

Appendix B Flora and Fauna Survey report



PHOENIX

ENVIRONMENTAL SCIENCES

Baseline flora, vegetation and fauna surveys for the Parker Range Haul Road Project

Prepared for Mineral Resources Ltd

May 2021

Final



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Phoenix Environmental Sciences Pty Ltd

2/3 King Edward Road OSBORNE PARK WA 6017

P: 08 6323 5410

E: admin@phoenixenv.com.au

Project code: 1292-PR-MRL-BOT, 1293-PR-MRL-VER

EXECUTIVE SUMMARY

Mineral Resources Ltd (MRL) is seeking to develop the Parker Range Haul Road Project (the Project), located approximately 20 km east of Southern Cross, Western Australia (WA), situated mainly in the Southern Cross subregion of the Coolgardie bioregion and extending south into the Merredin subregion of the Avon Wheatbelt bioregion. The Project is located in the Shire of Yilgarn and intersects the Southwest and South-western Interzone Botanical Provinces.

In September 2019, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by MRL to undertake a biological desktop review and reconnaissance survey for the Project to identify potential terrestrial biological values and inform further baseline survey requirements. Detailed flora, vegetation and fauna surveys were subsequently commissioned in October 2019, based on outcomes of the reconnaissance survey.

Flora and vegetation surveys were conducted over several seasons, entailing detailed and targeted surveys in November 2019 and July 2020, and additional targeted flora searches in September-October 2020. Level 1 fauna, targeted vertebrate fauna and short range endemic (SRE) invertebrate surveys were conducted in November-December 2019 and January 2020, with an additional targeted SRE and level 1 fauna (gaps) survey conducted in October 2020.

A total of 423 flora taxa identified to species level were recorded, representing 52 families and 161 genera. The assemblage included 414 native species and nine introduced species, including 380 perennial species, and 41 annual or short-lived species. The most prominent families recorded were Myrtaceae (88 spp.), Fabaceae (55 spp.), and Proteaceae (36 spp.).

A total of 25 Priority flora were recorded within the study area during the field survey, including seven P1, four P2, eleven P3, and three P4 species. One species, *Microcorys* sp. nov. (GBW 22/11/2019) was recorded that is considered significant as it represents an undescribed (new) species. A significant (200 km) range extension was recorded for one other species, *Rhagodia ulicina*, and therefore this record is considered significant for the species. No Threatened flora were recorded.

The likelihood of occurrence assessment for the remaining significant species identified in the desktop review determined 14 were likely to occur in the study area, seven may possibly occur and five are unlikely to occur.

A total of 23 vegetation types were defined for the study area. Broadly the 23 vegetation types comprised *Eucalyptus* mallee woodlands, *Eucalyptus* woodlands, *Allocasuarina* shrublands, *Acacia* shrublands, samphire shrubland, mixed shrubland over tussock grassland, and mixed shrubland over sparse forbland. Woodlands were most dominant, with four woodlands collectively comprising 51.3% of the study area.

Native vegetation in the study area was recorded to be in Pristine to Degraded condition with 81.2% in Pristine condition, with no obvious signs of damage caused by humans since European settlement, and only 0.6% in Degraded condition, showing signs of severe impact by grazing, very frequent fires, clearing or a combination of these activities.

The 'Plant assemblages of the Parker Range System' Priority Ecological Community (PEC, Priority 3) was found within the study area and extrapolation mapping area. Ten vegetation types were recorded within the PEC representing 1,284.1 ha, with multiple occurrences of the same vegetation types outside of the PEC's current recorded buffer representing a further 4,511.8 ha. Based on advice from the Department of Biodiversity, Conservation and Attractions (DBCA), a Threatened and Priority ecological community report form will be submitted to DBCA for occurrences of these mapped vegetation types that occur within the existing PEC buffer area, which are considered to be regionally significant.

Six broad fauna habitat types were identified in the study area, with the predominant habitats comprising Mallee over shrubland and Open woodland. Less extensive areas of Low open shrubland,

Mid-tall shrubland, Breakaway platform, and Bare playa were present; most of these associated with palaeodrainage and low hills.

The recorded fauna assemblage comprised 92 vertebrate species, including 56 bird species, 22 reptiles and 14 mammals. Eight introduced fauna taxa were recorded, seven of them mammals. Few of the recorded species were not identified in the desktop review.

Two Threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *WA Biodiversity Conservation Act 2016* (BC Act) were recorded: *Leipoa ocellata* (Malleefowl) and *Dasyurus geoffroii* (Western Quoll or Chuditch), both listed as Vulnerable (VU) under both acts. Both species occurred at multiple sites within the study area. Malleefowl was recorded from direct sightings, tracks, foraging debris, and recently active and degraded mounds, occurring in Mallee over shrubland and Mid-tall shrubland habitats. Western Quoll was recorded from scats and from camera trap images, mostly in Open woodland and at breakaways, with few records in Mallee over shrubland.

Secondary evidence (foraging diggings) in mid-tall shrubland habitats indicate presence of a bandicoot *Isoodon* sp. within the study area, which was not expected to occur based on the desktop review. Based on advice from the Western Australian Museum's curator of mammals, this is considered to represent an undescribed species close to *Isoodon fusciventer* (Quenda, Priority 4). This habitat type was targeted for search and camera trapping during the survey, finding additional diggings, but no sightings or scats were recorded. These records are considered significant both as a range extension, and as representing a poorly known taxon likely to merit listing in a conservation category equivalent to Quenda or higher.

Old evidence was recorded for presence of a significant species now extinct in mainland Australia, except in fenced conservation reserves, *Leporillus conditor* (Greater Stick-nest Rat; Conservation Dependent BC Act, VU EPBC Act). This species is not of relevance to the Project.

The likelihood of occurrence assessment for the remaining significant fauna species identified in the desktop review determined three were likely to occur in the study area, eight may possibly occur and nine are unlikely to occur.

A total of 35 invertebrate taxa collected in the baseline SRE survey are considered potential SREs. They comprised 13 mygalomorph trapdoor spiders, one scorpion, nine pseudoscorpions, four centipedes and eight isopods. The additional targeted survey recorded at least three additional potential SREs, all outside the proposed disturbance footprint, as well as indeterminate taxa some of which may represent species previously collected in the baseline survey.

Notably, at least 23 new species were recorded in the SRE surveys, with very few matches with desktop SRE records. Despite this evidence for high undiscovered diversity of potential SRE species, there is no indication that any are restricted to relictual or specialised habitat types, with all specimens of SRE groups obtained from habitats widespread in and adjacent to the study area.

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1 INTRODUCTION

Mineral Resources Ltd (MRL) is seeking to develop the Parker Range Haul Road Project (the Project), located approximately 20 km east of Southern Cross, Western Australia (WA; Figure 1-1). The proposed haul road links the Parker Range Iron Ore Project to the Koolyanobbing Iron Ore mine site and is roughly 80 km long. The Project is located in the Shire of Yilgarn, and intersects the Southwest and South-western Interzone Botanical Provinces as defined by EPA (2016c).

In September 2019, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by MRL to undertake a biological desktop review and reconnaissance survey for the Project to identify potential terrestrial biological values and inform further baseline survey requirements. Detailed flora, vegetation and fauna surveys were subsequently commissioned in October 2019, based on outcomes of the reconnaissance survey.

This report presents the findings of the baseline terrestrial biological surveys conducted for the Project.

1.1 BACKGROUND

MRL is developing the Parker Range Iron Ore Project (PRIOP), located at the southern terminus of the Project. PRIOP is approved under the *Environmental Protection Act 1986* (EP Act; Ministerial Statement (MS) No. 892) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act; EPBC 2010/5435).

MRL is proposing to use the Project to transport ore mined from PRIOP to its Koolyanobbing operations for blending. The Project was not part of the original PRIOP proposal approved under MS 892 and EPBC 2010/5435. The baseline terrestrial biological surveys were therefore required to inform environmental approvals for the Project.

1.2 SCOPE OF WORK

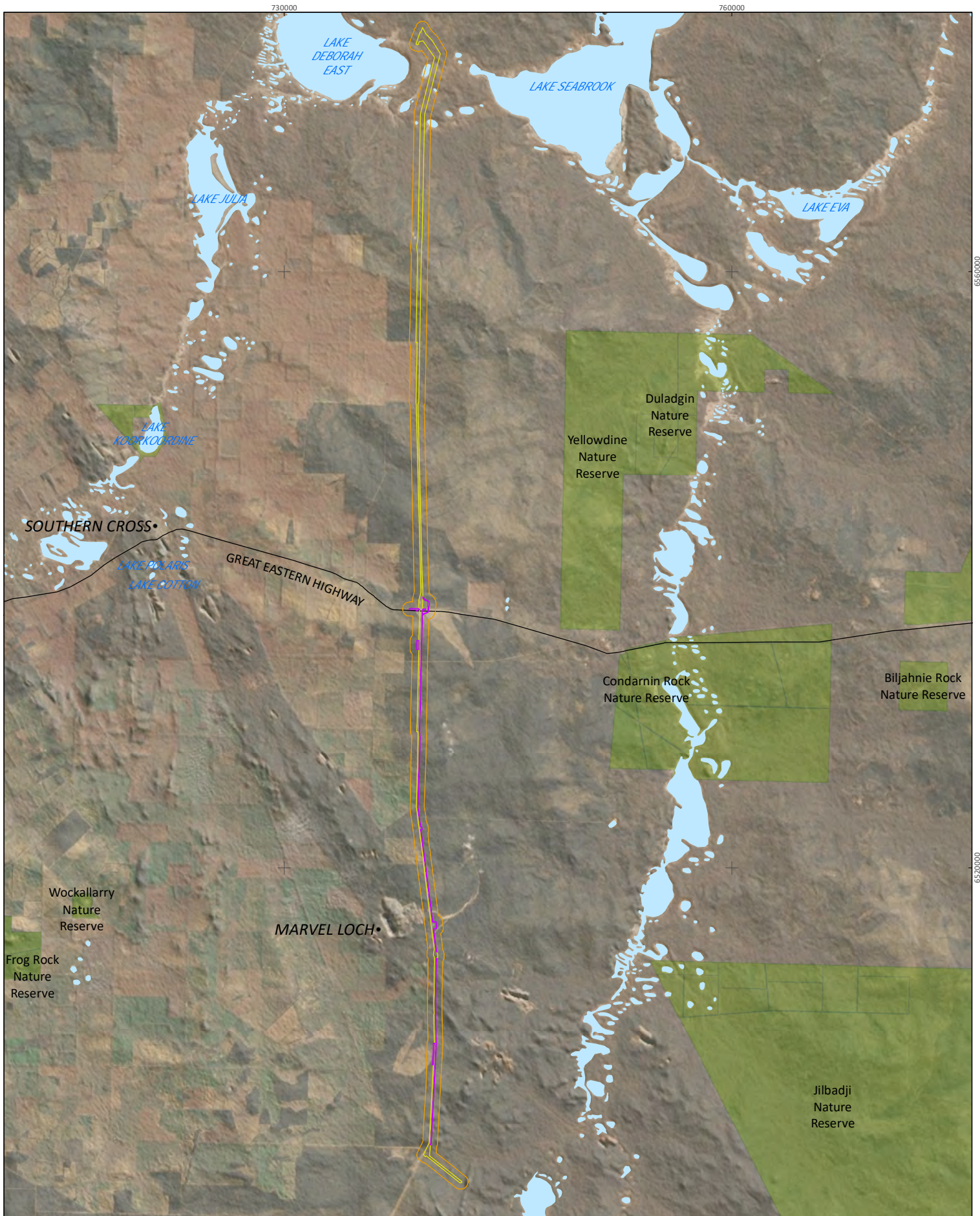
The scope of work for the targeted SRE survey was as follows:


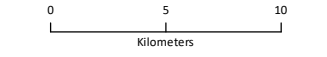
- conduct a biological desktop review to identify potential terrestrial biological values in the study area
- undertake a field reconnaissance survey on the study area that includes
 - high level vegetation structure (NVIS Level 2) mapping
 - identification of general location and extent of potentially significant vegetation (e.g. sandplain, eucalypt/mallee and samphire communities)
 - identification of general location and extent of potential habitat for significant flora and fauna, including Malleefowl
 - observations and high- level mapping of potential weed occurrences
- undertake a detailed, two season flora and vegetation survey in the study area
- undertake a Level 1 vertebrate fauna survey, targeted survey for significant fauna species and Level 2 short range endemic (SRE) invertebrate fauna survey in the study area
- prepare a technical report on the findings of the surveys.

1.3 STUDY AREA

The study area extends approximately 80 km north-south, with a total area approximately 1,498.7ha (Figure 1-1). This includes an original study area of 1,391.8 ha and a gaps study area of 106.9 ha (Figure 1-1); collectively referred to as 'the study area' in this report. The gaps study area was added part-way through the survey program and is mainly comprised of a ~20 m eastern extension/widening of the original study area, small extensions along the intersection of Great Eastern Highway, and the inclusion of historical borrow pit areas (Figure 1-1)

In addition, vegetation type extrapolation was undertaken generally 500 m from the centreline of the study area (extrapolation study area in Figure 1-1).



Mineral Resources Ltd Parker Range Iron Ore Project Haul Road	
Project No	1292, 1293
Date	22/01/2021
Drawn by	IN
Map author	KC
	
	
1:328,000 (at A4) GDA 1994 MGA Zone 50	







Study area	— Road
 Original study area	 Lakes
 Gaps study area	 DBCA managed land
 Extrapolation study area	

Figure 1-1
Project location and study area



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2 LEGISLATIVE CONTEXT

The protection of flora and fauna in WA is principally governed by three acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

The BC Act came into full effect on 1 January 2019 and replaced the functions of the *Wildlife Conservation Act 1950* (WC Act).

2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of the Environment and Energy (DoEE). The EPBC Act provides for the listing of Threatened flora, Threatened fauna and Threatened Ecological Communities (TECs) as matters of National Environmental Significance (NES). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of NES, require approval from the Australian Government Minister for the Environment through a formal referral process.

Conservation categories applicable to Threatened flora and fauna species under the EPBC Act are as follows:

- Extinct (EX)¹ – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium term
- Conservation Dependent (CD)¹ – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable, Endangered or Critically Endangered.

Ecological communities are defined as ‘naturally occurring biological assemblages that occur in a particular type of habitat’ (English & Blyth 1997). There are three categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

The EPBC Act is also the enabling legislation for protection of Migratory species as matters of NES under several international agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

¹ Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

2.2 STATE

2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened flora and fauna species (Government of Western Australia 2018a, b)² in the following categories:

- Critically Endangered (CR) – species facing an extremely high risk of extinction in the wild in the immediate future³
- Endangered (EN) – species facing a very high risk of extinction in the wild in the near future³
- Vulnerable (VU) – species facing a high risk of extinction in the wild in the medium term future³.

Species may also be listed as specially protected (SP) under the BC Act in one or more of the following categories:

- species of special conservation interest (conservation dependent fauna, CD) – species with a naturally low population, restricted natural range, of special interest to science, or subject to or recovering from a significant population decline or reduction in natural range
- migratory species (Mig.), including birds subject to international agreement
- species otherwise in need of special protection (OS).

The Department of Biodiversity, Conservation and Attractions (DBCA) administers the BC Act and also maintains a non-statutory list of Priority flora and fauna. Priority species are still considered to be of conservation significance – that is they may be Threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority flora and fauna lists are assigned to one of four Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

2.2.2 Critical habitat

Under the BC Act, habitat is eligible for listing as critical habitat if it is critical to the survival of a Threatened species or a TEC and its listing is otherwise in accordance with the ministerial guidelines.

2.2.3 Threatened and Priority Ecological Communities

The BC Act provides for the listing of TECs in the following categories:

- Critically Endangered – facing an extremely high risk of becoming eligible for listing as a collapsed ecological community in the immediate future³
- Endangered – facing a very high risk of becoming eligible for listing as a collapsed ecological community in the near future³
- Vulnerable – facing a high risk of becoming eligible for listing as a collapsed ecological community in the medium term future³.

An ecological community may be listed as a collapsed ecological community under the BC Act if there is no reasonable doubt that the last occurrence of the ecological community has collapsed or the

² The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act.

³ As determined in accordance with criteria set out in the ministerial guidelines.

ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure.

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

2.2.4 Other significant flora, vegetation and fauna

Under the EPA’s environmental factor guidelines, flora, vegetation and fauna may be considered significant for a range of reasons other than listing as a Threatened or Priority species or ecological community. In addition to listing as Threatened or Priority, EPA (2016a) identifies the following:

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

In addition to listing as Threatened or Priority, EPA (2016b) identifies the following attributes that constitute significant fauna:

- species with restricted distribution (see also section 2.2.5)
- species subject to a degree of historical impact from threatening processes
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

Provided in the guide for assessment of applications to clear native vegetation (DER 2014) is a scale for assessing the bioregional conservation status of ecological vegetation classes (Table 2-1).

Table 2-1 Bioregional conservation status of ecological vegetation classes

Conservation status	Description
Presumed extinct	Probably no longer present in the bioregion
Endangered*	Less than 10% of pre-European extent remains
Vulnerable*	10-30% of pre-European extent exists
Depleted*	More than 30% and up to 50% pre-European extent exists
Least concern	More than 50% of pre-European extent exists and subject to little or no degradation over a majority of this area

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

2.2.5 Short range endemic invertebrates

SRE fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km², that may also be disjunct and highly localised (Harvey 2002). EPA (2016b) identifies species with restricted distributions as being significant fauna in the context of environmental impact assessments (EIA). SRE fauna need to be considered in EIA as localised, small populations of species that are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa.

Short range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002):

- Relictual – where the drying climate reduced the area of suitable habitat available to a species, forcing a range contraction. Such habitats typically maintain historic mesic conditions (e.g. south-facing rock faces or slopes of mountains or gullies).
- Habitat speciality – where species settled in particular isolated habitat types (e.g. rocky outcrops) by means of dispersal and evolved in isolation into distinct species.

However, SRE invertebrates have also been reported in more widespread habitats such as spinifex plains or woodlands, mainly in groups with low dispersal capabilities, for example mygalomorph spiders and millipedes (see for example Car & Harvey 2014; Rix *et al.* 2018a).

There can be uncertainty in categorising a specimen as an SRE due to several factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage at hand. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as ‘barcoding’ (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum applies four categories which were adopted in this assessment: confirmed, potential, uncertain and not SRE. Confirmed SREs are taxa for which the distribution is known to be less than 10,000 km², the taxonomy is well known and the group is well represented in collections and/ or via comprehensive sampling (WAM 2013). Potential SREs include those taxa for which there is incomplete knowledge of the geographic distribution of the group and its taxonomy, and the group is not well represented in collections.

2.2.6 Environmentally Sensitive Areas

Under section 51B of the EP Act the Minister for Environment may declare by notice either a specified area of the State or a class of areas of the State to be ESAs. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (Government of Western Australia 2005).

ESAs are areas where the vegetation has high conservation value. Several types of areas are declared ESAs including:

- the area covered by vegetation within 50 metres (m) of Threatened flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened flora is located
- the area covered by a TEC
- a defined wetland (Ramsar wetlands, conservation category wetlands and nationally important wetlands) and the area within 50 m of the wetland
- Bush Forever sites.

2.2.7 Introduced flora

Introduced flora (weeds) pose threats to biodiversity and natural values by successfully out-competing native species for available nutrients, water, space and sunlight; reducing the natural structural and biological diversity by smothering native plants or preventing them from growing back after clearing, fire or other disturbance; replacing the native plants that animals use for shelter, food and nesting; and altering fire regimes, often making fires hotter and more destructive (AWC 2007).

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

- Declared Pest – the Biosecurity and Agriculture Management Act 2007 (BAM Act), Section 22 makes provision for a plant taxon to be listed as a Declared Pest organism in parts of, or the entire State. Under the Biosecurity and Agriculture Management Regulations 2013 Declared Pests are assigned to one of three control categories that dictate the level of management required (DPIRD 2019).
- Weed of National Significance (WoNS) – high impact, established introduced flora causing major economic, environmental, social and/or cultural impacts in a number of states/territories, and which have strong potential for further spread (Australian Weeds Committee 2012). Management is required in accordance with DPIRD guidelines for particular WoNS.

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

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia's landscapes into large 'bioregions' and 'subregions' based on climate, geology, landform, native vegetation and species information (DoEE 2016). The study area is almost entirely within the Southern Cross subregion (COO2) of the Coolgardie bioregion (1,442.8 ha), while small portions of the southern end intersect the Merredin subregion (AVW01) of the Avon Wheatbelt bioregion (47.0 ha) (Figure 3-1).

The Southern Cross subregion has subdued relief, comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills. It lies on the 'Southern Cross Terrains' of the Yilgarn Craton, where granite strata are interrupted by parallel intrusions of Archaean greenstone. Drainage is occluded. Valleys have Quaternary duplex and gradational soils and include chains of saline playalakes. Diverse *Eucalyptus* woodlands (*Eucalyptus salmonophloia*, *E. salubris*, *E. transcontinentalis*, *E. longicornis*) rich in endemic eucalypts occur around these salt lakes, on the low greenstone hills, valley alluvials and broad plains of calcareous earths. The salt lake surfaces support dwarf shrublands of samphire. The granite basement outcrops at mid-levels in the landscape and supports swards of *Borya constricta*, with stands of *Acacia acuminata* and *Eucalyptus loxophleba*. Upper levels in the landscape are the eroded remnants of a lateritic duricrust yielding yellow sandplains, gravelly sandplains and laterite breakaways. Mallees (*Eucalyptus leptopoda*, *E. platycorys* and *E. scyphocalyx*) and scrub-heaths (*Allocasuarina corniculata*, *Callitris preissii*, *Melaleuca uncinata* and *Acacia beauverdiana*) occur on these uplands, as well as on sand lunettes associated with playas along the broad valley floors, and sand sheets around the granite outcrops. The scrubs are rich in endemic acacias and Myrtaceae (Cowan *et al.* 2001).

The Avon Wheatbelt is characterised as an area of active drainage dissecting a Tertiary plateau in Yilgarn Craton, a gently undulating landscape of low relief. Proteaceous scrub-heaths, rich in endemics, on residual lateritic uplands and derived sandplains; mixed eucalypt, *Allocasuarina huegeliana* and Jam-York Gum woodlands on Quaternary alluvials and eluvials. Within this bioregion, AVW01 is an ancient peneplain with low relief, gently undulating landscape. There is no connected drainage; salt lake chains occur as remnants of ancient drainage systems that now only function in very wet years. Lateritic uplands are dominated by yellow sandplain (Beecham 2001).

3.2 LAND SYSTEMS AND SURFACE GEOLOGY

DPIRD undertakes land system mapping for WA using a nesting soil-landscape mapping hierarchy (Schoknecht & Payne 2011). While the primary purpose of the mapping is to inform pastoral and agricultural land capability, it is also useful for informing biological assessments. Under this hierarchy, land systems are defined as areas with recurring patterns of landforms, soils, vegetation and drainage (Payne & Leighton 2004).

The study area intersects five land systems (Table 3-1; Figure 3-2).

Table 3-1 Land systems and extent in study area

Land system	Description	Area (ha)	% of study area
AC1	Gently sloping to gently undulating plateau areas, or uplands, on granites, gneisses, and allied rocks, with long gentle slopes and, in places, abrupt erosional scarps	747.7	49.9
DD15	Undulating plains with some low dunes, seasonal lakes, and clay pans	462.5	30.9
SV2	Saline valleys with some dunes including barchan forms--salt lake channels, mostly devoid of true soils, and their fringing areas	48.9	3.3
My44	Undulating ridge and low hilly terrain with some mesas and buttes and small valley plains	105.4	7.0
JJ17	Small ranges of metasediments (whitestones), some rock outcrops	134.2	9.0

According to the Surface Geology of Australia 1:1,000,000 scale, WA database (Stewart *et al.* 2008), the study area intersects nine geological formations (Table 3-2; Figure 3-2).

Table 3-2 Surface geology of the study area, extent by deposit type

Surface geology	Abbreviation	Description	Area (ha)	% of study area
Sand plain	Czs	Sand - residual	492.8	32.8
Ferruginous duricrust	Czl	Lateritic duricrust	326.3	21.9
Holocene alluvium	Qa	Alluvial sediment	177.5	11.9
Quaternary colluvium	Qrc	Colluvial sediment	162.8	10.9
Lunette dunes	Qdlu	Sand – aeolian, lacustrine sediment	140.8	9.5
Pelitic and psammitic sedimentary rocks	Asy	Shale, sandstone, conglomerate, chert, volcanoclastic rock	97.7	6.6
Gneiss, granulite, migmatite	An	Felsic gneiss, mafic granulite, felsic granulite, banded iron formation, migmatite	79.8	5.4
Felsic gneiss, migmatite	Anh	Felsic gneiss, migmatite	10.5	0.7
Volcanic and sedimentary rocks	Awy	Rhyolite, volcanoclastic rock, tuff, para-amphibolite, quartzite	10.5	0.7

700000

790000

+

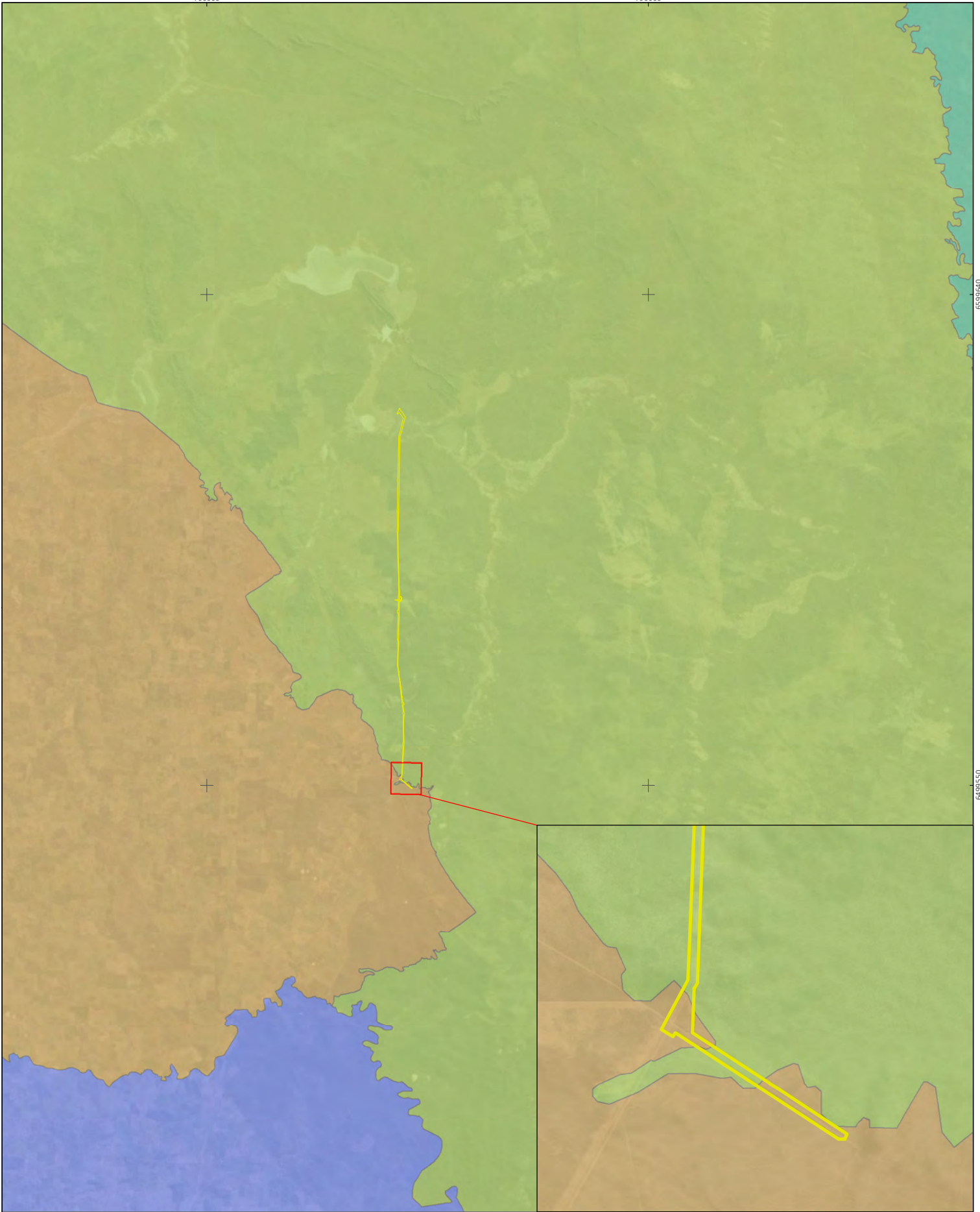
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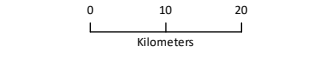
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Mineral Resources Ltd Parker Range Iron Ore Project Haul Road		
Project No	1292, 1293	
Date	22/01/2021	
Drawn by	IN	
Map author	KC	1:1,000,000(at A4) GDA 1994 MGA Zone 50






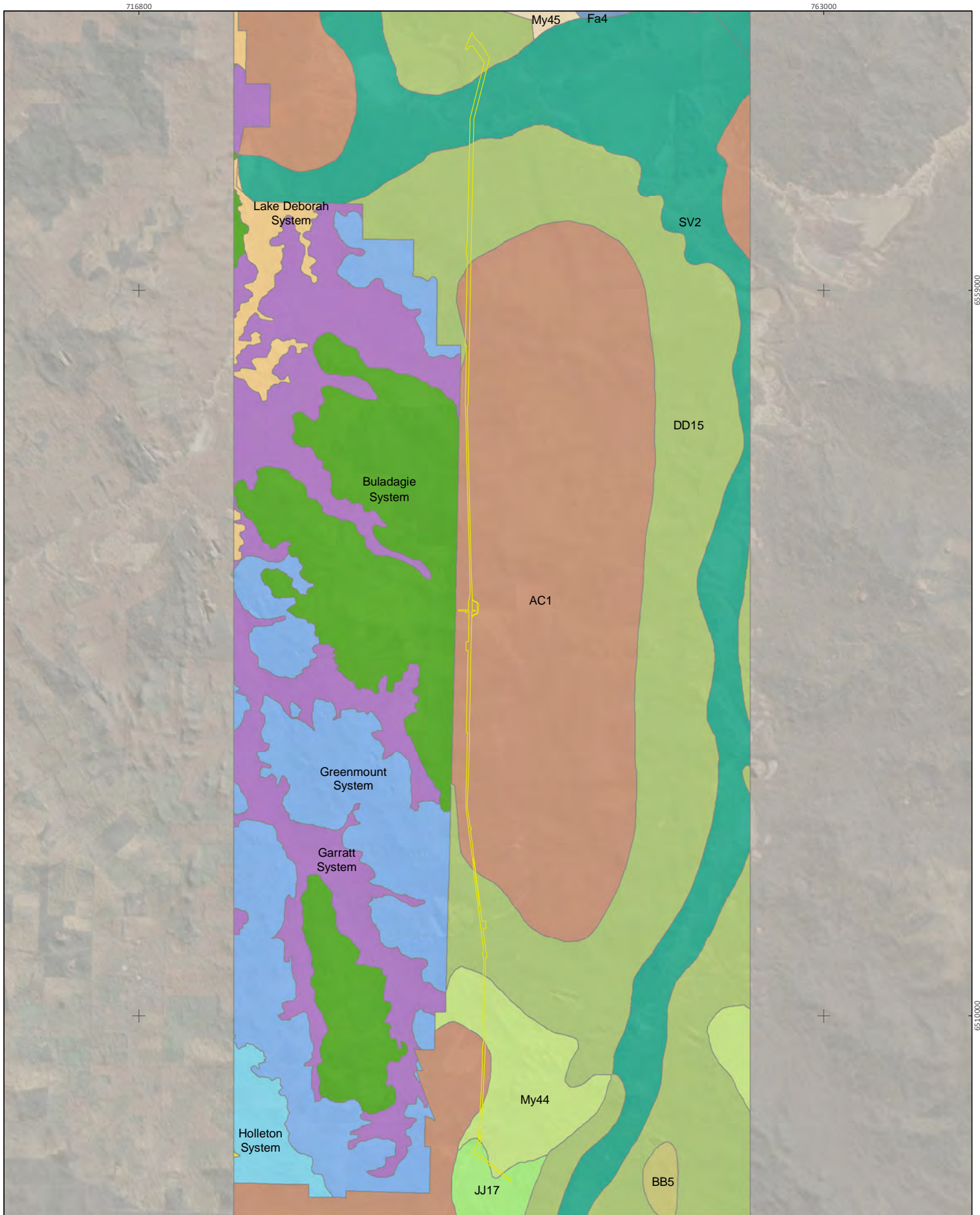

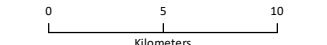
-  Study area
- IBRA region and subregion**
-  Avon Wheatbelt, Merredin
-  Coolgardie, Eastern Goldfield
-  Coolgardie, Southern Cross
-  Mallee, Western Mallee

Figure 3-1
Study area in relation to IBRA bioregions and subregions



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 Study area	 Greenmount System
Land system	 Holleton System
 AC1	 JJ17
 BB5	 Kellerberrin System
 Buladagie System	 Lake Deborah System
 DD15	 My44
 Fa4	 My45
 Garratt System	 SV2

Figure 3-2

Land systems in the study area



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3.3 CLIMATE AND WEATHER

The climate of the Southern Cross subregion is described as arid to semi-arid warm Mediterranean climate with 250-300 mm of mainly winter rainfall (Cowan *et al.* 2001). The nearest Bureau of Meteorology (BoM) weather station with comprehensive data collection and recent historic climate data is Southern Cross Airfield (no. 012320), Latitude: 31.24°S Longitude 119.36°E, located 14.5 km west of the study area.

Southern Cross Airfield records the highest mean maximum monthly temperature (34.7°C) in January (lowest in July, 16.7°C) and the lowest minimum mean monthly temperature (3.6°C) in July (highest in January, 17.8°C) (BoM 2020) (Figure 3-3). Average annual rainfall is 306 mm with March and July recording the highest monthly averages (36.1 and 35.1 mm respectively; Figure 3-3). These two rainfall peaks reflect the influence of late-summer cyclonic events (variable in timing and intensity) and winter rainfall typical of Mediterranean climate zones.

3.3.1 Season 1 survey

Daily mean temperatures at Southern Cross Airfield twelve months preceding the first season flora and vegetation survey and the fauna survey (November/December 2019) were mostly higher than long term averages in December-March and July-October, with the greatest difference (4°C) in September (Figure 3-3).

For the three months (August-October 2019) preceding the first season flora survey, mean daily temperatures were above the long term average and monthly rainfall was below the long term average (Figure 3-3).

Rainfall records from Southern Cross Airfield show considerable variability from long term averages, with very low totals in November 2018, January, April, May and September 2019, and high rainfall in March.

Conditions during the fauna survey were conducive to fauna activity and detection, other than frogs (November/December no rainfall, maximum daily temperatures ranging from 24.7 to 36.0°C; January 9.2. mm rain over 3 days, max temps 27.3 to 38.8°C).

3.3.2 Season 2 survey

Daily mean temperatures at Southern Cross Airfield twelve months preceding the second season flora and vegetation survey (July 2020) were higher than long term averages for July-December 2019 and April-June 2020, and lower than long term average from January-March (Figure 3-4).

Rainfall records from Southern Cross Airfield show considerable variability from long term averages. Low monthly rainfall totals were recorded for September - November 2019, and March - April 2020, and high monthly rainfall totals were recorded in February 2020.

For the three months (April - June) preceding the second season flora and vegetation survey, mean daily maximum temperatures were above the long term average and mean daily minimum temperatures were above the average for April and June, and below average for May. Monthly rainfall was below the long-term average for April to June (Figure 3-4).

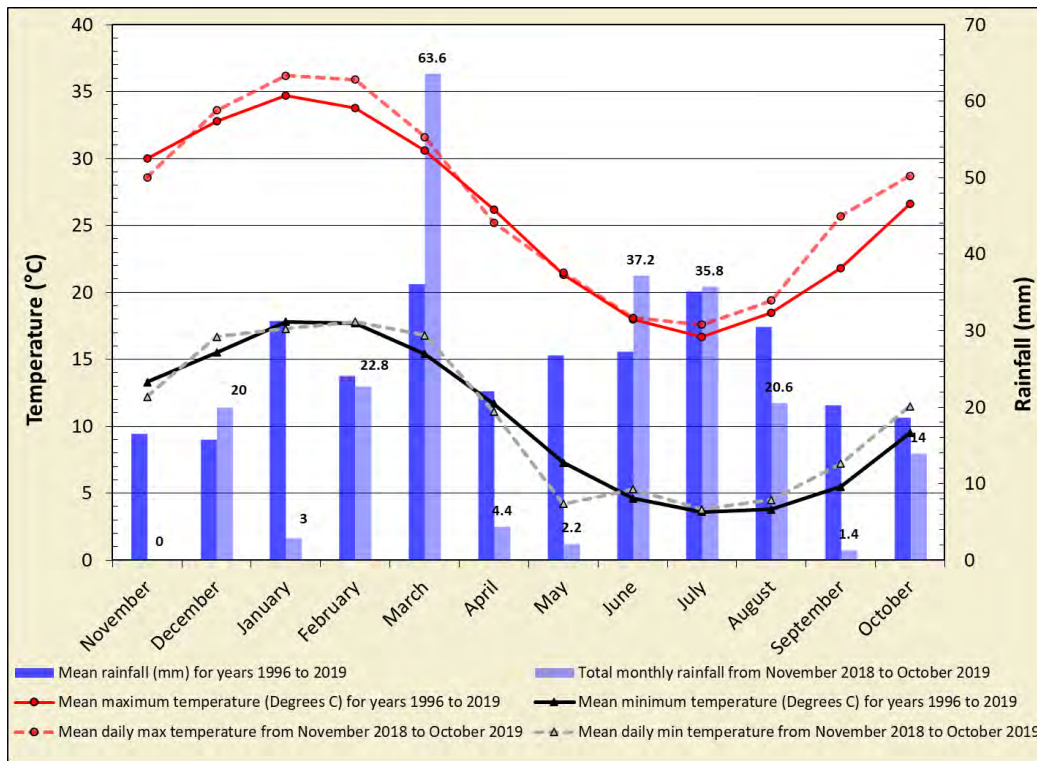


Figure 3-3 Annual climate and weather data for Southern Cross Airfield (no. 012320) and mean monthly data for the 12 months preceding the first season surveys (BoM 2020)

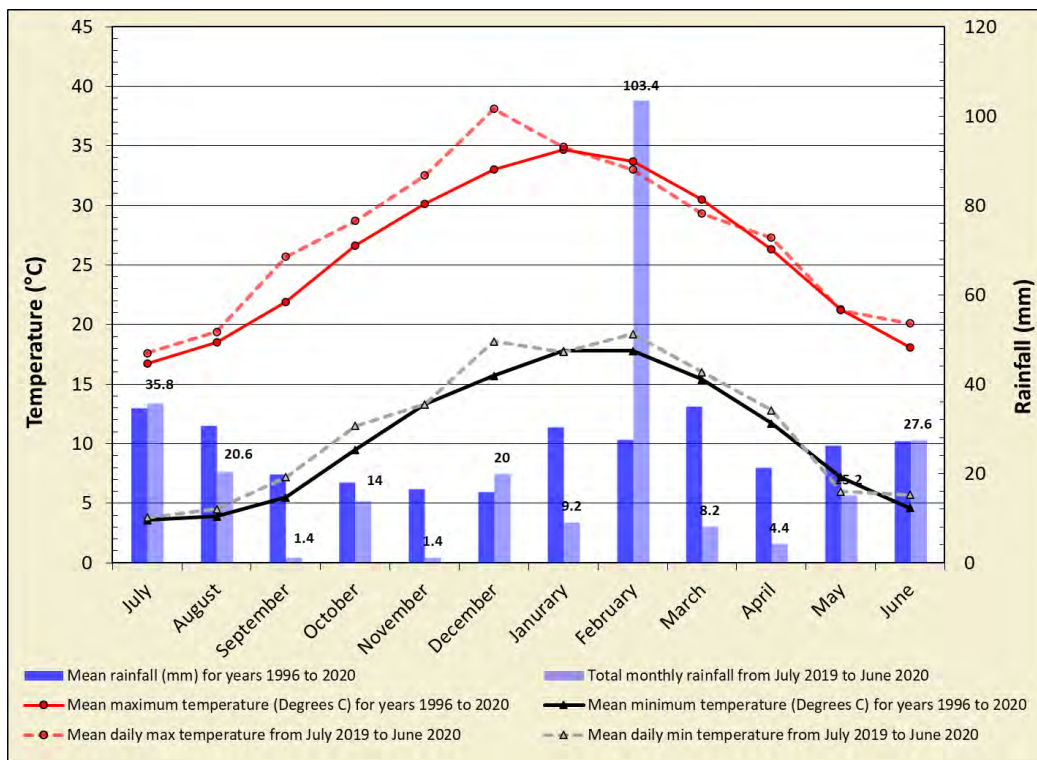


Figure 3-4 Annual climate and weather data for Southern Cross Airfield (no. 012320) and mean monthly data for the 12 months preceding the second season flora and vegetation survey (BoM 2020)

3.4 LAND USE

Predominant land uses in the AVW01 and COO2 subregions are summarised by Beecham (2001) and Cowan *et al.* (2001). Parts of the study area are bounded to the west by dryland agriculture (wheat), and the part south of Marvel Loch is crossed by access and haul roads associated with existing mining operations. For most of its length, the study area encompasses the DPIRD-managed State Barrier Fence, its 40 m-wide reserve and access road. The remainder is Unallocated Crown Land.

3.5 CONSERVATION RESERVES AND ESAs

There are no conservation reserves intersecting the study area or located closer than approximately 9.5 km from it (Figure 1-1). Two Nature Reserves are within 20 km of the study area; Yellowdine Nature Reserve (49.3 ha) is 9.3 kms to the east and Jilbadji Nature Reserve (25.1 ha) is 13.9 kms to the east of the study area.

4 METHODS

The surveys were conducted in accordance with relevant survey guidelines and guidance, including:

- EPA Environmental Factor Guideline: Flora and vegetation (EPA 2016a)
- EPA Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment (EPA 2016c)
- EPA Environmental Factor Guideline: Terrestrial fauna (EPA 2016b)
- EPA Technical Guidance: Terrestrial fauna surveys (EPA 2016f)
- EPA Technical Guidance: Sampling methods for terrestrial vertebrate fauna (EPA 2016d)
- EPA Technical Guidance: Sampling of short range endemic invertebrate fauna (EPA 2016e).

4.1 DESKTOP REVIEW

Searches of several biological databases were undertaken to identify and prepare lists of significant flora, vegetation and fauna that may occur within the study area (Table 4-1). A literature search was conducted for accessible reports for biological surveys conducted within approximately 50 km of the study area to build on the lists developed from the database searches (Table 4-2). This included survey reports for the original PRIOP approvals and more recent compliance related surveys (Table 4-2).

Table 4-1 Database searches conducted for the desktop review

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (DoEE 2020a)	EPBC Act Threatened flora, fauna and ecological communities	Approximate centre line of study area (-30.92°S, 119.50°E to -31.61°S, 119.53°E) with 10 km buffer
DBCA Threatened and Priority Flora Database (DBCA 2019c)	Threatened and Priority flora	Study area plus a 10 km buffer
DBCA Threatened and Priority Fauna Database (DBCA 2019b)	Threatened and Priority fauna	Study area plus a 10 km buffer
DBCA Threatened and Priority Ecological Communities Database (DBCA 2019d)	TECs and PECs	Study area plus a 10 km buffer
DBCA NatureMap Database (DBCA 2019a)	Flora and fauna records	Study area plus a 10 km buffer
BirdLife BirdData (Birdlife Australia 2020)	Avifauna	Study area plus a 20 km buffer
WA Museum Arachnid and Myriapod Database, Mollusca Database	Arachnid, myriapod and mollusc SREs	~100 km ² buffer of study area (30.88°S, 118.45°E (northwest corner) and 32.55°S, 120.52°E (southeast corner))

Table 4-2 Survey reports included in the desktop review

Report author	Survey description	Project
Wilcox and Davis (2008)	Level 1 fauna survey	St Barbara operation, Nevorla area
KLA (2009)	Level 2 fauna survey	Mt Caudan – Parker Range Iron Ore Project
Ecoscape (2012)	Level 1 fauna survey	Western Power microwave bearer sites adjacent to Great Eastern Highway
Biota (2012)	SRE invertebrate survey	Southern Koolyanobbing Range
Biota (2014)	Level 2 fauna survey	Southern Koolyanobbing Range
Western Wildlife (2017)	Level 2 fauna survey	Mt Holland Project
Edward <i>et al.</i> (2009)	SRE invertebrate survey	St Barbara operation, Marvel Loch
Botanica Consulting (2010a)	Level 1 flora and vegetation survey Level 2 flora and vegetation survey Targeted searches	PRIOP
Botanica Consulting (2012)	Targeted search for <i>Chamelaucium</i> sp. Parker Range (P1)	PRIOP
Phoenix (2020c)	Significant flora baseline monitoring survey And targeted searches for <i>Chamelaucium</i> sp. Parker Range	PRIOP
Phoenix (2020d)	Targeted search <i>Isopogon robustus</i>	PRIOP
Phoenix (2020e)	Targeted search for <i>Westringia acifolia</i> and <i>Microcorys</i> sp. nov. (GBW 22/11/2019).	PRIOP
Phoenix (2020b)	Baseline Malleefowl mound survey	PRIOP

4.2 FIELD SURVEY

4.2.1 Survey timing

Field survey dates and seasonal timing of survey visits are provided in Table 4-3.

Table 4-3 Survey dates and seasonal timing

Survey type	Season	Dates	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Flora, vegetation and fauna reconnaissance survey	Spring	3-4 Oct 2019													
Flora & vegetation survey 1	Spring	13-20 Nov 2019													
		27-30 Nov 2019													
Level 1 & targeted vertebrate fauna survey and SRE survey, trip 1	Spring	25 Nov – 3 Dec 2019													
Targeted flora survey	Spring	27-30 Nov 2019													
Targeted vertebrate fauna survey and SRE survey, trip 2	Summer	15–21 Jan 2020													
Flora & vegetation survey 2	Winter	21-28 Jul 2020													
Targeted flora survey	Winter	21-28 Jul 2020													
Targeted flora survey and gaps survey	Spring	29 Sept – 3 Oct 2020													
Level 1 fauna survey (gaps) and targeted SRE survey	Spring	1-3 Oct 2020													
Targeted flora gaps survey	Spring	25 Oct – 26 Oct 2020													
Targeted SRE survey	Spring	2-3 October 2020													

4.2.2 Flora and vegetation

Field methods for the flora and vegetation survey of the study area included:

- surveying of quadrats and relevés (see 4.2.2.1)
- targeted flora searches (4.2.2.2)
- vegetation type and condition mapping (4.2.2.3, 4.2.2.4)
- TEC/PEC assessment (4.2.2.5).

Prior to the commencement of the field surveys, data including satellite imagery, survey boundary, and pre-selected vegetation quadrats and relevés were loaded onto electronic field devices. The field survey involved assessing and mapping vegetation boundaries, conducting quadrat and relevé sampling and collecting opportunistic flora specimens. GPS locations of vegetation and condition boundaries, survey sites and flora specimen data were recorded digitally.

4.2.2.1 Quadrats and relevés

Quadrat locations were selected to ensure that an accurate representation of the major vegetation types within the study area were sampled adequately, with a minimum of at least three quadrats per vegetation type. Two methods were used for the selection of quadrat placement within the study area. Preliminary quadrat locations were pre-selected using aerial photography, with selection based on apparent changes in the vegetation visible in the aerial imagery. Final quadrat placement was determined in the field while ground-truthing the study area on foot. Some preliminary quadrats were moved to locations which better represented vegetation types and some quadrats were changed to relevés, where only dominant vegetation was recorded for the purposes of accurate vegetation mapping.

In total, 74 quadrats (20 m x 20 m) and 16 relevés were surveyed across the study area (Figure 4-1; Appendix 1). Quadrat sampling dimensions were 20 m x 20 m in accordance with EPA guidance for the Coolgardie bioregion, as the study area is predominantly within this bioregion. The following information was recorded for each quadrat (Appendix 2):

- location – the geographic coordinates of all four corners of the quadrat in WGS84 projection
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (NVIS; ESCAVI 2003) and in accordance with EPA (2016c) (Appendix 3)
- habitat – a brief description of landform and habitat
- geology – a broad description of surface soil type and rock type
- disturbance history – a description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance, human activity and fauna activity
- vegetation condition – using the condition scale in EPA (2016c) for the Southwest and South-western Interzone Botanical Provinces
- height and percentage foliage cover (PFC) – a visual estimate of cover of total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover
- photograph – a colour photograph of the vegetation within each quadrat in a south-easterly direction from the north-west corner of the quadrat
- flora species list – comprehensive list of all flora species recorded within the quadrat.

To ensure accurate taxonomic identification of flora species present within the study area, collections were made of each specimen at least once and each collection was pressed and documented for identification using the WA Herbarium resources.

For each species identified, records on FloraBase and the Australasian Virtual Herbarium were consulted to provide information on known ranges to determine whether the survey area represented a range extension for the species.

Relevés were sampled within vegetation units where dominant species, soils and topography were representative of vegetation surveyed in quadrats. Information collected in relevés was the same as for quadrats with the exception that:

- only a single geographic coordinate was recorded
- only prominent flora species were recorded.

4.2.2.2 Targeted flora searches

Targeted searches were undertaken for significant flora (Threatened and Priority), Declared Pests and WoNS. As the flora of the local region is known for cryptic flora species (difficult to distinguish), multiple survey visits were employed over multiple seasons to help detect significant species during their various flowering and fruiting periods. During the final targeted survey visit, additional searches were conducted outside and adjacent to the study area for key significant flora with the potential for higher proportional impacts. Due to a greater abundance of priority plants in proximity to the Great Eastern Highway a higher intensity of targeted searches within and immediately adjacent to the Study Area at this location were performed.

Remnant vegetation was traversed by foot in meandering transects with the searches focused on a) habitats considered likely to support greater incidence of significant flora, b) areas identified as potentially occurring within future clearing footprint areas, and c) previously recorded locations of significant plants or populations within and in close proximity to the study area. Where possible, targeted searches attempted to resurvey significant flora populations previously recorded (DBCA database records) to verify and/or improve data. Where resurvey of an existing record was not feasible, the previous record was assumed as current.

Due to an abundance of significant flora plants in some areas of the study area some significant flora populations could not be fully surveyed for extent and plant numbers. In such cases, transects were employed to record plant numbers in order to calculate an estimated plant density (plants per hectare) to assist in population and plant number extrapolations.

If an encountered flora species was considered to potentially be a significant species (i.e. similar floristic characteristics and occurring within suitable habitat) the following information was collected:

- GPS coordinates, including population boundary where applicable
- description of the habitat and floristic community in which the potential significant species was located
- population size estimate (i.e. estimated number of individual plants) where applicable
- specimen collection for taxonomic identification and lodgement at the WA Herbarium
- photograph of live plant in situ and description of important details, such as flower colour, height of individual or average height of population.

Following the field survey, the likelihood of occurrence for each significant flora species identified in the desktop review was assessed and assigned to one of four ratings:

- recorded – species recorded within the study area by previous or current survey
- likely – study area within current known range of species; suitable habitat within the study area, records within 5 km and may not have been detectable during survey (e.g. survey conducted outside flowering period, annual plant survey conducted outside likely period of

occurrence, small herbaceous plant in dense vegetation), or entire area of habitat not thoroughly searched

- possible – study area within known range of species; some potential habitat within the study area, no records within 5 km of study area and may not have been detectable during survey (e.g. survey conducted outside flowering period, annual plant survey conducted outside likely period of occurrence, small herbaceous plant in dense vegetation), or entire area of habitat not thoroughly searched
- unlikely – study area outside known range of species and/or no suitable habitat present in study area and/or suitable/potential habitat present but study area considered adequately searched for the species.

4.2.2.3 Vegetation type mapping

Vegetation mapping occurred progressively over the life of the survey program. The reconnaissance survey produced a broad map of vegetation structure that was used to assist vegetation site (quadrat and relevé) location selection. A preliminary vegetation map was produced following the first flora and vegetation survey visit. Cluster analysis of site data was used to assist production of the preliminary vegetation map to a) verify vegetation types, b) identify gaps in mapping, and c) identify potential identification errors in key structural species. Additional sites and ground-truthing were performed during the second flora and vegetation survey visit to address gaps in the preliminary vegetation map.

Final vegetation mapping was undertaken at a scale of 1:10,000 using NVIS sub-association level (L5) for structural descriptions (ESCAVI 2003). The vegetation descriptions from quadrats and relevés from the survey were grouped according to similarity of community structure (i.e. canopy levels), species composition and combination of species and the prevalent community structure (i.e. woodland, shrubland, etc.). The vegetation boundaries were mapped utilising a combination of ArcGIS ESRI imagery and high resolution (10 cm) raster imagery supplied by MRL, supported by vegetation boundaries recorded on GPS during the field survey.

To support delineation of vegetation types, a final cluster analysis was conducted based on species presence in each quadrat. The fusion strategy for the site classification was flexible UPGMA with a beta value of -0.1 and Bray Curtis association measure in the software package PATN (Belbin 2003). A dendrogram was produced to illustrate the similarities between the vegetation units identified. Statistically distinct vegetation units (the floristic group) classified the vegetation at a local scale. Local scale vegetation units were described at NVIS Level V – Association (ESCAVI 2003). The term 'vegetation type' was used for local scale vegetation units in accordance with EPA technical guidance (EPA 2016c).

Additional targeted searches were undertaken for a small section of the survey area after the completion of the vegetation mapping was complete and so these quadrats were excluded from analysis.

4.2.2.4 Vegetation condition mapping

The condition of vegetation was mapped across the study area based on the appropriate condition scale for the Southwest and South-western Interzone Botanical Province (Keighery 1994 in EPA 2016c) (Table 4-4). The vegetation condition ratings relate to vegetation structure, the level of disturbance and weed cover at each structural layer and the ability of the vegetation unit to regenerate. Vegetation condition ranged from Pristine being the highest rating to Degraded as the lowest.

Completely cleared areas (e.g. roads, tracks, paddocks) were excluded from condition ratings and mapped as 'NA'.

Table 4-4 Vegetation condition rating scale (EPA 2016c)

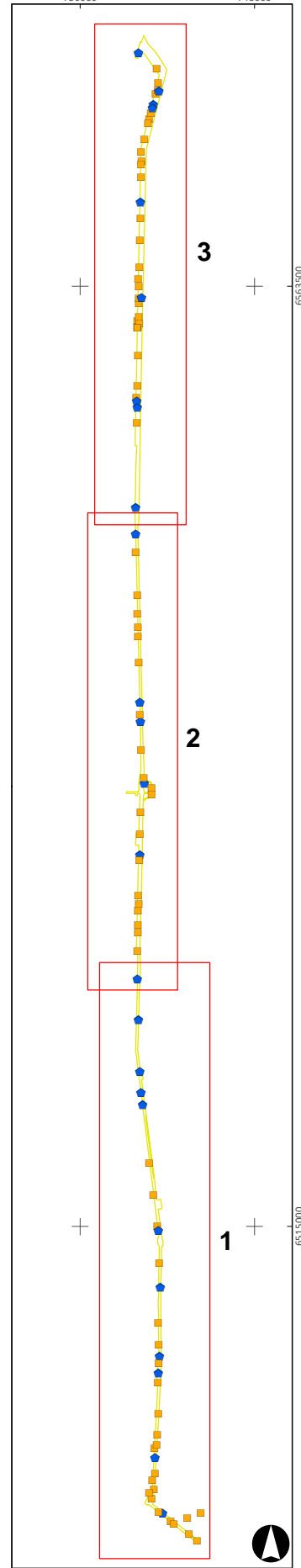
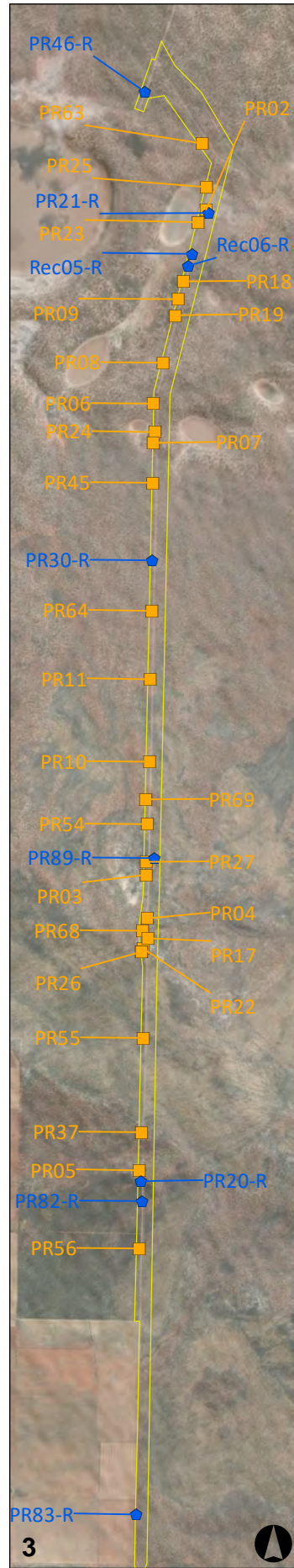
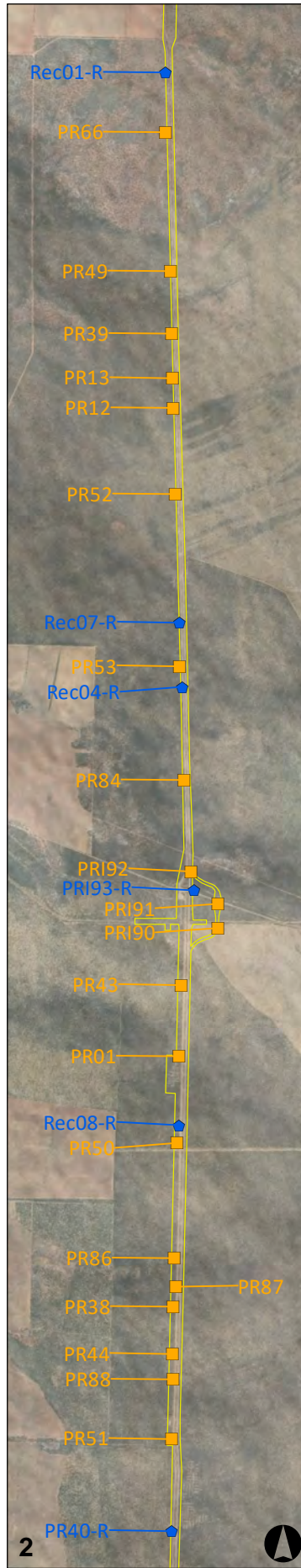
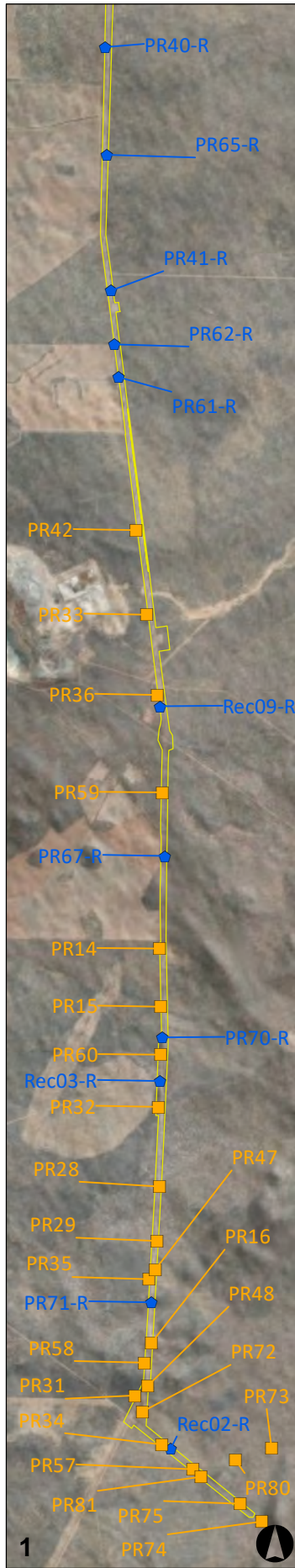
Condition rating	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by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


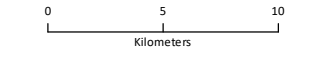
4.2.2.5 TEC/PEC assessment

Areas of the 'Plant assemblages of the Parker Range System' PEC that intersect the study area were investigated during field survey. Quadrats and relevés were performed to capture the varying vegetation types present within the PEC buffer. Additional advice was sought from the DBCA regarding the definition and treatment of the multiple plant assemblages that comprise the 'Plant assemblages of the Parker Range System' PEC. Mapped vegetation types resulting from survey and final cluster analysis were compared to the DBCA's list of Threatened and Priority Ecological Communities (DBCA 2020c).

4.2.2.6 Vegetation extrapolation

Vegetation type mapping was extrapolated outside the study area generally to 500 m (up to 1,375 m) either side of the centreline of the study area to conform with EPA requirements for linear corridors (EPA 2016c). The vegetation extrapolation area was mapped by examining aerial photography and mapping of the known vegetation types in the study area and extending existing boundaries where possible while also mapping areas of similar appearance as known types. Vegetation condition assessment of extrapolation mapping areas was not performed as these areas were generally not visited during field survey. The results of this extrapolation approach are provisional until ground-truthing has occurred.



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-  Study area
- Site type**
-  Quadrat
-  Relevé

Figure 4-1
Flora and vegetation survey sites



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4.2.3 Terrestrial fauna

Field methods for the fauna survey of the study area included:

- habitat assessment (see 4.2.3.1)
- active searches (4.2.3.2)
- avifauna surveys (4.2.3.3)
- camera trapping (4.2.3.4)
- Malleefowl habitat assessment (4.2.3.5)
- LiDAR survey and ground-truthing of Malleefowl mounds (4.2.3.6)
- SRE invertebrate sampling (4.2.3.7).

A total of 57 survey sites were sampled (Figure 4-2; Appendix 1).

4.2.3.1 Habitat assessment

Initial habitat characterisation was undertaken using various remote geographical tools, including aerial photography (Google Earth®), land system maps and topographic maps. Habitats with the potential to support significant terrestrial fauna species were identified based on known habitats of such species within the Coolgardie bioregion. Tentative sites were selected for the terrestrial fauna survey to represent all habitat types. Final survey site selection was conducted after ground-truthing of site characteristics.

At the broadest scale, site selection considered aspect, topography and land systems. At the finer scale, consideration was given to proximity to water bodies (drainage lines and creek), vegetation complexes and condition and soil type. Sites were primarily chosen to represent the best example of distinct habitats within the broader habitat associations of the study area with a focus on species of conservation significance identified in the desktop review. Habitat descriptions and characteristics were recorded at all Level 1 and Targeted survey sites (Figure 4-2; Table 4-5; Appendix 4).

Table 4-5 Terrestrial fauna survey effort

Site ¹	Site type ²	Foraging/ birding (hr)	Camera traps (hr)	Litter sieve (#)	Invert foraging (hr)	Invert wet pits (trap nights)
M001	VF	1.3				
M002	VF	1.1				
M003/PR015	VF	1.7				
M004	VF	0.5				
M005	VF	0.8				
M006/PR014	VF	5.0				
M007/CAM03	VF&CAM	2.1	688.1			
M008	VF	0.4				
PR001	VF					
PR002/CAM02	VF&CAM	2.8	592			
PR003	VF	1.6				
PR004/CAM01	VF&CAM	3.0	598.8			
PR005	VF					
PR006	VF	1.0				
PR007	VF	0.7				
PR008	VF	3.9				
PR009	VF	1.0				
PR010/CAM04	VF&CAM	3.3	594.2			
PR011	VF	2.6				
PR012	VF	0.8				
PR013	VF	1.4				
PR016	VF	2.3				
PR017	VF	1.7				
PR018	VF	1.0				
PR019	VF	0.8				
PR020	VF	1.8				
PR021	VF	1.1				
PR022	VF	0.6				
PR023	VF	0.8				
PR024	VF	1.0				
PR025	VF	0.4				
PR026	VF	1.1				
PR027	VF	2.6				
PR028	VF	0.4				
PR029	VF	0.8				
PR030	VF	0.8				
PR031	VF	1.2				
PR032	VF	1.2				
PR033	VF	1.0				
PR034	VF	0.8				

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Site ¹	Site type ²	Foraging/ birding (hr)	Camera traps (hr)	Litter sieve (#)	Invert foraging (hr)	Invert wet pits (trap nights)
PR035	VF	1.6				
PR036	VF	3.1				
PR037	VF	1.1				
PR038	VF	2.6				
PR039	VF	0.7				
PR040	VF	4.4				
PR041	VF	2.9				
PR-SRE01	SRE	1.0		3	1.0	275
PR-SRE02	SRE	1.0			1.0	275
PR-SRE03	SRE			3	0.6	280
PR-SRE04	SRE	1.4		3		245
PR-SRE05	SRE			3		265
PR-SRE06	SRE	0.7		3	1.3	240
PR-SRE07	SRE				1.0	255
PR-SRE08	SRE	0.4		3	0.8	250
PR-SRE09	SRE					245
PR-SRE10	SRE			3	0.7	240
TOC-01	SRE targeted			3	3	
TOC-02	SRE targeted			3	3	
TOC-03	SRE targeted			3	3	
TOC-04	SRE targeted			3	3	
TOC-05	SRE targeted			3	3	
TOC-06	SRE targeted			3	3	
TOC-07	SRE targeted			3	3	

¹ Site names are prefixed PR, except those sampled during the reconnaissance visit (M001-M008).

² Site type: VF = vertebrate fauna site, VF&CAM = vertebrate fauna site with camera trapping, SRE = short range endemic invertebrate site.

4.2.3.2 Active searches

Active searches were undertaken at most habitat assessment sites (Table 4-5; Figure 4-2). Active searches primarily targeted diurnal herpetofauna and mammals from direct sightings and secondary evidence. Searches focused primarily on significant species identified in the desktop review or reconnaissance visit as potentially occurring within the study area, including Malleefowl, Chuditch, Red-tailed Phascogale and bandicoot.

Searches were undertaken in any observable microhabitats considered likely to support mammals and reptiles. Techniques included: raking leaf and bark litter, overturning logs, searching beneath the bark of trees, investigating dead trees and logs, investigating burrows, investigating infrastructure ruins or disused building materials such as tin piles, and identifying any secondary evidence including tracks, diggings, scats, sloughs (shed skins), predation or feeding sites, and fauna constructed structures such as pebble mounds or nests. Variable amounts of time were spent actively searching and birding at each site (Table 4-5), for a total of 77.3 person hours over the duration of the field survey.

4.2.3.3 Avifauna surveys

Avifauna observations were recorded opportunistically while other field work was being completed, including observations made during travel and active searches. Effort is combined with active search as 'foraging/birding' in Table 4-5.

4.2.3.4 Camera trapping

Five camera traps were deployed at each of four sites considered to represent habitat for either Chuditch, Red-tailed Phascogale, or *Isoodon* sp. bandicoot. Cameras were baited (universal bait) and left in place for five nights.

4.2.3.5 Malleefowl habitat assessment

Malleefowl habitat was assessed in the field using a set of environmental variables based on features of critical Malleefowl habitat in Western and Central Australia, as described in the National Recovery Plan (Benshemesh 2007). Individual sites were assessed with a numerical score as a basis for mapping areas of suitable habitat in the study area. The score used is an unweighted sum of binary values (0 absent, one present) for the following attributes:

- sandy substrate (sand/sandy loam/sandy clay)
- litter (leaf litter forming distinct patches under trees/shrubs or continuous blanket over soil)
- canopy (tall shrubs or trees forming more or less continuous canopy, contributing to suitable ground microclimates and screen from aerial predators)
- level (ground approximately level, tending to prevent disturbance of soil and litter by rainfall runoff)
- mallee (presence of any mallee-form *Eucalyptus* sp.)
- *Melaleuca* (presence of any *Melaleuca* sp.)
- mulga s.l. (presence of any *Acacia* sp. of subgenus *Juliflorae*)
- *Triodia* (presence of any *Triodia* sp.).

Scores of four or greater (meaning a site contained at least 50% of features that comprise critical Malleefowl habitat) were considered to represent potential Malleefowl habitat. Sites that attained a value of four or greater were applied to vegetation type polygons and the entire polygon (usually) assigned as potential Malleefowl habitat. Where two or more sites were assessed within a single polygon, the higher score was applied unless features of the lower-scored site(s) were more representative. Where no site occurred within a polygon, polygons were classified based on scores for similar vegetation nearby and inspection of relative vegetation density.

4.2.3.6 LiDAR survey and ground-truthing Malleefowl mounds

LiDAR surveys were conducted via aircraft in November 2019 by AAM Pty Ltd to detect any mounds within the haul road corridor and 1 km buffer, in conjunction with surveys for the mine development area (Phoenix 2020b). The LiDAR survey identified a total of 81 potential Malleefowl mounds within this area, all of which were visited during January 2020. At each identified location, assessments were conducted of mound presence, activity status, and Malleefowl habitat attributes.

Mounds were classified as either active, inactive or long unused based on evidence of Malleefowl activity (Table 4-6), as per the National Malleefowl Monitoring Manual (National Malleefowl Recovery Team 2019). The inactive classification was broken down into two sub-classes (sub-class 1 and sub-class 2) to provide a greater resolution on level of Malleefowl activity, consistent with the classification

applied in the PRIOP Significant Fauna Management Plan (Mineral Resources Ltd 2020) . Landscape features that were incorrectly identified as Malleefowl mounds by the LiDAR survey were classified as null.

Table 4-6 Mound status classification

Mound Status	Definition
Active	Currently being used by Malleefowl as an incubator for their eggs and are likely to contain eggs.
Inactive (sub-class 1)	Mound shows signs of recent Malleefowl activity, such as scats, tracks or fresh scrapings.
Inactive (sub-class 2)	No evidence of recent activity but mound remains well formed and in good condition for future use.
Long unused	Evidence of an extended period of inactivity such as dense shrubs or trees growing from hollow or mound very degraded/poorly formed. Highly unlikely to become active in the future.

4.2.3.7 SRE invertebrate sampling

4.2.3.7.1 Baseline SRE survey

Baseline sampling for SRE invertebrates was conducted at ten sites (Figure 4-2), in areas identified as suitable habitat for SREs. Sampling comprised the following methods:

- wet pit trapping
- active foraging
- litter/soil sieving.

Ten wet pitfall trapping sites were established, each comprising five one-litre plastic containers with a 70 mm diameter dug in flush with the surface in suitable microhabitats at each site. Pit traps were half-filled with propylene glycol, which has been shown to preserve DNA under laboratory conditions in invertebrates (Vink *et al.* 2005) and Phoenix has successfully sequenced COI from specimens caught in propylene glycol pitfall traps from previous surveys. All traps were covered with a plastic lid elevated 25 mm above the trap with wooden blocks to minimise bycatch of vertebrates where possible. Traps remained open following the setup and were retrieved by site personnel approximately six weeks later.

Active foraging for SRE invertebrate groups comprised inspection of logs, larger plant debris, the underside of bark of larger trees and the underside of rocks. Methodical searches were conducted amongst the leaf litter of shade-bearing tall shrubs and trees, including raking of litter, and spinifex bases were inspected thoroughly. Rocks and rock crevices were inspected, particularly for pseudoscorpions. A powered leaf-blower was also used to detect trapdoor spider burrows.

Each site was sampled for approximately one person hour, either concurrently or in addition to active searches for vertebrate fauna, a total search effort of 6.5 hours dedicated to invertebrates (Table 4-5). Trapdoor spider burrows identified during the searches were excavated if they were considered inhabited. Excavation involved removing soil from around the burrow to carefully expose the burrow chamber and remove the spider.

Combined litter/soil sifts were undertaken at seven sites, with three sifts conducted at each site. In total, 21 sifts were undertaken (Table 4-5). The collection of leaf litter samples was standardised volumetrically by the diameter and height (310 mm x 50 mm = 1.55 L) of the sieves which were completely filled with compressed litter and the upper layers of underlying soil. Samples were sieved through three stages of decreasing mesh size over a round tray and invertebrates were picked from the sieves and tray with forceps. These samples particularly targeted small spiders (Araneomorphae),

pseudoscorpions, buthid scorpions, millipedes, centipedes (in particular Geophilomorpha and Cryptopidae), smaller species of molluscs (e.g. Pupillidae) and slaters.

4.2.3.7.2 Targeted SRE survey

Supplementary targeted sampling was conducted for SREs collected in the baseline survey was conducted in October 2020. The aim of this survey was to collect additional specimens of the target taxa outside the proposed disturbance footprint and gather adequate habitat information to inform a risk assessment for these species. This survey targeted 16 SRE taxa at seven sites that were recorded from only from a single site in the baseline survey (Table 5-20).

Where possible, the targeted searches were conducted within a 100 m radius of the SRE record, within the same habitat type but outside the proposed disturbance footprint. At some sites searches were conducted beyond the 100 m radius to avoid the proposed disturbance footprint. Targeted survey sites were chosen within the same habitat type as the corresponding site of the SRE record. Sampling methods comprised active foraging and litter/soil sieving. Habitat assessments of the target SRE records were undertaken to determine the extent of habitat continuity in the vicinity of the records.

4.2.3.8 Likelihood of occurrence assessment

Following the field survey, the likelihood of occurrence for each significant fauna species identified in the desktop review was assessed and assigned to one of four ratings:

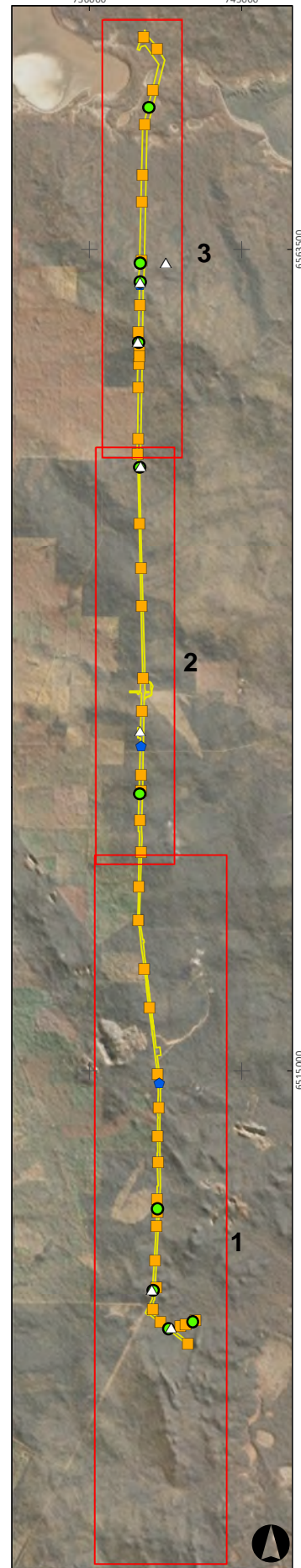
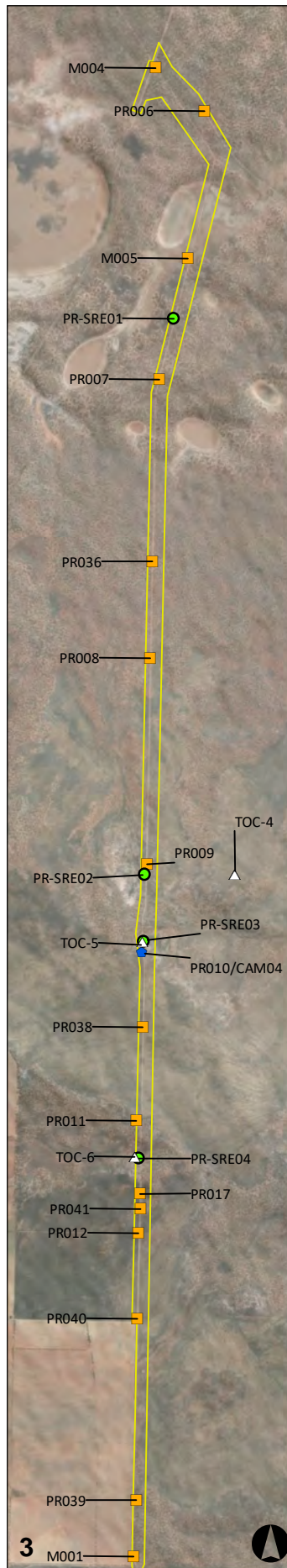
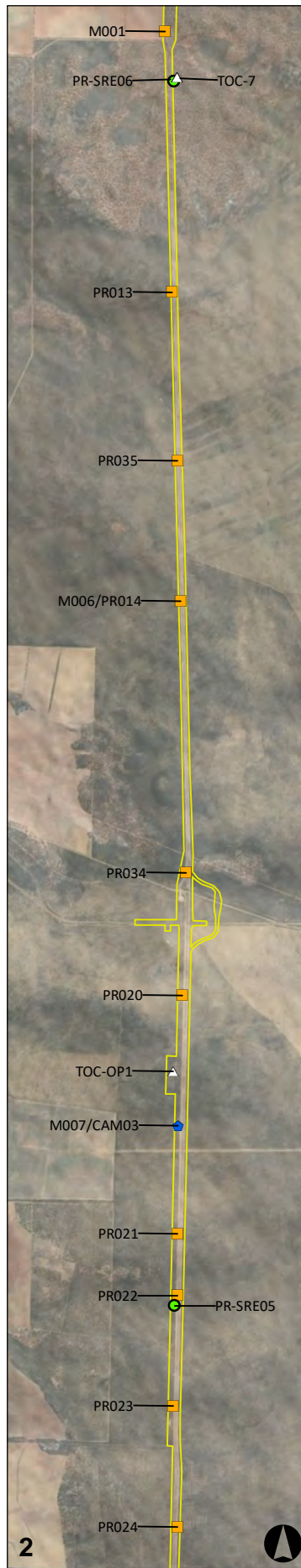
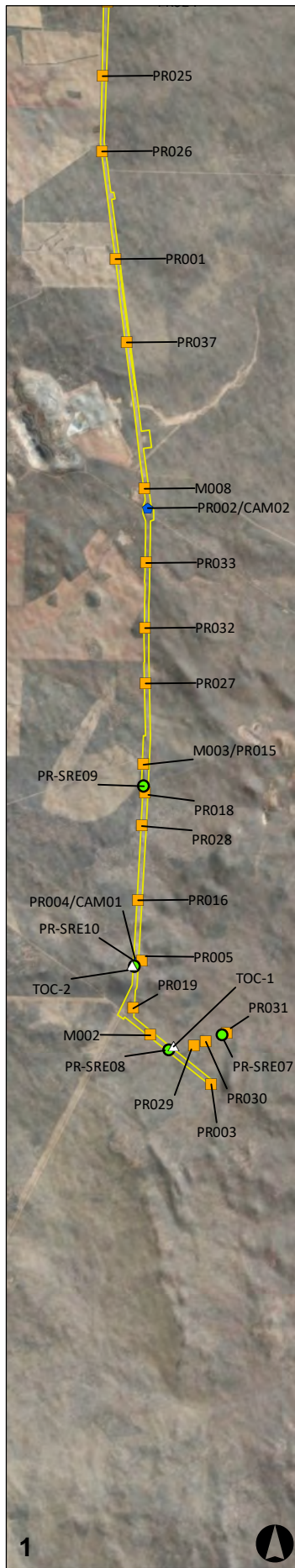
- recorded – species recorded within the study area by previous or current survey
- likely – study area within current known range of species, suitable habitat within the study area and home range of species intersects study area based on known records
- possible – study area within current known range of species, suitable habitat within the study area and home range of species does not intersect study area based on known records
- unlikely – study area outside current known range of species or no suitable habitat present in study area.

4.2.4 Survey personnel

The personnel involved in the surveys are listed in Table 4-7. Senior staff possessed sufficient experience within the region to fulfill requirements of relevant technical guidances. All survey work was carried out under relevant licences issued by DBCA under the BC Act (Table 4-7).

Table 4-7 Survey personnel

Name	Permit	Qualifications	Role/s
Karen Crews		BSc Hons (Env. Biol.)	Project oversight and review
David Leach	FB62000045	PhD (Plant Biol.); BAppSc Hons (Cons. & Park Mgmt)	Project manager, field surveys, data management, analysis, vegetation mapping, reporting
John Scanlon	BA27000192	PhD (Zoology)	Field surveys, reporting
Simon Pynt	BA27000192	BSc (Zoology)	Field surveys, reporting
Caitlin Nagle	BA27000192	MSc (Cons. Biol.); BSc (Zool. & Cons. Biol.)	Field surveys
Shenade Findlay	FB62000173	BSc (Biol); MSc (Cons. Biol)	Field surveys, reporting
Andrew Perkins	FB62000181	BSc. Hons; PhD	Field surveys, taxonomy
Martin Henson	FB62000110	BSc Hons (Env. Biol.)	Field surveys, taxonomy
Alice Watts	FB62000116	BSc Hons (Cons. Biol. & Bot.)	Field surveys
Calum Woods		BSc (Cons. Biol. & Env. Sci.); MSc (Cons. Biol.)	Field surveys, data management
Adam Crosby-Clark		BSc (Env. Mgt)	Field surveys



Mineral Resources Ltd Parker Range Iron Ore Project Haul Road	
Project No	1292, 1293
Date	4/05/2021
Drawn by	IN
Map author	KC
1:375,000 (at A4) GDA 1994 MGA Zone 50	

- Study area
- Survey site type**
- Short-range endemic invertebrate site
- Vertebrate fauna site
- Vertebrate fauna site with camera trapping
- Targeted SRE site

Figure 4-2
Terrestrial fauna survey sites

All information within this map is current as of 4/05/2021. This product is subject to COPYRIGHT and is property of Phoenix Environmental Sciences (Phoenix). While Phoenix has taken care to ensure the accuracy of this product, Phoenix make no representations or warranties about its accuracy, completeness or suitability for any particular purpose.

5 RESULTS

5.1 DESKTOP REVIEW

5.1.1 Flora and vegetation

5.1.1.1 Flora assemblage

The desktop review identified records of 203 flora taxa within the desktop search extent. Botanica Consulting (2010b) recorded 196 flora taxa from 35 families and 78 genera in their baseline surveys for PRIOP.

5.1.1.2 Significant flora

Records of 46 significant flora species were identified within the desktop search extent, comprising one Threatened species listed as Critically Endangered under the EPBC Act and BC Act, 44 Priority flora and one newly discovered species (Table 5-1; Figure 5-1).

Botanica Consulting (2010b) recorded nine of the significant flora species during their 2009 and 2010 baseline surveys of the Parker Range region (Table 5-1; Figure 5-1). Previous surveys undertaken in 2019 by Phoenix for PRIOP compliance related purposes also recorded nine of the significant flora (Table 5-1; Figure 5-1). All of these studies were in the vicinity of the southern part of the study area, some partly overlapping it.

Ten of the significant flora identified in the desktop review have previously been recorded in the study area:

- *Acacia desertorum* var. *nudipes* – P3
- *Baeckea grandibracteata* subsp. Parker Range (K. Newbey 9270) – P3
- *Banksia shanklandiorum* – P4
- *Bossiaea* sp. Jackson Range (G. Cockerton & S. McNee LCS 13614) – P3
- *Chamelaucium* sp. Parker Range (B.H. Smith 1255) – P1
- *Hakea pendens* – P3
- *Leucopogon* sp. Yellowdine (M. Hislop & F. Hort MH 3194) – P1
- *Lissanthe scabra* – P2
- *Microcorys* sp. nov. (G. Wells 22/11/2019)
- *Westringia acifolia* – P1.

Table 5-1 Significant flora identified in the desktop review

Species	Status	Proximity to study area	Habitat ¹	Phoenix (2020a, c, d, e) ²	Botanica Consulting (2010b)
<i>Acacia ancistrophylla</i> var. <i>perarcuata</i>	P3	2.1 km E	In <i>Eucalyptus corrugata</i> and <i>E. salubris</i> or <i>E. salmonophloia</i> low woodlands over mixed scrub. Red sand, clay loam, loam. Undulating plains.		
<i>Acacia asepala</i>	P2	3.9 km W	In open <i>Eucalyptus</i> woodland. Red-brown sandy loam. Undulating plains, along drainage lines.		
<i>Acacia concolorans</i>	P2	1.5 km SE	In <i>Eucalyptus</i> woodland, often associated with <i>Acacia erinacea</i> , <i>Scaevola spinescens</i> , and <i>Melaleuca</i> sp. Red/brown loam, clay. Low lateritic hills, flats.	✓	✓
<i>Acacia crenulata</i>	P3	0.9 km W	In mixed heathlands or open shrublands under open <i>Eucalyptus</i> woodlands. Red/brown loam, clay. Low lateritic hills, flats.		
<i>Acacia desertorum</i> var. <i>nudipes</i>	P3	In study area	Occurs in mixed scrub of <i>Allocasuarina spinosissima</i> , <i>A. corniculata</i> , <i>Melaleuca cordata</i> , <i>Conospermum stoechadis</i> subsp. <i>stoechadis</i> , <i>Petrophile stricta</i> , <i>Petrophile circinata</i> over <i>Ecdeicola monostachya</i> and mixed low shrubs. Yellow sand, lateritic gravel. Sandplains, flats.		
<i>Acacia filifolia</i>	P3	1.4 km E	In tall open scrub over open heath and sedgeland, with <i>Allocasuarina campestris</i> , <i>Daviesia euphorbioides</i> , <i>D. hakeoides</i> subsp. <i>subnuda</i> , <i>Ecdeicola monostachya</i> . On yellow sand, gravelly lateritic sands. Sandplains.		
<i>Baeckea grandibracteata</i> subsp. Parker Range (K. Newbey 9270) ³	P3	In study area	<i>Eucalyptus</i> scattered mallees over <i>Allocasuarina</i> high shrubland over <i>Melaleuca</i> sp., over low open heath over <i>Ecdeicola monostachya</i> sedgeland over <i>Schoenus</i> low open sedgeland. Yellow sand over laterite, midslopes.		✓
<i>Banksia arborea</i>	P4	9.5 km N	In <i>Acacia cockertoniana</i> , <i>A. aneura</i> , <i>A. quadrimarginea</i> , <i>Eremophila clarkei</i> tall shrubland over <i>Philotheca brucei</i> subsp. <i>brucei</i> , <i>Grevillea paradoxa</i> open shrublands over <i>Olearia humilis</i> low open shrublands. Stony loam. Ironstone hills.		
<i>Banksia shanklandiorum</i>	P4	In study area	White/yellow sand with lateritic gravel.	✓	✓
<i>Beyeria rostellata</i>	P1	7.9 km NE	Open low woodlands of <i>Eucalyptus ebbanoensis</i> subsp. <i>ebbanoensis</i> , <i>E. longissima</i> , <i>Allocasuarina acutivalvis</i> subsp. <i>acutivalvis</i> , over <i>Hibbertia exasperata</i> , <i>Calycopeplus paucifolius</i> , <i>Philotheca brucei</i> subsp. <i>brucei</i> and <i>Alyxia buxifolia</i> . Silty, loamy sand. Banded ironstone hills and slopes.		

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Species	Status	Proximity to study area	Habitat ¹	Phoenix (2020a, c, d, e) ²	Botanica Consulting (2010b)
<i>Bossiaea</i> sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)	P3	In study area	In low open woodland dominated by <i>Eucalyptus loxophleba</i> subsp. <i>supralaevis</i> and/or <i>E. salubris</i> over sparse shrubland of mixed species including <i>Eremophila oldfieldii</i> subsp. <i>oldfieldii</i> , <i>Acacia tetragonophylla</i> , <i>Senna artemisioides</i> subsp. <i>filifolia</i> , <i>Dodonaea inaequifolia</i> and <i>Scaevola spinescens</i> . Red-brown clay loam soils. Lower slopes of granite breakaways.		
<i>Calamphoreus inflatus</i>	P4	2.3 km E	Low woodland of <i>Eucalyptus sheathiana</i> with occasional other <i>Eucalyptus</i> species over low Scrub of mixed species including <i>Acacia merrallii</i> , <i>Halgania andromedifolia</i> , <i>Calamphoreus inflatus</i> and <i>Melaleuca lanceolate</i> . Clay loam with ironstone gravel. Flats, disturbed sites.		
<i>Chamelaucium</i> sp. Parker Range (B.H. Smith 1255)	P1	In study area	In open mallee over open shrubs or in mixed heaths. Associated with <i>Acacia yorkrakinensis</i> , <i>Grevillea pterosperma</i> , <i>Melaleuca hamata</i> , <i>Thryptomene kochii</i> , and <i>Persoonia saundersiana</i> . Yellow sand over laterite. Plains and gentle slopes.	✓	
<i>Cryptandra crispula</i>	P3	5.6 km E	In tall shrubland of <i>Allocasuarina spinosissima</i> over open shrubland, sedgeland and hummock grassland of <i>Drummondita hassellii</i> , <i>Lepidosperma sanguinolentum</i> , <i>Leucopogon hamulosus</i> and <i>Triodia rigidissima</i> . Brown sandy clay, yellow loamy sand, red soil, pebbles. Dune ridges, hills, near salt lakes.		✓
<i>Eremophila caerulea</i> subsp. <i>merrallii</i>	P4	3.9 km W	In open woodlands of <i>Eucalyptus salubris</i> or other <i>Eucalyptus</i> sp. over <i>Santalum acuminatum</i> . Sand, clay or loam. Undulating plains.		
<i>Eutaxia lasiocalyx</i>	P2	2.4 km SE	In woodland and open shrubs. Associated with <i>Eucalyptus salmonphloia</i> , <i>E. calycogona</i> , <i>Daviesia argillacea</i> , <i>Phebalium tuberculatum</i> , <i>Acacia erinacea</i> , <i>A. merrallii</i> and <i>Westringia rigida</i> . Red sandy loam, laterite and quartz gravel. Gentle lower slopes.		
<i>Gompholobium cinereum</i>	P3	0.2 km W	In open mallee woodland, with shrubby understorey of <i>Acacia</i> sp. and <i>Grevillea</i> sp. Yellow sand, clayey sand, brown loam, sandy gravel, laterite. Well-drained open sites, slopes, plains, roadsides.		
<i>Goodenia heatheriana</i>	P1	1.9 km E	In open herbfields, with <i>Eucalyptus corrugata</i> , <i>Acacia erinaceae</i> , <i>Grevillea acuaria</i> , <i>Exocarpos aphyllus</i> , and <i>Alyxia buxifolia</i> . Red crumbly clay, greenstone gravel and cobbles. Lower slopes, moderately exposed gently undulating plain, roadsides.		
<i>Grevillea georgeana</i>	P3	3.5 km S	Stony loam/clay. Ironstone hilltops and slopes.	✓	
<i>Hakea pendens</i>	P3	In study area	In mid-dense <i>Allocasuarina</i> shrub. Also associated with <i>Eucalyptus yilgarnensis</i> . Stony loam. Ironstone ridges.		✓

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Species	Status	Proximity to study area	Habitat ¹	Phoenix (2020a, c, d, e) ²	Botanica Consulting (2010b)
<i>Hydrocotyle corynophora</i>	P1	8.7 km E	In open annual herbfield surrounded by open eucalypt woodland. Red clay loam soil adjacent to creek bed.		
<i>Isopogon robustus</i>	T (CR EPBC Act; BC Act)	1.8 km S	Very open shrubland, associated vegetation includes <i>Alyxia buxifolia</i> , <i>Hakea pendens</i> , <i>Leucopogon</i> sp. Parker Range (F.H. & M.P. Mollemans 2860), and <i>Melaleuca uncinata</i> . Skeletal grey sandy loam, laterite. Ridges.	✓	✓
<i>Lepidium genistoides</i>	P3	8.3 km E	Sandy loam.		
<i>Lepidium merrallii</i>	P2	3.5 km E	Clay loam.		
<i>Lepidosperma ferricola</i>	P3	9.4 km NE	Scrub of <i>Allocasuarina acutivalvis</i> ssp. <i>acutivalvis</i> , <i>Calycopeplus paucifolius</i> , <i>Jacksonia jackson</i> , <i>Hibbertia exasperata</i> , <i>Melaleuca leiocarpa</i> and <i>Allocasuarina eriochlamys</i> . Sometimes recorded with emergent <i>Eucalyptus</i> sp. Well-drained stony loam, silty clay, banded ironstone. On rocky ledges, scree slopes, crevices and ravines.		
<i>Lepidosperma</i> sp. Mt Caudan (N. Gibson & M. Lyons 2081)	P1	2.3 km SE	<i>Eucalyptus capillosa</i> subsp. <i>polyclada</i> low forest over <i>Melaleuca uncinata</i> . Orange -brown sandy loam, with ironstone gravel, gentle slopes.	✓	✓
<i>Lepidosperma</i> sp. Parker Range (N. Gibson & M. Lyons 2094)	P1	0.5 km SE	Brown-orange clay loam over granite. Undulating broad subdued rocky hills with banded ironstone formation outcropping.	✓	✓
<i>Leucopogon</i> sp. Yellowdine (M. Hislop & F. Hort MH 3194)	P1	In study area	In open tall shrubland of <i>Allocasuarina spinosissima</i> , <i>Allocasuarina campestris</i> and <i>Grevillea didymobotrya</i> subsp. <i>didymobotrya</i> over open sedge of <i>Ecdeiocolea monostachya</i> and <i>Melaleuca cordata</i> over open hummock grassland and rushland of <i>Triodia rigidissima</i> , <i>Lepidobolus preissianus</i> subsp. <i>volubilis</i> and <i>Borya constricta</i> . Yellow-orange sandplain, laterite, sandy loam soil.		
<i>Leucopogon validus</i>	P1	1.8 km SE	In open heath of <i>Melaleuca leiocarpa</i> , <i>Hakea pendens</i> , <i>Callitris canescens</i> . Dry, brown, rocky sandy loam, brown-orange sandy clay, gravel, ironstone, sandstone. Low ranges, on and around exposed breakaways.		
<i>Lissanthe scabra</i>	P2	In study area	Associated with open <i>Eucalyptus salubris</i> woodland over sparse shrubland of <i>Alyxia buxifolia</i> , <i>Melaleuca leiocarpa</i> , <i>Allocasuarina acutivalvis</i> subsp. <i>acutivalvis</i> and <i>Acacia andrewsii</i> . Dry, white to orange-brown clay, sandy gravel loams, granite. Breakaways, uplands.		

Baseline flora, vegetation and fauna surveys for the Parker Range Haul Road Project
Prepared for Mineral Resources Ltd

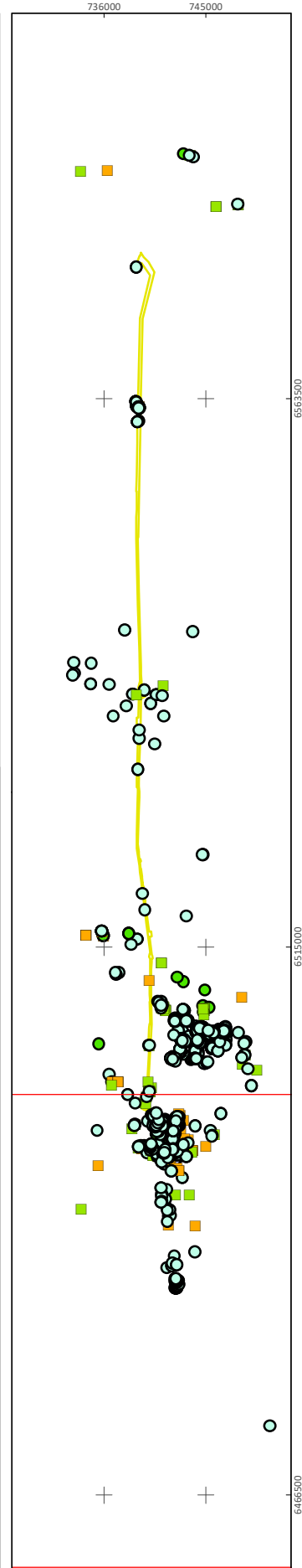
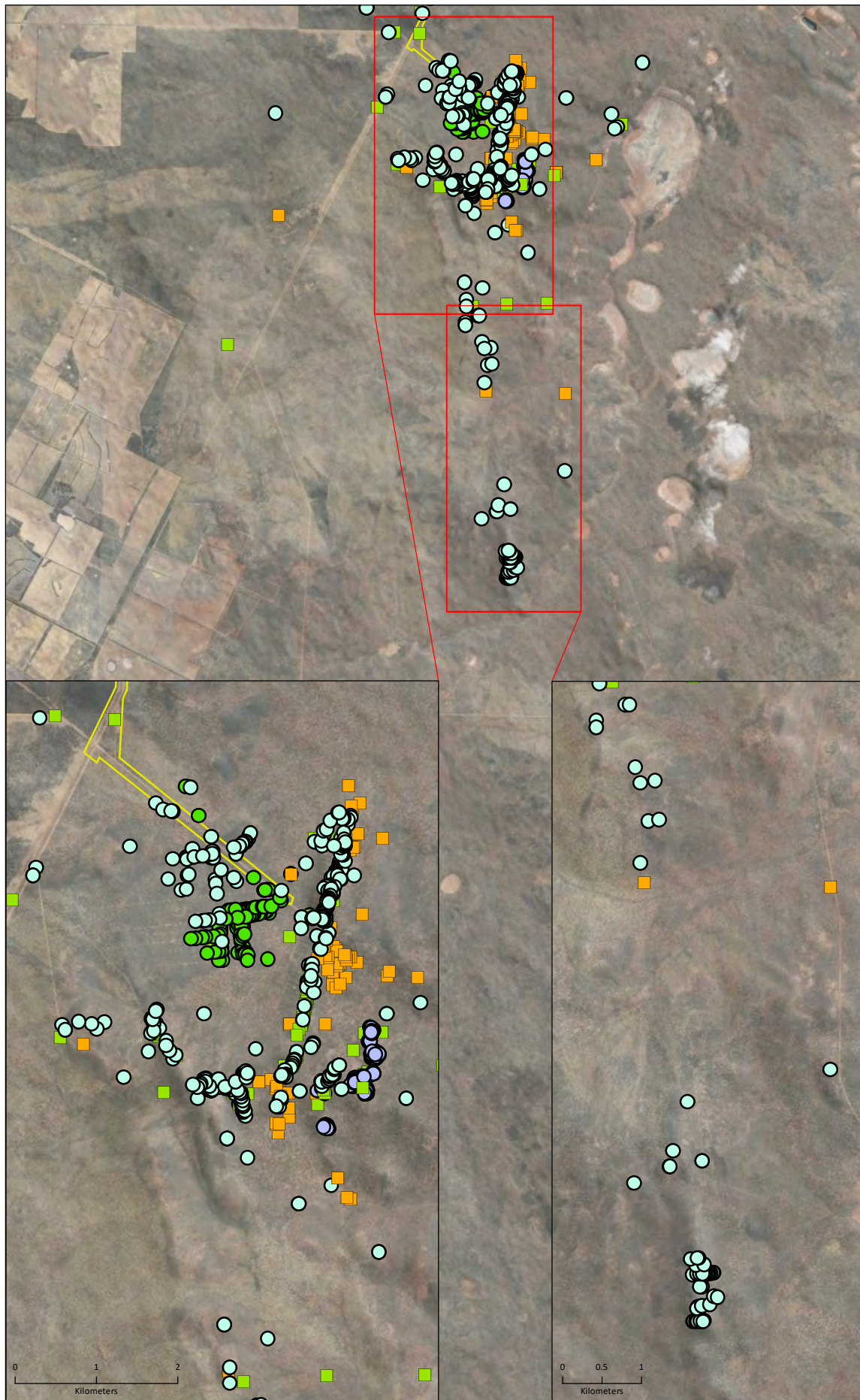
Species	Status	Proximity to study area	Habitat ¹	Phoenix (2020a, c, d, e) ²	Botanica Consulting (2010b)
<i>Melaleuca grieviana</i>	P1	5.8 km S	In mixed <i>Eucalyptus</i> sp. open mallee over <i>Melaleuca eleuterostachya</i> tall open shrubland over <i>M. lateriflora</i> , <i>Daviesia benthammi</i> and <i>Acacia hemiteles</i> . Well-drained orange-brown loam, brown clay. Plains, gentle slopes, edge of crop paddocks.		
<i>Microcorys</i> sp. Forrestania (V. English 2004)	P4	4.7 km E	In open mallee shrublands of mixed <i>Eucalyptus</i> sp., over open shrublands of <i>Grevillea oncogyne</i> and <i>Melaleuca teuthidoides</i> . Yellow sandy clay or red-brown clay. Open woodland or cleared areas.	✓	
<i>Microcorys</i> sp. nov. (GBW 22/11/2019).	New species	In study area	Shrublands and mallee woodlands of low hill slopes and plains in yellow/orange sandy clay/sandy loam soil, occasionally with ferrous ironstone (Phoenix 2020e).	✓	
<i>Microseris walteri</i>	P3	9.2 km E	<i>Halosarcia (Tecticornia)</i> succulent low shrubland. Dunes, brown clay, along edge of salt lake.		
<i>Millotia newbeyi</i>	P1	4.6 km E	In open <i>Eucalyptus</i> woodlands. Red/brown loam, red clay. Undulating plains.		
<i>Notisia intonsa</i>	P3	5.4 km E	Open <i>Eucalyptus</i> woodlands. Often associated with <i>E. salubris</i> , <i>E. transcidentalis</i> , <i>Atriplex</i> sp. And <i>Olearia muelleri</i> . Floodplain, plain, Ironstone and quartz gravel. Red-orange clayey sand.		
<i>Prostanthera nanophylla</i>	P3	1.2 km W	Mallee, <i>Acacia</i> and <i>Grevillea</i> scrub. Yellow sand over laterite, rocky loam. Sandplains.		
<i>Rinzia medifila</i>	P1	2.7 km SE	In <i>Eucalyptus salubris</i> , <i>E. transcidentalis</i> open woodland over <i>Melaleuca pauperiflora</i> and <i>Beyeria breviflora</i> open heath. Yellow sandy loam, with ironstone gravel, on a gentle mid slope.		✓
<i>Rinzia torquata</i> (Necklace Rinzia)	P3	0.2 km SE	Associated with <i>Acacia</i> sp. and <i>Eucalyptus</i> mallee open scrub over <i>Leptospermum</i> sp., <i>Thryptomene kochii</i> high shrubland over <i>Euryomyrtus maidenii</i> low open shrubland. Yellow sand over lateritic gravel.		
<i>Stenanthemum bremerense</i>	P4	1.7 km W	In low woodlands or mallee heath. Orange-brown sandy loam, orange-red gravelly loam, skeletal red loam, laterite, ironstone. Top or sides of outcrops and breakaways.		
<i>Stylidium choreanthum</i>	P3	4.2 km W	White/yellow or red sand. Plains.		
<i>Verticordia mitodes</i>	P3	1.1 km W	Yellow sand. Undulating plains.		
<i>Verticordia multiflora</i> subsp. <i>solox</i>	P2	0.2 km W	Associated with <i>Allocasuarina campestris</i> , <i>Acacia assimilis</i> , <i>Calothamnus gilesii</i> shrubland over <i>Hibbertia eatoniae</i> , <i>Baeckea crispiflora</i> low shrubland over <i>Amphipogon carcinus</i> very open grassland. Yellow sand over gravel, sand over granite.		


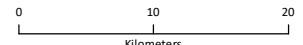
**Baseline flora, vegetation and fauna surveys for the Parker Range Haul Road Project
Prepared for Mineral Resources Ltd**

Species	Status	Proximity to study area	Habitat ¹	Phoenix (2020a, c, d, e) ²	Botanica Consulting (2010b)
<i>Verticordia pulchella</i>	P2	7.8 km N	Associated with <i>Allocasuarina campestris</i> , <i>Acacia</i> sp., <i>Leptospermum</i> sp., <i>Calytrix</i> sp. and <i>Borya</i> sp. Sandy soils over granite. Massive granite areas.		
<i>Verticordia stenopetala</i>	P3	1.9 km W	In shrub heath, and sedge. Associated species include <i>Melaleuca hamata</i> , <i>M. johnsonii</i> , <i>M. eleuterostachya</i> , <i>M. tuberculata</i> , <i>Allocasuarina corniculata</i> , <i>Thryptomene kochii</i> , <i>Hibbertia rostellata</i> and <i>Lepidosperma</i> sp. Yellow sand, sometimes with gravel. Undulating plains.		
<i>Westringia acifolia</i>	P1	In study area	Open heath. Mallee woodlands of low hill slopes in yellow, sandy clay/sandy loam soil (Phoenix 2020e).	✓	

¹Habitat descriptions from Florabase (WA Herbarium 2020), unless stated otherwise. ²One or more of these surveys.

³This species may currently be subject to taxonomic review



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

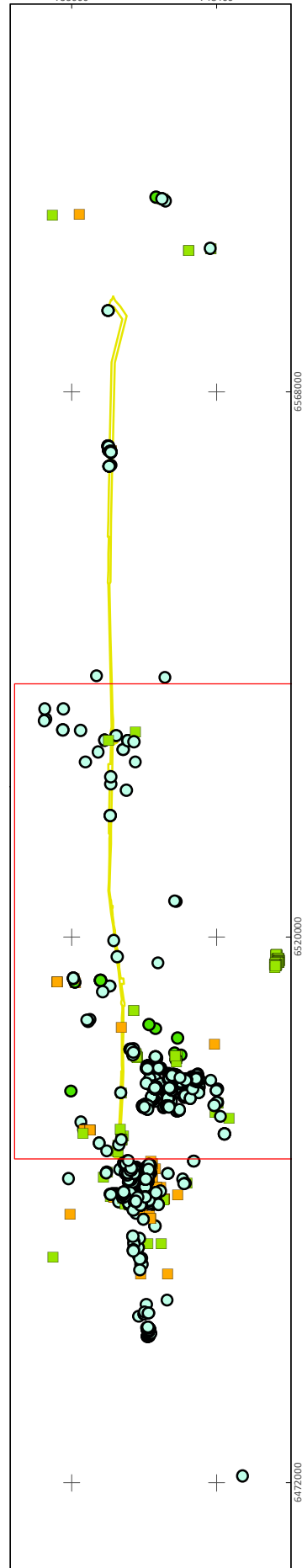
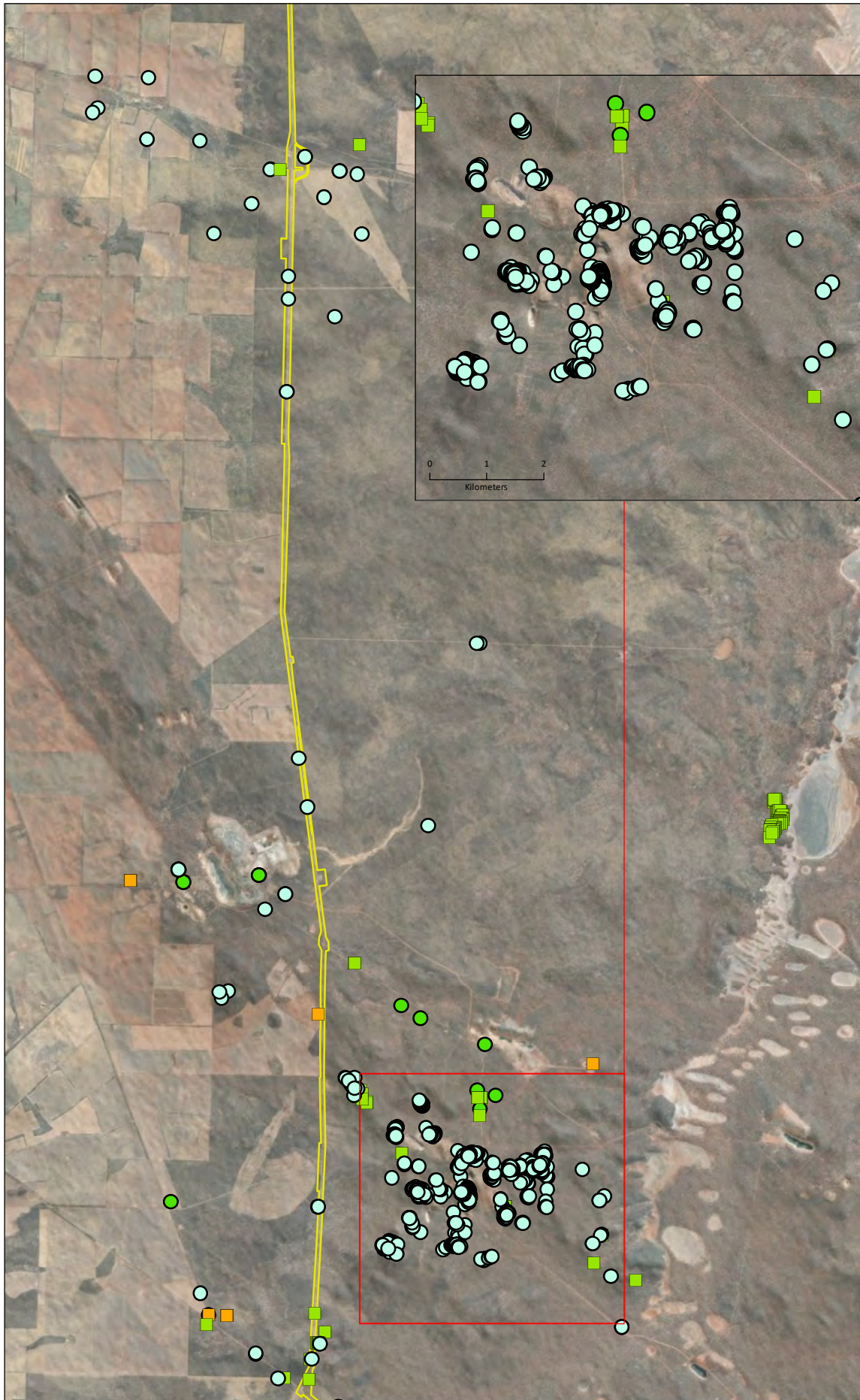
-  Study area
- Status**
-  P1
-  P2
-  P3
-  P4
-  Threatened

Figure 5-1a
Desktop records of significant flora



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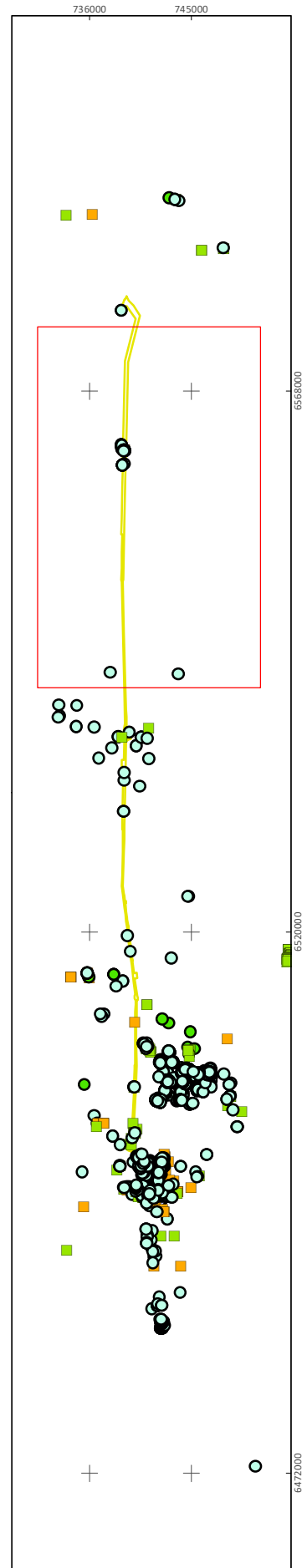
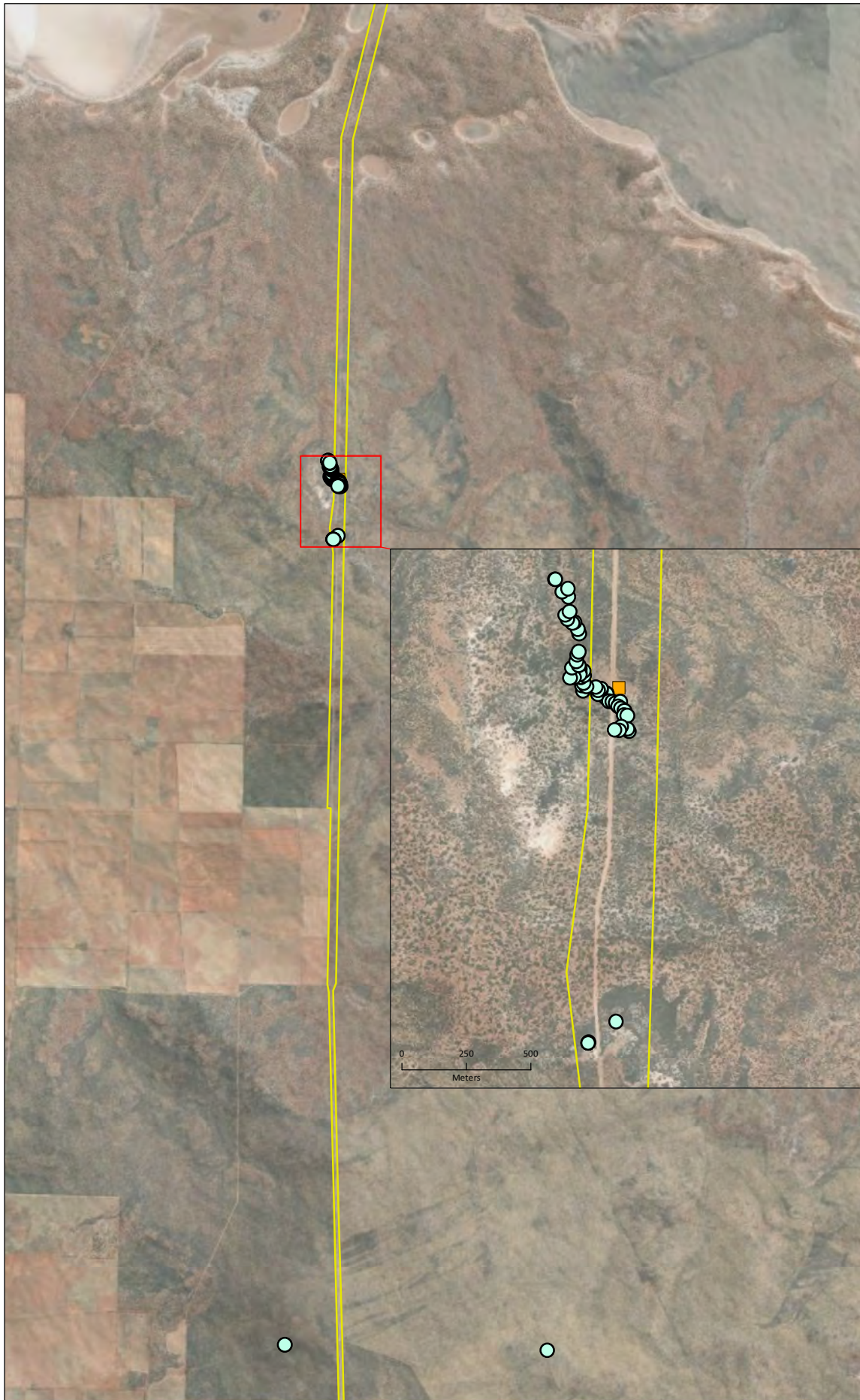



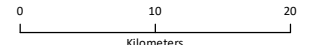
Mineral Resources Ltd Parker Range Iron Ore Project Haul Road	
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Drawn by	IN
Map author	KC
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- Study area
- Status**
- P1
- P2
- P3
- P4
- Threatened

Figure 5-1b
Desktop records of significant flora

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

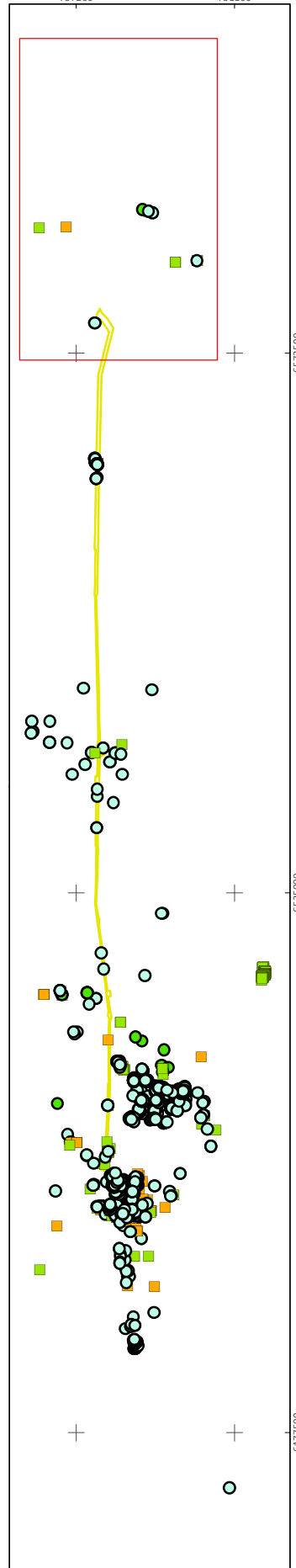
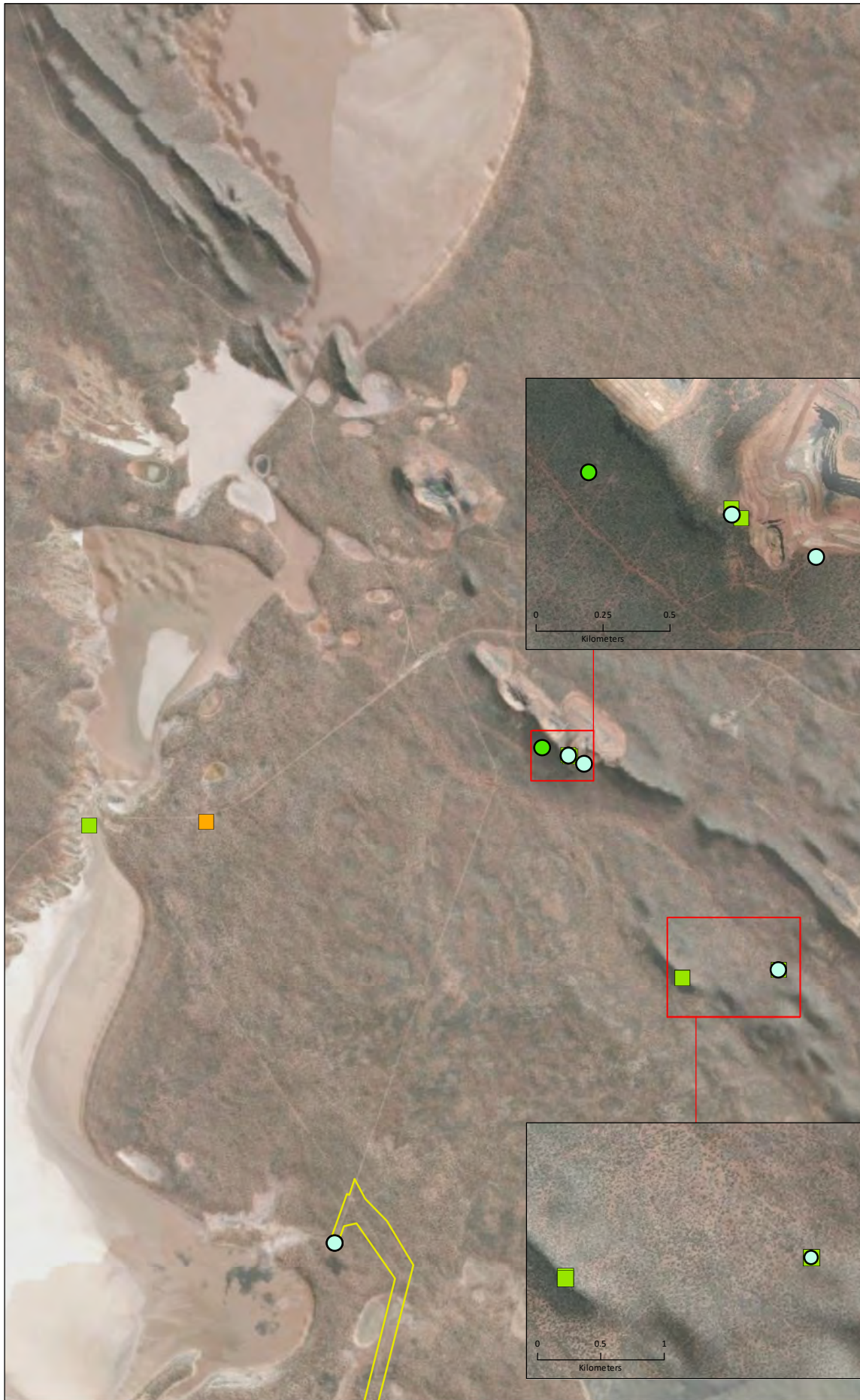
-  Study area
- Status**
-  P1
-  P2
-  P3
-  P4
-  Threatened


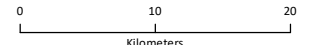
Figure 5-1c

Desktop records of significant flora



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

-  Study area
- Status**
-  P1
-  P2
-  P3
-  P4
-  Threatened

Figure 5-1d

Desktop records of significant flora



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5.1.1.3 Introduced flora

The desktop review identified 18 records introduced species within the desktop search extent, of which one, **Moraea miniata* is a Declared Pest (Appendix 5). No WoNS were identified in the desktop review.

5.1.1.4 Vegetation associations

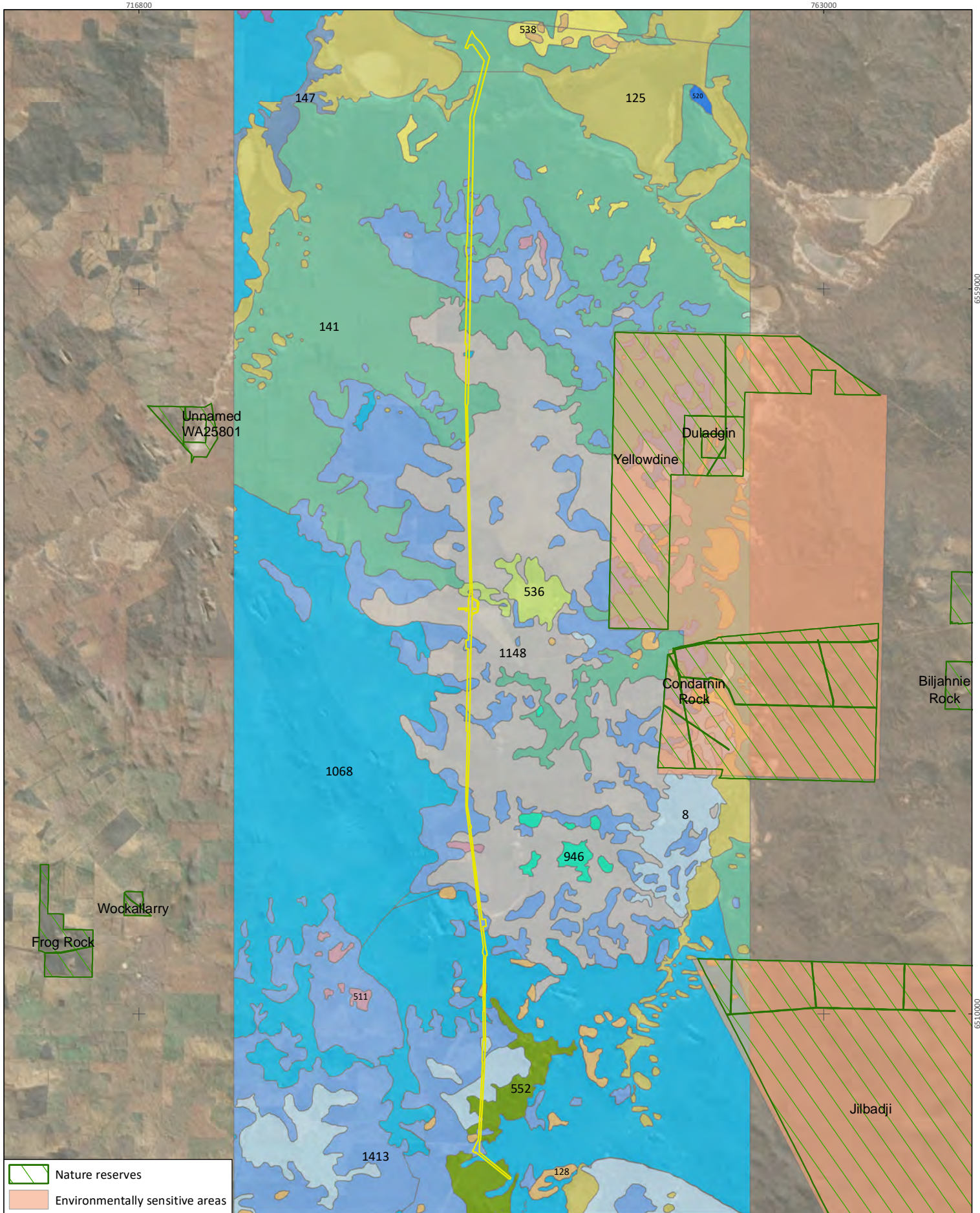
Regional scale vegetation mapping by Shepherd *et al.* (2002) mapped nine vegetation associations in the study area (Table 5-2; Figure 5-2). Vegetation association 511 occupies the largest portion of the study area (36.8%), followed by association 141 (28.6%) and association 1148 (20.2%). At the statewide scale and within the Coolgardie bioregion, all the associations have over 50% of original extent remaining (Table 5-2) and are therefore assigned the status of least concern (see section 2.2.4). Within the Avon Wheatbelt bioregion however, several of the associations have less than 50% remaining (Table 5-2) and are Vulnerable (10-30% remaining) or Depleted (>30-50% remaining).

Several associations are poorly represented in DBCA managed lands (<10%), particularly at the bioregional scale (Table 5-2).

Table 5-2 Statewide extent of Pre-European vegetation associations present in the study area (Government of Western Australia 2019)

Veg. assoc.	Description	Pre-European extent (ha)			Current extent (ha)			Remaining (%) ¹			Current extent in DBCA lands (%)			% of study area
		WA	AVW ²	COO ³	WA	AVW ²	COO ³	WA	AVW ₂	COO ³	WA	AVW ₂	COO ³	
8	Medium woodland; salmon gum & gimlet	694,638.1	356,571.8	280,248.3	346,425.8	50,340.3	275,589.1	49.9	14.1	98.3	13.6	8.7	9.67	3.6
128	Bare areas; rock outcrops	329,836.2	41,967.2	184,549.9	288,813.5	22,998.9	183,891.2	87.6	54.8	99.6	24.0	19.0	18.9	6.2
141	Medium woodland; York gum, salmon gum & gimlet	1,158,760.3	250,615.0	883,085.7	960,755.6	77,320.4	858,525.1	82.9	30.9	97.2	42.5	1.5	47.4	28.6
511	Medium woodland; salmon gum & morrel	700,692.6	96,357.2	464,423.6	520,615.3	17,931.6	435,177.2	74.3	18.6	93.7	20.2	16.7	20.6	36.8
536	Medium woodland; salmon gum & morrel	13,177.5	11,170.8	2,006.7	5,432.8	3,970.0	1,462.8	41.2	35.5	72.9	23.5	32.2	-	0.7
552	Shrublands; <i>Casuarina acutivalvus</i> & <i>Calothamnus</i> (also <i>Melaleuca</i>) thicket on greenstone hills	33,908.0	11,347.2	6,172.7	31,668.7	11,263.1	5,896.6	93.4	99.3	95.5	0.9	-	-	3.1
1068	Medium woodland; salmon gum, morrel, gimlet & <i>Eucalyptus sheathiana</i>	268,900.4	74,875.5	193,988.2	142,088.4	37,249.2	104,804.2	52.8	49.7	54.0	11.8	7.0	13.5	0.6
1148	Shrublands; scrub-heath in the Coolgardie Region	260,383.6	16.9	254,931.8	258,227.4	16.9	252,775.6	99.1	100.0	99.2	17.7	-	17.3	20.2
1413	Shrublands; <i>Acacia</i> , <i>Casuarina</i> & <i>Melaleuca</i> thicket	1,679,916.3	546,675.5	1,061,212.3	1,286,855.5	174,102.8	1,042,553.8	76.6	31.8	98.2	17.3	7.3	18.5	0.3

¹Red cells = Vulnerable community (10-30% remaining), yellow cells = Depleted community (>30-50% remaining). ²AVW = Avon Wheatbelt bioregion. ³COO = Coolgardie bioregion.



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Parker Range Iron Ore Project Haul Road

Project No 1292, 1293
 Date 22/01/2021
 Drawn by IN
 Map author KC

0 5 10
 Kilometers

1:330,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- Pre-european vegetation association**
 - 8: Medium woodland; salmon gum & gimlet
 - 125: Bare areas; salt lakes
 - 128: Bare areas; rock outcrops
 - 141: Medium woodland; York gum, salmon gum & gimlet
 - 147: Succulent steppe with scrub; acacia species over saltbush
 - 435: Shrublands; Acacia neurophylla, A. beauverdiana & A. resinomarginea thicket
 - 511: Medium woodland; salmon gum & morrel
 - 520: Shrublands; Acacia quadrimarginea thicket
 - 536: Medium woodland; morrell & rough fruited mallee (Eucalyptus corrugata)
 - 538: Shrublands; Acacia brachystachya scrub
 - 552: Shrublands; Casuarina acutivalvus & calothamnus (also melaluc) thicket on greenstone hills
 - 946: Medium woodland; wandoo
 - 1067: Medium woodland; salmon gum, morrel, gimlet & rough fruited mallee
 - 1068: Medium woodland; salmon gum, morrel, gimlet & Eucalyptus sheathiana
 - 1071: Succulent steppe with scrub; acacia species over saltbush & bluebush
 - 1148: Shrublands; scrub-heath in the Coolgardie Region
 - 1413: Shrublands; acacia, casuarina & melaleuca thicket

Figure 5-2
Regional vegetation associations, conservation reserves and environmentally sensitive areas

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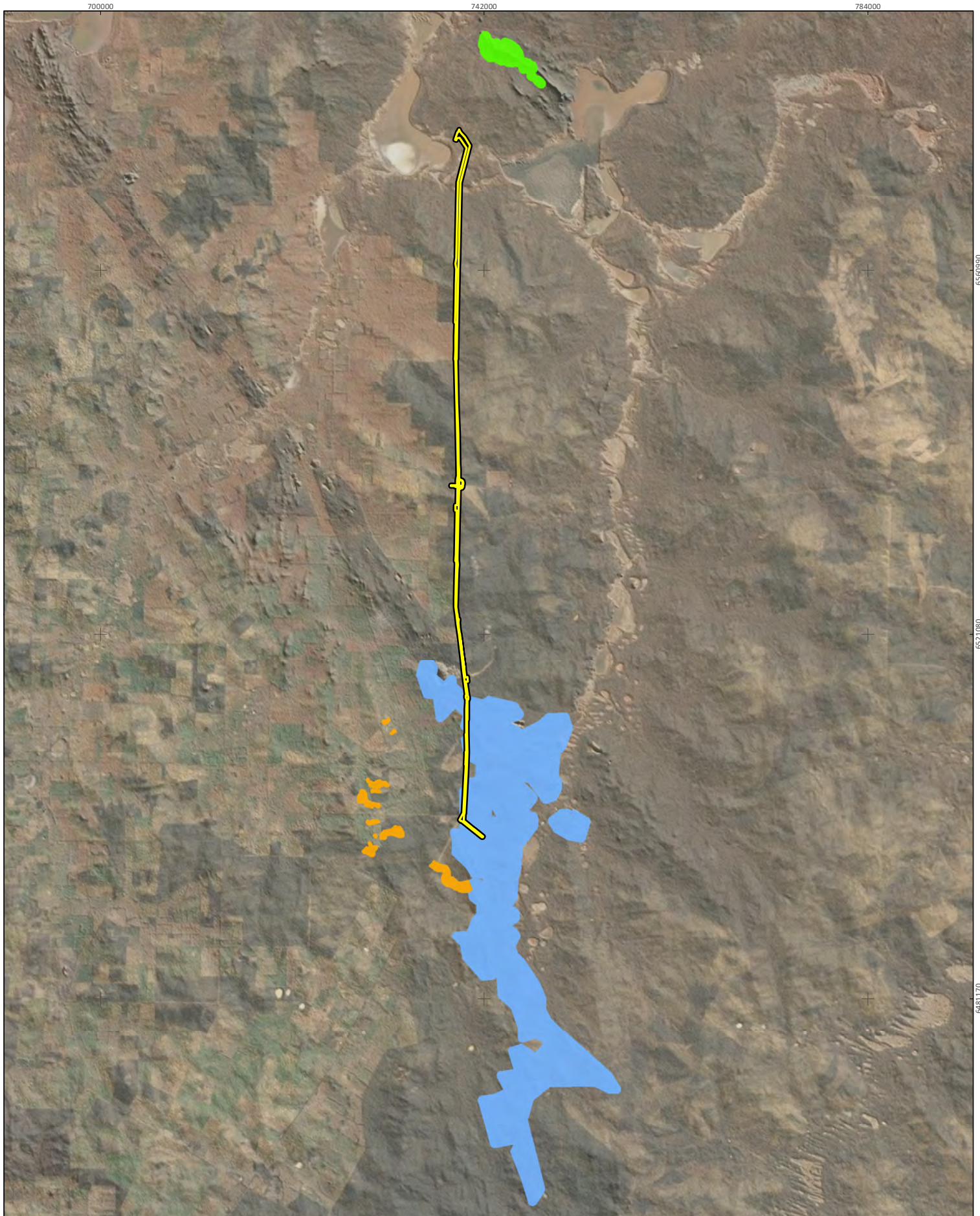
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5.1.1.5 Significant vegetation

The DBCA Threatened and Priority Ecological Communities database search identified the presence of no TECs and three PECs within the desktop search extent. One of the communities, the Plant assemblages of the Parker Range System intersects the study area (Figure 5-1; Table 5-3).

Table 5-3 TECs and PECs identified in the desktop review

Community name	Status	Proximity to study area	Description
Eucalypt woodlands of the Western Australian Wheatbelt	T (EN) EPBC Act P3 (WA)	Approx. 7 km W of southern part of study area	The community occurs in the IBRA Avon Wheatbelt 1 and 2 and Western Mallee subregions. It also includes outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt, that are off the Darling Range, and receive less than 600 mm mean annual rainfall. The structure of the ecological community is a woodland in which the minimum crown cover of the tree canopy in a mature woodland is 10%. The key dominant or co-dominant species of the tree canopy are species of <i>Eucalyptus</i> trees that typically have a single trunk. Native understorey is present but is of variable composition, being a combination of grasses, other herbs and shrubs (Department of the Environment 2016; Threatened Species Scientific Committee 2015). Threats: altered hydrology, grazing, altered fire regimes, vegetation clearing, exotic species, soil cultivation and fertilization (DBCA 2020b).
Koolyanobbing vegetation complex (banded ironstone formation)	P1	Approx. 8 km N	This community is associated with the Koolyanobbing Range located approximately 8 km north of the northern terminus of the study area. Values include Threatened and Priority flora and restricted vegetation units (Mineral Resources 2019). Threats: Subject to clearing for mining (DBCA 2020b).
Plant assemblages of the Parker Range System	P3	Within study area	The vegetation of the Parker Range system as originally described in Beard (1979) includes all the vegetation units of the range including: <i>Eucalyptus sheathiana</i> with <i>E. transcontinentalis</i> and/or <i>E. eremophila</i> woodland on sandy soils at the base of ridges and low rises; <i>E. longicornis</i> with <i>E. corrugata</i> and <i>E. salubris</i> or <i>E. myridena</i> woodland on broad flats; <i>E. salmonophloia</i> and <i>E. salubris</i> woodland on broad flats; <i>Allocasuarina acutivalvis</i> and <i>A. corniculata</i> on deeper sandy soils of lateritic ridges; <i>E. capillosa</i> subsp. <i>polyclada</i> and/or <i>E. loxophleba</i> over <i>Hakea pendens</i> thicket on skeletal soils on ridges (laterites, breakaways and massive gossanous caps); and <i>Callitris glaucophylla</i> low open woodland on massive greenstone ridges (vegetation units as described in Gibson and Lyons 1998). Threats: clearing for exploration and mining (DBCA 2020b).



Mineral Resources Ltd
 Parker Range Iron Ore Project Haul Road

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Map author	KC

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Kilometers

1:536,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- TEC and PEC**
- Eucalypt Woodlands of the Western Australian Wheatbelt Critically Endangered (EPBC Act), Priority 3 (DBCA)
- Koolyanobbing vegetation complex (banded ironstone formation), Priority 1
- Plant assemblages of the Parker Range System, Priority 3

Figure 5-3
Desktop records of Threatened and Priority Ecological Communities



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5.1.2 Terrestrial fauna

5.1.2.1 Vertebrate fauna

The desktop review identified records of 265 vertebrate taxa within the desktop search extent. The list comprised four frogs, 71 reptiles, 149 birds (including two naturalised species, and seven with no positive records but identified in the Protected Matters search with notation ‘Species or species habitat may occur within area’) and 41 mammals (including 11 introduced). Two additional frogs and six reptiles were considered potentially present based on inspection of broader distribution in NatureMap or field guides, increasing the total to 273 (Table 5-4; Appendix 6). One previous fauna survey included a site within the study area, where four reptile, 14 bird and four mammal species were recorded (Ecoscape 2012).

Twenty-three significant vertebrate species were identified in the desktop review, comprising 11 species listed as Threatened, Conservation Dependent or Specially Protected under the EPBC Act and/or BC Act (Table 5-5). Seven avifauna species are listed as Migratory under the EPBC Act and BC Act, and a further five species are listed as Priority by DBCA (Table 5-5). One significant vertebrate species, Malleefowl, has previously been recorded opportunistically within the study area (DBCA 2019b) (Figure 5-4).

Two mammal taxa identified in the desktop are listed as extinct and therefore not conservation significant (mainland subspecies of Boodie, and Lesser Stick-nest Rat), but former presence is potentially identifiable during surveys from burrows or nests.

Table 5-4 Summary of terrestrial fauna desktop results

Class	Native	Introduced	Total
Amphibians	6	0	6
Reptiles	77	0	77
Birds	147	2	149
Mammals	30	11	41
Total	260	13	273

Table 5-5 Significant vertebrate fauna identified in the desktop review

Species	Status	Proximity to study area	Habitat and distribution
Reptiles (2)			
<i>Aspidites ramsayi</i> Woma (southwest population)	P1 (DBCA)	3.9 km W	Occurs in areas of sandplain with myrtaceous heath vegetation; southwest population has declined and is locally extinct in most of its former range (Storr <i>et al.</i> 2002).
<i>Paroplocephalus atriceps</i> Lake Cronin Snake	P3 (DBCA)	24.3 km S	Occurs in semi-arid open eucalypt woodland, often associated with granite outcrop; partly arboreal and saxicoline (Bush 2017). Known from Lake Cronin and other freshwater lakes and granite outcrops in the eastern Mallee and southern Coolgardie bioregions.
Birds (13)			
<i>Leipoa ocellata</i> Malleefowl	VU (EPBC & BC Acts)	within study area	Malleefowl occur mainly in scrubs and thickets of mallee (<i>Eucalyptus</i> spp.), boree (<i>Melaleuca lanceolata</i>) and bowgada (<i>Acacia linophylla</i>), and other dense litter-forming shrublands including mulga shrublands (Johnstone and Storr, 2004). Nest mounds require sandy soil as well as abundant litter (Benshemesh 2007).
<i>Apus pacificus</i> Fork-tailed Swift	Mig. (EPBC & BC Acts)	*	Widespread migratory species that does not breed in Australia, typically present from October to April. It occurs in a wide range of dry or open habitats across most of WA (DoEE 2020b).
<i>Falco hypoleucos</i> Grey Falcon	VU (EPBC & BC Acts)	*	Occurs in a wide variety of arid habitats including open woodlands and open <i>Acacia</i> shrubland, hummock and tussock grasslands and low shrublands, particularly where crossed by tree-lined water courses (Threatened Species Scientific Committee 2020). Range has contracted northwards in WA, now rarely occurs south of 26°S (Johnstone & Storr 1998).
<i>Falco peregrinus</i> Peregrine Falcon	OS (BC Act)	11.1 km NE	Preferred habitat includes cliffs and wooded watercourses. Nesting occurs mainly on cliff ledges, granite outcrops, quarries and in trees with old raven or Wedge-tailed Eagle nests (Johnstone & Storr 1998).
<i>Thinornis rubricollis</i> Hooded Plover	P4 (DBCA)	*	Predominantly coastal, non-migratory species endemic to Australia; occurs on sandy beaches of all southern States, and the Western Australian population winters on inland salt lakes up to 250 km from the coast (Birdlife Australia N.D.).
<i>Actitis hypoleucos</i> Common Sandpiper	Mig. (EPBC & BC Acts)	*	Coastal and some inland wetlands including small ponds, large inlets, mudflats where they forage on the shore usually close to the vegetation (DoEE 2020b).
<i>Calidris acuminata</i> Sharp-tailed Sandpiper	Mig. (EPBC & BC Acts)	*	Occurs on saline wetlands such as coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (DoEE 2020b).

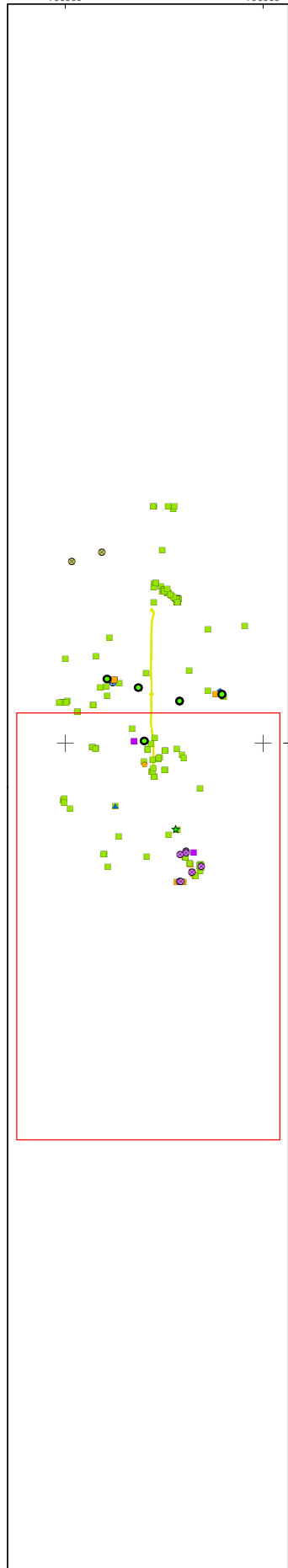
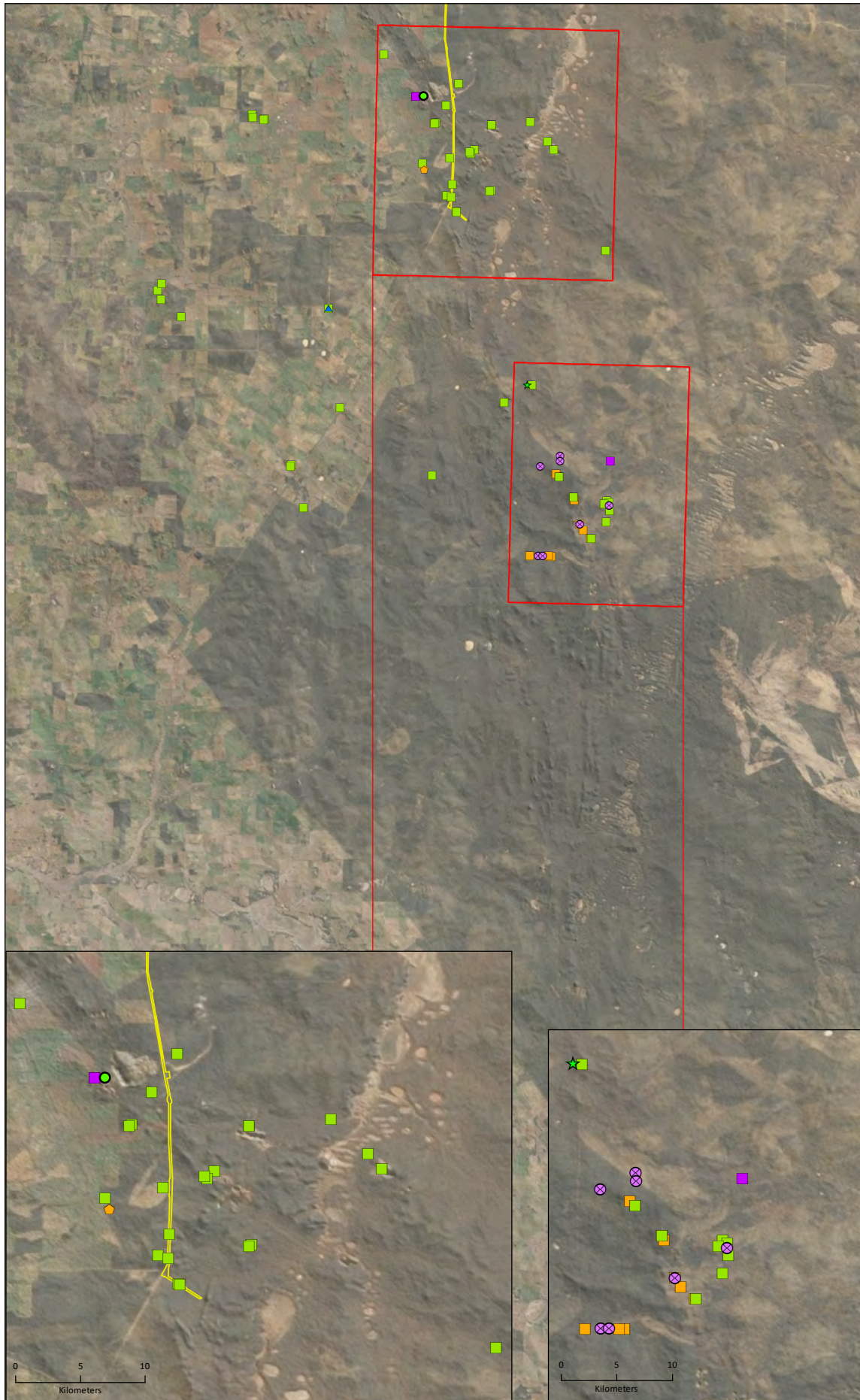
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Species	Status	Proximity to study area	Habitat and distribution
<i>Calidris ferruginea</i> Curlew Sandpiper	CR, Mig. (EPBC & BC Acts)	*	Mainly occur on intertidal mudflats in sheltered coastal areas, also around non-tidal swamps, lakes and lagoons near the coast. Less often inland around ephemeral and permanent lakes and waterholes, usually with bare edges of mud or sand (DoEE 2020b).
<i>Calidris melanotos</i> Pectoral Sandpiper	Mig. (EPBC & BC Acts)	*	Occurs on shallow fresh to saline wetlands, usually coastal or near-coastal but occasionally further inland. Prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation (DoEE 2020b).
<i>Tringa nebularia</i> Common Greenshank	Mig. (EPBC & BC Acts)	17.6 km W	Mostly on the coast but sometimes inland; uses permanent and ephemeral terrestrial wetlands, including rivers and creeks (DoEE 2020b).
<i>Pezoporus occidentalis</i> Night Parrot	EN (EPBC & BC Acts)	*	Rare and cryptic species most frequently associated with <i>Triodia</i> hummock grass and chenopod shrubs (samphire, saltbush etc), particularly where these occur together as a mosaic or along a boundary (ecotone). Suitability of habitat is thought to depend on particular stages of regeneration after fire (DoEE 2018). All confirmed records are hundreds of km away (DBCA 2020a).
<i>Platycercus icterotis xanthogenys</i> Western Rosella (inland)	P4 (DBCA)	<1 km SE	Eucalypt and sheoak woodlands and scrubs, especially those containing wandoo (<i>E. wandoo</i>), flooded gum, salmon gum (<i>E. salmonophloia</i>), tall mallee and rock sheoak (<i>Allocasuarina huegeliana</i>) (Johnstone & Storr 1998). Rarely recorded north of Great Eastern Highway (DBCA 2020a; KLA 2011).
<i>Motacilla cinerea</i> Grey Wagtail	Mig. (EPBC & BC Acts)	*	A rare vagrant, summer visitor mostly to northern WA (Nov-April), utilises a wide variety of habitats, mostly associated with running water and shorelines (DoEE 2020b).
Mammals (8)			
<i>Dasyurus geoffroii</i> Chuditch, Western Quoll	VU (EPBC & BC Acts)	5.7 km W	Formerly widespread in very diverse habitats, now mostly in Jarrah forest and woodland of the southwest, also heath and mallee habitats along the south coast; uses horizontal hollow logs or earth burrows as refugia and dens (DEC 2012b).
<i>Phascogale calura</i> Red-tailed Phascogale	EN (EPBC); CD (BC Act)	4.0 km W	Forest and woodland with tree hollows (mainly <i>Eucalyptus wandoo</i> and <i>Allocasuarina huegeliana</i>), sometimes mallee or heath; prefers long-unburnt habitat with continuous canopy (Menkhorst & Knight 2011; Short <i>et al.</i> 2011).
<i>Myrmecobius fasciatus</i> Numbat	EN (EPBC & BC Acts)	13.1 km E	Previously occurred in a wide variety of habitat types including eucalypt forest and woodland, and current populations (mostly reintroduced) occur in upland Jarrah forest, open eucalypt woodland, banksia woodland and tall closed shrubland. Habitats usually have abundant soil termites, hollow logs and branches for shelter (DEC 2012c).

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Species	Status	Proximity to study area	Habitat and distribution
<i>Macrotis lagotis</i> Bilby	VU (EPBC & BC Acts)	3.9 km W	Previously widespread, now restricted to parts of northern and central Australia; occupies a variety of habitats with uncluttered ground-level vegetation, including cracking clays, desert sandplains, and dune fields with hummock grassland and Acacia shrubland (DEC 2012a).
<i>Bettongia lesueur graii</i> Boodie, Burrowing Bettong	EX (EPBC & BC Acts)	~10 km NE	This previously widespread subspecies occupied habitats from open woodland to sandridge desert but is now extinct, and the species does not occur in mainland Australia except for reintroduced populations within fenced reserves (DoEE 2020b).
<i>Notamacropus irma</i> Western Brush Wallaby	P4 (DBCA)	35.2 km S	Grazing species, occurs in open forest or woodland with low grasses and scrubby thickets, and also found in some areas of mallee and heathland (DEC 2012e).
<i>Petrogale lateralis lateralis</i> Black-flanked Rock-wallaby	EN (EPBC & BC Acts)	21.7 km SW (uncertain sighting)	Southwestern populations are either relictual or reintroduced to granite outcrops in the wheatbelt (mostly near Kellerberrin). Habitat depends on availability of suitable refuge (cliff, rock-pile, talus or escarpment) close to sufficient vegetation to provide food (DBCA 2017; Pearson 2013).
<i>Leporillus</i> sp. Stick-nest Rat species (<i>L. apicalis</i> Lesser or <i>L. conditor</i> Greater)	EX (EPBC & BC Acts); VU (EPBC Act)/CD (BC Act)	~10 km NE	Totally extinct (<i>L. apicalis</i>), or extinct on the mainland except where reintroduced in fenced reserves (<i>L. conditor</i>); both species live in semi-arid shrublands and construct large nests of sticks and rocks cemented with urine in dense vegetation, or in rock crevices or overhangs where they may persist for many decades after disuse (DoEE 2020b).

* EPBC Protected Matters Search does not return species record locations and may include instances where suitable habitat may occur but the species has not necessarily been observed.



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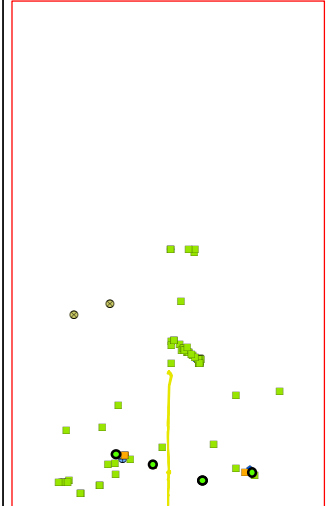
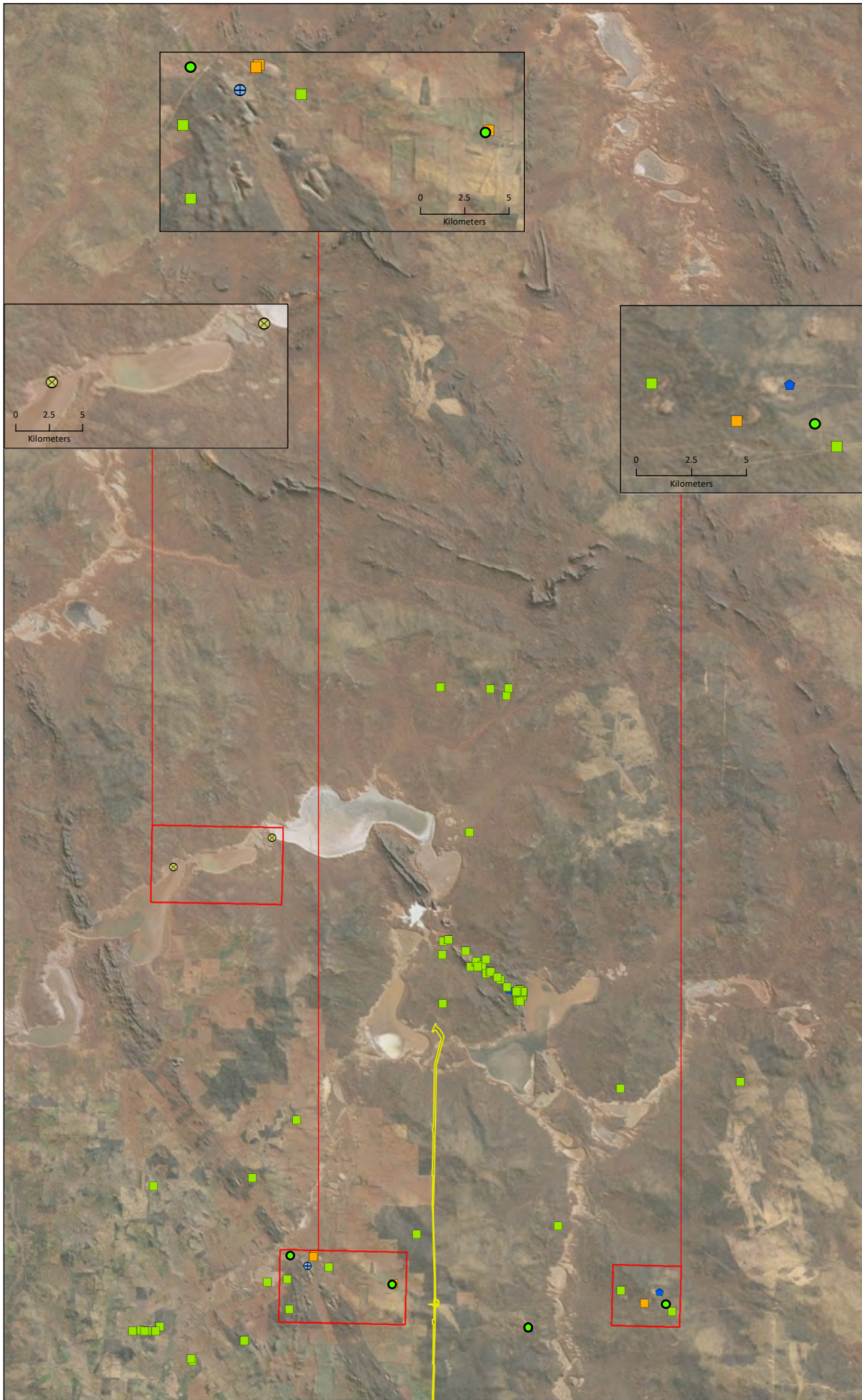
1:2,900,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- Significant fauna**
- ▲ *Petrogale lateralis lateralis*, EN
- *Dasyurus geoffroyi*, VU
- *Leipoa ocellata*, VU
- *Macrotis lagotis*, VU
- ◆ *Phascogale calura*, CD
- *Aspidites ramsayi* Woma (southwest population), P1
- ★ *Paraplocephalus atriceps*, P3
- ⊗ *Notamacropus irma*, P4

Figure 5-4a
Desktop records of significant vertebrate fauna



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1:2,900,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- Significant fauna**
- ▲ *Myrmecobius fasciatus*, EN
- *Dasyurus geoffroi*, VU
- *Leipoa ocellata*, VU
- ◆ *Falco peregrinus*, OS
- ⊕ *Tringa nebularia*, IA
- *Aspidites ramsayi* Woma (southwest population), P1
- ⊗ *Thinornis rubricollis*, P4

Figure 5-4b
Desktop records of significant vertebrate fauna



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5.1.2.2 Invertebrate fauna

The desktop review identified records of four Priority-listed invertebrates, eight confirmed SRE taxa and 22 potential SRE taxa from within the SRE desktop search area (Table 5-6; Figure 5-5). Of the confirmed or potential SRE taxa, seven are named species, all recently described millipedes (Car & Harvey 2014; Edward & Harvey 2010). The remaining potential SRE and unknown taxa are named only to morphospecies codes as applied by the WA Museum or are not identified to confirmed species level (i.e. "sp." or "cf.").

A further 23 taxa of 'unknown' SRE status were identified; these are mainly records of 'indeterminate' ('sp. indet.', e.g. female or juvenile specimens) taxa from groups known to contain SRE species. Often these contained multiple records in the same taxon, which may represent new species or other species listed in the same genus where records exist (Table 5-6).

None of the desktop records are within the study area.

Several records of potential SREs from a WA Museum taxonomic report from Marvel Loch (Edward *et al.* 2009) were not returned in the WA Museum invertebrate database searches. These therefore are not considered current and have been excluded from the results.

Table 5-6 Priority and SRE invertebrate taxa identified in the desktop review

Higher taxon, family	Species	SRE category	Nearest record to study area	Habitat
Class Arachnida, subclass Araneae, infraorder Mygalomorphae (trapdoor spiders)				
Actinopodidae	<i>Missulena</i> 'sp. indet.'	Unknown	93 km S	Indet. Eucalypt woodland.
Anamidae	<i>Aname</i> 'MYG182'	Potential	72.7 km SW	No habitat description.
	<i>Aname</i> 'sp. indet. (juvenile) (sp. 1?)'	Unknown	9.5 km NE (N end)	Indet. Flagged as SRE by WAM, records >100 km apart but may not be same species. No habitat description.
	<i>Aname</i> 'sp. indet. (juvenile) (sp. 2?)'	Unknown	9.5 km NE (N end)	Indet. Flagged as SRE by WAM, records >100 km apart but may not be same species. No habitat description.
	<i>Aname</i> 'Trayning'	Potential	61.4 km W	Known from single location, Forrestania, 40.9 km NE. of Holt Rock, site FR06. No habitat description.
	<i>Aname</i> 'sp. indet.'	Unknown	52.8 km E	Indet. Mallee/heath, <i>Callitris</i> heath isolate, often no description.
	<i>Proshermacha</i> 'MYG429'	Potential	1.2 km NE (S end)	Known from 2 locations - Marvel Loch and Mt Caudan. Under log.
	<i>Teyl</i> 'large sp.'	Potential	76.8 km E	Only collected from Boorabin. No habitat description.
	<i>Teyl</i> 'marked angle door group'	Potential	1.2 km N of S end	Only collected from Mt Caudan. No habitat description.
	<i>Teyl</i> 'MYG012'	Potential	12.4 km W	Collected from Marvel Loch and Lake Cronin Under rock.
	<i>Teyl</i> 'MYG268'	Potential	95 km W	Only collected from Koonadgin. No habitat description.
	<i>Teyl</i> 'MYG457'	Potential	650 m E (S end)	Only collected from Mt Caudan. No habitat description.
<i>Teyl</i> 'MYG480'	Potential	1.2 km E (S end)	Only collected from Mt Caudan. No habitat description.	
Barychelidae	<i>Idiommata</i> 'sp. indet.'	Unknown	10.4 km W	Indet. Under <i>Triodia</i> dump in mallee woodland on yellowish sand. Under log.

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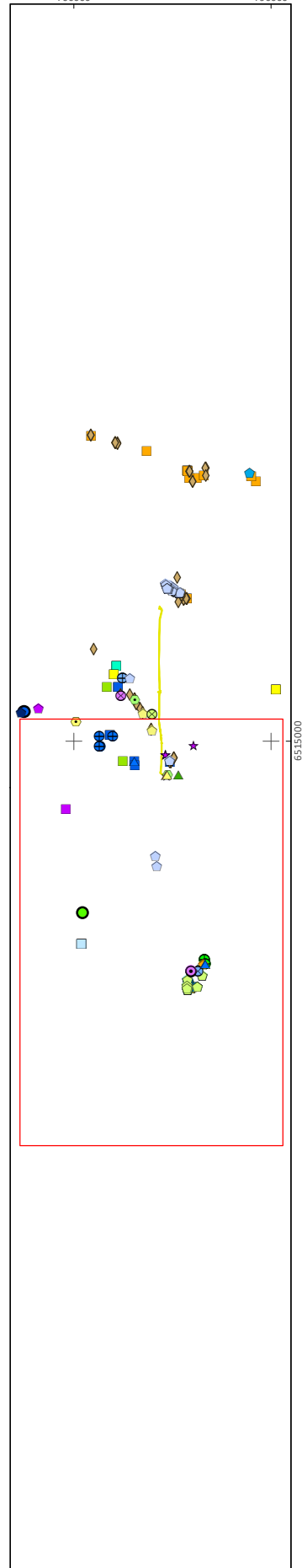
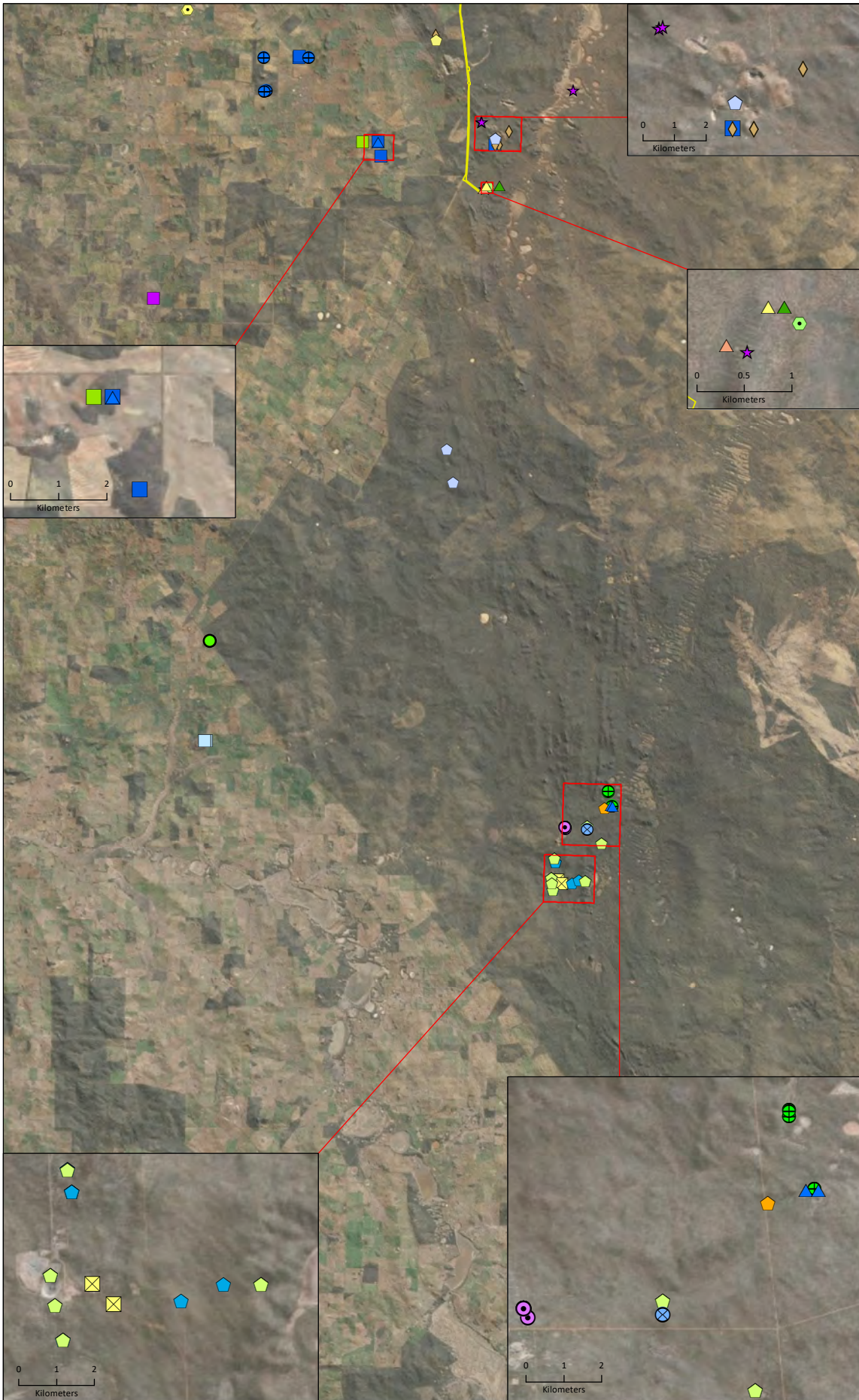
Higher taxon, family	Species	SRE category	Nearest record to study area	Habitat
	<i>Synothele</i> `forrestiana`	Potential	89.5 km S	Only known from Forrestania area. No habitat description.
	<i>Synothele</i> `new sp. 92`	Potential	3.1 km W	Only known from Marvel Loch area. No habitat description.
	<i>Synothele</i> `new sp. 93`	Potential	17.4 km W	Only known from Marvel Loch area. Under log.
	<i>Synothele</i> `sp. (female) (sp. 2)`	Unknown	10.9 km NE	Indet. No habitat description.
	<i>Synothele</i> `sp. indet. (juvenile) (sp. 2)`	Unknown	12.0 km NE (N end)	Indet. No habitat description.
	<i>Synothele</i> `sp. indet. (juvenile)`	Unknown	76.8 km E	Indet. Debris.
Halonoproctidae	<i>Conothele</i> `sp. indet. (female)`	Unknown	11.4 km W	Indet. No habitat description.
Idiopidae	<i>Idiosoma/ Eucyrtops</i> `sp. indet. (female)`	Potential	96.5 km S	Indet. No habitat description.
	<i>Eucyrtops</i> `sp. indet.`	Unknown	12.4 km W	Indet. No habitat description.
	<i>Gaius</i> `MYG063`	Potential	13.4 km W	Collected from Forrestania area. Known distribution < 10,000km ² . No habitat description.
	<i>Gaius</i> `sp. indet. (villosus or jonesae)`	Potential	16.8 km W	Collected from Southern Cross area. No habitat description.
	Idiopidae `Genus indet.`	Unknown		Indet. No habitat description.
	<i>Idiosoma</i> `bifida spp. Grp`	Potential	87.1 km E	Single record from Lake Cronin. Mallee/shrubs.
	<i>Idiosoma</i> `galeosomoides_sp_2`	Potential	55 km W	Single record from Noongar. No habitat description.
	<i>Idiosoma</i> `MYG064`	Potential	89.2 km S	Forrestania area. Many collections but restricted distribution. Open woodland.
	<i>Idiosoma</i> `MYG065`	Potential	89.2 km S	Forrestania area. Many collections but restricted distribution. No habitat description.
	<i>Idiosoma</i> `sp. indet. (juvenile) (sp. 2?)`	Unknown	10.9 km NE (N end)	Indet. No habitat description.
	<i>Idiosoma</i> `sp. near MYG064`	Potential	131 km SW	Lake Bryde Nature Reserve. No habitat description.
	<i>Idiosoma</i> `species A (Biota)`	Unknown	89.1 km S	Indet. No habitat description.
	<i>Idiosoma</i> `twig-lining race`	Potential	3.8 km W	From Marvel Loch. No habitat description.
	<i>Idiosoma (=Aganippe) castellum (Tree-stem Trapdoor Spider)</i>	P4 (not SRE)	3.7 km E	Flood-prone depressions and flats which support myrtaceous shrub communities, particularly Broombush (<i>Melaleuca unicata</i>) and Sheoaks (such as <i>Allocasuarina acutivalvis</i>) in sandy loam soils.

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Higher taxon, family	Species	SRE category	Nearest record to study area	Habitat
	<i>Idiosoma intermedium</i>	P3 (not SRE)	62.9 km W	Widespread but poorly defined distribution. Known range extends from Bodallin north to Billiburning Rock in the eastern. Wheatbelt, and east to near the Helena-Aurora Range, Mount Manning, and Koolyanobbing in the Coolgardie bioregion (Rix <i>et al.</i> 2018a). Open eucalypt woodland.
	<i>Idiosoma</i> 'sp. indet.'	Unknown	11 km NE	Indet. Mixed eucalypt woodland, <i>Melaleuca</i> thicket, <i>Eucalyptus</i> over <i>Melaleuca</i> & mixed shrub, often no description.
Class Arachnida, order Pseudoscorpiones (pseudoscorpions)				
Chernetidae	<i>Chernetidae</i> 'Genus indet.'	Unknown	1.8 km S (S end)	Indet. No habitat description.
Garypidae	<i>Synsphronus</i> 'sp. indet.'	Unknown	12.3 km E	Indet. Under granite on outcrop.
Olpidae	Olpidae 'Genus indet.'	Unknown	1.8 km S	Indet. No habitat description.
Class Arachnida, order Scorpiones (scorpions)				
Bothriuridae	<i>Cercophonius</i> 'sp. indet.'	Unknown	17.6 km W	Indet. Under bark, rough bark.
Buthidae	<i>Isometroides</i> 'sp.'	Unknown	3.8 km W	Indet. Tall eucalypt woodland, sparse <i>Melaleuca</i> & bluebush.
	<i>Lychas</i> 'sp.'	Unknown	3.8 km E	Indet. No habitat description.
Urodacidae	<i>Urodacus</i> 'sp. nov. (GBW 22/11/2019).'	Unknown	16.0 km E	Indet. No habitat description.
	<i>Urodacus</i> 'woodwardii?'	Potential	89.1 km S	Collected from Forrestania, Edwards Find, Dragon Rocks NR. One questionable record from Perth a likely mis-ID. No habitat description.
	<i>Urodacus</i> 'sp. indet.'	Unknown	35.9 km W	Indet. No habitat description.
Class Diplopoda (millipedes), order Polydesmida				
Paradoxosomatidae	<i>Antichiropus</i> 'Marvel Loch? (female)'	Confirmed	18.9 km W	Known from two locations, 34 km apart. Under rock, leaf litter.
	<i>Antichiropus framenaui</i>	Confirmed	11 km NE	Well collected but restricted distribution. Leaf litter, dense bushland, open woodland.
	<i>Antichiropus howardi</i>	Confirmed	19.3 km W	Only collected from the Marvel Loch area. Mallee shrubs, under rocks.
	<i>Antichiropus inflatus</i>	Confirmed	46.1 km SW	Known from one male specimen collected from Mt Hampden Nature Reserve. No habitat description.
	<i>Antichiropus saxatilis</i>	Confirmed	20.7 km W	Very localised. Associated with granite outcrops, damp sheoak litter, debris.
	<i>Antichiropus serratus</i>	Confirmed	3.8 km E, 11.5 km W	All records from Marvel Loch area. Leaf litter, under rocks and logs.
	<i>Antichiropus</i> 'sp. indet.'	Unknown	3.7 km E	Indet. Lots of records within and beyond SRE desktop search area. Unknown if any

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Higher taxon, family	Species	SRE category	Nearest record to study area	Habitat
				conspecific. Under rock, collected dead in damp litter under <i>Brachychiton</i> trees, in litter at base of granite outcrop.
	<i>Antichiropus succedaneus</i>	Confirmed	85 km SW	Known from only 3 specimens on King Rock, 30 km east of Hyden. Granite outcrop.
Class Diplopoda (millipedes), order Spirostreptida				
Iulomorphidae	<i>Atelomastix bamfordi</i>	Confirmed	85 km SW	Readily collected from Koolyanobbing and Windarling Ranges, Marvel Loch, and Mt Jackson. Distribution <10,000km ² Leaf litter, in soil, under stones, logs.
Class Branchiopoda, Order Anostraca				
Parartemidae (brine shrimps)	<i>Parartemia contracta</i> (a brine shrimp (Wheatbelt))	P1 (not SRE)	37.7 km W	Salt lakes.
Class Branchiopoda, Order Cladocera				
Daphniidae	<i>Daphnia jollyi</i> (a water flea (inland south west))	P1 (not SRE)	21.6 km W	Shallow pools on granite outcrop.



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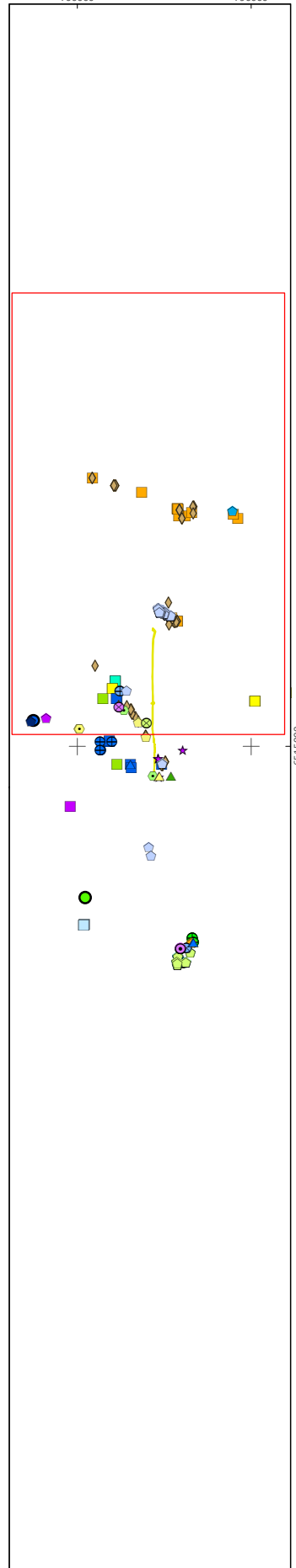
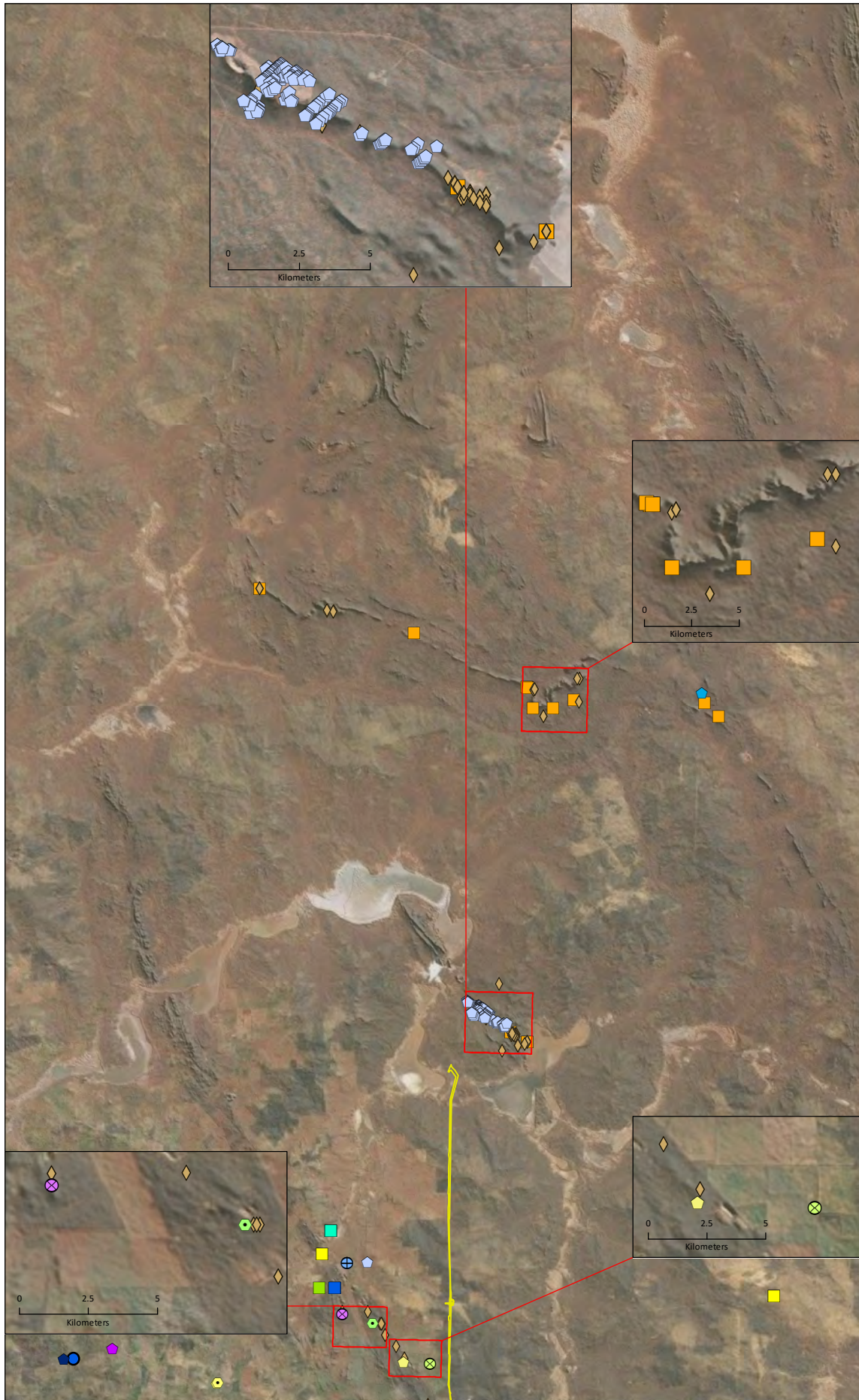
1:2,900,000(at A4) GDA 1994 MGA Zone 50

- Study area
- Significant invertebrate fauna**
- *Aname* 'MYG182', Potential
- *Antichiropus* 'Marvel Loch?' (female), Confirmed
- *Antichiropus inflatus*, Confirmed
- *Antichiropus serratus*, Confirmed
- *Antichiropus succedaneus*, Confirmed
- ◆ *Atelomastix bamfordi*, Confirmed
- ★ *Austrorhynchus* 'PSE034', Potential
- *Daphnia jollyi* (a water flea (inland south west)), P1. Not SRE
- *Galus* 'MYG063', Potential
- *Idiosoma* (=Aganippe) castellum (Tree-stem Trapdoor Spider), P4. Not SRE
- *Idiosoma* 'MYG064', Potential
- *Idiosoma* 'MYG065', Potential
- *Idiosoma* 'bifida spp. Grp.', Potential
- *Idiosoma* 'twig-lining race', Potential
- *Parartemia contracta* (a brine shrimp (Wheatbelt)), P1. Not SRE
- *Prashermacha* 'MYG429', Potential
- *Synothele* 'forrestiana', Potential
- *Synothele* 'new sp. 92', Potential
- ▲ *Teyl* 'MYG012', Potential
- ▲ *Teyl* 'MYG457', Potential
- ▲ *Teyl* 'MYG480', Potential
- ▲ *Teyl* 'marked angle door group', Potential
- *Urodacus* 'woodwardii?', Potential
- *Idiosoma/Eucyrtops* 'sp. indet. (female)', Potential

Figure 5-5a

Desktop records of Priority and SRE invertebrates

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1:3,300,000 (at A4) GDA 1994 MGA Zone 50

- Study area
- Significant invertebrate fauna**
- *Aname* 'Traying', Potential
- *Antichiropus* 'Marvel Loch?' (female), Confirmed
- *Antichiropus framenai*, Confirmed
- *Antichiropus howardi*, Confirmed
- *Antichiropus saxatilis*, Confirmed
- *Antichiropus serratus*, Confirmed
- ◆ *Atelomastix bamfordi*, Confirmed

- *Gaius* 'sp. indet. (villosus or jonesae)', Potential
- *Idiosoma* (=Aganippe) castellum (Tree-stem Trapdoor Spider), P4. Not SRE
- *Idiosoma* 'MYG064', Potential
- *Idiosoma* 'galeosomoides_sp_2', Potential
- *Idiosoma* 'twig-lining race', Potential
- *Idiosoma intermedium* (Coolgardie shield-backed trapdoor spider), P3. Not SRE
- *Proshermacha* 'MYG429', Potential
- *Synothele* 'new sp. 93', Potential

Figure 5-5b

Desktop records of Priority and SRE invertebrates

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