vegetation community occurs on pale loamy sand with quartz rubble – also matching formal description of the PEC.

Mx is found within three discrete units in the Ravensthorpe Range, all of which are within the Project area. During the field survey within the quadrat falling within Mx we detected; *E. cernua* (Projected cover (%);  $\bar{x}$  = 15), *E. phaenophylla* (Projected cover (%);  $\bar{x}$  = 5), *M. bracteosa* (Projected cover (%);  $\bar{x}$  = 10) and *M. sophisma* (Projected cover (%);  $\bar{x}$  = 30) (Table 4-8). Following classification procedures these quadrats were assigned to Community 2 (*Eucalyptus clivicola* – *Eucalyptus astringens*) which is described as having two main physiognomic facies: one dominated by *M. sophisma* and the other by *M. haplantha*.

Community 2 consists of 13 polygons and as whole is distributed across 17.5 ha within the Project area. Importantly, only one of these polygons is dominated by *M. sophissima* and covers 1.0 ha. In a precautionary fashion we also incorporated a buffer around database records as well as field opportunistic observations of *M. sophissima* to delineate the full extent (34.2 ha), subsequently this PEC area now incorporates Community 7 & 9 as well. Additionally, DPAW (2016) noted that the PEC abuts *Eucalyptus astringens* low woodland – an observation which is consistent with our new classification (i.e. Community 2, is named *Eucalyptus clivicola* – *Eucalyptus astringens* after its two most dominant taxa). As a result, the new buffer also includes this area as described by DPAW (2016) as marginal. We remain confident that this new buffer captures the extent of this PEC and captures the majority of the ecological substrate (pale loamy sand with quartz rubble) representing the niche of this PEC community as well as that of the Priority 4 species, *M. sophissima*. As a point, this surface geology (Qrg; Table 4-4) which exhibits the loamy sand with quartz rubble appears and extends south from the southern extent of the Project area. Approximately 2 ha (6%) of this PEC will be directly impacted based on the current disturbance footprint.

**Table 4-8: Species Recorded in 1 Quadrat Intersecting with Craig *et al.*'s (2008) Mx polygon (bold and shaded taxa are those identified as characteristic floristic elements).**

Species	Number of observations	Average projected cover (%)
<b><i>Melaleuca sophisma</i></b>	<b>1</b>	<b>30</b>
<b><i>Eucalyptus cernua</i></b>	<b>1</b>	<b>15</b>
<b><i>Melaleuca bracteosa</i></b>	<b>1</b>	<b>10</b>
<i>Melaleuca torquata</i>	1	10
<b><i>Eucalyptus phaenophylla</i></b>	<b>1</b>	<b>5</b>
<i>Melaleuca cucullata</i>	1	5
<i>Acacia ingrata</i>	1	1
<i>Gahnia</i> sp. South West (K.L. Wilson & K. Frank K LW 9266)	1	1
<i>Lepidosperma</i> sp.	1	1
<i>Melaleuca lateriflora</i>	1	1

Table 4-9 provides a summary of estimated impacts to vegetation communities, which based on the above assessment, potentially represent TECs/PECs listed in Table 4-2. Potential impacts have been considered at a local scale (i.e. within the Project Area) and at a regional scale (i.e. within the context of the wider Ravensthorpe Range). Figure 4-5 shows the distribution of these communities within the Project Area.

**Table 4-9: Threatened and Priority Ecological Community Impacts**

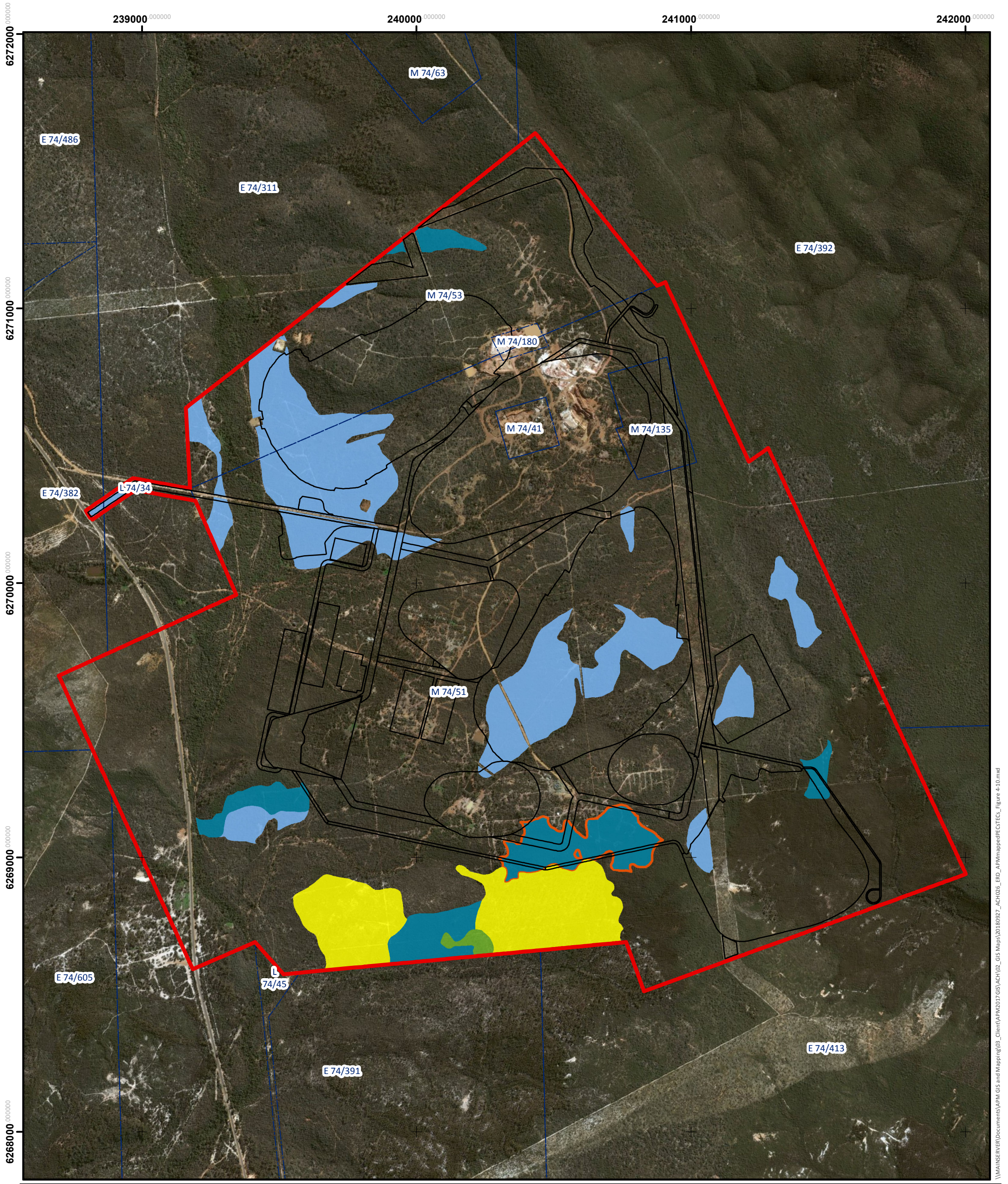
TEC/PEC Representation	Vegetation Community	Community occurrence in the Project area (ha) <sup>1</sup>	Community Directly Impacted (ha)	Disturbance to TEC/PEC within the Project area (%)	Disturbance to TEC/PEC in the Occurring within a 30 km Radius of the Project Area (%) <sup>2</sup>
Priority 1 PEC – Very open Mallee over <i>Melaleuca</i> sp. Kundip dense heath.	Community 2	34.2 <sup>3</sup>	1.2	3.5	8.8
	Community 7				
	Community 9				
TEC/PEC – Proteacea Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA	Community 5	76.7 <sup>4</sup>	38.4	50.1	< 0.1
	Community 7				

<sup>1</sup> 8.9 ha of vegetation community 7 meets the criteria for both and therefore must be subtracted from the total. The total area of these communities within the Project area is therefore 101.9 ha (not 110.8 ha).

<sup>2</sup> Calculated using shapefiles provided by DBCA on 16 June 2016. For the purpose of estimating the total area of each TEC/PEC the 500 m buffers were removed from each polygon.

<sup>3</sup> The area provided represents specific portions of Communities 2, 7 and 9 considered as PEC 'Very open Mallee over *Melaleuca* sp. Kundip dense heath', and isolated towards the south within the Kundip Mine Site.

<sup>4</sup> Validation for the estimated extent of this TEC/PEC along the access corridor from the Hopetoun-Ravensthorpe Road can be made, as, brief survey work in early August (2018) comprised of quadrat and species collections that were found to reflect Community 5 (TEC/PEC).



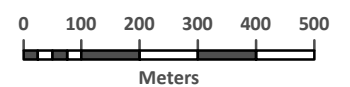
**Figure 4-5: Vegetation Representative of Priority and Threatened Ecological Communities at the Ravensthorpe Gold Project Area**

**LEGEND**

**TECs and PECs of the RGP (APM 2018)**

- Community 2 - PEC - Melaleuca sp. Kundip dense heath
- Community 5 - TEC/PEC Kwongkan Shrublands
- Community 7 - TEC/PEC Kwongkan Shrublands
- Community 7 - TEC/PEC Kwongkan and PEC Melaleuca sp. Kundip
- Community 9 - PEC - Melaleuca sp. Kundip dense heath

- RGP Disturbance Footprint
- Ravensthorpe Gold Project Area
- Mining Tenements



Date: 27/09/2018

Scale: 1:13,000

GDA 1994 MGA Zone 51

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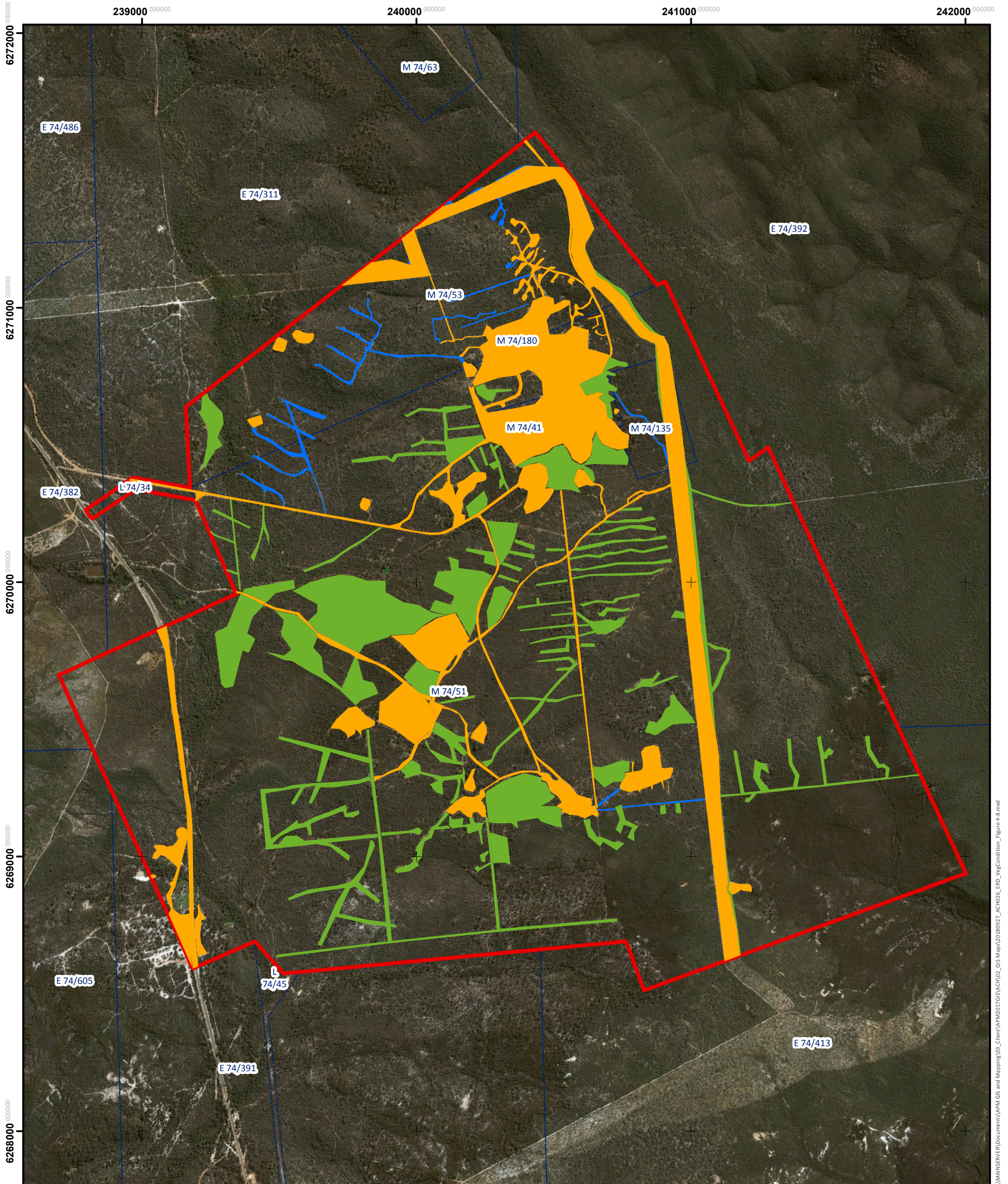


\\WAISERVER\Documents\APM GIS and Mapping\03\_Client\APM2017\GIS\ACH\02\_GIS Maps\20180927\_ACH\026\_ERD\_APMmappedPECs\_TECs\_Figure 4-10.mxd

#### 4.2.4 Vegetation Condition

There is a longstanding legacy of mining practice within the Kundip Mine Site stemming from the early 19<sup>th</sup> century to present day exploration projects. As such, vegetation within the Project Area consequently reflects a mosaic of conditions (Keighery, 1994). Areas containing established access roads and all historically disturbed areas such as open pits, underground workings, WRL, heap leach pad and old hardstand areas are of 'Completely Degraded' condition (Keighery, 1994). Recent exploration works (drill lines at 25 – 50 m resolution) are areas of both 'Good' and 'Degraded' condition vegetation (Keighery, 1994), given that some areas of disturbance have had more time to regenerate. Areas containing historic exploration lines, historic access tracks and some historically cleared areas are of 'Very Good' condition (Keighery, 1994). All areas that have not been mapped to a specific condition are considered of 'Very Good' condition (Keighery, 1994) or better (i.e. up to 'Excellent' and 'Pristine' (Keighery, 1994).

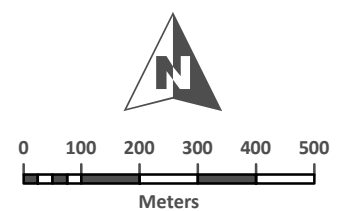
In total, there is 70.9 ha of 'Completely Degraded' vegetation within the Project Area. Condition mapping for vegetation within the Kundip Mine Site is shown in Figure 4-6.



**Figure 4-6: Vegetation Condition at the Ravensthorpe Gold Project Area**

**LEGEND**

- |   |  |
|---|--|
| <b>Vegetation Condition</b>   |  Ravensthorpe Gold Project Area |
|  Completely Degraded |  Mining Tenements               |
|  Good to Degraded    |  |
|  Very Good           |  |



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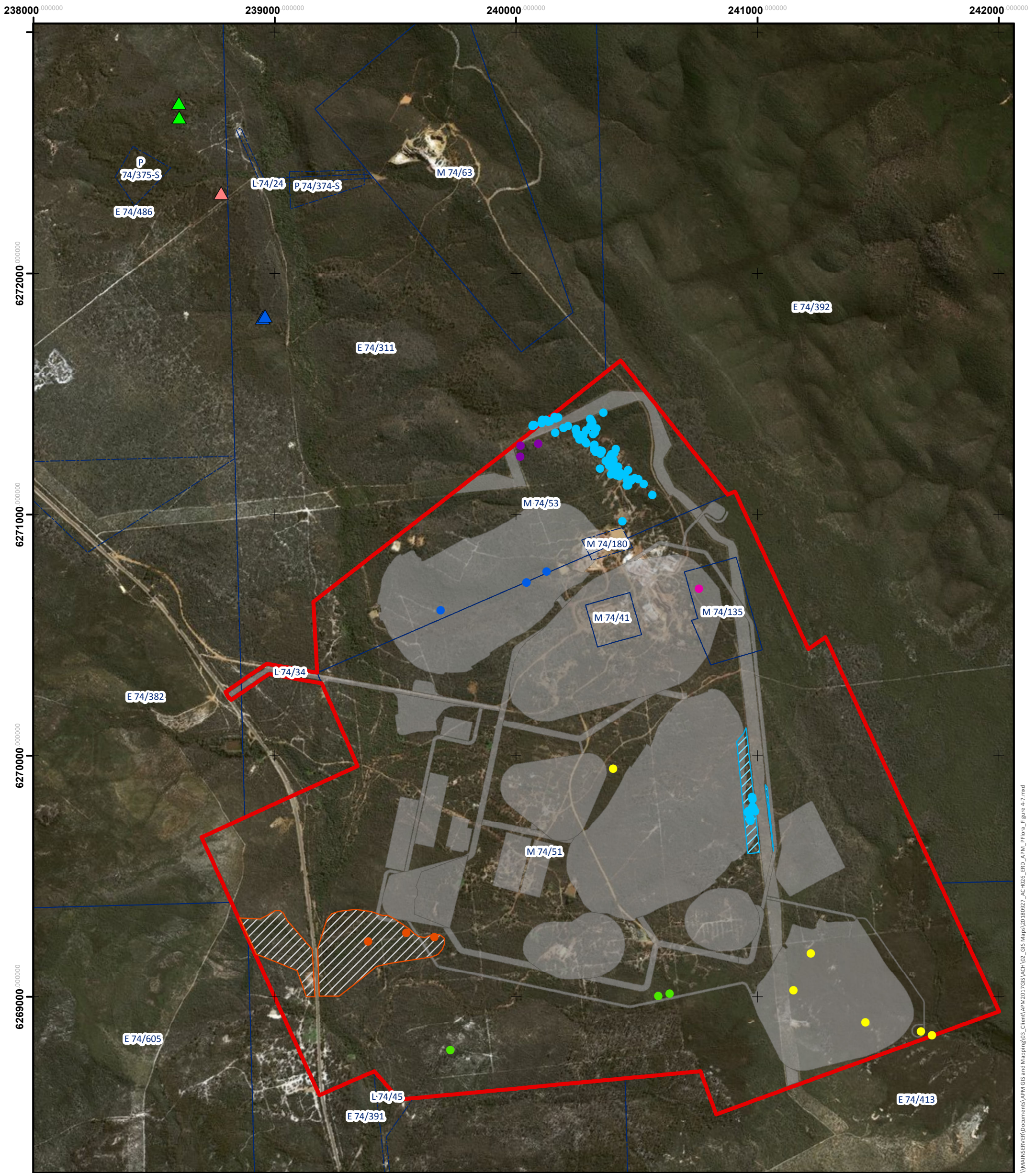


#### 4.2.5 Conservation Significant Flora

The 2016 - 2018 APM biological surveys identified a total of 7 flora species of conservation significance as occurring within the overall Project Area (Table 4-10). The location of recorded individuals is shown in Figure 4-7, with actual or estimated (~) population sizes provided in Table 4-10. The recorded distribution of each species in a local and regional context is discussed below.

**Table 4-10: Flora of Conservation Significance Recorded within the Ravensthorpe Gold Project Area**

Species	Conservation Status	Recorded in APM Quadrat(s)	Recorded in APM Targeted Search(es)	No. of Individuals Recorded
<i>Calothamnus roseus</i>	P1	*		≈753+
<i>Dampiera</i> sp. Ravensthorpe	P3			1
<i>Hydrocotyle</i> sp. Decipiens	P2	*	*	4
<i>Lepidosperma</i> sp. Elverdton	P1			1
<i>Marianthus mollis</i>	P4		*	≈1569+
<i>Melaleuca sophisma</i>	P1	*	*	3
<i>Pultenaea craigiana</i>	P3	*	*	8
<i>Stachystemon vinosus</i>	P4	*		1
<i>Thysanotus parviflorus</i>	P4	*		4



**Figure 4-7: Records of Priority Flora collected by APM at the Ravensthorpe Gold Project Area**

**LEGEND**

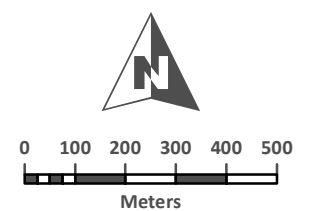
**Priority Flora Records (APM 2016 and 2017)**

- Calothamnus roseus
- Hydrocotyle sp. Decipiens (G.J. Keighery 463)
- Marianthus mollis
- Melaleuca sophisma
- Pultenaea craigiana
- Stachystemon vinosus
- Thysanotus parviflorus

**Priority Flora Records (APM 2017)**

- ▲ Hibbertia hamata
- ▲ Hydrocotyle sp. Decipiens
- ▲ Melaleuca sophisma

- Mining Tenements
- Ravensthorpe Gold Project Area
- Ravensthorpe Gold Project Footprint
- Marianthus mollis population polygon
- Calothamnus roseus population polygon



Date: 27/09/2018

Scale: 1:15,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au





APM have been unable to confirm the status of phrase name sedges of the Genus *Lepidosperma* within the Project area, despite making collections near previous records and submitting these to the paid ID at the State Herbarium. The WA Herbarium has stated:

*“The genus Lepidosperma is large and taxonomically complex. It is currently in the early stages of revision by Russell Barrett, formerly of Kings Park but who is now based in Canberra and not working on Lepidosperma. Russell has so far adopted very narrow species concepts and in addition to the published taxa and formally recognised phrase names there are many other waiting in the wings. This has left users with the problem of how to distinguish previously described species from the numerous formal and informal phrase names that Russell recognises, in the absence of documentation of the character differences that his is using. This basically means that the W.A. Herbarium is now in the unsatisfactory position of frequently being unable to provide authoritative identifications in the genus.”* Michael Hislop (2017).

It cannot therefore be confirmed whether any of these sedges would represent conservation significant flora based on the WA Herbarium response. The following conservation significant *Lepidosperma* sedge species that could potentially occur within the Project Area include:

- *Lepidosperma* sp. Archer Drive (S. Kern & R. Jasper LCH 18300) (P1);
- *Lepidosperma* sp. Elverdton (R. Jasper *et al.* LCH 16844) (P1);
- *Lepidosperma* sp. Maydon (S. Kern, R. Jasper, H. Hughes LCH 17844) (P1);
- *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); and
- *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1).

Of these species *Lepidosperma* sp. Mt Short and *Lepidosperma* sp. Elverdton have previously been recorded by the DBCA databases as occurring within the Project Area.

#### 4.2.6 Introduced Flora

APM identified 17 weed species within the RGP, including *\*Aloe brevifolia*, *\*Aloe maculata*, *\*Arctotheca calendula*, *\*Asparagus asparagoides*, *\*Atriplex prostrata*, *\*Carpobrotus aequilaterus*, *\*Cersium vulgate*, *\*Cotula coronopifolia*, *\*Conyza bonariensis*, *\*Hypochaeris glabra*, *\*Lolium rigidum*, *\*Oxalis pes-caprae*, *\*Pelargonium capitatum*, *\*Pentameris airoides* subsp. *airoides*, *\*Santhus oleraceus*, *\*Trifolium* spp. and *\*Ursinia anthemoides*. Of these, only one, *\*Asparagus asparagoides*, is classified as a Weed of National Significance (WONS) by the DoEE (2012) and is also a Declared Pest by the DPIRD *Biosecurity and Agriculture Management Act 2007* (BAM Act) and is categorised as C3 (Management) (DAFWA, 2016). The locality of this species is isolated to areas of high disturbance and is associated with annual weed species (Plate 4).

The location of *A. asparagoides* and other annual weeds recorded within the Project Area during APM surveys is indicated in Figure 4-8.



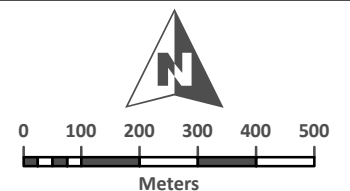
**Plate 4: *\*Asparagus asparagoides* Weed Patch (APM, 2016)**



**Figure 4-8: Location of \**Asparagus asparagoides* and other Annual Weeds (Buffer Zone) and Eradication Zone at the Ravensthorpe Gold Project Area**

**LEGEND**

- Buffer Zone - *Asparagus asparagoides* and Other Annual Weeds
- Eradication Zone - *Asparagus asparagoides* and Other Annual Weeds
- Ravensthorpe Gold Project Area
- Mining Tenements



Date: 27/09/2018  
 Scale: 1:13,000  
 GDA 1994 MGA Zone 51  
 Author: sarah@animalplantmineral.com.au



\\MAINSERVER\Documents\APM GIS and Mapping\03\_Client\APM\2017\GIS\ACH\02\_GIS Maps\20180927\_ACH026\_ERD\_Weeds\_Figure 4-8.mxd

## 5 TERRESTRIAL VERTEBRATE FAUNA RESULTS

### 5.1 DESKTOP SURVEY

Collectively, database searches indicate that a total of 297 fauna species are expected to occur within 10 km of the Project area: the total of 297 species comprise 133 birds, 27 mammals, 7 amphibians, 33 reptiles and 97 invertebrates. NatureMap lists records for 5 amphibians, 29 reptiles, 14 mammals and 69 birds. The AoLA lists records for 7 amphibians, 26 reptiles, 13 mammals, 77 birds and 94 invertebrates.

Baseline fauna surveys have recorded a total of 101 terrestrial vertebrate fauna species in the Project area, including 54 bird species, 12 mammals (9 native and 3 introduced), 29 reptiles and 6 amphibians. The assimilated survey records represent collections of approximately 50% of the expected fauna species likely to be present in the Project area. Some of the common fauna elements of the Project have been discussed in the context of the fauna habitat types within which they occur.

Database searches of Conservation Significant fauna indicate that a total of 46 fauna species are expected to occur within 10km of the Project area. This comprises 28 birds, 15 mammals, 2 reptiles and 1 invertebrate. The EPBC Protected Matters Search Tools lists records for 15 fauna species of Conservation Significance (comprising 11 birds and 4 mammals). The DBCA database search lists 34 Conservation Significant fauna (comprising of 20 birds, 11 mammals, two reptiles and one insect).

Conservation significant fauna identified by the database searches and the likelihood they occur in the Project Area are discussed in Table 5-1.

Fauna surveys carried out in January and November of 2004 by Biota Environmental Sciences Pty Ltd (Biota) recorded five fauna taxa of Conservation Significance. These included Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Malleefowl (*Leipoa ocellata*), Ravensthorpe Range Slider (*Lerista viduata*), Western Whipbird (Mallee) (*Psophodes nigrogularis* subsp. *oberon*) and the Western Brush Wallaby (*Macropus Irma*). The Biota surveys also recorded two species of mygalomorph spiders, *Aname mainae* and *Chenistonia tepperi*, in the Project area.

**Table 5-1: Conservation Significant Fauna Potentially Occurring and those Recorded During the Surveys in the Ravensthorpe Gold Project Area**

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
<b>Birds</b>							
<i>Apus pacificus</i>	Fork-tailed Swift	IA	IA	The Fork-tailed Swift occurs on coastal plains and sometimes foothills (DoEE, 2018b). They are mostly found over dry or open habitats including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. This species is almost exclusively aerial (DoEE, 2018b).	Moderate	Yes	This species is almost exclusively aerial and therefore will not be dependent upon habitats within the RGP.
<i>Ardea ibis</i>	Cattle Egret	IA		The heaviest distribution of this species in WA is in the north east, and into the Northern Territory. In the non-breeding season, it can be found throughout most of Australia (DoEE, 2018b).	Low	No	There is no suitable habitat in the RGP.
<i>Ardea modesta</i>	Eastern Great Egret	IA		The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2004). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2012).	Moderate	Yes	If this species did occur, it would only be as a transitory visitor foraging over the site.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	EN	In Western Australia the species was formerly widespread in the south west however is now thought to only occur on the western coastal plain, southern coastal region and inland to some wetlands in the	Low	No	There is no suitable habitat in the RGP.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Jarrah forests (DoEE, 2018b).							
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	Carnaby's Cockatoo is a postnuptial nomad and typically moves west soon after breeding. The species nests in hollows of smooth-barked eucalypts, particularly Salmon Gum ( <i>Eucalyptus salmonophloia</i> ) and Wandoo ( <i>E. Wandoo</i> ) but is not limited to these eucalypts. Diet consists of an array of Proteaceous and Myrtaceous species. Foraging habitat, including <i>Banksia</i> woodlands, is habitat critical to the survival of the species (DPaW, 2013).	Recorded	Yes	The majority of vegetation remaining at the Project Area represents potential feeding habitat for this species. While the Project is located on the edge of the breeding range for Carnaby's Cockatoo (DoEE 2018b), no hollow-bearing trees have been identified within the Project area (APM 2016; 2017). The record made by Biota in 2004 was of individuals flying over and perching on site on two occasions, by which the species was sighted a total of 6 times. APM also recorded individuals flying over the site in 2016.
<i>Dasyornis longirostris</i>	Western Bristlebird	EN	VU	The Western Bristlebird inhabits floristically diverse low dense coastal heathland.  It occurs in three distinct locations: Fitzgerald River National Park, Hassell (Cheynes) Beach/Waychinicup National Park/Two Peoples Nature Reserve, and a translocated population near Walpole, though this last population may no longer occur there. There is also a record of two Western Bristlebirds at Kundip Nature Reserve from December 2003. However, it is unknown if this record represents a permanent subpopulation or was a record of vagrant or dispersing birds (DoEE, 2018b).	Low	No	The Project is not in the preferred range for this species. The Western Bristlebird occurs mostly in the deep south west of the State occupying dense thickets and heath. A record of two birds have been made on the Jerdacuttup Road immediately south of the Project Area however, these are isolated occurrences, when compared to the 1000+ records made within and adjacent the Fitzgerald National Park.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
<i>Falco peregrinus</i>	Peregrine Falcon	-	OS	A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2012). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests.	Recorded	Yes	Individuals would forage over the site as part of a broader foraging territory. However, nesting is unlikely due to lack of suitable natural habitat.  One individual was recorded during the APM 2016 survey flying over heavily disturbed areas around Two Boys pit adjacent the 'Low Woodland Mallee and Heath' vegetation of the Kundip Mine Site.
<i>Leipoa ocellata</i>	Malleefowl	VU	VU	Malleefowl habitat requirements are quite specific. The species requires unburnt Mallee and woodland with low scrub and abundant litter to use in nesting mounds (Morcombe, 2004).	Recorded	Yes	One historically inactive mound has been located within the Kundip Mine Site in the 'Low Woodland Mallee and Heath habitat' and individuals were recorded during the APM 2016 survey foraging in the 'Low Woodland and Mallee Heath' habitat around the Kundip Battery and running across the Hopetoun-Ravensthorpe Road adjacent to the Kundip Mine Site entrance. In 2017 APM sighted one individual dashing across the main road further towards the town of Ravensthorpe, outside of the Project Area. Despite extensive ground searches, no active or recently inactive mounds have been located.
<i>Merops ornatus</i>	Rainbow Bee-eater	M	-	The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2004).	High	Yes	This species is ubiquitous across much of the south west and nests in loosened soil in spoil heaps and topsoil dumps. Therefore, the Project Area potentially provides habitat of value to this species.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
<i>Motacilla cinerea</i>	Grey Wagtail	IA	IA	The Grey Wagtail prefers the banks and rocks of fast-running fresh water habitats. It occurs in open and forested areas but can be found anywhere during migration (Johnstone and Storr, 2004).	Low	No	There is no fast-running fresh water habitat available in the Project Area. Though the species may move past during migration, it is not likely to be recorded within the site.
<i>Pandion cristatus</i>	Eastern Osprey	IA	IA	The Osprey is found in coastal areas (Johnstone and Storr, 1998).	Low	No	The Project Area is not adjacent to the coast.
<i>Pezoporus occidentalis</i>	Night Parrot	EN	CR	The Night Parrot requires treeless or sparsely wooded spinifex grasslands near water (Johnstone and Storr, 1998).	Low	No	There is no habitat suitable for this species in the Project Area.
<i>Psophodes nigrogularis oregon</i>	Western Whipbird (Mallee)	-	P4	The Western Whipbird species is restricted to four races in small fragmented populations including Two Peoples Bay, Kangaroo Island, and 'Murray Mallee' (Pizzey & Knight, 2012). This species prefers dense long unburnt thickets of healthy shrubs, low Eucalypts and Mallee trees (Pizzey & Knight, 2012).	Recorded	Yes	There is little evidence of recent fire in the Kundip Mine Site and much of the habitat is suitable for this species particularly along the north and eastern edges of the tenement.  This species was previously recorded by Biota (2004) and again during the APM (2017) survey. On all occasions the species was recorded in the 'Low Woodland Mallee and Heath' and one record location was the same for the Biota and APM surveys in the centre of the Development Envelope.
<i>Pezoporus flaviventris</i>	Western Ground Parrot	CR	CR	Heathland dominated by <i>Banksia</i> and <i>Hakea</i> and in low open Mallee in swampy areas. The species prefers vegetation that has been unburnt for at least six years.	High	Yes	The primary population of Western Ground Parrot occurs within the Fitzgerald River National Park, with smaller populations to the west in the Cheyne Beach/Waychincup area and to the east in Cape Arid National Park and Nuytsland Nature Reserve.  This species has not been recorded in the Kundip



Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Mine Site by Biota (2004), or APM (2016 and 2017).							
<b>Reptiles</b>							
<i>Lerista viduata</i>	Ravensthorpe Range Slider skink	-	P1	As with other species from the <i>Lerista</i> genus, the Ravensthorpe Range Slider is found in loose soil or sand beneath stones, logs, termite mounds etc. This species has only been recorded in the Ravensthorpe Range (Cogger, 2014).	Recorded	Yes	This species was recorded by Biota in 2004 in the 'Low Woodland Mallee and Heath' where open Mallee and very dense proteaceous thicket of <i>Banksia lemanniana</i> is typical and soils were skeletal pale grey to orange loamy sands with lateritic gravel.
<b>Mammals</b>							
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	VU	VU	Following European settlement, the range of this species contracted dramatically, from much of the continent to a small area in the south west. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and Mallee shrubland (Van Dyck & Strahan, 2008). Most of the records are found in the contiguous Jarrah forests of the south west of Western Australia (DoEE, 2018b). Recent records exist within the Gnangara pine forest and Walyunga National Park.	Recorded	Yes	The 'Low Dense Forest/Forest' habitat of the Kundip Mine Site provides suitable habitat and individuals were recorded on camera during the APM 2016 and 2017 surveys in the same location.  In the area within which this species was recorded was a number of mine shafts and a significant amount of building debris from the old Kundip Battery.
<i>Hydromys chrysogaster</i>	Water Rat/Rakali	-	P4	The Water Rat is found in a range of habitats including subalpine streams, slow inland rivers, lakes, farm dams and sheltered marine waters (Menkhorst and Knight 2001).	Moderate	Yes	This species may occur at the dams within the Kundip Mine Site, however, this would be sub optimal habitat due to the lack of waterside vegetation.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
<i>Isoodon fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).	Recorded	Yes	The 'Low Dense Forest / Forest' habitat of the Kundip Mine Site provides suitable habitat particularly in areas where sedges and grasses form a dense understory. Diggings consistent with this species' form were identified in all 3 fauna habitat types during the APM (2016) survey.
<i>Notamacropus eugenii derbianus</i>	Tammar Wallaby	-	P4	The Tammar Wallaby is thought to have persisted in disjunct mainland populations for up to 10,000 years however given the large scale vegetation clearing since the arrival of Europeans, the range of this species has contracted. In the south west of Western Australia, this species occurs in several reserves in the wheatbelt and national parks in the Great Southern Region (Van Dyck & Strahan, 2008).	High	Yes	This species has the potential to be cosmopolitan across the Project Area when foraging, retreating to thicker heath and scrub for refuge during the day.
<i>Notamacropus irma</i>	Western Brush Wallaby	-	P4	The Western Brush-wallaby occurs in the southwest of Western Australia. Its preferred habitat consists of open sclerophyll forest or woodland and favours open flats over scrub thickets. It is also found in larger areas of Mallee and heathland in the wheatbelt and is uncommon in wet sclerophyll forest (Van Dyck & Strahan, 2008).	Recorded	Yes	The preferred habitat of this species is open forests and woodlands, but it also occurs in scrubby thickets, Mallee and heath. All of these habitat types occur within the Kundip Mine Site. The species was recorded as roadkill at the entrance of the Kundip Mine Site by Biota (2004) and more recently south of the Project Area on the Hopetoun-Ravensthorpe Road (2017).

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
<i>Myrmecobius fasciatus</i>	Numbat, Walpurti	EN	EN	Originally widespread, the Numbat now only persists in two remnant populations at Dryandra and Perup in Western Australia with several reintroduced populations in the Western Australian Wheatbelt (DoEE, 2018b).	Low	No	This species would no longer be present in the region.
<i>Parantechinus apicalis</i>	Dibbler	EN	EN	The Dibbler appears to be able to occupy a range of habitats. They seem to prefer vegetation with a dense canopy greater than 1 m high, unburnt for at least 10 years. In some areas, the presence of Proteaceous and Myrtaceous flowering shrubs may also be important (DoEE, 2018b).	Moderate	Yes	Areas of vegetation within the Kundip Mine Site have both a dense canopy and a composition dominated by proteaceous shrubs. Therefore, suitable habitat does occur.
<i>Phascogale calura</i>	Red-tailed Phascogale, Kenngoor	VU	CD	The Red-tailed Phascogale is found in the branches of Rock Sheoak ( <i>Allocasuarina huegeliana</i> ) with a tail the same colour as the exposed wood from this plant. It is restricted to areas that receive an annual rainfall of 300-600 mm in isolated patches of forest. Its preferred habitat is the denser and taller communities with Wandoo and Rock Sheoak with hollows in Wandoo providing nesting sites (Van Dyck & Strahan, 2008).	Low	No	There is no habitat suitable for this species in the Project Area.
<i>Pseudomys occidentalis</i>	Western Mouse	-	P4	The Western Mouse is a nocturnal species that live in burrows during the day (20-30 cm deep) consisting of a single vertical entrance shaft connected to a horizontal	High	Yes	Habitat for this species is described as shrublands that have not been burnt for 15-30 years on clay loams, usually with a laterite component (Lee, 1995). This habitat is present within the Kundip

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
				loop 2-3 metres in diameter. The nesting chamber is directly opposite the entrance. The entrance shaft is commonly located in dense leaf litter. Capture sites of the Western Mouse have long unburnt vegetation (30-50 years) with layers of extremely dense vegetation at 0.5-2.5 metres high. Dominant upper storey includes <i>Eucalyptus</i> , <i>Isopogon</i> , <i>Acacia</i> , <i>Casuarina</i> and <i>Melaleuca</i> (Van Dyck & Strahan, 2008).			Mine Site.
<i>Pseudomys shortridgei</i>	Heath Mouse, Dayang	EN	VU	The Heath Mouse is found in lowland heath, woodlands and sclerophyll forests (Atlas of Living Australia 2016). Largely confined to habitats with a Mallee overstorey on variable soils including loamy-sands and sandy-loams with a laterite component, stony clays and sandy light clay on greenstone (Cooper <i>et al.</i> , 2003).	Moderate	Yes	The initial survey (APM, 2016) was thought to have recorded <i>Pseudomys shortridgei</i> (Heath Mouse) based on a field identification. The specimen was not vouchered to the WA Museum at the time of collection. Intensive trapping on two further surveys failed to reveal further evidence of this species. It is suspected that the original recording was a Bush Rat rather than the Heath Mouse.

## 5.2 FIELD SURVEY

### 5.2.1 Previous Survey Work

Previous fauna surveys undertaken within the Project area are listed in Table 2-3.

### 5.2.2 Avifauna Records

Meliphagidae (honeyeaters and wattlebirds) were the most abundant avifauna group recorded during the survey. This is likely a function of the structure of the vegetation, with low mallee woodlands and heaths dominant, as well as abundant Myrtaceae & subordinate Proteaceae species. A total of 301 New Holland Honeyeaters were recorded during Biota's systematic bird censuses. The full records of the avifauna census works are presented in Table 5-2.

### 5.2.3 Fauna Trapping

Baseline fauna surveys have recorded a total of 101 terrestrial vertebrate fauna species in the Project area, including 54 bird species, 12 mammals (9 native and 3 introduced), 29 reptiles and 6 amphibians (Table 5-3).

The number of small mammals captured during the surveys provides some indication of the quality of fauna habitat in the area. A total of 56 Pygmy Possums (*Cercartetus concinnus*) and 87 Honey Possums (*Tarsipes rostratus*) were captured in pit traps around the Project area.

Despite their apparent fragility these two species are often trapped in high numbers and may be considered a good indicator of environmental health. Pygmy possums feed on pollen and nectar, so an abundant population indicates an abundant array of Proteaceae species. Honey Possum are also a good indicator of the biomass of Proteaceae and Myrtaceae and are often most abundant in climax communities that have remained unburnt for many years (Bradshaw pers. Comm.) which matches habitat age (>100 years) estimated by Craig (2008).

The 87 individuals captured during the Biota survey of 2004 equates to a capture rate of almost 20%. This is four times higher than the average capture rate of a long-term survey in the Scott River National Park (Figure 5-1).

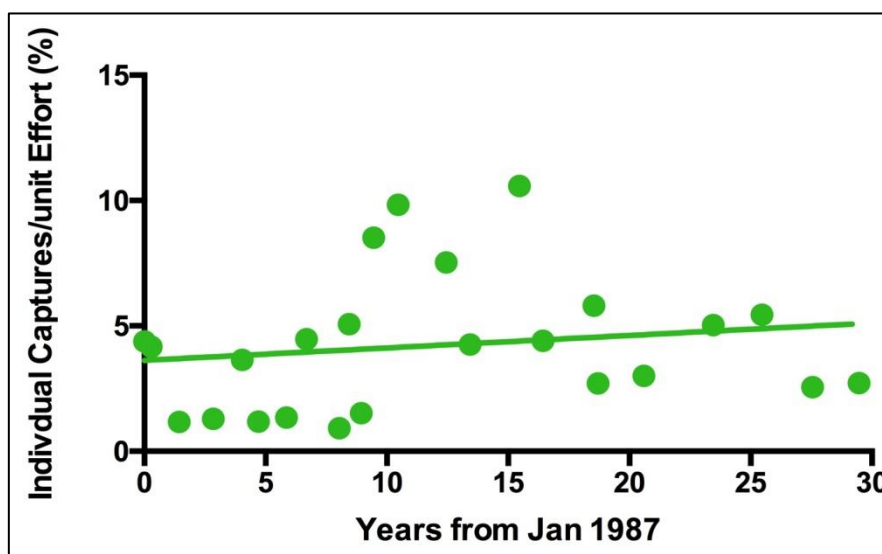


Figure 5-1: Capture Rates for Honey Possum in the Scott River National Park (Bradshaw in prep.)

Table 5-2: Avifauna Census Data

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
<b>CASUARIIFORMES</b>										
	Casuariidae	<i>Dromaius novaehollandiae</i>	Latham, 1790	Emu	6	x	x			2
<b>GALLIFORMES</b>										
	Megapodiidae	<i>Leipoa ocellata</i>	Gould, 1840	Malleefowl	3		x		x	1
	Phasianidae	<i>Coturnix ypsilophora</i>	Bosc, 1792	Brown Quail	8		x			1
<b>COLUMBIFORMES</b>										
	Columbidae	<i>Phaps chalcoptera</i>	Latham, 1790	Common Bronzewing	1		x			1
		<i>Phaps elegans</i>	Temminck, 1809	Brush Bronzewing	1				x	1
<b>CAPRIMULGIFORMES</b>										
	Podargidae	<i>Podargus strigoides</i>	Latham, 1802	Tawny Frogmouth	1				x	1
	Eurostopodidae	<i>Eurostopodus argus</i>	Hartert, 1892	Spotted Nightjar	1		x			1
<b>ACCIPITRIFORMES</b>										
	Accipitridae	<i>Lophoictinia isura</i>	Gould, 1838	Square-tailed Kite	3	x	x			2
		<i>Accipiter fasciatus</i>	Vigors and Horsfield, 1827	Brown Goshawk	1		x			1
<b>CHARADRIIFORMES</b>										
	Turnicidae	<i>Turnix varius</i>	Latham, 1802	Painted Button-	1		x			1

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
				quail						
<b>PSITTACIFORMES</b>										
	Cacatuidae	<i>Calyptorhynchus latirostris</i>	Carnaby, 1948	Carnaby's Black-Cockatoo	13		x			1
	Psittacidae	<i>Glossopsitta porphyrocephala</i>	Dietrichsen, 1837	Purple-crowned Lorikeet	192	x	x			2
		<i>Barnardius zonarius</i>	Shaw, 1805	Australian Ringneck	22	x	x			2
		<i>Purpureicephalus spurius</i>	Kuhl, 1820	Red-capped Parrot	3		x			1
<b>CUCULIFORMES</b>										
	Cuculidae	<i>Chalcites lucidus</i>	J.F. Gmelin, 1788	Shining Bronze-Cuckoo	5		x			1
		<i>Cacomantis flabelliformis</i>	Latham, 1802	Fan-tailed Cuckoo	1		x			1
<b>STRIGIFORMES</b>										
	Strigidae	<i>Ninox novaeseelandiae</i>	J.F. Gmelin, 1788	Southern Boobook	1				x	1
	Tytonidae	<i>Tyto javanica</i>	J.F. Gmelin, 1788	Eastern Barn Owl	1		x			1
<b>PASSERIFORMES</b>										
	Maluridae	<i>Malurus pulcherrimus</i>	Gould, 1844	Blue-breasted Fairy-wren	10		x			1
	Acanthizidae	<i>Sericornis frontalis</i>	Vigors and Horsfield, 1827	White-browed Scrubwren	23	x	x			2
		<i>Hylacola cauta</i>	Gould, 1843	Shy Heathwren	11		x			1

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
		<i>Smicrornis brevirostris</i>	Gould, 1838	Weebill	71	x	x			2
		<i>Gerygone fusca</i>	Gould, 1838	Western Gerygone	1	x				1
		<i>Acanthiza apicalis</i>	Gould, 1847	Inland Thornbill	9	x	x			2
	Pardalotidae									
		<i>Pardalotus punctatus</i>	Shaw, 1792	Spotted Pardalote	26	x	x			2
		<i>Pardalotus striatus</i>	J.F. Gmelin, 1789	Striated Pardalote	19	x	x			2
	Meliphagidae									
		<i>Lichenostomus leucotis</i>	Latham, 1802	White-eared Honeyeater	3		x			1
		<i>Lichenostomus cratitius</i>	Gould, 1841	Purple-gaped Honeyeater	9		x			1
		<i>Anthochaera lunulata</i>	Gould, 1838	Western Wattlebird	25		x			1
		<i>Anthochaera carunculata</i>	Shaw, 1790	Red Wattlebird	36	x	x			2
		<i>Anthochaera paradoxa</i>	Daudin, 1800	Yellow Wattlebird						
		<i>Glyciphila melanops</i>	Latham, 1802	Tawny-crowned Honeyeater	49		x			1
		<i>Lichmera indistincta</i>	Vigors and Horsfield, 1827	Brown Honeyeater	47	x	x			2
		<i>Phylidonyris novaehollandiae</i>	Latham, 1790	New Holland Honeyeater	301	x	x			2
		<i>Melithreptus brevirostris</i>	Vigors and Horsfield, 1827	Brown-headed Honeyeater	2		x			1
		<i>Melithreptus chloropsis</i>	Gould, 1848	Western White-naped Honeyeater	16	x	x			2
	Pomatostomidae									
		<i>Pomatostomus superciliosus</i>	Vigors and Horsfield, 1827	White-browed Babbler	2		x			1
		<i>Psophodes nigrogularis</i>	Gould, 1844	Western Whipbird	9		x		x	1



Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
	Campephagidae	<i>Coracina novaehollandiae</i>	J.F. Gmelin, 1789	Black-faced Cuckoo-shrike	3	x	x			2
	Pachycephalidae	<i>Pachycephala pectoralis</i>	Latham, 1802	Golden Whistler	9		x			1
		<i>Colluricincla harmonica</i>	Latham, 1802	Grey Shrike-thrush	4	x	x			2
		<i>Oreoica gutturalis</i>	Vigors and Horsfield, 1827	Crested Bellbird	9		x			1
	Artamidae	<i>Artamus cyanopterus</i>	Latham, 1802	Dusky Woodswallow	9	x	x			2
		<i>Cracticus torquatus</i>	Latham, 1802	Grey Butcherbird	2		x			1
		<i>Cracticus tibicen</i>	Latham, 1802	Australian Magpie	1		x			1
		<i>Strepera versicolor</i>	Latham, 1802	Grey Currawong	28		x			1
	Rhipiduridae	<i>Rhipidura leucophrys</i>	Latham, 1802	Willie Wagtail	4		x			1
	Corvidae	<i>Corvus coronoides</i>	Vigors and Horsfield, 1827	Australian Raven	10	x	x			2
	Monarchidae	<i>Myiagra inquieta</i>	Latham, 1802	Restless Flycatcher	1		x			1
	Petroicidae	<i>Eopsaltria griseogularis</i>	Gould, 1838	Western Yellow Robin	2		x			1
		<i>Drymodes brunneopygia</i>	Gould, 1841	Southern Scrub-robin	27	x	x			2
	Timaliidae	<i>Zosterops lateralis</i>	Latham, 1802	Silvereye	61		x			1
	Hirundinidae									

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
		<i>Hirundo neoxena</i>	Gould, 1842	Welcome Swallow	35		x			1
		<i>Petrochelidon nigricans</i>	Vieillot, 1817	Tree Martin	23		x			1
<b>Species richness:</b>		<b>54</b>				<b>19</b>	<b>49</b>	<b>0</b>	<b>5</b>	<b>-</b>
<b>Total number of individuals:</b>					<b>1161</b>					

Table 5-3: Fauna Captured or Recorded in the Ravensthorpe Gold Project Area

Species	Common Name	No. Recorded	Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage	Opportunistic	No of Habitats
<b>AMPHIBIANS</b>							
<b>Hylidae</b>							
<i>Litoria moorei</i>	Motorbike Frog	1			x		1
<i>Litoria cyclorhyncha</i>		8		x			1
<b>Myobatrachidae</b>							
<i>Crinia pseudinsignifera</i>		2		x			1
<i>Lymnodynastes dorsalis</i>	Western Banjo Frog	1		x	x		2
<i>Myobatrachus gouldii</i>	Turtle Frog	1		x			1
<i>Neobatrachus kunapalari</i>		1		x			1
<b>REPTILES</b>							
<b>Agamidae</b>							
<i>Caimanops amphibularoides</i>		1		x			1
<i>Amphibolourus norrissi</i>		2		x			1
<i>Ctenophorus maculatus griseus</i>		4		x			1
<i>Pogona minor minor</i>	Western Bearded Dragon	1				x	
<b>Carphodactylidae</b>							
<i>Underwoodisaurus milii</i>	Barking gecko	25	x	x			2
<b>Diplodactylidae</b>							
<i>Crenodactylus ocellatus</i>	Clawless gecko	17	x	x			2
<b>Gekkonidae</b>							
<i>Christinus marmoratus</i>	Marbled gecko	16	x	x			2
<i>Diplodactylus granariensis granariensis</i>		19	x	x			2
<b>Pygopidae</b>							
<i>Pygopus lepidodopus</i>	Common scaly-foot	1		x			1
<i>Delma australis</i>		3		x			1
<i>Delma fraseri fraseri</i>		2		x			1
<i>Aprasia repens</i>		1		x			1

Species	Common Name	No. Recorded	Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage	Opportunistic	No of Habitats
<b>Scincidae</b>							
<i>Egernia kingii</i>	King's skink	1		x			1
<i>Tiliqua rugosa</i>	Bobtail lizard	7	x	x	x		3
<i>Acritoscincus trilineatus</i>	South west cool skink	1		x			1
<i>Hemiergis peronii</i>	Four-toed earless skink	31	x	x			2
<i>Morethia obscura</i>	Shrubland morethia skink	15		x			1
<i>Cryptoblepharus virgatus clarus</i>		28	x	x			2
<i>Hemiergis initialis</i>		24	x	x			2
<i>Menetia greyii</i>		21	x	x			2
<i>Lerista distinguenda</i>		8	x	x			2
<i>Ctenotus impar</i>		3		x			1
<i>Lerista viduata</i>		1		x			1
<i>Ctenotus labillardieri</i>		1		x			1
<b>Varanidae</b>							
<i>Varanus rosenbergii</i>	Rosenberg's monitor	10	x	x			2
<b>Boidae</b>							
<i>Morelia spilota imbricata</i>	Carpet python	2					
<b>Elapidae</b>							
<i>Elapognathus coronatus</i>	Crown snake	4		x			1
<i>Parasuta gouldii</i>	Gould's hooded snake	1		x			1
<i>Pseudonaja affinis affinis</i>	Dugite	2	x	x			2
<b>MAMMALS</b>							
<b>Muridae</b>							
<i>Rattus fuscipes</i>	Bush rat	68	x	x	x		3
<i>Mus musculus</i>	House mouse	47		x	x		2
<b>Peramelidae</b>							
<i>Isodon fusciventer</i>	Southern Brown Bandicoot (Quenda)					x	3

Species	Common Name	No. Recorded	Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage	Opportunistic	No of Habitats
<b>Dasyuridae</b>							
<i>Dasyurus geoffroii</i>	Chuditch	2	x			x	1
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart	1		x			1
<i>Sminthopsis griseoventer</i>	Grey-bellied Dunnart	9	x	x			2
<b>Tarsipedidae</b>							
<i>Tarsipes rostratus</i>	Honey possum	87	x	x			2
<b>Macropodidae</b>							
<i>Macropus fuliginosus</i>	Western Grey Kangaroo	3	x	x			1
<i>Notamacropus irma</i>	Western Brush Wallaby	1		x		x	1
<b>Burramyidae</b>							
<i>Cercartetus concinnus</i>	Pygmy Possum	56	x	x			2
<b>Canidae</b>							
<i>Vulpes vulpes</i>	Red Fox			x			1
<b>Felidae</b>							
<i>Felis catus</i>	Feral Cat	1				x	
<b>Tachyglossidae</b>							
<i>Tachyglossus aculeatus</i>	Echidna	1	x	x			2
<b>Species richness</b>		<b>46</b>	<b>19</b>	<b>42</b>	<b>5</b>	<b>5</b>	
<b>Total number of individuals</b>		<b>542</b>					

### 5.2.4 Bat Acoustic Recording

The database searches for a 10 km radius revealed that only two species of bat had been recorded previously. This provides some indication of the lack of survey work completed in the area. This became particularly apparent the Biota and the APM surveys both returned acoustic signatures for the same four species of bat (Table 5-4).

**Table 5-4: Bat Species Recorded in the Ravensthorpe Gold Project Area**

		Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage
<b>Vespertilionidae</b>				
<i>Chalinolobus gouldii</i>	Gould's Wattle Bat		x	x
<i>Chalinolobus morio</i>		x	x	x
<i>Vespadelus regulus</i>		x	x	x
<b>Molossidae</b>				
<i>Austronomus australis</i>	White-striped Mastiff Bat		x	x

### 5.2.5 Fauna Habitats

#### Low Dense Forest/Forest

Dense low forest occurred on areas of sheet wash on a low gradient slope. Residual, quartzofeldspathic sand overlies granite rock. The highest vegetation includes mallets of *Eucalyptus astringens*, *E. cernua*, *E. clivicola*, *E. platypus* and mallees of *E. pileata* and *E. flocktoniae* subsp. *flocktoniae*, with tall *Melaleuca cucullata* shrubs over *Daviesia nematophylla*, *Exocarpus aphyllus*, *Melaleuca* sp. Gorse (A.S. George 7224) mid shrubs and low *Grevillea huegelii*. In some areas there are colluvium of deeply eroded surfaces with associated minor outcrops of sandstone and conglomerate or Cemented ironstone gravel and laterite and in areas of poor drainage the ground story can comprise almost entirely of sedges such as *Gahnia aristata*.

These landforms support a complex array of fauna. All of the four species of gecko collected during the surveys, Barking Gecko, Clawless Gecko, Marbled Gecko and the Wheatbelt Stone Gecko, were collected in this habitat, as was a suite of fossorial skinks including the *Hemiergis peronei*, *Hemiergis initialis initialis* and *Lerista distinguenda*. Chuditch were recorded on motion-sensing cameras (APM 2016; 2017) around the Kundip battery in the lower south western section of the Project area containing patches of 'Low Dense Forest/Forest' within the broader vegetation complex, 'Low Woodland Mallee and Heath' habitat.

Dense and structurally diverse vegetation and floristics also provided abundant suitable habitat for the smaller ground-dwelling Grey-bellied Dunnart and the arboreal Honey Possum and Pygmy Possum. Evidence of a diverse and abundant small fauna assemblage was further supported by the presence of larger predatory fauna species such as Rosenberg's Monitor and the Dugite.

The Low Dense Forest/Forest habitat was not particularly well represented within the Project area (52.76 ha), which is comprised mainly of undulating landforms (Figure 5-2). In total, 17.21 ha of this habitat will be cleared within the extent of the Kundip Mine Site, representing 32.62% of the Low Dense Forest/Forest available in the project area. This habitat type was not present within the extent of the corridor.

### Damplands and Drainage Lines

The Damplands and Drainage lines contain common eucalypt species such as *E. platypus* subsp. *platypus* and the mallees *E. suggrandis* subsp. *suggrandis*. Tall shrubs are dominated by *Melaleuca* spp. differing from the low dense forest/forest. In Damplands and Drainage lines, more than six species are dominant in the upper strata including *M. cucullata*, *M. bromelioides*, *M. haplantha*, *M. pauperiflora* subsp. *pauperiflora*, *M. bracteosa*, *M. sp. Kundip* (GF Craig 6020), *M. stramentosa*, *M. acuminata* subsp. *acuminata* and *M. cuticularis*. Acacias are also present in the mid to upper storey. Sedges (*Gahnia trifida*, *G. ancistrophylla*, *Mesomelaena stygia* subsp. *stygia*, *Lepidosperma sp. Cordingup* (GF Craig 6138)), grasses (*Spartochloa scirpoidea*) and Herbs (\**Asparagus asparagoides*, *Cassytha melantha*) are common ground story component.

Few species were captured in this habitat type, which is possibly an artefact of the poor conditions during the survey, with a delayed onset of spring and little warm weather during the survey. Surveys in drainage lines during the Biota surveys in January would also not have been particularly productive due to lack of water. Only the Spotted-thighed Frog, Western Banjo Frog, Bobtail Lizard, Bush Rat and House Mouse were recorded.

This habitat has intrinsic value as a connective corridor, currently limiting any fragmentation between all 3 of the broad habitats identified within the Project area.

In total, 27.8 ha of the Damplands and Drainage habitat will be disturbed by the Kundip Mine Site and Corridor, representing 32.0 % of this habitat type within the Project area (Figure 5-2).

### Low Woodland Mallee and Heath

The dry Low Woodlands Mallee contain a broad variety of eucalypt species including *E. falcata* subsp. *falcata*, *E. flocktoniae* subsp. *flocktoniae*, *E. incrassata*, *E. pleurocarpa*, *E. phaenophylla*, *E. proxima*, *E. suggrandis* subsp. *suggrandis*, and *E. uncinata*. The primary difference between this habitat and the Dampland and Drainage Lines is the location (this habitat type exists on rises and hills), and the presence of a more diverse array of species preferring dry or better drained substrates. Banksia (*B. media*) and Hakea (*Hakea laurina*, *H. pandanica* subsp. *crassifolia*, *H. pandanica* subsp. *pandanica*) species were prevalent and the mid-shrub layer was diverse, including *Allocasuarina humilis*, *Calothamnus gibbosus*, *C. gracilis*, *B. cirsioides*, *Grevillea oligantha* and *H. corymbosa*. Low shrubs were also diverse and dense, including *Acacia gonophylla*, *Baeckea corynophylla*, *Beaufortia micrantha* var. *micrantha*, *Beaufortia schaueri*, *Boronia inornata*, *Hakea m.*, *Isopogon sp. Fitzgerald River* (DB Foreman 813), *Leucopogon fimbriatus*, *Lysinema ciliatum*, *P. squamata* subsp. northern (J Monks 40).

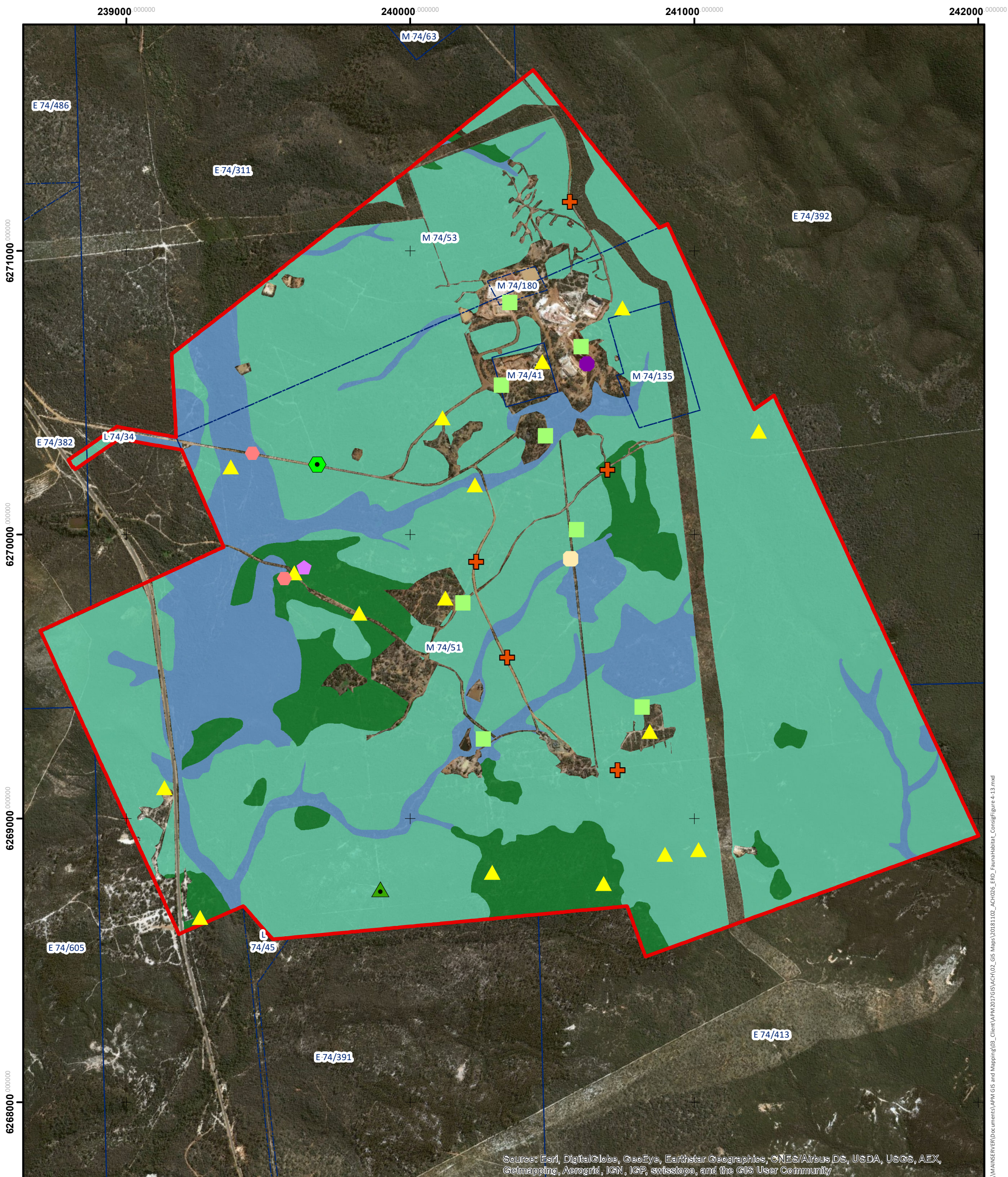
Of the 47 non-volant species recorded throughout the project area, 43 were recorded within this fauna habitat. The records illustrate both the dominance of this vegetation type in the area and the associated sampling bias that is unavoidable in impact assessment. In addition, this habitat is present across the majority of areas likely to be impacted. This bias is not a shortcoming of the survey design, as such intensive sampling achieves a better understanding of the fauna habitat most likely to be impacted by the development.

Within this habitat type, all four of the *Pygopid* (true legless lizards) were collected. Large skinks, the Bobtail Lizard, and the King Skink, were recorded, with the latter collected under building refuge near the historic heap leach facility.

This habitat was the most common habitat type from which the Bush Rat was collected. It is also the habitat within which the Ravensthorpe Range Slider was recorded by Biota (2004). Chuditch were recorded on motion-sensing cameras around the historic Kundip Battery in the lower south western section of the Project area and Malleefowl observed foraging in the same location. A historically inactive Malleefowl mound resides in this habitat type in the lower south-east of the Kundip disturbance footprint near the proposed TSF. In addition to the Dugite, the two small elapids, Crown snake and Gould's hooded snake, were collected under building material in this habitat. Figure 5-2 illustrates the location of this habitat type in the Project area.

Of the 440.9 ha of Low Woodland Mallee and Heath present within the project area, 24.1% (106.4 ha) will be disturbed by the Kundip Mine site, and Corridor.





Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

**Figure 5-2: Fauna Habitats and Conservation Significant Fauna Records within the Ravensthorpe Gold Project Area**

<b>LEGEND</b>		
Ravensthorpe Gold Project Area		
Mining Tenements		
<b>Fauna Habitats</b>		
Damplands and Drainage Habitat		
Low Dense Forest / Forest Habitat		
Low Woodland Mallee and Heath Habitat		
<b>Conservation Significant Fauna</b>		
Aname mainae	Carnaby's Cockatoo	Malleefowl
Chuditch	Lycosidae sp., Aname mainae	Peregrine
Western Whipbird, Aname mainae	Western Whipbird	Quenda

Date: 02/11/2018  
 Scale: 1:12,500  
 GDA 1994 MGA Zone 51  
 Author: sarah@animalplantmineral.com.au

### 5.2.6 Conservation Significant Fauna

Fauna surveys carried out in January and November of 2004 by Biota Environmental Sciences Pty Ltd (Biota) recorded five fauna taxa of Conservation Significance. These included:

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered, EPBC Act; Schedule 2 / Division 2 WC Act);
- Malleefowl (*Leipoa ocellata*) (Endangered, EPBC Act; Schedule 3 / Division 2 WC Act);
- Ravensthorpe Range Slider (*Lerista viduata*) (Priority 1, WC Act);
- Western Whipbird (Mallee) (*Psophodes nigrogularis oberon*) (Priority 4, WC Act); and
- Western Brush Wallaby (*Notamacropus irma*) (Priority 4, WC Act).

The APM 2016 and 2017 field surveys identified six conservation significant fauna species listed under the EPBC Act and WC Act. These included:

- Chuditch (*Dasyurus geoffroii*) (Vulnerable, EPBC Act; Schedule 3 / Division 1 WC Act);
- Peregrine Falcon (*Falco peregrinus*) (Other Specially Protected Schedule 7 / Division 2 WC Act);
- Quenda (*Isoodon fusciventer*) (Priority 4, WC Act)
- Malleefowl (*Leipoa ocellata*) (Vulnerable, EPBC Act; Schedule 3 / Division 2 WC Act);
- Western Brush Wallaby (*Notamacropus irma*) (Priority 4, WC Act).
- Western Whipbird (Mallee) (*Psophodes nigrogularis oberon*) (Priority 4, WC Act).

In total, eight terrestrial vertebrate fauna species of Conservation Significance have been recorded during surveys of the RGP. Table 5-5 outlines the conservation significant fauna recorded during the Biota and APM surveys.

**Table 5-5: Conservation Significant fauna expected or recorded in the Ravensthorpe Gold Project area**

Fauna Species	Common Name	Conservation Status		Database		Biological Surveys			
		Cwlth	State	NatureMap (6 km)	AoLA (5 km)	Biota 2004 Summer	Biota 2004 Spring	APM 2016	APM 2017
<b>Birds</b>									
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	EN	S2	X		X			
<i>Falco peregrinus</i>	Peregrine Falcon	-	S4					X	
<i>Leipoa ocellata</i>	Malleefowl	VU	S3	X	X	X		X	X
<i>Psophodes nigrogularis oberon</i>	Western Whipbird (Mallee)	-	P4	X		X	X		X
<b>Mammals</b>									
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	VU	S3	X				X	X
<i>Isodon fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	X				X	
<i>Notamacropus eugenii derbianus</i>	Tammar Wallaby (WA subsp.)	-	P4	X	X				
<i>Notamacropus irma</i>	Western Brush Wallaby	-	P4	X		X			X
<b>Reptiles</b>									
<i>Lerista viduata</i>	Ravensthorpe Range Slider Skink	-	P1	X	X	X			

## 5.2.7 Conservation Significant Fauna Known to Occur in the RGP

### 5.2.7.1 Carnaby's Cockatoo – *Calyptorhynchus latirostris*

Carnaby's Cockatoo is endemic to, and widespread in, the south west of WA. It occurs in uncleared or remnant native Eucalypt woodlands, especially those that contain Salmon Gum and Wandoo, and in shrubland or Kwongkan heathland dominated by *Hakea*, *Banksia* and *Grevillea* species. It also occurs in remnant patches of native vegetation on land otherwise cleared for agriculture (DoEE, 2018b; Saunders 1974, 1979, 1980, 1982, 1986).

Breeding habitat encompasses areas which contain suitably sized nest trees that contain hollows and adjacent foraging habitat. Breeding activity is restricted to Eucalypt woodlands mainly in the semi-arid and sub-humid interior in the wheatbelt. The species nests in large hollows in tall, living or dead Eucalypts. It nests most commonly in smooth-barked Wandoo and Salmon Gum but has also been noted breeding in other vegetation types and is likely to nest in any species of Eucalypt with a suitable hollow (DoEE, 2018b).

During the breeding season, Carnaby's Cockatoo forages in native vegetation surrounding their breeding site. The species are opportunistic feeders and will utilise introduced food sources (e.g. pine plantations). Research indicates that foraging habitat within 12 km of a breeding site is one of the key factors in ensuring successful breeding (DoEE, 2018b; Cale, 2003). Maintaining foraging habitat close to breeding areas and providing corridors of vegetation linking breeding areas to patches of foraging habitat is essential to allow birds to move between isolated patches, and for Black Cockatoo chick survival (DoEE, 2018b; Saunders, 1977, 1990).

To date, Carnaby's Cockatoo has been recorded perching and foraging on six occasions by Biota in 2004, whilst only having been recorded by APM flying over the Kundip site (2016). On two of the occasions in 2004, the birds were sighted in *Melaleuca cucullata* – *Melaleuca acuminata* subsp. *acuminata* (APM Community 11), one sighting within *Taxandria spathulata* – *Melaleuca rigidifolia* (APM Community 6) and three sightings within the mapped Kwongkan Shrublands TEC/PEC north west of the Project Area. It should also be noted that, some natural regrowth of vegetation within the low-grade stockpiles at Kundip (as surveyed in August 2018) is forming APM Community 6. In addition to this, the vegetation within the rehabilitation site at RAV8 is reforming as APM Community 11. Both Community 6 and 11 are communities that support species of feeding value to the Carnaby's Cockatoo. Food species that have naturally recruited and become established on the low-grade stockpiles have been estimated to have grown to maturity (seed bearing) in less than 30 years.

### 5.2.7.2 Chuditch – *Dasyurus geoffroii*

Chuditch formerly ranged across nearly 70% of the continent, occurring in every mainland State and Territory (DEC, 2012b). Free-ranging populations of Chuditch are now restricted to WA within an estimated 5% of their former range. The major portion of the remaining natural populations occur in varying densities in Jarrah (*Eucalyptus marginata*) forests and woodlands in the south west coast of WA, and in woodlands, Mallee shrublands and heaths along the south coast, east to the Ravensthorpe area (DEC, 2012b).

Chuditch use a range of habitats including forest, Mallee shrublands, woodland and desert. The most dense populations have been found in riparian Jarrah forest. Chuditch require adequate numbers of suitable den and refuge sites (horizontal logs or earth burrows) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to persist locally (DEC, 2012b). They are capable of travelling long distances, have large home ranges, and even at their most abundant, Chuditch are generally present in low numbers. Chuditch are preyed upon by foxes and feral cats. For this reason, Chuditch require contiguous suitable habitat as they are more susceptible to predation in fragmented and open habitats.

Chuditch are solitary animals for most of their life. In the absence of foxes, they occupy relatively large home ranges; males ranging over 15 km<sup>2</sup> and females 3 – 4 km<sup>2</sup> (DEC, 2012b; Serena & Soderquist, 1989). While