REPORT

Terrestrial Ecological Assessment for Vulcan South

for Vitrinite Pty Ltd

21/08/2024

METSERVE
Mining & Energy Technical Services Pty Ltd

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METSERVE
Mining & Energy Technical Services Pty Ltd
310 Edward St
Brisbane City
QLD 4000

ABN 94 143 463 316

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1 EXECUTIVE SUMMARY

Vitrinite Pty Ltd proposes to construct a small open-cut coal mine on a proposed Mining Lease (ML) within its exploration tenements EPC 1233, 1234 and 1732, midway between Dysart and Moranbah, Queensland. This proposed mine forms the project, Vulcan South. The project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) to the Minister for the Environment on 1 February 2024. The Minister determined on 4 March 2024 that the Project is a controlled action and approval is required as the action has the potential to have a significant impact on the following Matters of National Environmental Significance (MNES) protected under Part 3 of the EPBC Act:

1. Listed threatened species and ecological communities (Section 18 & Section 18A); and
2. A water resource, in relation to unconventional gas development and large coal mining development (Section 24D & Section 24E).

It was also determined that the proposed action was to be assessed by a Public Environment Report (PER). This Terrestrial Ecological Assessment (TEA) provides supporting information for the PER.

This assessment is based on a combination of field surveys and a review of past records of matters of environmental significance from the general region. Field surveys were initially undertaken in 2018-2020, spanned multiple seasons, and covered a broader region (6,982 ha) than the mining lease application (MLA) area for the project (3,819 ha). Habitat quality data were subsequently gathered from the footprint in June 2023.

Fauna for the 2018-2020 fieldwork was surveyed at 127 locations. Techniques included pitfall traps, funnel traps, Elliott traps, cage traps, remote-sensory cameras, ultrasonic bat recorders, targeted searches and spotlighting.

Flora was surveyed at 485 locations, allowing the production of a field-verified regional ecosystem map, which corrects errors contained within regulated vegetation mapping, as well as provides a finer scale of information. This revised vegetation map was used in conjunction with known habitat preferences of wildlife (based on published records and field data) to infer the distribution of matters of state and national environmental significance in and near the proposed footprint of Vulcan South.

Field surveys detected 41 species of mammal, 135 species of bird, 36 species of reptile, 14 species of frog and 429 species of vascular plant across the region containing Vulcan South. Species accumulation curves fitted to the data estimated that the surveys successfully detected 88% of the plants, 100% of reptiles, 97% of amphibians, 100% of birds, 92% of non-bat mammals and 100% of the bats present within the survey area that could potentially have been detected using the methodology employed. This represents a thorough knowledge of the region's ecology.

In accordance with best practice, Vulcan South has been strategically positioned to avoid disturbance to as many matters of state and/or national environmental significance as practicable. No protected conservation estates or secured offset areas will be disturbed for the project.

Vulcan South's footprint contains 11 regional ecosystems, including eight least concern, one of concern and two endangered regional ecosystems. Of these, 769.7 ha are remnant vegetation and 59.1 ha are regrowth vegetation. The remainder of the project's footprint comprises cleared pastures (647.7 ha).

The following four matters of national environmental significance (MNES) were detected during surveys of the site, and each is likely to experience significant residual impacts from the project:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) threatened ecological community (endangered) – 71.2 ha is within the disturbance footprint;
- Koala (*Phascolarctos cinereus*) (endangered) – 1,166.9 ha total habitat is within the disturbance footprint, including 938.6 ha of foraging/shelter/dispersal habitat, 45.5 ha of shelter/dispersal habitat, and 182.8 ha of dispersal habitat;

- Squatter Pigeon (*Geophaps scripta scripta*) (vulnerable) – 1219.1 ha are within the disturbance footprint, including 372.5 ha of breeding and foraging habitat, 78.9 ha of foraging habitat, and 767.6 ha of dispersal habitat; and
- Greater Glider (*Petauroides armillatus*) (endangered) – 1476.4 ha of habitat are contained within the disturbance footprint, including the following:
    - Likely/current denning: 750 ha;
    - Potential/future denning: 234.6 ha;
    - Foraging: 19.3 ha; and,
    - Dispersal: 52.9 ha.

Additional impacts on the Ornamental Snake and Northern Quoll were considered possible but not likely. Neither species was recorded on site, and the habitat present is suboptimal for both species.

It is proposed that environmental offsets are to be provided in accordance with the *EPBC Act Environmental Offsets Policy 2012* for each of the above four matters prior to the commencement of Vulcan South.

Each of the four MNES likely to experience significant residual impacts are also matters of state environmental significance (MSES) protected under the *Nature Conservation Act 1992* (NC Act) or *Vegetation Management Act 1999.* However, as impacts to these matters are to be assessed under the EPBC Act, the Queensland Government cannot impose additional offset conditions on these matters. Nevertheless, the following vegetation types are MSES that are not also MNES, and as they will be impacted by Vulcan South, will be subject to offsets in accordance with Queensland's *Environmental Offsets Act 2014*:

- 12.4 ha of the of concern regional ecosystem, 11.3.2; and
- 28.5 ha of regional ecosystems 11.3.25, 11.5.9, 11.5.9b, 11.10.1, 11.10.3 and 11.10.7 located within a defined distance from the defining banks of a relevant watercourse.

In addition, minor impacts to the Short-beaked Echidna (*Tachyglossus aculeatus*), Glossy Black-cockatoo (*Calyptorhynchus lathami*) and Common Death Adder (*Acanthophis antarcticus*) (listed as special least concern, vulnerable and vulnerable under the NC Act, respectively) possibly qualify as significant, due to the disturbance of potential feeding and/or breeding sites, which qualify as "ecologically significant locations". These impacts are to be assessed by the Queensland Government to determine whether they are subject to further environmental offsets.

2 INTRODUCTION

Vitrinite Pty Ltd has been investigating the development potential of coal reserves contained within the Exploration Permit Coal (EPC) tenements 1233, 1234 and 1732. As part of its investigations, Vitrinite Pty Ltd engaged Mining and Energy Technical Services Pty Ltd (METServe) to undertake baseline terrestrial ecological surveys across large parts of its three EPC tenements. These surveys spanned the wet and dry seasons of 2018-2019, and the wet season of 2020.

Based on initial investigations, Vitrinite Pty Ltd developed its initial mining project, the Vulcan Coal Mine, located on ML700060. As a result of knowledge gained through additional exploration work and the operation of the Vulcan Coal Mine, Vitrinite Pty Ltd proposes to develop a second small-scale mining project, Vulcan South, on its exploration tenements EPC 1233, EPC 1234 and EPC 1732. Vulcan South will operate independently from Vulcan Coal Mine.

Vulcan South occupies a much smaller area than that surveyed because, at the time ecology surveys commenced, the scale of the project was unknown. Nevertheless, the findings of all surveys—not only those within the project footprint—are presented in this report for two reasons. Firstly, it is valuable to place the ecological values of the project area into a broader regional context. Secondly, species recorded outside the proposed footprint, but in habitats that are also present within the footprint, could be impacted by Vulcan South.

The Project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) to the Minister for the Environment on 1 February 2024. The Minister determined on 4 March 2024 that the Project is a controlled action and approval is required as the action has the potential to have a significant impact on the following Matters of National Environmental Significance (MNES) protected under Part 3 of the EPBC Act:

3. Listed threatened species and ecological communities (Section 18 & Section 18A); and
4. A water resource, in relation to unconventional gas development and large coal mining development (Section 24D & Section 24E).

It was also determined that the proposed action was to be assessed by a Public Environment Report (PER). This Terrestrial Ecological Assessment (TEA) provides supporting information for the PER.

The TEA was originally published in 2022 and presented the findings of ecological surveys across 6,982 hectares (ha) spanning the three tenements. It also assessed the potential impacts of Vulcan South on local environmental values pertaining to terrestrial ecology. Since the original publication of the TEA in 2022, new desktop data and Commonwealth threatened species advice have become available, which has made an update necessary. Thus, a 2024 update (the present document) has been prepared. This update includes this new information. Further, it incorporates data from additional fieldwork which are relevant to the assessment of Vulcan South's ecological context.

2.1 LOCATION

Throughout this report, the "survey area" refers to the 6,982 ha area in which ecological surveys were undertaken. The "project area" refers to the proposed MLA area containing Vulcan South (3,819 ha). The project area therefore forms a part of the survey area. The 1,476 ha "disturbance footprint" is contained within, and is a subset of, the project area and is to be the maximum extent of clearing.

Note that habitat mapping will include a 2 km buffer around the disturbance footprint to illustrate local context for habitats.

The survey area is located midway between Moranbah and Dysart, in the Bowen Basin of central Queensland (**Figure 2-1**). The project falls within the jurisdiction of the Isaac Regional Council. It lies immediately south and west of the Vulcan Coal Mine, and just west of the Peak Downs Mine and Saraji Mine, alongside the Saraji Road. The project area is contained within the following properties:

- Lot 2 on Plan SP296877;
- Lot 59 on Plan SP235297;

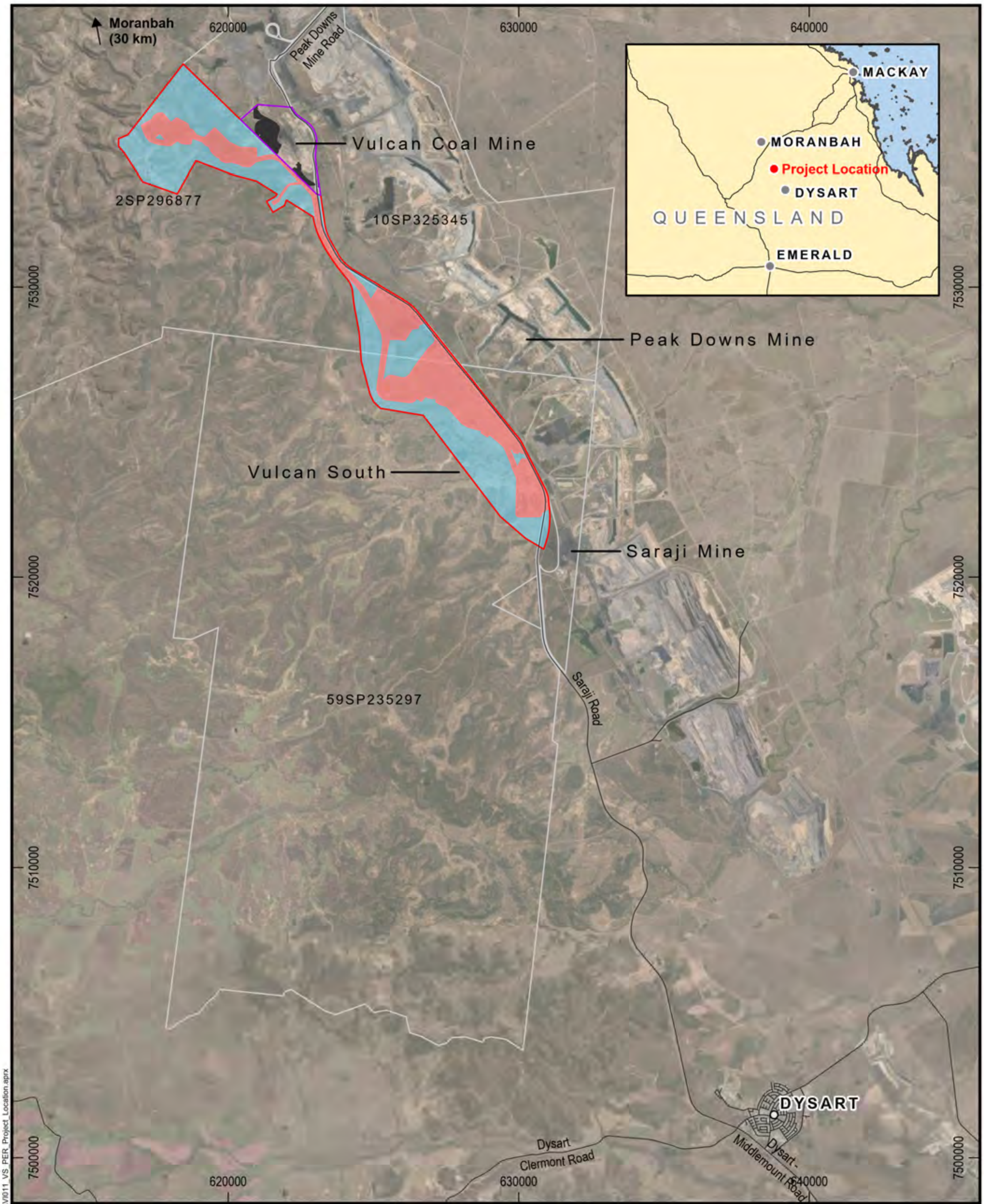
- Lot 72 on Plan SP137467;
- Lot 26 on Plan CNS125;
- Lot 2 on Plan CNS109; and
- Lot 3 on Plan CNS109.

The survey area also encompasses a portion of Lot 10 on Plan SP208611.

The survey area falls mostly within the Northern Bowen Basin subregion of the Brigalow Belt North bioregion, according to the Interim Biogeographic Regionalisation for Australia. A small portion falls within the Isaac-Comet Downs subregion.

2.2 EXISTING LAND-USE

The project area is located on predominantly leasehold land that is used primarily for cattle grazing. The project area is bounded to the north and east by proposed and existing coal mining operations. A rail line and sealed highway (Saraji Road) run along the eastern edge of the project area.



Legend

- Town
- Road
- Cadastral Boundary

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Avoidance Area

Vulcan Coal Mine (VCM) – Matilda Pit and Ancillary Infrastructure (2022/09361)

- ML 700060
- VCM Matilda Disturbance Footprint

Source: Population centres - Queensland, State of Queensland (Department of Resources) 2020; QLD Roads and Tracks, State of Queensland (Department of Resources) 2021; Cadastral data weekly - whole of State Queensland, State of Queensland (Department of Resources) 2022; Vulcan South and Vulcan Coal Mine datasets, Vitrinite & METServe 2022-2024. Imagery - Geosciences Australia, Esri, GEBCO, Garmin, NaturalVue, Earthstar Geographics.

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Vulcan South

Project Location

0 2 4 8

Kilometers

Scale: 1:190,000 (A4)

5/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 2-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

2.3 PROPOSED ACTIVITIES

Vulcan South is a small-scale coal mine that will extract approximately 13.5 Mt of run-of-mine (ROM) coal, consisting predominately of hard coking coal with an incidental thermal secondary product, at a rate of up to 1.95 million tonnes per annum (Mtpa). The project will operate for approximately nine years, including primary rehabilitation works, following a two-year construction period. Coal extraction will occur in three open-cut pits; Vulcan North, Vulcan Main and Vulcan South (**Figure 2-2**). Each pit will be approximately 60 m deep. Truck-and-shovel mining operations will be employed to develop the pits. Coal will be processed by a modular coal handling and preparation plant (CHPP). The proposed CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within waste rock dumps. No wet tailings wastes or tailings dams are proposed. Coal transportation will occur via a rail loop and load-out facility, located between the Vulcan North and Vulcan Main pits. Coal will be transported on the Goonyella Rail network to coal terminals at either Dalrymple Bay or Gladstone.

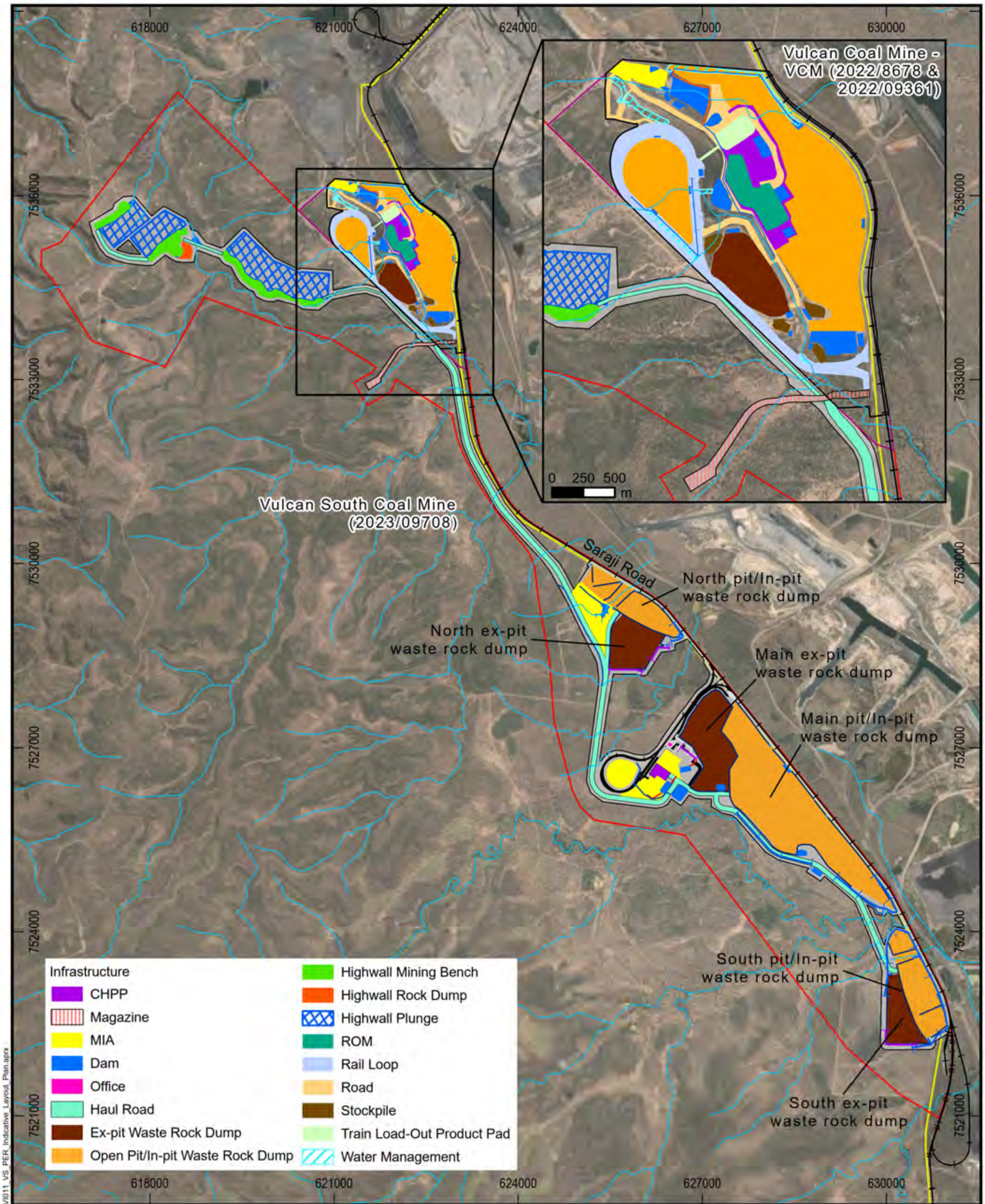
All processing wastes (reject material and dry tailings) will be stored within waste rock dumps. Local waste rock possesses a geochemistry that does not pose a significant risk of generating saline or metalliferous drainage, and no selective handling and treatment measures are proposed. Initial waste rock extracted during the early stages of each pit will be placed in ex-pit dumps to the west of the open pits. Following this initial ex-pit placement and once sufficient pit space has been established, in-pit placement of waste rock will commence. Any voids remaining at the conclusion of mining in each pit will be back-filled with a subset of material stored in ex-pit dumps. The remaining material stored in ex-pit dumps will be rehabilitated in situ. The in-pit dumps will extend up to approximately 60 m above the height of the former ground surface, with batters shaped up to a maximum slope of 15 %. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited).

Ancillary infrastructure will include an access road, ROM pad, offices and a Mine Infrastructure Area (MIA) containing workshops, heavy vehicle parking and storage. Water management infrastructure will be established to divert clean water catchments around operational areas and to manage runoff from disturbed areas. A series of mine water dams will be established to manage raw water supply, pit water and supply water for dust suppression. A series of drains and bunds will be established to direct runoff to sediment control structures. Vulcan South will require up to 1,250 ML/annum of external water to operate. This will come from a mix of an existing pipeline supply, water trucks delivering from off-site sources and, potentially, unallocated groundwater in local non-alluvial aquifers.

In addition to the open-cut operations, Vulcan South will also include a small-scale highwall mining trial in the north of the ML area. The trial will involve the establishment of four highwall mining benches across three hillsides to allow extraction of coal utilising a CAT HW300 highwall miner, or similar. The highwall mining trial will target up to 750 kt of coal which will be transported by truck to the CHPP via a dedicated haul road within the MLA area. The coal occurs in seams 0.9 to 1.5 m thick beneath 12 to 50 m of overburden. Coal will be extracted using a series of plunges that are 3.5 m wide and up to 400 m long. Minimal infrastructure is required to support the highwall mining trial, including mobile diesel tanks, workshop containers and portable bathroom amenities. Access roads and benches will be constructed in order to provide a stable surface on which to operate the machinery. A small waste rock dump will be built on one of the benches, while will be rehabilitated in situ. Mine-affected water will be contained on each bench and allowed to drain to completed highwall plunges (voids). The trial is scheduled to be completed within the first year of mining operations.

An explosives magazine will be constructed between the highwall trial area and the Vulcan North pit, a safe distance from operational areas and critical infrastructure.

The peak operational workforce is anticipated to comprise 190 positions. On average, less than a third of this workforce would be present on site at any one time due to shift and roster arrangements. The workforce will reside in camps and private facilities in Dysart and/or Moranbah. It is estimated that 80% of the travel to/from site will be undertaken in buses/work vehicles and 20% in private vehicles. There would be two 12-hour shifts per day, with crews operating on a 7-days-on, 7-days-off roster.



Legend

- Railway
- Road
- Rail Loop and Mine Roads
- Mine Access Road
- Flood Levee
- Diversion Bund
- Diversion Drain
- Mine Water Drain
- Surface Water Drain
- Dam Wall
- Project Area (ML 700073)
- Disturbance Footprint
- ML 700060
- VCM Maximum Disturbance Footprint

Source: QLD roads and tracks - State of Queensland (Department of Resources) 2021; Rail network - QLD - State of Queensland (Department of Resources) 2022; Watercourse lines - QLD - State of Queensland (Department of Resources) 2023; Infrastructure - Vitrinite, WRM and METServe 2022-2024; Imagery - Earthstar Geographics, Maxar

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Vulcan South

Indicative Site Layout

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

5/07/2024

Datum: GDA2020
Projection: MGA55

FIGURE 2-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

2.4 RELEVANT LEGISLATION

2.4.1 Queensland

Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) regulates environmental management and aims to achieve ecologically sustainable development. The EP Act outlines legal obligations and the duty of care all persons have to the environment and directions for preparing environmental protection policies. As the project includes "environmentally relevant activities", an application for an environmental authority will be required under the EP Act.

Nature Conservation Act 1992

The *Nature Conservation Act 1992* (NC Act) regulates native flora, fauna and habitat conservation within Queensland.

Nature Conservation (Wildlife) Regulation 2006

The *Nature Conservation (Wildlife) Regulation 2006* prescribes the conservation status of Queensland wildlife, following provisions of the NC Act.

Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VM Act) provides a planning framework for the management of native vegetation across Queensland. It regulates clearing of vegetation and aims to conserve Queensland's biodiversity through vegetation management.

Environmental Offsets Act 2014

The *Environmental Offsets Act 2014* (EO Act) provides for environmental offsets to counterbalance significant residual impacts of activities on particular matters of state or local environmental significance.

Biosecurity Act 2014

The *Biosecurity Act 2014* lists weeds and pest animals that constitute prohibited or restricted matters, and obligations pertaining to these matters.

2.4.2 Commonwealth

Environmental Protection and Biodiversity Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) provides for the identification and management of Matters of National Environmental Significance, including threatened flora and fauna species, ecological communities, migratory species protected under international treaties, internationally recognised significant wetlands and critical habitat areas. Under the *EPBC Act*, an action will require approval from the Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance.

EPBC Act Environmental Offsets Policy 2012

The *EPBC Act Environmental Offsets Policy* (EOP) provides guidance on how the federal government considers the suitability of a proposed offset, when there are residual impacts of a project on Matters of National Environmental Significance.

3 METHODS

3.1 LITERATURE REVIEW

For the 2022 TEA, a desktop-based assessment was undertaken using publicly available databases to determine the ecological values potentially occurring in the vicinity of the project. The following databases were consulted:

1) Queensland Government's Wildlife Online search tool (records within a 20 km buffer from the central point −22.3678, 148.2352);
2) Department of Environment and Energy's Protected Matters Search Tool (records within a 20 km buffer from central point: -22.3678, 148.2352);
3) Atlas of Living Australia;
4) eBird;
5) the Australasian Virtual Herbarium Search tool; and
6) the Department of Environment and Science's regulated vegetation management mapping.

For each species flagged during the literature review, but not recorded on site during field surveys, an assessment of the likelihoods of their presence within the survey area and project area was undertaken based on the reliability and recentness of the record(s) and whether suitable habitat—as described by the Australian Government's Species Profiles and Threats Database, species recovery plans, referral guidelines, and/or primary scientific literature—is present.

Updates and changes were made to the literature review in 2024, as per the following:

1) The PMST was re-run on 16th April 2024 (records within a 20 km buffer from disturbance footprint shapefile);
2) Atlas of Living Australia, which includes data from eBird, WildNet, "research grade" iNaturalist and the Australasian Virtual Herbarium records, was searched on 9th May 2024 (150 km buffer applied to the disturbance footprint); and,
3) Regulated vegetation mapping was superseded by Regional Ecosystem verification and subsequent BioCondition assessments.

The following process was used to download and tidy the dataset prior to plotting it on GIS software for further spatial analysis.

1. A list of all MNES species highlighted in the PMST were downloaded from the Atlas of Living Australia spatial portal in CSV format, limited to records within 150 km and after the year 1980.
2. Data was tidied by:
    a. Removing all records with an uncertainty of over 5 km. No species were removed from the list at this step.
    b. All records marked as "unconfirmed" were removed. No species were removed from the list.

Records which are pre-1980, which are unconfirmed, and which had an uncertainty of over 5 km are considered unreliable and are generally not discussed further.

3.2 FIELD SURVEYS

3.2.1 Flora (2022 TEA)

The principal flora survey was undertaken between 4 February and 15 February 2019 by Dr Chris Wiley (Principal Consultant – Ecology) and Jacob Rolley (Consultant – Ecology). The approach taken followed that prescribed by Neldner *et al*. (2019) in *Methodology for Survey and Mapping of Regional Ecosystems* *and Vegetation Communities in Queensland, Version 5.0*. Survey timing coincided with maximum plant growth in the mid to late wet season and was optimal for detecting threatened species as well as describing overall diversity.

Additional surveys for supplementary vegetation mapping were undertaken on 1-2 October 2019 in the far south of the survey area, and between 27 March and 5 April 2020 in the far north-west of the survey area. The former took place in a small area of non-remnant vegetation added to the survey area subsequent to the February 2019 survey. Due to October being a sub-optimal month for flora surveys (dry conditions mean that most grasses and herbs are dormant), this survey aimed primarily to assess the spatial extent of vegetation units rather than comprehensively document the species present within these. The latter took place in a small area added to the north-western survey area subsequent to the October 2019 survey, and was optimal for detecting threatened species, vegetation mapping and recording diversity.

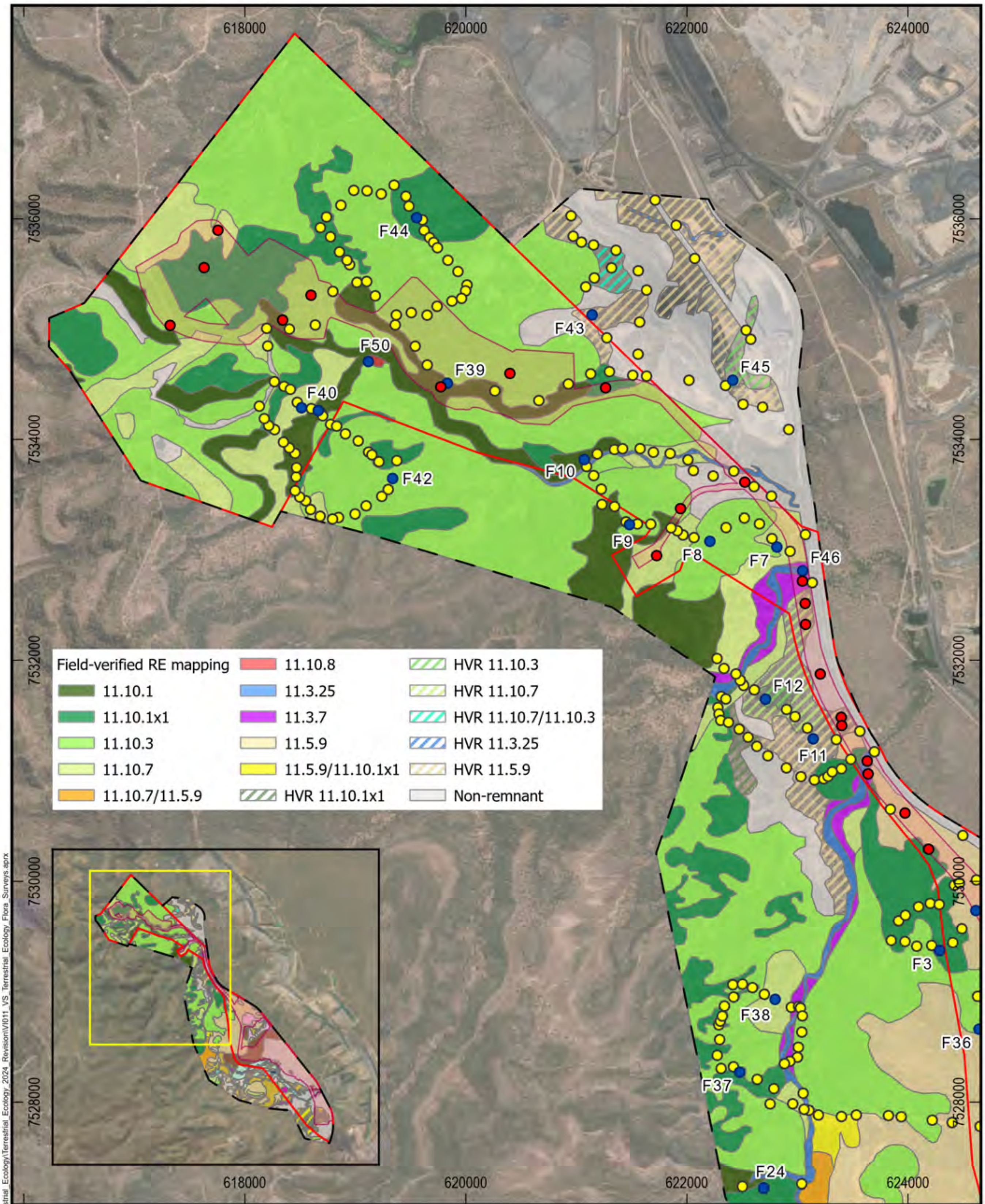
For all flora surveys, the survey area was traversed by car and (mostly) on foot, and routes were pre-selected to maximise coverage of the site, and the number of mapped vegetation units visited. The aim of the field surveys was to ground-truth a sufficient sample of sites to enable interpolation of regional ecosystems across the survey area using detailed satellite imagery. In total, 485 sites were ground-truthed across the survey area (**Figure 3-1** and **Figure 3-2**). These comprised 433 quaternary sites and 52 secondary sites, as per Neldner *et al.* (2019). Secondary sites are detailed floristic and structural assessments of the vegetation communities present. These were only assessed during optimal conditions in February 2019 and March 2020. Quaternary sites are simple descriptions of the dominant species present and their corresponding regional ecosystem. A small subset (3.5%) of quaternary sites was assessed in October 2019, while the remainder were assessed under optimal conditions in February 2019 and March 2020. Field data were then used in conjunction with satellite imagery to produce a field-verified regional ecosystem map of the entire survey area. This field-verified map corrects numerous errors in certified mapping, as well as provides greater resolution due to its finer scale.

Table 3-1 below outlines the Assessment Units (AUs) within the Survey area which were used to interpolate habitat values collected during field surveys.

Table 3-1 Assessment units within the Survey Area

Assessment Unit	Description	Area (ha)	$N_{sampling\ locations}$
AU1	Remnant 11.3.2	5.22	2
AU2	Remnant 11.3.7	3.83	2
AU3	Remnant 11.3.25	7.56	2
AU4	Remnant 11.4.8	66.94	4
AU5	Remnant 11.4.9	0.22	1
AU6	Remnant 11.5.3	7.08	2
AU7	Remnant 11.5.9	211.97	6
AU8	Remnant 11.9.2	163.98	4
AU9	Remnant 11.10.1	41.42	2
AU10	Remnant 11.10.1x1	69.27	3
AU11	Remnant 11.10.3	163.74	4
AU12	Remnant 11.10.7	28.23	2
AU13	High-value regrowth 11.10.3	30.13	2
AU14	High-value regrowth 11.10.7	5.39	2
AU15	High-value regrowth 11.4.8	4.01	1
AU16	High-value regrowth 11.5.3	45.23	2
AU17	High-value regrowth 11.5.9	3.83	2
AU18	Woody non-remnant (>5% canopy cover)	277.73	3
AU19	Non-woody non-remnant (<5% canopy cover)	297.53	6

AU20	Highly disturbed non-remnant	43.13	3
	Total	**1,476**	55



Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Survey Boundary

Survey Points

Quaternary

Secondary

Biocondition

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics.

Vulcan South

Locations of Flora Surveys (North)

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 3-1

VITRINITE BRIGHTER COAL

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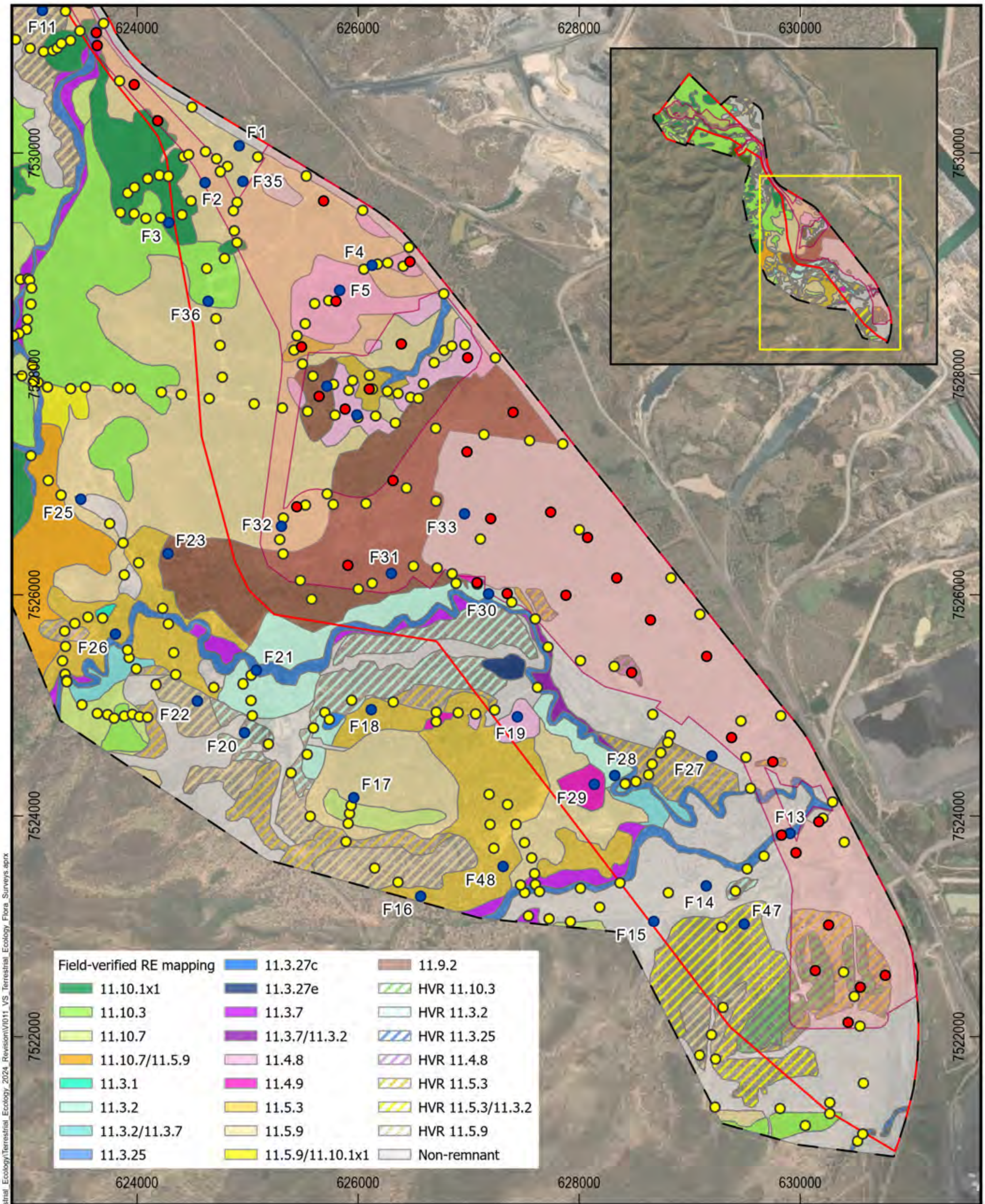


Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Survey Boundary

Survey Points

Quaternary

Secondary

Biocondition

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics

Vulcan South

Locations of Flora Surveys (South)

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 3-2

Neldner *et al*. (2019) recommends sampling a minimum of three secondary sites per regional ecosystem. An average of 3.25 secondary sites per regional ecosystem was sampled during field surveys. One quarter of the regional ecosystems present on site were represented by single, small patches less than 10 ha in extent, preventing them being sampled over three sites. The remaining regional ecosystems were sampled at an average of 4.3 secondary sites, surpassing guideline requirements.

In addition to plant lists generated at each secondary site, additional plant species were noted during timed meander searches while walking between sites. These searches had the primary goal of targeting species of conservation significance in accordance with the *Flora Survey Guidelines – Protected Plants version 2.01*. They also allowed for a comprehensive inventory of floral diversity across the survey area.

3.2.2 Fauna (2022 TEA)

3.2.2.1 Seasonal Conditions

The following fauna surveys were undertaken across the survey area in order to encompass seasonal variation in faunal movements and detectability:

1) 24 October 2018 to 2 November 2018;
2) 4 February 2019 to 15 February 2019 (bird surveys and spotlighting were undertaken during the flora survey);
3) 25 March 2019 to 29 March 2019 (abandoned prematurely due to heavy rain);
4) 8 April 2019 to 17 April 2019;
5) 1 May 2019 to 9 May 2019; and
6) 23 September to 4 October 2019.

All of the above surveys fell within the two seasons recommended by the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre *et al*. 2018) for the Brigalow Belt bioregion.

Heavy rain events (>100 mm within 24 h) occurred during the first and third surveys, leading to flash-flooding of creeks and the filling of temporary pools and gilgais. This provided optimal conditions for the detection of frogs and burrowing snakes. Light rain events (~15 mm) also occurred during the second and fourth surveys, stimulating moderate frog activity. A light shower (<5 mm) during the sixth survey was the first rain received by the site in many months, stimulating moderate frog activity.

The mean maximum temperature across all surveys was 33.4°C (range = 24.3°C–41.4°C). The mean minimum temperature across all surveyed was 16.8°C (range = 6.6°C–22.9°C). With the possible exception of three nights that fell below 10°C in May 2019, conditions were optimal for detecting ectothermic fauna.

3.2.2.2 General Approach

In accordance with the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre *et al*. 2018), the entire survey area was divided into assessment units based on broad vegetation groups and age (remnant versus regrowth). These guidelines stipulate that each assessment unit is to be sampled at a minimum of three trap sites. This sampling intensity was achieved for most of the broad vegetation groups present on site, and all broad vegetation groups contained within the project area (**Table 3-2**). Two of the broad vegetation groups present on site (7a and 34d) were not amenable to sampling via traps; 7a was too small, rocky and remote, while 34d was primarily open water. These were sampled via targeted searches (day and night), instead. A remote-sensory camera was also installed in broad vegetation group 7a. Where broad vegetation groups were represented on site by both remnant vegetation and high-value regrowth, sampling effort was focused on the former, but the latter was also sampled if it comprised more than 5% of the total area of the broad vegetation group. In total, 34 comprehensive trap sites were sampled. A list of sites and photographs of each are provided in **Appendix A**.

Table 3-2 Summary of sampling effort per broad vegetation group (BVG)

BVG	Constituent regional ecosystems	Short description	Area (hectares)		$N_{trap\ sites}$	
			Remnant	Regrowth	Remnant	Regrowth
10a	11.10.1	*Corymbia citriodora* woodland on hilly terrain.	244.5	0	3	0
12a	11.10.7, 11.10.1x1	Ironbark (*Eucalyptus* spp.) and/or bloodwood (*Corymbia* spp.) woodland on scarps and sandstone tablelands.	836.7	59.6	3	2
16a/9e*	11.3.25/11.3.7	*E. camaldulensis* forest fringing drainage lines/*Corymbia* spp. woodland on alluvial terraces	147.7/86.1	5.3/0	3	0
17a	11.3.2, 11.5.3	*Eucalyptus populnea* woodland on sandplains or alluvium.	406.3	387.2	3	1
17b	11.9.2	*Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks.	325.5	0	3	0
18b	11.5.9	*Eucalyptus crebra* woodland on flat to undulating plains.	877.7	271.4	3	2
24a	11.10.3	*Acacia shirleyi* or *A. rhodoxylon* open forest on residual surfaces.	1,589.0	68.8	3	1
25a	11.3.1, 11.4.8, 11.4.9	*Acacia harpophylla* woodland to open forest on clay soils	145.2	4.0	3	0
34d	11.3.27c, 11.3.27e	Freshwater swamps and billabongs on floodplains.	8.5	0	0	0
7a	11.10.8	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks.	1.3	0	0	0
Non-remnant pasture		Cleared pasture, +/- scattered trees or young regrowth	1,517.6		4	

*Broad vegetation groups 16a and 9e occur as parallel, narrow bands along waterways. Due to the narrow width of these vegetation units relative to the area of the standard trapping array, trap sites placed on creek banks invariably spanned both broad vegetation groups. For this reason, they were treated as a single assessment unit.

3.2.2.3 Comprehensive Trap Sites

Each of the 34 comprehensive trap sites was sampled using methodology described in the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland version 3.0* (Eyre *et al*. 2018). The following traps were installed and monitored twice daily over four days and nights per site:

1) 45 m of 40-cm-high aluminium fly-screen drift fence was installed flush with the ground in a T-arrangement (**Figure 3-3**);
2) four 20-L buckets were installed as pitfall traps beneath this drift fence;
3) three pairs of funnel traps were installed along the drift fence;
4) 20 Elliott traps (baited with an oat-and-peanut-butter mix) were placed at 10 m spacing parallel to the drift fence; and
5) one Reconyx HC550 Hyperfire White Flash remote-sensory camera (baited with an oat-and-peanut-butter mix) was installed approximately 50 m from the drift fence.

The entire trap array spanned approximately 120 m × 50 m. Note that the survey guidelines suggest the use of one cage trap per site, instead of the camera. This recommended approach was adopted during the October 2018 survey but abandoned in favour of cameras in all other survey rounds. Remote-sensory cameras are able to detect all species potentially caught by a cage trap but have several advantages. They are (i) easier to transport, (ii) able to 'catch' more than one individual/species per night, and (iii) able to detect a broader range of species that are too large (macropods, dingos, pigs) or small (birds, rodents) to be caught in a cage trap.

In addition to the four days of trapping, each trap site was also subjected to the following targeted surveys:

1) 40 person-minutes of spotlighting;
2) 40 person-minutes of diurnal active searches;

3) 80 minutes of bird surveys (10 minutes during each check of the traps); and
4) one night of recording with an AnaBat Express bat-call detector.

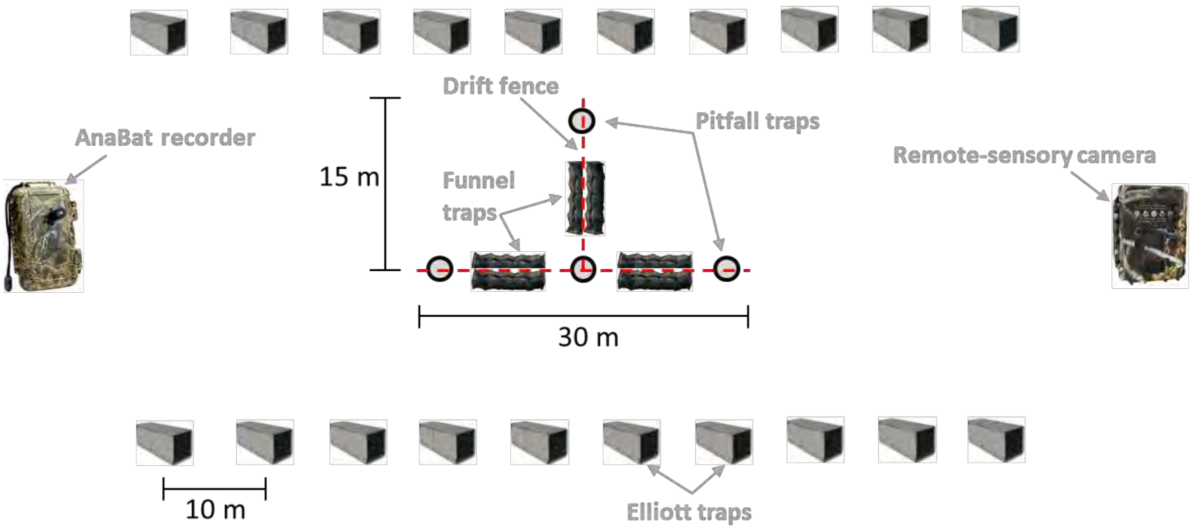


Figure 3-3 Schematic diagram of the trapping array at each comprehensive trap site

3.2.2.4 Supplementary Targeted Surveys

In addition to the sampling at comprehensive trap sites, further targeted searches were undertaken in a range of habitats that are difficult to sample using conventional trapping (e.g., rock outcrops, dams, wetlands, wood piles). Furthermore, targeted searches were undertaken to fill spatial gaps in assessment units that were very extensive and/or spatially heterogenous.

The following surveys were undertaken at additional sites away from the comprehensive trap sites:

1) Diurnal active searches of at least 40 person-minutes' duration were undertaken at 28 sites. This involved turning over logs and rocks, raking through leaf litter, searching for signs of Koalas, and recording all birds seen or heard;
2) Spotlighting for at least 40 person-minutes was undertaken at 28 sites;
3) Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded;
4) AnaBat recordings were carried out at 10 sites that represented likely flyways for bats: tracks through forest, creek lines and around dams. Recordings were made across a single night (12 hours) per site; and
5) Remote-sensory cameras were installed at three sites (a total of 12 trap-nights) along creek lines, which are favoured movement pathways for fauna.

3.2.2.5 Total Survey Effort

The total amount of survey effort expended for faunal surveys of the survey area is summarised in **Table 3-3** and the locations of surveys are shown on **Figure 3-4** and **Figure 3-5**. The adequacy of survey effort against relevant guidelines is summarised in **Table 3-4**.

Table 3-3 Fauna survey effort across the survey area between October 2018 and October 2019

Survey Method	Targeted Species	Potential EVNT Species*	Total Effort†	Unit
Pitfall trap	Frogs, small reptiles, small mammals	Ornamental Snake, Common Death Adder, Dunmall's Snake, Allan's Lerista	588	Trap-nights
Funnel trap	Lizards, snakes	Ornamental Snake, Common Death Adder, Yakka Skink, Dunmall's Snake, Allan's Lerista	882	Trap-nights
Elliott trap	Small mammals	n/a	2,860	Trap-nights
Cage trap	Medium-sized mammals	Northern Quoll	31	Trap-nights
Remote-sensory camera	Mammals, birds	Short-beaked Echidna, Northern Quoll, Squatter Pigeon	122	Trap-nights
AnaBat	Microchiropteran bats	Ghost Bat, Large Pied Bat	45	AnaBat-nights
Bird survey	Birds	Squatter Pigeon, Red Goshawk, Painted Honeyeater, Australian Painted-snipe, Black-throated Finch, migratory birds	288	Person-hours
Diurnal targeted search	Reptiles, larger mammals	Allan's Lerista, Yakka Skink, Dunmall's Snake, Common Death Adder, Short-beaked Echidna, Koala	45.3	Person-hours
Spotlighting	Frogs, reptiles, mammals, birds	Ornamental Snake, Common Death Adder, Short-beaked Echidna, Central Greater Glider, Koala	52.5	Person-hours

*Potential EVNT species are those listed as endangered, vulnerable, near threatened or special least concern within Queensland and/or nationally that have been historically recorded within the region.

†Note that not all sites were surveyed over four nights, as heavy rain necessitated the early closure of five sites. Four of these were re-surveyed on a later date, resulting in >4 survey nights for these sites.

Table 3-4 Survey methodology in accordance with guideline requirements

Target MNES Category	Relevant Guidelines/Documentation	Guideline methodology recommendations and minimum standards	Survey Effort	Survey Adequacy
Brigalow Belt Reptiles	Survey Guidelines for Australia's Threatened Reptiles Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles	**Survey Guidelines for Australia's Threatened Reptiles** Surveys should be conducted at night during warm, wet weather. Survey techniques should include searching around suitable gilgai habitat while frogs are active, diurnal searches under sheltering sites and driving roads at night after wet weather. Pitfall and funnel traps can also be used. Minimum standards are not outlined in this document, as it is considered here to be subordinate to the Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles (see below). **Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles** Diurnal searches of a minimum of 1.5 person-hours over three days per hectare. Spotlighting of a minimum of 1.5 person-hours over three days per hectare. Roads should be surveyed opportunistically on warm nights and following rainfall. The following trap site effort is considered minimum along a 30 m drift fence over 4 days where optimal microhabitats occur: a. 6 pitfall traps and b. 2 funnel traps should be installed	• 3 trap sites over 145.2 ha, each set for 4 nights • 882 trap nights (funnel traps) • 588 trap nights (pitfall) • 52.5 person hours spotlighting • Opportunistic night searches on roads following rainfall • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint.	Fauna surveys for the original Terrestrial Ecological Assessment occurred in October and November 2018, and February, March, April, May, September and October in 2019. Surveys for reptiles that rely on warm and wet weather therefore occurred during optimal conditions. It is noted that spotlighting for the Ornamental Snake for the original Terrestrial Ecological Assessment was conducted on nights following heavy ran events which occurred midway through October 2018 and March 2019, which had resulted in widespread flash-flooding and surface water pooling in gilgais and other depressions. Surveyed areas also included roads following rainfall.

		c. At least two replicate fence lines per habitat type.		**Survey Guidelines Met.**
Squatter Pigeon	Survey Guidelines for Australia's Threatened Birds Terrestrial Vertebrate Fauna Survey Guidelines for Queensland	**Survey Guidelines for Australia's Threatened Birds** Surveyed by area searches or transect surveys (minimum of 15 hours over three days), and by flushing surveys (10 hours over three days) for areas up to 50 ha.	• Timed Surveys (20 minutes) • Transect and flushing surveys • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint. Incidental searches were conducted while traversing between survey locations.	Timed surveys of at least 20 minutes' duration were undertaken at 24 sites, including transect searches and flushing surveys, in addition to diurnal active search sites in addition to 51 habitat/BioCondition assessments. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded. **Survey Guidelines Met.**
Koala	A Review of Koala Habitat Assessment Criteria and Methods Terrestrial Vertebrate Fauna Survey Guidelines for Queensland Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory	**A Review of Koala Habitat Assessment Criteria and Methods** (Youngentob, et al., 2021) Strip transects during the day are one of the most commonly used survey methods for Koalas. Spotlighting detects Koalas more effectively than daytime searches. The highest detection rates are via thermal detection drones and scat surveys. Camera traps may also be used but are an inefficient way to detect Koalas specifically. Call playback can be effective for detecting males in the breeding season. **Terrestrial Vertebrate Fauna Survey Guidelines for Queensland**	• Diurnal active searches of at least 40 person-minutes' duration was undertaken at 28 sites -including scat and scratch searches. • Spotlighting for at least 40 person-minutes was undertaken at 28 sites 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint. Habitat quality assessments included specially tailored habitat quality scores for all 'large trees' that	Diurnal searches including incidental scat and scratch searches and spotlighting at 84 sites for a total of 4070 person minutes in addition to 51 habitat/BioCondition assessments. **Survey Guidelines Met.**

		Spotlighting surveys are conducted within the 100 x 100 m generic survey site for 30-person minutes. Each spotlight survey involves an observer/s walking slowly and systematically through the 100 x 100 m generic survey site (e.g., spotlighting up and back the middle 100 m transect in sparsely vegetated sites, or spotlighting up one side of the 100 m x 100 m area and then spotlighting back the other side of the 100 m x 100 m area in more densely vegetated sites).	could constitute habitat for nocturnal arboreal mammals. This includes listing the species and DBH of all non-eucalyptus trees over 20 cm and all Eucalyptus/Corymbia trees over 30 cm with the BioCondition plot.	
Greater Glider	Survey guidelines for Australia's threatened mammals 2011 Guide to Greater Glider habitat in Queensland Terrestrial Vertebrate Fauna Survey Guidelines for Queensland	The **Survey Guidelines for Australia's Threatened Mammals** lists the following spotlight survey methodology for presence/absence for arboreal marsupials (in summary): • Hand-held spotlights, held near observer's line of vision and moved slowly at a consistent speed; • Binoculars, once an animal has been spotted, to confirm identity; • Speed of 10 m per minute; • Avoid very windy or rainy nights. Minimum standards are as follows: • Survey at least two 200 m transects per 5 ha site, or longer transects as necessary; • Maintain intervals of at least 100 m between transects; • Transect surveys repeated on two separate nights where possible; The Commonwealth guidelines also mention that Queensland methodology is also acceptable, placing a greater bias on habitat suitability. This is ascertained by	• Spotlighting for at least 40 person-minutes was undertaken at 28 sites • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint. Habitat quality assessments included specially tailored habitat quality scores for all 'large trees' that could constitute habitat for nocturnal arboreal mammals. This includes listing the species and DBH of all non-eucalyptus trees over 20 cm and all Eucalyptus/Corymbia trees over 30 cm with the BioCondition plot. Gliding distance was measured as a % of trees within gliding distance to account for Greater Gliders.	Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat and included data collection on visible hollows *and* tree DBH for *Corymbia, Eucalyptus* and *Angophora* species. Spotlighting was conducted at 84 sites for a total of 4070 person minutes. **Survey Guidelines Met.**

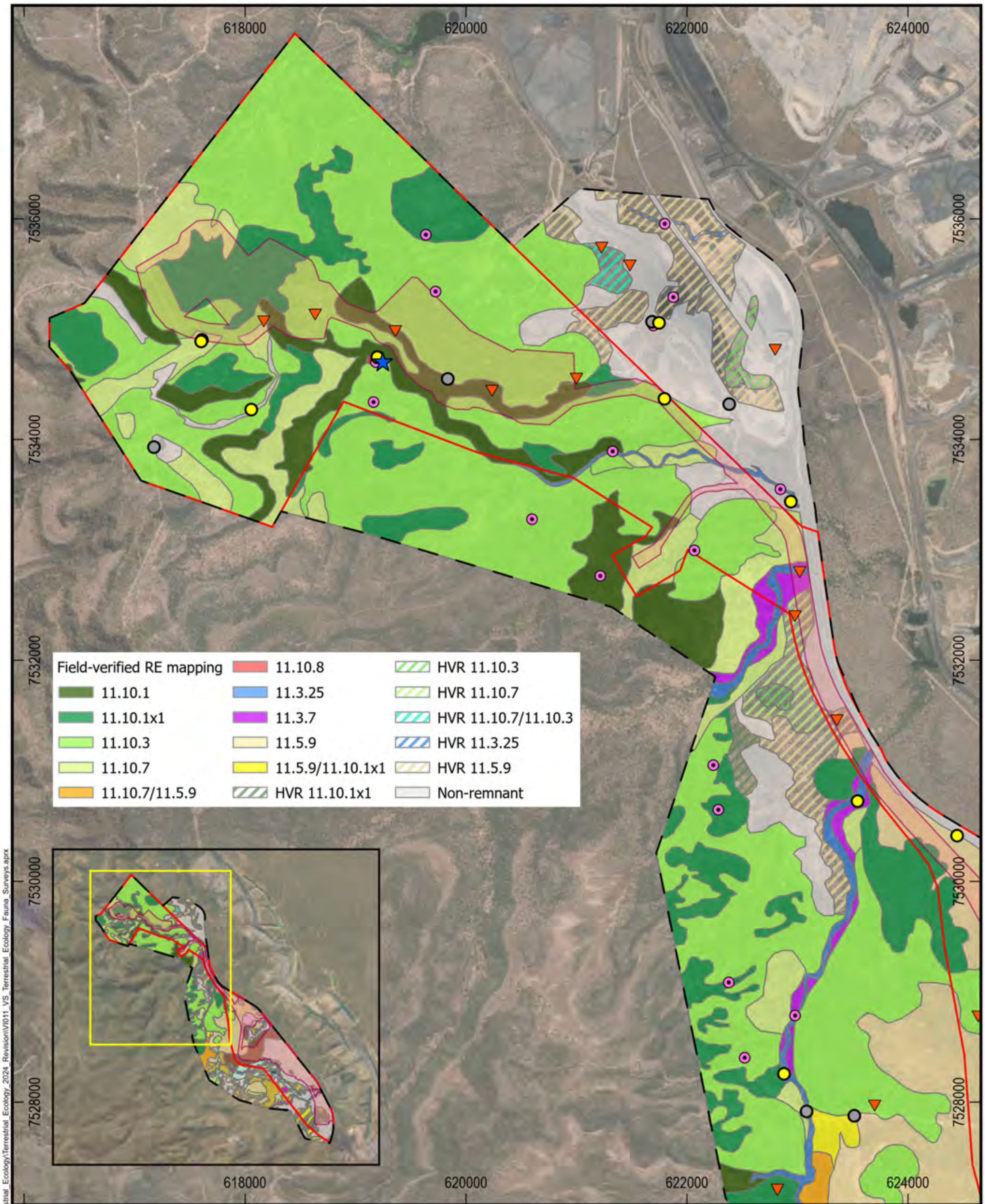
		presence of "Eucalypt" species with a DBH >30cm as a surrogate for presence of visible hollows. **Terrestrial Vertebrate Fauna Survey Guidelines for Queensland** Spotlighting surveys are conducted within the 100 x 100 m generic survey site for 30-person minutes. Each spotlight survey involves an observer/s walking slowly and systematically through the 100 x 100 m generic survey site (e.g., spotlighting up and back the middle 100 m transect in sparsely vegetated sites, or spotlighting up one side of the 100 m x 100 m area and then spotlighting back the other side of the 100 m x 100 m area in more densely vegetated sites).		
Wading birds	SPRAT database (Commonwealth of Australia 2010) Draft referral guidelines for 14 birds listed migratory under the EPBC Act Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species Survey Guidelines for Australia's Threatened Birds	**SPRAT database** In Australia, surveys should be conducted between October and February, which is the period between the species' arrival and departure in Australia. Surveys are best conducted during the day, as the snipe appears to disperse from roosting areas at dusk and then return before or at dawn. **Survey Guidelines for Australia's Threatened Birds** Populations of Latham's Snipe and the Australian Painted Snipe can be surveyed by performing area searches or line transects in suitable habitat (i.e. wetlands or other waterbodies and their surrounding vegetation). The surveys should be conducted on foot. To maximise the chances of detecting all birds present, a number of observers should arrange themselves into a line and then advance in unison, preferably whilst accompanied by bird dogs. Another potential	The Latham's Snipe was not listed as threatened during the survey period, therefore was not specifically searched for. Habitats were, however, assessed for suitability alongside other threatened wading birds such as the Australian Painted Snipe. Applicable surveys used: • Area surveys • General bird surveys • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint.	Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019) were also recorded. Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat. **Survey Guidelines Met**

		technique is to drag a length of rope over an area of suitable habitat.		
Aerial insectivorous birds	Draft referral guidelines for 14 birds listed migratory under the EPBC Act	**Draft referral guidelines for 14 birds listed migratory under the EPBC Act** While there are no standard survey techniques for swifts, they should be counted by an experienced person from elevated viewpoints (if present) during the Austral summer. Prevailing weather conditions should be noted as this can greatly affect likelihood of occurrence (e.g. swifts often travel ahead of storm fronts).	• Area surveys • General bird surveys • 51 Habitat/BioCondition assessments	Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or seen during flora surveys (10 days of survey effort in February 2019, including in stormy weather) were also recorded. Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat. Species accumulation curve described in **Section 4.1.4.1** below indicate that all birds species in the survey area were detected. **No specific survey requirement – however survey effort considered sufficient.**
Migratory woodland birds	Draft referral guidelines for 14 birds listed migratory under the EPBC Act	**Draft referral guidelines for 14 birds listed migratory under the EPBC Act** Area survey, preferably a two-hectare survey in 20 minutes, over sufficient survey plots to estimate a density, and hence the population size across the	• Area surveys • General bird surveys • 51 Habitat/BioCondition assessments	Bird surveys of at least 20 minutes' duration were undertaken at 24 sites, in addition to diurnal active search sites. All birds heard or

		proposed development area. Surveys should be undertaken in an appropriate season - spring or summer in southern Australia.		seen during flora surveys (10 days of survey effort in February 2019) were also recorded. Outcomes from the 51 BioCondition/habitat assessments identified suitable habitat. Species accumulation curve described in **Section 4.1.4.1** below indicate that all bird species in the survey area were detected. **Survey effort considered sufficient.**
Brigalow TEC	Conservation Advice for the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (2013) Brigalow (*Acacia harpophylla* dominant and co-dominant) information sheet (2001)	The Conservation Advice outlines key diagnostic characteristics and condition thresholds (in summary): 1. *Acacia haypophylla* must be one of the most abundant tree species in patch; 2. In Queensland, the patch must include at least one of the following Regional Ecosystems: REs 11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14 and 11.12.21 for the Brigalow Belt region; 3. Patch size greater than 0.5 ha; 4. Exotic perennial plants comprise less than 50% of the total vegetation cover of the patch, as assessed over a minimum sample area of 0.5 ha; and,	The approach taken followed that prescribed by Neldner et al. (2019) in *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Version 5.0*. Survey timing coincided with maximum plant growth in the mid to late wet season and was optimal for detecting threatened species as well as describing overall diversity. • 51 Habitat/BioCondition assessments were undertaken within 20 AU's across the disturbance footprint	Regional Ecosystems were verified following Neldner (2019) methodology. The Queensland BioCondition process was used to determine the condition of Brigalow patches, by including weed cover in the assessment. **Survey Guidelines met**

		5. Exclusion of REs 11.3.17, 11.9.10, 11.9.11, and 11.11.16 in the Brigalow Belt region. Further, surveys must be conducted in consideration of the time of year and history of disturbance.		
Bats	A Review of Ghost Bat Ecology, Threats and Survey Requirements 2021 Survey Guidelines for Australia's Threatened Bats 2010	The *Review of Ghost Bat Ecology, Threats and Survey Requirements* recommends the following methods (in summary): • Identify known caves and mines prior to survey; • Passive ultrasonic detection at cave entrances or within roost chambers (full-spectrum device recording at a sample rate of at least 128 kHz); • Active acoustic detection (playback) only when appropriate (i.e., at water holes or ponds in suspected foraging locations); • Omnidirectional and directional microphones, used as appropriate; • Trapping only when necessary for specific purposes; The following effort is recommended: • Surveys should be repeated twice, approximately 6 months apart; and, Once a potential location has been identified, echolocation detectors should be placed at the entrance for a minimum of 3 nights.	• Passive Acoustic monitoring with omnidirectional microphones • General spotlight searches • Note: No suitable caves were found to apply roost surveying methodologies to.	AnaBat recordings were completed at 10 sites that represented likely flyways for bats: tracks through forest, creek lines and around dams. Recordings were made overnight for one night at each site. Spotlight surveys were also conducted for 40 person minutes at 28 sites. No caves or overhangs were found to be suitable for Ghost Bat roosting or breeding. No Ghost Bats were detected by spotlight. Given that the opportunity for the existence of roosts was low due to none being found, the **survey effort was considered sufficient.**
Small to medium	Survey guidelines for Australia's threatened mammals 2011	**Survey guidelines for Australia's threatened mammals 2011** Cage trapping:	• Remote sensory camera • Cage trapping • Spotlight searches	The current survey included 122 camera-nights of sampling, in addition to 31

carnivorous marsupials		• 10 cage traps (or Elliott B traps, see species profiles for details) placed at each sampling site • Traps placed on the ground approximately 50 metres apart in two parallel straight lines (transects) separated by 20–50 metres (a greater distance between traps is recommended in some species profiles) • One sampling site per representative habitat, with a minimum of two sampling sites required per 5 hectares • (replication across habitat types in areas greater than 5 hectares) • Set traps for four consecutive nights. Spotlighting: • Survey at least two 200 metre transects per 5 hectare site (or longer transects for larger sites) • Maintain an interval of at least 100 metres between the two transects in order to maximise the area surveyed, which is usually 1 kilometre. In addition, the usage of camera traps is recommended in conjunction with other survey techniques such as spotlighting. The guidelines state: • Cameras should be deployed for at least 14 nights, and • Approximately 10 cameras should be deployed per hectare.		trap-nights of cage trapping and 28 spotlight surveys. These surveys failed to detect any Northern Quolls. **Survey Guidelines met**



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Boundary

Survey Points

- Trap Site
- Camera
- AnaBat
- Spotlight
- Target

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_Terrestrial_Ecology_Fauna_Surveys.aprx

Vulcan South

Locations of Fauna Surveys (North)

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

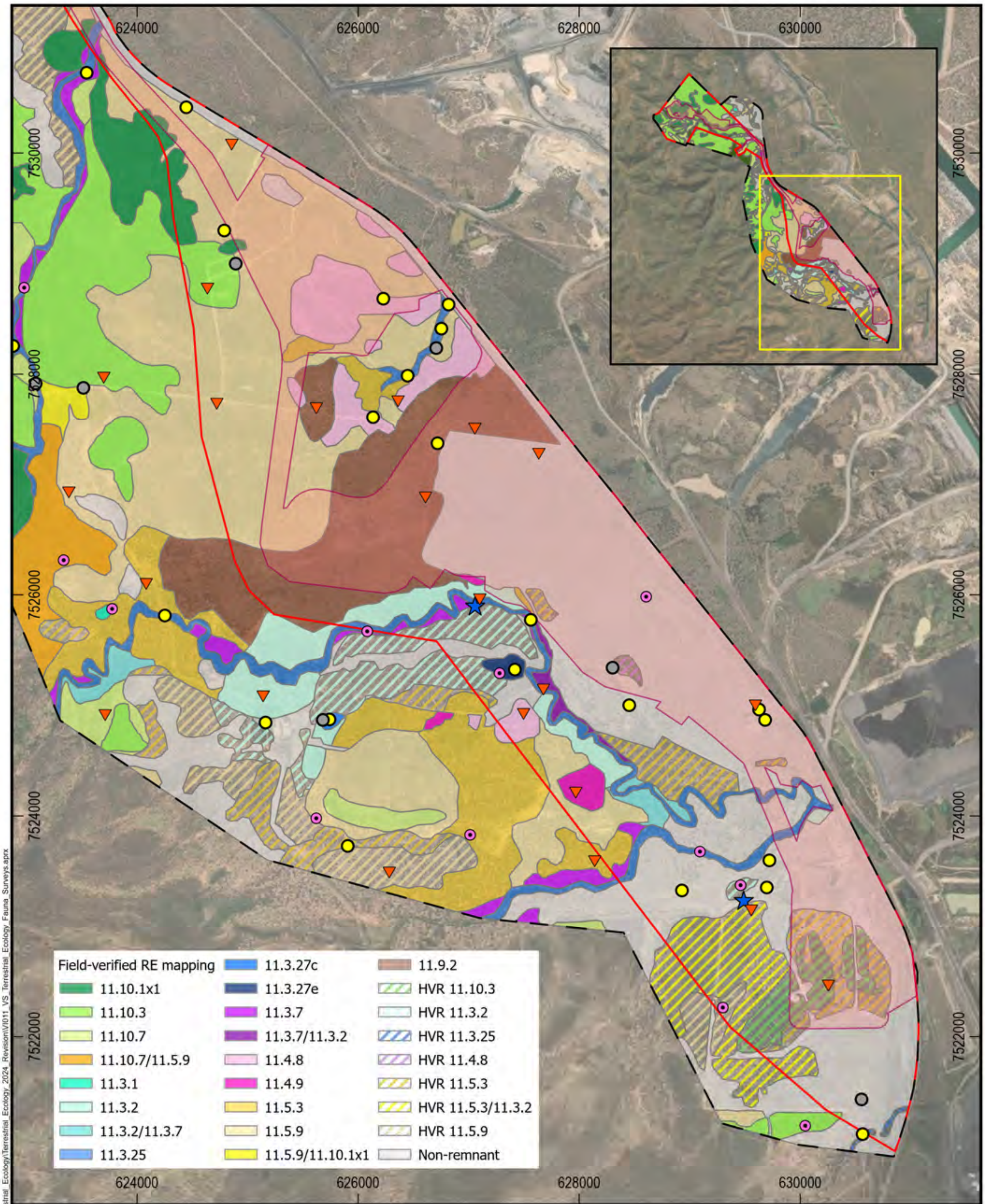
19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 3-4

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Boundary

Survey Points

- Trap Site
- Camera
- AnaBat
- Spotlight
- Target

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics

Vulcan South

Locations of Fauna Surveys (South)

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 3-5

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

3.2.3 Habitat Quality Assessment

It is noted that the field data (described below in Section 4) collected between October 2018 and October 2019, are now over five years old. Despite their age, the 2018-2019 surveys are considered to be a reliable source of information. Habitat quality data was gathered from the footprint in June 2023 as part of a BioCondition assessment, for the purpose of assessing suitable offsets sites. Based on this assessment, there is little reason to expect any changes to the faunal habitat values of the site since the 2018-2019 surveys were undertaken. The footprint has not experienced any clearing, droughts, fires, floods or cyclones since the 2018-2019 surveys. The main alteration to the local landscape is the construction of the Vulcan Coal Mine immediately east of the footprint. Noise, light and dust associated with this disturbance may mean that habitats occupied in 2019 have since been vacated by some fauna. For this reason, data gathered in the 2018-2019 surveys represent a more conservative assessment of the habitat values of the site than if the surveys were to be undertaken today.

The methodology follows that outlined in the *Guide to Determining Terrestrial Habitat Quality version 1.3* (Department of Environment and Science 2020a). This guideline proposes two methodologies for assessing habitat quality:

- BioCondition assessments conducted in accordance with the *BioCondition Assessment Manual version 2.2* (Department of Science, Information Technology, Innovation and the Arts 2015); and
- Specially tailored, species-specific habitat quality scores developed by considering the foraging, breeding, sheltering and dispersal requirements of each species, along with local threat levels.

The former provides a general assessment of the overall state of the vegetation community. BioCondition assesses both site-specific habitat quality attributes, as well as landscape-scale attributes such as connectivity, size of habitat patch and regional context. The site-specific component of BioCondition is broadly analogous to the "site condition" score suggested within *How to Use the Offset Assessment Guide.* The landscape-scale component is broadly analogous to "site context" score. Meanwhile, the species-specific habitat quality scores indirectly reflect the potential stocking rate of the listed species that the habitat is able to support, by specifically targeting habitat features that are likely to be limiting local populations.

The impact area was assessed using the sampling design framework described by the *Guide to determining terrestrial habitat quality version 1.3*. (DES, 2020a)

The Offsets Assessment Guide requires evidence-based habitat quality scores for the impact and offset areas. Habitat quality is to consider site condition, site context and species stocking rates, but no federal guidelines or manuals exist that prescribe how habitat quality is to be assessed. The Guidelines within DES (2022a) were used to assess the habitat quality of the Vulcan south footprint. This guide recommends undertaking a comprehensive literature review of the species to identify the factors that constitute, and have the ability to affect the following components of habitat quality:

- Quality and availability of food and habitat required for foraging;
- Quality and availability of habitat required for shelter and breeding;
- Quality and availability of habitat required for mobility; and
- Exposure to threats.

A project-specific set of indicators and a scoring system has been devised in order to assess habitat quality for the Squatter Pigeon (**section 4.3.3.1**), Koala (**section 4.3.3.2**) and Greater Glider (**section 4.3.3.3**).

3.3 GROUNDWATER-DEPENDENT ECOSYSTEMS

The Queensland Government has undertaken mapping of groundwater-dependent ecosystems (GDEs) across most of the State (Department of Science, Information Technology and Innovation 2015). The survey area has, however, not been mapped in the most recent version (version 1.5) of this GDE mapping.

Instead, the *National Atlas of Groundwater Dependent Ecosystems* (BOM 2019) was consulted to identify locations where there is a moderate to high potential for vegetation communities to be dependent on groundwater. This dataset was compared to the field-verified regional ecosystem mapping undertaken as per **Section 3.2.1**. Regional ecosystems present within areas mapped as potentially groundwater-dependent ecosystems were assessed for their likelihood of groundwater dependence by examining:

1) Published literature on the ecology of the dominant tree species in each regional ecosystem;
2) landscape position;
3) water-holding capacity of the soil; and
4) site-specific data on the depth to groundwater (where available).

For regional ecosystems considered likely to be groundwater-dependent, their mapped boundaries were taken from field-verified regional ecosystem mapping, rather than the coarser-scale *National Atlas of Groundwater Dependent Ecosystems.* This integration of GDE mapping with regional ecosystem mapping is a core principle of the Queensland GDE Mapping Project (Department of Science, Information Technology and Innovation 2015).

4 ENVIRONMENTAL VALUES

4.1 OVERVIEW OF THE REGION'S ECOLOGY

4.1.1 Habitat Features

The survey area contains a variety of remnant, regrowth and cleared habitats. The western half of the survey area is dominated by low sandstone ridges and escarpments of the Cherwell/Harrow Range. These escarpments rise 100-170 m above the surrounding plains, and mostly support remnant vegetation. Dominant tree species across the Cherwell/Harrow Range include *Corymbia citriodora, Corymbia aureola, Eucalyptus crebra, Corymbia trachyphloia, Eucalyptus melanophloia* and *Acacia shirleyi.* The sandstone escarpments contain an abundance of boulders and rock outcrops (**Figure 4-1**), which provide shelter for reptiles and rock-wallabies. Rock overhangs and small caves are also present, primarily in the northwest, and these provide potential shelter sites for bats and other fauna.

The eastern half of the survey area predominantly comprises a sand plain supporting woodlands of *Eucalyptus crebra, Eucalyptus melanophloia, Eucalyptus populnea* and/or *Corymbia clarksoniana* (**Figure 4-1**). This plain also contains sections of heavy clay, supporting *Acacia harpophylla, Casuarina cristata* and/or *Eucalyptus cambageana.* These heavier soils have mostly been cleared of their remnant vegetation, although small fragments remain, especially near Saraji Road. The clay soils support minor gilgai formation. These gilgais tended to be less than 30 cm deep and held water for less than one month after heavy rain. They provide marginal breeding habitat for frogs, and frog densities tended to be low, even after heavy rain.

A low (~10 m above the surrounding plain) clay rise running northeast-southwest through the southern half of the survey area supported open woodland of *Eucalyptus orgadophila*. The cracking clay soil provided potential shelter for some reptiles and mammals; however, the understorey had been markedly affected by prolonged heavy grazing by livestock. This understorey was dominated by the exotic pasture grass, *Bothriochloa pertusa*, which was grazed to a lawn during dry periods, affording little protection for ground-dwelling fauna.

Heavy grazing pressure was also a notable feature of the sand plains across the survey area. This manifested through the altered composition of the understorey vegetation (Fensham *et al.* 1999; Walker *et al.* 2006). Native perennial grasses, an important food source for a variety of granivorous animals (Lewis 2007; Crowley 2008), were scarce, while introduced pasture grasses (especially *Cenchrus ciliaris, Bothriochloa pertusa, Melinis repens* and *Urochloa mosambicensis*) and native annual species (e.g., *Alloteropsis cimicina, Setaria surgens, Dactyloctenium radulans, Perotis rara*) dominated all remnant and non-remnant habitats away from the sandstone ridges.

The survey area is bisected by numerous first order to fourth order watercourses that flow in an easterly direction. All of these are tributaries of the Isaac River. All watercourses on site are ephemeral and sustain flows for short periods (less than one week) following heavy rain. Sub-surface flows (beneath the sandy creek beds) occur for longer periods, and third order and fourth order watercourses support a dense fringe of *Eucalyptus camaldulensis, Melaleuca leucadendra* and/or *Melaleuca fluviatilis,* trees that can access this water supply. These sandy-bedded watercourses do not provide an important water source for fauna, due to a lack of pools and the short duration of surface flows. The only watercourse on site that retained pooled water for extended periods (i.e., months) after rain was North Creek, but only in its upper reaches. Where it passes through gorges within sandstone escarpments, the boulder-strewn bed of North Creek (**Figure 4-1**) contains numerous small pools, which provide a drinking source for fauna. These pools were dry in the late dry season (September-October).

Other surface water features that provide important water sources for fauna include farm dams and natural wetlands. The latter are represented on site by two billabongs formed in the former channel of Hughes Creek (**Figure 4-1; Figure 4-2**). The western one is a mapped wetland under the *Vegetation Management Act 1999*. Both billabongs had heavily grazed margins and supported few waterfowl. Among the farm dams, two areas provided particularly important habitat for waterfowl and other aquatic wildlife: 1) a chain of dams in the far southeast of the survey area (along a drainage line), and 2) a large dam beside cattle yards in the southwest of the survey area. Both sites supported a diversity of sedges and rushes, providing refuge for waterfowl and other fauna. A smaller, but equally well vegetated dam occurred in the northeast of the survey area, within the Vulcan Coal Mine ML (**Figure 4-1; Figure 4-2**).

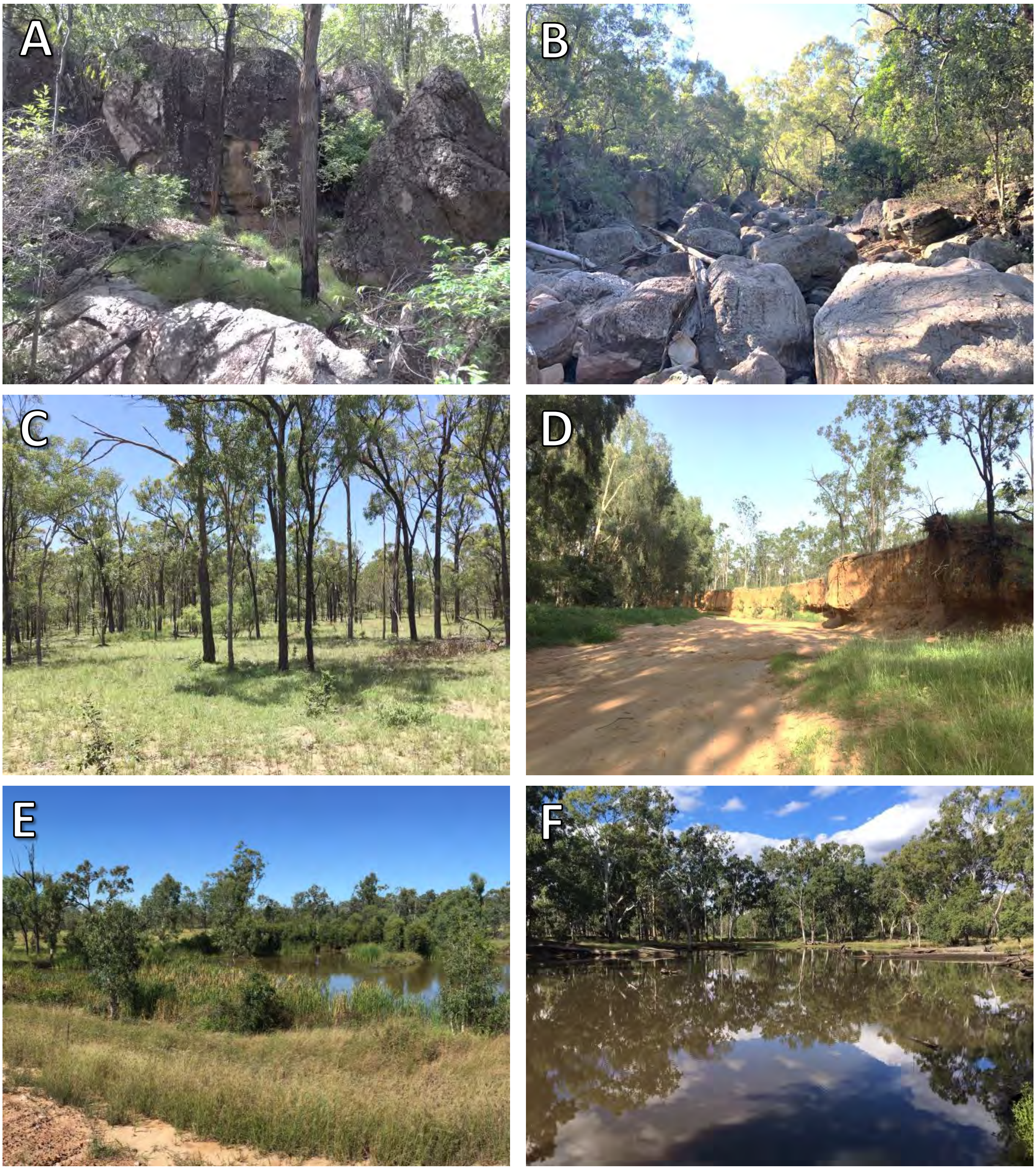
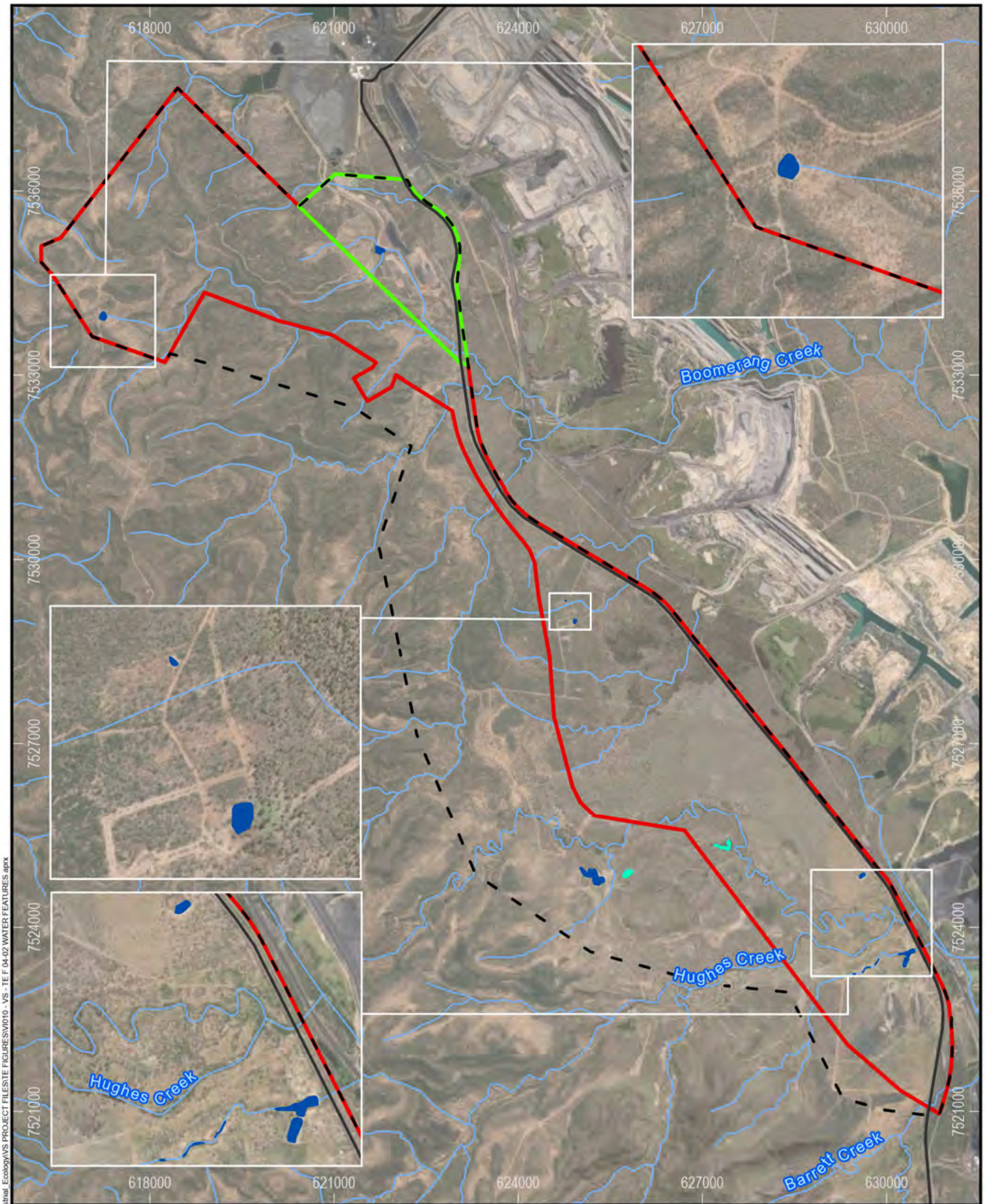


Figure 4-1 **Habitat features of the survey area:** A) sandstone outcrops, B) headwaters of North Creek, C) sand plain woodland dominated by *Eucalyptus crebra* (RE 11.5.9), D) middle reaches of Hughes Creek showing sandy watercourse bed, E) dam in northeast, from which cattle are excluded, and F) natural billabong beside Hughes Creek.



Legend

- Saraji Road
- Drainage Lines
- ML 700060
- MLA Area
- Survey Area

Water Features in the Survey Area

- Dam
- Natural Wetland

Source: Geoscience Australia 2015, State of Queensland (Department of Resources) 2021, Vitrinite 2022, METServe 2020-2022, Earthstar Geographics.

Vulcan South

Water Features

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

13/10/2023

Datum: GDA2020
Projection: MGA55

FIGURE 4-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\VS PROJECT FILES\TE FIGURES\V010 - VS - TE F 04-02 WATER FEATURES.aprx

4.1.2 Vegetation Communities

Sixteen regional ecosystems were recorded within the survey area (**Table 4-1, Figure 4-3**). Of these, 14 were present within the ML area. Field surveys revealed widespread errors in the original regulated vegetation map of the site, which has since been updated based on these surveys (for the regulated vegetation map, refer to **Figure 4-22**):

1) A large unit located in the centre of the survey area was erroneously mapped as the endangered regional ecosystem 11.4.8. Field surveys revealed that this entire unit contains the least concern regional ecosystem 11.9.2. This is supported by secondary sites 6, 23 and 31 (**Appendix B**). The regulated vegetation map has been updated accordingly.
2) The dominant unit in the western part of the survey area was mapped as a mixed mosaic containing 11.10.1, 11.10.3 and 11.10.8. While 11.10.3 is widespread in this unit, 11.10.8 is confined to a single, tiny patch (secondary site 50). Regional ecosystem 11.10.1 is represented by two distinctly different subtypes. The classic subtype (dominated by *Corymbia citriodora, Corymbia trachyphloia* and *Eucalyptus crebra*) is limited in extent, primarily occurring in sheltered gorges and south-facing slopes. The more widespread subtype was an open forest dominated by *Corymbia aureola* and *Eucalyptus melanophloia*, which usually grew on plateaux and other exposed sites with shallow, rocky soil. This vegetation unit did not match any of the described regional ecosystems in Queensland but bore some similarity to 11.10.4a and 11.10.13b (both belong to the broad vegetation group 12a, unlike classical 11.10.1, which belongs to 10a). The Queensland Herbarium has opted to combine both subtypes under 11.10.1 in the updated regulated vegetation map. However, these subunits are mapped separately in this report, in light of their different habitat values to threatened fauna. The subtype dominated by *C. aureola* and *E. melanophloia* is assigned the code 11.10.1x1, as per Nelder *et al.* (2019). Secondary sites assessing 11.10.1x1 include 3, 24, 37 and 44 (**Appendix B**).
3) Large parts of the survey area are mapped as the regional ecosystem 11.5.9b. These areas are better described as 11.5.9, due to the absence of *Eucalyptus tenuipes* and *Lysicarpus angustifolius*, and the frequent dominance of *Eucalyptus melanophloia, Alphitonia excelsa, Acacia* spp. and *Melaleuca nervosa*. This is supported by secondary sites 2, 17, 25 and 32 (**Appendix B**). In some places (e.g., secondary sites 1, 4 and 35), the *Eucalyptus* stratum is missing, resulting in a dense shrub layer of *Melaleuca nervosa, Acacia burdekensis* and/or *Allocasuarina luehmannii*. Presumably this occurs where drainage is impeded by shallow bedrock or texture contrast soils. Such areas may constitute 11.5.2, specifically 11.5.2a where *A. luehmannii* is dominant. However, this designation is not perfect, given the frequent presence of *E. melanophloia,* a species not listed in the description of 11.5.2. Due to a lack of suitable alternatives for these communities, they are retained as subtypes of 11.5.9, despite the localised absence of a *Eucalyptus* stratum.
4) Extensive areas mapped as regional ecosystem 11.5.9b were located on the foot slopes of sandstone outcrops. In many instances, there was substantial outcropping of sandstone present. Based on gully erosion present at some of these sites, the sandy layer was only approximately 0.5 m thick above sandstone. These areas were more appropriately considered 11.10.7, which is the equivalent *E. crebra* and/or *E. melanophloia* community on land zone 10. This is supported by secondary sites 7, 38 and 40 (**Appendix B**).
5) The extent of land zone 3 (alluvium) tended to be over-estimated by certified regional ecosystem mapping. Often, there were relatively flat terraces on the sandstone slopes close to waterways that resembled alluvial plains on aerial imagery. However, field surveys revealed steep boulder-strewn slopes (land zone 10) between these terraces and the banks of the waterway, indicating that these terraces are not alluvial. Furthermore, where land zone 5 (sand plain) abutted waterways, there was often no detectable drop in elevation or change in soil colouration as one approached the waterway, consistent with a shift to land zone 3. In some cases, the terrain actually rose slightly from the neighbouring plain to the banks of the watercourse (with a very steep bank present on one side of the watercourse). Such cases are more appropriately considered land zone 5 up to the watercourse bank.

6) Certified regional ecosystem mapping is undertaken at a broad scale, and contains numerous units composed of a mosaic of multiple regional ecosystems. The fine scale of the field-verified mapping has allowed, in most cases, the re-mapping of each regional ecosystem separately. The updated regulated vegetation map now maps each unit separately.

It should also be noted that the land use within the ML has been consistent from the time of surveys to the present, to the extent that changes to habitat values will be non-existent or negligible at best. Nevertheless, the values here are considered conservative to the point that the habitats for some species is likely over-estimated. Section 4.3 addresses habitat quality scores and methodologies for MNES species that are considered confirmed or likely to occur in the Project area.

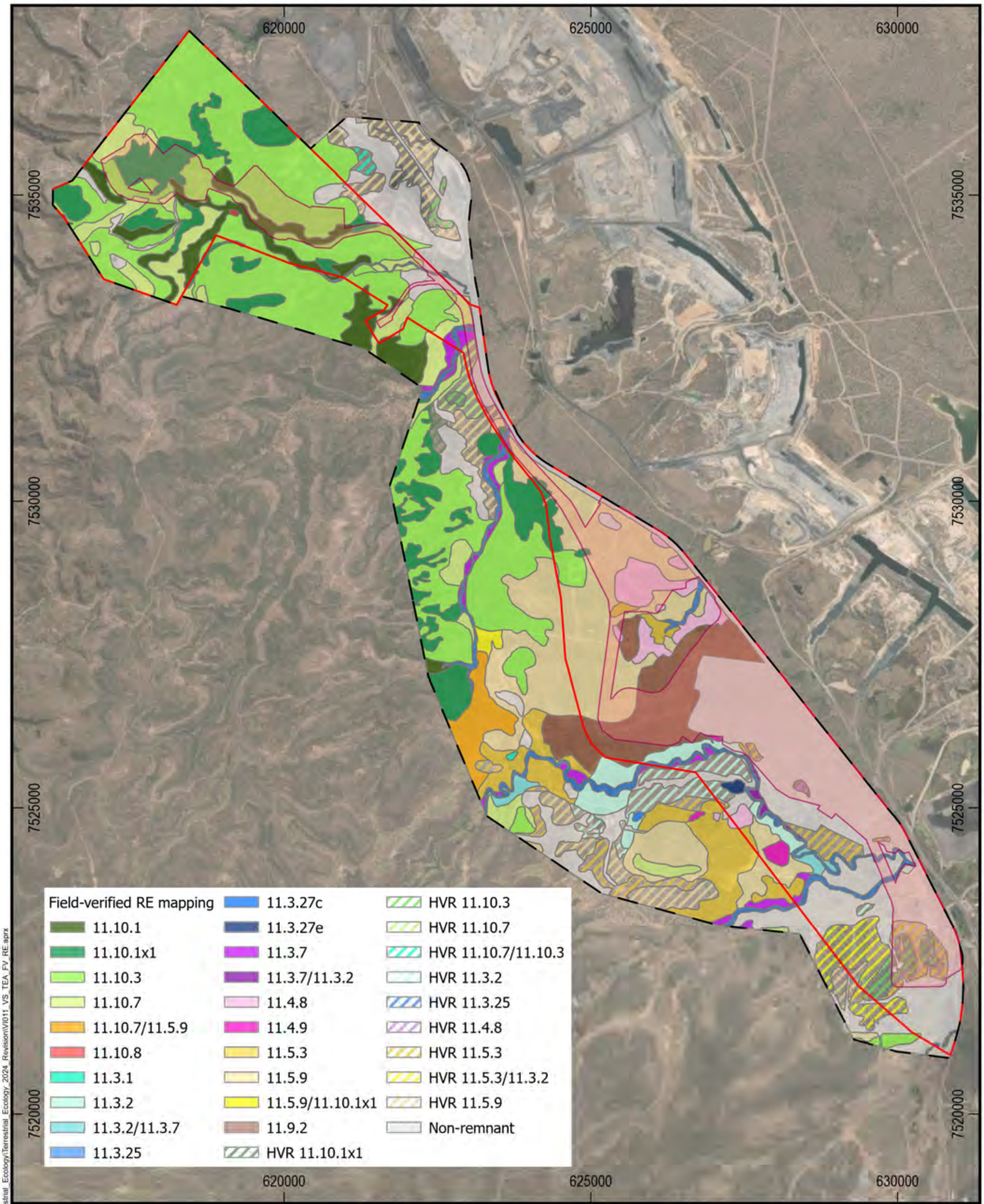
Table 4-1 Regional ecosystems recorded in the survey and project areas

Regional Ecosystem	BVG*	Short description	VM class†	Biodiv. Status‡	Hectares within survey area		Hectares within project area	
					Remnant	Regrowth	Remnant	Regrowth
11.3.1	25a	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	E	E	1.6	0	0	0
11.3.2	17a	*Eucalyptus populnea* woodland on alluvial plains	OC	OC	127.7	148.2	55.4	63.9
11.3.7	9e	*Corymbia* spp. woodland on alluvial terraces	LC	OC	86.1	0	31.3	0
11.3.25	16a	*E. camaldulensis* forest fringing drainage lines.	LC	OC	147.7	5.3	71.9	2.0
11.3.27c	34d	Mixed sedgeland in freshwater wetland	LC	OC	2.0	0	0	0
11.3.27e	34d	Open water freshwater wetland with fringing trees	LC	OC	6.5	0	6.5	0
11.4.8	25a	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* on Cainozoic clay plains.	E	E	127.4	4.0	124.5	4.0
11.4.9	25a	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.	E	E	16.2	0	13.9	0
11.5.3	17a	*Eucalyptus populnea* woodland on Cainozoic sand plains and/or remnant surfaces.	LC	NC	278.7	239.0	33.1	141.7
11.5.9	18b	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces.	LC	NC	877.7	271.4	488.6	17.0
11.9.2	17b	*Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks.	LC	NC	325.5	0	267.8	0
11.10.1	10a	*Corymbia citriodora* woodland on coarse-grained sedimentary rocks.	LC	NC	244.5	0	161.0	0
11.10.1x1	12a	*Corymbia aureola* and *Eucalyptus melanophloia* open forest on scarps and sandstone tablelands.	LC	NC	474.0	11.3	227.8	0
11.10.3	24a	*Acacia shirleyi* open forest on coarse-grained sedimentary rocks. Crests and scarps.	LC	NC	1,589.0	68.8	849.9	47.1
11.10.7	12a	*Eucalyptus crebra* woodland on coarse-grained sedimentary rocks.	LC	NC	362.7	48.3	181.9	10.3
11.10.8	7a	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks.	OC	OC	1.3	0	1.3	0
Non-remnant	-	Cleared pasture, +/- scattered trees or young regrowth	-	-	1,517.6		1,018.4	

*BVG = broad vegetation group

†VM class = classification under the *Vegetation Management Act 1999*: E = endangered, OC = of concern. LC = least concern.

‡Biodiversity status relates to environmentally sensitive areas under the *Environmental Protection Act 1994*: E = endangered, OC = of concern, NC = no concern at present



Legend

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Survey Boundary

Source: State of Queensland (Department of Resources) 2023, METServe 2019-2024, Vitrinite 2024, Earthstar Geographics

Vulcan South

Field-verified Regional Ecosystems

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-3

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_FV_RE.aprx

4.1.3 Groundwater-dependent Ecosystems

There are three main categories of groundwater-dependent ecosystems (Department of Science, Information Technology and Innovation 2015):

1) vegetation that accesses sub-surface groundwater through its roots;
2) wetlands that receive groundwater discharge (e.g., springs); and
3) subterranean aquatic ecosystems, and marine systems that receive sub-marine discharge of groundwater.

Of these, categories 2 and 3 are aquatic ecosystems assessed elsewhere through an aquatic ecological assessment. Category 1, however, refers to terrestrial ecosystems that are dependent on access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.

For vegetation to access groundwater in the sub-surface, the roots must be able to reach the capillary zone above the water table and the water quality of groundwater must be adequate. In order to assess and map potential terrestrial groundwater-dependent ecosystems across the survey area, the following data sources were considered:

- *National Atlas of Groundwater Dependent Ecosystems version 2.0* (BOM 2019);
- published literature on root depths and groundwater usage among local vegetation types;
- depth-to-groundwater mapping of part of the project area (provided by hydrogeologist.com.au); and
- groundwater quality (hydrogeologist.com.au 2024).

4.1.3.1 Review of Groundwater Use by Terrestrial Vegetation

There has been much recent worldwide research into groundwater-dependent ecosystems, combining tools such as stable isotope analysis, measurement of pre-dawn leaf water potential, and seasonal tracking of transpiration rates and "greenness" indices. One of the key findings of this research is that the use of groundwater by terrestrial vegetation depends greatly on the depth of this groundwater, and the influence of depth is largely consistent across continents and vegetation communities:

- In arid regions of China, groundwater up to 4–10 m below the surface is used by vegetation (Jin *et al.* 2011; Lv *et al*. 2012; Liu *et al*. 2017).
- In California, groundwater up to a depth of 6–8 m is used by vegetation (McLendon *et al*. 2008).
- Various studies in Australia have identified lower limits to the root extraction of groundwater of 7.5 m (Benyon *et al*. 2006), 5–11 m (O'Grady *et al*. 2006a), 8–10 m (Robinson *et al*. 2006), and 9 m (Zolfaghar *et al*. 2017).

Despite these relatively consistent average patterns, not all tree species access groundwater equally. For example, based on spatial patterns in declining canopy conditions during drought, Kath *et al.* (2014) inferred that *Eucalyptus populnea* (a species native to the survey area) regularly accessed groundwater to a depth of 13 m and, to far lesser extent, up to 26 m. To explore this variation between species in their propensity to access groundwater, published data on local vegetation types were reviewed and summarised in **Table 4-2**. Note that this assessment is limited to regional ecosystems within the project area, as the accuracy of depth-to-groundwater mapping far beyond this is limited by a lack of survey data.

Where data is lacking, it is practical to use the widely adopted rule-of-thumb (e.g., Eamus *et al*. 2006a; Department of Natural Resources, Mines and Energy (DNRME) 2019a), that vegetation is likely to use groundwater where it is up to a depth of 10 m, may possibly use groundwater at depths of 10-20 m, but is unlikely to access water deeper than 20 m.

Table 4-2 Published groundwater usage by local tree species

Regional Ecosystem	Rooting depths of dominant species	Likelihood of groundwater-dependence
11.3.2	*Eucalyptus populnea* accesses groundwater in some situations (Anderson and Hodgkinson 1997) but not others (Fensham and Fairfax 2007). On Brigalow Belt floodplains, *E. populnea* accesses groundwater up to 13 m deep and, to a lesser extent, up to 26 m, but not deeper (Kath *et al.* 2014).	**Moderate:** Possibly uses ground water where groundwater levels are within 13 m, and there may be minimal use of groundwater at sites where the water table is within 25 m of the surface.
11.3.7	*Corymbia tessellaris* accessed groundwater at the only site where it has been studied, where the water table was 4 m deep (O'Grady *et al.* 2006a). As the species is largely confined to terraces along watercourses (where the water table is usually shallow), it is probably often groundwater-dependent. *Corymbia clarksoniana* is highly dependent on groundwater between 6.5 and 10 m deep during the dry season (Cook and O'Grady 2006; O'Grady *et al.* 2006a).	**Moderate:** Possibly utilises groundwater where this is <20 m deep, and likely uses it within 10 m.
11.3.25	*Eucalyptus camaldulensis* is often dependent on shallow aquifers and water courses (Bacon *et al.* 1993). Isotope studies indicate that *E. camaldulensis* accesses groundwater up to a depth of 9.4–11.2 m, but not deeper (Rumman *et al.* 2018). A similar finding—that *E. camaldulensis* commonly accesses groundwater to a depth of 12.5 m—was revealed by studies of tree condition (Kath *et al.* 2014). The latter study revealed that groundwater may also be accessed to a limited extent up to 20 m, but not deeper. *Melaleuca leucadendra* and other riparian *Melaleuca* spp. are reliant on river water and/or shallow groundwater, up to 9 m deep (O'Grady *et al.* 2005, 2006a, 2006b).	**High:** Water tables are within reach of this vegetation, and the constituent species are regularly groundwater-dependent elsewhere.
11.3.27e	This is a vegetated wetland that, to be groundwater-dependent, requires the surface expression of groundwater.	**Nil:** The water table is too low for there to be any surface expression.
11.4.8	Tunstall and Connor (1981) found *Acacia harpophylla* roots to penetrate to at least a depth of 4 m, although high salt content of the soil caused plants to experience strong water deficiencies except immediately after rain. This dependence on rain implied a failure to utilise groundwater. Subsoils beneath *A. harpophylla* communities tend to be heavy, saline and/or sodic, impeding water availability (Tunstall and Connor 1981). *A. harpophylla* tissue is even more resistant to desiccation than that of other shallow-rooted arid-zone *Acacia* spp. (Connor and Tunstall 1968), implying a lack of reliance on groundwater.	**Low:** Unlikely to utilise groundwater.

Regional Ecosystem	Rooting depths of dominant species	Likelihood of groundwater-dependence
11.4.9	Tunstall and Connor (1981) found *Acacia harpophylla* roots to penetrate to at least a depth of 4 m, although high salt content of the soil caused plants to experience strong water deficiencies except immediately after rain. This dependence on rain implies a failure to utilise groundwater. Subsoils beneath *A. harpophylla* communities tend to be heavy, saline and/or sodic, impeding water availability (Tunstall and Connor 1981). *A. harpophylla* tissue is even more resistant to desiccation than that of other shallow-rooted arid-zone *Acacia* spp. (Connor and Tunstall 1968), implying a lack of reliance on groundwater.	**Low:** Unlikely to utilise groundwater.
11.5.3	*Eucalyptus populnea* accesses groundwater in some situations (Anderson and Hodgkinson 1997) but not others (Fensham and Fairfax 2007). On Brigalow Belt floodplains, *E. populnea* accesses groundwater up to 13 m deep and, to a lesser extent, up to 26 m, but not deeper (Kath *et al*. 2014).	**Low-Moderate:** Possibly uses ground water where groundwater level is within 13 m, and there may be minimal use of groundwater elsewhere.
11.5.9	Ironbark species (*Eucalyptus crebra* and *E. melanophloia*) are sensitive to die-back during drought and exhibit xylem flows and root depths consistent with a lack of access to groundwater (Rice *et al*. 2004; Fensham and Fairfax 2007). *Corymbia clarksoniana* is highly dependent on groundwater between 6.5 and 10 m deep during the dry season (Cook and O'Grady 2006; O'Grady *et al*. 2006a). Gow *et al*. (2016) found that *Eucalyptus crebra*, *E. decorticans* and *Corymbia* spp. woodlands on rocky hill slopes exhibited temperature radiation patterns consistent with the use of deep soil water. As the water table was generally between 10 m and 60 m, the authors hypothesised that most of the water used was intercepted while draining through the unsaturated zones of the soil profile, rather than originating from groundwater per se.	**Low-Moderate:** In places where the water table is within 10 m of the ground surface, sub-dominant components of this RE are likely to be groundwater-dependent.
11.9.2	No data has been published on the root structure or groundwater dependence of *Eucalyptus orgadophila*. *Corymbia erythrophloia*, a sub-dominant component of the ecosystem, showed xylem flow patterns consistent with access to some amount of sub-soil water (Rice *et al*. 2004), although whether this reflects use of groundwater is not known.	**Low:** Unlikely to utilise groundwater, due to consistently large depths where this RE occurs.
11.10.1	When *Corymbia citriodora* grew above a shallow water table (i.e., 3.1 m deep), root and evapotranspiration patterns indicated that groundwater was an important water source (Falkiner *et al*. 2006; Benyon *et al*. 2006). No data are published on the use of deeper sources of groundwater by *C. citriodora*. Ironbarks (*Eucalyptus crebra* and *E. melanophloia*) are sensitive to die-back during drought and exhibit xylem flows and root depths consistent with a lack of access to groundwater (Rice *et al*. 2004; Fensham and Fairfax 2007).	**Low:** With the possible exception of the bases of certain gorges, groundwater is too deep within the sandstone ranges to be available to this RE.
11.10.1x1	No data have been published on the groundwater dependence of *Corymbia aureola, Corymbia trachyphloia* or *Eucalyptus exserta.* This vegetation type primarily occupies sandstone plateaux, where groundwater is far beyond the root zone of most trees.	**Low:** Unlikely to utilise groundwater, except when shallow.

Regional Ecosystem	Rooting depths of dominant species	Likelihood of groundwater-dependence
11.10.3	There are no published data on the groundwater-dependence or rooting depths of *Acacia shirleyi* or *Acacia rhodoxylon*. However, other *Acacia* spp. that grow on similar rocky substrates (e.g., *A. aneura, A. aptaneura* and *A. kempeana*) do not access groundwater, but instead have reinforced xylem vessels that are able to cope with strong water deficiencies (Anderson and Hodgkinson 1997; Nolan *et al*. 2017).	**Low:** Dominant species are unlikely to utilise groundwater.
11.10.7	Ironbarks (*Eucalyptus crebra* and *E. melanophloia*) are sensitive to die-back during drought and exhibit xylem flows and root depths consistent with a lack of access to groundwater (Rice *et al*. 2004; Fensham and Fairfax 2007). Gow *et al*. (2016) found that *Eucalyptus crebra*, *E. decorticans* and *Corymbia* spp. woodlands on rocky hill slopes exhibited temperature radiation patterns consistent with the use of deep soil water. As the water table was generally between 10 m and 60 m, the authors hypothesised that most of the water used was intercepted while draining through the unsaturated zones of the soil profile, rather than originating from groundwater per se.	**Low:** Dominant species are unlikely to utilise groundwater and groundwater is likely to be too deep at the locations where this RE occurs (on terraces and slopes).
11.10.8	No data have been published on the root structure or groundwater dependence of local vine thicket trees and shrubs. Most species are semi-deciduous, avoiding drought stress by shedding their leaves and thereby minimising transpiration. Studies of vine thickets across a range of soil types in northern New South Wales found water stress to be ubiquitous during drought periods (Curran *et al*. 2009), implying a lack of access to groundwater during dry periods.	**Low:** Dominant species are unlikely to utilise groundwater.

4.1.3.2 Depth to Groundwater

Hydrogeologist.com.au (2024) developed a calibrated, numerical groundwater model of all relevant aquifers within the vicinity of Vulcan South's proposed pits. This was based on a range of data sources, including an on-site groundwater monitoring network, groundwater assessments from nearby mines, and the *Queensland Groundwater and Surface Water Monitoring* database (DNRME 2019b).

An aquifer is generally defined as a geological unit that can transmit and store significant quantities of groundwater. In the vicinity of the project area, some geological units yield low volumes of groundwater and would not typically be classified as aquifers in most hydrogeological settings. However, as these could provide a small and/or temporary source of groundwater for vegetation, they are referred to as aquifers for the purposes of this assessment.

Groundwater may be stored, even if only temporarily, in three hydro-stratigraphic units present on site:

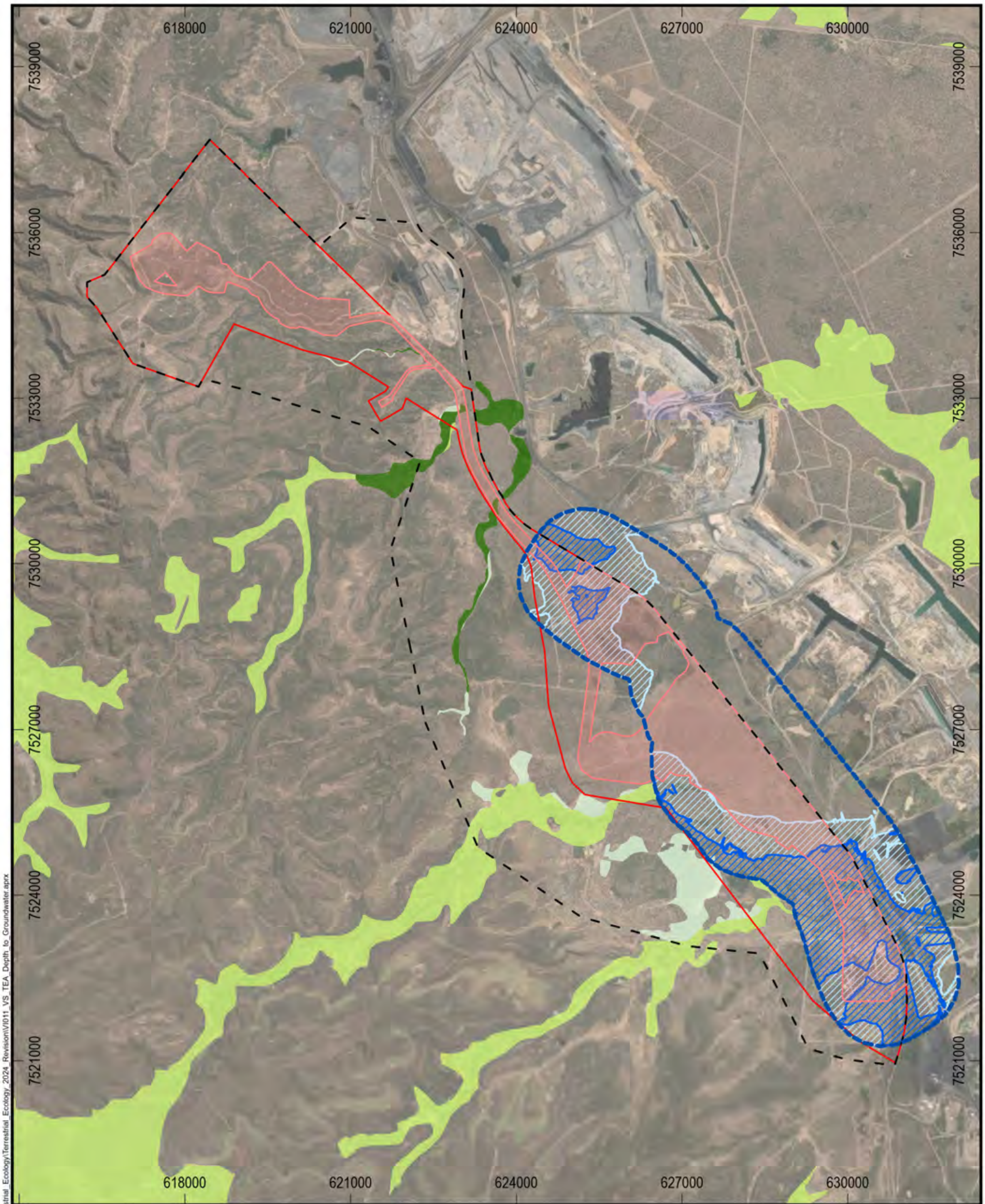
1) Quaternary Alluvium: The silted-up stream channels of ephemeral creeks support small, localised, temporary unconfined "aquifers". The alluvium saturates following flow events within the creeks. As the watercourses are highly ephemeral, some component of sub-surface flow through the alluvium persists after the surface water flow ceases.
2) Tertiary Sediments: This is a mix of Tertiary sediments (lenses of palaeochannel gravels and sands separated by dry, densely compacted sandy silts, sandy clays and clays) and weathered Permian regolith. These aquifers tend to be of limited lateral and vertical extent and consequently have low hydraulic conductivity. This layer was generally unsaturated in the survey area.
3) Permian Coal Measures: The coal seam aquifers are generally confined above and below by the low-permeability inter- and overburden. The coal seam aquifers present on site are regarded as poor aquifers because of their limited thickness and the presence of low-permeability interburden. Across most of the survey area, these aquifers represent the shallowest source of groundwater for vegetation.

Although Quaternary alluvium can provide a temporary source of shallow, fresh groundwater for terrestrial vegetation, this is recharged exclusively via rain and surface flows, and is therefore unaffected by any drawdown that may result from Vulcan South. For most of the survey area, the Permian Coal Measures and, occasionally, the Tertiary sediments contain the uppermost groundwater.

A map of composite groundwater elevation contours, within a buffer of 1 km out from the proposed mining pit edge, was developed by Hydrogeologist.com.au (2024). This was converted to a depth-to-groundwater map based on surface topography obtained from aerial LiDAR data. This map revealed that in some of the project area water tables were within 20 m of the ground surface (**Figure 4-4**) and were therefore potentially within reach of vegetation. In some areas, the groundwater was within 10 m of the ground surface, where it is likely to be utilised by vegetation. The chief location where this occurs is along Hughes Creek in the south of the project area. Note, the groundwater data provided by Hydrogeologist.com.au (2024) in this report do not include data for the northern half of the survey area (the highwall mining area). However, drilling undertaken in that area has never intercepted groundwater within or above the target coal seams, and highwall mining will therefore not intersect or affect groundwater (Hydrogeologist.com.au 2024).

4.1.3.3 National Atlas of Groundwater Dependent Ecosystems

According to the *National Atlas of Groundwater Dependent Ecosystems*, there is a high potential for terrestrial groundwater-dependent ecosystems along the lower reaches of Boomerang Creek and its larger tributaries, including North Creek (**Figure 4-4**). Riparian vegetation along Hughes Creek and its tributaries is mapped as having a moderate potential of being a terrestrial groundwater-dependent ecosystem (**Figure 4-4**).



Legend

Vulcan South Coal Mine (2023/09708)
- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)
- Depth to Groundwater Boundary

Depth to Water
- 0 - 10m
- 10 - 20m

Groundwater Dependent Ecosystems
- High potential Terrestrial GDE
- Moderate potential Terrestrial GDE
- Low potential Terrestrial GDE

Source: Bureau of Meteorology 2012, Hydrogeologist.com.au 2020, Vitrinite 2022-2024, METServe 2022-204, Earthstar Geographics.

Vulcan South

Depth to Groundwater in Relation to the GDE Atlas

0 2 4

Kilometers

Scale: 1:100,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-4

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There was reasonable accordance between the *National Atlas of Groundwater Dependent Ecosystems* and depth-to-groundwater mapping. Areas mapped as moderate GDEs along Hughes Creek had a depth to groundwater of less than 20 m, and some of this was shallower than 10 m. However, shallow groundwater was widespread beyond the boundaries of the mapped GDEs (confined to the floodplain of Hughes Creek), suggesting that this national atlas may not include all local GDEs.

While depth-to-groundwater mapping only exists for a subset of the project area, it can be safely assumed that vegetation along Boomerang, Middle and North Creeks are also groundwater-dependent. This is because the depth-to-groundwater mapping closest to these creeks suggests that groundwater is likely to be shallow. Furthermore, the national mapping (which largely accords with depth-to-groundwater mapping along Hughes Creek) indicates a high likelihood of vegetation along these northern creeks being GDEs.

4.1.3.4 Water Quality

All groundwater sampled to date within the project area is saline to highly saline. Electrical conductivity ranges between 5.18 and 22.2 dS/m, with a mean value of 10.9 dS/m (Hydrogeologist.com.au 2024). For context, sea water has an electrical conductivity of approximately 50 dS/m, while drinking water has 0.05–0.5 dS/m. The pH of groundwater on site is generally close to neutral (Hydrogeologist.com.au 2022). Electrical conductivity greater than 3–4 dS/m inhibits the growth of most plants (Katerji *et al.* 2003), although tolerance to salt varies between species. As the water table within the project area is beyond the reach of most local plant communities, the most relevant plant species are those inhabiting regional ecosystems 11.3.2, 11.3.25, 11.3.7, 11.5.3 and 11.5.9.

Some local tree species are known to utilise groundwater with salinity that would preclude its use by most plants. *Eucalyptus camaldulensis*, a dominant tree along local waterways (RE 11.3.25), is one such salt-tolerant species. Salinity comparable to the lower levels recorded onsite impairs the growth of *E. camaldulensis* seedlings but has no effect on survival (Sun and Dickinson 1995a; Farrell *et al.* 1996). Furthermore, isotope analyses have confirmed that adult trees growing above a 2–3 m deep, highly saline (30–50 dS/m) water table were able to use this groundwater, despite experiencing substantial water stress as a result (Mensforth *et al.* 1994). While saline groundwater can potentially sustain *E. camaldulensis* during dry periods, most growth occurs in response to saturation of the upper soil profile with freshwater during floods. These intermittent flooding events provide half to two-thirds of the water requirements of the species and are vital for maintaining their health (Eamus *et al.* 2006b; Wen *et al.* 2009).

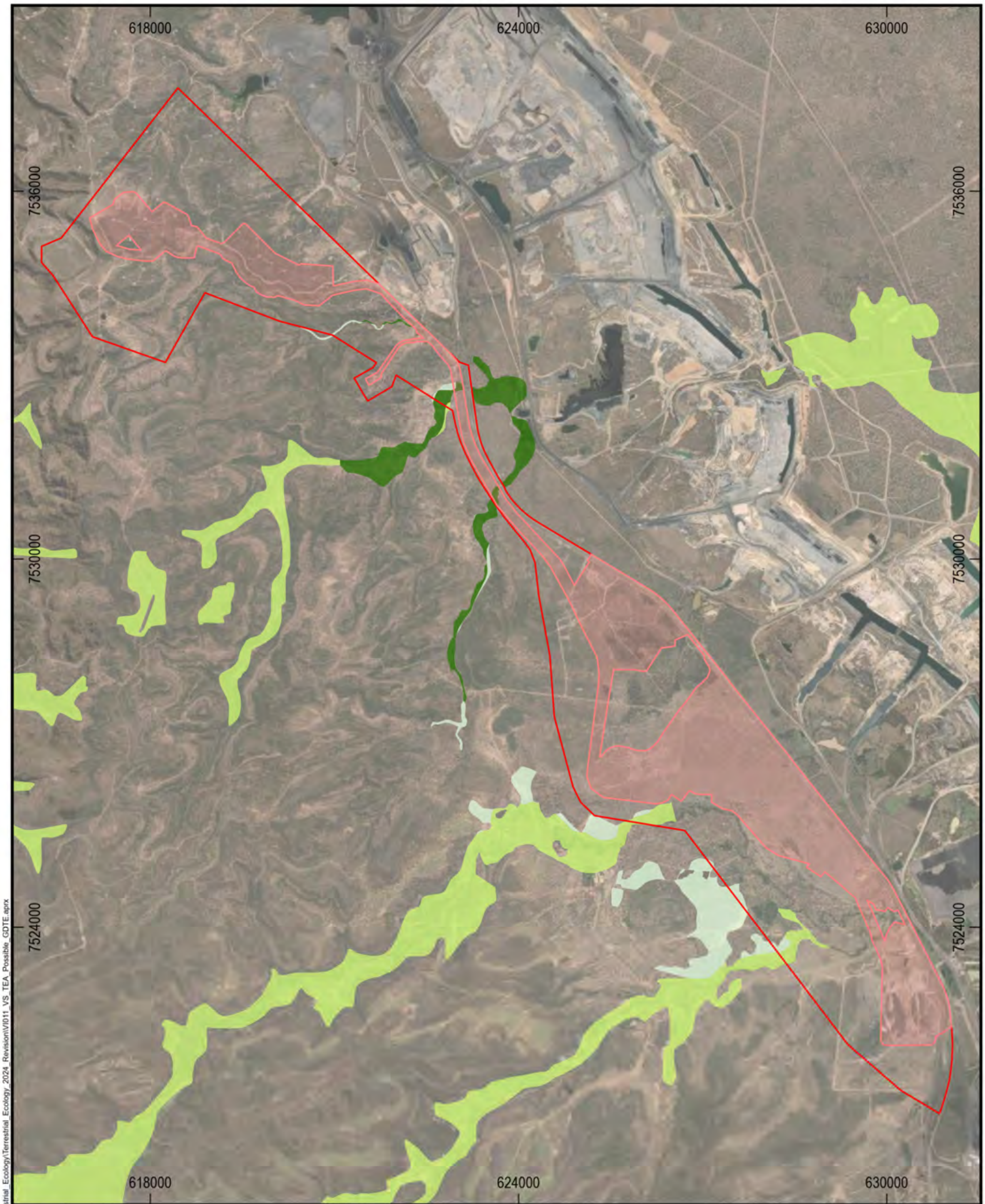
Melaleuca leucadendra, the other dominant riparian species in regional ecosystem 11.3.25 is known to be variously salt-sensitive (van der Moezel *et al.* 1991) to salt-tolerant (Sun and Dickinson 1995a). This species may be able to use groundwater at the lower end of local salinity levels (equivalent to electrical conductivity up to 5 dS/m), even though such concentrations of salt greatly impair growth (Nguyen *et al.* 2009). It is likely that *M. leucadendra* is dependent on shallow, sub-surface flows through Quaternary alluvium along watercourses following rain events but is not likely to be able to utilise saline groundwater within Tertiary sediment and Permian Coal Measures.

Corymbia tessellaris, a dominant species in RE 11.3.7, is relatively salt-sensitive (Sun and Dickinson 1995b). *Eucalyptus crebra,* a dominant species in RE 11.5.9 and subdominant in RE 11.3.7 and 11.3.25, but more abundant on land zones 5 and 10, has moderate salt tolerance only (Gill and Abrol 1991; Sun and Dickinson 1993; Hoy *et al.* 1994). These species are unlikely to be able to utilise most groundwater on site. *Eucalyptus populnea*, the dominant tree in RE 11.3.2 and 11.5.3, shows a comparable salt-tolerance to *E. camaldulensis* in short-term laboratory trials (Madsen and Mulligan 2006). However, no field studies have examined whether *E. populnea* is able to use saline groundwater.

In summary, most regional ecosystems within the project area are unlikely to be groundwater dependent. Possible exceptions are regional ecosystems 11.3.25, 11.3.2 and 11.5.3, which may use saline groundwater when this is within the reach of roots (<20 m below the soil surface).

4.1.3.5 Potential Groundwater-dependent Ecosystems

Based on literature reviews (see **Section 4.1.3.1**), depth-to-groundwater data (see **Section 4.1.3.2**), national GDE mapping (see **Section 4.1.3.3**) and water quality data (see **Section 4.1.3.4**), there are likely to be some GDEs contained within the project area. The locations of these likely GDEs closely match that mapped within the *National Atlas of Groundwater Dependent Ecosystems*. Additional partly groundwater-dependent ecosystems may be located in the central and southern parts of the project area, based on depth-to-groundwater data. The location of these GDEs is presented in **Figure 4-5**.



Legend

Groundwater Dependent Ecosystems

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Source: Bureau of Meteorology 2012. Hydrogeologist.com.au 2020. Vitrinite 2022-2024. METServe 2022-2024. Earthstar Geographics 28/09/2023

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Possible_GDTE.aprx

Vulcan South

Possible Groundwater Dependent Terrestrial Ecosystems

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-5

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4.1.4 Biodiversity

Field surveys detected 41 species of mammal, 135 species of bird, 36 species of reptile, 14 species of frog and 429 species of vascular plant (**Appendix C**). Not all bat calls could be identified to unique species, and unresolved calls may have arisen from an additional species of bat not included in the above tally (**Appendix D**).

4.1.4.1 Thoroughness of Surveys (2022 TEA)

The nature of ecological surveys means that it is inevitable that some species present remain undetected. To estimate the extent to which this occurred, species accumulation curves were fitted to the fauna and flora data using EstimateS 9.1.0. The total numbers of species that occur within the survey area were estimated using the Chao2 richness estimator. These analyses suggested that, of the species that could have been detected using the methodology employed, the surveys to date have detected:

1) 88% of the floral diversity;
2) 100% of reptiles;
3) 97% of amphibians;
4) 100% of birds;
5) 92% of non-bat mammals; and
6) 100% of bats.

Note that the above are estimates generated from a statistical analysis of the detection rate per sampling unit (e.g., per trap site). It only takes into account species that *could* be detected by the surveys. Species that were inactive at the time of surveys, or which are visitors that did not occur during the sampling periods are not incorporated into these estimates. Sampling across a broad range of seasons and climatic conditions, as was done for this study, limits the number of species considered undetectable. Nevertheless, it is possible that even for taxonomic groups with total detection, additional species could be detected with additional effort. Still, the number missed is expected to be very low. Overall, the species accumulation curves indicate that the data gathered on the area's ecology is relatively thorough. The incomplete knowledge of mammals reflects the cryptic behaviour (shy, difficult to trap) and low density of many species. The incomplete knowledge of amphibians is due to the highly patchy distribution of populations and the narrow windows of time (immediately after heavy rain) that these are detectable. The incomplete knowledge of plants in part owes to the high diversity present (almost 430 species already recorded), and the observation that many are restricted to patchily distributed micro-habitats within the sandstone ridges and gorges within the survey area.

4.1.4.2 Species at their Distributional Limit (2022 TEA)

In general, the faunal and floral communities of the survey area were typical of the dry *Acacia* and *Eucalyptus* woodlands of the northern Brigalow Belt.

The location of the project, midway between the mesic environments of coastal regions and the arid interior, results in a mixture of species from wetter and drier environments. The following species widespread in coastal regions reach their western distributional limits in the vicinity of the project: Little Lorikeet (*Glossopsitta pusilla*), Scarlet Honeyeater (*Myzomela sanguinolenta*), Golden Whistler (*Pachycephala pectoralis*), Rufous Fantail (*Rhipidura rufifrons*) and the plants, *Deeringia amaranthoides, Euroschinus falcatus, Aristolochia thozetii, Desmodium rhytidophyllum, Pycnospora lutescens, Trophis scandens, Gossia bidwillii, Lophostemon grandiflorus, Sorghum leiocladum, Persoonia amaliae, Cheilanthes nudiuscula, Cyclophyllum coprosmoides, Pavetta granitica, Acronychia laevis, Flindersia australis, Planchonella pohlmanniana* and *Tetrastigma nitens.* Most of these species were recorded in isolated, sheltered pockets within sandstone gorges.

The project area also represents the eastern distributional limit for the following species typical of more arid environments: Inland Forest Bat (*Vespadelus baverstocki*) and the plants, *Heliotropium cunninghamii, Cleome tetrandra* and *Cyperus betchei.*

Only one species (the plant, *Heliotropium peninsulare*) reaches its southern distributional limit near the project area, and one species (Speckled Warbler, *Pyrrholaemus sagittatus*) is near its northern distributional limit.

None of the above species are threatened or near threatened.

The project lies within the contact zone between two species of near-identical rock-wallabies, the Unadorned Rock-wallaby (*Petrogale inornata*) and Herbert's Rock-wallaby (*Petrogale herberti*). These species are not possible to distinguish in the field without genetic testing or chromosomal analysis. In coastal areas, the Fitzroy River is a dispersal barrier that marks the boundary between the two species. However, it is not known if the two species meet further inland. The project occurs closest to known populations of Unadorned Rock-wallabies, just north of Moranbah. However, the Isaac River lies in between. In contrast, there are no major rivers between the Harrow Range (where Vulcan South is located) and Herbert's Rock-wallaby populations near Clermont. Neither species is listed as threatened and, therefore, the identity of the local rock-wallaby species is inconsequential to assessing the environmental impacts of the project.

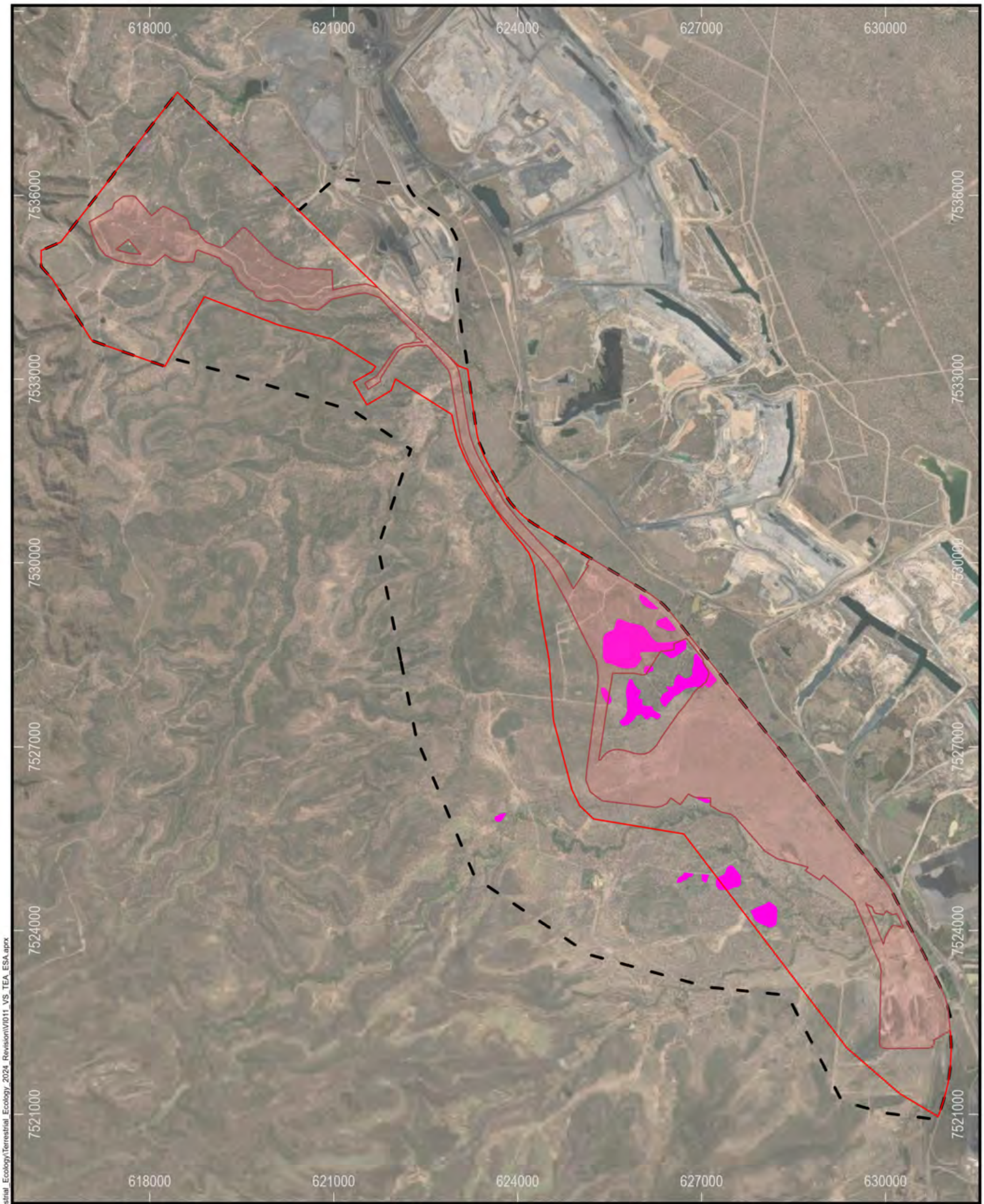
All of the above species occupy relatively broad ranges, and it is unexceptional that a small subset of the 653 species recorded on site occurs near the edge of their distribution. However, one species recorded on site occurs within a very narrow geographic range. The Ornate Velvet Gecko (*Oedura picta*) is a newly described species of reptile (Hoskin 2019) confined to sandstone outcrops within the Cherwell-Harrow Range between Moranbah and Tieri. The project area lies midway along the eastern edge of this very small distribution. The project largely avoids disturbance to the ranges inhabited by this gecko, but small areas of disturbance are expected. Despite its limited range, the Ornate Velvet Gecko is not listed as a threatened or near threatened species.

4.2 ENVIRONMENTALLY SENSITIVE AREAS

Category A and B environmentally sensitive areas are defined under Schedule 12 of the *Environmental Protection Regulation 2008*, while category C environmentally sensitive areas are defined in the *Eligibility Criteria and Standard Conditions for Mining Lease Activities* (Department of Environment and Heritage Protection 2016).

No category A or C environmentally sensitive areas occur in or near the survey area.

The only category B environmentally sensitive areas within the survey area are "endangered regional ecosystems identified in the database known as the 'Regional ecosystem description database'". Field-verified regional ecosystem mapping revealed a total of 145.2 ha of endangered regional ecosystems within the survey area. The locations of these category B environmentally sensitive areas are shown in **Figure 4-6**.



Legend

Vulcan South Coal Mine (2023/09708)

Survey Area

Disturbance Footprint

Project Area (ML 700073)

Category B Environmentally Sensitive Areas

Endangered Regional Ecosystem

Source: Vitrinite 2022, METServe 2020-2022, Earthstar Geographics

Vulcan South

Environmentally Sensitive Areas

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

19/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-6

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4.3 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Matters of national environmental significance (MNES) are those protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These are:

1. World heritage places;
2. National heritage places;
3. Wetlands of international importance;
4. Listed threatened species and ecological communities;
5. Migratory species protected under international agreements;
6. Commonwealth marine areas;
7. The Great Barrier Reef Marine Park;
8. Nuclear actions; and
9. A water resource, in relation to coal seam gas development and large coal mining development.

The last two matters on the list are not ecological matters and are assessed elsewhere. Of the remainder, the only MNES present in the vicinity of the project are 4 and 5.

Note that within this document, regional context is retained with the inclusion of mapped habitat within a 2 km buffer of the Project area, which will not be directly impacted or cleared for the purposes of this Project.

Threatened species and ecological communities described below have been assessed for their likelihood of occurrence. The definitions of likelihood terms are described in **Table 4-3**:

Table 4-3 Definitions of likelihood terms

Presence	Definition
Confirmed	• Species was sighted or photographed during field surveys; and/or, • Direct evidence of species was found during field surveys such as scats, feathers, burrows or other signs. • A TEC was confirmed as present, meeting the RE type and TEC condition threshold
Likely	• Habitat is suitable^; and, • Species known from local area with confirmed records
May occur	• Habitat is marginal*; and/or, • Habitat is outside normal flyways or migration paths. • Habitat is suitable^ but there are no recent (since 1980) records within 100 km, or this habitat is separated from known populations by geographic barriers to dispersal
Unlikely / Not Present	**Unlikely** • No suitable habitat on site; and/or, • No historic records within 100 km; and/or, • Species is considered locally extinct. **Not Present** • A TEC is found to be not present as determined by lack of component REs, or where component REs are present, they do not meet condition thresholds.

^Suitable – The habitat contains the features required by a species at a quality that it is likely to occur in the habitat frequently or predictably, including areas visited regularly on migration routes.

*Marginal – The habitat lacks the required features and/or is of a reduced quality, is used by a species only irregularly or infrequently, or only a small proportion of individuals are found in the habitat. This also includes all areas outside normal migration routes.

4.3.1 Threatened Ecological Communities

One threatened ecological community (TEC) was confirmed to be present on site, and four other vegetation communities were raised by the literature review, as shown in **Table 4-4** and further elaborated below in **Section 4.3.1.1** to **4.3.1.5**.

Table 4-4 Likelihood of occurrence summary for threatened TECs

TEC name	Status (EPBC Act / NC Act) **	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Were suitable REs verified on-site?	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
1. *Brigalow*	Endangered / -	**Likely** to occur, in feature area	N/A for a TEC	This TEC is represented by mapped component REs in the impact area	**Likely**	**Yes.** The component REs were confirmed as present	**Yes.** Component REs were assessed and met the condition thresholds for size and native cover to qualify as the TEC in remnant areas.	**Confirmed**
2. *Poplar Box Grassy Woodland on Alluvial Plains*	Endangered / -	**Likely** to occur, in feature area	N/A for a TEC	This TEC is represented by mapped component REs in the impact area	**Likely**	**Yes.** The component REs were confirmed as present	**No.** Despite the RE being suitable, the non-native vegetation cover meant that it did not meet the condition threshold to qualify as a TEC.	**Not present**
3. *Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin*	Endangered / -	**Likely** to occur, in feature area	N/A for a TEC	Not mapped within the impact area, but within the region	**Possible**	**No.** The component REs were not found in the impact area. No further consideration required.	**No.**	**Not present**
4. *Weeping Myall Woodlands*	Endangered / -	**Likely** to occur, in buffer area only	N/A for a TEC	Not mapped within the impact area, but within the region	**Possible**	**No.** The component REs were not found in the impact area. No	**No.**	**Not present**

TEC name	Status (EPBC Act / NC Act) **	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Were suitable REs verified on-site?	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
						further consideration required.		
5. *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions*	Endangered / -	**Likely** to occur, in buffer area only	N/A for a TEC	Not mapped within the impact area, but within the region	**Possible**	**No.** A potential Section of this TEC was found during surveys; however, it did not meet diagnostic thresholds for required soils.	**No.** Condition thresholds for the TEC as per the Approved Conservation Advice were not met.	**Not present**

4.3.1.1 Brigalow

A total of 71.2 ha of the threatened ecological community listed as "Brigalow (*Acacia harpophylla* dominant and co-dominant)" are contained within the survey area. This includes remnants and high-quality regrowth of the constituent regional ecosystems, 11.3.1, 11.4.8 and 11.4.9 (see **Figure 4-3**). 71.2 ha of Brigalow TEC is present within the impact area.

4.3.1.2 Poplar Box Woodland on Alluvium

The ecological community listed under the EPBC Act as "Poplar Box Grassy Woodland on Alluvial Plains" broadly corresponds to remnant and high-value regrowth forms of regional ecosystem 11.3.2, among others not found on site. A total of 127.7 ha of remnant 11.3.2 and 148.2 ha of regrowth 11.3.2 occurs within the survey area, mostly along Hughes Creek. Of this, 55.4 ha of remnant 11.3.2 and 63.9 ha of regrowth 11.3.2 occurred within the project area.

According to the draft conservation advice for this ecological community, in order to be considered a MNES, areas of the ecological community must meet key diagnostic characteristics and condition thresholds. One key diagnostic characteristic listed by the draft conservation advice is a "ground layer (<1 m) mostly dominated across a patch by native grasses, other herbs and occasionally chenopods". Dominance is defined as "accounting for more than 50% of the cover". None of the regional ecosystem 11.3.2 within the survey area met this criterion. Weeds (non-native species) comprised 91.8% and 92.9% of the ground layer at the two secondary sites sampled in remnant 11.3.2. These two sites were in the largest, best-quality examples of the community available. This high weed density was typical of ecosystems on alluvial soils in general; weeds also made up an average of 82.2% of the ground layer in 11.3.25.

Within the survey area, *Eucalyptus populnea* (Poplar Box) also formed ecological communities on sand plains. Here, three out of seven secondary sites sampled met the criterion of being dominated by native ground layer species. These sites were on very sandy, leached soils unfavourable for weed establishment. These soil conditions are characteristic of non-alluvial sites, which do not form part of the Poplar Box Grassy Woodland on Alluvial Plains.

Given the dominance of weeds across alluvium within the survey area, none of the *E. populnea* woodlands occurring there qualify as a threatened ecological community under the EPBC Act.

4.3.1.3 Semi-evergreen Vine Thicket

A small area (1.3 ha) of semi-evergreen vine thicket is located in a gorge in the upper reaches of North Creek. Floristically, this resembles the threatened ecological community listed under the EPBC Act as "Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions". However, the particular regional ecosystem assigned to this vine thicket (11.10.8) is not included in the listed threatened ecological community, on the grounds that it occurs on coarse-grained sedimentary rock (Department of Climate Change, Energy, the Environment and Water 2022a).

4.3.1.4 Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin

Suitable REs are mapped within the region, however the component REs are not found within the impact area. No areas matching the definitions of the Queensland Regional Ecosystem descriptions for component REs 11.3.21 or 11.3.24 are present in the Project area, therefore this TEC is not present.

4.3.1.5 Weeping Myall Woodlands

Suitable REs are mapped within the region, however the component REs were not found within the Project area. The required dominant species *Acacia pendula* was not present, and in the unlikely event that it was present as isolated trees, the species certainly would not have qualified as dominant.

4.3.2 Likelihood of occurrence summary for threatened and migratory species

A total of 46 species were identified from the PMST search as potentially occurring in the region, **Table 4-5** below lists and provides a likelihood summary for both Threatened and Migratory species. The likelihoods will be discussed further in **Section 4.3.3** for Threatened species and **Section 4.3.4** for Migratory species.

Table 4-5 MNES species considered likely to occur in the region following PMST search

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
1. ***Gallinago hardwickii* (Latham's Snipe)**	Bird	V, M/SL (Re-assessed in more detail as a newly listed Threatened species.)	**May** occur within area, in feature area.	Records are scattered in all directions, though none are within 60 km of the impact area. Predictably, most of these are associated with water bodies.	**Yes,** Satellite imagery shows potential wetlands and records indicate the species may infrequently fly through the area on migration.	**Possible** Local wetlands may possibly support this species during migration, though infrequently and in small numbers for very short time periods (likely to be days rather than weeks or months)	**Yes.** If the species was to occur in the impact area, this non-breeding visitor would only use these locations as stopovers for the purposes of foraging, and the airspace above for dispersal. Given that the sightings are more common on the coast and the area around the Project is subjected to surveys for a number of other projects, habitat may appear suitable but is unlikely to be used by the species	**No** This species was not recorded within the survey area despite optimal survey timing. However, this species is cryptic, and the presence of undetected individuals is possible. Other surveys for other projects in the immediate area have not located this species.	**May occur** (Re-assessed. Was originally considered "likely")

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
							as it is outside the normal flyway for this area.		
2. ***Eucalyptus raveretiana* (Black Ironbox)**	Plant	V/LC	**May** occur within area, in feature area.	Yes, Most records are found over 60 km to the northeast and 100 km southeast in more humid ranges. A single record at around 100 km to the south exists, with another at Emerald within the town limits.	The only SPRAT listed RE that this species is known from that may occur in the impact area is 11.3.25a, which does not occur within the impact area. Other species this Eucalypt is known to be co-dominant with are known from the impact area, though these are all species that are wide ranging and tolerant of a wide variety of conditions.	**Possible** Listed co-dominant species exist in the impact area, based on mapping, though these are all wide-ranging species.	**No.** No suitable habitat for this species was found within the impact area or adjacent habitats.	**No.** Despite the thorough surveys in this project and other mining projects in the region, no evidence of this species was found.	**Unlikely**
3. ***Hemiaspis damelii* (Grey Snake)**	Reptile	E/E	**May**	Record from 1800 is 50 km west (unable to	REs consistent with habitat known for the	**Unlikely.** Due to the distance of the nearest record,	Not applicable	Not applicable	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			occur within area, in buffer area only.	be verified). Verified sighting approximately 120km south from Project (Springton) from 2004.	species are present. These are unlikely to be suitable as the closest record is over 100km away and is itself an outlier.	which in itself is an outlier.			
4. ***Polianthion minutiflorum***	Plant	V/V	**May** occur within area, in feature area.	The closest verified record is located approximately 132 km south from the Project. A verified record approximately 149 km is located north from the Project.	REDD database lists 12.9-10.7 as suitable habitat for this species. This ecosystem is not known in the area of the Project as it is a coastal ecosystem. Sighting of low uncertainty were plotted onto Queensland Government mapping and were found to be on the following mapped REs: 11.7.2, 11.7.1,	**Possible.** Suitable habitat possibly exists, however records are disjunct. Therefore, it is possible based on a desktop review. The ALA records indicate colonies of this plant commonly contained of 200 hundred individuals or more. Field assessment did not identify the presence of colonies or individuals.	**No**	**No.** Despite the presence of habitat deemed suitable for this species, no individuals were found. The species' distribution is disjunct, and populations are widely separated by several hundred kilometres; Vulcan South is not located near these populations. Species accumulation curves fitted to the flora field data combined with estimations of species richness predict that 88% of floral diversity was detected by field surveys. Based on the relatively high modelled detection rate, it is unlikely that the species, or	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					11.9.5b, 11.7.2, 11.10.8, 11.10.1. The following REs are found within the Project area: 11.10.8, 11.10.1. Further, approved conservation advice indicated overlap with semi-evergreen thicket (RE 11.10.8), however this is not equivalent to the TEC Semi-evergreen vine thickets of the Brigalow Belt. In addition, RE 11.10.1x1 is considered suitable for this species. Prior ALA records are particularly associated with sandstone			evidence of this species, was not detected during field survey. Further, the Principal Consultant on the survey was qualified by the Queensland Herbarium and was familiar with the species. It is therefore unlikely that the species, were it encountered during the survey, was unrecognised.	

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					outcrops and substrate.				
5. ***Stagonopleura guttata* (Diamond Firetail)**	Bird	V/V	May occur within area, in feature area.	No The Project is located north from the majority of records. There are three uncertain records north from the Project. The closest record is located approximately 170 km south from the Project (Springsure).	Mapped likely to occur habitat within the SPRAT database is located south of Nanango (approximately 600 km south from the Project).	**Unlikely.** Due to the distance from mapped likely habitat within the conservation advice, it is unlikely. Further, the closest record is unverified and approximately 120 km from the Project.	Not applicable	Not applicable	**Unlikely**
6. ***Geophaps scripta scripta* (Squatter Pigeon)**	Bird	V/V	**Known** to occur within area, in feature area.	N/A, species is known from area	Yes	**Likely**	**Yes.** Suitable foraging and dispersal habitat is present in the survey area, including in the project area.	**Yes.** Frequently sighted in suitable habitats	**Confirmed**
7. ***Hirundapus caudacutus***	Bird	V/V	Not flagged by the latest	This species is likely to occur in	Yes.	**Likely**	**Yes.**	**Yes.**	**Confirmed**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
(White-throated Needletail)			PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	airspaces over all habitats within their migration paths, records are therefore not important for this species due to its high level of mobility.	The species is likely over all habitats		Only foraging habitat was found. This species forages for insects overhead and is not likely to land or directly interact with any terrestrial habitats in the Project impact area.	The species was recorded on site.	
8. ***Petauroides volans*** **(Greater Glider)**	Mammal	E/E	**Known** to occur within area, in feature area.	Yes	Yes	**Likely**	**Yes.** Breeding / shelter (denning), foraging and dispersal habitats are all confirmed by site surveys.	**Yes.** the species was sighted.	**Confirmed**
9. ***Phascolarctos cinereus*** **(Koala)**	Mammal	E/E	**Known** to occur in feature area, in feature area.	N/A, species is known from area	Yes	**Likely**	**Yes.** The survey area, including the project area, features high to low value habitat.	**Yes.** Sighted within suitable habitats in the survey and impact areas	**Confirmed**
10. ***Denisonia maculata***	Reptile	V/V	**Known** to occur within area,	14 records exist within 10 km of the impact area,	Yes. However, the quality of these	**Likely**	**Yes.** Suitable habitat of low quality is	**No.** Field surveys did not detect this species despite extensive	**May occur** Given the extremely low

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
(Ornamental Snake)			in feature area.	though all of these are to the east of the impact area and isolated from it by other mining projects.	mapped REs on land zone 4 are questionable and field investigation is required.		present due to minor gilgai development. Further, where gilgais occurred, these tended to be less than 30 cm deep, and held water for less than one month after heavy rain. Consequently, frog diversity and density was very low in gilgais on site. Higher quality habitat is located east of Saraji Road.	survey effort and ideal conditions. However, the survey area is adjacent to known populations, and some potential habitat occurs on site. It is likely that small numbers of Ornamental Snakes utilise the survey area.	density of frog diversity (primary diet) and marginal quality of habitat and the species not being detected species
***11. Aristida annua* (Annual Wiregrass)**	Grass	V/V	**Likely** to occur within area, in buffer area only.	A single record exists 35 km to the southwest of a preserved specimen collected in 1999 from the "Eastern slopes of Lord's Mountain".	Some possibly suitable habitat exists within the impact area.	**Unlikely**	**Yes.** Potential habitat exists within the survey area in the form of black clay soils derived from fine-grained sedimentary rock	**No.** This species was not found during surveys either in this or neighbouring projects.	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
12. ***Dasyurus hallucatus* (Northern Quoll)**	Mammal	E/LC	**Likely** to occur within area, in feature area.	The nearest recent (post-2000) records of the Northern Quoll are from the Clarke Range, 100 km northeast of the survey area. No Northern Quolls have ever been detected at neighbouring mines within the Bowen Basin.	The *EPBC Act Referral Guideline for the Endangered Northern Quoll* (Department of the Environment, 2016) defines critical habitat as “habitat within the modelled distribution of the northern quoll which provides shelter for breeding, and refuge from fire, predation and potential poisoning from Cane Toads”. The survey area occurs within the modelled distribution of the Northern Quoll. Most of the otherwise suitable habitat	**Possible** Habitat is not especially likely to support the species considering the high probability of toads.	**Yes.** The survey area includes critical habitats on Land zones 3 and 10.	**No.** Northern Quolls were not detected during surveys including spotlighting and camera trapping; however the presence of suitable habitat indicates its presence remains a possibility.	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					in the impact area				
13. *Dichanthium queenslandicum* (King Blue-grass)	Grass	E/V	**Known** to occur within area, in feature area.	9 records exist within 50 km since 2020. The closest is 11 km to the northwest of the impact area.	Heavy clay soils supporting grasses are represented within the area by remnant regional ecosystem 11.9.2 and cleared pastures that formerly supported regional ecosystem 11.4.9.	**Possible** Both habitats have been subjected to long periods of heavy grazing. This has led to the almost complete replacement of native perennial grasses with the exotic *Bothriochloa pertusa*.	**Yes.** Potential habitat occurs on site; however, this is of poor quality. Nowhere within the survey area were clay soils observed to support a native grassland community due to heavy grazing regimes and incursion of *Bothriochloa pertusa*.	**No.**	**May occur**
14. *Dichanthium setosum* (Hairy Bluegrass, bluegrass)	Grass	V/LC	**Likely** to occur within area, in buffer area only.	Based on herbarium records, there appears to be a 280 km gap between known populations at Springsure and Glenden. The survey area	**Yes.** Potential clay soil habitat occurs on site, however the survey area lies just outside the Department of Climate Change, Energy, the Environment and	**Possible** This species is associated with heavy basaltic black soils and red-brown loams with clay subsoil. It is tolerant of a moderate amount of disturbance, but excessive grazing and invasion of exotic	**Yes.** Potential habitat occurs on site; however, this is of poor quality. All clay soils within the survey area which would support this species were dominated by the	**No.**	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
				occurs within this gap; the nearest known record is 95 km to the north.	Water's (2022k) modelled "may occur" range of the species.	grasses threatens the species (Department of Climate Change, Energy, the Environment and Water, 2022k). Despite potential habitat occurring on site, the lack of local records and the heavily degraded nature of the available habitat suggest that the survey area is not suitable for the Hairy Bluegrass.	exotic pasture grass *Bothriochloa pertusa*. No native grass communities were observed on clay within the survey area.		
15. ***Egernia rugosa* (Yakka skink)**	Reptile	V/V	**May** occur within area, in feature area.	The nearest records (Queensland Museum specimens from 1976 and 2000) of this species are from the vicinity of Blackwater, 130 km to the south. Furthermore, no colonies have ever been recorded in the	**Yes.** Suitable REs are mapped, though following field surveys may be found to be unsuitable.	**Possible** Given the lack of sightings, number of field surveys and distance to nearest records, the species would be considered unlikely, though its cryptic nature suggests it may go unnoticed, therefore remains a slim possibility.	**Yes.** All remnant and regrowth vegetation within the survey area qualifies as "suitable habitat" for the species, as all contain woody debris and/or rocks that provide structural support for burrows. The survey area does not contain	**No.** No Yakka Skinks were recorded during surveys on site. However, given the large size of the survey area, it was not practical to inspect every possible burrow location within it.	**May occur**

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				northern Bowen Basin, despite extensive ecological surveys undertaken across Dysart-Moranbah-Collinsville for various mining projects.			habitat connected to known populations of the Yakka Skink.		
16. ***Erythrotriorchis radiatus*** **(Red Goshawk)**	Bird	V/E	**May** occur within area, in feature area.	Three records exist within 150 km of the impact area. The closest record is 80 km to the southwest, a 1938 record of an egg. The second record is 100 km to the north and is from Glenden, adjacent to remnant habitats.	**No** Large unfragmented habitat areas are no longer found in the region within or adjacent to the impact area.	**Unlikely** Given the highly fragmented habitats in the region, and the numerous ecological surveys undertaken in the last 20 years, the species is unlikely from a desktop level.	**Yes.** Potential habitat is present on site but is of low quality. Escarpments and nearby waterways mostly lack surface water, and the surrounding landscape is already highly modified through mining and clearing for grazing.	This species was not recorded during surveys. Dispersing Red Goshawks may occasionally use the wider survey area.	**May occur**

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				A third is from 120 km to the south and is a preserved egg kept with Museums Victoria, with no valid date.					
17. Macroderma gigas (Ghost Bat)	Mammal	V/E	**May** occur within area, in feature area.	A single Queensland government record exists 120 km north of the impact area from 2009 in Crediton State Forest.	No specific REs are attributed to the Ghost Bat as habitat, features such as caves are more important in considering likelihood of occurrence, and the species is known to be particular in choosing roost sites, more so when choosing breeding sites.	**Possible** There is some, though only a small likelihood of suitable caves existing on site and given the number of mines and ecological surveys in the area it would be expected that there would be records if the species did frequent the area. It is acknowledged that the Ghost Bat is difficult to detect by ultrasonic means, but the audible chirps would be likely to be detected on acoustic monitoring setups aimed at birds, especially after dark	**No.** There are no known roost sites in the survey area. However, the existence of unknown roost sites is possible, and the proliferation of mining across the Bowen Basin may have inadvertently created new roosting habitats (in disused mines).	**No.** This species was not recorded during surveys. It is possible that the impact area may be used intermittently by Ghost Bats. This use would solely be in a foraging capacity, as none of the sandstone ridges on site supported caves of a size and structure suitable as a roost site.	**May occur**

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						when bird calls are minimal.			
18. *Rostratula australis* (Australian Painted-snipe)	Bird	E/V	**May** occur within area, in feature area.	3 records exist within 150 km of the impact area. The closest, 28 km to the east was from 2017 and offers no information on spatial accuracy. A specimen was collected in Emerald, 120 km to the south in 1978. A 2015 record exists from St Lawrence on the coast, 120 km to the east.	Habitat is suboptimal with few suitable areas compared to closer to the coast.	**Possible**	**Yes.** Potential habitat was recorded at natural and artificial (dams) wetlands in the southern third of the survey area. In addition, a small dam in the northeast of the survey area possessed margins vegetated with suitable sedges and rushes, but the steep banks lacking areas of shallow mud limit the suitability of this habitat. One of the habitats within the survey area outside the Project area) contains a small island, which has	**No.** This species was not recorded in the survey area. Due to its secretive and highly mobile behaviour, it may still be considered a possible visitor to the survey area. Small numbers (singles or small groups) possibly utilise habitat within the project area for short periods during transit through the region.	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
							potential as a nest site.		
19. ***Calidris ferruginea*** **(Curlew Sandpiper)**	Bird	CE/E	**May** occur within area, in feature area.	Two non-coastal records occur for this species between 80 and 90 km southeast and southwest, both since 2019, the southeastern record, however, is of dubious spatial accuracy. Records are clustered along the coast, as to be expected.	**No.** This species primarily inhabits coastal mudflats, but occasionally also uses the muddy margins of large freshwater wetlands.	**Unlikely** Given the coastal nature of the species and the lack of inland records in this highly surveyed region, the species is not likely to occur from a desktop level	Not applicable.	Not applicable.	**Unlikely**
20. ***Elseya albagula*** **(Southern Snapping Turtle)**	Reptile	CE/E	**May** occur within area, in feature area.	The closest records are located approximately 80 km east from the Project, both from the year 1988. Further records are	**No** Permanent water in riverine systems is required, the waterways in the impact area are unsuitable.	**Unlikely**	**No** Suitable habitat was not found for this species	**No**	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
				located more than 100 km to the south.					
21. ***Furina dunmalli* (Dunmall's Snake)**	Reptile	V/V	**May** occur within area, in feature area.	2 records occur 70 km to the southwest, in the vicinity of Clermont. Both are preserved specimens.	Suitable habitat for the Dunmall's Snake is forests to woodlands within the range of species. Habitat fitting this very broad definition is mapped in the impact area.	**Possible.** The impact area is *not* within a zone marked as "likely to occur" by DCCEEW mapping, nor does it connect any such areas. For habitat to be considered "important" to this species, mapped "likely" areas must intersect with suitable habitat.	**Yes.** The survey area contains potential habitat fitting of the broad description given in the *Draft Referral Guidelines for Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities , 2011)	**No.** No Dunmall's Snakes were detected during surveys. The nearest record is from Clermont, 80 km southwest of the survey area. The species has never been recorded in the Dysart-Moranbah region, despite extensive ecological survey effort at other mine sites. Given the absence of local records despite targeted searches undertaken for Vulcan South and numerous neighbouring mining operations, it is considered unlikely that the species occurs locally.	**Unlikely**
22. ***Grantiella picta* (Painted Honeyeater)**	Bird	V/V	**May** occur within area, in feature area.	A single record 150 km south was recorded in 2017.	**Yes.** This species utilises open woodlands, especially dominated by	**Possible.** Sightings of this species show a tendency to avoid the region and given the lack of sightings available from	**No.** This species depends on an abundance of mistletoe. Trees likely to be host to	**No.** This species was not observed during field surveys.	**Unlikely**

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					Acacia harpophylla or other *Acacia* species. This species also relies on the presence of mistletoes.	a desktop assessment level and considering the number of ecological surveys conducted in the region over the last 20 years, this species should be regarded as "possible", as it is not highly likely.	suitable mistletoes are present in the survey area, however mistletoe itself was scarce based on field surveys.		
***23. Lerista allanae* (Allan's Lerista)**	Reptile	E/E	**Likely** to occur within area, in feature area.	2 records exist 25-75 km to the west and southwest. Both are preserved specimens, one from 1938 and the other 1993.	The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities , 2011) defines suitable habitat for the species as being regional ecosystems 11.8.5 and 11.8.11, both of which are lacking	**Possible** The species is difficult to rule out as marginal habitat may be found within the impact area	**Yes.** Habitat similar to regional ecosystems known to support this species is present in the survey area.	**No.** No Allan's Leristas were found during surveys despite survey effort which exceeded the sample effort guidelines for Brigalow Belt reptiles. Taking into account the known distribution of the species and the search effort conducted to date, it is unlikely that Allan's Lerista occurs within the survey area.	**Unlikely**

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					from the survey area. Nevertheless, regional ecosystem 11.9.2 (*E. orgadophila* open woodland on soil derived from fine-grained sedimentary rock) occurs on site, and closely resembles 11.8.5 in its floristics and soil attributes. Furthermore, models within the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities ,				

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					2011) indicate that the species may occur within the survey area, despite the site being outside the modelled "known/likely to occur" zone.				
24. ***Neochmia ruficauda ruficauda*** **(Star Finch)**	Bird	E/E	**Likely** to occur within area, in feature area.	The two nearest records (from the years 1996 and 2000) are located approximately 90 km east from the Project area.	**Yes.** The impact area is likely to contain habitat that would have been suitable for the Star Finch	**Unlikely.** Despite the presence of suitable habitat, the Star Finch is likely extinct in the Bowen Basin.	**Not applicable**	**Not applicable**	**Unlikely** The species is likely locally extinct
25. ***Nyctophilus corbeni*** **(Corben's Long-eared Bat/south-eastern long eared bat))**	Mammal	V/V	**May** occur within area, in feature area.	No records within 150 km. All records are to the south.	**No** Habitats are well outside this species' range	**Unlikely** Original desktop analysis incorrectly assessed this species as a cave-dwelling species. Reassessment determined that it remains unlikely, though this is based on known distribution.	**No** Habitat is well outside species' known range	Habitat may be broadly suitable; however, the impact area was determined to be well north of the known distribution of the species.	**Unlikely**

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26. Poephila cincta cincta (Southern Black-throated Finch)	Bird	E/E	**May** occur within area, in feature area.	A 2022 record with a 30 km uncertainty is known from approximately 50 km south of the impact area. This record is backed by photographic evidence. It is acknowledged that this species has been the subject of recent public attention linked to other mining projects to the north. Given the publicity, efforts to locate other populations have been increased. The number of ecological surveys in the	**Possible** The impact area may contain suitable foraging resources for this species.	**Unlikely** Despite the presence of suitable habitat, the Southern Black-Throated Finch is likely to be locally extinct	**Yes** Habitat may be marginally suitable in the area with water sources and a variety of grasses present, though it is degraded in quality to the point that this species may not persist.	**No** Surveys were conducted for this and other projects in the area and no individuals of this species were sighted.	**Unlikely**

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				region would have been expected to locate individuals if they are persisting locally.					
27. ***Pteropus poliocephalus* (Grey-headed Flying-fox)**	Mammal	V/LC	**Likely** – in buffer only Foraging, feeding or related behaviour likely to occur within area, in buffer area only.	5 records are known from within 150 km. Of these, the only to the south was an entangled specimen from 145 km away. The remaining 4 records are all to the north in Eungella National Park and verified by the Queensland Parks and Wildlife Service.	**No** The impact area is unlikely to be of high enough quality to attract this species. Roosting camps are not known from the area, the only camp north of Bundaberg is an outlier near Ingham.	**Unlikely**	**No.** Habitat is marginal at best; the species is unlikely in the area as anything more than a fly-by species and richer habitats closer to the coast are available.	**No.**	**Unlikely**

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28. ***Rheodytes leukops* (Fitzroy River Turtle)**	Reptile	V/V	**May** occur within area, in feature area.	The closest records are located between 80km and 90km to the east of the Project, from the years 1980 and 1988 respectively. These records have been generalised for sensitivity concerns.	**No.** Permanent rivers are not found within the impact area or directly adjacent	**Unlikely**	**No.** Permanent rivers are not found within the impact area or directly adjacent	**No.**	**Unlikely**
29. ***Samadera bidwillii* (Quassia)**	Tree	V/V	**May** occur within area, in feature area.	One record is known from the coast, 130 km to the east.	**No**	**Unlikely**	**No.** No suitable habitat recorded.	**No** This distinctive species was not observed	**Unlikely**
30. ***Maccullochella peelii* (Murray Cod)**	Fish	V/-	Not flagged by the latest PMST database search but appeared in prior searches during desktop	No	The Project is outside the native range of this species, which is the Murray/Darling basin.	**Unlikely**	**No**	**No**	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			assessments for the Terrestrial Ecological Assessment.		Suitable waterways are not found within the impact area				
31. ***Cycas ophiolitica*** **(Marlborough Blue Cycad)**	Cycad	E/E	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	Two records are found within 110-130 km southeast of the impact area. One from 2003 and one from 1990.	**No**	**Unlikely**	**No.** This is an obvious and distinctive species and given the number and thoroughness of flora and general ecological surveys in the region, its presence is highly unlikely in the impact area.	**No**	**Unlikely**
32. ***Cadellia pentastylis*** **(Ooline)**	Tree	V/V	Not flagged by the latest PMST database search but appeared in prior searches during desktop	The nearest record is located more than 100 km southeast from the Project, from the year 1991. More records are	**No** Habitat is unlikely to be present for this species.	**Unlikely** Habitat is not likely to be present for this species and closest records are sufficiently distant to rule this species out	**No** No habitat was surveyed in the impact area or greater survey area that would be considered suitable for this species	**No.** Despite BioCondition and other habitat surveys, this distinctive tree was not observed.	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			assessments for the Terrestrial Ecological Assessment.	located further south.					
33. ***Tringa stagnatilis*** **(Marsh Sandpiper)**	Bird	M/SL	Not flagged by the latest PMST database search but appeared in prior searches during desktop assessments for the Terrestrial Ecological Assessment.	Two records, both from the year 2001, are located within about 12 km north of the Project area near the Peak Downs Mine.	Muddy margins of shallow fresh or brackish water. These are not likely present on site	**Unlikely** Suitable habitat is not likely found within the impact area	**No**	**No**	**Unlikely**
34. ***Gelochelidon nilotica*** **(Gull-billed Tern)**	Bird	M/SL	Not flagged by the latest PMST database search but appeared in prior searches during desktop	Yes, a record exists from a large wetland at Peak Downs Mine from 1999	Suitable wetlands are not likely in the impact area	**Possible**	Yes, although marginal	**No**	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
			assessments for the Terrestrial Ecological Assessment.						
35. *Rhipidura rufifrons* (Rufous Fantail)	Bird	M/SL	**Likely** to occur within area, in feature area.	Yes, this species is expected to be found within the region	Yes, suitable habitat exists	**Likely**	**Yes**	**Yes**	**Confirmed**
36. *Apus pacificus* (Fork-tailed Swift)	Bird	M/SL	**Likely** to occur within area, in feature area.	Not important. This is a fast-flying species that almost certainly overflies the impact area as it utilises airspace over a wide range of habitats during migration.	N/A, habitat is likely to be airspace above entire region	**Likely**	Foraging and dispersal only in airspace above project	Yes, though only likely to overfly	**Likely**
37. *Cuculus optatus* (Oriental Cuckoo)	Bird	M/SL	**Likely** to occur within area, in feature area.	The only record within 100 km is approximately 6 km north from 2009.	Yes, suitable habitat for this species is similar to that of the rufous fantail,	**Possible**	Habitat that may be suitable for the species was found, although it is not as	**No.**	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
					though more of a coastal species that may occasionally pass through the impact area		close to the coast as this species prefers.		
38. ***Monarcha melanopsis* (Black-faced Monarch)**	Bird	M/SL	**Likely** to occur within area, in feature area.	Records are known from the area.	Typically associated with rainforest. Migrating individuals may utilise dense riparian vegetation	**Possible**	Possible in dense riparian vegetation in the limited portions of the impact area it may be found.	**No**	**May occur**
39. ***Myiagra cyanoleuca* (Satin Flycatcher)**	Bird	M/SL	**Likely** to occur within area, in feature area.	Records are known from the area.	Tall wet forests of the coast and nearby ranges. Vagrant individuals may occasionally occur inland, where they are most likely in denser forests (e.g., along waterways).	**Possible**	Habitat is marginal, species may occasionally use the area, though better habitat is found closer to the coast.	**No**	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
40. ***Plegadis falcinellus* (Glossy Ibis)**	Bird	M/SL	**Likely** to occur within area, in feature area.	A 2001 record is known from 1 km from the impact area in an area that appears to be influenced by sheet flooding. Otherwise, records are known to be scattered throughout the region, over 70 km from the impact area.	Shallow, marshy edges of large freshwater wetlands	**Possible**	Marginal habitat was found	**No**	**May occur**
41. ***Calidris acuminata* (Sharp-tailed Sandpiper)**	Bird	M/SL	**Known** to occur in area, in feature area	Yes, a record exists from the BMA Peak Downs mine in a large wetland	Estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the impact area	**Possible**	Yes, although marginal	No	**May occur**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
42. ***Actitis hypoleucos* (Common Sandpiper)**	Bird	M/SL	**May** occur in buffer area only	No, no records within 130 km	Estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the impact area	**Possible**	**No**	**No**	**Unlikely**
43. ***Calidris melanotos* (Pectoral Sandpiper)**	Bird	M/SL	**May** occur within area overfly marine area, in feature area	One record within 130 km from 2009, in the west of Shoalwater Bay	Estuarine and freshwater wetlands with extensive shallow, muddy margins	**Unlikely**	**No**	**No**	**Unlikely**
44. ***Motacilla flava* (Yellow Wagtail)**	Bird	M/SL	**May** occur within area, in feature area; may occur within area overfly marine area, in feature area	No records	**No**	**Unlikely**	**No**	**No**	**Unlikely**

Species Name	Class	Status (EPBC Act/NC Act)**	PMST likelihood output†	ALA, PlantNet, iNat, Herbrecs, WildNet records in area within suitable timeframe?	Are suitable REs or other habitat mapped or visible in area of interest?	Is this species or TEC likely following desktop review?	Was suitable habitat found? (including Breeding, Shelter, Foraging, Dispersal for fauna species)	Was the species or evidence of the species found within the Project area?	Updated likelihood conclusion following field surveys
45. *Pandion haliaetus* (Osprey)	Bird	M/SL	**Likely** to occur within area, in buffer area only	Most records occur along the coast. Near the Project, the closest is about 80 km to the east from the year 2000.	**No**	**Unlikely**	**No**	**No**	**Unlikely**
46. *Tringa nebularia* (Common Greenshank)	Bird	M/SL	**May** occur within area, in buffer area only	Two nearby records are from the Peak Downs Mine in 1999, and near the Moranbah Airport in 1978. The next closest sightings are located at least 60 km to the south of the Project.	**No** Primarily coastal, but occasionally also uses the muddy margins of large freshwater wetlands.	**Unlikely**	**No**	**No**	**Unlikely**

** EPBC Act = *Environment Protection and Biodiversity Act 1999* (Commonwealth). NC Act = *Nature Conservation Act 1992* (Queensland).

† Likelihood that species or species habitat occurs in the PMST database search. ‘Feature area’ = disturbance footprint.

E=Endangered, M=Migratory, SL=Special Least Concern, V=Vulnerable.

4.3.3 Threatened Species

A total of 27 species of plants and animals listed as threatened species under the EPBC Act were flagged by database searches for the 2022 TEA as being potentially present in the region. Following the updated desktop review in 2024, 5 additional species were flagged and have been included here, for a total of 32.

Some species that were flagged in the original run of the PMST did not appear in the 2024 version, however these have been retained and discussed below for completeness. In total, 51 matters have been identified either during the 2024 desktop review or the 2022 desktop review as potentially occurring within the Project area.

Field surveys have confirmed that four of these (Koala, Central Greater Glider, Squatter Pigeon and White-throated Needletail) are present within the survey area (**Figure 4-7**). No threatened species of plants were detected within the survey area.

The likelihoods that the remaining species occur within the survey area were assessed by considering the proximity and recentness of records, as well as availability of potential habitat. A detailed description of the habitat requirements of each is provided in the following subsections.

Sample site locations rather than AU's were used to derive the habitat quality scores as these provide a point in space rather than a broad area. This enabled a finer level of resolution to be achieved for the habitat quality scores as shown below in **Table 4-8**, **Table 4-12** and **Table 4-15.**

Figure 4-7 Photographs of threatened wildlife taken during surveys: A) Central Greater Glider, B) Koala, and C) Squatter Pigeons

4.3.3.1 Squatter Pigeon

The southern subspecies of the Squatter Pigeon (*Geophaps scripta scripta*) is listed as vulnerable under the EPBC Act. This species was recorded on numerous occasions throughout the survey area (66 individual records at 28 locations). There is no recovery plan in place for the species. However, the Commonwealth Government has provided advice about the species' ecology and priority actions to mitigate key threats within the conservation advice (Threatened Species Scientific Committee 2015a) and the SPRAT profile for the species (Department of Climate Change, Energy, the Environment and Water 2022b).

Habitat is described as follows:

BREEDING HABITAT

Any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3. 5 or 7) and within 1 kilometre of a suitable, permanent or seasonal waterbody.

FORAGING HABITAT

Any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3, 5 or 7) and within 3 kilometres of a suitable, permanent or seasonal waterbody.

DISPERSAL HABITAT

Any forest or woodland occurring between patches of foraging or breeding habitat that facilitates movement between patches of foraging habitat, breeding habitat and/or waterbodies, and areas of cleared land less than 100 metres wide linking areas of suitable breeding and/or foraging habitat.

BEHAVIOUR AND ECOLOGY

The Squatter Pigeon is a ground-dwelling bird that feeds on seeds among sparse and low grass, in improved pastures, and beside railway lines and around settlements (Threatened Species Scientific Committee 2015). The Squatter Pigeon inhabits the grassy understorey of open eucalypt woodland, and less often savannas. It is nearly always found near permanent water such as rivers, creeks and waterholes (Threatened Species Scientific Committee 2015). Sandy areas dissected by gravel ridges, which have open and short grass cover, allowing easier movement, are preferred (Threatened Species Scientific Committee 2015). It is less commonly found on heavier soils with dense grass (Threatened Species Scientific Committee 2015). It often occurs in burnt areas and is sometimes found on tracks and roadsides (Threatened Species Scientific Committee 2015).

The species nests on the ground, usually laying two eggs among or under vegetation (Threatened Species Scientific Committee 2015).

Provided land is not overgrazed, Squatter Pigeons coexist readily with cattle grazing; however, the species has largely disappeared from the southern part of its distribution (e.g., New South Wales and southern Queensland), where sheep grazing is widespread, and rabbit densities are high (Threatened Species Scientific Committee 2015). Squatter Pigeons often favour thinned habitats where grazing cattle create open patches of ground for foraging. Some introduced pastures also provide a valuable food source for the species (Crome 1976). A moderate amount of land modification probably benefits the species, reflected by long-term population increases (between 1934 and 1999) in grazing properties elsewhere in the Brigalow Belt (Woinarski and Catterall 2004). This is also supported by data comparing undisturbed woodlands near Townsville with areas disturbed by grazing or military activities; the latter two land uses supported ten times more Squatter Pigeons (Woinarski and Ash 2002).

The SPRAT profile defines foraging habitat for the Squatter Pigeon as remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species, on sandy or gravelly soils (Queensland land zones 5 and 7), within 3 km of a suitable, permanent or seasonal waterbody (Department of Climate Change, Energy, the Environment and Water 2022b). Breeding habitat occurs on rises occurring on sandy or gravelly soils, within 1 km of a suitable, permanent waterbody (Department of Climate Change, Energy, the Environment and Water 2022b). Typically, the ground-covering vegetation layer in foraging and breeding habitat is considerably patchy, consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This patchy, ground layer of vegetation rarely exceeds 33% of the ground area (Department of Climate Change, Energy, the Environment and Water 2022b). The remaining ground comprises bare soil with a light covering of leaf litter (Department of Climate Change, Energy, the Environment and Water 2022b).

Except where this has been cleared, all vegetation within the survey area (with the exception of one small patch of vine-thicket) is dominated by *Eucalyptus, Corymbia* and/or *Acacia* species. Most is located on land zone 5 (sandy plain) favoured by Squatter Pigeons. Here, *Eucalyptus crebra*, *Eucalyptus populnea, Eucalyptus melanophloia* and *Corymbia clarksoniana* are the dominant canopy species. The understorey is usually dominated by the introduced pasture grasses *Bothriochloa pertusa*, *Cenchrus ciliaris* and *Melinis repens*. However, the native grasses *Aristida* spp., *Chrysopogon fallax*, *Eriochloa crebra* and *Alloteropsis cimicina* are occasionally dominant.

Narrow ribbons of land zone 3 (sandy alluvium) occur along creeks, where dense forests of *Eucalyptus camaldulensis* and *Melaleuca leucadendra* grow. Creek terraces support open forests of *Corymbia tessellaris, Eucalyptus populnea, Corymbia dallachiana* and *Corymbia clarksoniana.* In general, land zone 3 contains too thick a grass cover to be favourable for Squatter Pigeons; the mean ground vegetation cover is 58% and four out of five sites sampled exceeded 33% cover. However, most permanent water points (dams and natural wetlands) are located in this land zone, and these provide water resources for Squatter Pigeons. Furthermore, as the ground around these water points is often heavily grazed, patches of suitable foraging habitat exist in an otherwise unfavourable matrix. These "islands" of highly favourable habitat (water with adjacent foraging habitat) were the locations of many Squatter Pigeon sightings (**Table 4-6**).

Land zone 10 (sandstone rises and escarpments) occurs along the western fringe of the MLA area, and more extensively further west. Steep slopes, extensive rock outcropping, no surface water, and a lack of bare ground patches within this land zone make it largely unsuitable for Squatter Pigeons. Of 17 sites sampled, nine were unsuitable for Squatter Pigeons due to having >33% vegetation cover or <10% bare ground. The eight sites classed as suitable based on understorey composition were primarily in regional ecosystems 11.10.7 or 11.10.3 located on the foot slopes. Squatter Pigeon sightings largely mirrored these habitat assessments. Despite comprising 39% of the total survey area, only 3% of individuals sighted were in land zone 10 (all in regional ecosystem 11.10.7), and all were within 300 m of land zone 3 or 5.

The vast majority of sightings (69.7%) were in land zone 5, a finding that strongly accords with habitat preferences presented in the SPRAT profile.

No Squatter Pigeons were recorded on land zones 4 or 9. The heavy clay soils in land zone 9 support an excessively dense grass cover. In remnant 11.9.2, vegetation covers an average of 63% of the ground, and this increases to 85% in areas where 11.9.2 has been cleared. The clay soils in land zone 4 are similarly unsuitable for Squatter Pigeons. Sites surveyed within this land zone fell into one of two categories. In areas where the canopy was open, vegetation covered far greater than 33% of the ground. In areas where the canopy was dense, there was very little grass as a source of seed and/or bare ground on which to forage (one or both categories constituted less than 10% of the total ground cover).

In summary, data gathered on site strongly supports the habitat preferences described in the SPRAT profile, in that land zone 5 constitutes the primary foraging and breeding habitat for Squatter Pigeons within the survey area, land zone 3 is utilised in the vicinity of water, and land zone 10 is mostly not utilised, except for regional ecosystem 11.10.7 on the foot slopes. There is no local evidence that heavy clays on land zones 4 and 9 are utilised by Squatter Pigeons.

Table 4-6 Squatter Pigeon records per habitat type

Land Zone	Vegetation Age	Percentage of Survey Area	Percentage of Squatter Pigeon Records
3: Alluvium	Remnant	5.5%	21.2%*
	Regrowth	2.3%	4.5%*
	Cleared	4.2%	6.1%*
4: Clay plain	Remnant	2.1%	0%
	Regrowth	0.1%	0%
	Cleared	1.6%	0%
5: Sand plain	Remnant	17.1%	15.2%
	Regrowth	7.5%	6.0%
	Cleared	12.2%	48.5%
9: Clay derived from fine-grained sedimentary rock	Remnant	4.8%	0%
	Regrowth	0%	0%
	Cleared	2.8%	0%
10: Sandstone ranges	Remnant	37.5%	3%
	Regrowth	1.7%	0%
	Cleared	0.8%	0%

*Detection rates of Squatter Pigeons in alluvial areas may overestimate the true value of this habitat for the species, as the high grass density within this land zone means that individuals are more likely to forage on tracks, where they are more detectable.

Many cleared patches of vegetation within the survey area had regrown sufficiently, or a sufficient density of trees was retained during clearing, for some cleared areas to qualify as "sparse open-woodland or scrub" used by Squatter Pigeon for foraging and breeding. Accordingly, as can be seen from **Table 4-6**, many Squatter Pigeon records came from cleared vegetation.

There is no single, standard definition of "sparse" vegetation in Australia. The most widely used vegetation classification system (the Specht classification system: Specht 1970) defines "sparse" vegetation classes as possessing 10-30% foliage projection cover or 20-50% canopy cover (the latter includes gaps between leaves within each canopy). However, in its *National Forest and Sparse Woody Vegetation Data* (Department of Industry, Science, Energy and Resources 2020), the Australian Government adopts a more conservative definition of sparse woody vegetation as having 5-19% canopy cover. Given that the definition of Squatter Pigeon habitat as "open-forest to sparse, open-woodland or scrub" was developed by the Australian Government for their SPRAT profile, the Australian Government's definition of "sparse" as >5% canopy cover was adopted for habitat mapping purposes.

Regardless of the status of vegetation under Queensland's VM Act (non-remnant, regrowth or remnant), any parts of land zones 3 or 5 that qualified as "sparse" vegetation according to *National Forest and Sparse Woody Vegetation Data* were considered Squatter Pigeon foraging habitat and/or breeding habitat. Likewise, any remnant or former regional ecosystem 11.10.7 was considered habitat if this qualified as "sparse" vegetation. Vegetation with less than 5% cover of woody vegetation, vegetation occurring on land zones 4 or 9, and any vegetation on land zone 10 that is not 11.10.7 were not considered appropriate foraging or breeding habitat.

Most habitats within the survey area that did not qualify as foraging or breeding habitat did qualify as dispersal habitat. Dispersal habitat is defined by the SPRAT profile as any vegetation unit on any land zone where trees are at least 100 m apart. Most of the survey area, including areas that do not qualify as "sparse woody vegetation" have trees that are 100 m or less apart. Satellite imagery was used to identify non-remnant patches where trees were further than 100 m apart. Any vegetation outside these bare patches that were not foraging habitat qualified as dispersal habitat.

The distribution of Squatter Pigeon habitat across the survey area is shown in **Figure 4-8.** In total the disturbance footprint contains the following habitat categories:

- Breeding and Foraging: 372.5 ha
- Foraging: 78.9 ha
- Dispersal: 767.6 ha.

Total habitat within the disturbance footprint = 1219.1 ha.

Habitat within a 500 m indirect impact buffer around the Project contains the following habitat categories:

- Breeding and Foraging: 858.8 ha
- Foraging: 338.7 ha
- Dispersal: 1318.2 ha.

Total habitat within the 500 m indirect impact buffer = 2515.7 ha.

HABITAT ASSESSMENT

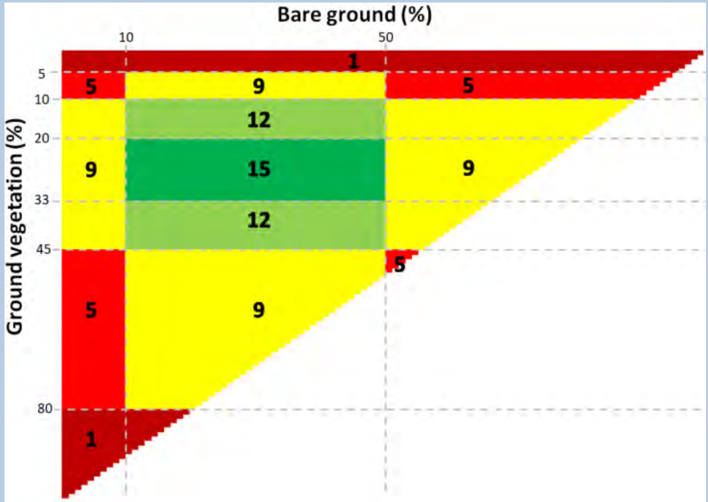
Project-specific indicators and scoring system have been devised to assess the quality of habitat for the Squatter Pigeon (**Table 4-7**). Note that the resulting habitat quality scores (**Table 4-8**) are largely independent from the habitat type.

Note that a third of the Squatter Pigeon's final habitat quality score is partly derived from the BioCondition score, the other two-thirds are from the outcomes of the assessment in **Table 4-7**.

The habitat quality data remains relevant with the land use in the area being consistent since the time of survey, with no clearing or rehabilitation likely to affect these scores.

Table 4-7 Species-specific habitat quality scoring for the impact site (Squatter Pigeon)

Squatter Pigeon	**1 Threats to species**	Score	1	6	11	16
		Invasion by Buffel Grass	**High:** Buffel Grass has a ground cover >40%	**Moderate:** Buffel Grass has a ground cover of 10-40%.	**Low:** Buffel Grass has a ground cover of 0.1-9.9%.	**None:** Buffel Grass is absent.
		Score	0	3	7	9
		Predation by feral predators	**Very High:** Assessment unit is within 5 km of a town, dump or other source of supplementary food for dogs and cats, and no control programs are in place.	**High:** Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, and no control programs are in place.	**Moderate:** Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs and cats, but active control measures (baiting, trapping or shooting) occur within the assessment unit and effectively reduce cat and dog densities (as shown by monitoring).	
	2 Quality and availability of food and foraging habitat	Score	**0**	**1**	*Unlike for other habitat attributes and species, the score for distance to water is multiplied by the sum of the other foraging scores to generate an overall foraging habitat score for Squatter Pigeons.	
		Distance to water*	**High:** Assessment unit is >3 km from water.			
		Score	Scores (1-15) are assigned based on the percentage of ground covered by low vegetation (<1 m) and bare ground, as shown in the below table			

		Ground cover					
		Score	**1**	**3**	**5**	**8**	**10**
		Understorey richness	**Very low:** <5 species of grasses and forbs.	**Low:** 5-14 species of grasses and forbs.	**Moderate:** 15-24 species of grasses and forbs.		
	3 Quality and availability of habitat for shelter and breeding	Score	**0**	**1**	*Unlike for most other habitat attributes and species, the score for distance to water is multiplied by the other breeding habitat score below to generate an overall breeding habitat score for Squatter Pigeons.		
		Distance to water*	**High:** Assessment unit is >1 km from permanent water	**Low:** Assessment unit is within 1 km of permanent water.			
		Score	**1**	**4**	**11**	**18**	**25**
		Normalised Difference Vegetation Index (NDVI)	**Very poor:** the assessment unit does not contain any 1-ha cells with a mean NDVI > 0.125.				
		Score	Scores are assigned based on the below table				

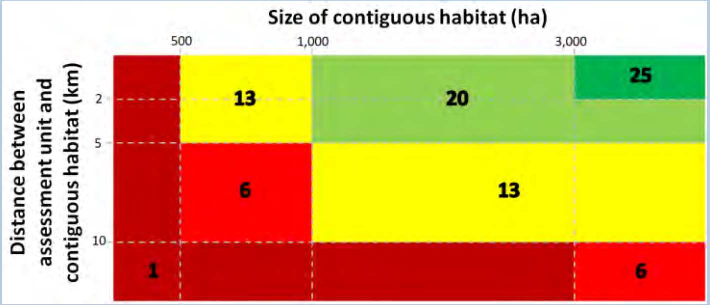
4 Species mobility capacity	Extent of, and distance to, large patches of contiguous habitat	

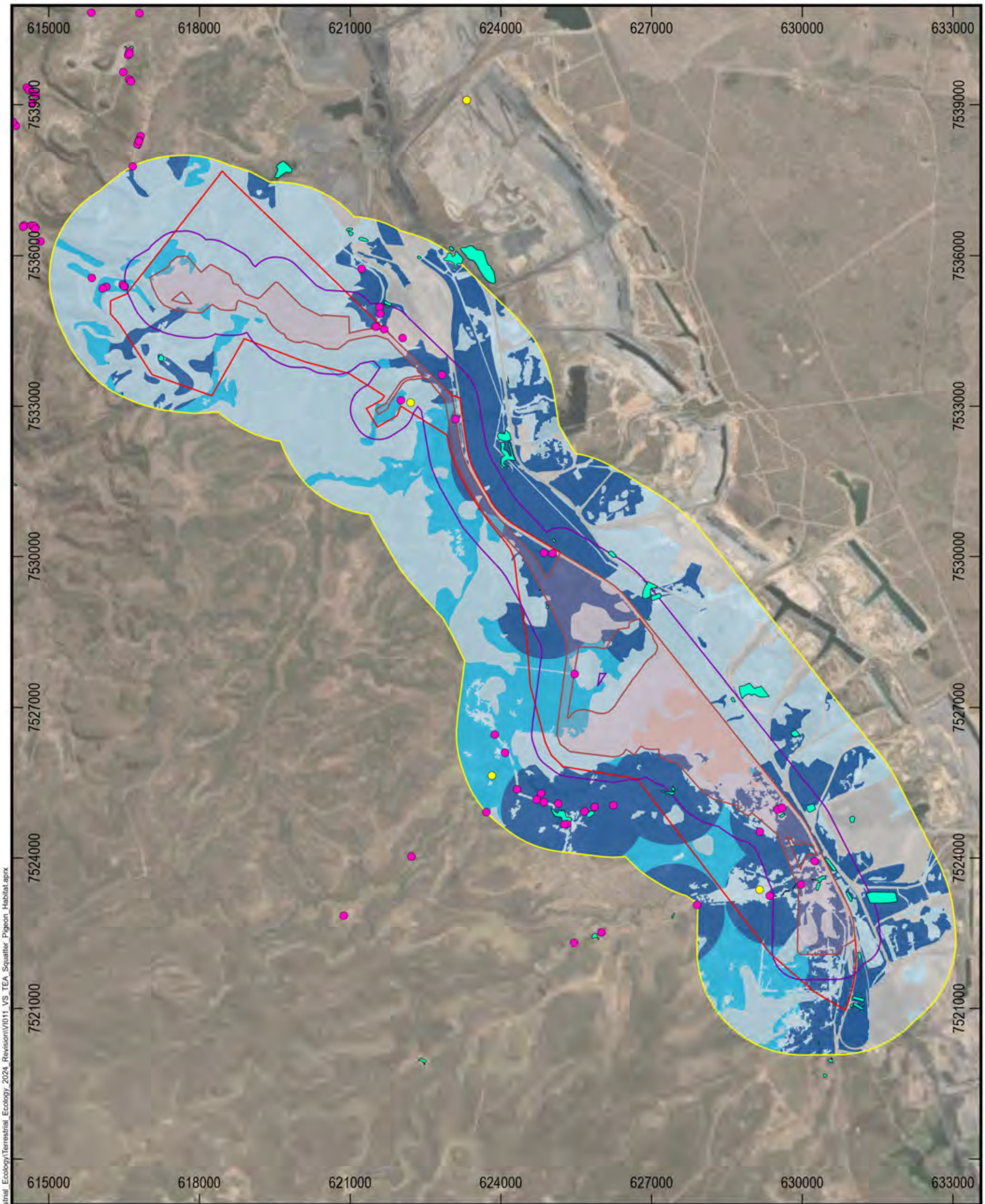
Table 4-8 Squatter Pigeon Habitat Scores

Sample Site code	RE	Area (ha)	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I01	11.10.1x1	6.86	Dispersal	81
I02	11.10.7	41.44	Foraging	61
I03	11.10.1x1	99.83	Dispersal	49
I04	11.10.3	57.46	Dispersal	67
I05	11.10.1	9.03	Dispersal	64
I06	11.10.3	48.4	Dispersal	65
I07	11.10.1	105.57	Dispersal	64
I08	11.10.3	519.00	Dispersal	60
I09	11.10.7	30.85	Foraging	46
I10	11.10.3	1448.68	Dispersal	68
I11	NR 11.3.7	11.30	Breeding and Foraging	62
I12	11.3.7	8.60	Breeding and Foraging	74
I13	NR 11.10.7	39.10	Breeding and Foraging	80
I14	NR 11.10.7	39.10	Breeding and Foraging	78
I15	NR 11.5.9	14.66	Breeding and Foraging	79
I16	11.5.9	46.12	Breeding and Foraging	75
I17	11.5.9a	1.54	Breeding and Foraging	86
I18	11.3.25	16.5	Breeding and Foraging	83
I19	11.3.7	6.86	Breeding and Foraging	73
I20	11.5.9	639.41	Foraging	72
I21	11.10.1x1	71.97	Dispersal	76
I22	11.5.9	639.41	Breeding and Foraging	88
I23	11.4.8	4.41	Dispersal	85
I24	11.5.9	30.49	Breeding and Foraging	82
I25	11.4.8	58.73	Dispersal	61
I26	11.4.8	26.66	Dispersal	83

Sample Site code	RE	Area (ha)	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I27	11.9.2	306.32	Dispersal	69
I28	11.5.3	13.39	Foraging	67
I29	11.4.8	19.57	Dispersal	70
I30	11.9.2	19.15	Dispersal	61
I31	11.5.3	5.92	Breeding and Foraging	65
I32	NR 11.9.2	185.10	Dispersal	52
I33	11.9.2	306.32	Dispersal	51
I34	11.9.2	306.32	Dispersal	49
I35	11.5.9	639.41	Foraging	64
I36	NR 11.9.2	185.10	Non-habitat	45
I37	11.4.9	1.33	Dispersal	77
I38	11.3.2	52.5	Breeding and Foraging	78
I39	NR 11.9.2	185.10	Non-habitat	68
I40	NR 11.9.2	185.10	Non-habitat	62
I41	NR 11.4.8	29.98	Non-habitat	63
I42	NR 11.4.8	47.53	Non-habitat	46
I43	NR 11.5.3	192.26	Dispersal	77
I44	NR 11.5.3	192.26	Dispersal	58
I45	NR 11.4.8	4.01	Dispersal	70
I46	NR 11.4.8	14.43	Dispersal	61
I47	11.3.2	1.89	Breeding and Foraging	70
I48	11.3.25	87.52	Breeding and Foraging	68
I49	NR 11.5.3	78.09	Dispersal	61
I50	NR 11.5.3	31.95	Breeding and Foraging	70
I51	NR 11.10.3	40.84	Dispersal	76
I52	NR 11.5.3	12.36	Breeding and Foraging	70
I53	NR 11.10.3	12.69	Dispersal	70

Sample Site code	RE	Area (ha)	Squatter Pigeon habitat type	Squatter Pigeon habitat score
I54	NR 11.5.9	0.71	Breeding and Foraging	73
I55	NR 11.5.3	192.26	Breeding and Foraging	72

Table note: "Patch size" refers to the size of the individual mapped polygon the sample point is located within, including potions that fall outside the disturbance footprint.



Legend

- Squatter Pigeon Sightings

Atlas of Living Australia Records

- Geophaps scripta (Squatter Pigeon)
- Waterbodies

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer

Squatter Pigeon Habitat

- Breeding and Foraging
- Foraging
- Dispersal
- Non-habitat

Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Earthstar Geographics.

Vulcan South

Squatter Pigeon Habitat and Sightings

0 1 2 3

Kilometers

Scale: 1:110,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-8

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.3.3.2 Koala

Koalas (*Phascolarctos cinereus*) within Queensland, New South Wales and the Australian Capital Territory are listed as endangered under the EPBC Act. This species was recorded 14 times within the survey area, involving at least 12 individuals. It is highly likely that more individuals were present than were detected. The Threatened Species Scientific Committee (2012) suggests an average Koala density of 0.005 Koalas/ha across the Brigalow Belt. Assuming this same density across the survey area, 33 individuals are likely to occur within the survey area. This estimate has low reliability, given the lack of local data on population densities.

The former Australian Government Department of Agriculture, Water and the Environment (2022a) published the *National Recovery Plan for the Koala* Phascolarctos cinereus *(combined populations of Queensland, New South Wales and the Australian Capital Territory)*. The Australian Government has also provided advice about the species' ecology and priority actions to mitigate key threats within the SPRAT profile for the species (Department of Climate Change, Energy, the Environment and Water 2022c) and the conservation advice (Department of Agriculture, Water and the Environment (2022b).

On the western slopes, tablelands and plains in Queensland, Koalas are found in sub-humid *Eucalyptus*-dominated forests and woodlands in riparian and non-riparian environments, and some *Acacia*-dominated forests and woodlands in non-riparian environments (Department of Climate Change, Energy, the Environment and Water 2022c). The main habitat requirement is availability of suitable food trees and, to a lesser extent, shelter trees, which tend to have shadier foliage, be taller and/or located in sheltered locations in gullies (Crowther *et al.* 2013).

While Koalas have been observed sitting in or eating up to 120 species of eucalypt (Phillips 1990), the diet of individual Koalas is usually limited to one or a few species (Moore and Foley 2000). Preferences also vary between regions or seasons (Moore and Foley 2000). Chemical anti-feedants, soil nutrients and leaf water content in semi-arid areas may limit or prevent Koalas feeding on foliage of individual trees even when the species is considered preferred (Lawler *et al.* 1998; Moore *et al*. 2005). In the northwest of their range in Queensland (including the project area), Koala distribution is limited by heat and water availability, with the highest densities of Koalas occurring along creek lines (Munks *et al.* 1996; Sullivan *et al*. 2003). Variability in leaf nutrition creates patchiness such that species-based assessments of habitat likely overestimate the availability of high-quality habitat (Threatened Species Scientific Committee 2012).

Despite limitations in habitat mapping caused by varying leaf nutrition, a conservative approach to habitat mapping is appropriate, which assumes that any individuals of tree species known to be eaten by Koalas could constitute a potential food tree. Likewise, the SPRAT database defines Koala habitat as "any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees" (Department of Climate Change, Energy, the Environment and Water 2022c). This includes remnant, regrowth and modified vegetation communities. Assessment of habitat quality for Koalas therefore relies on the identification of local preferences for species and the quantification of the availability of those species (Department of Climate Change, Energy, the Environment and Water 2022c).

The Australian Koala Foundation (2015) maintains a database of the food trees known to be used by Koalas in each local government area of Australia (**Table 4-9**), while the distribution of these species is outlined in **Table 4-10**.

Table 4-9 Locally important Koala trees in the Brigalow Belt

Species	Common name	In disturbance footprint?
Brigalow Belt locally important Koala trees		
Eucalyptus brownii	Brown's box, Red river box	N
Eucalyptus chloroclada	Baradine gum, Red gum, Dirty gum	N
Eucalyptus conica	Fuzzy box, Fuzzy gum	N
Eucalyptus coolabah	Coolibah, Coolabah	N
Eucalyptus drepanophylla	Queensland grey ironbark, Narrow-leaved ironbark	N
Eucalyptus dura	Ironbark	N
Eucalyptus fibrosa	Broad-leaved red ironbark, Blue-leaved ironbark, Dusky-leaved ironbark	N
Eucalyptus laevopinea	Silvertop stringybark	N
Eucalyptus largiflorens	Black box, Flooded box, River box	N
Eucalyptus longirostrata	Grey Gum	N
Eucalyptus major	Queensland grey gum, Grey gum	N
Eucalyptus microcarpa	Grey box, Narrow-leaved box, Inland box	N
Eucalyptus moluccana	Coastal grey box, Gum-topped box, Grey box	N
Eucalyptus ochrophloia	Yapunyah, Napunyah, Yellow jacket	N
Eucalyptus punctate	Grey gum, Grey iron gum, Long-capped grey gum	N
Eucalyptus saligna	Sydney blue gum, Blue gum	N
Eucalyptus sideroxylon	Red ironbark, Mugga ironbark, Three-fruited red ironbark	N
Eucalyptus camaldulensis	River Red Gum, Murray red gum, Yarrow	Y
Eucalyptus crebra	Narrow-leaved ironbark, Narrow-leaved red ironbark, Muggago	Y
Eucalyptus exserta	Queensland peppermint, yellow messmate, Bendo	Y
Eucalyptus melanophloia	Silver-leaved Ironbark	Y
Eucalyptus orgadophila	Mountain Coolibah, Gum topped box	Y
Eucalyptus populnea	Poplar gum, Bimble box	Y
Eucalyptus tereticornis	Forest red gum, Flooded gum, Queensland blue gum	Y
Ancillary habitat trees		
Acacia harpophylla	Brigalow, Spearwood, Orkor	Y
Acacia salicina	Cooba, Motherumba, Broughton willow, Sally Wattle	Y
Acacia tephrina	Boree	N
Corymbia citriodora	Lemon-scented gum, Spotted gum	Y

Species	Common name	In disturbance footprint?
Corymbia dallachiana	Dallachy's ghost gum	Y
Corymbia erythrophloia	Red bloodwood, Variable-barked bloodwood, Red-barked bloodwood, Gum-topped bloodwood	Y
Corymbia intermedia	Pink bloodwood, Red bloodwood	Y
Corymbia tessellaris	Moreton Bay ash, Carbeen	Y
Eucalyptus acmenoides	White Mahogany, Narrow-leaved white stringybark	Y
Eucalyptus baileyana	Bailey's Stringybark, Black stringybark	N
Eucalyptus cambageana	Dawson River blackbutt, Dawson's gum, Coowarra box	Y
Eucalyptus decorticans	Gum-top Ironbark	N
Eucalyptus platyphylla	White Gum, Poplar gum	Y
Eucalyptus thozetiana	Thozet's box, Mountain yapunyah	Y
Melaleuca bracteata	Black tea-tree, River tea-tree, Mock olive	Y

The Australian Koala Foundation (2015) acknowledges that *Eucalyptus crebra* can sometimes constitute an additional secondary food species in localised areas with better soils and nutrient availability. Given that this tree species is eaten by Koalas at nearby sites (Ellis *et al*. 2002; Melzer *et al*. 2014), it is conservatively considered a food tree for the purposes of habitat mapping. This species is widespread across the survey area and surrounding region, being a dominant component of many of the regional ecosystems occurring on site. Given the low fertility of local sandy soils, it is unlikely that most local *E. crebra* is utilised to a significant extent by Koalas. Indeed, no Koalas were recorded anywhere on land zone 5 (sand plains), where soils are least fertile. However, small numbers were observed on land zone 10 (sandstone) where *E. crebra* was growing. In accordance with the SPRAT definition of Koala habitat (i.e., any forest or woodland containing species that are known Koala food trees), any vegetation containing *E. crebra* is included as potential habitat.

Table 4-10 Distribution of Koala food trees across vegetation units

Regional Ecosystem*	Area (ha)*	Primary Food Trees	Secondary Food Trees	Overall foraging Value to Koalas†	Habitat type	N_{Koalas}/100ha‡
11.3.1	1.6	Absent	Absent	Nil	SHELTER / DISPERSAL	0
11.3.2	276.2	Absent	*E. populnea* dominant	Moderate	FORAGING / SHELTER / DISPERSAL	0
11.3.7	86.4	*E. camaldulensis* occasionally present	*E. populnea* and/or *E. crebra* sometimes subdominant	Moderate	SHELTER / DISPERSAL	0
11.3.25	153.0	*E. camaldulensis* dominant	*E. populnea* and/or *E. crebra* sometimes subdominant	High	FORAGING / SHELTER / DISPERSAL	7.19
11.3.27c	2.0	Absent	Absent	Nil	SHELTER / DISPERSAL	0
11.3.27e	6.5	*E. camaldulensis* dominant	*E. populnea* and/or *E. crebra* sometimes subdominant	High	FORAGING / SHELTER / DISPERSAL	0
11.4.8	131.4	Absent	Absent	Nil	SHELTER / DISPERSAL	0
11.4.9	16.2	Absent	Absent	Nil	SHELTER / DISPERSAL	0
11.5.3	517.6	Absent	*E. populnea* dominant	Moderate	FORAGING / SHELTER / DISPERSAL	0
11.5.9	1,152.5	Absent	*E. crebra* sometimes dominant, but some variants of this RE lack secondary food trees.	Moderate	FORAGING / SHELTER / DISPERSAL	0
11.9.2	326.4	Absent	*E. orgadophila* dominant	Moderate	FORAGING / SHELTER / DISPERSAL	0
11.10.1	265.9	Absent	*E. crebra* usually subdominant	Moderate	FORAGING / SHELTER / DISPERSAL	0.38
11.10.1x1	412.3	Absent	*E. crebra* occasionally present in low densities	Low	FORAGING / SHELTER / DISPERSAL	0
11.10.3	1,642.1	Absent	*E. crebra* occasionally present as a scattered emergent	Low	FORAGING / SHELTER / DISPERSAL	0.06
11.10.7	341.6	Absent	*E. crebra* dominant	Moderate	FORAGING / SHELTER / DISPERSAL	0.29
11.10.8	1.3	Absent	Absent	Nil	DISPERSAL	0

*Remnant, regrowth and modified forms of regional ecosystems can all constitute habitat, provided non-juvenile food trees (>4 m tall: Queensland Government 2015) are present. Only remnant and regrowth total area is presented in the table, as no Koalas were recorded in cleared vegetation. However, non-remnant habitat that is sufficiently dense to qualify as "sparse woody vegetation" (see **Section 4.3.3.1**) was also considered Koala habitat in **Figure 4-9** and when assessing potential impacts to the species.

†High, moderate and low value habitats all qualify as Koala habitat under the Australian Government's definition (Department of Climate Change, Energy, the Environment and Water 2022c).

‡Refers to the number of Koalas recorded in each regional ecosystem as a function of the total area in hectares of each regional ecosystem within the survey area. Note that this is not the same as population density, as not all Koalas present are likely to have been detected. Nevertheless, it is a useful indicator of relative density.

In addition, the document "A review of Koala habitat assessment criteria and methods" (The Australian National University, 2021) outlines the following locally important Koala trees in the Brigalow Belt. These include food trees (locally important Koala trees) and trees that are most likely used for shelter trees (Ancillary habitat trees). These are presented in **Table 4-9.**

In consideration of both of the above sources, habitat for the Koala in the survey area includes the following remnant and non-remnant (NR) REs:

FORAGING/SHELTER/DISPERSAL:

- 11.10.1x1: *Corymbia aureola* and *Eucalyptus melanophloia* open forest on scarps and sandstone tablelands. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra* in low quantities. For details on this RE, refer to **Section 4.1.2**.
- 11.10.3/NR 11.10.3: *Acacia shirleyi* open forest on coarse-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra* in low quantities.
- 11.10.7: *Eucalyptus crebra* woodland on coarse-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra.*
- 11.3.2: *Eucalyptus populnea* woodland on alluvial plains. Primary food trees are absent. Secondary food trees include *Eucalyptus populnea*.
- 11.3.25: *Eucalyptus camaldulensis* forest fringing drainage lines. Primary food trees include *Eucalyptus camaldulensis*. Secondary food trees include *Eucalyptus populnea* and/or *E. crebra*.
- 11.5.3/NR 11.5.3: *Eucalyptus populnea* woodland on Cainozoic sand plains and/or remnant surfaces. Primary food trees are absent. Secondary food trees include *Eucalyptus populnea.*
- 11.5.9/NR 11.5.9: *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces. Primary food trees are absent. Secondary food trees include *E. crebra* (some variants of this RE lack secondary food trees).
- 11.5.9a: *Eucalyptus melanophloia* woodland. Occurs on Cainozoic sandplains formed on plateaus and broad crests of hills and ranges.
- 11.9.2/NR 11.9.2: *Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus orgadophila*.
- 11.10.7: *Eucalyptus crebra* woodland on coarse-grained sedimentary rocks. Primary food trees are absent. Secondary food trees include *Eucalyptus crebra.*

SHELTER/DISPERSAL:

- 11.3.7/NR 11.3.7: *Corymbia* spp. woodland on alluvial terraces.
- 11.4.9*:* *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.
- 11.10.1: *Corymbia citriodora* woodland on coarse-grained sedimentary rocks.
- 11.4.8/NR 11.4.8: *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* on Cainozoic clay plains. No food trees are present

DISPERSAL

Dispersal habitats are areas of habitat that are between foraging habitats without dispersal barriers, i.e., habitats which are no more than 4 km apart but themselves contain little or no resources for the species. They are *not* functional for the Koala as standalone habitats. Despite the addition of these areas to calculations, they are inconsequential to the species for offsetting purposes. Dispersal habitat is generally considered to have little to no value as shelter from hot or dry conditions. In most cases these are areas of non-remnant REs.

NON-HABITAT

Non-habitat areas are areas that contain no resources for the species. This includes areas that would be considered dispersal habitat, but with preferred corridors within them that contain forage and shelter trees. For example, an open treeless area with a defined line of trees intersecting it would be considered non-habitat, where the defined line of trees itself is considered foraging/shelter and therefore a preferred dispersal pathway. In the context of the Project, the open areas between foraging/shelter habitats and Saraji Road to the east are considered non-habitat due to the lack of dispersal destinations. As for dispersal habitat, non-habitat is generally considered to have little to no value as shelter from hot or dry conditions.

All but one sighting of Koalas occurred in remnant vegetation. The single exception was in regrowth 11.3.25 along Barrett Creek. No Koalas were recorded in cleared vegetation units, despite detectability being higher in smaller trees and open landscapes. This aligns with known preferences of the species for tall trees (Callaghan *et al*. 2011; Smith *et al*. 2013). This finding conflicts with the broad definition of Koala habitat presented in the SPRAT profile (Department of Climate Change, Energy, the Environment and Water 2022c) as any remnant, regrowth and modified vegetation communities containing Koala food trees. As most cleared portions of the survey area contain widely scattered food trees, they therefore qualify as habitat under this definition, despite being of negligible importance to local Koalas. They are therefore mapped as the same low value as remnant units containing low densities of secondary food trees (e.g., 11.10.13 or 11.10.3).

Non-remnant regrowth that had a canopy cover less than 5% is considered “non-woody” vegetation by the *National Forest and Sparse Woody Vegetation Data* (Department of Industry, Science, Energy and Resources 2020) and was accordingly mapped as non-habitat.

The Brigalow Belt bioregion contains the largest population of Koalas within Queensland (Department of Climate Change, Energy, the Environment and Water 2022c), owing to its large size and subhumid climate (other large bioregions are in semi-arid climates with low Koala densities). Habitat connectivity is high across the region surrounding Vulcan South. Habitats containing secondary food trees connect ribbons of important habitat (containing primary food trees) occurring along major watercourses and provide opportunities for dispersal. The project, however, lies at a habitat edge, as it is bounded to the north and east by existing mining operations that represent an impediment to dispersal. The Koala population present within the survey area is connected to the broader region via extensive tracts of eucalypt forests that cover the Cherwell-Harrow Range, to the west and south.

Habitat clearance and climate change represent the major threats to Koala populations in the Brigalow Belt. The location of primary food trees along watercourses means that they represent important drought refugia. Road-based mortality is another local threat, and multiple fatalities occur along Saraji Road each year. Attacks by domestic dogs, a key threat in densely settled regions of Queensland, is a negligible threat locally, given the low density of houses.

Koala habitat in the disturbance footprint is delineated as follows (**Figure 4-9**):

- Foraging/shelter/dispersal = 938.6 ha
- Shelter/dispersal = 45.5 ha
- Dispersal = 182.2 ha.
- Total direct: 1,166.9 ha

Additional areas within 500 m indirect impact buffer include the following:

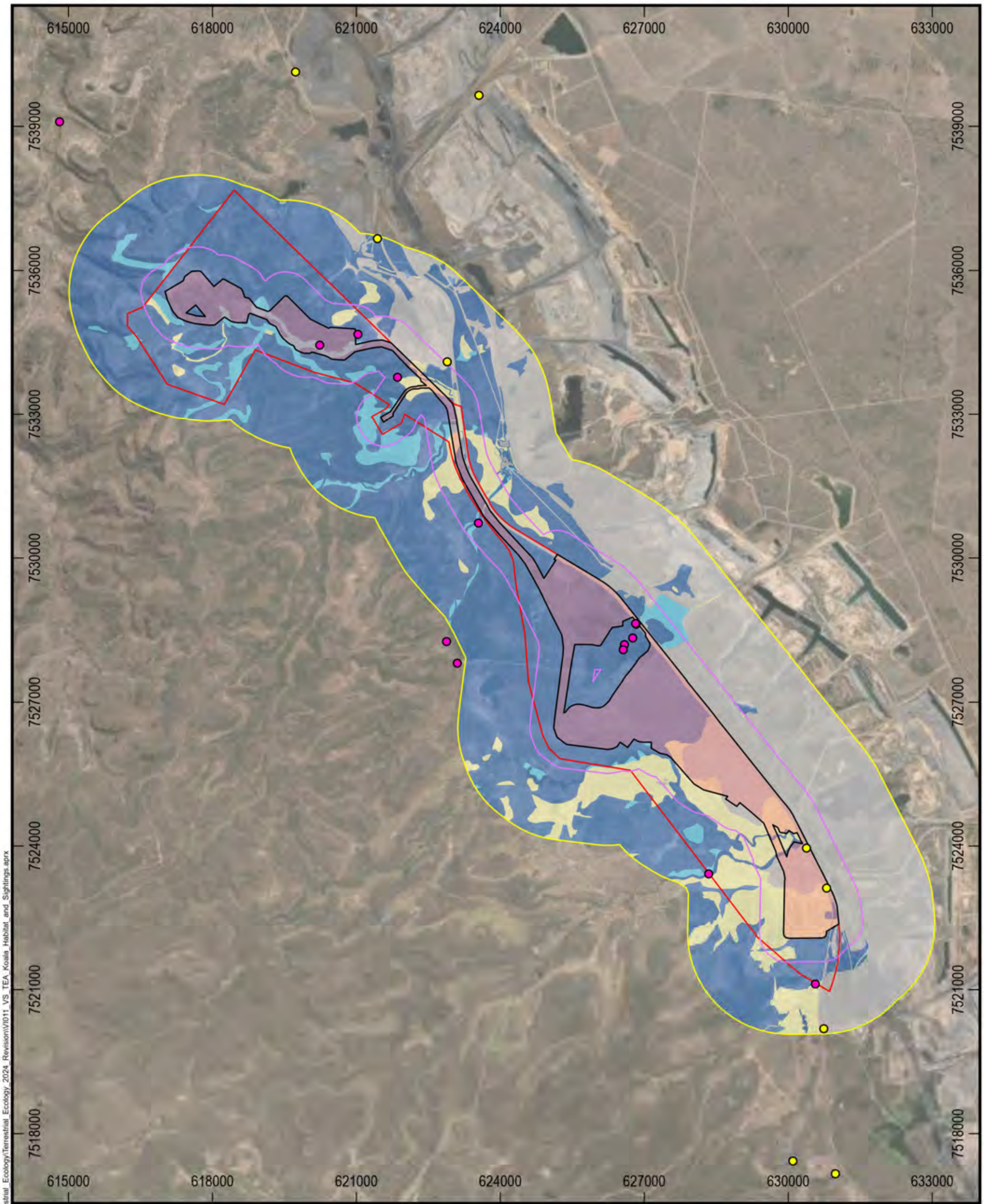
- Foraging/shelter/dispersal = 1532.0 ha
- Shelter/dispersal = 188.4 ha

- Dispersal = 390.5 ha.
- Total indirect: 2,110.9 ha

A 500 m buffer was used to represent impacts from noise, dust and vibration as these impacts reduce in intensity with distance and a distance further than 500 m would likely limit the impacts of these variables on wildlife to the point where the impact is negligible.

HABITAT ASSESSMENT

Project-specific indicators and scoring system have been devised to assess the quality of habitat for the Koala (**Table 4-11**). Note that the resulting habitat quality scores (**Table 4-12**) are largely independent from the habitat type. Habitat value for the Koala is shown in **Figure 4-10**.



Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Koala_Habitat_and_Sightings.aprx

Legend

- Koala Sighting

Atlas of Living Australia Records

- *Phascolarctos cinereus* (Koala)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer

Koala Habitat Type

- Foraging/shelter/dispersal
- Shelter/dispersal
- Dispersal
- Non-habitat

Source: Atlas of Living Australia 2024, Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, Koala Habitat - METServe 2024. Earthstar Geographics 28/09/2023

Vulcan South

Koala Habitat Type and Sightings

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-9

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Table 4-11 Species-specific habitat quality scoring system proposed for the impact site (Koala)

Koala	**1 Threats to species**	Score	0	3	6	8
		Risk of road-based mortality	High: Assessment unit borders a public road with 100 kph speed limit.	Moderate: Assessment unit is within 1 km of a public road with 100 kph speed limit, OR borders a public road with 60-100 kph speed limit.	Low: Assessment unit lies 1-2 km from public roads, AND any private tracks through or near the unit are used infrequently at night (less than once per week) and at low speeds (less than 50 kph).	Nil: Assessment unit lies >2 km from a public road, AND any private tracks through or near the unit are used infrequently at night (less than once per week) and at low speeds (less than 50 kph).
		Score	0	5	8	
		Risk of dog attack	High: Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, and no control programs are in place.	Moderate: Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, but active control measures (baiting, trapping or shooting) occur within the assessment unit and effectively reduce dog densities (as shown by monitoring).	Low: Assessment unit is further than 18 km from a town, dump or other source of supplementary food for dogs.	
		Score	0	5	9	
		Importance as a drought refuge	**Low:** The assessment unit is further than 2 km from a watercourse or source of surface water, OR is 1-2 km from a watercourse, but no vegetation occurs along the watercourse.			
		Score	Scores are assigned based on combination of basal area and proportion of primary food trees, as shown in the below table			

<table>
<tr><td rowspan="4"></td><td rowspan="3">2 Quantity and quality of food</td><td>Density and quality of food trees</td><td colspan="5">
<table>
<tr><td rowspan="2" colspan="2"></td><td colspan="5">Percentage of total food tree basal area that comprises primary food trees (E. camaldulensis or E. tereticornis)</td></tr>
<tr><td>0</td><td><10</td><td>10-40</td><td>40-70</td><td>70-100</td></tr>
<tr><td rowspan="6">Combined basal area of all food trees (m^2/ha)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td><2</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>2-5</td><td>2</td><td>3</td><td>5</td><td>7</td><td>8</td></tr>
<tr><td>5-8</td><td>3</td><td>5</td><td>7</td><td>10</td><td>12</td></tr>
<tr><td>8-10</td><td>4</td><td>7</td><td>10</td><td>13</td><td>16</td></tr>
<tr><td>>10</td><td>5</td><td>8</td><td>12</td><td>16</td><td>20</td></tr>
</table>
</td></tr>
<tr><td>Score</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Number of large food trees</td><td>None: No large food trees</td><td>Poor: 1 or 2 large food trees per 0.5 ha</td><td>Moderate: 3 to 6 large food trees per 0.5 ha</td><td>High: 7 to 10 large food trees per 0.5 ha</td><td>Very high: >10 large food trees</td></tr>
<tr><td rowspan="5">3 Quality and availability of shelter</td><td>Score</td><td>1</td><td>2</td><td>4</td><td>7</td><td>10</td></tr>
<tr><td></td><td>Canopy cover of trees taller than 4 m.</td><td>None: No trees taller than 4 m.</td><td>Poor: <10% cover.</td><td>Moderate: 10-30% cover.</td><td>High: 30-60% cover.</td><td>Very high: >60% cover.</td></tr>
<tr><td></td><td>Score</td><td>0</td><td>2</td><td>4</td><td>7</td><td>10</td></tr>
<tr><td></td><td>Number of large non-food trees</td><td>0</td><td>1</td><td colspan="3">2-4</td></tr>
<tr><td></td><td>Score</td><td>0</td><td>5</td><td colspan="3"></td></tr>
</table>

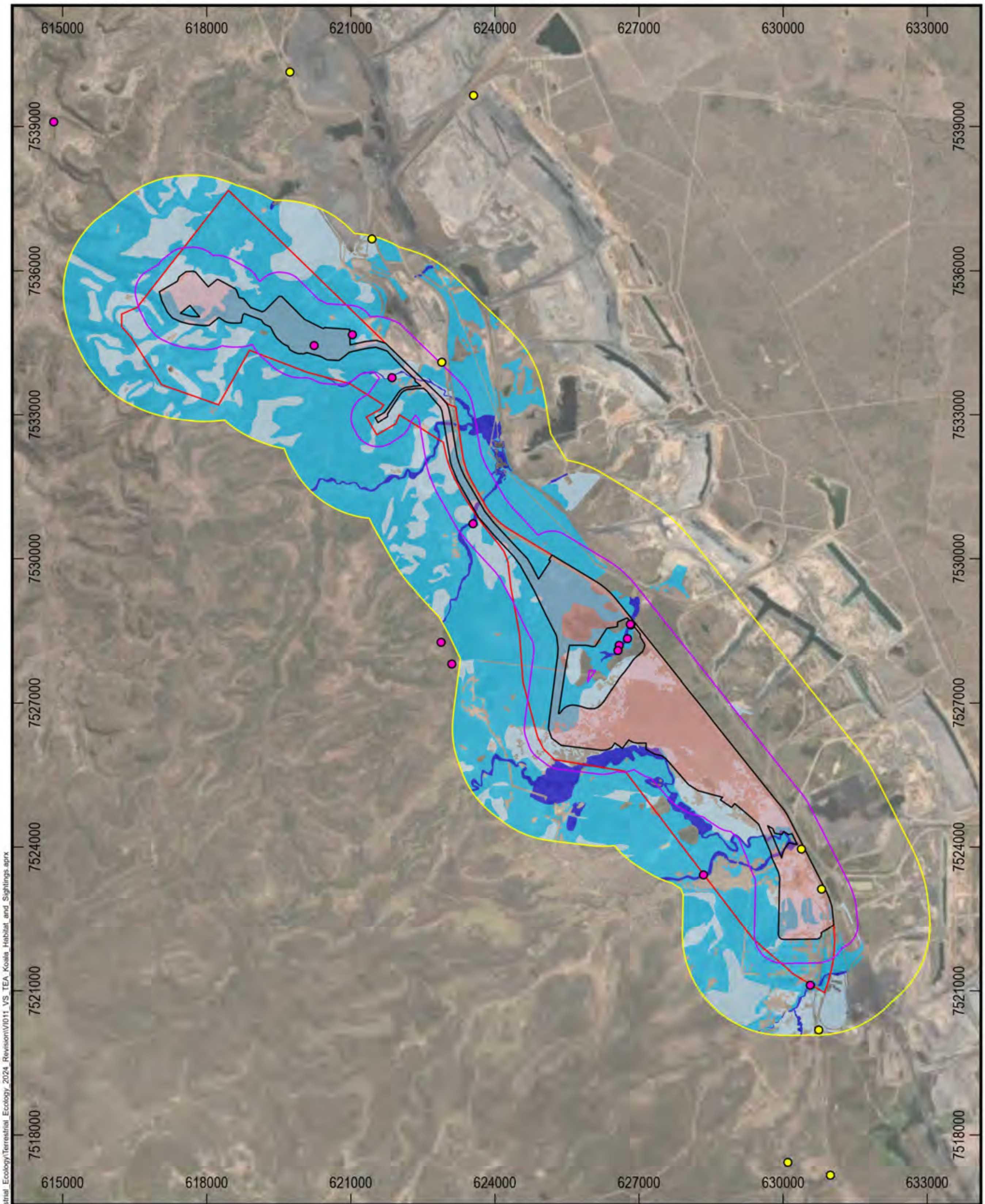
		Presence of dense shade trees	Trees taller than 6 m and with a crown that has >75% cover are absent	Trees taller than 6 m and with a crown that has >75% cover are present			
	4 Species mobility capacity	Score	1	5	10	17	25
		Extent of contiguous habitat.	**Very poor:** Assessment unit is further than 5 km from contiguous habitat larger than 200 ha.	**Poor:** Assessment unit is 2-5 km from contiguous habitat larger than 200 ha	**Moderate:** Assessment unit is connected to, or within 2 km of, a contiguous landscape that is 200-500 ha.	**Good:** Assessment unit is within 2 km of a contiguous landscape that is 500-1,000 ha.	**Very good:** Assessment unit is connected to or within 2 km of a contiguous landscape that is >1,000 ha.

Table 4-12 Habitat scores for the Koala

Sample Site code	RE	Area (ha)	Koala habitat type	Koala habitat score
I01	11.10.1x1	6.86	Foraging / shelter / dispersal	49
I02	11.10.7	41.44	Foraging / shelter / dispersal	52
I03	11.10.1x1	99.83	Dispersal	48
I04	11.10.3	57.46	Foraging / shelter / dispersal	52
I05	11.10.1	9.03	Shelter / dispersal	51
I06	11.10.3	48.4	Foraging / shelter / dispersal	55
I07	11.10.1	105.57	Shelter / dispersal	67
I08	11.10.3	519.00	Dispersal	60
I09	11.10.7	30.85	Shelter / dispersal	55
I10	11.10.3	1448.68	Shelter / dispersal	60
I11	NR 11.3.7	11.30	Shelter / dispersal	61
I12	11.3.7	8.60	Shelter / dispersal	55
I13	NR 11.10.7	39.10	Dispersal	46
I14	NR 11.10.7	39.10	Dispersal	54
I15	NR 11.5.9	14.66	Foraging / shelter / dispersal	66
I16	11.5.9	46.12	Dispersal	64
I17	11.5.9a	1.54	Dispersal	64
I18	11.3.25	16.5	Foraging / shelter / dispersal	75
I19	11.3.7	6.86	Shelter / dispersal	58
I20	11.5.9	639.41	Dispersal	51
I21	11.10.1x1	71.97	Dispersal	52
I22	11.5.9	639.41	Foraging / shelter / dispersal	58
I23	11.4.8	4.41	Shelter / dispersal	64
I24	11.5.9	30.49	Foraging / shelter / dispersal	66
I25	11.4.8	58.73	Shelter / dispersal	59
I26	11.4.8	26.66	Dispersal	57
I27	11.9.2	306.32	Foraging / shelter / dispersal	46
I28	11.5.3	13.39	Foraging / shelter / dispersal	62

Sample Site code	RE	Area (ha)	Koala habitat type	Koala habitat score
I29	11.4.8	19.57	Dispersal	58
I30	11.9.2	19.15	Foraging / shelter / dispersal	50
I31	11.5.3	5.92	Foraging / shelter / dispersal	65
I32	NR 11.9.2	185.10	Foraging / shelter / dispersal	42
I33	11.9.2	306.32	Foraging / shelter / dispersal	47
I34	11.9.2	306.32	Foraging / shelter / dispersal	61
I35	11.5.9	639.41	Foraging / shelter / dispersal	54
I36	NR 11.9.2	185.10	Shelter / dispersal	46
I37	11.4.9	1.33	Shelter / dispersal	62
I38	11.3.2	52.5	Foraging / shelter / dispersal	62
I39	NR 11.9.2	185.10	Foraging / shelter / dispersal	46
I40	NR 11.9.2	185.10	Dispersal	46
I41	NR 11.4.8	29.98	Shelter / dispersal	46
I42	NR 11.4.8	47.53	Shelter / dispersal	42
I43	NR 11.5.3	192.26	Foraging / shelter / dispersal	57
I44	NR 11.5.3	192.26	Foraging / shelter / dispersal	48
I45	NR 11.4.8	4.01	Foraging / shelter / dispersal	71
I46	NR 11.4.8	14.43	Dispersal	51
I47	11.3.2	1.89	Foraging / shelter / dispersal	71
I48	11.3.25	87.52	Foraging / shelter / dispersal	83
I49	NR 11.5.3	78.09	Foraging / shelter / dispersal	58
I50	NR 11.5.3	31.95	Foraging / shelter / dispersal	54
I51	NR 11.10.3	40.84	Foraging / shelter / dispersal	59
I52	NR 11.5.3	12.36	Foraging / shelter / dispersal	52
I53	NR 11.10.3	12.69	Foraging / shelter / dispersal	57
I54	NR 11.5.9	0.71	Foraging / shelter / dispersal	49
I55	NR 11.5.3	192.26	Foraging / shelter / dispersal	51

Table note: "Patch size" refers to the size of the individual mapped polygon the sample point is located within, therefore the total area will not equal the total area to be disturbed.



Legend

- Koala Sighting

Atlas of Living Australia Records

- *Phascolarctos cinereus* (Koala)

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Koala Habitat Value (Average Overall Scores)

- High Quality (Score ≥ 65)
- Moderate (Score 55 - 65)
- Low (Score 45 - 55)

Source: Atlas of Living Australia 2024, Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024, Koala Habitat - METServe 2024. Earthstar Geographics 28/09/2023

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Koala_Habitat_and_Sightings.aprx

Vulcan South

Koala Habitat Value and Sightings

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-10

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.3.3.3 Greater Glider (southern and central)

The Greater Glider (*Petauroides volans*) is listed as an endangered species under the EPBC Act. Recent studies have suggested that this taxon actually comprises three genetically distinct species, with the Central Greater Glider (*P. armillatus*) being present in the survey area (McGregor *et al.* 2020). Its taxonomy under the EPBC Act is yet to be revised in accordance with this recent study.

Habitat is broadly defined as follows, noting that denning habitat includes both breeding and shelter habitat:

DISPERSAL HABITAT

Areas with trees (that do not qualify as foraging or denning) which provide connectivity to isolated patches of denning habitat and are at least 100 metres wide.

FORAGING HABITAT

Areas containing locally important dominant/co-dominant trees for foraging within 200 metres of denning habitat.

POTENTIAL/FUTURE DENNING HABITAT

Areas containing appropriate trees with a diameter at breast height greater than 30 cm, but less than the Regional Ecosystem threshold for large trees.

LIKELY/CURRENT DENNING HABITAT

Areas containing appropriate trees (*Eucalyptus, Corymbia, Angophora*) with a diameter at breast height greater than the Regional Ecosystem threshold for large trees generally >40cm.

A total of 20 Greater Gliders were recorded within the survey area, with most of these occurring in riparian forests along watercourses. There is no recovery plan in place for the species. However, the Commonwealth Government has provided advice about the species’ ecology and priority actions to mitigate key threats within the conservation advice (Threatened Species Scientific Committee 2016).

Greater Gliders are known to use a range of trees for foraging and denning. The tree species present in the Project area as per the results of the BioCondition assessments that are also listed in the *Guide to Greater Glider Habitat in Queensland* (Eyre, et al., 2022) are outlined in **Table 4-13** below, with reference to their utility by the species.

Table 4-13 Trees from the "Eucalypt" group that may be utilised by Greater Gliders in the Survey area

Tree species	Usage by Greater Gliders
Corymbia citriodora	Denning and foraging
Eucalyptus crebra	Denning and foraging
Eucalyptus molluccana	Denning and foraging
Eucalyptus tereticornis and Eucalyptus camaldulensis	Denning and foraging
Corymbia intermedia	Foraging
Corymbia tessellaris	Foraging
Eucalyptus melanophloia	Foraging
Corymbia aureola	No use recorded

Tree species	Usage by Greater Gliders
Eucalyptus cambageana	No use recorded
Eucalyptus trachyphloia	No use recorded
Eucalyptus orgadophylla	No use recorded
Corymbia clarksoniana	Unspecified use
Corymbia dallachiana	Unspecified use
Corymbia erythrophloia	Unspecified use
Eucalyptus platyphylla	Unspecified use
Eucalyptus populnea	Unspecified use

The project lies near the western edge of the distribution of the Central Greater Glider (Kearney *et al.* 2010). Water availability limits the distribution of local populations (Kearney *et al.* 2010). Consequently, local populations are largely restricted to riparian environments, where large, hollow trees are most abundant, and subsoil moisture allows suitable food trees to grow fresh leaves over extended periods of the year.

Each individual requires many large, hollow-bearing trees within its home range of 1-4 ha (Comport *et al*. 1996; Lindenmayer *et al*. 2004). Southern Greater Gliders generally require trees larger than 50 cm (diameter of trunk at breast height) (Kehl and Borsboom 1984), and even larger trees may be required in tropical environments, in order for hollows to be buffered against extreme daytime temperatures (Kearney *et al.* 2010). During ecological surveys of the survey area, high densities of trees of this size were very rarely encountered away from riparian zones. Nevertheless, large, hollow *Corymbia citriodora* occasionally grew in sheltered, south-facing slopes of gorges within the Harrow Range. One Greater Glider was recorded within such habitat during surveys. For this reason, regional ecosystem 11.10.1 was also considered potential habitat for Greater Gliders within the survey area.

With the exception of the single record in regional ecosystem 11.10.1, all other records were in riparian environments (regional ecosystems 11.3.25, 11.3.7, 11.3.27e and regrowth 11.3.25 with many retained large trees), despite these habitats comprising only 3.7% of the survey area. This is clear evidence for the importance of riparian habitats for local populations of the Central Greater Glider. Local populations are likely to be relatively large, as the species was recorded along all major drainage lines surveyed. Conservatively assuming that each pair occupies 16 ha (the home range in lower productivity forests and more open woodlands: Threatened Species Scientific Committee 2016), there is expected to be at least 58 individuals inhabiting the survey area. This population could be larger than 450 individuals if an average home range of 2 ha is assumed (a more typical size: Threatened Species Scientific Committee 2016). This local population is connected to the broader region via extensive tracts of eucalypt forests that cover the Harrow Range, to the west and south (regional ecosystem 11.10.1 is a subdominant community within this range).

Non-remnant habitats (e.g., regrowth) are unlikely to be utilised by Greater Gliders, due to an absence of hollows for shelter. An exception is where many large, hollow trees were retained during clearing. The only part of the survey area where this was observed was in the far south, along Barrett Creek. Here, a pair of Greater Gliders was observed to emerge from one of the retained hollow dead trees. Riparian vegetation along Barrett Creek was therefore mapped as habitat, while regrowth elsewhere within the survey area was considered to be unsuitable for Greater Gliders.

The habitat definitions described above are based on highly conservative guidance provided by DCCEEW. The following points outline the notion that this is likely to vastly over-represent the extent of local habitat for the Greater Glider:

- For an assessment unit to be classed as "denning habitat", large trees (as defined by the BioCondition benchmarks) are to be present but no minimum density is required, as per DCCEEW's conservation advice. Some units that qualify as denning habitat possessed fewer than one large tree per hectare, on average, and lacked large trees at more than half the 0.5-ha plots surveyed. However, a study by Eyre *et al*. (2022) indicates that only 15-30% of "large" trees support hollows that may be suitable for Greater Gliders. Furthermore, all studies of Greater Gliders to date revealed they require more than one hollow tree per home range. The minimum density of hollows required for habitat to be inhabitable by Greater Gliders is unknown, but all available data suggest that at least four suitable hollows per hectare are required by the species (Eyre, 2006; Smith, et al., 1994; Comport, et al., 1996; Smith, et al., 2007). Given that only 15-30% of "large" trees support hollows, a density of at least 13 large trees per hectare is required to achieve the hollow densities typically required by Greater Gliders. Only two assessment units contained such high densities of eucalypts (regional ecosystems 11.3.25 and 11.3.2), suggesting that most of the area mapped as denning habitat is unlikely to be occupied by Greater Gliders.
- Mapped foraging habitat is anywhere within 200 m of denning habitat that contains known species of food trees for Greater Gliders. However, the size of trees is not considered. Studies into the foraging behaviour of Greater Gliders have found that the species consistently find that trees with trunk diameters less than 30 cm are significantly avoided by the species when foraging, whereas foraging is generally concentrated on the largest trees (Smith, et al., 2007; McGregor, et al., 2023; Eyre, et al., 2022). As "denning habitat", by definition, contains larger trees than "foraging habitat", there is little reason to expect individuals to venture far from denning habitat to feed. Furthermore, it is unlikely that Greater Gliders would be expected to commute 200 m from their den to feed, even if food resources within the "foraging habitat" was superior to the that in the "denning habitat". The average distance from den trees to the edge of home ranges (data from (Starr, et al., 2021; Comport, et al., 1996; Kehl & Borsboom, 1984; Smith, et al., 2007) is only 45 m. Furthermore, radio-tracking data kindly provided by G. Smith from a study at Barakula State Forest revealed the average distance from a food tree to the nearest den was 42 m, and the 90th percentile was 82 m. All available data thus suggests that the foraging habitat mapped for Vulcan South is highly conservative.
- Future denning habitat was mapped as anywhere containing eucalypts with a stem diameter at breast height of 30 cm or more. Based on an extensive dataset compiled by Ngugi et al. (2015) from across Queensland, the dominant local trees *Eucalyptus crebra*, *Eucalyptus melanophloia* and *Corymbia citriodora* exhibit mean diameter growth rates of 0.17 cm/y, 0.19 cm/y and 0.19 cm/y, respectively. Given these growth rates, it is expected that *E. crebra*, *E. melanophloia* and *C. citriodora* will take 65 years, 58 years and 82 years to reach the relevant "large tree" size threshold (for the regional ecosystems in which these species are dominant) from a starting size of 30 cm. Mapping "future" habitats that will take more than half a century to be realised clearly involves a high level of uncertainty, as it depends on future land management practices and natural disasters. Remnant areas that have not been cleared have already reached their capacity for large hollow-bearing trees, there is no capacity for additional hollows in these areas. Cleared/non-remnant areas have not been set aside for regrowth under the current agricultural land use, therefore further growth of trees and hollow formation is highly unlikely.

Within the disturbance footprint, the following habitat areas are mapped according to DCCEEW guidelines, with a total of 1056.8 ha:

- 750 ha of likely/current denning habitat
- 234.6 ha of future denning habitat
- 19.3 ha of foraging habitat
- 52.9 ha of dispersal habitat.

Additional habitat within a 500 m indirect impact buffer includes a total 2209.8 ha:

- 1412.3 ha of likely/current denning habitat
- 787.1 ha of potential/future denning habitat

- 3.5 ha of foraging habitat
- 7.0 ha of dispersal habitat.

Habitat according to these definitions is mapped in **Figure 4-11**.

The habitat definitions proposed by DCCEEW and applied in **Figure 4-11** are highly conservative. They also fail to illustrate variation in the quality of local habitats for Greater Gliders. To provide better guidance to Vitrinite about the locations of habitats of highest importance to Greater Gliders (so that these could be avoided to the maximum extent practicable during the design stage of Vulcan South), two alternate, independent data sources were used to map glider habitat.

Figure 4-12 illustrates the detection rates of Greater Gliders across each of the assessment units surveyed on site. Habitat quality scores, as assessed by combining scores for food resources, shelter resources, habitat connectivity and threat level, as measured across 55 habitat quality assessment sites within the impact area support this observation. As the two independent datasets revealed qualitatively similar patterns, it is with high confidence that these reflect the distribution of Greater Gliders across the impact area and neighbouring regions.

Predictive modelling as illustrated in **Figure 4-12** based on field survey results gives estimates of Greater Glider density as individuals per kilometre per assessment unit. This results in the following habitat value outcomes:

- High value with 2-4 individuals per kilometre – 7.7 ha.
- Moderate value with 1-2 individuals per kilometre – 53.7 ha.
- Low value with 0-1 individuals per kilometre – 163.7 ha.

Project-specific indicators and scoring system have been devised to assess the quality of habitat for the Greater Glider **Table 4-14**. Results are presented in **Table 4-15**. Habitat values are shown in **Figure 4-13**.

Table 4-14 Species-specific habitat quality scoring system proposed for the impact site (Greater Glider)

<table>
<tr><td rowspan="7">Greater Glider</td><td rowspan="6">1 Threats to species</td><td>Score</td><td colspan="3">Scores are assigned based on the below table</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Threat of intense canopy fires</td><td colspan="3"><table><tr><td colspan="2"></td><td colspan="3">Position in landscape</td></tr><tr><td colspan="2"></td><td>Valley</td><td>Midslope</td><td>Crest</td></tr><tr><td rowspan="3">Elevated Fine Fuel Hazard</td><td>Low</td><td>10</td><td>9</td><td>8</td></tr><tr><td>Moderate</td><td>7</td><td>5</td><td>4</td></tr><tr><td>High to extreme</td><td>5</td><td>2</td><td>1</td></tr></table></td></tr>
<tr><td>Score</td><td>0</td><td>3</td><td>5</td><td>7</td><td>10</td></tr>
<tr><td>Importance as a climate change refuge</td><td>None: Assessment unit is further than 1 km from a drought refuge OR occurs within 1 km of a drought refuge but there is a vegetation gap > 0.5 km between the unit and the drought refuge.</td><td>Low: Assessment unit is <1 km from a permanent watercourse or an area mapped as a 'moderate' or 'high' potential groundwater-dependent ecosystem in the National GDE Atlas AND is connected to these drought refuges by woody vegetation.</td><td colspan="3">Moderate: Assessment unit is within 100 m of a farm dam or other water impoundment OR overlaps with a 'low' potential groundwater-dependent ecosystem in the National GDE Atlas.</td></tr>
<tr><td>Score</td><td>0</td><td>5</td><td colspan="3"></td></tr>
<tr><td>Threat of barbed wire fences</td><td colspan="5">High: Assessment unit is crossed by one or more fences with barbed top wire.</td></tr>
<tr><td></td><td>Score</td><td colspan="5">Scores are assigned based on combination of basal area and proportion of primary food trees, as shown in the below table</td></tr>
</table>

	2 Quality and availability of food	Density and quality of food trees					

Total basal area of food trees (m^2/ha)	Species richness of *Eucalyptus* and *Corymbia* in 0.5 ha: 1	2	3	4	5+
0	**0**	**0**	**0**	**0**	**0**
<2	**1**	**2**	**3**	**4**	**5**
2-5	**2**	**3**	**5**	**7**	**8**
5-8	**3**	**5**	**7**	**10**	**12**
8-10	**4**	**7**	**10**	**13**	**16**
>10	**5**	**8**	**12**	**16**	**20**

	2 Quality and availability of food	Score	**1**	**2**	**3**	**4**	**5**
		Number of large food trees (>30 cm DBH)	**None:** No large food trees	**Poor:** 1 or 2 large food trees per 0.5 ha	**Moderate:** 3 to 6 large food trees per 0.5 ha	**High:** 7 to 10 large food trees per 0.5 ha	**Very high:** >10 large food trees
		Score	**0**	**4**	**6**	**10**	**15**
	3 Quality and availability of shelter	Number of large shelter trees (>RE threshold for DBH) per 0.5 ha transect.	**None:** No eucalypt trees >RE threshold for DBH	**Poor:** 1 to 2 eucalypt trees >RE threshold for DBH.	**Moderate:** 3 to 5 eucalypt trees >RE threshold for DBH.	**High:** 6 to 9 eucalypt trees >RE threshold for DBH.	**Very high:** > 10 eucalypt trees >RE threshold for DBH.
		Score	**0**	**3**	**6**	**10**	
		Availability of hollows of a suitable size (over 8 cm entrance diameter) per	**None:** No hollows observed, trees unlikely to be able to support hollows (<30 cm DBH)				

		hectare (double the number recorded per half hectare BioCondition transect).	
	4 Species mobility capacity	Score	Scores are assigned based on a combination of size of the habitat patch and connectivity to other patches, as shown in the below table.
		Size and connectivity of habitat patch	

Size of habitat patch†		**Connectivity to nearest patch**					
		Patches <1 km apart and connected by woody vegetation*	**Patches 1-8 km apart and connected by woody vegetation***	**Patches >8 km apart and connected by woody vegetation***	**Patches <0.5 km apart and separated by open areas***	**Patches 0.5-3 km apart and separated by open areas***	**Patches >3 km apart and separated by open areas***
	>300 ha	25	23	21	20	18	15
	100-300 ha	24	20	17	15	12	10
	50-100 ha	23	17	10	8	6	4
	<50 ha	22	14	8	6	3	1

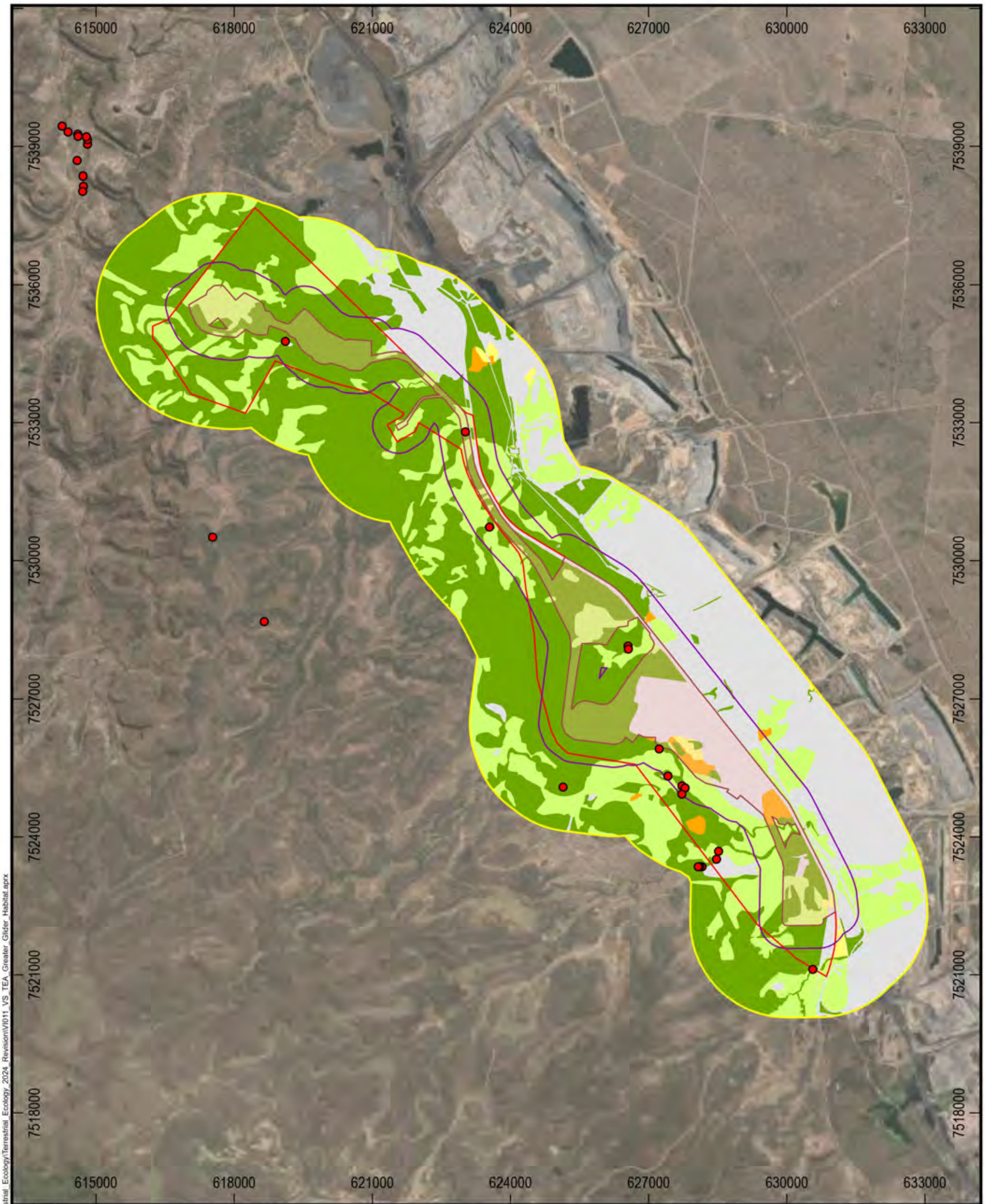
*Distinction between open areas versus wooded vegetation is defined by the gliding distance of Greater Gliders (i.e., average spaces between trees should not exceed the height of trees in wooded vegetation).

†Habitat patch size classes are based on ability of the patch to support a viable population of 100 Greater Gliders, assuming a mean home range size of 3 ha.

Table 4-15 Habitat scores for the Greater Glider

Sample Site code	RE	Area (ha)	Greater Glider habitat type	Greater Glider habitat score
I01	11.10.1x1	6.86	Potential/future denning	58
I02	11.10.7	41.44	Potential/future denning	52
I03	11.10.1x1	99.83	Potential/future denning	47
I04	11.10.3	57.46	Likely Denning	53
I05	11.10.1	9.03	Likely Denning	60
I06	11.10.3	48.4	Likely Denning	58
I07	11.10.1	105.57	Likely Denning	50
I08	11.10.3	519.00	Potential/future denning	46
I09	11.10.7	30.85	Potential/future denning	56
I10	11.10.3	1448.68	Potential/future denning	51
I11	NR 11.3.7	11.30	Likely Denning	54
I12	11.3.7	8.60	Likely Denning	57
I13	NR 11.10.7	39.10	Dispersal	41
I14	NR 11.10.7	39.10	Potential/future denning	43
I15	NR 11.5.9	14.66	Likely Denning	48
I16	11.5.9	46.12	Potential/future denning	42
I17	11.5.9a	1.54	Likely Denning	58
I18	11.3.25	16.5	Likely Denning	67
I19	11.3.7	6.86	Likely Denning	63
I20	11.5.9	639.41	Potential/future denning	41
I21	11.10.1x1	71.97	Potential/future denning	44
I22	11.5.9	639.41	Potential/future denning	48
I23	11.4.8	4.41	Likely Denning	49
I24	11.5.9	30.49	Potential/future denning	45
I25	11.4.8	58.73	Potential/future denning	48
I26	11.4.8	26.66	Potential/future denning	44
I27	11.9.2	306.32	Potential/future denning	53
I28	11.5.3	13.39	Potential/future denning	45
I29	11.4.8	19.57	Denning	51
I30	11.9.2	19.15	Potential/future denning	57
I31	11.5.3	5.92	Potential/future denning	53

Sample Site code	RE	Area (ha)	Greater Glider habitat type	Greater Glider habitat score
I32	NR 11.9.2	185.10	Nil	17
I33	11.9.2	306.32	Potential/future denning	55
I34	11.9.2	306.32	Likely Denning	63
I35	11.5.9	639.41	Likely Denning	49
I36	NR 11.9.2	185.10	Nil	18
I37	11.4.9	1.33	Dispersal	48
I38	11.3.2	52.5	Likely Denning	61
I39	NR 11.9.2	185.10	Nil	17
I40	NR 11.9.2	185.10	Nil	17
I41	NR 11.4.8	29.98	Nil	17
I42	NR 11.4.8	47.53	Nil	17
I43	NR 11.5.3	192.26	Nil	21
I44	NR 11.5.3	192.26	Nil	18
I45	NR 11.4.8	4.01	Likely Denning	46
I46	NR 11.4.8	14.43	Foraging	42
I47	11.3.2	1.89	Likely Denning	82
I48	11.3.25	87.52	Likely Denning	77
I49	NR 11.5.3	78.09	Likely Denning	55
I50	NR 11.5.3	31.95	Potential/future denning	40
I51	NR 11.10.3	40.84	Likely Denning	43
I52	NR 11.5.3	12.36	Potential/future denning	40
I53	NR 11.10.3	12.69	Foraging	36
I54	NR 11.5.9	0.71	Foraging	39
I55	NR 11.5.3	192.26	Dispersal	43



Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Greater Glider Habitat (Current)

- Likely/Current Denning
- Potential/Future Denning
- Dispersal
- Foraging
- Non-habitat

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Vulcan South

Greater Glider Habitat and Sightings

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-11

VITRINITE BRIGHTER COAL

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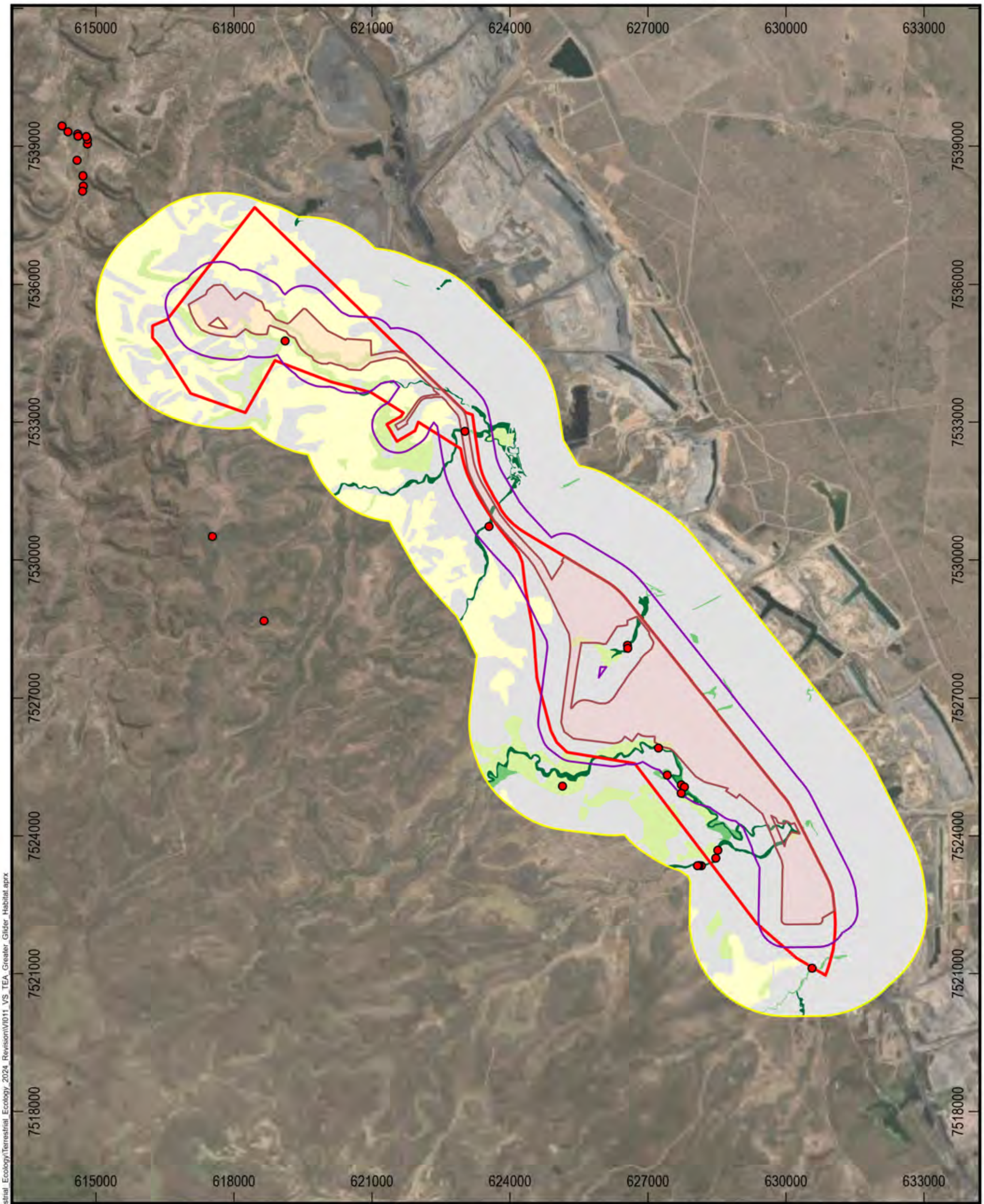


Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Greater Glider Relative Density (Individuals per km per Unit)

- 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Vulcan South

Greater Glider Relative Density and Sightings

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

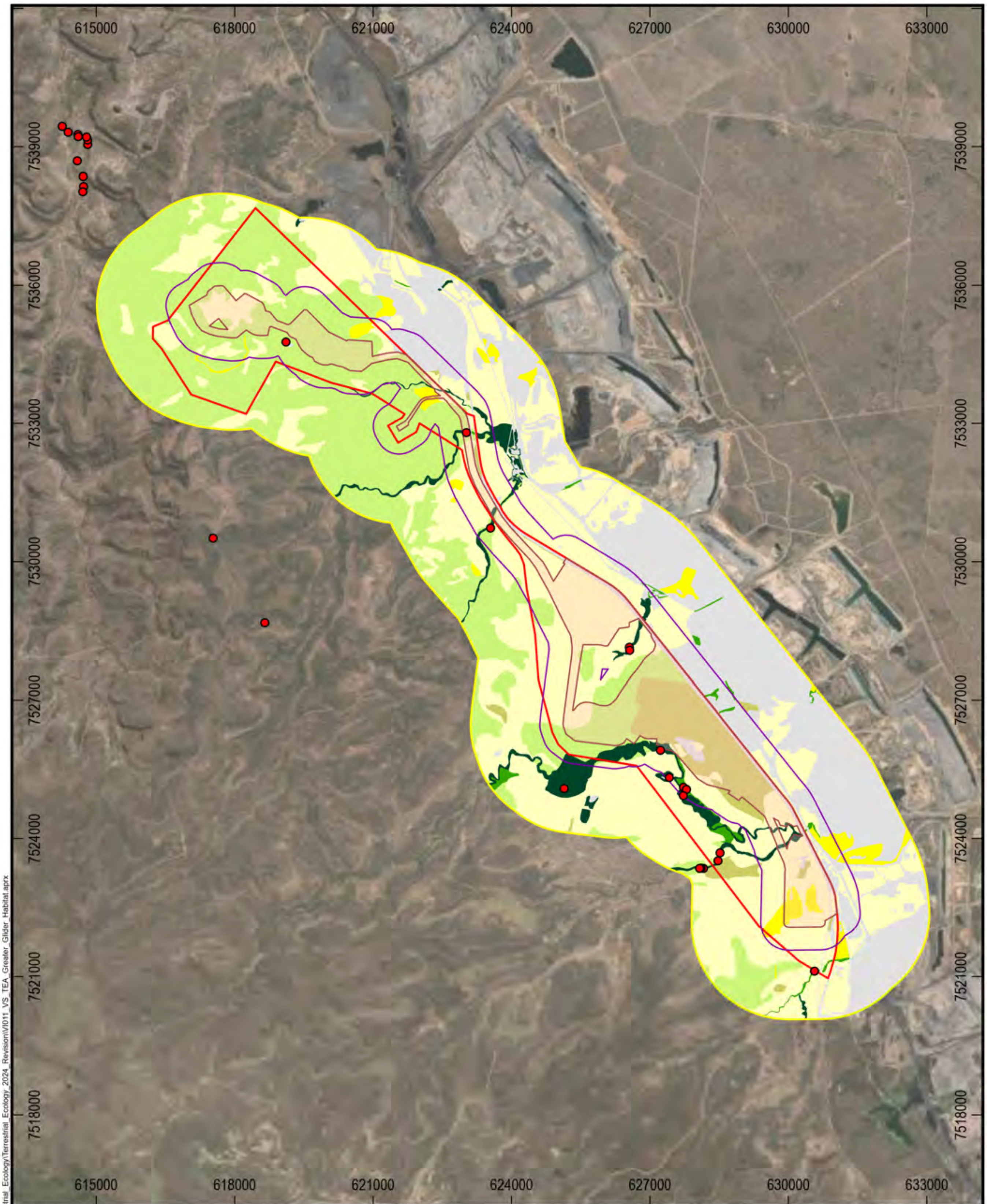
20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-12

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



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Legend

- Greater Glider Sightings

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 500m Indirect Impact Buffer
- 2 km Buffer

Average Overall Greater Glider Habitat Value Score

- 0
- <30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- >70

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Vulcan South

Greater Glider Habitat Value and Sightings

0 1 2 4

Kilometers

Scale: 1:120,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-13

VITRINITE BRIGHTER COAL

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4.3.3.4 White-throated Needletail

The species is listed as Vulnerable under the EPBC Act. The White-throated Needletail is an almost exclusively aerial bird that visits eastern Australia when not breeding (the Austral summer). Under the EPBC Act, it is listed both as a threatened species (vulnerable) and a migratory species. White-throated Needletails are migratory birds protected under the China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act.

Habitat is described as follows:

SHELTER HABITAT

Roosting habitat includes trees among dense foliage in the canopy or in hollows (Threatened Species Scientific Committee, 2019)

FORAGING/DISPERSAL HABITAT

In general, this species is recorded most often above wooded areas, including open forest and rainforest. This species may also fly below the canopy (Threatened Species Scientific Committee, 2019).

BREEDING HABTIAT

This species does not breed in the Southern Hemisphere (Threatened Species Scientific Committee, 2019).

White-throated Needletails feed on flying insects in large, fast-moving flocks that can cover huge distances in a day. In central Queensland, the species is most often recorded in the vicinity of the coast and nearby ranges. It tends to favour forested areas and landforms facilitating updraughts (ranges, cliffs and sand dunes), but can occur over a wide variety of landforms and vegetation types. No White-throated Needletails were recorded in the survey area during the various ecological surveys undertaken on site, despite the species being highly detectable when present. There were also no nearby recent records of the species. However, a flock of approximately 100 White-throated Needletails was observed moving north in airspace above the Vulcan Coal Mine (far northeast of the survey area) during weed monitoring undertaken in March 2022.

White-throated Needletails regularly follow the edges of low-pressure systems, and the sighting coincided with unstable storm activity. The timing of the sighting and the direction of travel suggest that the flock was likely on its northward passage to breeding grounds in East Asia. It is possible that the storm cells encouraged the flock to move west of the usual migration route along the coast and sub-coastal ranges.

White-throated Needletails were recorded on site. The survey area is likely to be west of their primary migration route, but flocks occasionally feed in the area when drawn west by low-pressure systems. The survey area is of no particular importance to the White-throated Needletail on a local or regional scale, and the project will not include any wind turbines, tall buildings, airports or other structures that threaten airspace used by the species for foraging and dispersal.

This species does not interact with local terrestrial habitats and roosting trees are unlikely to be found here. The airspace above the entire Project area (1476.44 ha) is considered foraging and dispersal habitat for this species.

The Project area is unlikely to be of great importance to the White-throated Needletail. It lies west of the species' usual migration route and the species is rarely recorded in the local region. The survey area is most likely to be used for foraging by flocks that roost in the Clarke Range, but which occasionally follow low-pressure systems further west.

4.3.3.5 Ornamental Snake

Ornamental Snakes feed on frogs and favour habitats supporting the temporary pooling of water where frogs breed (Department of Climate Change, Energy, the Environment and Water 2022d). Ornamental

Snakes primarily inhabit gilgai (melon-hole) mounds and depressions in land zone 4 (deep-cracking clay plains), but also lake margins and wetlands (Department of Climate Change, Energy, the Environment and Water 2022d). Locally, such habitats tend to support vegetation communities dominated by *Acacia harpophylla* (broad vegetation group 25a). Areas with a diversity of gilgai sizes and depths provide optimal habitat (Department of Climate Change, Energy, the Environment and Water 2022d). An abundance of fallen timber is also important for shelter (Department of Climate Change, Energy, the Environment and Water 2022d). Cleared grasslands may also be utilised, provided that gilgais are present and some debris remains for shelter.

Habitat for the Ornamental Snake is described as follows:

BREEDING/FORAGING/SHELTER AND DISPERSAL HABITAT

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities 2011) defines suitable habitat for Ornamental Snakes as "open-forests to woodlands associated with gilgai formations and wetlands. These are commonly mapped as QLD REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.5.16 or mapped as cleared but where the above REs formerly occurred". Important habitat is defined by these guidelines as "gilgai depressions and mounds".

DISPERSAL-ONLY HABITAT

Dispersal habitat is not defined in the literature, however, is likely to be low lying areas connecting other suitable habitat types.

Ornamental Snakes are active, and therefore detectable, only when frogs are active (i.e., following heavy rainfall events). For the remainder of the year, most local frogs (especially the genera *Cyclorana, Platyplectrum* and *Limnodynastes*) remain buried underground, and Ornamental Snakes are similarly inactive. At optimal times of the year, Ornamental Snakes are readily detectable by spotlighting around flooded gilgais where frogs are active, or via funnel and pitfall traps installed in favourable habitats (Department of Climate Change, Energy, the Environment and Water 2022d).

Most of the fauna surveys undertaken on site coincided with ideal conditions for detecting Ornamental Snakes. Heavy rain events occurred midway through the October 2018 and March 2019 surveys, resulting in widespread flash-flooding and the pooling of surface water in gilgais and other depressions. Spotlighting on the nights following these rain events targeted 10 locations potentially supporting Ornamental Snakes (flooded gilgais, dams and billabongs). A total of 8 person-hours were spent spotlighting in possible habitat under optimal conditions. This represented a disproportionate search effort for this species; it equates to 18.5 % of the total spotlighting effort on site, despite potential Ornamental Snake habitats constituting only 1.8 % of the survey area. In addition, there were three trap sites installed in broad vegetation group 25a, and rain fell midway through the sampling of each of these. Two other trap sites were installed in *Eucalyptus populnea* woodland close to dams with potential to support Ornamental Snakes. Despite all the above search effort, no Ornamental Snakes were recorded on site.

14 records exist within 10 km of the Project area, though all of these are to the east of the Project area and isolated from it by other mining projects. These include 3 records from 7 km to the east from the northern portion of the Vulcan South mining lease (2010, WildNet), and 11 more records approximately 4 km to the east of the southern portion of the Vulcan South mining lease from within the last 25 years (WildNet). There are several more records between 50 km and 150 km from the Project, most of which occur in the north. Ornamental Snakes have been recorded at the adjacent Peak Downs Mine and Saraji Mine (both located immediately east of the survey area) on numerous occasions since 2000. Despite the close proximity, there are several differences between the habitat in the survey area and that present east of Saraji Road. Firstly, certified regional ecosystem mapping indicates that land zone 4 is far more widespread to the east. Within the survey area, it was confined to small, isolated patches mostly less than 5 ha in extent. Secondly, most of land zone 4 within the survey area has very minor to no gilgai development. Where gilgais occurred, these tended to be less than 30 cm deep, and held water for less than one month after heavy rain. Consequently, frog diversity and density was very low

in gilgais on site. In contrast, extensive ponds and wetlands (many of which are constructed as part of water management at neighbouring mines) occur to the east of Saraji Road, and many frogs were heard calling from this direction.

Nevertheless, given that the survey area is adjacent to known populations of Ornamental Snakes, and some potential habitat occurs on site, it is likely that small numbers of Ornamental Snakes utilise the survey area. Failure to detect the species despite optimal survey conditions, combined with the poor quality of habitat present, suggests that the survey area is of marginal importance to the Ornamental Snake.

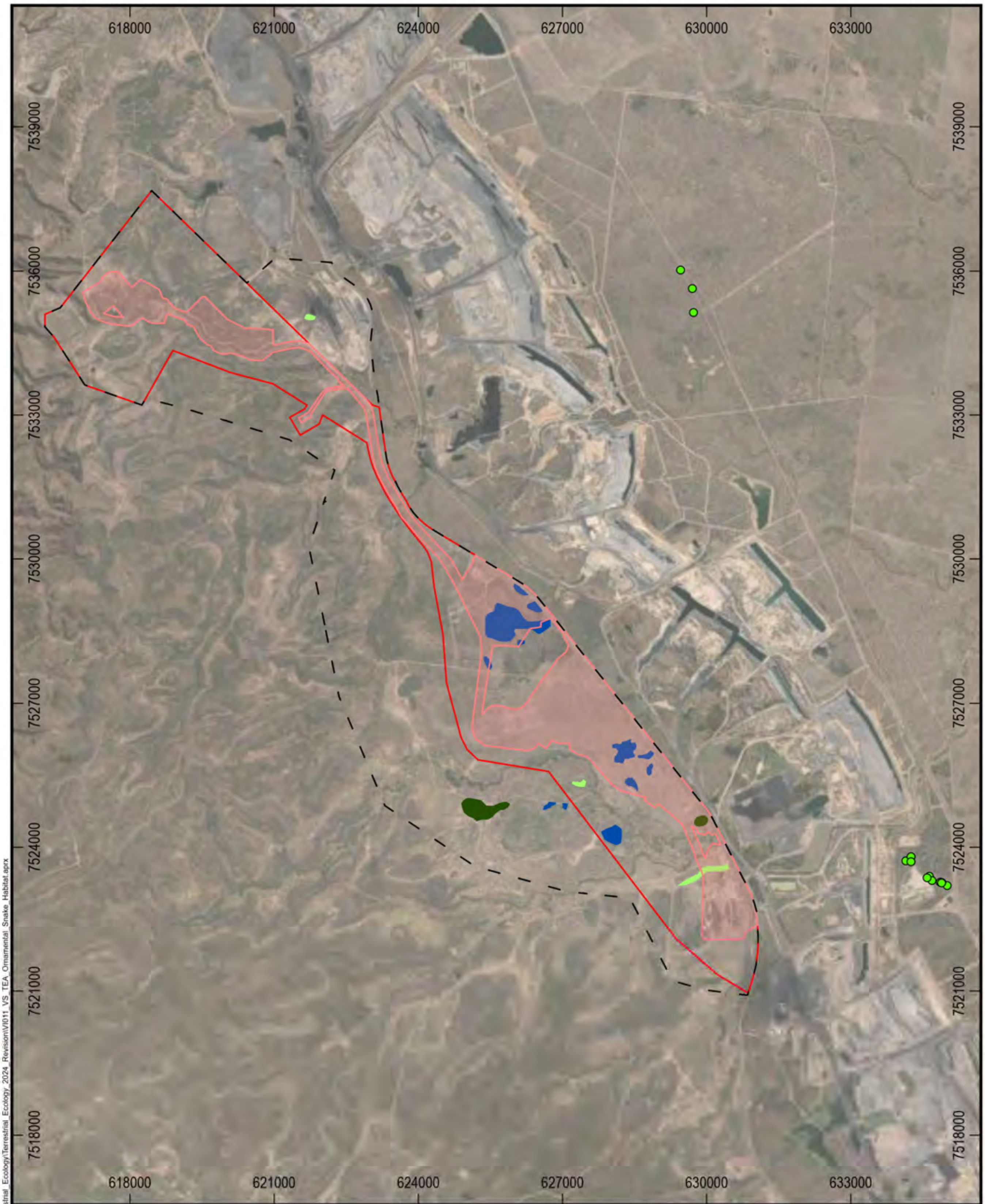
In the Project area, the occurrence of suitable cracking clay soils for shelter and breeding did not overlap with areas of high frog diversity as noted during spotlight surveys at optimal times when frogs were clearly heard and seen calling elsewhere. Only one species of frog (*Platyplectrum ornatum*) was noted calling, and in very low numbers. These areas contained patches of *Acacia harpophylla* with few gilgais that were shallow (less than 10 cm deep) and therefore cannot support high frog diversity because of limited availability of long-standing water. Due to limited food resources surveyed at optimal times, these areas are generally regarded as poor habitat for foraging opportunities. 88.9 ha of this Shelter/Breeding habitat mapped as "Clay soils with gilgais" habitat was recorded following field surveys.

Moderate frog diversity (5-100 individuals or 2-5 species) occurred in sandy soils in a low-lying area of dam overflow where water pooled during and after rain events, this habitat is considered "foraging only" habitat. Cracking clays were absent, therefore shelter and breeding habitat was also absent. High frog abundance (over 100 individuals and 5 species) was recorded in a sandy depression that contained pooled water following rain. This habitat, in addition to the habitat above is considered "foraging only". Cracking clays are not found at these locations, so shelter and breeding sites are also absent. Note that these areas are disjunct, separated by, at minimum, 1 km. Given the distance and lack of overlap between ground-truthed foraging and breeding/shelter habitat it is highly unlikely that the species, being a small and slow-moving reptile will commute such distances to forage. Therefore, the only habitat that meets all of the core requirements of breeding/feeding/shelter will be restricted to the "clay Soil with gilgais", though with a poor food supply, which would support only a small number of Ornamental Snakes, if any.

In summary, the following habitat areas have been calculated for the disturbance footprint:

- Foraging only with high frog abundance: 4.3 ha
- Foraging only with moderate frog abundance: 5.1 ha
- Shelter / Breeding habitat (not suitable foraging habitat): 88.9 ha.

Habitat and nearby records are shown in **Figure 4-14**.



Legend

ALA Records

Denisonia maculata (Ornamental Snake)

Survey Area

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Disturbance Footprint

Potential Ornamental Snake Habitat

Clay Soil with Gilgais

Frog Breeding Habitat in Sandy Soils

High frog abundance (>100 individuals and >5 species)

Moderate frog abundance (5-100 individuals or 2-5 species)

Source: Atlas of Living Australia 2024, Vulcan South datasets, Ornamental Snake and Frog Habitats - Vitrinite & METServe 2020-2024, Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Ornamental_Snake_Habitat.aprx

Vulcan South

Potential Ornamental Snake Habitat and Sightings

0 1 2 4

Kilometers

Scale: 1:115,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-14

4.3.3.6 Yakka Skink

Yakka Skinks are large, gregarious lizards that inhabit a broad range of woodland and forest communities across sub-coastal and semi-arid Queensland (Department of Climate Change, Energy, the Environment and Water 2022e). The core habitat of this species is within the Mulga Lands and Brigalow Belt South Bioregions (Department of Climate Change, Energy, the Environment and Water 2022e), and there are few records in the Brigalow Belt North Bioregion (where Vulcan South is located).

Yakka Skinks live in colonies within cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows (Department of Climate Change, Energy, the Environment and Water 2022e). They remain in close proximity to their burrows and are only active for brief periods at dawn and dusk (Department of Climate Change, Energy, the Environment and Water 2022e). This, combined with their low density, makes them difficult to detect.

Habitat for the Yakka Skink is as follows:

BREEDING/SHELTER/FORAGING HABITAT

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities 2011) defines suitable habitat for Yakka Skinks as "open-forests to low-woodlands and scrub in QLD RE Land Zones (LZ) 3, 4, 5, 7, 8, 9, 10 and 12 (LZ 8 not considered core habitat; LZ 12 in Wet Tropics bioregion only). Colonies have been found in large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes". Important habitat is defined as "any contiguous patch of suitable habitat, particularly remnant vegetation, where a colony is known or identified, or any microhabitat where colonies are likely to be found".

DISPERSAL HABITAT

Dispersal habitat is not defined, though it is logical to consider any vegetated areas of connectivity between patches of habitat that individuals are likely to be able traverse. The species is known to have high site fidelity and is known to be limited in their capacity to disperse from a colony site (Department of Climate Change, Energy, the Environment and Water, 2024).

The project area lies outside the Yakka Skink's modelled "known/likely to occur" distribution (Department of Sustainability, Environment, Water, Population and Communities 2011). However, the modelled distribution of the Yakka Skink shows that the species "may occur" with the project area (Department of Sustainability, Environment, Water, Population and Communities 2011).

No Yakka Skinks were recorded during surveys on site. Detectability is greatest during warm, humid conditions (Department of Climate Change, Energy, the Environment and Water 2022e), and the surveys were therefore under optimal conditions. Nevertheless, given the large size of the survey area, it was not practical to inspect every possible burrow location within it.

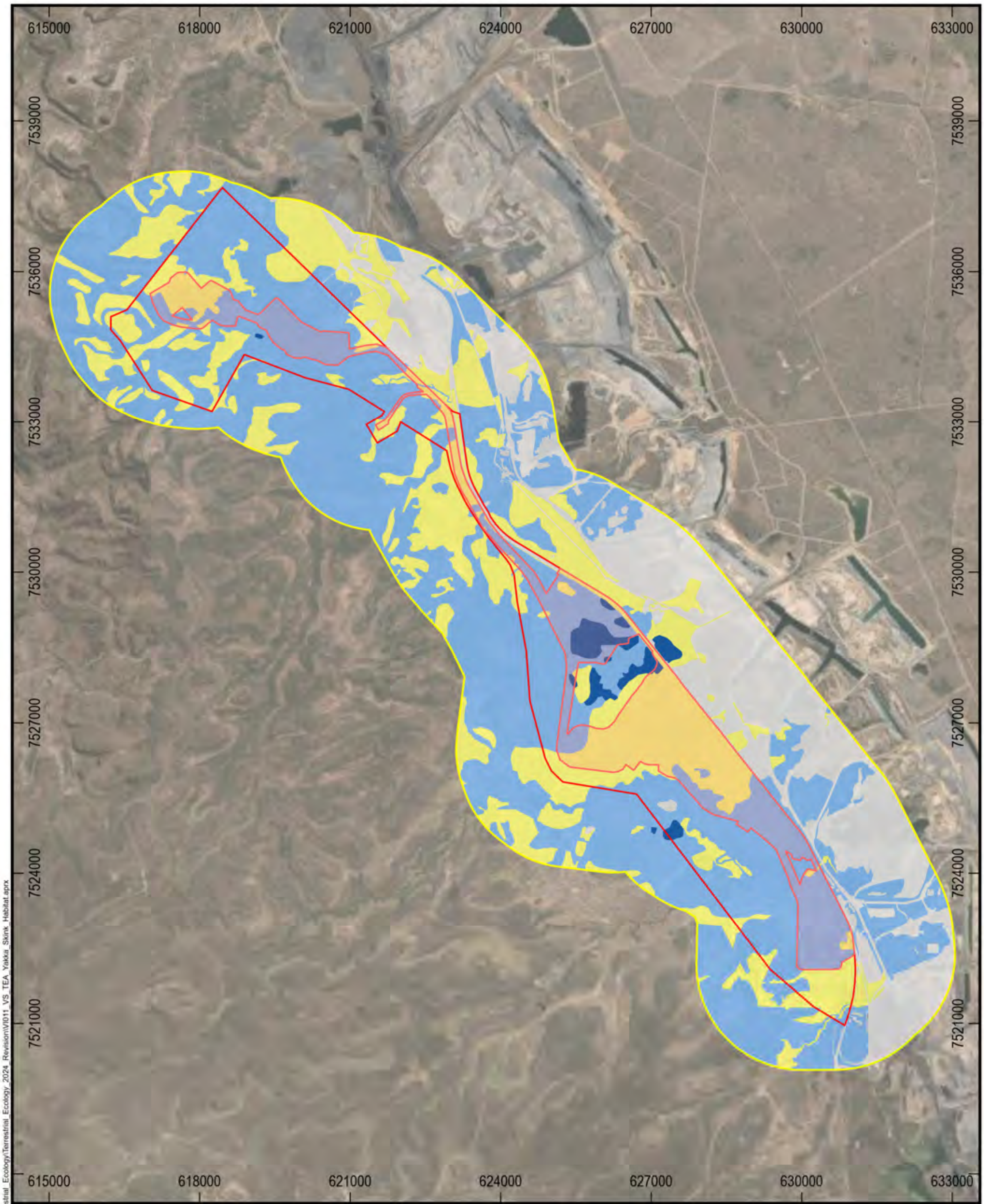
The survey area does not contain habitat connected to known populations of the Yakka Skink. The nearest post-1980 record (a Queensland Museum specimen from 2000) of this species is from the vicinity of Blackwater, 130 km to the south. Furthermore, as no colonies have ever been recorded in the northern Bowen Basin, despite extensive ecological surveys undertaken across Dysart-Moranbah-Collinsville for various mining projects, colonies are not "likely to be found" in the vicinity of the Project. Consequently, no "important habitat" is located within the survey area.

Nevertheless, there are scattered records of Yakka Skinks as far north as Cape York, and there remains a slight possibility that the species occurs within the survey area. All remnant and regrowth vegetation within the survey area qualifies as "suitable habitat" for the species, as all contain woody debris and/or rocks that provide structural support for burrows.

Habitat in the disturbance footprint is as follows (**Figure 4-15**):

- High density of coarse woody debris (>490 m/ha) = 66.94 ha

- Medium density of coarse woody debris (245-490 m/ha) = 769.90 ha
- Low density of coarse woody debris (<245 m/ha) = 639.60 ha.



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Legend

Vulcan South Coal Mine (2023/09708)

- Disturbance Footprint
- Project Area (ML 700073)
- 2 km Buffer

Potential Yakka Skink Habitat

- High density of coarse woody debris (>490 m/ha)
- Medium density of coarse woody debris (245-490 m/ha)
- Low density of coarse woody debris (<245 m/ ha)
- Non-habitat

Source: Vulcan South datasets, Potential Yakka Skink Habitat - Vitrinite & METServe 2020-2024, Earthstar Geographics 28/09/2023

Vulcan South

Potential Yakka Skink Habitat

0 1 2 3

Kilometers

Scale: 1:110,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-15

VITRINITE BRIGHTER COAL

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4.3.3.7 Northern Quoll

The Northern Quoll inhabits a broad range of habitats across eastern and northern Australia. The *EPBC Act Referral Guideline for the Endangered Northern Quoll* (Department of the Environment 2016) defines critical habitat as "habitat within the modelled distribution of the northern quoll which provides shelter for breeding, and refuge from fire, predation and potential poisoning from Cane Toads". These can include rocky habitats, treed creek lines and structurally diverse forest with large trees, termite mounds and hollow logs (Department of the Environment 2016). The survey area occurs within the modelled distribution of the Northern Quoll (Department of the Environment 2016). Within the survey area, critical habitats were found on land zones 3 and 10 (2,901.8 ha within the survey area). Land zone 10, particularly in the northwest of the survey area, contained boulder-strewn escarpments and gorges, which are potentially important for Northern Quolls (Pollock 1999; Woinarski *et al.* 2008; Hill and Ward 2010). Den sites close to (within 300 m of) permanent fresh water are preferred by the species (Pollock 1999). Such sites were scarce within the survey area, totalling 170.9 ha in extent.

The two major threats to Northern Quolls (Feral Cats and Cane Toads: Hill and Ward 2010) were common and widespread across the survey area.

The *EPBC Act Referral Guideline for the Endangered Northern Quoll* (Department of the Environment 2016) recommends a minimum of ten baited remote-sensory cameras to be deployed for four nights each (total of 40 camera-nights). The current survey included 122 camera-nights of sampling, in addition to 31 trap-nights of cage trapping. These surveys failed to detect any Northern Quolls.

In recent decades, the Queensland distribution of the Northern Quoll has contracted towards the most rugged habitats close to the coast (Braithwaite and Griffiths 1994; Woinarski *et al.* 2008). The nearest recent (post-2000) records of the Northern Quoll are from the Clarke Range, 100 km northeast of the survey area. No Northern Quolls have ever been detected at neighbouring mines within the Bowen Basin.

The lack of nearby records despite extensive ecological surveys undertaken in the Moranbah region in recent decades may suggest that the Northern Quoll is extinct in the region. Nevertheless, as the habitat present on site meets the criteria specified in the *EPBC Act Referral Guideline for the Endangered Northern Quoll*, the presence of the species within the survey area remains a possibility. If present, the local population is expected to be of very low density, given the lack of detection, abundance of toads and cats, and the relative paucity of surface water in rocky areas.

Habitat is described as follows:

BREEDING/SHELTER HABITAT

Den sites close to (within 300 m of) permanent fresh water are preferred by the species (Pollock, 1999). Females create dens in hollow logs, termite mounds and especially rock crevices (Threatened Species Scientific Committee, 2005). Specific habitats outside of large tracts of rocky areas for breeding purposes on a large scale are not easily defined and should be considered microhabitat features within foraging habitat rather than a separate habitat classification.

FORAGING HABITAT

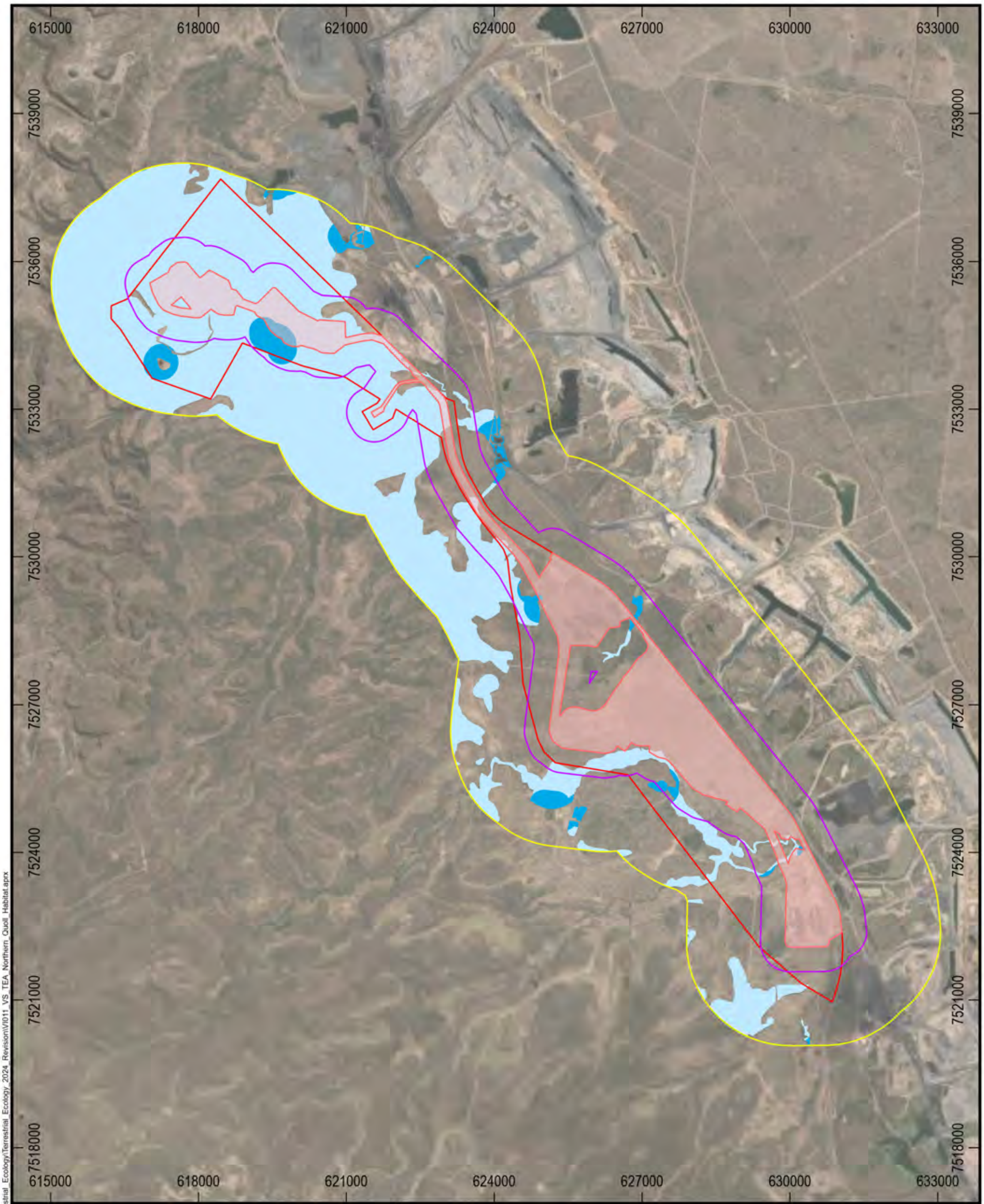
Northern quolls forage in a wide range of habitats in the vicinity of breeding/shelter habitat for a wide range of food sources which include fruits, figs, invertebrates and small vertebrates. The habitats most likely to be inhabited by the species appear to be high relief rocky areas which provide shelter opportunities, particularly for denning females and an abundance of food (Threatened Species Scientific Committee, 2005).

DISPERSAL HABITAT

Vegetated habitats in general are considered suitable for dispersal (Department of Climate Change, Energy, the Environment and Water, 2024).

Habitat in the disturbance footprint is as follows (**Figure 4-16**):

- Habitat within 300m of water = 19.70 ha.
- Land Zones 3 and 10 = 299.71 ha.



Legend

Potential Northern Quoll Habitat

- Habitat within 300m of water
- Landzone 3 and 10

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- 2 km Buffer
- 500m Indirect Impact Buffer

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics.

Vulcan South

Potential Northern Quoll Habitat

0 1 2 4

Kilometers

Scale: 1:112,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-16

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

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4.3.3.8 Common Greenshank

This species can be found throughout coastal Australia and limited suitable locations inland. Habitat is described as follows:

FORAGING HABITAT

Foraging habitat includes wetland edges, in soft mudflats, channels, or within shallows around the edge of waterbodies. These locations are often situated near or among mangroves or other sparse, emergent or fringing vegetation such as sedges or saltmarsh (Department of Climate Change, Energy, the Environment and Water, 2024c). Roosting habitat includes estuary and mudflat environments, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms, and flooded crops.

SHELTER HABITAT

Roosting habitat occurs in both on the coast and inland in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms, and flooded crops (Department of Climate Change, Energy, the Environment and Water, 2024c).

BREEDING HABITAT

This species breeds in the northern hemisphere.

DISPERSAL HABITAT

As an aerial dispersing species, the Common Greenshank is not likely to land on any habitat it will not utilise for foraging or shelter.

There are 0 ha of habitat within the Project area for this species. The Project area is within the DCCEEW modelled "Species or species habitat may occur", however it is unlikely that the species is present at all within the Project area as suitable habitat was not found during site surveys.

4.3.3.9 Diamond Firetail

Diamond Firetails occur on the south-east mainland of Australia from south-east Queensland to Eyre Peninsula, South Australia, extending 300 km inland from the sea. Their range once extended to north Queensland inland from Cardwell, but they now occur only in the very south of the state (Department of Climate Change, Energy, the Environment and Water, 2023).

Diamond firetails occur in *Eucalyptus, Acacia* or *Casuarina* woodlands, open forests and other lightly timbered habitats, including farmland and grassland with scattered trees.

BREEDING/FORAGING HABITAT

The species prefers areas with relatively low tree density, few large logs, and little litter cover but high grass cover. (Department of Climate Change, Energy, the Environment and Water, 2023).

SHELTER HABITAT

Birds roost in dense shrubs or in smaller nests built especially for roosting (Department of Climate Change, Energy, the Environment and Water, 2023).

DISPERSAL HABITAT

This species, like other finches is likely nomadic, moving according to seasonal resources. Most vegetated habitats have potential for the species to temporarily shelter in during dispersal.

This species is mapped 'likely to occur' habitat within the SPRAT database and is located south of Nanango (approximately 600 km south from the Project). Due to the distance from mapped likely habitat within the conservation advice, the species is unlikely to be present. Further, the closest record is unverified and approximately 120 km from the Project.

4.3.3.10 Grey Snake

In Queensland, the grey snake has a broader and more dispersed distribution, with most records along the Macintyre and Condamine Rivers and associated floodplains of the southern Brigalow Belt from Goondiwindi and Dalby west to Glenmorgan, on the Darling Downs and western Lockyer Valley, near Rockhampton on the central Queensland coast, and on the Darling Riverine Plains near Currawinya in south-western Queensland (Department of Climate Change, Energy, the Environment and Water, 2022m).

The Grey Snake is known to be found in low lying areas associated with watercourses. Habitat is defined as follows:

BREEDING/FORAGING/SHELTER HABITAT

In Queensland, Grey Snake habitat is Brigalow *Acacia harpophylla* and Belah *Casuarina cristata* woodlands on heavy, dark brown to black cracking clay soils, particularly in association with water bodies, areas with small gullies and ditches, and floodplain environments where the species shelters beneath logs, rocks and soil cracks. Habitat in Queensland also includes Queensland bluegrass *Dichanthium sericeum* and/or Mitchell grass *Astrebla* spp. grassland on alluvial plains with cracking clay soils. Grey Snake occurrence on the western downs of Queensland has a strong positive association with red sodosol soils which have a strong texture contrast between the A horizon and sodic B horizon, and which are often quite dense and coarsely structured (blocky, prismatic or columnar peds) favouring the crack-inhabiting and foraging ecology of this species (Department of Climate Change, Energy, the Environment and Water, 2022m).

DISPERSAL HABITAT

It is logical to assume that this species may be dispersed by floodwaters, given the strong association the species has with floodplains. Dispersal abilities are likely limited otherwise, and dispersal habitat is probably low-lying areas adjacent to breeding/foraging/shelter habitat.

REs consistent with habitat known for the species are present in the Project area, however it is outside its known distribution. There are 0 ha of habitat within the Project area for this species.

4.3.3.11 Southern Snapping Turtle

This species is found only in Queensland in the Fitzroy, Mary and Burnett Rivers and associated smaller drainages in southeastern Queensland (Department of the Environment, 2014a). This species prefers clear, flowing, well-oxygenated waters within river systems (Department of the Environment, 2014a).

BREEDING HABITAT

The conservative assumption is that any waterways occupied by this species will have suitable breeding sites adjacent to them above the high-water line.

FORAGING/SHELTER HABITAT

Clear, flowing, well oxygenated waters within catchments known to be occupied by the species will be utilised for foraging and shelter from most predators.

DISPERSAL HABITAT

Like other freshwater turtles, this species is likely to be somewhat mobile over land, though is likely only to move from one pool to another when the waterways are drying, not venturing further from water than absolutely necessary.

Permanent water in riverine systems is required, however such suitable habitat was not identified during field surveys; the waterways in the Project area are unsuitable as they are ephemeral. There are 0 ha of habitat within the Project area for this species.

4.3.3.12 *Fitzroy River Turtle*

This species is only found in the Fitzroy River and its tributaries (Department of the Environment, Water, Heritage and the Arts, 2008).

Within its mapped distribution, the species appears to be confined to well-defined habitats which are characteristic of the main channels of the rivers in the catchment. Habitats are defined as follows:

SHELTER/FORAGING HABITAT

This species occurs in flowing rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (Department of the Environment, Water, Heritage and the Arts, 2008).

BREEDING HABITAT

Like other turtles, nesting is likely to occur in suitable substrates above the breeding season high water mark adjacent to suitable shelter and foraging habitats.

DISPERSAL HABITAT

Like other freshwater turtles, dispersal will almost entirely be along watercourses, with occasional dispersal overland, presumably to move from one drying pool to another when aquatic dispersal is not possible.

There are 0 ha of habitat within the Project area for this species. No suitable river systems are found within 60 km of the Project area. All watercourses within and adjacent to the Project area are ephemeral and only experience surface flow following heavy rain.

4.3.3.13 *Painted Honeyeater*

The species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe, with which its breeding season is closely matched. Many birds move after breeding to semi-arid regions such as north-eastern South Australia, central and western Queensland, and central Northern Territory. Considering its dispersive habits, the species is considered to have a single population (Department of the Environment, 2015c).

The species prefers woodlands which contain a higher number of mature trees, as these host more mistletoes (Department of the Environment, 2015c).

BREEDING HABITAT

The Painted Honeyeater makes nests in trees that contain mistletoes that they feed on, usually preferring to nest in mistletoe clumps (Department of the Environment, 2015c).

FORAGING /SHELTER HABITAT

This species inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of black box and river red gum, box-ironbark-yellow gum woodlands, *Acacia*-dominated woodlands, paperbarks, *Casuarina*, *Callitris*, and trees on farmland or gardens (Department of the Environment, 2015c).

DISPERSAL HABITAT

The Painted Honeyeater disperses widely outside the areas it is known to breed in. Being a species that disperses aerially, all dispersal habitat is likely to be overfly habitat that is not directly used for foraging.

There are 0 ha of habitat within the Project area for this species. This species depends on an abundance of mistletoe. Suitable regional ecosystems were present within the survey area, and trees likely to be host to suitable mistletoes are present in the survey area. However, mistletoe was scarce based on field surveys.

4.3.3.14 Star Finch (eastern)

This subspecies occurs in central Queensland; however, its distribution is poorly understood and it has disappeared from much of its former range. The most recent records occur in an area from near Wowan, north to Bowen, west to beyond Winton. It is possible that the subspecies could occur (or occurred) north of Bowen, based on historic records of Star Finches at Mount Surprise and in the Cloncurry/Mount Isa region, but these records cannot be definitively attributed to the eastern subspecies. The Star Finch (eastern) is suspected to occur in four discrete subpopulations. The Star Finch (eastern) occurs within the Desert Channels, Burdekin and Fitzroy (Queensland) Natural Resource Management Regions (Department of the Environment, Water, Heritage and the Arts, 2008).

BREEDING/FORAGING/SHELTER HABITAT

The Star Finch feeds primarily on seeds but will also eat insects and other invertebrates. This subspecies has been recorded from damp grasslands, sedgelands or grassy woodlands near permanent water or areas of regular inundation. Occasionally, individuals have been reported in disturbed habitat and suburban areas (Department of the Environment, Water, Heritage and the Arts, 2008). Application of the *Precautionary Principle* would suggest all habitat utilised by this species for foraging would also be likely breeding habitat.

DISPERSAL HABITAT

Dispersal habits appear to be unknown for this species. Similar species tend to be nomadic, moving with food and water resources as dictated by seasons. As this is a species that disperses by flight, it is likely to be an overflying species and not interact much, if at all with habitats not used for foraging or breeding.

There is 0 ha of habitat within the Project area for this species. The impact area is likely to contain habitat that would have been suitable for the Star Finch (eastern), however this subspecies is likely extinct from the Bowen Basin. Habitat is well outside the subspecies' known range.

4.3.3.15 Southern Black-throated Finch

The southern subspecies occurs in coastal northern Queensland and inland central Queensland.

This subspecies occupies woodland savannah and riverine vegetation. Inland, it prefers grassy woodland dominated by eucalypts, paperbacks or acacias, where there is access to seeding grasses and water (Threatened Species Scientific Committee, 2005).

BREEDING/SHELTER HABITAT

The Black-Throated Finch (Southern) requires three key resources for survival and breeding:

- Water sources within 400 m of potential breeding areas
- Grass seeds (*Urochloa mosambicensis, Enteropogon acicularis, Panicum decompositum, Panicum effusum, Dichanthium sericeum, Alloteropsis semialata, Eragrostis sororia* and *Themeda triandra*) within 1 km of nesting habitat
- Trees providing suitable nesting habitat

During the breeding season the species is rarely seen more than 1 km from water (Department of the Environment, Water, Heritage and the Arts, 2009).

FORAGING HABITAT

The subspecies forages up to 3 km from water sources outside breeding season (Department of the Environment, Water, Heritage and the Arts, 2009). Areas that provide a high diversity of the grass species listed above, that are also in the vicinity of suitable nesting sites, given that the species is sedentary and appears to not be overly nomadic and certainly not migratory.

DISPERSAL HABITAT

The Black-Throated Finch (Southern) will disperse over uninhabitable areas, providing the distance to fly is less than 1 km, though this species is known to be sedentary overall (Department of the Environment, Water, Heritage and the Arts, 2009).

There are 0 ha of habitat within the Project area for this species. The Project aeea may contain suitable foraging resources for this species; habitat may be marginally suitable in the area with water sources and a variety of grasses present, though it is degraded in quality to the point that this species may not persist. The lack of all of the components needed to ensure this subspecies could support a viable population strongly suggests that none of the Project area is considered habitat for this species.

4.3.3.16 Corben's Long-eared Bat/South-eastern Long-eared Bat

This species is found in central Queensland (and in regions in New South Wales, Victoria, and South Australia). Approximately 30% of the total distribution of the species occurs in Queensland, although there are records from fewer than 30 localities, mainly from within the Brigalow Belt South bioregion (Threatened Species Scientific Committee, 2015c).

Habitat is as follows:

FORAGING/BREEDING/SHELTER HABITAT

This species is found in a wide range of inland woodland vegetation types. These include box / ironbark / cypress pine woodlands, Buloke woodlands, Brigalow woodland, Belah woodland, smooth-barked apple woodland, river red gum forest, black box woodland, and various types of tree mallee (Threatened Species Scientific Committee, 2015). Habitat types are likely to overlap with this species, foraging is likely to occur within or adjacent to breeding and shelter sites.

DISPERSAL HABITAT

Dispersal habits are not specified for this species, however it is an aerial dispersing species that is likely to overfly most or all terrestrial habitats during dispersal.

Habitats in the Project area are well outside this species' range. Habitat may be broadly suitable; however, the Project area is determined to be well north of the known distribution of the species. There are 0 ha of habitat within the Project area for this species

4.3.3.17 Grey-headed Flying Fox

This distribution of the Grey-Headed Flying-Fox ranges from Bundaberg in Queensland to Melbourne in Victoria and may also occur in parts of South Australia (Threatened Species Scientific Committee, 2001). Occasional records at mixed-species camps occur in the Townsville, Mackay and Rockhampton regions (Department of Climate Change, Energy, the Environment and Water, 2024).

This species has historically occupied forests and woodlands in the coastal lowlands, tablelands and slopes of eastern Australia, from Bundaberg in Queensland to Geelong in Victoria, with some isolated camps and rare sightings outside this range (Department of Agriculture, Water and the Environment , 2021). Habitat is as follows:

BREEDING/SHELTER HABITAT

Breeding and shelter sites are well known camps, which may be viewed on the National Flying-Fox Monitoring Viewer (Department of Climate Change, Energy, the Environment and Water, 2024). These are generally in humid sites adjacent to water sources and may be shared with other flying-fox species.

FORAGING HABITAT

This species forages on blossoms of a range of species, especially from the genera *Eucalyptus, Syzigium, Banksia, Angophora* and *Corymbia*. Figs and a range of fruits are also consumed when available. Foraging habitat will ideally include as many of these foraging options as possible. Foraging habitat is within 40 km of roost sites (Department of Agriculture, Water and the Environment , 2021).

DISPERSAL HABITAT

The species disperses aerially over a range of habitats. Given the aerial dispersal method, it is unlikely to utilise any of the habitats it overflies, but, like other flying-fox species may occasionally roost in unexpected areas, particularly when displaced, sick or lost.

There are 0 ha of habitat within the Project area for this species.

The impact area is unlikely to be of high enough quality to attract this species. Roosting camps are not known from the area, no camps were found in the National Flying-Fox monitoring viewed that were within 100 km. Habitat is marginal at best in the Project area; the species is unlikely in the area as anything more than an unlikely vagrant species as richer habitats closer to the coast are available.

4.3.3.18 Murray Cod

The Murray Cod occurs naturally in the waterways of the Murray-Darling Basin (Threatened Species Scientific Committee, 2003).

HABITAT

This species is known to live in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers and billabongs (Threatened Species Scientific Committee, 2003).

There are 0 ha of habitat within the Project area for this species. The Project is outside the native range of this species, which is the Murray Darling basin. Suitable waterways are not found within the Project area.

4.3.3.19 Black Ironbox

This species occurs between Rockhampton and Ayr in Queensland (Department of the Environment, Water, Heritage and the Arts, 2008a).

HABITAT

Black Ironbox occurs on the banks of rivers, creeks and other watercourses, on clayey or loamy soil (Department of the Environment, Water, Heritage and the Arts, 2008a). There are 0 ha of habitat within the Project area for this species.

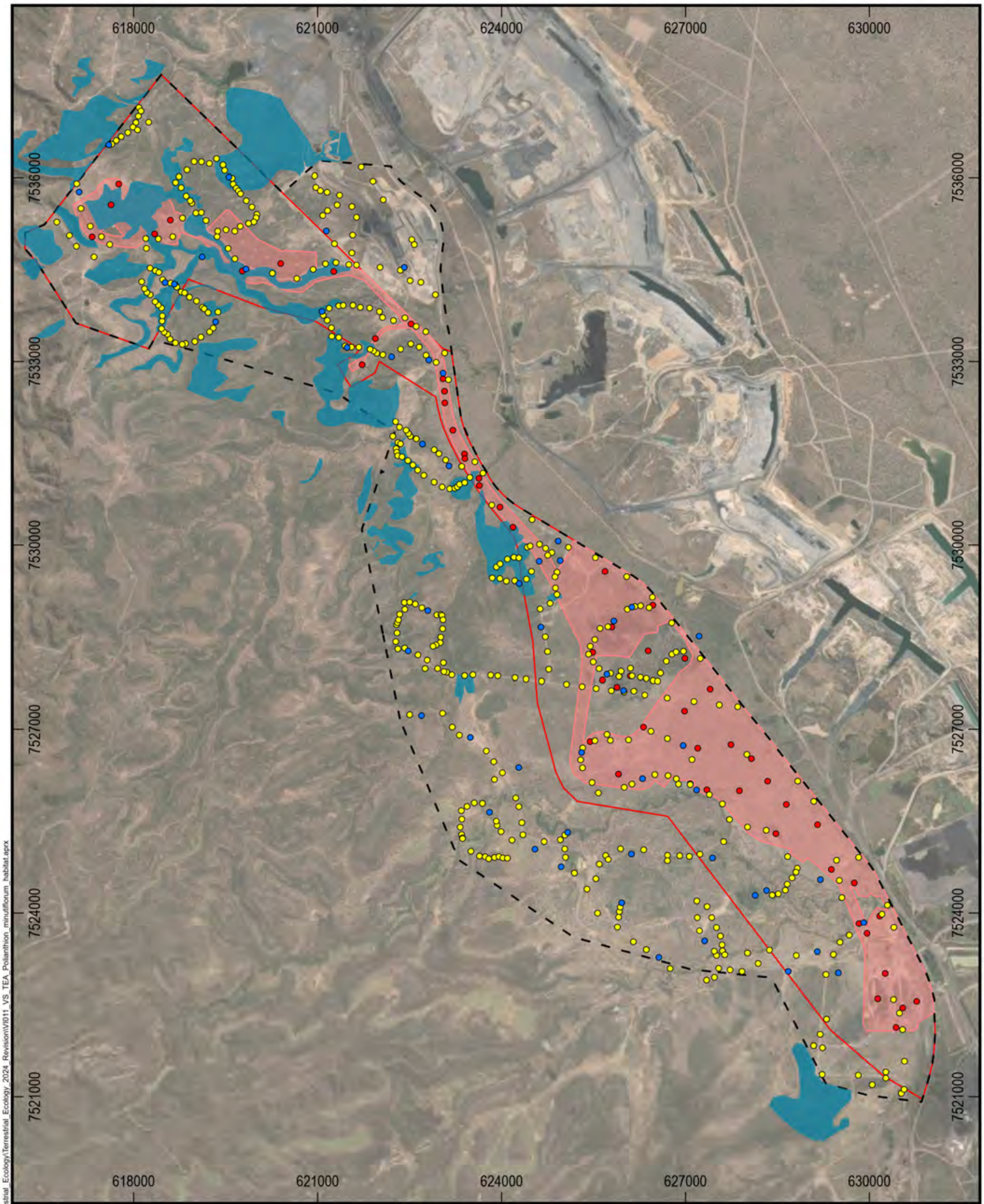
4.3.3.20 Polianthion minutiflorum

This species is known from five areas in east Queensland, from Redcliffe Vale, about 110 km west of Mackay, south to Kingaroy, covering a distance of approximately 800 km.

HABITAT

It grows in forest and woodland on sandstone slopes and gullies with skeletal soil, or deeper soils adjacent to deeply weathered laterite (Department of the Environment, Water, Heritage and the Arts, 2008).

The following REs are found within the Project area: 11.10.8, 11.10.1. Further, approved conservation advice indicates the species is known from semi-evergreen thicket (RE 11.10.8), however this is not equivalent to the TEC Semi-evergreen vine thickets of the Brigalow Belt. In addition, RE 11.10.1x1 is considered suitable for this species. Prior ALA records are particularly associated with sandstone outcrops and substrate. There are 110.70 ha of habitat within the disturbance footprint for this species, as shown in **Figure 4-17**.



Legend

Survey Sites

- Quaternary
- Secondary
- BioCondition

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Potential habitat for *Polianthion minutiflorum*

Source: Vulcan South datasets - Vitrinite 2024 & METServe 2020-2024. Earthstar Geographics 28/09/2023.

Vulcan South

Potential Habitat for *Polianthion minutiflorum*

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-17

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.3.3.21 Quassia

This species occurs between Scawfell Island (near Mackay) and Goomboorian (north of Gympie) (Department of the Environment, Water, Heritage and the Arts, 2008a).

HABITAT

Quassia commonly occurs in lowland rainforest or on rainforest margins and can also occur in open forest and woodland. It is commonly found in areas adjacent to both temporary and permanent watercourses (Department of the Environment, Water, Heritage and the Arts, 2008a).

There are 0 ha of habitat within the Project area for this species. Quassia occurs in lowland rainforest approximately 120 km east of the Project area.

4.3.3.22 Marlborough Blue Cycad

This species occurs from Marlborough in the north, to the Fitzroy River near Rockhampton in the south (Queensland Herbarium, Environmental Protection Agency, 2007).

HABITAT

General habitat is woodland or open woodland dominated by eucalypts, often on serpentinite substrates (Queensland Herbarium, Environmental Protection Agency, 2007). There are 0 ha of habitat within the Project area for this species.

4.3.3.23 Ooline

Ooline occurs on the western edge of the NSW north-west slopes, from Mt Black Jack near Gunnadah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton (Department of the Environment, Water, Heritage and the Arts, 2008b).

HABITAT

Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent (Department of the Environment, Water, Heritage and the Arts, 2008).

There are 0 ha of habitat within the Project area for this species. No habitat was surveyed in the impact area or greater survey area that would be considered suitable for this species.

4.3.3.24 Australian Painted-snipe

The Australian Painted-snipe is a nomadic shorebird that is an endangered species under the EPBC Act. This species was not recorded within the survey area. There are also very few records of the species from the region, and none of these are recent; it was recorded from near Moranbah on a couple of occasions prior to 1976 (per BirdLife Australia's historical bird atlas). Nevertheless, as this is a secretive, highly mobile species and potential habitat occurs in the vicinity of the project, it is considered a possible visitor to the survey area.

There is no recovery plan in place for the species. However, the Commonwealth Government has provided advice about the species' ecology and priority actions to mitigate key threats within the conservation advice (Threatened Species Scientific Committee 2013) and the SPRAT profile for the species (Department of Climate Change, Energy, the Environment and Water 2022f).

Habitat is described as follows:

FORAGING HABITAT

Favoured wetlands have muddy shorelines and margins of rank grass, sedges, rushes, reeds, samphire, lignum (*Muehlenbeckia*), canegrass or sometimes tea-tree. The Australian Painted-snipe can use modified habitats, including farm dams; however, they do not necessarily breed in such habitats.

BREEDING HABITAT

Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover.

SHELTER HABITAT

This species is most likely to shelter adjacent to foraging and breeding habitats, therefore this habitat type is not considered a category of its own.

DISPERSAL HABITAT

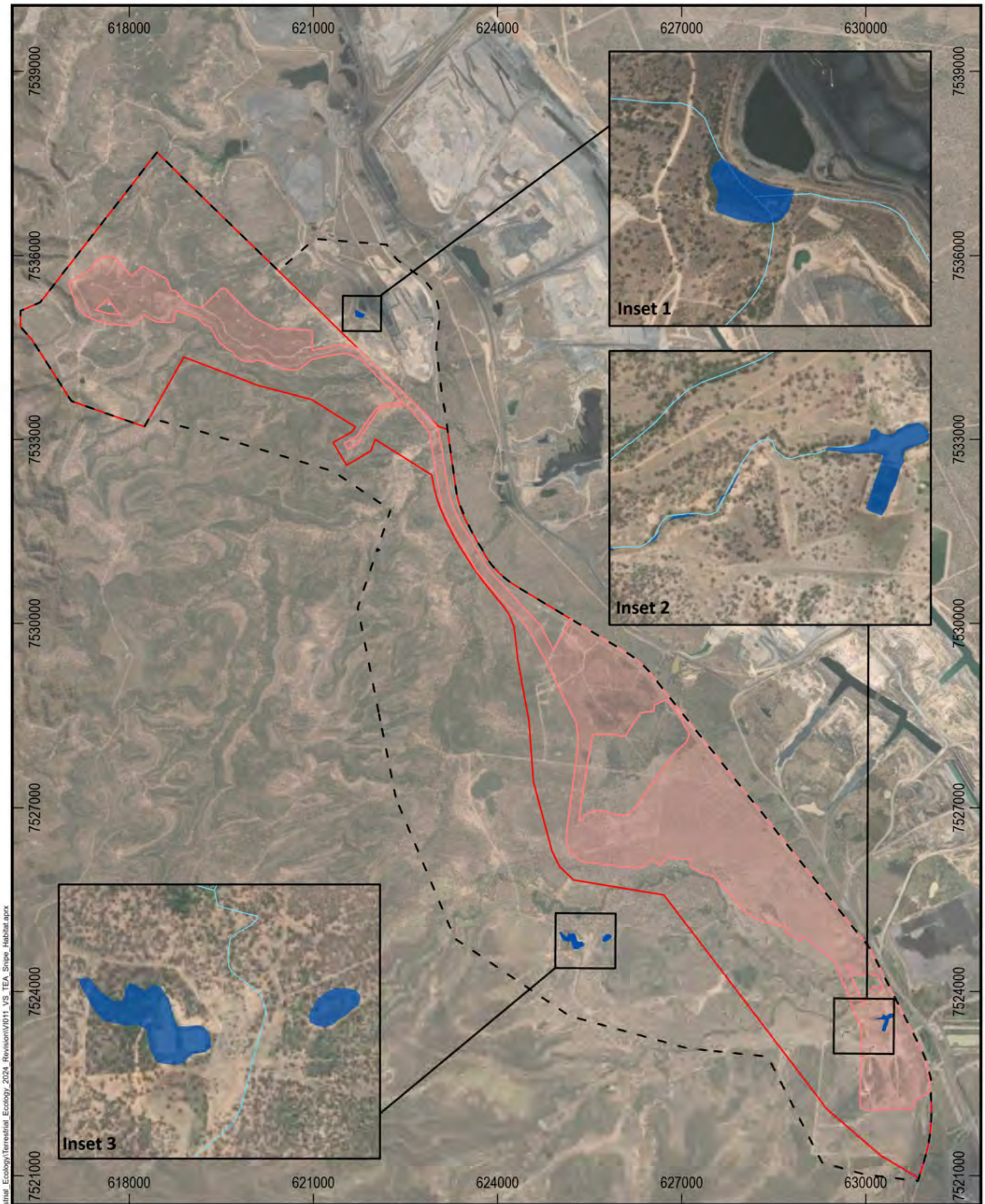
Being a nomadic species dispersing by flight it is most likely that the species will overfly any habitats not used for foraging or breeding.

The Australian Painted-snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Department of Climate Change, Energy, the Environment and Water 2022f). Favoured wetlands have muddy shorelines and margins of rank grass, sedges, rushes, reeds, samphire, lignum (*Muehlenbeckia*), canegrass or sometimes tea-tree (*Melaleuca*) (Department of Climate Change, Energy, the Environment and Water 2022f). The Australian Painted-snipe can use modified habitats, including farm dams; however, they do not necessarily breed in such habitats (Department of Climate Change, Energy, the Environment and Water 2022f). Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (Department of Climate Change, Energy, the Environment and Water 2022f).

Potential habitat for the Australian Painted-snipe was recorded at natural and artificial (dams) wetlands in the southern third of the survey area (**Figure 4-18**). In addition, a small dam in the northeast of the survey area possessed margins vegetated with suitable sedges and rushes, but the steep banks lacking areas of shallow mud limit the suitability of this habitat for Australian Painted-snipe.

The total potential habitat for the Australian Painted-snipe in the survey area is 10.4 ha, with 2.9 ha contained within the project area.

One of the habitats within the survey area contains a small island, which has potential as a nest site for Australian Painted-snipe (inset 3 in **Figure 4-18**). This wetland lies outside the project area. The Australian Painted-snipe is highly mobile and is considered to occur in a single, contiguous breeding population (Department of Climate Change, Energy, the Environment and Water 2022f). Small numbers (singles or small groups) possibly utilise habitat within the project area for short periods during transit through the region.



Legend

Drainage Lines

Potential Latham's Snipe and Australian Painted-snipe Habitat

Vulcan South Coal Mine (2023/09708)

Survey Area

Disturbance Footprint

Project Area (ML 700073)

Source: Vitrinite 2022, METServe 2020-2022, Maxar, Earthstar Geographics

Vulcan South

Potential Habitat for Latham's Snipe and Australian Painted-snipe

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-18

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.3.3.25 Red Goshawk

The Red Goshawk is a bird-eating hawk listed as endangered under the EPBC Act. There is a recovery plan in place for the species (Department of Environment and Resource Management 2012).

The Red Goshawk formerly had a wide distribution across northern and eastern Australia, occupying a variety of forested environments, but favouring the ecotone between dense forest and open woodland, especially near rivers and wetlands. In partly cleared parts of eastern Queensland it is associated with gorge and escarpment country (Threatened Species Scientific Committee 2015b). Within the last two decades, it has largely disappeared from the southern half of its former distribution. Since 2000, there have been very few (possibly no) confirmed records within New South Wales, where it is listed as critically endangered (NSW Scientific Committee 2008).

Likewise, over the past 20 years in Queensland there are very few records of the species south of Townsville. There are two records from 1992 and 2001 about 80 km north-east (WildNet); 80 km north near Hail Creek Mine (no date, WildNet); 100 km to the north near Glenden (2013, WildNet), adjacent to remnant habitats; 120 km to the south, a preserved egg kept with Museums Victoria with no valid date; and two records from 1989 and 1995 about 150 km north, near Eugenella National Park (WildNet). Given the propensity for misidentification of the species (Department of Environment and Resource Management 2012), it is likely that many of these records are erroneous. Some of the records (especially those older than ten years) are undoubtedly authentic, given that at least three nests were known in southeast Queensland between 2001 and 2003 (Czechura *et al.* 2010). However, extensive targeted surveys at the same locations between 2013 and 2014 failed to find any Red Goshawks (Seaton 2014).

The survey area occurs within the historical distribution of the Red Goshawk. Potential habitat for the species occurs on site, although it is not of high quality; escarpments and nearby waterways mostly lack surface water, dense forest is lacking, and the surrounding landscape is highly modified through mining and clearing for grazing. The Red Goshawk rarely breeds in areas with fragmented native vegetation (Threatened Species Scientific Committee 2015b), and never more than 1 km from water.

While it is considered possible that dispersing Red Goshawks may occasionally use the survey area, the importance of the site to the species is considered to be low.

4.3.3.26 Annual Wiregrass

The Annual Wiregrass (*Aristida annua*) is thought to be restricted to the black clay soils of central Queensland (Simon 1984), which is where almost all herbarium specimens have been collected. These soils are mostly derived from basalt and support native grasslands or open woodlands dominated by *Eucalyptus orgadophila, Eucalyptus crebra* or *Eucalyptus melanophloia*. One specimen (held at the Queensland Herbarium) was anomalously collected by D. Osten "on a ridge...[with] sandy red loam". However, according to regional ecosystem mapping, the collection location falls within land zone 8 (clay soil derived from basalt), and the habitat reported is probably erroneous.

No basalt-derived soil exists within the survey area, but black clay soils derived from fine-grained sedimentary rock occur on site and support similar vegetation communities (regional ecosystem 11.9.2). However, these areas were heavily degraded by grazing, with the exotic pasture grass *Bothriochloa pertusa* comprising more than 90% of the vegetation cover. No areas dominated by native grasses were observed on clay soil.

No Annual Wiregrass was recorded during flora surveys. Elsewhere in central Queensland, the species has been collected in flower (when easiest to detect and identify) between February and June. The survey period coincided with the start of this period. Given the early start to the 2018-2019 growing season (e.g., heavy rain commenced in October 2018), and the abundance of flowering annual grasses of other species recorded in February 2019 and March 2020, it is expected that, if present, Annual Wiregrass would have been flowering and readily detectable at the time of survey.

The survey area lies outside the known distribution of Annual Wiregrass, and outside the modelled map of where the "species or species habitat may occur" (Department of Climate Change, Energy, the Environment and Water 2022g). However, the nearest record is only 35 km southwest of the survey area. Given that potential habitat for this threatened grass exists within the survey area, its occurrence on site is considered possible. However, based on the highly degraded nature of the habitat present, the survey area is likely to be of negligible importance to the species.

4.3.3.27 Ghost Bat

Ghost Bats are large, carnivorous bats whose distribution is primarily limited by suitable roost sites. Ghost bats roost and breed in caves that comprise a small entrance hole and a large chamber, where conditions remain warm and humid year-round (Toop 1985; Armstrong and Anstee 2000). Roost sites are often 30-50 m deep within the cave, where conditions are most stable (Armstrong and Anstee 2000). However, smaller caves may be used transiently (Armstrong and Anstee 2000). Ghost Bats move between a number of caves seasonally or as dictated by weather conditions, and require a range of cave sites. Ghost Bats also colonise disused mines, especially those that are deep and complex, with an isothermal zone (Armstrong and Anstee 2000).

Ghost Bats forage in a wide range of native vegetation types. Foraging areas average 61 ha in size and are generally within 1-10 km of roost sites (Tideman *et al.* 1985; Diete *et al.* 2016).

Suitable roost sites are scarce across eastern Queensland. There are only two known breeding colonies of Ghost Bats in central eastern Queensland: at Rockhampton and Cape Hillsborough. Genetic studies indicate that these populations are isolated from other populations and each other (Worthington Wilmer *et al*. 1999). This suggests a general lack of suitable breeding habitat elsewhere in central eastern Queensland (Worthington Wilmer *et al*. 1999). Ghost Bats may disperse in winter 20-50 km from the maternity roosts (Toop 1985), and the closest record of a dispersing individual (presumably from Cape Hillsborough) is at the Clarke Range (80 km northeast of the survey area).

The survey area is well outside the known winter dispersal and foraging zones of the two central Queensland populations of Ghost Bats. However, given that the existence of unknown breeding sites is possible, and the proliferation of mining across the Bowen Basin may have inadvertently created new roosting habitats (in disused mines), it is considered possible that the survey area may be used intermittently by Ghost Bats. This use would solely be in a foraging capacity, as none of the sandstone ridges on site supported caves of a size and structure suitable as a roost site. No Ghost Bats were recorded during surveys.

4.3.3.28 Dunmall's Snake

The Dunmall's Snake is poorly known and rarely recorded. The species inhabits a variety of wooded habitats, ranging from *Acacia harpophylla* on cracking clay soil to *Corymbia citriodora, Eucalyptus crebra* and *Eucalyptus melanophloia* open forest on sandstone-derived soil (Department of Climate Change, Energy, the Environment and Water 2022h). In the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*, important habitat for the species is defined as any forest or woodland "within the 'Known/Likely to occur' modelled distribution of the species…and any habitat corridors in between" Department of Sustainability, Environment, Water, Population and Communities 2011). Despite containing potential habitat for the species, the survey area lies outside the known/likely distribution of the Dunmall's Snake, as modelled in the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*. It is, therefore, not considered "important habitat" for the species. Nevertheless, the survey area lies within the modelled "may occur" zone, and given the difficulty associated with detecting this highly cryptic species, its presence on site is considered possible. No Dunmall's Snakes were detected during surveys. The nearest record is from Clermont, 80 km southwest of the survey area. The species has never been recorded in the Dysart-Moranbah region, despite extensive ecological survey effort at other mine sites. Given the absence of local records despite targeted searches undertaken for Vulcan South and numerous neighbouring mining operations, it is considered unlikely that the species occurs locally.

4.3.3.29 Allan's Lerista

Allan's Lerista is a skink that is confined to black soil downs (undulating plains formed primarily on basalt) in the vicinity of Clermont. It burrows within the upper profile of heavy clay soil under tussocks of grass (Department of Climate Change, Energy, the Environment and Water 2022i). It is typically recorded from *Eucalyptus orgadophila* and *Corymbia erythrophloia* open woodlands (Department of Climate Change, Energy, the Environment and Water 2022i).

No Allan's Leristas were found during surveys. The nearest known population to the survey area is 30 km west. However, it is separated from the survey area by a 130-km long sandstone range, which likely constitutes an important barrier to dispersal. The species has never been recorded east of this range.

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities 2011) defines suitable habitat for the species as being regional ecosystems 11.8.5 and 11.8.11, both of which are lacking from the survey area. Nevertheless, regional ecosystem 11.9.2 (*E. orgadophila* open woodland on soil derived from fine-grained sedimentary rock) occurs on site, and closely resembles 11.8.5 in its floristics and soil attributes. Furthermore, models within the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* indicate that the species may occur within the survey area, despite the site being outside the modelled "known/likely to occur" zone.

A total of four trap sites were installed in the only patch of potential habitat located within the survey area (three in remnant 11.9.2 and one in cleared 11.9.2), which is twice the sample effort recommended by the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*.

Taking into account the known distribution of the species and the search effort conducted to date, it is unlikely that Allan's Lerista occurs within the survey area.

4.3.3.30 King Blue-grass

King Blue-grass (*Dicanthium queenslandicum*) inhabits native grasslands and open woodlands on black cracking clay soil derived from basalt. The species also colonises pastures established following the clearance of *Acacia harpophylla* and other dense vegetation communities growing on heavy clay soil. King Blue-grass cannot tolerate continual heavy stocking regimes, and is outcompeted by exotic grass species and weeds, which tend to dominate heavily grazed pastures (Fensham 1999). For this reason, most extant populations are confined to road reserves and other sites semi-protected from grazing livestock.

Heavy clay soils supporting grasses are represented within the survey area by remnant regional ecosystem 11.9.2 and cleared pastures that formerly supported regional ecosystem 11.4.9. Both habitats have been subjected to long periods of heavy grazing. This has led to the almost complete replacement of native perennial grasses with the exotic *Bothriochloa pertusa.* Road verges protected from grazing livestock were dominated by other weed grasses, such as *Cenchrus ciliaris, Megathyrsus maximus, Chloris* spp. and *Hyparrhenia rufa*. Nowhere within the survey area were clay soils observed to support a native grassland community.

Nine records exist within 50 km since 2020. The closest is 11 km to the northeast of the Project area (2022, Queensland Herbarium). While the species possibly once inhabited the survey area, its continued existence is unlikely considering current grazing regimes. The survey area lies just outside the Department of Climate Change, Energy, the Environment and Water's (2022j) modelled "may occur" range of the species.

4.3.3.31 Hairy Bluegrass

Hairy Bluegrass (*Dicanthium setosum*) is associated with heavy basaltic black soils and red-brown loams with clay subsoil (Department of Climate Change, Energy, the Environment and Water 2022k). It is tolerant of a moderate amount of disturbance, but excessive grazing and invasion of exotic grasses threatens the species (Department of Climate Change, Energy, the Environment and Water 2022k). All clay soils within the survey area were dominated by the exotic pasture grass *Bothriochloa pertusa*. No native grass communities were observed on clay within the survey area.

Hairy Bluegrass has a patchy distribution across subcoastal eastern Australia. Based on herbarium records, there appears to be a 280 km gap between known populations at Springsure and Glenden. The survey area occurs within this gap; the nearest known record is 95 km to the north.

The survey area lies just outside the Department of Climate Change, Energy, the Environment and Water's (2022k) modelled "may occur" range of the species. Despite potential habitat occurring on site, the lack of local records and the heavily degraded nature of the available habitat suggest that the survey area is not important for the Hairy Bluegrass.

4.3.3.32 Latham's Snipe

This is a Migratory species that is also listed as Vulnerable under the EPBC Act. Latham's Snipe is a shorebird with similar ecological requirements to the Australian Painted-snipe (see **4.3.3.24**). Latham's Snipe are migratory birds protected under the Bonn Convention, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act and is listed as Vulnerable under the EPBC Act In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

Habitat is described as follows:

FORAGING HABITAT

Soft mudflats or shallow water typically at night, early morning, or evening.

SHELTER HABITAT

Small wetlands for shelter during the day, including urban water bodies, saltmarshes, as well as creek edges where there is adequate shallow flooded or inundated substrate. They also use crops and pasture. They mostly are found among dense cover comprising sedges, grasses, lignum, reeds, and rushes. The bird tends to disperse after dusk to forage over larger areas.

BREEDING HABITAT

This species does not breed in Australia.

DISPERSAL HABITAT

This species, being migratory is expected to follow seasonal migration routes and overfly most habitat types, stopping only to shelter and forage.

Latham's Snipe inhabit the muddy edges of freshwater and brackish wetlands where there exists abundant low, dense vegetation for shelter. Important habitat for Latham's Snipe is defined in the *Wildlife Conservation Plan for Migratory Shorebirds* (Department of the Environment 2015b) as "areas that have previously been identified as internationally important for the species, or areas that support at least 18 individuals of the species".

The Latham's Snipe was not recorded within the survey area, despite surveys coinciding with seasons when presence is most likely (August-April). Nevertheless, this is a cryptic species and small numbers may have gone undetected. Latham's Snipe commonly utilises relatively small farm dams, provided that its needs for a muddy substrate and vegetated margins are met. There are numerous records of the species within a 100 km radius of the survey area, in many cardinal directions.

Locations of potential habitat are as for the Australian Painted-Snipe. There are 2.9 ha of potential habitat within the Project area for this species (see **Figure 4-18**).

4.3.3.33 Sharp-tailed Sandpiper

The Sharp-tailed Sandpiper is a migratory bird protected under the Bonn Convention, China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act. It is listed as Vulnerable under the EPBC Act. In Queensland, it is also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

No Sharp-tailed Sandpipers were recorded within the survey area, but there is a nearby record from Peak Downs Mine in 2001. They are likely to be occasional summer visitors to suitable habitat within the survey area.

Habitat is described as follows:

FORAGING HABITAT

includes fresh and hypersaline environments, feeding along the edge of water on mudflats, coastal and inland wetlands, and sewage ponds. After rainfall events, the species may also feed on areas of agricultural pasture (Department of Climate Change, Energy, the Environment and Water, 2024a).

SHELTER HABITAT

Generally rocky and sandy beaches, freshwater habitats, and inland saltwater habitats (Department of Climate Change, Energy, the Environment and Water, 2024a).

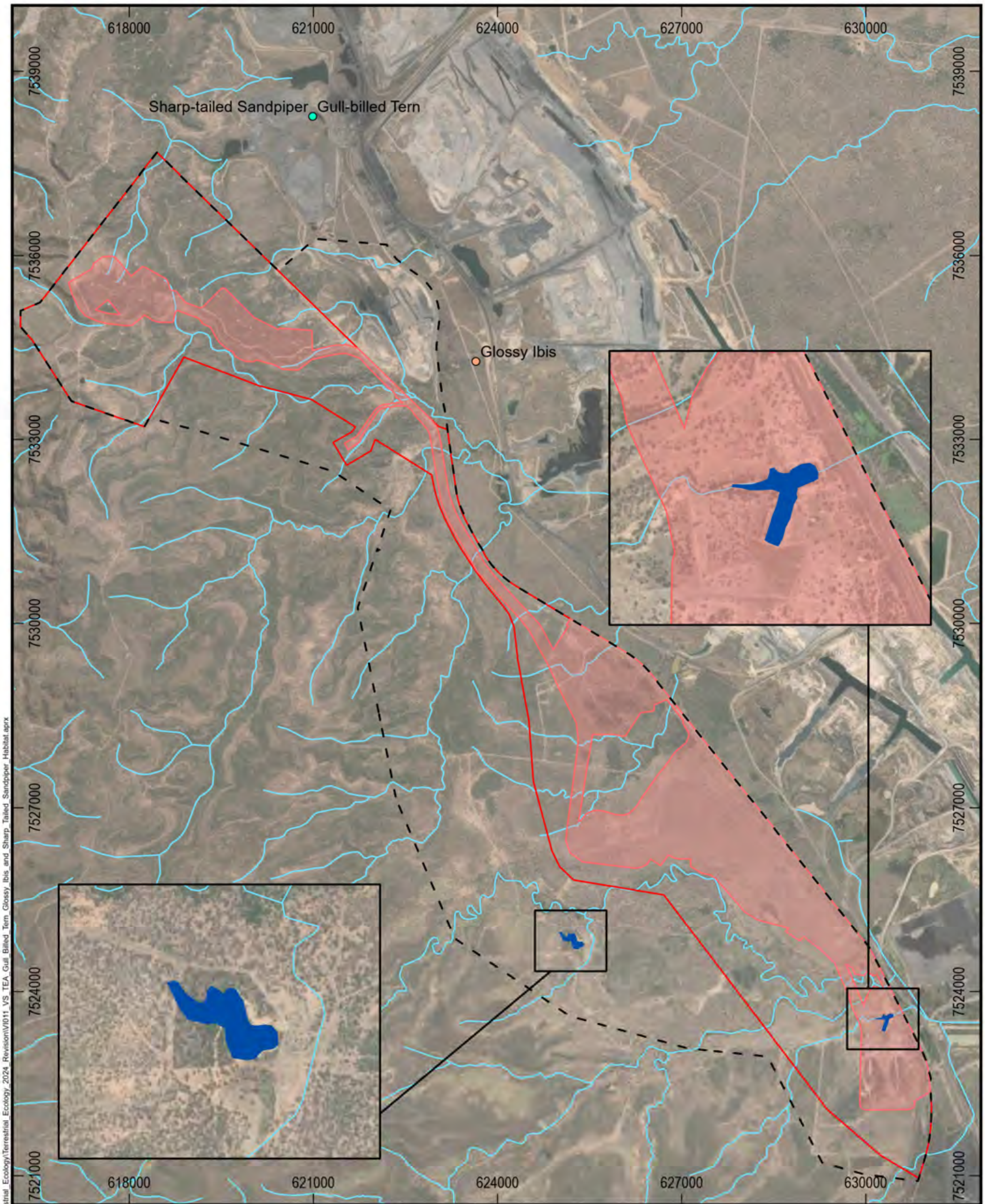
BREEDING HABITAT

This species does not breed in Australia.

DISPERSAL HABITAT

This species, being migratory is expected to follow seasonal migration routes and overfly most habitat types, stopping only to shelter and forage.

Sharp-tailed Sandpipers depend on open wetlands with shallow, muddy margins and often short, damp vegetation. The natural wetlands present on site are too small and/or are too heavily treed to provide favourable habitat for this species. However, two dams constitute marginal habitat that may be used briefly under optimal weather conditions (i.e., when retreating water levels expose muddy banks). Both dams are located in the southern half of the survey area (see inset 2 and 3 in **Figure 4-2**), one of which is in the ML area. None of the habitat present within the survey area is considered important for the Sharp-tailed Sandpiper. There are 2.82 ha of potential habitat in the disturbance footprint (**Figure 4-19**).



Legend

ALA Records

- Calidris acuminata (Sharp-tailed Sandpiper) and Gelochelidon nilotica (Gull-billed Tern)
- Plegadis falcinellus (Glossy Ibis)
- Drainage Lines
- Potential Gull-billed Tern, Glossy Ibis and Sharp-tailed Sandpiper Habitat

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Maxar. Earthstar Geographics

Vulcan South

Potential Habitat and Sightings for the Gull-billed Tern, Glossy Ibis and Sharp-tailed Sandpiper

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-19

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Gull_Billed_Tern_Glossy_Ibis_and_Sharp_Tailed_Sandpiper_Habitat.aprx

4.3.3.34 Rufous Fantail

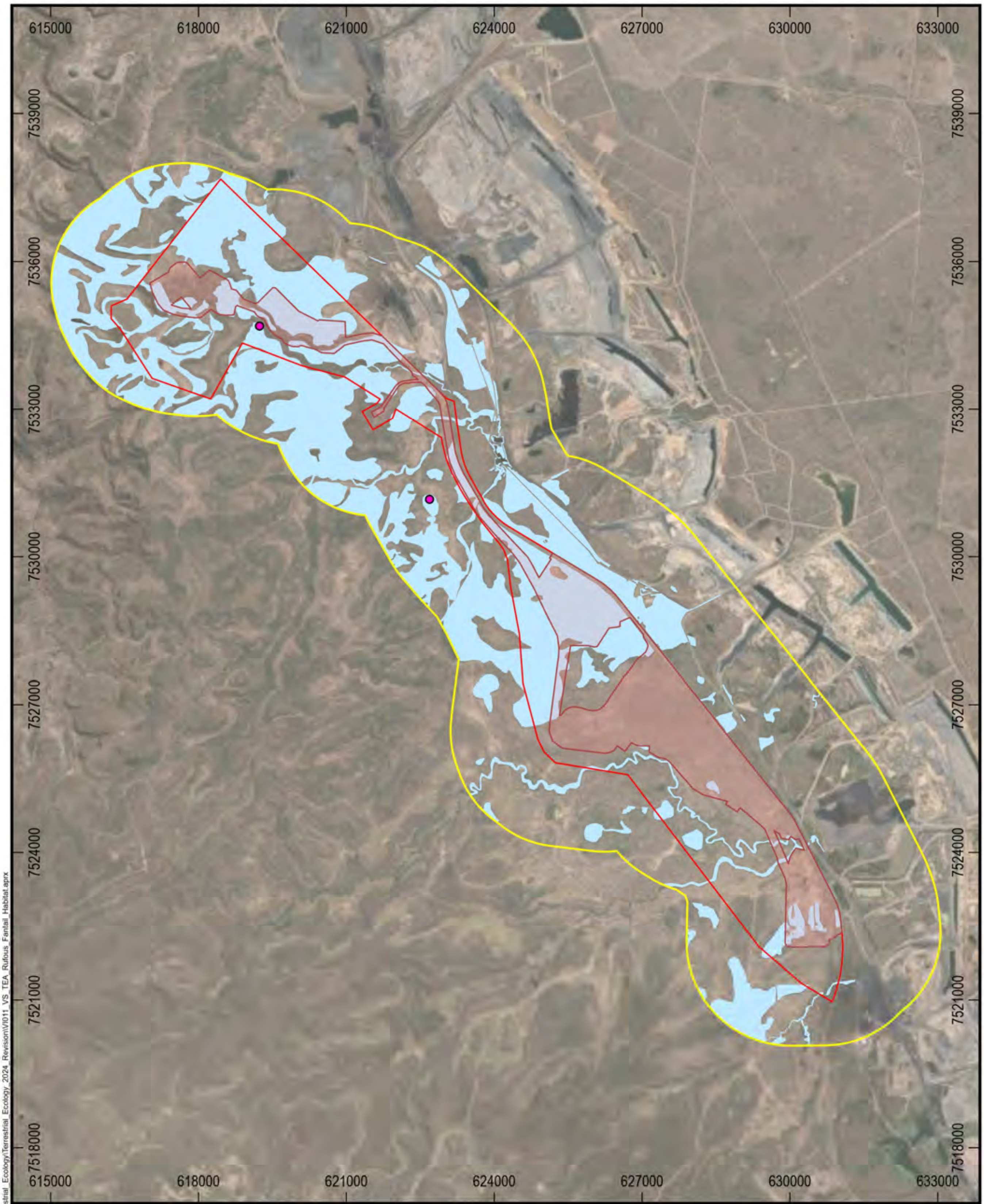
Rufous Fantails are migratory birds protected under the Bonn Convention and the EPBC Act. In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006*.

Rufous Fantails pass through the project area during transit in spring and autumn. The species lives primarily along the east coast and nearby ranges, in rainforest and wet eucalypt forests with a dense, shrubby midstorey. During migration, they can inhabit drier woodlands further west. Two individuals were recorded on site in September-October 2019: one within vine-thicket and the other within dense *Acacia* regrowth. The subspecies of these individuals is not known, but given the suboptimal habitat usage, these were likely to be migrants. Therefore, they belonged either to *Rhipidura rufifrons rufifrons* (south-eastern Australian subspecies) or migratory sub-populations of *Rhipidura rufifrons intermedia* (Queensland subspecies).

It is likely that small numbers (5 to 10) pass through the survey area during each northward or southward migration. According to population estimates provided by the *Referral guideline for 14 birds listed as migratory species under the EPBC Act* (Department of the Environment 2015a), this constitutes a tiny fraction (0.001% to 0.002%) of the total population size of the subspecies involved.

Within the survey area, habitats possessing a dense midstorey of *Acacia, Melaleuca* or vine-thicket species are most likely to be used. In total 1,503.3 ha of habitat outside normal dispersal pathways suitable for shelter and foraging occurs within the impact area which, consequently, is of marginal significance for the Rufous Fantail, given that most of the population migrates through more coastal habitats further east (based on eBird and Atlas of Living Australia records). Consequently, the habitats within the Project area are not critical to the population and do not meet the definitions of "important habitat" for migratory species. There are 474.09 ha of habitat in the disturbance footprint (**Figure 4-20**).

The survey area is of marginal significance for the Rufous Fantail, given that most of the population migrates through more coastal habitats further east (based on eBird and Atlas of Living Australia records). Breeding has never been recorded in dry habitats west of the coastal ranges in central Queensland (Barrett *et al.* 2003) and is not likely within the survey area.



Path: S:\Projects\V011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\V011_VS_TEA_Rufous_Fantail_Habitat.aprx

Legend

Rufous Fantail Sighting

Rufous Fantail Habitat

Vulcan South Coal Mine (2023/09708)

2 km Buffer

Project Area (ML 700073)

Disturbance Footprint

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Vulcan South

Rufous Fantail Habitat and Sightings

0 1 2 4

Kilometers

Scale: 1:112,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-20

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.3.4 Migratory Species

Migratory species listed in the following international agreements are protected under the EPBC Act as Matters of National Environmental Significance:

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

Of the 15 migratory species determined to be potential in the area by PMST search results, two listed migratory species, the Rufous Fantail and White-throated Needletail, were detected within the survey area. Two additional species (Fork-tailed Swift and Latham's Snipe) are likely visitors, and an additional six species (Sharp-tailed Sandpiper, Oriental Cuckoo, Gull-billed Tern, Black-faced Monarch, Satin Flycatcher, Glossy Ibis) are possible visitors.

The survey area contains important habitat for the Rufous Fantail, Oriental Cuckoo and Satin Flycatcher, according to definitions of the Department of the Environment (2015). However, for no migratory species does the survey area contain "important habitat" that supports an "ecologically significant proportion of the population", as defined by the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (Department of the Environment 2013a), *Referral Guidelines for 14 Birds Listed as Migratory Species under the EPBC Act* (Department of the Environment 2015a) and *Industry Guidelines for Avoiding, Assessing and Mitigating Impacts on EPBC Act Listed Migratory Shorebird Species* (Department of Environment and Energy 2017). Each species is discussed further in the following sub-sections.

4.3.4.1 White-throated Needletail

See **section 4.3.3.4**.

4.3.4.2 Fork-tailed Swift

Fork-tailed Swifts are migratory birds protected under the China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act. In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

Fork-tailed Swifts visit Australia during their non-breeding season (the austral summer). They are exclusively aerial, foraging for flying insects in airspace above most habitats, including cleared farmland. The species is ecologically similar to the White-throated Needletail, and the two species often flock together. The Fork-tailed Swift is the more likely of the two species to forage over inland plains. Flocks of Fork-tailed Swifts are highly mobile and don't remain long in any one location. While no Fork-tailed Swifts were recorded during ecological surveys, it is likely that passing flocks utilise the survey area briefly and intermittently during summer, but possibly not every year. The nearest record is from 30 km south of the Project area.

The survey area is of no particular importance to the Fork-tailed Swift on a local or regional scale, and the project will not include any wind turbines, tall buildings, airports or other structures that threaten airspace used by the species for foraging and dispersal.

4.3.4.3 Latham's Snipe

See **section 4.3.3.32**.

4.3.4.4 Oriental Cuckoo

Oriental Cuckoos are migratory birds protected under the China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act. In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.* No Oriental Cuckoos were recorded within the survey area. The only record within 70 km is approximately 6 km north of the Project area from 2023. Numerous further records are located along the coast, and some are located scattered further inland south of the Project more than 100 km away.

Habitat is described as follows:

FORAGING/SHELTER HABITAT

When in Australia, Oriental Cuckoos typically inhabit monsoonal rainforest, vine thickets, wet sclerophyll forest and open woodlands. They typically favour riparian areas and other ecotones between dense forest and more open habitat.

BREEDING HABITAT

This species does not breed in Australia

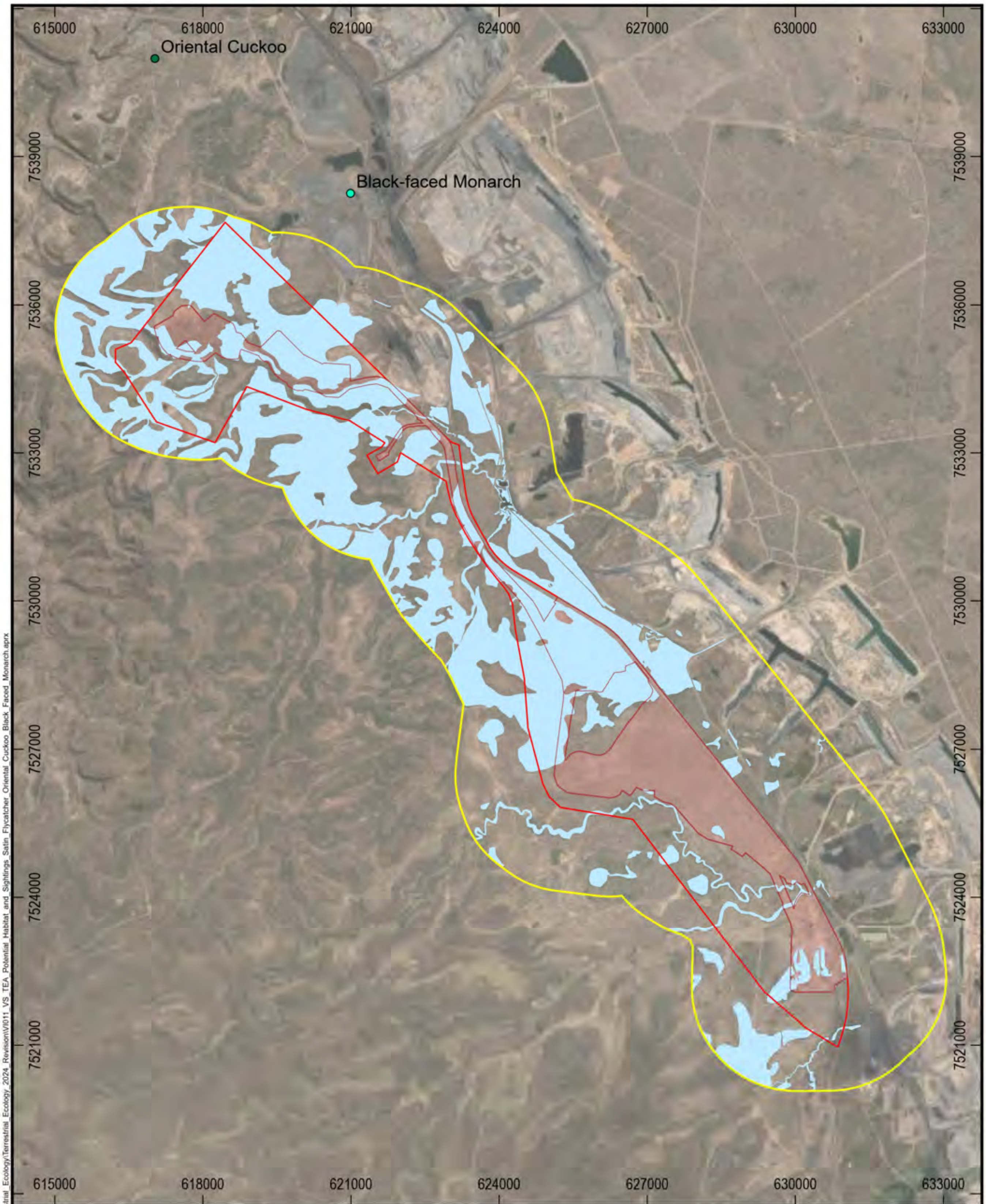
DISPERSAL HABITAT

This species disperses aerially, and consequently is unlikely to land in habitat unsuitable for the purposes of foraging and shelter.

Oriental Cuckoos visit Australia when not breeding in the Austral summer (November-April).

Most eastern Australian records are along the coast or sub-coastal ranges, with very few sightings further than 100 km from the coast. All inland records listed in eBird are in the vicinity of watercourses, corresponding with the species' preference for denser forests. The survey area lies 135 km from the coast. Occasional individuals may stray to the survey area, where they are most likely to occur along forested watercourses.

A nationally important, ecologically significant proportion of the species' population is described by the former Department of the Environment (2015a) as 1,000 individuals. No more than one or two Oriental Cuckoos are expected to utilise the survey area in any one 12-month period. There are 474.09 ha of potential habitat in the disturbance footprint (**Figure 4-21**).



Legend

ALA Records

Cuculus optatus (Oriental Cuckoo)

Monarcha melanopsis (Black-faced Monarch)

Potential Satin Flycatcher, Oriental Cuckoo and Black-faced Monarch Habitat

Vulcan South Coal Mine (2023/09708)

2 km Buffer

Project Area (ML 700073)

Disturbance Footprint

Potential_Satin_Flycatch

Source: Atlas of Living Australia 2024. Vitrinite 2024. METServe 2020-2024. Earthstar Geographics

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Potential_Habitat_and_Sightings_Satin_Flycatcher_Oriental_Cuckoo_Black_Faced_Monarch.aprx

Vulcan South

Potential habitat and sightings for the Oriental Cuckoo, Black-faced Monarch and Satin Flycatcher

0 1 2 4

Kilometers

Scale: 1:112,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-21

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.3.4.5 Black-faced Monarch

Black-faced Monarchs are migratory birds protected under the Bonn Convention and EPBC Act. In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

Black-faced Monarchs breed in rainforest and wet sclerophyll forest, especially in mountainous areas, sheltered gullies and slopes with a dense understorey of ferns and/or shrubs. In central Queensland, migrating individuals are rarely observed in drier woodlands further than 100 km from the coast. No Black-faced Monarchs were recorded within the survey area, although there is a published record (from 1999) at the adjacent Peak Downs Mine. As the survey area is west of their primary migration route, it does not contain important habitat for the Black-faced Monarch. There are 474.09 ha of potential habitat in the disturbance footprint, though this is almost certainly greatly overestimated (**Figure 4-21**).

4.3.4.6 Satin Flycatcher

Satin Flycatchers are migratory birds protected under the Bonn Convention and EPBC Act. In Queensland, they are also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

Satin Flycatchers breed in tall, wet sclerophyll forest at high altitudes in southeastern Australia and winter at rainforest edges in north Queensland and New Guinea. The survey area lies outside the known breeding and wintering range of the species. Most records of migrating individuals are along the coast and sub-coastal ranges, but occasional records occur in drier woodlands further west. No Satin Flycatchers were recorded within the survey area. The most recent dated records are two occurrences from 2004, about 125 km south, in the Emerald area. Numerous other records are located closer to the coast.

Most inland records listed in eBird occur in September-October or February-March, coinciding with southward and northward migration. While the survey area is west of their primary migration route, small numbers (fewer than five) may pass through annually in a transient capacity. The survey area does not support a nationally important, ecologically significant proportion (defined by the former Department of the Environment (2015a) as 1,700 individuals) of the population at any time. There are 474.09 ha of habitat within the disturbance footprint for this species, though this is almost certainly greatly overestimated (**Figure 4-21**).

4.3.4.7 Glossy Ibis

The Glossy Ibis is a migratory bird protected under the Bonn Convention and EPBC Act. In Queensland, it is also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

Habitat is described as follows:

BREEDING HABITAT

The Glossy Ibis nests in mixed species colonies, with a low breeding site fidelity and will inhabit new habitat if it becomes available. The nest is a platform of twigs and vegetation usually positioned less than one metre above water (occasionally up to 7 m) in tall dense stands of emergent vegetation, low trees or bushes. The nest is often lined with aquatic vegetation.

Australian breeding habitat types include wooded and shrubby swamps in the semi-arid and arid regions of the Northern Territory and Queensland.

In Queensland, breeding appears to be mostly confined to the Channel Country of the following drainages:

- Bulloo
- Diamantina
- Georgina
- Cooper

FORAGING HABITAT

Glossy Ibis forage in the shallow, muddy edges of lakes, wet, marshy areas, and flooded pastures with short vegetation.

SHELTER HABITAT

The Glossy Ibis is most likely to roost in trees near foraging and breeding areas. Regular roosting sites are not likely to be regular in habitats the species only occasionally uses.

DISPERSAL HABITAT

The Glossy Ibis is migratory or nomadic and will overfly all habitats it does not utilise for shelter, foraging and breeding purposes.

Glossy Ibis inhabit the shallow, muddy edges of lakes, wet, marshy areas, and flooded pastures with short vegetation. The natural wetlands present on site are too small and/or are too heavily treed to provide favourable habitat for the Glossy Ibis. However, two dams constitute marginal habitat that may be used briefly under optimal weather conditions (i.e., when water levels are optimal). Both dams are located in the southern half of the survey area, one of which is in the ML area (refer to insets on **Figure 4-19**). None of the habitat present within the survey area is considered important for the Glossy Ibis. No Glossy Ibis were recorded within the survey area, but the species has been recorded at the adjacent Peak Downs Mine. There are 2.82 ha of potential habitat in the disturbance footprint, as shown in **Figure 4-19**).

4.3.4.8 Sharp-tailed Sandpiper

See **Section 4.3.3.33**. Potential habitat is shown in **Figure 4-19.**

4.3.4.9 Gull-billed Tern

The Gull-billed Tern is a migratory bird protected under the China-Australia Migratory Bird Agreement and EPBC Act. In Queensland, it is also listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006.*

Gull-billed Terns forage over coastal estuaries and large inland lakes and wetlands for fish. All water bodies within the survey area are too small to be favourable for the species, although the two largest dams in the southern part of the survey area (see insets on **Figure 4-19**) may be used for brief periods by transient individuals. The species has been recorded (in 1999) at the adjacent Peak Downs Mine, which contains larger dams than are present within the survey area. None of the habitat present within the survey area is considered important for the Gull-billed Tern.

Habitat is described as follows:

FORAGING HABITAT

Gull-billed Terns forage over coastal estuaries and large inland lakes and wetlands for crabs and invertebrates, unlike most other terns it does not grab fish from the water (eBird, 2024).

BREEDING HABITAT

The Gull-Billed Tern breeds almost exclusively along the coast in saltmarshes, sandy beaches and sandy islands (Cornell Lab of Ornithology, 2024).

SHELTER HABITAT

Shelter habitat is not clearly defined, but this species is most likely to opportunistically roost on sandbars, shorelines or other low structures directly adjacent to water.

DISPERSAL HABITAT

This species disperses aerially and is only likely to land for the purposes of feeding or resting.

There are 2.82 ha of potential habitat in the disturbance footprint (**Figure 4-19**). All water bodies within the survey area are too small to be favourable for the species, although the two largest dams in the southern part of the survey area may be used for brief periods by transient individuals.

4.3.4.10 Marsh Sandpiper

This species is found throughout coastal Australia and within inland wetlands. Two records, from the years 1999 and 2001 (BirdLife Australia), are located within about 12 km north of the Project area near the Peak Downs Mine. Most records are concentrated along the Queensland coast and in the near (30 km) vicinity inland; these are all about 100 km away and further from the Project in the east and the south. There are 0 ha of suitable habitat for this species in the Project area.

4.3.4.11 Common Sandpiper

This species may be found throughout Australia, and sightings records mainly follow the coastline. Habitat is as follows:

BREEDING HABITAT

This species breeds in Russia.

FORAGING HABITAT

This species utilises estuarine and freshwater wetlands with extensive shallow, muddy margins. Sometimes foraging occurs in grassy areas.

SHELTER HABITAT

Roost sites are normally on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other structures, and to sometimes rest on mud or 'loaf' on rocks.

DISPERSAL HABITAT

This species disperses aerially and is therefore unlikely to land on habitats it does not utilise for foraging or shelter.

There are 0 ha of habitat within the Project area for this species. This species utilises estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the Project area.

4.3.4.12 Curlew Sandpiper

Curlew sandpipers are most common in the far south-east and north-west of Australia. They are found in many Australian coastal sites and may also be seen inland in suitable wetland habitats. In Queensland there are scattered records in the Gulf of Carpentaria. The species is widespread along the coast south of Cairns. Inland, the species is sparsely scattered, but there have been regular sightings around Mount Isa (Department of Climate Change, Energy, the Environment and Water, 2023a).

Habitat is described as follows:

BREEDING HABITAT

The Curlew Sandpiper does not breed in Australia. Breeding habitat occurs on the margins of marshes or pools, on the slopes of hummock tundra, or on dry patches in *Polygonum* tundra (Department of Climate Change, Energy, the Environment and Water, 2023).

FORAGING HABITAT

Foraging habitat includes mudflats and nearby shallow water. Occasionally they forage on wet mats of algae or waterweed, or on banks of beachcast seagrass or seaweed. At high tide, the species tends to forage among low sparse emergent vegetation such as saltmarsh, and sometimes within flooded paddocks or inundated saltflats (Department of Climate Change, Energy, the Environment and Water, 2023).

SHELTER HABITAT

Roosting habitat occurs around intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes, and lagoons near the coast. Roosting has been recorded on occasion near ponds in saltworks and sewage farms. Less often, individuals are recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand (Department of Climate Change, Energy, the Environment and Water, 2023).

DISPERSAL HABITAT

The Curlew Sandpiper disperses aerially and is not likely to land on habitat it does not utilise for foraging or shelter.

There are 0 ha of habitat within the Project area for this species. This species primarily inhabits coastal mudflats, but occasionally also uses the muddy margins of large freshwater wetlands. No wetlands are large enough to be of any utility to this species.

4.3.4.13 Pectoral Sandpiper

This species may occur throughout Australia, with the coast being favourable. Habitat is described as follows:

BREEDING HABITAT

This species does not breed in Australia, breeding in northern Russia and North America. In Russia, its breeding distribution is from the Yamal Peninsula, east along the Arctic coast, through the Deltas of Lena and Kolmyra Rivers, to the Chukotskiy Peninsula. In North America, its breeding distribution extends from Goodnews Bay, north through Wales to Point Barrow, east and north Canada from the northern regions of Yukon and Mackenzie, north to Banks, Bathurst, Devon, north Baffin Island and south and west to Hudson Bay (Department of Climate Change, Energy, the Environment and Water, 2024b).

SHELTER HABITAT

It is likely that the Pectoral Sandpiper roosts in similar areas to other sandpipers such as the Common Sandpiper.

FORAGING HABITAT

In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum (Department of Climate Change, Energy, the Environment and Water, 2024b).

DISPERSAL HABITAT

This species disperses aerially and is therefore unlikely to land on habitats it does not utilise for foraging or shelter.

There are 0 ha of habitat within the Project area for this species. This species utilises estuarine and freshwater wetlands with extensive shallow, muddy margins. These occur in the general area, but not in the Project area.

4.3.4.14 Osprey

This species occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia (Australian Government, 2020). There are numerous records along the coastline. There are only isolated records closer to the Project, but none are closer than about 80 km.

Habitat is described as follows:

FORAGING/BREEDING/SHELTER HABITAT

This species frequents a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. Ospreys require extensive areas of open fresh, brackish or saline water for foraging. Breeding is in tall trees or structures near foraging areas (Australian Government, 2020).

DISPERSAL HABITAT

Ospreys disperse aerially and are not likely to land or use any habitat during dispersal other than for the purposes of shelter or foraging.

There are 0 ha of habitat within the Project area for this species. The Project area is mapped as being within the Vagrant Range of the species (not the Core Range where suitable habitats are usually found) (Department of the Environment, 2015a).

4.3.4.15 Yellow Wagtail

This species is generally rare but may occur throughout most of Australia. In Australia, habitat (non-breeding) is generally in well-watered open grasslands and the fringes of wetlands. Roosting habitat includes mangroves and other dense vegetation (Department of the Environment, 2015a).

There are no records within 155 km of the Project. There is practically no habitat for this species in the Project area.

4.4 MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE

Matters of state environmental significance are defined in the *State Planning Policy 2017.* Each of these are summarised below, with respect to the project.

4.4.1 Protected Areas

No national parks, conservation parks, resource reserves, special wildlife reserves, nature refuges or coordinated conservation areas are located in or near the survey area.

4.4.2 Marine Matters

No marine parks, marine plants or fish habitat protected under the *Fisheries Act 1994*, *Fisheries Regulation 2008* or the *Marine Parks Act 2004* is contained in the survey area.

4.4.3 Designated Precinct in Strategic Environmental Areas

No strategic environmental areas are listed for the Isaac Regional Council area.

4.4.4 Wetlands and Watercourses

No wetlands or watercourses of high ecological significance are located within the survey area.

4.4.5 Secured Offset Areas

No legally secured offset areas from other projects are located in or bordering the survey area.

4.4.6 Regulated Vegetation

The following regulated vegetation under the *Vegetation Management Act 1999* (VM Act) is classed as a matter of state environmental significance in the *State Planning Policy 2017*:

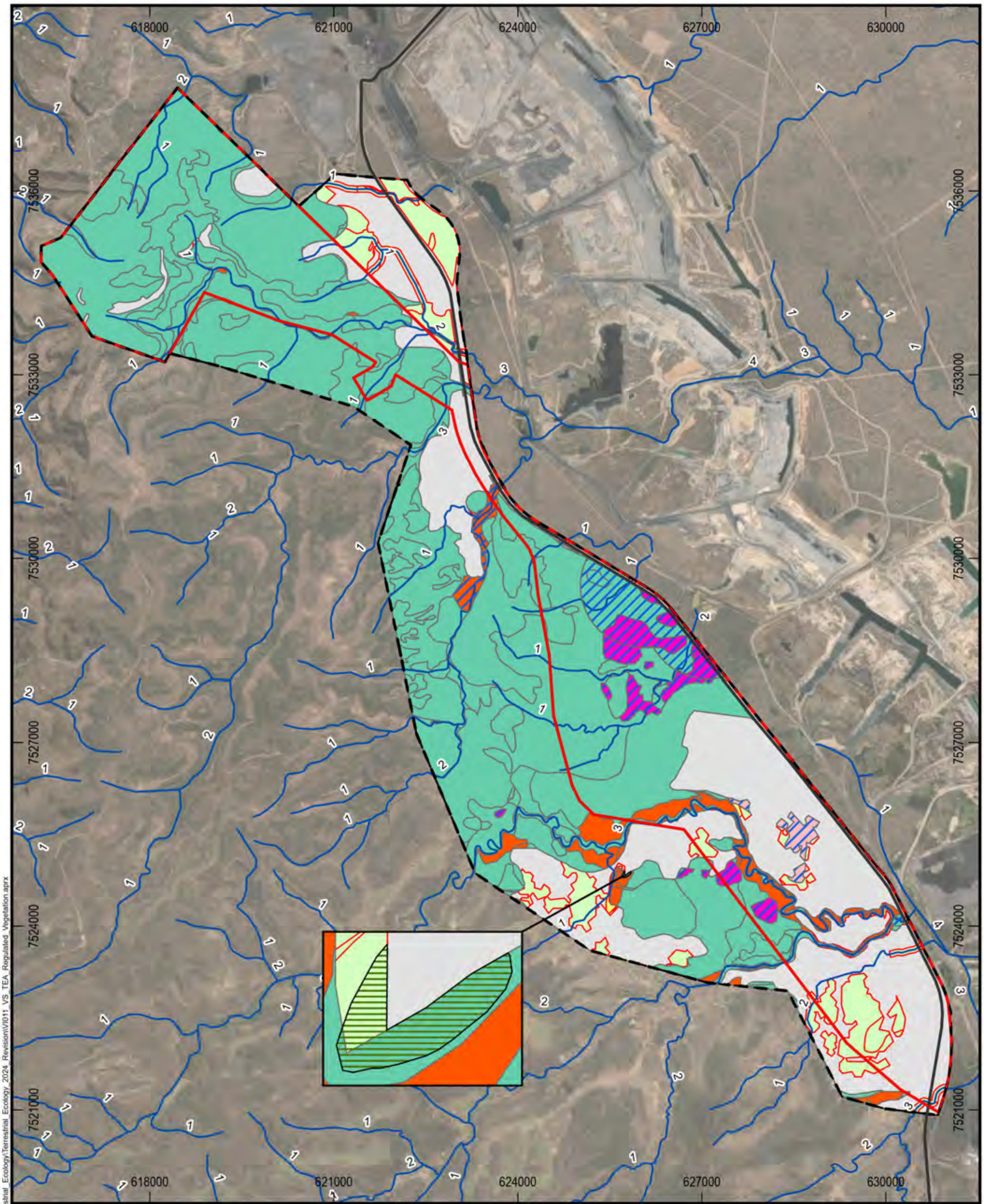
I. Category B areas (regional ecosystems) on the regulated vegetation management map that are 'endangered' and 'of concern' regional ecosystems;
II. Category C areas (regrowth) on the regulated vegetation management map that are 'endangered' and 'of concern' regional ecosystems;
III. Category R areas (non-remnant vegetation within 50 m of watercourses) on the regulated vegetation management map;
IV. Areas of essential habitat on the essential habitat map for wildlife prescribed as 'endangered wildlife' or 'vulnerable wildlife' under the *Nature Conservation Act 1992*;
V. Category A, B, C or R areas on the regulated vegetation management map that are located within a defined distance from the defining banks of a relevant watercourse identified on the vegetation management watercourse and drainage feature map; and
VI. Category A, B, C or R areas on the regulated vegetation management map that are located within a wetland or within 100 metres from the defining bank of a wetland identified on the vegetation management wetlands map.

The regulated vegetation management map, on which the above definitions of regulated vegetation are based (**Figure 4-22**), differs slightly from the field-verified regional ecosystem map. The main differences reflect the extent of regrowth (categories C and R) versus cleared areas (category X). On the regulated vegetation management map, these boundaries are primarily a legacy of an historical property map of assessable vegetation (PMAV). Despite the field-verified regional ecosystem map being a better reflection of what is present on site (hence why it is used for all habitat assessments and calculations for threatened species), the units on the regulated vegetation management map are what is protected under the VM Act. The regulated vegetation contained in the survey area is presented in **Table 4-16**.

Table 4-16 Regulated vegetation constituting MSES

Vegetation Type	Constituent REs	Total Area within the Survey Area	Total Area within the Project Area
Endangered and of concern regional ecosystems (category B)	11.3.2 (of concern)	177.7 ha	95.3 ha
	11.4.8 (endangered)	135.8 ha	131.3 ha
	11.4.9 (endangered)	17.2 ha	14.9 ha
	11.10.8 (of concern)	2.4 ha	1.4 ha
	Total	**333.0 ha**	**242.9 ha**
Endangered and of concern regrowth (category C)	11.3.2 (of concern)	9.8 ha	2.0 ha
	11.4.9 (endangered)	32.3 ha	32.2 ha
	Total	**42.1 ha**	**34.2 ha**
Non-remnant vegetation along watercourses (Category R)	n/a	54.6 ha	20.6 ha
Essential habitat for threatened wildlife	11.3.2, 11.3.25, 11.4.8, 11.4.9, HVR 11.4.9, 11.5.9	350.3 ha	308.0 ha
Category A, B, C or R areas that occur within 100 m of any wetland	11.3.2 (category B)	3.1 ha	0 ha
	11.3.27b (category B)	0.9 ha	0 ha
	11.5.3 (category B)	1.3 ha	0 ha
	HVR 11.3.2 (category C)	0.1 ha	0 ha
	HVR 11.3.27b (category C)	0.4 ha	0 ha
	HVR 11.5.3 (category C)	0.3 ha	0 ha
	Non-remnant (category R)	0 ha	0 ha
	Total	**6.2 ha**	**0 ha**
Category A, B, C or R areas that are located within a defined distance from the defining banks of a relevant watercourse*	11.3.2 (category B)	69.1 ha	52.6 ha
	11.3.7 (category B)	8.1 ha	1.8 ha
	11.3.25 (category B)	92.2 ha	38.9 ha
	11.3.27b (category B)	0.2 ha	0.2 ha
	11.4.8 (category B)	1.9 ha	1.9 ha
	11.5.3 (category B)	23.1 ha	2.6 ha
	11.5.9b (category B)	86.8 ha	56.7 ha
	11.9.2 (category B)	1.5 ha	1.3 ha
	11.10.1 (category B)	53.0 ha	28.9 ha
	11.10.3 (category B)	87.5 ha	48.2 ha
	11.10.7 (category B)	2.5 ha	2.5 ha
	11.10.8 (category B)	0.7 ha	0.7 ha
	HVR 11.3.2 (category C)	0.8 ha	0.2 ha
	HVR 11.3.25 (category C)	2.2 ha	0 ha
	HVR 11.5.3 (category C)	2.0 ha	0.3 ha
	HVR 11.5.9 (category C)	8.1 ha	0 ha
	HVR 11.5.9b (category C)	5.8 ha	0.3 ha
	HVR 11.10.3 (category C)	0.1 ha	0 ha
	HVR 11.10.7 (category C)	3.1 ha	0 ha
	Non-remnant (category R)	38.3 ha	17.3 ha
	Total	**508.4 ha**	**267.4 ha**

*The defined distance was listed by Department of Environment and Heritage Protection (2017) as 25 m for a first- or second-order stream and 50 m for a third- or fourth-order stream. The certified vegetation management watercourse map shows the centreline of relevant watercourses, but not the exact locations of their banks. Bank location was estimated based on the average width of watercourses in the survey area. Watercourse widths (distance between banks) were estimated to be 5 m for first-order streams, 10 m for second-order streams, 15 m for third-order streams and 20 m for fourth-order streams. Buffers around the watercourse centreline were enlarged beyond the "defined distance" to account for these stream widths.



Legend

Road

Vegetation Management Watercourse/Drainage Feature Map (Stream Order Labelled)

Vulcan South Coal Mine (2023/09708)

Project Area (ML 700073)

Survey Area

Essential Habitat

Vegetation Management Wetlands Map

Regulated Vegetation Management Map

Category A or B area containing endangered regional ecosystems

Category A or B area containing of concern regional ecosystems

Category A or B area that is a least concern regional ecosystem

Category C or R area containing endangered regional ecosystems

Category C or R area containing of concern regional ecosystems

Category C or R area that is a least concern regional ecosystem

Category X area

Source: State of Queensland (Department of Resources) 2023, Vitrinite 2022, METServe 2020-2024, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Regulated_Vegetation.aprx

Vulcan South

Regulated Vegetation Management Map

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-22

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.4.7 Threatened and Special Least Concern Wildlife

Forty-five species of plants and animals listed as matters of state significance were flagged by database searches as being potentially present in the region. Field surveys confirmed that six of these (Koala, Greater Glider, Squatter Pigeon, Short-beaked Echidna, White-throated Needletail and Rufous Fantail) were present within the survey area. Furthermore, a seventh species (Glossy Black-cockatoo) was recorded on site despite not being flagged as present in the region. No threatened or near threatened species of plants were detected within the survey area.

Most of the species that constitute matters of state significance are also matters of national significance, and were therefore discussed in **Section 4.3.3** and **4.3.4** (see **Table 4-5** for a list of their conservation status under the NC Act).

Only three species that are matters of state environmental significance are not also matters of national significance protected under the EPBC Act. These are the Glossy Black-cockatoo (*Calyptorhynchus lathami*), Short-beaked Echidna (*Tachyglossus aculeatus*) and Common Death Adder (*Acanthophis antarcticus*). The first two species were detected within the survey area and the third is a possible inhabitant. Each is discussed in the following subsections.

4.4.7.1 Glossy Black-cockatoo

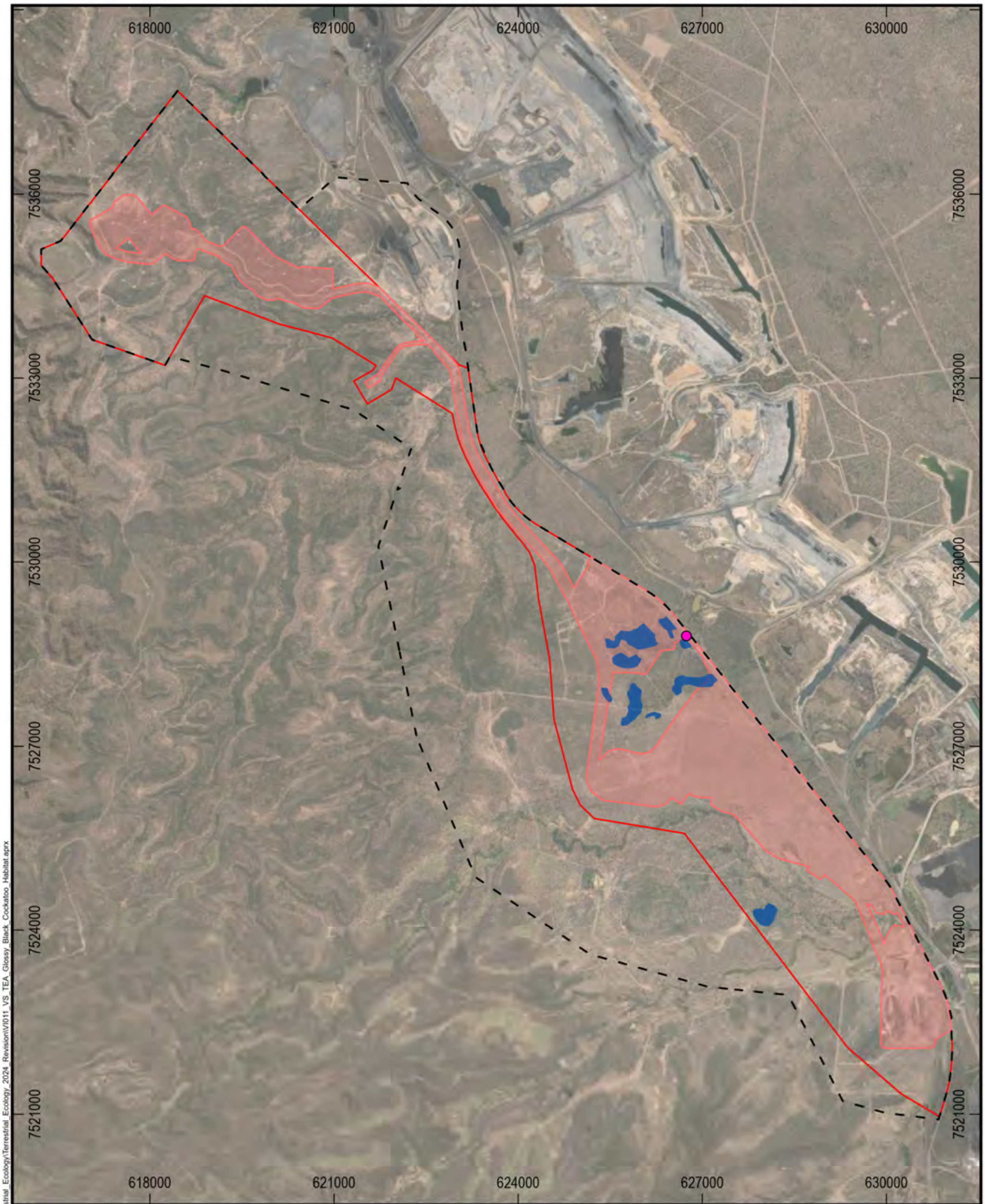
The Glossy Black-cockatoo is listed as Vulnerable under the NC Act. The Glossy Black-cockatoo was not recorded on site during ecology surveys and there were no recent records (from the last 50 years) within 100 km of the survey area. Desktop reviews therefore did not flag it as a species that potentially occurred in the vicinity of Vulcan South. Nevertheless, one pair was observed during weed monitoring undertaken within the survey area in March 2022 (**Figure 4-23**).

Glossy Black-cockatoos are dietary specialists, feeding on the seeds of only nine species of *Casuarina* and *Allocasuarina* (Chapman 2007). The cockatoo subspecies found in central Queensland (*C. l. erebus*) is known to feed primarily on *Casuarina cristata, Allocasuarina torulosa* and *Allocasuarina littoralis.* Of these food trees, only *C. cristata* (Belah) occurs within the survey area, where it grows within small patches of Brigalow. The pair of Glossy Black-cockatoos was observed feeding in one of these small groves of Belah. The other food trees are restricted to higher rainfall areas near the coast and nearby ranges.

The occurrence of Glossy Black-cockatoos within the survey area was unusual for several reasons:

- The survey area is far from the closest known permanent populations to the south and east, at Blackdown Tableland, the Clarke Range and the Rockhampton-Shoalwater Bay region.
- The survey area contains multiple small patches of feeding habitat (total of 74.5 ha in the survey area and 38.1 ha in the impact area) isolated from other feeding habitat by extensive tracts of cleared farmland, mines and forest lacking food trees. The small areas of habitat present are almost certainly insufficient to provide a year-round supply of seed. Glossy Black-cockatoos on Kangaroo Island generally require at least 400 ha of feeding habitat within 12 km of nests for successful breeding (Mooney and Pedler 2005).
- The species was not recorded during the extensive fauna surveys undertaken on site, despite particular focus on habitats likely to support the species (i.e., Brigalow areas), due to the potential of this habitat to also harbour Ornamental Snakes and other threatened species.

Taken together, the above evidence suggests that the site provides foraging habitat used occasionally by transient individuals, rather than a locally resident breeding population. The Capricornia region was experiencing a severe rainfall deficit during the survey periods. Furthermore, large areas of Glossy Black-cockatoo habitat at Shoalwater Bay experienced bushfires in 2021 (NAFI 2022). These environmental factors may have caused a food shortage within their more usual home ranges, encouraging dispersal to new, suboptimal locations. A similar pattern was observed in southeastern Queensland following the drought and fires of 2019 (Cornell Lab of Ornithology 2022).



Legend

- Glossy Black-Cockatoo Sighting
- Glossy Black-Cockatoo Habitat

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Source: Vitrinite 2022, METServe 2020-2022, Earthstar Geographics

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Glossy_Black_Cockatoo_Habitat.aprx

Vulcan South

Glossy Black-Cockatoo Habitat and Sighting

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-23

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

4.4.7.2 Short-beaked Echidna

The Short-beaked Echidna is the most widespread native mammal in Australia. It is listed as Special Least Concern under the *Nature Conservation (Wildlife) Regulation 2006*. It has no particular habitat requirements other than potential den sites (beneath rocks or fallen timber) and a supply of ants and termites, on which it feeds (Augee 2008). Short-beaked Echidnas, or their scats or excavations, were recorded on seven occasions during ecological surveys. These included within remnant and non-remnant vegetation. As echidnas utilise a broad diversity of natural and modified habitats and have very large home ranges spanning up to 100 ha (Nichol *et al.* 2011), the entire survey area (6,982.4 ha) comprises potential habitat for the Short-beaked Echidna.

4.4.7.3 Common Death Adder

The Common Death Adder is a snake that inhabits a broad range of habitats across eastern Australia. Its chief habitat requirement is abundant shelter in the form of leaf litter, woody debris and/or rocks. A low density of Cane Toads (*Rhinella marina*) is important, as ingested toads cause lethal poisoning (Phillips *et al.* 2009). Habitats well away from permanent water (where toads congregate and breed) are therefore likely to be most important for the species.

No Common Death Adders were recorded during ecological surveys. However, the species was recently recorded (in 2012) 25 km northeast of the project, and it is possible that populations persist on site despite high densities of Cane Toads. Within the survey area, the sandstone ridges in the western half probably contain the most valuable habitat for the species (**Figure 4-24**). Such habitats have the highest density of shelter sites and lowest densities of toads. There are 2,799.9 ha of remnant and regrowth vegetation on Land zone 10 (sandstone) within the survey area.

4.5 WEEDS AND PEST ANIMALS

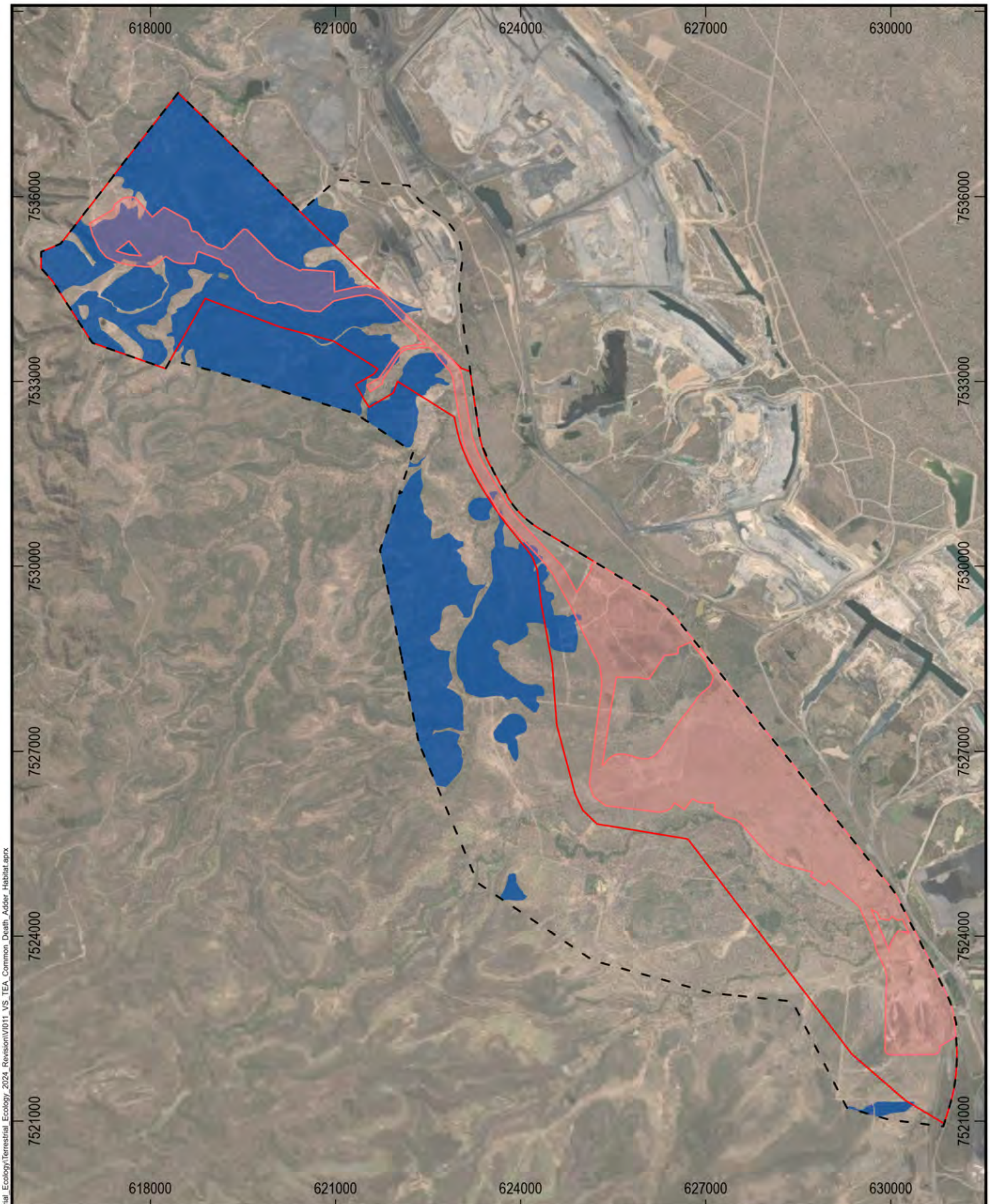
A total of 56 species of non-native plants were recorded within the survey area. Of these, the following weeds were most widespread, occurring at 30% or more of sampling sites:

- *Bothriochloa pertusa* (Indian Couch);
- *Sida spinosa* (Spiked Sida);
- *Cenchrus ciliaris* (Buffel Grass);
- *Melinis repens* (Natal Grass);
- *Portulaca pilosa* (Hairy Portulaca);
- *Stylosanthes scabra* (Shrubby Stylo); and
- *Urochloa mosambicensis* (Sabi Grass).

Seven species of weeds present within the survey area are category 3 restricted matters under the *Biosecurity Act 2014*, which prohibits their sale, trade or spread. These restricted weeds are:

- *Cryptostegia grandiflora* (Rubber Vine);
- *Harrisia martinii* (Harrisia Cactus);
- *Hymenachne amplexicaulis* (Olive Hymenachne);
- *Jatropha gossypiifolia* (Bellyache Bush);
- *Opuntia stricta* (Prickly Pear);
- *Opuntia tomentosa* (Velvet Pear); and
- *Parthenium hysterophorus* (Parthenium).

All of the above, except *H. martini*, are also classed as Weeds of National Significance. While this classification does not introduce additional restrictions, it acts to coordinate management across states.



Legend

- Potential Common Death Adder Habitat

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Source: Vitrinite 2022, METServe 2020-2024, Earthstar Geographics

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Common_Death_Adder_Habitat.aprx

Vulcan South

Potential Habitat for the Common Death Adder

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 4-24

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

The following eight species of non-native animals were recorded within the survey area:

- Feral Cat (*Felis catus*)*;
- Red Fox (*Vulpes vulpes*)*;
- Dingo (*Canis lupus dingo*)*;
- European Rabbit (*Oryctolagus cuniculus*)*;
- House Mouse (*Mus musculus*);
- Feral Pig (*Sus scrofa*)*;
- Cane Toad (*Rhinella marina*); and
- Common Myna (*Acridotheres tristis*).

Species marked with an asterisk are category 3, 4 and 6 restricted matters under the *Biosecurity Act 2014*. The Red Fox, Dingo and European Rabbit are also category 5 restricted matters under the *Biosecurity Act 2014.* Category 3 restricted matters must not be distributed or released, category 4 restricted matters must not be moved, category 5 restricted matters must not be kept, and category 6 restricted matters must not be fed.

5 ECOLOGICAL IMPACTS OF PROPOSED ACTIVITIES

5.1 GENERAL IMPACTS

5.1.1 Clearing

The clearing of vegetation to accommodate the pits, overburden stockpiles and infrastructure is the principal ecological impact of the project. The extent of this impact has been minimised to the greatest extent practicable by:

- utilising in-pit dumping of overburden, to reduce the overall size of the project footprint; and
- the partial use of highwall mining, which produces less waste rock material and disturbs less vegetation than open-cut or other underground methods.

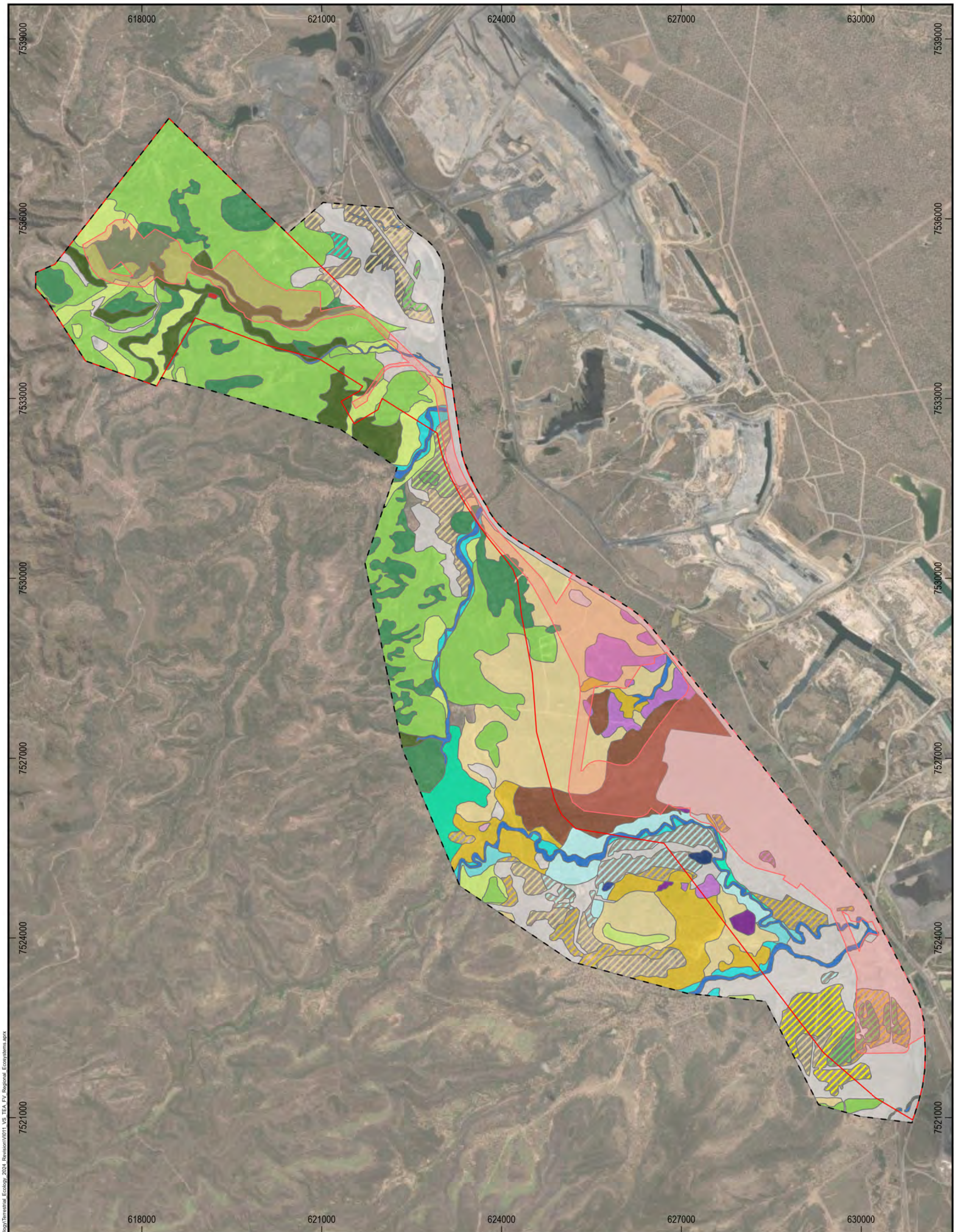
A total of 611.5 ha of remnant vegetation (category B regulated vegetation), 50.4 ha of high-value regrowth (category C regulated vegetation) and 647.7 ha of cleared pasture is contained within the clearing footprint of Vulcan South. The composition of this vegetation is listed in **Table 5-1** and shown in **Figure 5-1**.

Potentially clearing all of this vegetation constitutes the main potential loss of habitat that could result from the project. How this potential habitat loss affects matters of state and national environmental significance is assessed in **Section 5.3**.

Table 5-1 Maximum amount of vegetation to be disturbed for Vulcan South

Regional Ecosystem	Description	Maximum amount to be disturbed (includes areas above highwall not cleared) (ha)		Maximum amount to be cleared (excludes highwall footprint) (ha)	
		Field-verified	Regulated Vegetation Map	Field-verified	Regulated Vegetation Map
11.3.2	*Eucalyptus populnea* woodland on alluvial plains.	5.2	12.4	5.2	12.4
11.3.7	*Corymbia* spp. woodland on alluvial terraces.	3.8	0	3.8	0
11.3.25	*Eucalyptus camaldulensis* forest fringing drainage lines.	7.6	3.7	7.6	3.7
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* on Cainozoic clay plains.	66.9	73.4	66.9	73.4
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.	0.2	0.9	0.2	0.9
11.5.3	*Eucalyptus populnea* woodland on Cainozoic sand plains and/or remnant surfaces.	7.1	6.2	7.1	6.2
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces.	212.0	5.18	212.0	5.18
11.5.9b	*Eucalyptus crebra, E. tenuipes, Lysicarpus angustifolius +/- Corymbia* spp. woodland.	0	224.5	0	224.5
11.9.2	*Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks.	164.0	162.7	164.0	162.7
11.10.1	*Corymbia citriodora* woodland on coarse-grained sedimentary rocks.	41.4	73.7	34.1	44.2
11.10.1x1	*Corymbia aureola* and *Eucalyptus melanophloia* open forest on coarse-grained sedimentary rocks.	69.3	0	14.7	0

Regional Ecosystem	Description	Maximum amount to be disturbed (includes areas above highwall not cleared) (ha)		Maximum amount to be cleared (excludes highwall footprint) (ha)	
		Field-verified	Regulated Vegetation Map	Field-verified	Regulated Vegetation Map
11.10.3	*Acacia shirleyi* open forest on coarse-grained sedimentary rocks. Crests and scarps.	163.7	201.8	71.5	73.2
11.10.7	*Eucalyptus crebra* woodland on coarse-grained sedimentary rocks.	28.2	5.1	24.3	5.1
HVR 11.3.2	Regrowth *Eucalyptus populnea* woodland on alluvial plains.	0	2.5	0	2.5
HVR 11.3.25	Regrowth *Eucalyptus camaldulensis* forest fringing drainage lines.	0	0.9	0	0.9
HVR 11.10.3	Regrowth *Acacia shirleyi* open forest on coarse-grained sedimentary rocks. Crests and scarps.	30.1	12.0	30.1	12.0
HVR 11.10.7	Regrowth *Eucalyptus crebra* woodland on coarse-grained sedimentary rocks.	5.4	0	5.4	0
HVR 11.4.8	Regrowth *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* on Cainozoic clay plains.	4.0	0	4.0	0
HVR 11.4.9	Regrowth *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.	0	27.3	0	27.3
HVR 11.5.3	Regrowth *Eucalyptus populnea* woodland on Cainozoic sand plains and/or remnant surfaces.	45.2	11.4	45.2	11.4
HVR 11.5.9	Regrowth *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces.	3.8	0	3.8	0
HVR 11.5.9b	Regrowth *Eucalyptus crebra, E. tenuipes, Lysicarpus angustifolius +/- Corymbia* spp. woodland.	0	5.1	0	5.1
Non-remnant	Cleared pasture, +/- scattered trees or young regrowth	618.4	647.7	618.4	647.7
Total project footprint		1,476.4	1476.4	1,318.3	1318.3



Legend

Vulcan South Coal Mine (2023/09708)

- Survey Area
- Disturbance Footprint
- Project Area (ML 700073)

Field-verified RE mapping

- 11.10.1
- 11.10.1x1
- 11.10.3
- 11.10.7
- 11.10.7/11.5.9
- 11.10.8
- 11.3.1
- 11.3.2
- 11.3.2/11.3.7
- 11.3.25
- 11.3.27c
- 11.3.27e
- 11.3.7
- 11.3.7/11.3.2
- 11.4.8
- 11.4.9
- 11.5.3
- 11.5.9
- 11.5.9/11.10.13
- 11.9.2
- HVR 11.10.13
- HVR 11.10.3
- HVR 11.10.7
- HVR 11.10.7/11.10.3
- HVR 11.3.2
- HVR 11.3.25
- HVR 11.4.8
- HVR 11.5.3
- HVR 11.5.3/11.3.2
- HVR 11.5.9
- Non-remnant

Source: Vitrinite 2023, METServe 2020-2024, Maxar.

Vulcan South

Project Footprint Relative to Field-verified Regional Ecosystems

0 0.5 1 2
Kilometers
Scale: 1:60,000 (A3)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-1

VITRINITE BRIGHTER COAL
METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_FV_Regional_Ecosystems.aprx

The habitats present within the project's footprint are not unique in a local context. All vegetation to be disturbed is represented by areas of remnant vegetation within the broader survey area (see **Table 4-1** and **Figure 4-3**). However, most of REs 11.9.2 and 11.4.8 (50.4% and 52.5%, respectively) are to be removed.

Three species were recorded within the disturbance footprint but not elsewhere within the survey area:

- The Australasian Pipit (*Anthus novaeseelandiae*) was recorded in open, treeless pastures at fauna site S3 and nearby targeted search locations. These areas will be lost to accommodate the Vulcan Middle pit. Wooded habitats elsewhere within the survey area are largely unsuitable for this bird. Any impacts to the Australasian Pipit will be short term, as this species is one of the fastest colonisers of newly rehabilitated mines in Australia (Gould and Mackey 2015).
- The Yellow-faced Whipsnake (*Demansia psammophis*) was only recorded at two survey locations (S2 and S17), both of which happen to be located within the proposed disturbance footprint. This species has low detectability and is likely to be far more widespread than records indicate. Most wooded habitats within the survey area are likely to be suitable for this snake, and no long-term impacts of Vulcan South are anticipated.
- The Glossy Black-cockatoo (*Calyptorhynchus lathami*) was recorded on a single occasion within the proposed disturbance footprint. Habitat for this species is limited in extent locally and most of the habitat contained within the survey area will be removed for Vulcan South. The impact of this clearing is assessed in **Section 5.3.4.2.**

No locally unique ecological values will be disturbed by the proposed clearing of regrowth and already-cleared pastures.

5.1.2 Habitat Fragmentation

The project is located immediately south and west of existing mines (Peak Downs Mine and Vulcan Coal Mine), which already interrupts west-east movement of wildlife. There is a narrow strip of vegetation between the proposed disturbance footprint and Peak Downs Mine. Any fauna inhabiting this strip could potentially be prevented from dispersing westwards by the proposed open-cut pits. These barriers are only temporary, with the Vulcan North and Vulcan South pits only operating for three years each, and the Vulcan Main pit operating for nine years. Once mining is complete in each pit, they are to be refilled with waste rock material and rehabilitated. It is expected that most poorly dispersing terrestrial fauna (e.g., reptiles, frogs) will be able to cross these temporary barriers within 2-3 years after rehabilitation (once a cover of grass and young woody vegetation has established). Fauna dependent on closely spaced trees for dispersal (e.g., Central Greater Gliders) will be affected by the dispersal barriers for far longer (i.e., decades). However, most vegetation between Vulcan South and Peak Downs Mine (within the newly isolated strip) is young regrowth (based on regional ecosystem mapping), and Central Greater Gliders are unlikely to be present there due to an absence of hollow trees in such vegetation.

Overall, habitat fragmentation resulting from Vulcan South will have a relatively limited impact on local wildlife, on account of the limited duration of isolation and the low quality of the isolated habitat.

5.1.3 Subsidence

Highwall mining removes approximately half the target coal seam (average thickness of 1.1 m), leaving regular pillars for structural support. The panels are designed to maintain stability of the overlying strata, such that no subsidence is anticipated. In the unlikely event subsidence was to occur, this would be very limited in scale (less than 1.1 m drop), given the thin seams being removed.

The most important impact of subsidence on vegetation is through changes to surface water runoff patterns and infiltration (Vishwakarma *et al.* 2020). Cracking increases water infiltration and hydrologic associations between aquifers (Vishwakarma *et al.* 2020). However, the vegetation growing above the proposed highwall panels is on the crest of an already well-drained sandstone ridge. Furthermore, no groundwater occurs within the coal seams or in overlying strata, such that any cracking will not affect groundwater flow.

The minimum depth of the cover above the coal seam is 12 m, which is deeper than almost all tree roots (see **Section 4.1.3.1**). Furthermore, groundwater is too deep to be utilised by vegetation, and highwall mining will hence not damage tap roots accessing groundwater.

Overall, highwall mining is not expected to affect the health of vegetation growing above the panels. The inclusion of these panels within the disturbance footprint is highly conservative.

5.1.4 Removal of Dams

Two stock dams are located within the proposed disturbance footprint, and these will be removed to accommodate the Vulcan Main and Vulcan South pits. These dams provide a water source for Squatter Pigeons and other wildlife. They also provide potential habitat for water birds, frogs and frog-eating snakes. The quality of this habitat for aquatic fauna is low, as each dam's edges are heavily grazed and there is little vegetative cover present at the water's edge. Nevertheless, listed species such as Ornamental Snakes, Sharp-tailed Sandpipers, Gull-billed Terns, Latham's Snipe and Glossy Ibis may occasionally visit these habitats.

Vulcan South will not only remove some existing water sources for wildlife, but will also introduce some new ones, in the form of mine water dams and sediment ponds. As these will not be grazed while in use, they are expected to develop vegetation around their edges, providing potentially superior habitat for aquatic wildlife than the dams being removed. Furthermore, mine dams are proposed to be retained in the final landform, for use as stock dams.

While the net impact of dam removal is expected to be low, this varies between species, and is a consideration within **Section 5.3**, which assesses the residual impacts on each protected matter individually.

5.1.5 Edge Effects

Forest edges are associated with altered microclimate, invasion of weeds and disturbance to wildlife. In the southern half of the project area, edge effects should not increase, as most of it contains a patchy mosaic of remnant, regrowth, cleared areas and roads with a high total edge length. However, parts of the northern half of the project area may increase in edge effects, due to the establishment of a highwall mining haul road through it (See **Figure 2-2**), which could lead to the invasion of weeds. However, there is already an existing track within the project footprint that will be widened to accommodate haul trucks, so additional edge effects are likely to be minimal, if any. Furthermore, the infertile sandstone-derived soil in this area is relatively resistant to weed invasion, with very few weeds recorded at drill pads on this soil type.

The potential increase in weeds is discussed further in **Section 5.1.14.** Other potential edge effects (altered microclimate, disturbance to wildlife) would be short-term; the life of the highwall mining trial is 9-12 months, and the haul road is expected to redevelop vegetation cover within five years of rehabilitation commencing.

5.1.6 Direct Mortality

Nocturnal fauna that shelter during the day (when clearing is undertaken) in hollow trees and under rocks and fallen timber are susceptible to injury or death during the clearing process. Risk of direct mortality is highest for remnant vegetation to be cleared, due to the presence of hollow trees.

5.1.7 Vehicle Collisions

Vulcan South will not introduce any new major roads to the region. Vulcan South will, however, increase road traffic on existing roads, and rail traffic on existing tracks, which could slightly increase the risk of collisions with wildlife crossing roads and/or tracks. The daily commute of workers to/from accommodation in Moranbah and Dysart and the freight of construction materials will increase traffic on roads by up to 2.8% above baseline level during construction (year 1) and up to 1.2% above baseline conditions in later years (Stantec 2022).

Increases in rail traffic for coal transportation are expected to be nil during the construction phase and insignificant during the operational phase of Vulcan South. The project is located in close proximity to other, much larger, existing coal mining operations currently transporting coal by rail to export terminals on the same line. Considering these much larger operations already utilising the rail tracks, it is expected that any impacts of Vulcan South due to rail transport will be negligible. Impacts of increased traffic (road and rail) will be limited to the life of the mine (nine years). Outside this period, no increases in total traffic over baseline levels are expected.

The establishment of a highwall mining haul road within the northern half of the project footprint will introduce road traffic to habitat that is currently >1 km from a road. This could slightly increase the risk of collisions with wildlife crossing roads. Haul trucks will transport coal from the highwall mining area along this road to the CHPP for 9-12 months, 24 hours per day, at approximately four trucks per hour. Impacts of haulage along this road will be short-term, limited to the highwall mining trial (9-12 months).

5.1.8 Dust

Dust can impact nearby vegetation by blocking photosynthesis and increasing leaf temperature; both impacts can reduce drought tolerance (Farmer 1993). Dust that is severe enough to inhibit plant growth is only likely where vegetation is close to (within 100 m of) the source (roads, operational areas). The Brigalow threatened ecological community is located within 500 m of operational areas that could act as a source of dust.

Greater Gliders and Koalas both feed on new plant growth. It is possible dust could reduce food availability for these species. However, such effects would only occur close to highly disturbed areas, which these species will most likely avoid for other reasons (noise, light). Therefore, no effects from dust on these species are anticipated.

Any potential effects of dust are expected to be short-term (maximum of nine years), as any effects will cease immediately upon cessation of the adjacent operations.

5.1.9 Groundwater Drawdown and Contamination

Open-cut mining can lead to the drawdown of groundwater, potentially harming groundwater-dependent ecosystems. Some species (including the Koala and the Greater Glider) may be indirectly impacted by groundwater contamination through the negative impact it can have on vegetation communities that are important feeding and sheltering sources.

Groundwater modelling of the survey area suggests that any drawdown is highly localised and unlikely to affect groundwater-dependent ecosystems. The highwall mining panels do not intercept groundwater and this will have no impact on groundwater-dependent ecosystems. For further details, refer to **Section 5.3.2.**

Impacts to groundwater quality is considered unlikely due to the minimal groundwater inflow into the pit, poor quality of groundwater as it currently stands and strict mine groundwater monitoring and management. Impacts to groundwater are considered very unlikely due to negligible groundwater inflow into pit.

Regardless, this impact would only occur for 9 years maximum during operations, and it is unlikely groundwater would be impacted enough to affect growth of trees within the footprint. Regardless, all trees will be cleared within the footprint and therefore impacts of groundwater contamination are irrelevant. Impacts outside of the footprint is considered very unlikely and would be managed as per below.

5.1.10 Surface Water Contamination

Some species (including the Koala and the Greater Glider) may be indirectly impacted by surface water contamination through the negative impact it can have on vegetation communities that are important feeding and sheltering sources. The potential negative effect contamination may have on the growth of trees in the riparian areas within the footprint is considered the only indirect impact. However, these trees will be cleared during construction and operation and therefore any negative effects on tree growth are irrelevant. This impact will cease after a maximum of 9 years, when operations cease. No surface water contamination effects will occur offsite.

Direct impacts may occur if species drink from contaminated surface water. This is unlikely to occur outside of extremely dry conditions where other water sources are not available.

The highest risk of surface water contamination is during construction and operation, where the waste rock dumps have not been fully rehabilitated yet and mining is active (duration 9 years). During this time, it is very unlikely koalas would be present as all the trees will have been cleared and there will be no habitat for them. Therefore, they may return during the rehabilitation stage, at which the waste rock dumps will be fully rehabilitated, and mining will have ceased and therefore the risk of surface water contamination will be very low.

5.1.11 Noise and Vibration

Noise from traffic and industrial sources can have significant detrimental impacts on fauna (Shannon *et al.* 2016; Cunnington and Fahrig 2010; Barber *et al*. 2010). Vulcan South is located on a busy highway (Saraji Road), immediately west of a large mining operation. The increase in noise resulting from the project is expected to be negligible relative to existing background noise. Nevertheless, there may be localised disturbance from noise where operational areas are close to (e.g., within 200 m of) habitats for threatened fauna (e.g., Greater Gliders, Koalas).

Noise and vibration from blasting may disturb some species. Blasting disturbance may impact species in or near the disturbance footprint, resulting in behavioural changes which impact the normal routines of those species and abandon nearby habitat. The impact from Vulcan South is unlikely to be a significant addition in light of existing surrounding mining projects.

5.1.12 Artificial Lighting

The project will operate 24 hours per day, which will require flood-lighting around operational areas. Artificial lighting can impact fauna through interfering with the navigation of nocturnal species (Howell *et al.* 1954; Salmon *et al.* 1995; Poot *et al.* 2008; Longcore *et al.* 2012), interrupting natural patterns of sleep and cell repair (Ben-Shlomo and Kyriacou 2010), exposing nocturnal prey to elevated predation risks (Baker and Richardson 2006; Rotics *et al*. 2011; Davies *et al*. 2012), disturbing the timing of daily activities (Miller 2006; Kempenaers *et al*. 2010), and leading to long-term declines in insect populations (Conrad *et al*. 2006). Artificial lighting may also interfere with photosynthesis (Roman *et al*. 2000) and flower development in plants (Wang *et al*. 2003). Vulcan South is located immediately west of a large and strongly lit mining operation. Considering these background light levels, it is expected that any impacts of the project due to lighting will be small and highly localised (to within 500 m of operational areas). Impacts of lighting will be short-term, as most operational sites have a limited age (9-12 months for the highwall areas, 3 years for the Vulcan North and Vulcan South pits, and 9 years for the Vulcan Main pit).

5.1.13 Waste

Waste produced by mining operations (e.g., runoff from stockpiles) can have long-term detrimental effects on the surrounding ecology if allowed to enter waterways. All waste rock on site is chemically benign, and not expected to cause acid or metalliferous drainage. Sediment-collecting infrastructure has been incorporated into the project's design, and no downstream impacts are anticipated. Appropriate storage and disposal of food waste generated by mine workers will prevent feral animals (Black Rats, Feral Cats, Red Foxes) being attracted, which would otherwise indirectly impact threatened wildlife.

5.1.14 Weeds and Pest Animals

Land disturbance and the movement of soils, vehicles and people between areas can promote weed invasion. The risk that Vulcan South could encourage invasion by the seven restricted weeds recorded on site (see **Section 4.5**) is assessed in **Table 5-2**. Controls must be in place to manage the risks posed by Rubber Vine, Harrisia Cactus, Prickly Pear, Velvet Pear and Parthenium in order for Vulcan South to avoid being in violation of the *Biosecurity Act 2014.* While there are no legal obligations to manage non-declared weeds on site, the potential for these to spread and reduce habitat quality for threatened fauna must be considered when assessing the significance of impacts to individual matters. Non-native plants such as Buffel Grass, Indian Couch, Sabi Grass and Natal Grass are already abundant and widespread on site and have likely already reached the limits of their potential local distribution (limited by soil type and moisture availability).

The project will have negligible effects on pest animal populations. There will be a temporary cessation of current pig- and dingo-hunting in the vicinity of the project during operations. However, this is countered by the deterring effects of lights, noise and vegetation clearance associated with operations. The vast majority of the project footprint already supports high densities of Cane Toads. The removal of existing toad-breeding locations (farm dams) will be counteracted by the construction of other locations (sediment dams, water supply dams), such that Cane Toad densities are expected to remain high throughout the project area.

Table 5-2 Inherent Risk (without controls) that the project could spread restricted weeds

Species	Inherent Risk	Justification
Cryptostegia grandiflora (Rubber Vine)	Moderate	Rubber Vine was confined to creek banks within the project footprint (i.e., Middle and Boomerang Creeks). If not controlled prior to soil disturbance, seeds may be spread to new areas (e.g., soil stockpiles, tracks).
Harrisia martinii (Harrisia Cactus)	High	While not in high density, this cactus was recorded in numerous locations within the project footprint. As it can spread via stem fragments, new infestations could establish in soil stockpiles.
Hymenachne amplexicaulis (Olive Hymenachne)	Low	Olive Hymenachne is an aquatic weed recorded 1.7 km west of the project footprint. Suitable habitat for the species is present within the project footprint.
Jatropha gossypiifolia (Bellyache Bush)	Low	A small infestation (<10 plants) of this weed located 1 km east of the project was the only record of the species across the entire survey area.
Opuntia stricta (Prickly Pear)	Moderate	This cactus was only recorded once within the entire survey area, within the project footprint. If not controlled prior to soil disturbance, fragments may be spread to new areas (e.g., soil stockpiles, tracks).
Opuntia tomentosa (Velvet Pear)	High	This cactus occurred widely, in low densities, across most of the survey area, including within the project footprint. As it can spread via stem fragments, there is a risk that new infestations could establish in soil stockpiles.
Parthenium hysterophorus (Parthenium)	High	Parthenium was abundant on clay soils and alluvial areas (sites with moisture-retentive soil) within the project footprint. If not controlled prior to soil disturbance, seeds may be spread to new areas (e.g., soil stockpiles, tracks).

5.1.15 Cumulative Impacts

A Terrestrial Ecological cumulative impact assessment was undertaken to quantify impacts to terrestrial ecological values, identified in the Vulcan South Terrestrial Ecological Assessment, to comparable projects in the broader region, to estimate the expected quantum of total impacts to these values in a regional context. Most of the projects included in the PER guideline were considered in the cumulative impact assessment subject to availability of data.

This assessment is provided in **Appendix E.**

The assessment considered the impacts of projects within:

- The Brigalow Belt North bioregion as defined by the Queensland Government IBRA dataset, with particular attention to the:
  - Northern Bowen Basin sub-bioregion; and
  - The Isaac - Comet Downs sub-bioregion.

In addition, this assessment considered impacts of projects approved and/or commenced within the following time frames:

- no earlier than 01/01/2013; and
- no later than 01/01/2033.

Each project deemed relevant to the purposes of this assessment were searched for impact data within the following documents in order of preference:

- EIS Assessment Reports;
- Significant Impact Assessments (SIA); and

- Environmental Authorities (EA).

The Project will contribute to an impact on the following matters, where data are available:

Brigalow TEC equivalent REs contained within Vulcan South clearing footprint:

- RE11.4.8:
  - 0.041% of the remnant extent in Isaac – Comet Downs,
  - 2.1% of the remnant extent in the Northern Bowen Basin; and
  - 0.016% of the remnant extent in the total Brigalow Belt North; and
- RE11.4.9:
  - 0.004% of the remnant extent in Isaac – Comet Downs;
  - 0.7% of the remnant extent in the Northern Bowen Basin; and
  - 0.039% of the remnant extent in the total Brigalow Belt North.

For the known habitat clearing for major projects within the Brigalow Belt North sub bioregion (including Isaac-Comet Downs and the Northern Bowen Basin) since January 2013, Vulcan South will include a conservative maximum of:

- 7.4% of the total Koala habitat cleared by similar projects;
- 6.8% of the total Squatter Pigeon (southern) habitat cleared by similar projects; and
- 8.3% of the total Greater Glider habitat cleared by similar projects.

These impacts in respect to Vulcan South and nearby projects are likely to be additive as the quantum of impacts is unlikely to be greater than the sum of the individual impacts as these are generally widely separated. It should also be noted that the actual percentage is likely much lower given the lack of publicly available information on total clearing for project, major or otherwise. Likewise, comparison is difficult or not possible with projects that, for example, were approved and/or commenced prior to species such as the Greater Glider being listed as threatened and with recent changes to habitat definitions that subsequently change the total habitat areas.

5.1.16 Summary

The clearance of 769.7 ha of remnant vegetation and 50.4 ha of regrowth vegetation within the 1476.4 ha disturbance footprint will be the principal impact of Vulcan South on ecological matters. Direct mortality, vehicle collisions, artificial lighting and weeds are additional risks that require management.

5.2 Recommended Mitigation Measures

A list of recommended measures for reducing each of the impacts listed in **Section 5.1** is shown in **Table 5-3**.

Table 5-3 Recommended impact mitigation measures

Potential Impact	Recommended mitigation measures
Clearing	1) Vitrinite employees and contractors are to be made aware of environmental obligations and compliance requirements through a site induction program. 2) The edges of the project footprint, and the highwall mining area within it, are to be marked out to prevent unnecessary accidental clearing of the highwall mining area and neighbouring habitats. 3) Overburden is to be mostly returned to the mined pits, to limit the total disturbance footprint of the project. 4) Topsoil removed from each site in preparation for mining is to be stored and managed in accordance with a Progressive Rehabilitation and Closure Plan, to protect a favourable growing medium for vegetation post-mining. 5) Post-mine rehabilitation should aim for a post-mine land use with similar environmental values to those being lost (see the Progressive Rehabilitation and Closure Plan). 6) Clearing operations, while active are to utilise suitably qualified and experienced fauna spotter-catchers (FSCs) at a ratio of one FSC per machine involved in clearing habitat. FSCs will be the only personnel permitted to handle or relocate fauna on site.
Habitat fragmentation	1) Each of the mine pits is to be developed sequentially, so that Vulcan North pit will be rehabilitated prior to Vulcan South pit being developed. This will maintain dispersal corridors for east-west movement through the project area throughout the duration of operations.
Removal of a dam	1) Some mine dams will be retained in the final landform to replace water sources lost due to construction of the open-cut pits.
Edge effects (invasion of weeds)	1) All vehicles that will enter undisturbed parts of the site are to be washed and certified prior to arrival at the project site, to restrict the introduction of new weeds. Weed management activities are to control weeds in high traffic areas. 2) Light vehicles used for commuting between the project area and nearby towns (where they may be exposed to weeds) are to be parked in the visitor carpark. 3) Operational areas and the visitor carpark are to be inspected regularly (at least biannually) to identify new infestations of restricted weeds. These should be treated soon after detection, with follow-up treatment required until populations are eradicated.
Direct mortality	1) Clearing should occur in stages, to allow fauna the opportunity to exit the area. 2) Prior to any clearing, an ecologist or FSC is to conduct a walk-through within 48 hours of commencement of that section to identify nests and habitat trees and visibly mark them with flagging tape or bright spray paint. Marked trees are to have a maintained exit corridor to allow fauna to disperse away from the clearing footprint. Prior to felling, each marked tree is to be shaken by machinery and left overnight to allow fauna to escape. These trees and their associated exit corridors may be felled the next day. 3) Species Management Plans (SMPs) are to be anticipated and prepared by an ecologist at the earliest convenience to outline means of managing any breeding places that are likely to be encountered. These are to be submitted to DESI for approval, noting that approval may take 40 working days. 4) Injured fauna is to be taken to the nearest wildlife carer or veterinarian. 5) Any injury and/or mortality is to be communicated to DESI within 24 hours. 6) Vitrinite employees and contractors will be made aware of environmental obligations and compliance requirements through the site induction program.
Vehicle collisions	1) Buses are to transport ~80% of workers daily from accommodation to site, to reduce the total number of vehicles using the roads. 2) Trains used to transport coal are to be of the largest size safely driven on the relevant tracks, to reduce the total number of trips required. 3) Haul trucks used to transport coal from the highwall mining area to the CHPP (on site) are to be of the largest size safely driven on the relevant road, to reduce the total number of trips required. 4) On-site speed limits are to be restricted to 60 km/h on all roads through or adjacent to habitat critical to the survival of the koala during dawn and dusk and at night (Department of the Environment 2014). 5) Road signage along the highwall mining haul road is to be installed to alert drivers of koala crossings.

Potential Impact	Recommended mitigation measures
Dust	1) Mitigation measures for managing dust are described elsewhere in the Air Quality Assessment Report. No threatened plant species are located within close proximity to dust-generating operations, and any dust management measures in place for human health will be sufficient for managing risks of dust to environmental values.
Groundwater drawdown	Not applicable.
Noise and vibration	1) Mitigation measures for managing noise and vibration are described elsewhere in the Noise Assessment Report.
Artificial lighting	1) The following lighting designs should be used, where appropriate, in operational areas within 500 m of remnant vegetation: i. Artificial lighting used in operational areas is to be angled away from habitats supporting sensitive species (e.g., riparian areas supporting Koalas and Greater Gliders). ii. Floodlights with "low glare" louvres/attachments are recommended to limit lateral transmission of light. Note that newer LED-type flood lights may have glare-reduction technology built-in. iii. Any streetlights used are recommended to be of the "aeroscreen" type (flat glass lenses), to reduce sideways glare. iv. Light fittings should be positioned as close to horizontally as practicable.
Waste	1) Food wastes are to be stored in sealed containers and disposed off-site. 2) Mitigation measures for managing mine-affected water are described elsewhere in the Surface Water Assessment Report.
Weeds and pest animals	4) Putrescible waste is to be stored in animal-proof containers and removed from site. 5) All vehicles that will enter undisturbed parts of the site are to be washed and certified prior to arrival at the project site, to restrict the introduction of new weeds. Weed management activities will control weeds in high traffic areas. 6) Light vehicles used for commuting between the project area and nearby towns (where they may be exposed to weeds) are to be parked in the visitor carpark. 7) Operational areas and the visitor carpark are to be inspected regularly (at least biannually) to identify new infestations of restricted weeds. These should be treated soon after detection, with follow-up treatment required until populations are eradicated. 8) Any weeds germinating on topsoil stockpiles should be treated and eradicated to maintain a source of weed-free growing medium for use post-mining. 9) Only native species, or species with low weed risk, are to be included within seed mixes applied to rehabilitated sites.
Cumulative impacts	Not applicable.

5.3 Residual Impacts on Protected Matters

5.3.1 Regulated Vegetation

As it is a resource activity under the *Environmental Protection Act 1994,* section 107, Vulcan South represents exempt clearing work under the *Vegetation Management Act 1999*. Nevertheless, disturbance to some vegetation classed as a matter of state environmental significance may be subject to offsets. The vegetation to be disturbed for Vulcan South is listed in **Table 5-4**.

Table 5-4 Regulated vegetation to be disturbed by Vulcan South

Regulated Vegetation Category	Description	Area to be disturbed (ha)	Total area within survey area (ha)
A	**Declared area, offset area or other protected vegetation***[†]	0	0
B	**Remnant vegetation: Endangered***[†]	74.3	153.0
	Remnant vegetation: Of Concern*[†]	12.4	177.7
	Remnant vegetation: Least Concern	682.9	4,322.9
C	**High-value regrowth: Endangered***	27.3	32.3
	High-value regrowth: Of Concern*	1.7	5.3
	High-value regrowth: Least Concern	21.4	376.1
R	**Non-remnant vegetation within 50 m of a watercourse***	8.7	54.6
X	Already-cleared areas or other exempt areas not regulated by vegetation management laws	647.7	1,860.5
Total		1,476.4	6,982.4

*Vegetation categories in bold are classed as matters of state environmental significance

[†]Subset of matters of state environmental significance that are "prescribed matters" requiring offsets (Department of Environment and Science 2020)

While the above vegetation categories not shown in bold do not individually constitute matters of state environmental significance, most are classed as significant if they occur "within a defined distance from the defining banks of a relevant watercourse" or "within 100 metres of the defining bank of a wetland identified on the vegetation management wetlands map". Vegetation categories occurring within a defined distance from the defining banks of a relevant watercourse that will be disturbed for Vulcan South are listed in **Table 5-5**. No vegetation within 100 metres of the defining bank of a wetland identified on the vegetation management wetlands map will be disturbed. The wetland identified on the vegetation management wetlands map within the survey area is located well outside of the proposed footprint (1 km) and will not be impacted by Vulcan South.

Table 5-5 Area of each vegetation category contained within a defined distance of the defining banks of relevant watercourses

Regulated Vegetation Category	Description	Area to be disturbed (ha)	Total area within survey area (ha)
A*	Declared area, offset area or other protected vegetation	0	0
B*	Remnant vegetation: Endangered	0	1.9
	Remnant vegetation: Of Concern	6.6	69.1
	Remnant vegetation: Least Concern	28.5	376.3
C	High-value regrowth: Endangered	0	0
	High-value regrowth: Of Concern	0.2	0.8
	High-value regrowth: Least Concern	0	21.3
R	Non-remnant vegetation within 50 m of a watercourse	5.8	38.3
Total		**41.0**	**508.4**

*The subset of watercourse vegetation that is subject to offsets

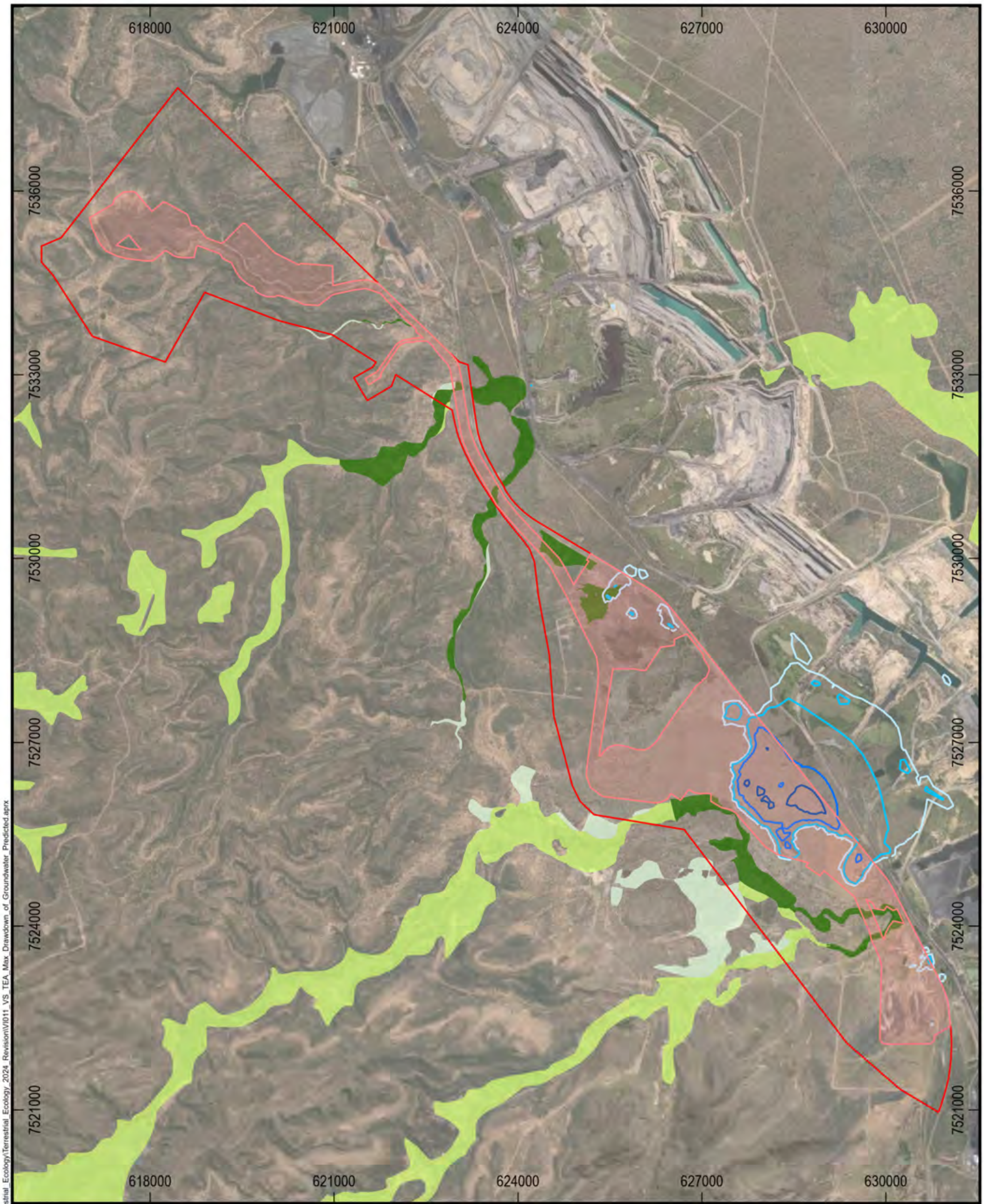
Overall, the regulated vegetation that is a matter of state environmental significance to be disturbed by Vulcan South is 86.7 ha of Endangered or Of Concern category B vegetation, 29.0 ha of Endangered or Of Concern category C vegetation, 8.7 ha of category R vegetation, and 41.0 ha of category B, C or R areas on the regulated vegetation management map that are located within a defined distance from the defining banks of a relevant watercourse.

5.3.2 Groundwater-dependent Ecosystems

Hydrogeologist.com.au (2022) has developed a numerical groundwater flow model of the survey area and broader region to predict the effects of Vulcan South on local groundwater levels. Groundwater flow into the Vulcan South and Vulcan North pits will be negligible, and these pits will be essentially dry. Groundwater flow into the Vulcan Main pit will be up to 43 m^3/day, which will cause localised drawdown in surrounding aquifers. The drawdown predicted from the groundwater flowing into the pits at Vulcan South is limited in geographic extent (up to 2,400 m to the east of the pits toward existing mining) and magnitude (up to 10 m). As the pits will be back-filled, no residual drawdown is expected following the cessation of the project. No remnant vegetation outside the project's clearing footprint is found within the zone of drawdown. Furthermore, any non-remnant vegetation within this zone is highly disturbed by existing mining operations associated with the Peak Downs Mine (**Figure 5-2**).

The groundwater quality is unlikely to be significantly altered by Vulcan South and, in any case, all local potentially groundwater-dependent ecosystems occur upgradient (in terms of the groundwater flow, which mimics the surface water drainage pattern from west to east) of potential effects.

In summary, no impacts to GDEs are predicted to result from Vulcan South, beyond that which will occur due to vegetation clearing.



Legend

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint

Groundwater Dependent Ecosystems

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Predicted Drawdown (m)

- 1m
- 2m
- 5m
- 10m

Source: Bureau of Meteorology 2012, Hydrogeologist.com.au 2020, Vitrinite 2023-2024, METServe 2023-2024, Esri, Maxar, Earthstar Geographics 28/09/2023.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\Terrestrial_Ecology\Terrestrial_Ecology_2024_Revision\VI011_VS_TEA_Max_Drawdown_of_Groundwater_Predicted.aprx

Vulcan South

Maximum Drawdown of Groundwater Predicted as a Result of Vulcan South

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

5.3.3 Matters of National Environmental Significance

An action that has, will have or is likely to have a significant impact on one or more Matters of National Environmental Significance must be referred and assessed under the EPBC Act. As discussed in detail below, significant residual impacts of Vulcan South are anticipated for one threatened ecological community (Brigalow) and three threatened species (Squatter Pigeon, Koala and Greater Glider).

According to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment 2013a), an action is likely to have a significant impact on an MNES if impacts meet certain thresholds. These are outlined for all relevant matters under the headings in this subsection:

ENDANGERED AND CRITICALLY ENDANGERED TECs

Impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- adversely affect habitat critical to the survival of an ecological community
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
- assisting invasive species, that are harmful to the listed ecological community, to become established, or
- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community that kill or inhibit the growth of species in the ecological community, or
- interfere with the recovery of an ecological community.

ENDANGERED AND CRITICALLY ENDANGERED SPECIES

An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:

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

VULNERABLE SPECIES

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

The following subsections outline the impacts to MNES within the disturbance footprint, those that are determined to be impacted are discussed further in Section 5.4 as matters requiring offsets. The Public Environment Report discusses the MNES and impacts in relation to each of the criteria above in greater detail.

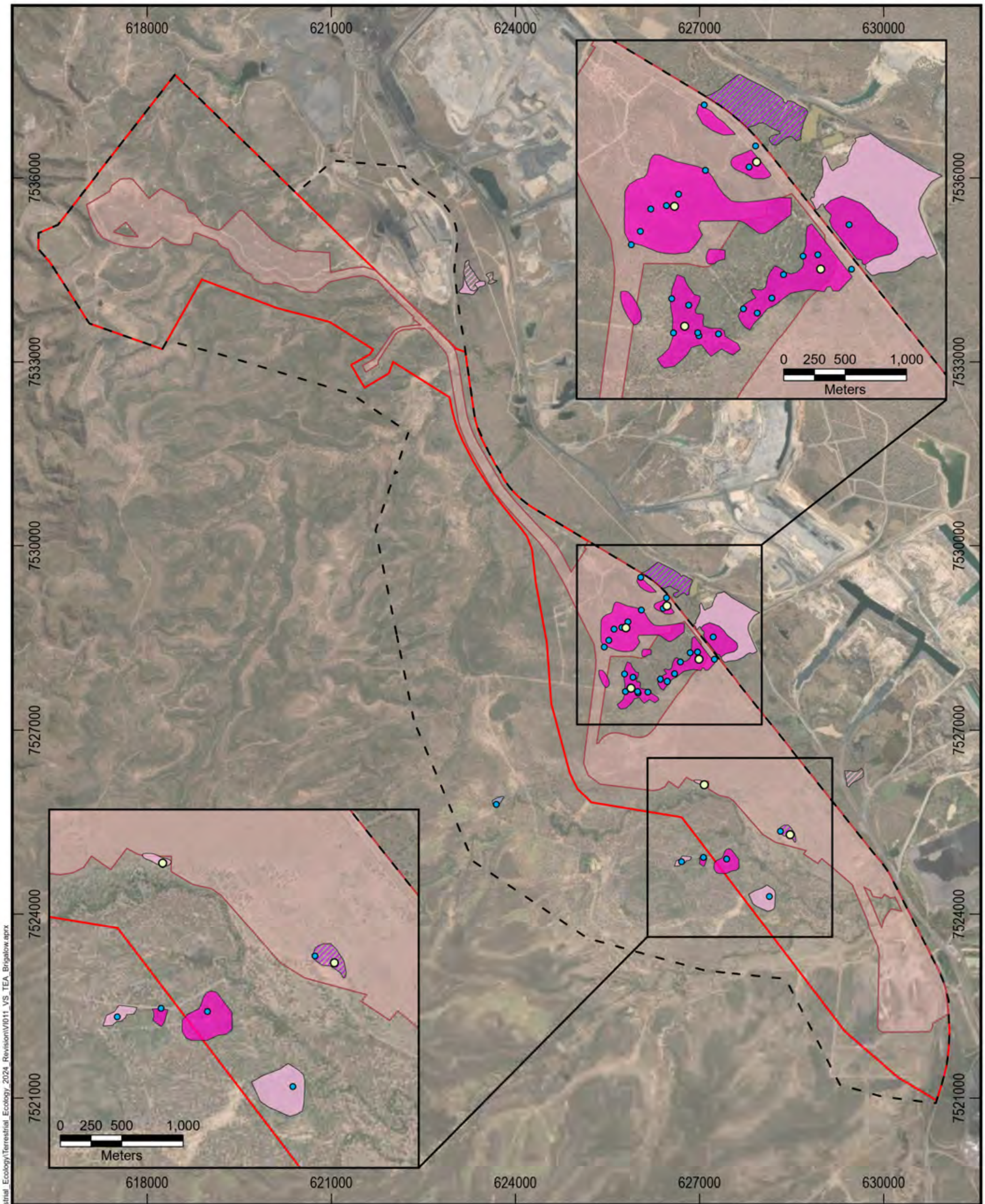
5.3.3.1 Brigalow Threatened Ecological Community

Field-verified vegetation mapping reveals that a total of 71.2 ha of the threatened ecological community listed as "Brigalow (*Acacia harpophylla* dominant and co-dominant)" is contained within the disturbance footprint (**Figure 5-3**). Of these, 67.2 ha constitute remnant vegetation, and the remainder is regrowth that meets the criteria of being older than 15 years, in accordance with the definition of the community within the approved conservation advice (Department of the Environment 2013b).

Note that this amount is less than what is indicated by the regulated vegetation map, which includes additional remnant regional ecosystems 11.4.8 and 11.4.9 (constituents of the Brigalow threatened ecological community) over the already-cleared Saraji Road and Norwich Park Branch Railway, along with a patch of regrowth 11.4.9 (which field surveys indicate does not exist) in the vicinity of the Vulcan Main pit.

An additional 47.8 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) is located within 500 m of the project's footprint boundary and may experience temporary effects of dust beyond the project's footprint.

Based on the criterion that the extent of the ecological community will be reduced by Vulcan South, the residual impacts to the Endangered Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community qualify as significant.



Legend

- Brigalow Flora Sites
- Brigalow Biocondition Sites

Vulcan South Coal Mine (2023/09708)

- Project Area (ML 700073)
- Disturbance Footprint
- Survey Area

Brigalow Threatened Ecological Community (TEC)

- 11.3.1
- 11.4.8
- 11.4.9
- HVR 11.4.8
- HVR 11.4.9

Source: Vitrinite 2024, METServe 2020-2024, Earthstar Geographics

Vulcan South

Project Footprint Relative to Brigalow

0 1 2 3
Kilometers
Scale: 1:90,000 (A4)

20/08/2024

Datum: GDA2020
Projection: MGA55

FIGURE 5-3

VITRINITE BRIGHTER COAL
METSERVE Mining & Energy Technical Services Pty Ltd

5.3.3.2 *Squatter Pigeon*

The clearing of vegetation to accommodate the Vulcan South Project will remove habitat for the Squatter Pigeon (see **Figure 4-8** in **section 4.3.3.1**):

- Breeding and Foraging: 372.5 ha
- Foraging: 78.9 ha
- Dispersal: 767.6 ha.

Outside the Project area (within a 500m indirect buffer), there are the following:

- Breeding and Foraging: 858.8 ha
- Foraging: 338.7 ha
- Dispersal: 1318.2 ha
- Non-habitat: 152.4 ha.

Furthermore, two sources of water (dams) used by Squatter Pigeons will be removed for Vulcan South. The removal of these water sources has the potential to reduce the local extent of breeding habitat beyond the boundaries of the disturbance footprint, as breeding habitat is defined by distance to water. However, the addition of new water sources (sediment dams, mine water dams, etc) have the potential to offset some or all of these impacts.

The size of the average home range of a pair of Squatter Pigeons is not known, but the related Partridge Pigeon (*Geophaps smithii*) is thought to occupy a home range of approximately 8 ha (Fraser *et al.* 2003). Assuming Squatter Pigeons are similar—a likely scenario, given their similar biology—the project could impact up to 54 breeding pairs of Squatter Pigeons. This is very likely to be an over-estimate, and occupancy rates of 50% within potential habitat are more consistent with rates of detection in the field. This implies an expected loss of habitat for up to 27 pairs of Squatter Pigeons.

An additional 170 ha of breeding habitat was or is approved to be removed for the neighbouring Vulcan Coal Mine. Assuming habitat from the Vulcan Coal Mine is not rehabilitated prior to the commencement of Vulcan South, breeding habitat for 102 pairs will be retained in the local landscape throughout the project (assuming each pair occupies 8 ha and 50% of available territories are occupied). The estimated size of this retained local population is highly conservative, as it does not include contiguous habitat west and south of the survey area. It is more likely that habitat for several hundred pairs will be retained in the local region, supporting a viable population that will serve as a source of recruitment for rehabilitated land post-mining.

The impacts of habitat clearance will persist at least for the short- to medium-term, until vegetation is re-established on mined land. Being a ground-dwelling bird, they are not dependent on old trees, and rehabilitated sites are expected to meet their requirements for a low, protective tree cover within 15 years post-rehabilitation (Ngugi and Neldner 2015). It is unknown whether the relatively simple understorey vegetation communities that typically establish on rehabilitated sites (Grigg *et al.* 2000; Ngugi and Neldner 2015) will meet the ecological needs of Squatter Pigeons. Their readiness to feed on introduced pasture species such as *Urochloa mosambicensis* and *Stylosanthes* spp. (Crome 1976; C. Wiley pers. obs. 2019) suggests that re-establishing appropriate food plants is likely to be achievable. Consequently, it is estimated that the duration of impacts will be approximately 24 years, although this estimate has low confidence, given the lack of data on the dietary requirements of the species.

As Vulcan South lies north of the Carnarvon Ranges, the local population of Squatter Pigeons does not qualify as an "important population" according to the Department of Climate Change, Energy, the Environment and Water (2022b), and hence criteria 1, 2, 3 and 5 are not relevant. The scale of habitat loss, relative to the large extent of habitat remaining in the local landscape, means that the project is not likely to jeopardise the viability of local populations (criterion 9 is not triggered).

Nevertheless, this local population is expected to temporarily decline by approximately 54 individuals, which may trigger a significant impact under the sixth criterion listed above. Also, because habitat used for foraging, breeding, roosting and dispersal (qualifies as "habitat critical to the survival of a species" under the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*) is proposed to be removed, criterion 4 is also triggered by the project.

Vulcan South may also lead to localised increases in some weeds, which qualify as invasive species potentially threatening ground-feeding Squatter Pigeons. Weed introduction could potentially occur during the construction, operation and rehabilitation phases of the project. However, these impacts are not likely to extend far beyond Vulcan South's disturbance footprint. As this impact assessment assumes all habitat within this footprint is to be removed, no additional impacts of weeds are anticipated.

Overall, Vulcan South is likely to have a significant impact on the Squatter Pigeon under the EPBC Act due to the expectation that it causes the loss of 1219.07 ha of habitat in total to the extent that the population is likely to decline, albeit to a limited extent and only temporarily.

5.3.3.3 Koala

Koala habitat in the disturbance footprint is delineated as follows (see **Figure 4-9** in **section 4.3.3.2**):

- Foraging/shelter/dispersal = 938.6 ha
- Shelter/dispersal = 45.5 ha
- Dispersal = 182.2 ha.

Total direct = 1,166.9 ha

Additional areas within 500 m indirect impact buffer include the following:

- Foraging/shelter/dispersal = 1532.0 ha
- Shelter/dispersal = 188.4 ha
- Dispersal = 390.5 ha.

Total indirect = 2,110.9 ha.

The impact of clearing will last until mature food trees have re-established in rehabilitated areas post-mining. Re-colonisation of rehabilitated sites after six years has been observed in wetter climates in south-east Queensland (Cristescu *et al.* 2013), but a more conservative estimate of 15 years is adopted here due to the drier climate and slower growth rates expected. As the final blocks of disturbed land can only commence rehabilitation at the cessation of mining activities (nine years after the commencement of the project), the duration of disturbance is estimated to be 24 years. Viable populations of Koalas are expected to be maintained in extensive neighbouring habitats (95.1% of the shelter/foraging/dispersal habitat within the survey area is being retained with low likelihood of indirect impacts, and extensive tracts of habitat occur throughout the adjacent Harrow Range) throughout this disturbance period, providing a source of recruitment to rehabilitated areas in the future. Average Koala densities in the Brigalow Belt are thought to be 0.005 Koalas/ha (Threatened Species Conservation Committee 2012). Given that the Cherwell-Harrow Range spans over 170,000 ha, the remaining Koala population within this range is expected to exceed 850 individuals.

The location of the proposed disturbance adjacent to existent mining operations, and the progressive staging of Vulcan South (at no time will all three pits be operational) means that no new barriers to dispersal are anticipated to arise as a result of Vulcan South.

Additional habitat is located within 500 m of the disturbance footprint and therefore may experience some disturbance from lighting, noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (1 to 9 years, depending on location).

Freight of construction materials and daily commute of workers will increase traffic rates on existing roads by up to 2.8% over baseline levels. This will lead to a negligible increase in risk of vehicles strikes. Due to the short duration and minor magnitude of these impacts, significant long-term impacts on local Koala populations are unlikely.

The *National Recovery Plan for the Koala* defines "area of occupancy" as the area within the extent of occurrence that is occupied by the species using 2 km × 2 km grid cells. Vulcan South will result in one grid cell that is currently occupied by Koalas becoming unoccupied, triggering criterion 2. Furthermore, Vulcan South will adversely affect habitat critical to the survival of the species (habitat used for feeding and resting), and thereby triggers criterion 4. The action therefore qualifies as a significant residual impact under the EPBC Act.

5.3.3.4 Greater Glider

Within the disturbance footprint, the following habitat areas are mapped according to DCCEEW guidelines (see **Figure 4-11** in **section 4.3.3.3**):

- 750.0 ha of likely/current denning habitat
- 234.6 ha of future denning habitat
- 19.3 ha of foraging habitat
- 52.9 ha of dispersal habitat.

This impact will last until tree hollows have been replaced in rehabilitated areas post-mining. It is expected to take 120 years post-planting for trees to be large enough to form natural hollows (Gibbons and Lindenmayer 2002; Smith & Agnew 2002). Re-colonisation of rehabilitated sites after 13 years has been recorded in central Queensland where nest boxes support glider populations in mining rehabilitation sites devoid of natural hollows (Cristescu 2011). However, nest boxes require regular maintenance and replacement (Beyer & Goldingay 2006), and it is doubtful whether such a commitment can be fulfilled over a 120 year-period, until natural hollows form. For this reason, it is conservatively predicted that the loss of hollow trees within Greater Glider habitat constitutes a near-permanent loss. However, where hollows are available nearby, Greater Gliders are expected to commence foraging within rehabilitated areas within 15 years. As the majority of the disturbance is for haul roads (see **Figure 2-2**), it is expected that most of this will be usable by Greater Gliders within 15 years after rehabilitation, as hollow trees will be retained nearby.

Viable populations of Greater Gliders are expected to be maintained in extensive neighbouring habitats (91.7 % of Greater Glider habitat is retained in the broader landscape) throughout the disturbance period, providing a source of recruitment to rehabilitated areas in the future. No data on population density is available for Central Greater Gliders within the Brigalow Belt, but the related Greater Glider occurs at average densities of 0.6 to 4 individuals per hectare (Henry 1984; Kehl and Borsboom 1984; van der Ree *et al.* 2004; Nelson *et al.* 2018), while the Northern Greater Glider occurs at a density of 3.3 to 3.8 individuals per hectare at the single site (Taravale) in which they have been studied (Comport *et al.* 1996). With a conservative assumption that densities within the survey area are on the lower end of published data (i.e., 0.6 per hectare), the 561.8 ha of habitat that will remain uncleared within the survey area supports at least 337 individuals. Furthermore, this population is likely to be connected to others throughout the Harrow Range to the west.

The location of this disturbance immediately west of existing mining operations means that no new barriers to dispersal are anticipated to arise as a result of the project. West of the project footprint, continuous tracts of riparian habitat remain connected to forests in sheltered gorges of the Harrow Range.

An additional 2209.8 ha of habitat for Greater Gliders is located within 500 m of the main operational areas (highwall mining and hauling, mine pit, waste rock dumps and offices) and therefore may experience some disturbance from lighting, noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (1 to 9 years, depending on location).

On the grounds that the project will reduce the area of occupancy and adversely affect habitat critical to the survival of a species (i.e., by removing hollow trees), Vulcan South is likely to significantly impact the Central Greater Glider.

Vulcan South may also lead to localised increases in some weeds, although no local weeds pose a threat to the health and long-term viability of large eucalypts used by Central Greater Gliders.

5.3.3.5 White-throated Needletail

Vulcan South will not introduce any aerial obstacles or hazards to the White-throated Needletail. The clearance of vegetation may result in the temporary reduction of flying insect prey, although this effect will be highly localised and have negligible impact on this fast-moving and wide-ranging bird.

The Approved Conservation Advice (Threatened Species Scientific Committee, 2019), there are few threats to the species in Australia, apart from collisions with overhead wires, lighthouses and windows on tall buildings. These threats will not be elevated by Vulcan South. Vulcan South is not expected to significantly impact the White-throated Needletail.

5.3.3.6 Ornamental Snake

The habitats present within the disturbance area are of marginal importance to Ornamental Snakes, given the limited development of gilgais, and small, patchy distribution of potential habitats. The following habitat areas have been calculated within the disturbance footprint (see **Figure 4-14** in **section 4.3.3.5**):

- Foraging only with high frog abundance: 4.34 ha
- Foraging only with moderate frog abundance: 5.06 ha
- Shelter / Breeding habitat (not suitable foraging habitat): 88.9 ha.

It should be noted that the field-verified foraging habitat for this species is separated from the shelter/breeding habitat in all instances by at least 1 km. This is too great a distance for the species to commute for the purposes of feeding, therefore the habitat present is unlikely to meet the requirements to sustain viable populations.

Vulcan South may also increase the isolation of the small, potential habitat patches between the two branches of Hughes Creek (by creating a barrier to dispersal to/from potential habitat to the east of the project), which could reduce the viability of these potential habitat patches for Ornamental Snakes. However, it is more likely that these small, isolated habitat patches are already unoccupied by Ornamental Snakes, as none were recorded there during survey, despite optimal conditions for detection. Furthermore, the closest records of Ornamental Snakes are on the eastern side of the Peak Downs Mine and Saraji Mine. Therefore, those mines already act as a western barrier to this potential habitat, rendering patches within the vicinity of Vulcan South inaccessible. West of the survey area, the Harrow Range acts as natural barrier. Therefore, no impacts on Ornamental Snakes through habitat fragmentation are anticipated.

Overall, the impacts of Vulcan South on the Ornamental Snake are difficult to predict as a result of uncertainty over which, if any, of the small patches of potential local habitat are occupied by the species. It is likely that Vulcan South will have a negligible impact on local populations, given the marginal importance of local habitats for the species. However, in a worst-case scenario, up to 98.3 ha of potential habitat may be lost to Ornamental Snakes. Any impacts could be permanent, given the practical difficulties of recreating gilgai mounds and depressions on a rehabilitated mined surface. In accordance with the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*, "important habitat" for the Ornamental Snake is to be used as a surrogate for an "important population" when assessing the significance of potential impacts. Important habitat for Brigalow Belt reptiles is defined as:

- habitat where the species has been identified during a survey
- near the limit of the species' known range;
- large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations); or
- a habitat type where the species is identified during a survey, but which was previously thought not to support the species.

No Ornamental Snakes were recorded on site during surveys, despite appropriate search effort during optimal seasonal conditions. The survey area is also not located near the limit of the known range of the Ornamental Snake. Suitable habitat for the species (i.e., gilgais) was very limited in extent, low in quality (gilgais were shallow and held water for short periods only) and very patchily distributed. The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* offer the following comment in specific reference to defining important habitat for the Ornamental Snake: "habitat connectivity between gilgais and other suitable habitats is important". In light of the poor connectivity and low quality of local habitats on site, in addition to the failure to detect the species on site, impacts to the Ornamental Snake are unlikely to qualify as significant under the EPBC Act.

5.3.3.7 Yakka Skink

Habitat in the disturbance footprint is as follows (see **Figure 4-15** in **section 4.3.3.6**):

- High density of coarse woody debris (>490 m/ha) = 66.94 ha.
- Medium density of coarse woody debris (245-490 m/ha) = 769.90 ha.
- Low density of coarse woody debris (<245 m/ha) = 639.60 ha

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* defines important habitat for the Yakka Skink as "any contiguous patch of suitable habitat, particularly remnant vegetation, where a colony is known or identified…[or] any microhabitat where colonies are likely to be found". The disturbance area does not contain habitat connected to known populations of the Yakka Skink. Furthermore, as no colonies have ever been recorded in the northern Bowen Basin, despite extensive ecological surveys undertaken across Dysart-Moranbah-Collinsville as part of various mining projects, colonies are not "likely to be found" in the vicinity of Vulcan South. Consequently, no "important habitat" is located within the disturbance area, and no significant residual impacts to the Yakka Skink are anticipated.

5.3.3.8 Northern Quoll

Important habitat for the Northern Quoll is located in "rocky habitats, treed creek lines and structurally diverse forest with large trees, termite mounds and hollow logs" (Department of the Environment 2016), which is locally restricted to the Harrow Range and major watercourses (see **Figure 4-16** in **Section 4.3.3.7**). Some of this habitat (up to 319.41 ha in the disturbance footprint) will be removed for Vulcan South. No Northern Quolls were recorded there.

Overall, the impacts of Vulcan South on the Northern Quoll are difficult to predict as a result of uncertainty as to whether any of the potential habitat for Northern Quolls is occupied by the species. Extensive survey efforts, in optimal conditions, failed to detect one within the survey area. There are also no records of the species west of the Clarke Range or Redcliffe Plateau in the past 40 years. It is therefore most likely that the Northern Quoll is absent from the vicinity of Vulcan South, and the project will not affect the species.

However, in the unlikely event that the species does occur on site, Vulcan South may have a significant residual impact on the Northern Quoll under the EPBC Act. The location of the highwall mining trial, in particular, contains sandstone outcrops and gorges that potentially harbour den sites for the species. These actions could therefore adversely affect habitat critical to the survival of the Northern Quoll.

An additional 996.35 ha of potential habitat for Northern Quolls is located within 500 m of the disturbance footprint and therefore may experience some disturbance from lighting, noise and dust. This disturbance is short-term, lasting only for the duration of the adjacent operations (9 months to 9 years, depending on location; but the vast majority is 9-12 months). The short-term and minor impacts of lighting, noise and dust on the Northern Quoll near Vulcan South do not qualify as an additional significant impact. Vulcan South is also unlikely to lead to an increase in populations of Feral Cats or Cane Toads, invasive species that threaten Northern Quolls.

Overall, it is considered unlikely that Vulcan South will affect the Northern Quoll, but the action should be referred to the Department of Climate Change, Energy, the Environment and Water for a formal assessment in order to decide on whether the anticipated impacts to the Northern Quoll qualify as significant.

5.3.3.9 Australian Painted-snipe

One of the dams to be removed to accommodate the Vulcan South pit contains potential habitat for the Australian Painted-snipe (see **Figure 4-18** in **section 4.3.3.24**). This farm dam has an area of 2.2 ha and a shoreline approximately 1.4 km in length. Most of the dam's edges were grazed and lacked aquatic vegetation, although sedges and reeds occupied approximately one-third of the shoreline. Furthermore, the chain of ponds that feeds into this dam has waterside vegetation suitable for Australian Painted-snipe. Whilst none were detected during extensive surveys in optimal conditions, it is possible they could be transient visitors there.

The other dam to be removed lacks any aquatic vegetation on its edges and is therefore highly unlikely to be used by the species.

Within 800 m to the southeast of the dam to be removed are several existing, much larger, water storage dams with densely, vegetated margins on the adjacent Saraji Mine lease. These dams could potentially act as alternative potential habitat for snipe during operations (9 years). It is anticipated these water storage dams at neighbouring mines will be retained for the life of Vulcan South.

The farm dam and chain of ponds to be removed form part of a drainage line that is proposed to be diverted during operations around the northern end of the South pit into Hughes Creek. The drainage line/chain of ponds will be reinstated postmining by constructing a vegetated drainage corridor through backfilled spoil.

The loss of the farm dam will be permanent, but eventually counteracted by the retention of mine dams constructed for Vulcan South into the final landform as new farm dams. Due to rapidly fluctuating water levels during operations, it is unlikely that mine dams will provide favourable conditions for the establishment of aquatic marginal vegetation (and therefore the Australian Painted-snipe). However, once these have transitioned to farm dams in the final landform, sedges and rushes are expected to establish around the more stable margins.

Overall, the low-quality habitat that will be lost due to Vulcan South is expected to have a negligible impact on the Australian Painted-snipe. The action is unlikely to trigger any of the significant impacts on an endangered species defined by the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*.

5.3.3.10 Red Goshawk

Red Goshawks are probably extinct in the local region. Potential habitat for the species that occurs on site is of poor quality; escarpments and nearby waterways mostly lack surface water, and the surrounding landscape is already highly modified through mining and clearing for grazing. The Red Goshawk rarely breeds in areas with fragmented native vegetation (Threatened Species Scientific Committee 2015b), and never more than 1 km from water. Consequently, the importance of the region to the species is considered to be low. The loss of any possible local habitat for the species (699.9 ha of remnant and regrowth, as defined on the field-verified vegetation map) is, therefore, considered inconsequential for its long-term conservation. Vulcan South does not trigger any of the significant impacts on vulnerable species defined by the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*.

5.3.3.11 Annual Wiregrass

Only low-quality habitat for Annual Wiregrass is present within the vicinity of Vulcan South; favoured basalt-derived soil is absent, and all the clay soils present support degraded exotic, not native, pasture. Nevertheless, there are 364.18 ha of potential habitat within the disturbance footprint for this species

Given that the site lies outside the known distribution of the Annual Wiregrass, and the habitat present is of poor quality, the proposed habitat clearance will likely have a negligible impact on the species. Vulcan South does not trigger any of the significant impacts on vulnerable species defined by the *Matters of National Environmental Significance Significant Impact Guidelines 1.1*.

5.3.3.12 Ghost Bat

Vulcan South will not disturb any roosts for Ghost Bats or remove foraging habitat within 1-10 km of known roost sites. It is unlikely that the project footprint contains important habitat for the species, and no residual impacts on Ghost Bats are anticipated.

5.3.3.13 Dunmall's Snake

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* defines important habitat for the Dunmall's Snake as any forest or woodland "within the 'Known/Likely to occur' modelled distribution of the species…and any habitat corridors in between" (Department of Sustainability, Environment, Water, Population and Communities 2011). As the disturbance area lies outside the known/likely distribution of the Dunmall's Snake, as modelled in the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*, no significant impacts to the species are anticipated.

5.3.3.14 Allan's Lerista

The *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability, Environment, Water, Population and Communities 2011) defines important habitat for the species as being "vegetation occurring on mid to dark-brown-coloured, non-cracking clay soils in Queensland regional ecosystems 11.8.5 and 11.8.11/11.8.5 and grassy open-woodland mapped as cleared but where the above regional ecosystems formerly occurred". The disturbance area does not contain important habitat for the species, and no significant residual impacts of Vulcan South are anticipated.

5.3.3.15 King Bluegrass

Potential habitat for King Bluegrass in the vicinity of Vulcan South is highly degraded by grazing and unlikely to support the species. Nevertheless, 378.83 ha of this low-quality habitat is to be removed to accommodate the Vulcan Main pit, mine infrastructure area and rail loop. In total, 164.0 ha of this is regional ecosystem 11.9.2 and the remainder is cleared pasture formerly supporting 11.9.2 and/or 11.4.9. Given the low likelihood that this species occurs onsite, the proposed habitat clearance will likely have a negligible impact on the species.

5.3.3.16 Hairy Bluegrass

Potential habitat for King Bluegrass in the vicinity of Vulcan South is highly degraded by grazing and unlikely to support the species. 378.83 ha of this low-quality habitat is to be removed to accommodate the Vulcan Main pit, mine infrastructure area and rail loop. The survey area lies just outside the Department of Climate Change, Energy, the Environment and Water's (2022k) modelled "may occur" range of the species. The lack of local records and the heavily degraded nature of the available habitat suggest that the survey area is not important for the Hairy Bluegrass. No significant impacts on the species are anticipated.

5.3.3.17 Common Greenshank

It is unlikely that the species is present at all within the Project area as suitable habitat was not found during site surveys. No significant impacts on the species are anticipated.

5.3.3.18 Diamond Firetail

Due to the distance from mapped likely habitat within the conservation advice, the species is unlikely to be present. Further, the closest record is unverified and approximately 120 km from the Project. No significant impacts are anticipated.

5.3.3.19 Grey Snake

REs consistent with habitat known for the species are present in the Project area, however it is outside its known distribution. Significant impacts are not anticipated.

5.3.3.20 Southern Snapping Turtle

Permanent water in riverine systems is required, however such suitable habitat was not identified during field surveys; the waterways in the Project area are unsuitable as they are ephemeral. Significant impacts are not anticipated.

5.3.3.21 Fitzroy River Turtle

Due to the absence of suitable habitat and lack of nearby records, this species is unlikely to be present, and no significant impacts are anticipated.

5.3.3.22 Painted Honeyeater

This species depends on an abundance of mistletoe. Suitable regional ecosystems were present within the survey area, and trees likely to be host to suitable mistletoes are present in the survey area. However, mistletoe was scarce based on field surveys. Significant impacts are not anticipated.

5.3.3.23 Star Finch (eastern)

The impact area is likely to contain habitat that would have been suitable for the Star Finch (eastern), however this subspecies is likely extinct from the Bowen Basin. Habitat is well outside the subspecies' known range. No significant impacts are anticipated.

5.3.3.24 Southern Black-throated Finch

Habitat present may be marginally suitable in the area with water sources and a variety of grasses present, though it is degraded in quality to the point that this species may not persist. The lack of all of the components needed to ensure this subspecies could support a viable population strongly suggests that none of the Project area is considered habitat for this species. No significant impacts are anticipated.

5.3.3.25 Corben's Long-eared Bat/South-eastern Long-eared Bat

Habitats are well outside this species' range. Habitat may be broadly suitable; however, the Project area is determined to be well north of the known distribution of the species. No significant impacts are anticipated.

5.3.3.26 Grey-headed Flying Fox

The impact area is unlikely to be of high enough quality to attract this species. Roosting camps are not known from the area, no camps were found in the National Flying-Fox monitoring viewed that were within 100 km. Habitat is marginal at best in the Project area; the species is unlikely in the area as anything more than an unlikely vagrant species as richer habitats closer to the coast are available. No significant impacts are anticipated.

5.3.3.27 Murray Cod

The Project is outside the native range of this species, which is the Murray Darling basin. Suitable waterways are not found within the Project area. No significant impacts are anticipated.

5.3.3.28 Black Ironbox

This species was not recorded in the survey area, and no significant impacts are anticipated.

5.3.3.29 Polianthion minutiflorum

While possible, it is unlikely that this species is present in the survey area. No significant impacts are anticipated.

5.3.3.30 Quassia

This species is unlikely to be present due to the lack of suitable habitat and lack of nearby records. No individuals were sighted during flora surveys, and no significant impacts are anticipated.

5.3.3.31 Marlborough Blue Cycad

Due to the lack of nearby records and the lack of habitat present within the project area, no significant impacts are anticipated.

5.3.3.32 Ooline

Due to the lack of nearby records and the lack of habitat present within the project area, no significant impacts are anticipated.

5.3.3.33 Migratory Species

The Rufous Fantail and White-throated Needletail are migratory species that utilise habitats in the vicinity of the project. The latter is also a vulnerable species (see **Section 5.3.3.5**). The Fork-tailed Swift, Latham's Snipe, Oriental Cuckoo, Black-faced Monarch, Satin Flycatcher, Sharp-tailed Sandpiper, Gull-billed Tern and Glossy Ibis are additional migratory species that possibly utilise habitats in the vicinity of Vulcan South. An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The definitions of "important habitat" for each of these species are defined by the *Referral Guideline for 14 birds Listed as Migratory* (Department of the Environment 2015a), the *Industry Guidelines for Avoiding, Assessing and Mitigating Impacts on EPBC Act listed Migratory Shorebird Species* (Department of Agriculture, Water and the Environment 2017) and the *Revision of the East Asian-Australasian Flyway Population Estimates for 37 Listed Migratory Shorebird Species* (Hansen *et al.* 2017). These are summarised in **Table 5-6**.

Table 5-6 Definitions of "important habitat" and "ecologically significant proportion of the population" for migratory species potentially utilising the Vulcan South area

Species	Important habitat	Invasive species that could be harmful	Ecologically significant proportion of the population	Area of important habitat likely to result in a significant impact if affected
Rufous Fantail	Moist, dense habitats, including mangroves, rainforest, riparian forests and thickets, and wet eucalypt forests with a dense understorey. When on passage a wider range of habitats are used including dry eucalypt forests and woodlands and Brigalow shrublands.	Black Rat *Rattus rattus*, invasive vines of riparian habitat (e.g. rubber vine *Cryptostegia grandiflora*).	1,100 individuals	Habitats within the Project area are not critical to the population and do not meet the definitions of "important habitat" for migratory species due to being outside the normal flyway and the total area to be disturbed not being likely to affect 1,100 individuals.
Fork-tailed Swift	Found across a range of habitats, from inland open plains to wooded areas, where it is exclusively aerial.	Unknown	100 individuals	Impacts only considered possible when wind turbines, tall buildings, airports, or other developments interrupt airspace.
Oriental Cuckoo	Monsoonal rainforest, vine thickets, wet sclerophyll forest or open *Casuarina*, *Acacia* or *Eucalyptus* woodlands. Frequently at edges or ecotones between habitat types. Riparian forest is favoured habitat in the Kimberley region.	Unknown	1,000 individuals	25,000 ha
Black-faced Monarch	Wet forest specialist, found mainly in rainforest and wet sclerophyll forest, especially in sheltered gullies and slopes with a dense understorey of ferns and/or shrubs.	Black Rat *Rattus rattus*, invasive vines of riparian habitat (e.g. rubber vine *Cryptostegia grandiflora*).	460 individuals	The Project area does not include important habitat due to the Project's location west of this species' primary migration route.
Satin Flycatcher	Eucalypt forest and woodlands, at high elevations when breeding. They are particularly common in tall wet sclerophyll forest, often in gullies or along water courses. In woodlands they prefer open, grassy woodland types. During migration, habitat preferences expand, with the species recorded in most wooded habitats except rainforests. Wintering birds in northern Qld will use rainforest/gallery forests interfaces, and birds have been recorded wintering in mangroves and paperbark swamps.	Black Rat *Rattus rattus*, invasive vines of riparian habitat (e.g. rubber vine *Cryptostegia grandiflora*).	1,700 individuals	The Project area has 474.09 ha (likely overestimated) of potential habitat, but this is unlikely to qualify as "important habitat" as it is out of the normal range of this species during migration.

Species	Important habitat	Invasive species that could be harmful	Ecologically significant proportion of the population	Area of important habitat likely to result in a significant impact if affected
Sharp-tailed Sandpiper	Nationally important habitat for migratory shorebirds is defined as supporting: • 0.1 per cent of the flyway population of a single species of migratory shorebird OR • 2000 migratory shorebirds OR • 15 migratory shorebird species.	Unknown	85 individuals	None of the habitat present within the survey area is considered important for this species.
Gull-billed Tern	Not prescribed			
Glossy Ibis	Not prescribed			

Vulcan South will not disrupt an ecologically significant proportion of any migratory species. The project is also not anticipated to cause the establishment of harmful invasive species. Within the project's footprint, important habitat (as defined by Department of the Environment 2015) exists for the Rufous Fantail, Oriental Cuckoo and Satin Flycatcher. However, the habitats present on site are marginal (more inland, drier and open than is generally preferred) for all three species. It is expected that only one or two Oriental Cuckoos and Satin Flycatchers, and up to 10 Rufous Fantails, pass through the survey area each year. A total of 474.09 ha of potential habitat for transient Rufous Fantails is contained within the disturbance footprint. This area also constitutes potential habitat for transient Satin Flycatchers and Oriental Cuckoos. It is highly unlikely that the marginal habitats to be disturbed are a limiting factor constraining the migration of any of the migratory bird species listed in **Table 5-6**. For this reason, it is considered unlikely that Vulcan South will result in a significant impact on any migratory species protected under the EPBC Act and identified as potentially occurring, or identified as confirmed, in the Project area

Several migratory species are highly unlikely to experience any significant impacts due to a lack of likely presence or habitat. The Marsh Sandpiper, Common Sandpiper, Curlew Sandpiper, Pectoral Sandpiper, Osprey and Yellow Wagtail are unlikely to occur within the Project area. There is no habitat in the Project area for the Marsh Sandpiper, Common Sandpiper, Curlew Sandpiper, the Pectoral Sandpiper, and the Yellow Wagtail. The Project area is within the mapped "Vagrant Range" of the Osprey and is not located within the "Core Range" where suitable habitats are usually found.

5.3.4 Species of State Environmental Significance

Most species of State environmental significance are also matters of national significance, and potential impacts to these matters were assessed in **Section 5.3.3.** Nevertheless, the Queensland Government applies different definitions of "significant impacts" under the NC Act to the definitions under the EPBC Act. As the criteria differ for threatened wildlife and special least concern wildlife, these are assessed separately in **Table 5-7** and **Table 5-8**, respectively.

Table 5-7 Assessment of significance of impacts to threatened species of state significance

Threatened Species	Will there be a long-term decrease in the size of a local population?	Will the extent of occurrence of the species be reduced?	Will an existing population be fragmented?	Will it cause genetically distinct populations to form through isolation?	Will it result in harmful invasive species?	Will it introduce disease?	Will it interfere with the recovery of the species?	Will it cause disruption to ecologically significant locations?*
Koala	No	Minor	No	No	No	No	No	Yes
Greater Glider	No	Minor	No	No	No	No	No	Yes
Squatter Pigeon	No	Minor	No	No	No	No	No	Yes
Glossy Black-cockatoo	No	No	No	No	No	No	No	Possibly Minor
White-throated Needletail	No	No	No	No	No	No	No	No
Ornamental Snake	No	Probably No	No	No	No	No	No	Probably No
Australian Painted-snipe	No	No	No	No	No	No	No	No
Common Death Adder	No	Possibly Minor	No	No	No	No	No	Possibly Minor
Red Goshawk	No	No	No	No	No	No	No	No
Yakka Skink	No	No	No	No	No	No	No	No
Annual Wiregrass	No	No	No	No	No	No	No	No
Ghost Bat	No	No	No	No	No	No	No	No
Dunmall's Snake	No	No	No	No	No	No	No	No
Allan's Lerista	No	No	No	No	No	No	No	No
King Blue-grass	No	No	No	No	No	No	No	No

*Ecologically significant locations are defined as breeding, feeding, nesting, migration or resting sites.

Table 5-8 Assessment of significance of impacts to Special Least Concern species of state significance

Special Least Concern Species	Will there be a long-term decrease in the size of a local population?	Will the extent of occurrence of the species be reduced?	Will an existing population be fragmented?	Will gene flow among populations be reduced?	Will ecologically significant locations be disrupted?* (net disruption)
Short-beaked Echidna	No	No	No	No	Minor
Fork-tailed Swift	No	No	No	No	No
Latham's Snipe	No	No	No	No	No
Rufous Fantail	No	No	No	No	No
Sharp-tailed Sandpiper	No	No	No	No	No
Oriental Cuckoo	No	No	No	No	No
Gull-billed Tern	No	No	No	No	No
Black-faced Monarch	No	No	No	No	No
Satin Flycatcher	No	No	No	No	No
Glossy Ibis	No	No	No	No	No

*Ecologically significant locations are defined as breeding, feeding or nesting sites.

The State government can only impose an offset condition in relation to a prescribed activity, if the same, or substantially the same impact and the same, or substantially the same matter has not been subject to assessment under the EPBC Act. As Vulcan South is likely to impact several matters of national environmental significance, it will be referred and assessed under the EPBC Act. Consequently, only two matters of state significance (Common Death Adder and Short-beaked Echidna) will not be assessed under the EPBC Act, and these are therefore discussed in further detail below.

5.3.4.1 Short-beaked Echidna

Short-beaked Echidnas occupy home ranges of 50-100 ha (Nichol *et al*. 2011), and the removal of 1,318.3 ha of potential habitat (19.5% of that within the survey area outside the approved footprint of the Vulcan Coal Mine) therefore amounts to a loss of 13–26 territories. Given the extensive and continuous matrix of potential habitat to the west and south of the project footprint, these prescribed actions will have a negligible effect on local populations. As the habitat being removed could be used for feeding and breeding, it qualifies as an ecologically significant location according to the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (Department of Environment and Heritage Protection 2014). Nevertheless, there are no habitat features of the project footprint that make it locally significant, and extensive tracts of similar habitat will be retained to the west. This retained habitat is of a higher quality than most of the habitat being removed, because much of it is remnant vegetation and thus contains an abundance of fallen timber, important for denning and providing termites. Sandstone areas to the west also contain an abundance of boulders, which provide den sites.

The main prey of Short-beaked Echidnas (ants and termites) recolonise rehabilitated mine sites almost immediately (i.e., at the time of soil profile reconstruction: Andersen *et al.* 2003; Spain *et al.* 2010).

Likewise, Short-beaked Echidnas recolonise rehabilitated mine sites relatively quickly (8 years: Nichols and Grant 2007; 6-10 years: unpublished data from Gove, Northern Territory). Consequently, any impacts of Vulcan South on the Short-beaked Echidna will be short-term only.

5.3.4.2 Glossy Black-cockatoo

A total of 38.1 ha of foraging habitat for the Glossy Black-cockatoo will be removed to accommodate the North Pit and associated infrastructure (see **Figure 4-23** in **section 4.4.7.1**). This habitat is currently used in a transient capacity by dispersing individuals.

The importance of this habitat to dispersing Glossy Black-cockatoos is probably low. Numerous small patches of *Casuarina cristata* (the local food tree) are scattered widely across the clay plains east of Peak Downs Mine, such that the small patches contained within the disturbance footprint are not the sole source of food in the local landscape. This suggests that Vulcan South is unlikely to lead to a reduction in population size or fragmentation/isolation of populations (by preventing dispersal through the region). Nevertheless, as individuals are known to feed within the disturbance footprint, at least occasionally, this habitat qualifies as an "ecologically significant location" (on the grounds it is used for feeding) according to the *Queensland Environmental Offsets Policy Significant Residual Impact Guidelines.*

5.3.4.3 Common Death Adder

While no Common Death Adders were detected in the survey area, possible habitat for the species occurs on site (see **Figure 4-24** in **section 4.4.7.3**). Habitat of the highest quality (remnant vegetation with sandstone boulders in elevated areas where Cane Toads are least abundant) occurs throughout the Harrow Range, and up to 274.4 ha of this habitat will be disturbed to accommodate a haul road and associated highwall mining benches and panels within the northern half of Vulcan South.

Potential high-quality habitat for the Common Death Adder is widespread within the survey area (88 % will not be disturbed by Vulcan South) and throughout the rest of the Harrow Range.

Common Death Adders are not confined to sandstone ranges and could potentially utilise any vegetated habitats (remnant and regrowth) on site. 583.6 ha of these more marginal habitats (lowland areas with an abundance of Cane Toads and few rocks) will also be removed for the proposed mine and associated infrastructure.

The vast majority of the project footprint already supports high densities of Cane Toads, a major threat to Common Death Adders. The removal of existing toad-breeding locations (farm dams) will be counteracted by the construction of other locations nearby (sediment dams, water supply dams), such that Cane Toad densities are expected to remain high throughout the project area. Therefore, the net indirect impact on Common Death Adders via Cane Toad populations is likely to be near neutral.

Overall, the low quality of most habitat, the small scale of disturbance to potentially important habitat corridors (along the Harrow Range), and the fact that no Common Death Adders were detected despite extensive survey effort in optimal conditions, means that Vulcan South will likely have a minor effect on local populations.

5.4 OFFSET REQUIREMENTS

Offsets are required if the residual impacts to prescribed matters, after avoidance and mitigation measures have been implemented, are considered significant in accordance with the relevant guidelines.

5.4.1 National

Based on the assessment contained in **Section 5.3.3**, the following impacts of Vulcan South on matters of national environmental significance are likely to qualify as significant impacts:

- Removal of 71.2 ha of the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community;
- Removal of the following habitats for the Koala:
    - 938.6 ha of foraging/shelter/dispersal
    - 45.5 ha of shelter/dispersal
    - 182.2 ha of dispersal only.
- Removal of the following habitats for the Greater Glider:
    - 750.0 ha of likely/current denning
    - 234.6 ha of future denning
    - 19.3 ha of foraging
    - 52.9 ha of dispersal.
- Removal of the following habitats for the Squatter Pigeon:
    - 372.5 ha of breeding and foraging
    - 78.9 ha of foraging
    - 767.6 ha of dispersal.

There are no significant impacts anticipated for the White-Throated Needletail, Rufous Fantail, and the Fork-tailed Swift.

Vulcan South may possibly affect the Ornamental Snake and Northern Quoll, although neither species was recorded on site, and the habitat present is suboptimal for both species.

An offset proposal has been prepared for all matters likely to experience a significant residual impact.

5.4.2 State

Significant residual impacts to matters of state significance may require offsetting under the *Environmental Offsets Act 2014.* In Queensland, the significance of residual impacts to prescribed matters is defined by the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (Department of Environment and Heritage Protection 2014), which is administered under the *Environmental Offsets Act 2014*.

As the matters of state environmental significance that are most likely to experience significant impacts are also matters of national environmental significance (to be assessed under the EPBC Act), duplicate offsets are not required. In accordance with the *Queensland Environmental Offsets Policy 2017*, the Queensland Government can only impose an offset condition in relation to a prescribed activity, if the same, or substantially the same, impact and the same, or substantially the same, matter has not been subject to assessment as a controlled action under the EPBC Act. However, an activity referred to the Commonwealth Government that receives a 'not a controlled action' or a 'not controlled action - particular manner' notice, could still be subject to an offset condition imposed by the Queensland Government. Given that it is likely that Vulcan South will be considered a controlled action, only state matters that are not protected under the EPBC Act may require offsetting under the *Environmental Offsets Act 2014.*

The following vegetation will require offsets under the *Environmental Offsets Act 2014*:

- 12.4 ha of Of Concern regional ecosystem 11.3.2; and
- 28.5 ha of regional ecosystems 11.3.25, 11.5.9, 11.5.9b, 11.10.1, 11.10.3 and 11.10.7 located within a defined distance from the defining banks of a relevant watercourse.

Note that the endangered regional ecosystems 11.4.8 and 11.4.9 do not require separate offsets under the *Environmental Offsets Act 2014,* as they are components of the Brigalow threatened ecological community that will likely require offsetting under the EPBC Act. Likewise, areas mapped as essential habitat under the *Vegetation Management Act 1999* do not require separate offsets, as these areas are contained within the habitat to be offset for threatened species listed under the EPBC Act. Despite being matters of state environmental significance, Category R vegetation and Category C vegetation are not prescribed matters (defined in Schedule 2 of the *Environmental Offsets Regulation 2014*) and do not require offsetting.

In addition to the above vegetation, impacts to low-quality habitat for the Glossy Black-cockatoo (vulnerable), Short-beaked Echidna (special least concern) and Common Death Adder (vulnerable) possibly qualify as significant, due to the disturbance of potential feeding and/or breeding sites, which qualify as "ecologically significant locations". Nevertheless, not all significant impacts require offsets under the Queensland Environmental Offset Framework; according to the *Queensland Environmental Offsets Policy Significant Residual Impact Guideline* (Department of Environment and Heritage Protection 2014), if residual impacts are significant an offset *may* be required. In light of the small scale of the proposed impacts, the possible absence of Common Death Adders from the site, and the negligible effects Vulcan South is likely to have on local populations of these three species, offsets may not be deemed necessary. This decision ultimately lies with the Department of Environment and Science, who will assess this via the Environmental Authority application process.

As environmental offsets are likely to be required, at least for the regulated vegetation to be disturbed, a Offset Strategy has been prepared. Following confirmation of this approach via habitat quality assessments of the proposed offset area, an Offset Management Plan is then to be developed and submitted to the State Government for approval.

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APPENDIX A

FAUNA TRAP SITE DESCRIPTIONS

Site Name: S1 **Description:** Remnant *Eucalyptus orgadophila* open woodland on clay derived from fine-grained sedimentary rock. **BVG:** 17b **Dates:** 24-28/10/2018 **Latitude, Longitude:** -22.3521, 148.2200	
Site Name: S2 **Description:** Remnant *Acacia harpophylla* open forest with emergent *Eucalyptus cambageana.* **BVG:** 25a **Dates:** 25-29/10/2018 **Latitude, Longitude:** -22.3515, 148.2272	
Site Name: S3 **Description:** Cleared pasture with *Carissa ovata* on clay soil **BVG:** n/a **Dates:** 25-29/10/2018 **Latitude, Longitude:** -22.3557, 148.2396	
Site Name: S4 **Description:** Edge of remnant riparian forest dominated by *Eucalyptus camaldulensis.* **BVG:** 16a/9e **Dates**: 25-29/10/2018 **Latitude, Longitude:** -22.3676, 148.2345	

Site Name: S5 **Description:** Ecotone between remnant *Corymbia tessellaris* forest on a sandy alluvial terrace and *Eucalyptus camaldulensis* and *Bauhinia hookeri* along the creek bank. **BVG:** 16a/9e **Dates:** 28/10-1/11/2018 **Latitude, Longitude:** -22.3749, 148.2401	
Site Name: S6 **Description:** Remnant open forest dominated by *Casuarina cristata* and *Acacia harpophylla* on clay soil. **BVG**: 25a **Dates**: 29/10-2/11/2018 **Latitude, Longitude:** -22.3834, 148.2431	
Site Name: S7 **Description:** Remnant *Eucalyptus populnea* open forest on a sand plain. **BVG:** 17a **Dates:** 29/10-2/11/2018 **Latitude, Longitude:** -22.3890, 148.2448	
Site Name: S8 **Description:** High-value regrowth of *Eucalyptus populnea* on a sand plain. **BVG:** 17a (regrowth) **Dates:** 29/10-2/11/2018 **Latitude, Longitude:** -22.3929, 148.2586	

Site Name: S9 **Description:** Heavily thinned *Eucalyptus crebra* and *Corymbia clarksoniana* woodland on a sand plain. **BVG:** 18b (regrowth) **Dates:** 25-28/3/2019 and 8-12/4/2019 **Latitude, Longitude:** -22.3900, 148.2267 Original trapping session was disrupted by heavy rain and had to be repeated at a later date.	
Site Name: S10 **Description:** Remnant *Eucalyptus populnea* open forest, with some *Eucalyptus melanophloia*, on a sandy alluvial terrace. **BVG:** 17a **Dates:** 26-28/3/2019 and 9-13/4/2019 **Latitude, Longitude**: -22.3757, 148.2155 Original trapping session was disrupted by heavy rain and had to be repeated at a later date.	
Site Name: S11 **Description:** Remnant *Corymbia clarksoniana* and *Eucalyptus crebra* open forest at the base of a rocky sandstone scree slope. **BVG:** 12a **Dates:** 26-28/3/2019 and 9-13/4/2019 **Latitude, Longitude:** -22.3773, 148.2017 Original trapping session was disrupted by heavy rain and had to be repeated at a later date.	
Site Name: S12 **Description:** Remnant *Acacia harpophylla* and *Eucalyptus cambageana* woodland on a clay plain. **BVG:** 25a **Dates:** 27-28/3/2019 and 8-12/4/2019 **Latitude, Longitude:** -22.3769, 148.2384 Original trapping session was disrupted by heavy rain and had to be repeated at a later date.	

Site Name: S13 **Description:** Cleared pasture with scattered *Eucalyptus populnea* on a sand plain. **BVG:** n/a **Dates:** 13-17/4/2019 **Latitude, Longitude:** -22.3761, 148.2588	
Site Name: S14 **Description:** Remnant *Eucalyptus populnea* woodland on a sand plain. **BVG:** 17a **Dates:** 9-13/4/2019 **Latitude, Longitude:** -22.3666, 148.2052	
Site Name: S15 **Description:** Partly thinned woodland dominated by *Eucalyptus crebra* on a low sandstone rise. **BVG:** 18b **Dates:** 12-16/4/2019 **Latitude, Longitude:** -22.3592, 148.1983	
Site Name: S16 **Description:** Remnant *Corymbia aureola* and *Eucalyptus melanophloia* open forest with a shrub layer dominated by *Acacia* spp. on sandstone. **BVG:** 12a **Dates:** 12-16/4/2019 **Latitude, Longitude**: -22.3567, 148.1928	

Site Name: S17 **Description:** Remnant *Eucalyptus orgadophila* open woodland on clay derived from fine-grained sedimentary rock. **BVG:** 17b **Dates:** 13-17/4/2019 **Latitude, Longitude:** -22.3537, 148.2339	
Site Name: S18 **Description:** Remnant open forest dominated by *Acacia rhodoxylon* and *Acacia shirleyi* on sandstone. **BVG:** 24a **Dates:** 1-5/5/2019 **Latitude, Longitude:** -22.3424, 148.2103	
Site Name: S19 **Description:** Remnant open forest dominated by *Acacia shirleyi* on sandstone. **BVG:** 24a **Dates:** 1-5/5/2019 **Latitude, Longitude:** -22.3497, 148.2013	
Site Name: S20 **Description:** Remnant woodland dominated by *Eucalyptus crebra* and *Corymbia clarksoniana*, with a shrub layer dominated by *Alphitonia excelsa, Petalostigma pubescens* and *Acacia burdekensis*, on a sand plain. **BVG:** 18b **Dates**: 1-5/5/2019 **Latitude, Longitude**: -22.3518, 148.2112	

Site Name: S21 **Description:** Remnant *Eucalyptus orgadophila* open woodland on heavy clay soil derived from fine-grained sedimentary rock. **BVG:** 17b **Dates:** 30/4-4/5/2019 **Latitude, Longitude:** -22.3593, 148.2296	
Site Name: S22 **Description:** Remnant open forest dominated by *Eucalyptus crebra, Corymbia clarksoniana* and *Eucalyptus melanophloia*, with a dense shrub layer containing *Alphitonia excelsa, Petalostigma pubescens* and *Acacia burdekensis.* **BVG:** 18b **Dates:** 4-8/5/2019 **Latitude, Longitude:** -22.3306, 148.2124	
Site Name: S23 **Description:** Remnant open forest dominated by *Corymbia tessellaris, Corymbia clarksoniana* and *Eucalyptus crebra* beside a creek lined with *Eucalyptus camaldulensis* and *Melaleuca* spp. **BVG:** 16a/9e **Dates:** 5-9/5/2019 **Latitude, Longitude:** -22.3062, 148.1943	
Site Name: S24 **Description:** Remnant open forest dominated by *Corymbia citriodora, Eucalyptus crebra* and *Corymbia trachyphloia,* with a shrub layer containing *Lysicarpus angustifolius* and *Acacia shirleyi.* **BVG:** 10a **Dates:** 5-9/5/2019 **Latitude, Longitude**: -22.2915, 148.1672	

Site Name: S25 **Description:** Remnant *Acacia shirleyi* open forest, but with many dead trees. **BVG:** 12a **Dates:** 5-9/5/2019 **Latitude, Longitude:** -22.2854, 148.1516	
Site Name: S26 **Description:** Non-remnant open woodland dominated by *E. melanophloia, C. clarksoniana* and *Melaleuca viridiflora* on sandy soil. One of the densest examples of non-remnant habitat. **BVG:** Cleared **Dates:** 23-27/09/2019 **Latitude, Longitude:** -22.2880, 148.1920	
Site Name: S27 **Description:** Remnant open forest dominated by *C. citriodora* on coarse-grained sedimentary rocks. **BVG:** 10a **Dates:** 24-28/09/2019 **Latitude, Longitude:** -22.2860, 148.1471	
Site Name: S28 **Description:** Remnant woodland dominated by *C. citriodora* on coarse-grained sedimentary rocks with dense *Acacia shirleyi* midstorey. **BVG:** 10a **Dates:** 24-28/09/2019 **Latitude, Longitude:** -22.2867, 148.1586	

Site Name: S29 **Description:** Remnant *A. shirleyi* open forest on coarse-grained sedimentary rocks. *C. aureola* also present with a sparse, grassy understorey*.* **BVG:** 24a **Dates:** 25-29/09/2019 **Latitude, Longitude:** -22.2905, 148.1746	
Site Name: S30 **Description:** High-value regrowth with many dead trees and large amounts of fallen debris. Heavily grazed and very open. Canopy dominated by *C. clarksoniana* and *E. crebra.* **BVG:** 12a **Dates:** 27-1/10/2019 **Latitude, Longitude:** -22.2812, 148.1792	
Site Name: S31 **Description:** High-value regrowth, dominated by *Eucalyptus crebra* with a dense midstorey of *A. burdekensis*, on coarse-grained sedimentary rocks. **BVG:** 12a (regrowth) **Dates:** 27-01/10/2019 **Latitude, Longitude:** -22.2797, 148.1767	
Site Name: S32 **Description:** High-value regrowth *E. crebra* and *C. clarksoniana* woodland on coarse-grained sedimentary rocks. **BVG:** 12a (regrowth) **Dates:** 28-02/10/2019 **Latitude, Longitude:** -22.3098, 148.1940	

Site Name: S33 **Description:** High-value regrowth *E. crebra* woodland with dense midstorey of *Acacia* spp. and *Melaleuca viridiflora*. **BVG:** 18b (regrowth) **Dates:** 28-02/10/2019 **Latitude, Longitude:** -22.3182, 148.1980	
Site Name: S34 **Description:** High-value regrowth dominated by *A. rhodoxylon.* Contained large amounts of fallen debris. **BVG:** 24a (regrowth) **Dates:** 29-03/10/2019 **Latitude, Longitude:** -22.3990, 148.2654	

APPENDIX B

VEGETATION DATA FROM SECONDARY SITES

SECONDARY SITE 1 **11.5.9**

Latitude, Longitude: -22.3307, 148.2130

Community description: Low open forest dominated by *Melaleuca nervosa,* with emergent *Alphitonia excelsa*, on a flat sandy plain. The species composition was similar to nearby RE 11.5.9, except for the absence of an upper stratum of *Eucalyptus crebra.* This was therefore considered to be a variation of 11.5.9.

Dominant species per stratum:

E: *Alphitonia excelsa, Melaleuca nervosa.*
T1: *Acacia burdekensis, Melaleuca nervosa.*
S1: *Acacia burdekensis, Melaleuca nervosa.*
S2: *Erythroxylum australe.*
G: *Perotis rara, Setaria surgens, Cheilanthes sieberi.*

Median (and range) canopy height per stratum: E = 9.2 m (9.0–12.4 m), T1 = 5.2 m (4.2–7.4 m), S1 = 2.25 m (2.0–3.0 m), S2 = 1 m (0.4–1.2 m).

% cover of each stratum (vertical projection along 100 m tape): E = 5.5%; T1 = 62.3%; S1 = 5.7%; S2 <0.1%; **total = 65.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Alphitonia excelsa* = 1 m^2/ha **(total = 1 m^2/ha).**
T1: *Melaleuca nervosa* = 4.17 m^2/ha; *Acacia burdekensis* = 0.67 m^2/ha; *Alphitonia excelsa* = 0.67 m^2/ha **(total = 5.51 m^2/ha).**
S1: *Melaleuca nervosa* = 0.5 m^2/ha; *Acacia burdekensis* = 0.17 m^2/ha **(total = 0.67 m^2/ha).**
S2: *Erythroxylum* < 0.15 m^2/ha **(total < 0.15 m^2/ha).**

Landform: Plain **Slope:** 1° E **Soil:** Brown sand

Disturbance: Nil

Ground cover: Rock = 0%, wood = 3%, bare = 30%, litter = 42%, vegetation = 25%.

Species (percent cover): *Acanthospermum hispidum** (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (0.4%), *Alphitonia excelsa* (0.2%), *Aristida holathera* (0.6%), *Bonamia media* (0.1%), *Cheilanthes sieberi* (7%), *Chrysocephalum apiculatum* (0.2%), *Crotalaria medicaginea* (0.1%), *Dactyloctenium radulans* (0.1%), *Desmodium varians* (0.3%), *Emilia sonchifolia** (0.1%), *Eragrostis sororia* (0.1%), *Erythroxylum australe* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.4%), *Heliotropium peninsulare* (0.1%), *Ipomoea polymorpha* (0.7%), *Melaleuca nervosa* (0.2%), *Murdannia graminea* (0.1%), *Perotis rara* (4%), *Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 1810) (0.2%), *Portulaca filifolia* (0.1%), *Richardia brasiliensis** (0.1%), *Setaria surgens* (5%), *Sida cordifolia** (0.8%), *Spermacoce brachystema* (0.1%), *Stylosanthes hamata** (0.3%), *Stylosanthes scabra** (0.1%), *Tephrosia dietrichiae* (0.1%), *Tricoryne elatior* (0.1%), *Urochloa piligera* (3%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 2 **11.5.9**

Latitude, Longitude: -22.3337, 148.2100

Community description: Low woodland dominated by *Eucalyptus melanophloia* on a flat, sandy plain.

Dominant species per stratum:

T1: *Eucalyptus melanophloia.*
T2: *Acacia burdekensis, Eucalyptus melanophloia.*
S1: *Erythroxylum australe, Petalostigma pubescens.*
G: *Alloteropsis cimicina, Aristida calycina* var. *calycina, Eriachne obtusa, Evolvulus alsinoides*

Median (and range) canopy height per stratum: T1 = 6.8 m (5.2–11.4 m), T2 = 4 m (3.2–5 m), S1 = 1.5 m (0.8–2 m).

% cover of each stratum: T1 = 20.2%; T2 = 23.9%; S1 = 5%; **total = 44.6%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus melanophloia* = 4.83 m^2/ha; *Acacia burdekensis* = 0.17 m^2/ha **(total = 5 m^2/ha).**
T2: *Acacia burdekensis* = 1.5 m^2/ha; *Eucalyptus melanophloia* = 0.17 m^2/ha **(total = 1.67 m^2/ha).**
S1: total <0.17 m^2/ha.

Landform: Plain **Slope:** 1°NE **Soil:** Yellow-brown sand

Disturbance: Lightly grazed

Ground cover: Rock = 0%, wood = 1%, bare = 35%, litter = 40%, vegetation = 24%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (9%), *Alphitonia excelsa* (0.2%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (2%), *Chrysopogon fallax* (0.3%), *Digitaria divaricatissima* (0.1%), *Digitaria* sp. A (0.2%), *Eragrostis lacunaria* (0.2%), *Eragrostis sororia* (0.1%), *Eriachne obtusa* (8%), *Eucalyptus melanophloia* (0.1%), *Evolvulus alsinoides* (0.9%), *Fimbristylis dichotoma* (0.6%), *Ipomoea polymorpha* (0.1%), *Melaleuca nervosa* (0.1%), *Murdannia graminea* (0.1%), *Paspalidium rarum* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus carpentariae* (0.1%), *Phyllanthus collinus* (0.1%), *Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 1810) (0.1%), *Portulaca pilosa** (0.1%), *Richardia brasiliensis** (0.1%), *Sida hackettiana* (0.1%), *Sida* sp. (Aramac E.J. Thompson+ JER192) (0.2%), *Stylosanthes scabra** (0.2%), *Tephrosia leptoclada* (0.1%), *Urochloa piligera* (0.1%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 3 **11.10.1x1**

Latitude, Longitude: -22.3370, 148.2069

Community description: Low open forest dominated by *Corymbia aureola, Eucalyptus melanophloia* and *Acacia shirleyi* on a low sandstone ridge.

Dominant species per stratum:

T1: *Acacia shirleyi, Corymbia aureola, Eucalyptus melanophloia.*
T2: *Acacia burdekensis.*
S1: *Erythroxylum australe.*
G: *Cleistochloa subjuncea*, *Digitaria diminuta.*

Median (and range) canopy height per stratum: T1 = 9.4 m (8.6–12.4 m), T2 = 5.2 m (3.4–6 m), S1 = 2.4 m (2–2.6 m), S2 = 1 m (0.5–1.5 m).

% cover of each stratum: T1 = 37.6%; T2 = 21.3%; S1 = 6.7%; t**otal = 56.6%**.

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia aureola* = 2.33 m^2/ha; *Acacia shirleyi* = 1.5 m^2/ha; *Eucalyptus melanophloia* = 1.17 m2/ha **(total = 5 m^2/ha).**
T2: *Acacia burdekensis* = 0.17 m^2/ha; *Acacia shirleyi* = 0.5 m^2/ha; *Alphitonia excelsa* = 0.17 m^2/ha; *Corymbia aureola* = 0.17 m^2/ha; *Eucalyptus melanophloia* = 0.17 m^2/ha **(total = 1.18 m^2/ha).**
S1: *Erythroxylum australe* = 0.33 m^2/ha **(total = 0.33 m^2/ha).**

Landform: Low rocky rise **Slope:** 3°NNE **Soil:** Grey sand

Disturbance: none

Ground cover: Rock = 45%, wood = 7%, bare = 10%, litter = 23%, vegetation = 15%.

Species (percent cover): *Acacia bancroftiorum* (0.1%), *Acacia shirleyi* (0.1%), *Achyranthes aspera* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis imicina* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida benthamii* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (0.1%), *Cleistochloa subjuncea* (7%), *Corymbia aureola* (0.1%), *Cyanthillium cinereum* (0.1%), *Desmodium macrocarpum* (0.1%), *Digitaria diminuta* (3.6%), *Eragrostis lacunaria* (0.1%), *Eragrostis sororia* (0.1%), *Eriochloa pseudoacrotricha* (0.1%), *Erythroxylum australe* (0.2%), *Eucalyptus melanophloia* (0.1%), *Euphorbia drummondii* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Hibiscus meraukensis* (0.1%), *Ipomoea brownii* (0.2%), *Marsdenia microlepis* (0.1%), *Melinis repens* (0.1%), *Panicum effusum* (0.1%), *Paspalidium gracile* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus carpentariae* (0.1%), *Pseuderanthemum variabile* (0.1%), *Scleria brownii* (0.1%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (0.1%), *Spermacoce brachystema* (0.1%), *Stylosanthes scabra** (0.2%), *Tephrosia juncea* (0.1%), *Themeda triandra* (0.1%), *Ventilago viminalis* (0.1%), *Xenostegia tridentata* (0.1%).

SECONDARY SITE 4 **11.5.9**

Latitude, Longitude: -22.3403, 148.2247

Community description: Low woodland dominated by *Allocasuarina leuhmannii* on a sand plain. It is best considered a variant of 11.5.9 lacking a *Eucalyptus* upper stratum.

Dominant species per stratum:

T1: *Allocasuarina luehmannii.*
T2: *Acacia burdekensis, Allocasuarina luehmannii, Grevillea striata.*
S1: *Allocasuarina luehmannii.*
G: *Eragrostis sororia*, *Chrysopogon fallax*, *Eriachne obtusa*.

Median (and range) canopy height per stratum: T1 = 9.4 (8–11.6 m), T2 = 5 m (4.2–5.6 m), S1 = 2.8 m (1.6–3 m).

% cover of each stratum: T1 = 31.3%, T2 = 20.8%; S1 = 11%; **total = 55.2%**.

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Allocasuarina luehmannii* = 3.83 m^2/ha; *Eucalyptus melanophloia* = 0.17 m^2/ha **(total = 4 m^2/ha).**
T2: *Allocasuarina luehmannii* = 4.5 m^2/ha **(total = 4.5 m^2/ha).**
S1: < 0.17 m^2/ha.

Landform: Slight rise on a sandy plain **Slope:** 2°E **Soil:** Yellow-brown sand

Disturbance: Nil

Ground cover: Rock = 0%, wood = 2%, bare = 34%, litter = 45%, vegetation = 19%.

Species (percent cover): *Allocasuarina luehmannii* (0.4%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida holathera* (0.1%), *Brunoniella australis* (0.1%), *Carissa ovata* (0.1%), *Cheilanthes sieberi* (0.3%), *Chrysopogon fallax* (3.1%), *Commelina lanceolata* (0.1%), *Eragrostis lacunaria* (0.1%), *Eragrostis sororia* (5%), *Eremochloa bimaculata* (0.1%), *Eriachne obtusa* (7%), *Evolvulus alsinoides* (0.8%), *Fimbristylis dichotoma* (0.1%), *Grevillea striata* (0.1%), *Murdannia graminea* (0.4%), *Oldenlandia mitrasacmoides* subsp. *trachymenoides* (0.1%), *Panicum effusum* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus collinus* (0.1%), *Polycarpaea corymbosa* (0.1%), *Portulaca pilosa** (0.1%), *Sida hackettiana* (0.1%), *Sphaeromorphaea australis* (0.1%), *Stylosanthes scabra** (0.1%), *Tephrosia leptoclada* (0.1%).

SECONDARY SITE 5 **11.4.8**

Latitude, Longitude: -22.3424, 148.2219

Community description: Low open forest dominated by *Casuarina cristata* and *Acacia harpophylla* (subdominant), with emergent *Eucalyptus cambageana*, on clay plain.

Dominant species per stratum:

E: *Eucalyptus cambageana.*
T1: *Acacia harpophylla, Casuarina cristata.*
T2: *Acacia harpophylla, Terminalia oblongata.*
S1: *Carissa ovata*.
G: *Ancistrachne uncinata, Paspalidium constrictum*, *Chloris divaricata*, *Cyperus gracilis*.

Median (and range) canopy height per stratum: E = 16 (14.4–16.4 m) T1 = 9.2 m (7.2–11.6 m), T2 = 3.5 m (3.0–4.0 m), S1 = 2 m (1.0–2.5 m).

% cover of each stratum: E = 19%; T1 = 67.1%; T2 = 13.1%; S1 = 4.3%; **total = 78.8%**.

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Eucalyptus cambageana* = 2.17 **(total = 2.17 m^2/ha).**
T1: *Casuarina cristata* = 5.83 m^2/ha; *Acacia harpophylla* = 1.33 m^2/ha; *Eucalyptus cambageana* = 0.83 m^2/ha; *Terminalia oblongata* = 0.33 m^2/ha. **(total = 8.32 m^2/ha).**
T2: *Acacia harpophylla* =0.33 m^2/ha **(total = 0.33 m^2/ha).**
S1: <0.17 m^2/ha.

Landform: Slight rise on a plain **Slope:** 1°E **Soil:** Reddish-brown sand, but probably texture contrast, with a clay subsoil.

Disturbance: Nil

Ground cover: Rock = 0%, wood = 8%, bare = 4%, litter = 75%, vegetation = 13%.

Species (percent cover): *Abutilon oxycarpum* (0.1%), *Acacia harpophylla* (0.1%), *Alectryon diversifolius* (0.1%), *Ancistrachne uncinata* (1.2%), *Apowollastonia spilanthoides* (0.1%), *Boerhavia pubescens* (0.1%), *Bothriochloa pertusa** (0.1%), *Brunoniella australis* (0.1%), *Bursaria incana* (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (5.5%), *Casuarina cristata* (0.2%), *Cheilanthes sieberi* (0.1%), *Chloris divaricata* (0.9%), *Cymbidium canaliculatum* (0.1%), *Cymbopogon refractus* (0.1%), *Cynanchum viminale* (0.1%), *Cyperus gracilis* (0.7%), *Desmodium varians* (0.1%), *Einadia nutans* (0.1%), *Enchylaena tomentosa* var. *tomentosa* (0.1%), *Enneapogon lindleyanus* (0.1%), *Eremophila mitchellii* (0.1%), *Erythroxylum australe* (0.1%), *Evolvulus alsinoides* (0.1%), *Geijera parviflora* (0.1%), *Grewia retusifolia* (0.1%), *Hibiscus brachysiphonius* (0.1%), *Hibiscus sturtii* (0.1%), *Jasminum didymum* subsp. *lineare* (0.1%), *Nyssanthes erecta* (0.1%), *Parsonsia lanceolata* (0.1%), *Paspalidium constricutum* (0.9%), *Phyllanthus collinus* (0.1%), *Pseuderanthemum variabile* (0.1%), *Sida corrugata* (0.2%), *Solanum ellipticum* (0.1%), *Solanum parvifolium* (0.1%), *Sporobolus scabridus* (0.1%), *Themeda avenacea* (0.1%), *Vachellia bidwillii* (0.1%).

SECONDARY SITE 6 **11.9.2**

Latitude, Longitude: -22.3503, 148.2209

Community description: Woodland dominated by *Eucalyptus orgadophila* and *Corymbia erythrophloia* on clay soil derived from fine-grained sedimentary rock.

Dominant species per stratum:

T1: *Eucalyptus orgadophila.*
T2: *Corymbia erythrophloia*, *Eucalyptus orgadophila*.
S1: *Bursaria incana, Denhamia cunninghamii, Atalaya hemiglauca.*
S2: *Carissa ovata.*
U: *Bothriochloa pertusa*.*

Median (and range) canopy height per stratum: T1 = 12.8 m (10.4–17.6 m), T2 = 5.2 m (4.0–7.0 m), S1 = 1.7 m (1.5–2.1 m), S2 = 0.9 m (0.5–1.2 m).

% cover of each stratum: T1 = 15.6%; T2 = 11.2% S1 = 0.5%, S2 = 3%; **total = 26.9%**.

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia erythrophloia* = 1.33 m^2/ha; *Eucalyptus crebra* = 0.33 m^2/ha; *Eucalyptus orgadophila* = 0.5 m^2/ha **(total = 4.08 m^2/ha).**
T2: *Corymbia erythrophloia* = 1 m^2/ha **(total = 1 m^2/ha).**
S1: <0.17 m^2/ha).
S2: < 0.17 m^2/ha.

Landform: Low rise **Slope:** 1°N **Soil:** Dark-brown clay

Disturbance: Heavily grazed

Ground cover: Rock = 0%, wood = 0.5%, bare = 10%, litter = 4.2%, vegetation = 85.3%.

Species (percent cover): *Abildgaardia ovata* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Alloteropsis semialata* (0.1%), *Aristida gracilipes* (0.1%), *Atalaya hemiglauca* (0.1%), *Bothriochloa ewartiana* (0.2%), *Bothriochloa pertusa** (78.9%), *Brunoniella australis* (0.1%), *Carissa ovata* (3%), *Cenchrus ciliaris** (0.1%), *Chrysopogon fallax* (0.1%), *Corymbia erythrophloia* (0.1%), *Cyanthillium cinereum* (0.1%), *Denhamia cunninghamii* (0.1%), *Desmodium varians* (0.1%), *Enneapogon* sp. A (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Grewia latifolia* (0.1%), *Heliotropium peninsulare* (0.1%), *Indigofera linifolia* (0.1%), *Indigofera linnaei* (0.1%), *Melhania oblongifolia* (0.1%), *Neptunia gracilis* (0.1%), *Phyllanthus fuernrohrii* (0.1%), *Rhynchosia minima* (0.1%), *Rostellularia adscendens* (0.1%), *Scleria brownii* (0.1%), *Sida hackettiana* (0.1%), *Stylosanthes scabra** (0.3%), *Tephrosia filipes* subsp. *filipes* (0.1%), *Themeda triandra* (0.1%).

SECONDARY SITE 7 **11.10.7**

Latitude, Longitude: -22.3041, 148.1923

Community description: Low woodland dominated by *Corymbia clarksoniana* on a low sandstone rise. The community does not closely match any of the described regional ecosystems, but is closest to 11.10.1 and 11.10.7. Nearby areas of the ridge had *Eucalyptus crebra* and/or *Eucalyptus melanophloia* growing alongside *C. clarksoniana*, so 11.10.7 was considered the best fit for the community.

Dominant species per stratum:

T1: *Corymbia clarksoniana.*
T2: *Acacia flavescens, Acacia burdekensis, Alphitonia excelsa, Petalostigma pubescens.*
S1: *Erythroxylum australe, Leptospermum lamellatum, Petalostigma pubescens.*
G: *Melinis repens*, Digitaria eriantha*, Aristida calycina* var*. calycina.*

Median (and range) canopy height per stratum: T1 = 9.6 m (9.6–10.6 m), T2 = 6.4 m (4.6–6.8 m), S1 = 2.5 m (1–3 m)

% cover of each stratum: T1 = 22.1%; T2 = 13.6%; S1 = 6%; S2 = 11%; **total = 52.4%**.

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia clarksoniana* = 1.83 m^2/ha **(total = 1.83 m^2/ha).**
T2: *Petalostigma pubescens* = 0.33 m^2/ha; *Corymbia clarksoniana* = 0.33 m^2/ha; *Terminalia porphyrocarpa* = 0.33 m^2/ha; *Alphitonia excelsa* = 0.17 m^2/ha; *Acacia burdekensis* = 0.17 m^2/ha **(total = 1.33 m^2/ha).**
S1: *Erythoxylum australe* = 0.67 m^2/ha **(total = 0.67 m^2/ha).**

Landform: Crest of low sandstone rise **Slope:** 4°NE **Soil:** Light grey-pink sand

Disturbance: Heavily grazed

Ground cover: Rock = 59%, wood = 1%, bare = 15%, litter = 15%, vegetation = 10%.

Species (percent cover): *Acacia flavescens* (0.2%), *Achyranthes aspera* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (0.5%), *Alphitonia excelsa* (0.1%), *Amaranthus interruptus* (0.1%), *Aristida benthamii* (0.1%), *Aristida calycina* var. *calycina* (1.7%), *Aristida holathera* (0.1%), *Bidens bipinnata** (0.1%), *Bidens pilosa** (0.1%), *Bonamia media* (0.1%), *Chamaecrista rotundifolia** (0.1%), *Cheilanthes sieberi* (0.1%), *Cleome viscosa* (0.1%), *Commelina lanceolata* (0.1%), *Cyperus betchei* (0.1%), *Digitaria eriantha** (3.7%), *Digitaria ramularis* (0.5%), *Dinebra decipiens* var. *decipiens* (0.1%), *Eragrostis spartinoides* (0.2%), *Eriachne mucronata* (0.5%), *Erythroxylum australe* (0.1%), *Euphorbia drummondii* (0.1%), *Evolvulus alsinoides* (0.1%), *Galactia tenuiflora* (0.1%), *Gomphrena celosioides** (0.1%), *Ipomoea brownii* (0.1%), *Larsenaikia ochreata* (0.1%), *Marsdenia microlepis* (0.1%), *Melinis repens** (2.7%), *Pandorea pandorana* (0.1%), *Paspalidium gracile* (0.1%), *Pavetta granitica* (0.3%), *Perotis rara* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus carpentariae* (0.1%), *Phyllanthus collinus* (0.1%), *Planchonella pohlmanniana* (0.1%), *Polycarpaea corymbosa* (0.1%), *Portulaca bicolor* (0.1%), *Portulaca oleracea** (0.1%), *Portulaca pilosa** (0.1%), *Pseuderanthemum variabile* (0.1%), *Setaria surgens* (0.1%), *Sida hackettiana* (0.3%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (0.1%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (0.1%), *Tephrosia filipes* subsp. *filipes* (0.1%), *Urochloa mosambicensis** (0.1%), *Xenostegia tridentata* (0.1%), *Zornia* sp. (0.1%).

SECONDARY SITE 8 **11.10.3**

Latitude, Longitude: -22.3037, 148.1864

Community description: Woodland dominated by *Acacia shirleyi* on sandstone crest.

Dominant species per stratum:

T1: *Acacia shirleyi, Alphitonia excelsa* (subdominant) *Corymbia clarksoniana* (subdominant).
S1: *Erythroxylum australe.*
G: *Alloteropsis cimicina, Cleistochloa subjuncea, Urochloa piligera.*

Median (and range) canopy height per stratum: T1 = 11.4 m (9.2–11.4 m), S1 = 3.5 (3.0–4.0 m).

% cover of each stratum: T1 = 36%; S1 = 27%; **total = 60.6%**.

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Acacia shirleyi* = 8.67 m^2/ha; *Corymbia clarksoniana* = 0.83 m^2/ha; *Alphitonia excelsa* = 0.5 m^2/ha **(total = 10.25 m^2/ha).**
S1: *Erythroxylum australe* = 0.5 m^2/ha **(total = 0.33 m^2/ha).**

Landform: Crest of sandstone ridge **Slope:** 1°N **Soil:** Grey sand

Disturbance: Heavily grazed; burn marks indicate a relatively recent fire.

Ground cover: Rock = 38%, wood = 2%, bare = 14%, litter = 32%, vegetation = 14%.

Species (percent cover): *Achyranthes aspera* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (6%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida enthamii* (0.5%), *Aristida calycina* var. *calycina* (0.1%), *Bidens bipinnata** (0.1%), *Chamaecrista absus* (0.1%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (0.8%), *Cyanthillium cinereum* (0.1%), *Cyperus betchei* (0.1%), *Digitaria diminuta* (0.1%), *Eragrostis lacunaria* (0.1%), *Erythroxylum australe* (0.5%), *Euphorbia drummondii* (0.1%), *Evolvulus alsinoides* (0.1%), *Galactia tenuiflora* (0.1%), *Hibiscus meraukensis* (0.1%), *Ipomoea brownii* (0.1%), *Marsdenia microlepis* (0.1%), *Melinis repens* (0.2%), *Perotis rara* (0.1%), *Phyllanthus carpentariae* (0.1%), *Portulaca bicolor* (0.1%), *Portulaca pilosa** (0.1%), *Pseuderanthemum variabile* (0.1%), *Ptilotus polystachyus* (0.1%), *Scleria sphacelata* (0.1%), *Sida aprica* (0.1%), *Sida atherophora* (0.1%), *Sida cordifolia** (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Spermacoce brachystema* (0.1%), *Tinospora smilacina* (0.1%), *Urochloa piligera* (2.6%), *Wrightia saligna* (0.1%), *Xenostegia tridentata* (0.1%).

SECONDARY SITE 9 **11.10.3**

Latitude, Longitude: -22.3024, 148.1793

Community description: Low open forest dominated by *Acacia shirleyi*, with emergent *Corymbia citriodora*, on sandstone hillside.

Dominant species per stratum:

E: *Corymbia citriodora.*
T1: *Acacia shirleyi.*
S1: *Acacia shirleyi, Erythroxylum australe.*
G: *Cleistochloa subjuncea.*

Median (and range) canopy height per stratum: T1 = 9.8 m (7.6–9.8 m), S1 = (2.5–3.0 m).

% cover of each stratum: T1 = 52.7; S1 = 6.7; **total = 52.8%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Corymbia citriodora* = 0.17 m^2/ha **(total = 0.17 m^2/ha).**
T1: *Acacia shirleyi* = 7.5 m^2/ha; *Corymbia clarksoniana* = 0.17 m^2/ha **(total = 7.67 m^2/ha).**
S1: *Acacia shirleyi* <0.17 m^2/ha; *Erythroxylum australe* <0.17 m^2/ha **(total <0.17 m^2/ha).**

Landform: Rocky hillside **Slope:** 20°E **Soil:** Brown sandy-loam with sandstone boulders

Disturbance: Fire scars to 3 m high on tree trunks; lightly grazed.

Ground cover: Rock = 20%, wood = 4.5%, bare = 5%, litter = 10%, vegetation = 61.5%.

Species (percent cover): *Acacia shirleyi* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida benthamii* (0.1%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (60%), *Cyanthillium cinereum* (0.1%), *Digitaria diminuta* (0.1%), *Erythroxylum australe* (0.1%), *Goodenia* sp. (Mt Castletower M.D. Crisp 2753) (0.1%), *Marsdenia microlepis* (0.1%), *Paspalidium gracile* (0.1%), *Persoonia falcata* (0.1%), *Phyllanthus collinus* (0.1%), *Scleria sphacelata* (0.1%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (0.1%), *Solanum parvifolium* (0.1%).

SECONDARY SITE 10 **11.10.1**

Latitude, Longitude: -22.2971, 148.1753

Community description: Open forest dominated by *Corymbia citriodora* on sandstone.

Dominant species per stratum:

- **T1:** *Corymbia citriodora, Corymbia trachyphloia.*
- **T2:** *Acacia shirleyi, Lysicarpus angustifolius.*
- **S1:** *Alphitonia excelsa, Dodonaea lanceolata.*
- **G:** *Cleistochloa subjuncea, Melinis repens**, *Scleria sphacelata.*

Median (and range) canopy height per stratum: T1 = 25.6 m (19–28.8 m), T2 = 10 m (9.2–11.8 m), S1 = 1.5 m (1.2–1.5 m).

% cover of each stratum: T1 = 51%; T2 = 45.6%; S1 = 3.6%; **total = 74.3%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

- **T1:** *Corymbia citriodora* = 2.83 m^2/ha **(total = 2.83 m^2/ha)**
- **T2:** *Lysicarpus angustifolius* = 1.83 m^2/ha; *Acacia shirleyi* = 1 m^2/ha; *Eucalyptus crebra* = 1 m^2/ha; *Bursaria incana* **=** 0.33 m^2/ha; *Larsenaikia ochreata* = 0.17 m^2/ha; *Corymbia trachyphloia* = 0.17 m^2/ha **(total = 4.5 m^2/ha)**
- **S1:** *Alphitonia excelsa* = 0.17 m^2/ha **(total = 0.17 m^2/ha)**

Landform: Steep foot slope of rocky hill **Slope:** 30°SE **Soil:** Sandy

Disturbance: Nil

Ground cover: Rock = 55%, wood = 1%, bare = 1%, litter = 25%, vegetation = 18%.

Species (percent cover): *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida benthamii* (0.2%), *Aristida calycina var. calycina* (0.1%), *Breynia oblongifolia* (0.1%), *Bursaria incana* (0.1%), *Capparis canescens* (0.1%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (9%), *Corymbia citriodora subsp. citriodora* (0.1%), *Corymbia trachyphloia* (0.1%), *Cyanthillium cinereum* (0.1%), *Cyclophyllum coprosmoides* (0.3%), *Cymbopogon obtectus* (0.1%), *Cymbopogon refractus* (0.2%), *Desmodium macrocarpum* (0.1%), *Dodonaea lanceolata* (0.1%), *Eragrostis spartinoides* (0.1%), *Erythroxylum australe* (0.1%), *Euphorbia drummondii* (0.1%), *Euphorbia tannensis* (0.1%), *Evolvulus alsinoides* (0.1%), *Gahnia aspera* (0.1%), *Galactia tenuiflora* (0.1%), *Goodenia* sp. (Mt Castletower M.D. Crisp 2753) (0.1%), *Hovea tholiformis* (0.1%), *Larsenaikia ochreata* (0.1%), *Leptospermum lamellatum* (0.1%), *Lomandra multiflora* (0.1%), *Marsdenia microlepis* (0.1%), *Melinis repens** (2%), *Murdannia graminea* (0.1%), *Oxalis corniculata* (0.1%), *Panicum effusum* (0.1%), *Persoonia amaliae* (0.1%), *Persoonia falcata* (0.1%), *Phyllanthus carpentariae* (0.1%), *Phyllanthus virgatus* (0.1%), *Pseuderanthemum variabile* (0.1%), *Rostellularia adscendens* (0.1%), *Scleria sphacelata* (2.2%), *Sida* sp. (0.1%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (0.1%), *Solanum ellipticum* (0.1%), *Themeda triandra* (0.2%).

SECONDARY SITE 11 **HVR 11.5.9**

Latitude, Longitude: -22.3198, 148.1956

Community description: Open forest dominated by *Eucalyptus crebra* on sand plain.

Dominant species per stratum:

T1: *Eucalyptus crebra, Eucalyptus melanophloia* (subdominant).
S1: *Erythroxylum australe, Petalostigma pubescens.*
G: *Chrysopogon fallax*, *Bothriochloa pertusa**.

Median (and range) canopy height per stratum: T1 =12 m (10–14 m), S1 = 3 m (0.5–3 m).

% cover of each stratum: T1 = 54.7%; **total = 54.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 8 m^2/ha; *Eucalyptus melanophloia* = 0.5 m^2/ha; *Corymbia dallachiana* = 0.17 m^2/ha; *Corymbia clarksoniana* = 0.17 m^2/ha **(total = 8.84 m^2/ha)**
S1: *Erythroxylum australe* <0.15 m^2/ha; *Petalostigma pubescens* <0.15 m^2/ha **(total <0.15 m^2/ha)**

Landform: Gently sloping plain **Slope:** 2°S **Soil:** Yellow-grey sand

Disturbance: Previously cleared; regular fire has maintained an open understorey.

Ground cover: Rock = 0%, wood = 1.5%, bare = 40%, litter = 35%, vegetation = 23.5%.

Species: *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Bothriochloa decipiens* var. *cloncurrensis* (0.3%), *Bothriochloa pertusa** (20%), *Brunoniella australis* (0.1%), *Cenchrus ciliaris** (0.1%), *Chamaecrista absus* (0.1%), *Chloris divaricate* (0.1%), *Chrysopogon fallax* (5%), *Cyanthillium cinereum* (0.1%), *Cyperus fulvus* (0.1%), *Digitaria divaricatissima* (0.1%), *Digitaria* sp. A (0.1%), *Eragrostis sororia* (0.1%), *Eulalia aurea* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Glycine tomentella* (0.1%), *Gomphrena celosioides** (0.1%), *Grewia latifolia* (0.1%), *Ipomoea polymorpha* (0.1%), *Melaleuca nervosa* (0.1%), *Melhania oblongifolia* (0.1%), *Murdannia graminea* (0.1%), *Phyllanthus carpentariae* (0.8%), *Phyllanthus collinus* (0.1%), *Portulaca pilosa** (0.1%), *Rostellularia adscendens* (0.1%), *Scoparia dulcis** (0.1%), *Sida hackettiana* (0.1%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (0.1%), *Sida spinosa** (0.2%), *Stylosanthes scabra** (0.1%), *Urochloa piligera* (0.1%), *Zornia areolata* (0.1%), *Zornia muriculata* subsp. *angustata* (0.1%).

SECONDARY SITE 12 **HVR 11.10.3**

Latitude, longitude: -22.3166, 148.1914

Community description: Low open forest dominated by *Acacia shirleyi*, with emergent *Eucalyptus crebra* and *Eucalyptus exserta*, on a sandstone ridge.

Dominant species per stratum:

E: *Eucalyptus crebra, Eucalyptus exserta.*
T1: *Acacia shirleyi.*
S1: *Erythroxylum australe.*
G: *Cleistochloa subjuncea, Paspalidium caespitosum.*

Median (and range) canopy height per stratum: T1 = 8.2 m (7–9.8 m), S1 = (1.5–4 m).

% cover of each stratum: T1 = 66.8%; S1 = 10%; **total 73.3%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: <0.17 m^2/ha)
T1: *Acacia shirleyi* =5.83 m^2/ha; *Eucalyptus exserta* = 1.3 m^2/ha; *Eucalyptus crebra* = 0.67 m^2/ha **(total = 7.8 m^2/ha)**
S1: *Erythroxylum australe* = 0.5 m^2/ha **(total = 0.5 m^2/ha)**

Landform: Ridge top **Slope:** 3°E **Soil:** Grey-brown silty sand

Disturbance: Burnt and probably previously cleared. Mapped as non-remnant.

Ground cover: Rock = 1%, wood = 6%, bare = 31%, litter = 42%, vegetation = 20%.

Species (percent cover): *Acacia shirleyi* (0.1%), *Alloteropsis cimicina* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.8%), *Calotis cuneifolia* (0.1%), *Cenchrus ciliaris** (0.1%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (0.1%), *Cleistochloa subjuncea* (8%), *Dianella nervosa* (0.1%), *Digitaria diminuta* (0.1%), *Eragrostis lacunaria* (0.2%), *Eriachne obtusa* (0.1%), *Erythroxylum australe* (0.1%), *Eucalyptus crebra* (0.1%), *Evolvulus alsinoides* (0.1%), *Jasminum didymum* subsp. *lineare* (0.1%), *Larsenaikia ochreata* (0.1%), *Marsdenia microlepis* (0.1%), *Opuntia tomentosa** (0.1%), *Panicum effusum* (0.1%), *Paspalidium caespitosum* (5%), *Paspalidium gracile* (0.4%), *Pseuderanthemum variabile* (0.1%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (1%), *Stylosanthes scabra** (0.4%), *Thyridolepis xerophila* (0.1%), *Urochloa mosambicensis** (0.2%).

SECONDARY SITE 13 **11.3.25**

Latitude, Longitude: -22.3866, 148.2619

Community description: Closed forest dominated by *Eucalyptus camaldulensis* and *Melaleuca fluviatilis* along an ephemeral watercourse.

Dominant species per stratum:

T1: *Eucalyptus camaldulensis, Melaleuca fluviatilis.*
T2: *Bauhinia hookeri.*
G: *Megathyrsus maximus* var. *pubiglumis *, Sida rhombifolia*, Bothriochloa pertusa*, Acanthospermum hispidum*, Urochloa mosambicensis*.*

Median (and range) canopy height per stratum: T1 = 24.8 m (15.6–55.8 m), T2 = 5 m.

% cover of each stratum: T1 = 86.9%; T2 = 0.5%; **total = 86.9%**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus camaldulensis* = 5.67 m^2/ha; *Melaleuca fluviatilis* = 6 m^2/ha; *Corymbia tessellaris* = 0.3 m^2/ha **(total = 11.97 m^2/ha)**
T2: *Bauhinia hookeri* = 0.3 m^2/ha **(total = 0.3 m^2/ha)**

Landform: Creek bank **Slope:** 0° **Soil:** Brown clay

Disturbance: Grazed and with very high weed densities.

Ground cover: Rock = 0%, wood = 1%, bare = 5%, litter = 7%, vegetation = 87%.

Species (percent cover): *Acanthospermum hispidum** (8%), *Achyranthes aspera* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (0.1%), *Bauhinia hookeri* (0.1%), *Bidens bipinnata** (0.1%), *Bothriochloa pertusa** (30%), *Calyptocarpus vialis** (0.1%), *Carissa ovata* (0.1%), *Cenchrus ciliaris** (0.1%), *Chloris virgata** (0.1%), *Commelina diffusa* (0.1%), *Crinum arenarium* (0.1%), *Cynodon dactylon** (3%), *Datura leichhardtii** (0.1%), *Digitaria eriantha** (2%), *Echinochloa colona** (1%), *Eragrostis elongata* (0.1%), *Eucalyptus camaldulensis* (0.1%), *Ficus opposita* (0.1%), *Gomphrena celosioides** (0.1%), *Ipomoea plebia* (0.1%), *Malvastrum coromandelianum** (0.1%), *Megathyrsus maximus* var. *pubiglumis** (4%), *Melinis repens** (0.1%), *Parthenium hysterophorus** (0.2%), *Perotis rara* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca pilosa** (0.1%), *Scoparia dulcis** (0.1%), *Senna occidentalis** (0.1%), *Sida cordifolia** (0.3%), *Sida rhombifolia** (8%), *Sida spinosa** (0.1%), *Solanum ellipticum* (0.1%), *Stachytarpheta jamaicensis** (0.1%), *Stylosanthes hamata** (0.1%), *Urochloa mosambicensis** (20%), *Verbesina encelioides** (0.1%), *Xanthium occidentale** (0.2%), *Zornia muriculata* subsp. *angustata* (0.1%).

SECONDARY SITE 14 **Non-remnant**

Latitude, Longitude: -22.3909, 148.2546

Community description: Open pasture derived from cleared *Eucalyptus populnea* dominated woodland.

Dominant species per stratum:

T1: *Eucalyptus populnea.*
S1: *Atalaya hemiglauca, Carissa ovata, Eucalyptus populnea.*
G: *Cenchrus ciliaris, Bothriochloa pertusa, Urochloa mosambicensis*

Median (and range) canopy height per stratum: T1 = 10 m (8–15.2 m), S1 = 2.5 m (1.5–4 m).

% cover of each stratum: T1 < 0.1%; S1 = 1.9%; **total = 1.9%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Persoonia falcata* = 0.75 m^2/ha; *Eucalyptus populnea* = 0.5 m^2/ha **(total = 1.25 m^2/ha)**
S1: *Atalaya hemiglauca* <0.15 m^2/ha, *Carissa ovata* <0.15 m^2/ha, *Eucalyptus populnea* <0.15 m^2/ha **(total = <0.15 m^2/ha)**

Landform: Plain **Slope:** 0° **Soil:** Dark-brown silt

Disturbance: Cleared, weed-infested and heavily grazed.

Ground cover: Rock = 0%, wood = 0.2%, bare = 10%, litter = 1%, vegetation = 88.8%.

Species: *Alternanthera nana* (0.1%), *Apowollastonia spilanthoides* (0.1%), *Atalaya hemiglauca* (0.1%), *Boerhavia pubescens* (0.1%), *Bothriochloa ewartiana* (0.1%), *Bothriochloa pertusa** (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (0.2%), *Cenchrus ciliaris** (65%), *Chrysopogon fallax* (0.1%), *Crotalaria juncea** (0.1%), *Cyanthillium cinereum* (0.1%), *Digitaria eriantha** (0.1%), *Enteropogon ramosus* (0.1%), *Eucalyptus populnea* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Gomphrena celosioides** (0.1%), *Grewia retusifolia* (0.1%), *Indigofera colutea* (0.1%), *Indigofera linnaei* (0.1%), *Neptunia gracilis* (0.1%), *Panicum effusum* (0.1%), *Parsonsia lanceolata* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca pilosa** (0.1%), *Rhynchosia minima* (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Sphaeromorphaea australis* (0.1%), *Sporobolus caroli* (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes humilis** (0.1%), *Stylosanthes scabra** (0.1%), *Urochloa mosambicensis** (10%).

SECONDARY SITE 15 **Regrowth 11.5.3**

Latitude, Longitude: -22.3939, 148.25

Community description: Low open forest dominated by *Eucalyptus populnea* on a sand plain.

Dominant species per stratum:

- **T1:** *Eucalyptus populnea*.
- **T2:** *Eucalyptus populnea*.
- **S1:** *Carissa ovata*.
- **G:** *Bothriochloa pertusa*, Sida hackettiana*

Median (and range) canopy height per stratum: T1 = 9.8 m (9.6–12 m), S1 = 1.6 m (1.4–2.5 m).

% cover of each stratum: T1 = 62.9%; S1 = 7%; **total = 66.2%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

- **T1:** *Eucalyptus populnea* = 8.17 m^2/ha; *Corymbia clarksoniana* = 0.33 m^2/ha; *Persoonia falcata* = 0.16 m^2/ha **(total = 8.66 m^2/ha)**
- **T2:** *Eucalyptus populnea* <0.17 m^2/ha **(total <0.17 m^2/ha)**
- **S1:** *Carissa ovata* <0.17 m^2/ha **(total < 0.17 m^2/ha)**

Landform: Plain **Slope:** 1°SW **Soil:** Yellow-brown loam.

Disturbance: Previously cleared and not quite old enough to qualify as high-value regrowth?; heavily grazed.

Ground cover: Rock = 0%, wood = 1%, bare = 53%, litter = 32%, vegetation = 14%.

Species (percent cover): *Abutilon oxycarpum* (0.1%), *Alternanthera denticulata* (0.1%), *Alternanthera nana* (0.1%), *Apowollastonia spilanthoides* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Boerhavia pubescens* (0.1%), *Bothriochloa pertusa** (8.6%), *Brunoniella australis* (0.1%), *Carissa ovata* (0.1%), *Cenchrus ciliaris** (0.1%), *Chrysopogon fallax* (0.1%), *Cyperus gracilis* (0.1%), *Enteropogon ramosus* (0.1%), *Eremophila debilis* (0.1%), *Eucalyptus populnea* (0.1%), *Evolvulus alsinoides* (0.1%), *Glycine* sp. (Mackay S.B. Andrews+ 43) (0.1%), *Gomphrena celosioides** (0.1%), *Grewia latifolia* (0.1%), *Grewia retusifolia* (0.6%), *Owenia acidula* (0.1%), *Phyllanthus collinus* (0.1%), *Portulaca oleracea** (0.1%), *Rhynchosia minima* (0.1%), *Sida hackettiana* (1.4%), *Sida spinosa** (0.1%), *Solanum ellipticum* (0.1%), *Sporobolus caroli* (0.1%), *Stylosanthes scabra** (0.1%), *Urochloa mosambicensis** (0.8%).

SECONDARY SITE 16 **11.5.3**

Latitude, Longitude: -22.3920, 148.2295

Community description: Open forest dominated by *Eucalyptus populnea* on sandy soils.

Dominant species per stratum:

T1: *Eucalyptus populnea.*
T2: *Corymbia clarksoniana, Eucalyptus populnea.*
G: *Cenchrus ciliaris*.*

Median (and range) canopy height per stratum: T1 = 14.2 m (13.4–18 m), T2 = 7.2 m (0.4–7.2 m), S1 = 3 m (2.0–4.0 m).

% cover of each stratum: T1 = 52.2%; T2 = 45.6%; **total = 72%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 5.17 m^2/ha **(total = 5.17 m^2/ha)**
T2: *Eucalyptus populnea* = 4.25 m^2/ha; *Corymbia clarksoniana* = 0.5 m^2/ha **(total = 4.75 m^2/ha)**

Landform: Plain on low rise **Slope:** 2°S **Soil:** Yellow-brown sand

Disturbance: Grazed and dominated by weed understorey.

Ground cover: Rock = 0%, wood = 1.5%, bare = 20%, litter = 30%, vegetation = 48.5%.

Species (percent cover): *Acanthospermum hispidum** (0.1%), *Achyranthes aspera* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Archidendropsis basaltica* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida holathera* (0.1%), *Aristolochia thozetii* (0.1%), *Boerhavia pubescens* (0.1%), *Bonamia media* (0.5%), *Bothriochloa pertusa** (0.5%), *Breynia oblongifolia* (0.1%), *Brunoniella australis* (0.1%), *Calotis cuneifolia* (0.1%), *Capparis canescens* (0.1%), *Capparis lasiantha* (0.1%), *Cenchrus ciliaris** (42%), *Chrysopogon fallax* (0.1%), *Clerodendrum tomentosum* (0.1%), *Cyanthillium cinereum* (0.1%), *Dactyloctenium radulans* (0.1%), *Dysphania melanocarpa* forma *melanocarpa* (0.1%), *Enneapogon lindleyanus* (0.1%), *Enteropogon ramosus* (0.1%), *Eragrostis lacunaria* (0.1%), *Eragrostis sororia* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Glycine* sp. (Mackay S.B. Andrews+ 43) (0.1%), *Glycine tomentella* (0.1%), *Gomphrena celosioides** (0.1%), *Grewia retusifolia* (0.1%), *Ipomoea polymorpha* (0.1%), *Parsonsia lanceolata* (0.1%), *Phyllanthus collinus* (0.1%), *Portulaca filifolia* (0.1%), *Rostellularia adscendens* (0.1%), *Setaria surgens* (0.1%), *Sida cordifolia** (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes humilis** (0.1%), *Urochloa mosambicensis** (1%), *Ventilago viminalis* (0.1%), *Zornia areolata* (0.1%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 17 **11.5.9**

Latitude, Longitude: -22.3839, 148.2236

Community description: Low open woodland dominated by *Corymbia clarksoniana*. Despite the absence of *Eucalyptus crebra*, it otherwise resembles regional ecosystem 11.5.9 in structure and floristics of the lower strata. A small number of sandstone boulders suggests that it might be 11.10.7 instead of 11.5.2, but the land form was otherwise a sandy plain.

Dominant species per stratum:

T1: *Corymbia clarksoniana.*
T2: *Acacia burdekensis, Alphitonia excelsa.*
S1: *Melaleuca nervosa.*
G: *Melinis repens*, Perostis rara, Alloteropsis cimicina, Aristida calycina* var. *calycina.*

Median (and range) canopy height per stratum: T1 =9.6 m (8.6–12.2 m), T2 = 6.4 m (5.4–7 m), S1 = 3.0 m (2.0–4.0 m).

% cover of each stratum: T1 = 3.7%; T2 = 14.3%; S1 = 10.7%; t**otal = 26.6%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia clarksoniana* = 1.5 m^2/ha **(total = 1.5 m^2/ha)**
T2: *Acacia burdekensis* = 0.83 m^2/ha; *Alphitonia excelsa* = 0.33 m^2/ha; *Petalostigma pubescens* = 0.17 m^2/ha; *Bursaria incana* = 0.17 m^2/ha **(total = 1.5 m^2/ha)**
S1: *Melaleuca nervosa* = 1.5 m^2/ha **(total = 1.5 m^2/ha)**

Landform: Low sandy plateau

Slope: 2°N

Soil: Yellow-brown coarse sand with scattered sandstone boulders.

Disturbance: Lightly grazed.

Ground cover: Rock = 1%, wood = 2%, bare = 45%, litter = 22%, vegetation = 30%.

Species: *Acacia burdekensis* (0.1%), *Acanthospermum hispidum** (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (2%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (3%), *Bonamia media* (0.1%), *Chamaecrista absus* (0.1%), *Chrysopogon fallax* (0.1%), *Cleome tetrandra* var. *tetrandra* (0.1%), *Cyanthillium cinereum* (0.1%), *Dactyloctenium radulans* (0.9%), *Digitaria eriantha** (0.6%), *Dysphania melanocarpa* forma *melanocarpa* (0.1%), *Eragrostis lacunaria* (0.1%), *Eragrostis sororia* (0.1%), *Erythroxylum australe* (0.1%), *Fimbristylis dichotoma* (0.1%), *Glycine tomentella* (0.1%), *Goodenia glabra* (0.1%), *Heliotropium peninsulare* (0.1%), *Indigofera colutea* (0.1%), *Ipomoea polymorpha* (0.1%), *Melaleuca nervosa* (0.1%), *Melinis repens** (9%), *Paspalidium rarum* (0.1%), *Perotis rara* (3.7%), *Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 1810) (0.1%), *Portulaca bicolor* (0.2%), *Psydrax oleifolia* (0.1%), *Setaria surgens* (0.1%), *Sida cordifolia** (0.1%), *Sida hackettiana* (1.3%), *Spermacoce brachystema* (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes scabra** (0.4%), *Tribulopis angustifolia* (0.1%), *Urochloa mosambicensis** (1%), *Urochloa piligera* (5%), *Zornia* sp. (0.1%).

SECONDARY SITE 18 **11.5.3**

Latitude, Longitude: -22.3767, 148.2250

Community description: Woodland dominated by *Eucalyptus populnea* on a sand plain.

Dominant species per stratum:

- **T1:** *Corymbia dallachiana.*
- **T2:** *Alphitonia excelsa, Acacia burdekensis, Eucalyptus populnea, Melaleuca nervosa.*
- **S1:** *Erythroxylum australe.*
- **G:** *Alloteropsis cimicina, Chrysopogon fallax, Eragrostis speciosa, Perotis rara, Sida hackettiana, Urochloa piligera.*

Median (and range) canopy height per stratum: T1 = 16.6 m (12.8–17.2 m), T2 = 6.4 m (6.0–7.2 m), S1 = 1.8 m (1.0–2.0 m).

% cover of each stratum: T1 = 2%; T2 = 45.4%; S1 = 4.4%; **total = 51.4%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

- **T1:** *Acacia burdekensis* = 2.33 m^2/ha; *Eucalyptus populnea* = 1.67 m^2/ha; *Corymbia dallachiana* = 0.3 m^2/ha; *Corymbia clarksoniana* = 0.17 m^2/ha **(total = 4.47 m^2/ha)**
- **T2:** *Melaleuca nervosa* = 4.83 m^2/ha; *Alphitonia excelsa* = 0.67 m^2/ha; **(total = 5.5 m^2/ha)**
- **S1:** *Erythroxylum australe* <0.15 m^2/ha **(total <0.15 m^2/ha)**

Landform: Low sandy plateau. **Slope:** 2°N **Soil:** Yellow-brown sand with scattered boulders.

Disturbance: Light grazing.

Ground cover: Rock = 0.5%, wood = 2%, bare = 40%, litter = 23%, vegetation = 33.5%.

Species (percent cover): *Acanthospermum hispidum** (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (7.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (8.1%), *Cyanthillium cinereum* (0.1%), *Desmodium filiforme* (0.1%), *Digitaria minima* (0.1%), *Eragrostis spartinoides* (0.1%), *Eragrostis speciosa* (2.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Ipomoea polymorpha* (0.1%), *Melaleuca nervosa* (0.1%), *Murdannia graminea* (0.1%), *Perotis rara* (8%), *Phyllanthus collinus* (0.1%), *Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 1810) (0.1%), *Portulaca filifolia* (1.2%), *Portulaca pilosa** (0.1%), *Setaria surgens* (0.1%), *Sida cordifolia** (0.1%), *Sida hackettiana* (2.1%), *Sida spinosa** (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes scabra** (0.1%), *Tephrosia leptoclada* (0.1%), *Tribulopis angustifolia,* (0.1%), *Urochloa piligera* (2.2%), *Zornia* sp. (0.1%).

SECONDARY SITE 19 **11.4.8**

Latitude, Longitude: -22.3772, 148.2379

Community description: Woodland dominated by *Acacia harpophylla* and *Eucalyptus cambageana* on a clay plain.

Dominant species per stratum:

- **T1:** *Acacia harpophylla, Eucalyptus cambageana.*
- **S1:** *Eremophila mitchellii, Ventilago viminalis.*
- **S2:** *Carissa ovata.*
- **G:** *Cenchrus ciliaris*, Chloris ventricosa, Urochloa mosambicensis*.*

Median (and range) canopy height per stratum: T1 = 11.6 m (10.6–14.6 m), S1 = 5.5 m (5.0–6.0 m), S2 = 1 m (0.5–1.6 m).

% cover of each stratum: T1 = 27.7%; S1 = 5.4%; S2 = 33.2%; **total = 53.8%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

- **T1:** *Acacia harpophylla* = 5.67 m^2/ha; *Eucalyptus cambageana* = 1.67 m^2/ha **(total = 7.34 m^2/ha)**
- **S1:** *Eremophila mitchellii* = 0.3 m^2/ha; *Flindersia dissosperma* = 0.17 m^2/ha **(total = 0.47 m^2/ha)**
- **S2:** *Carissa ovata* <0.15 m^2/ha **(total <0.15 m^2/ha)**

Landform: Plain **Slope:** 1°E **Soil:** Grey-brown sandy-clay, possibly heavier subsoil. No gilgais.

Disturbance: Grazed; numerous dead trees.

Ground cover: Rock = 0%, wood = 1%, bare = 20%, litter = 20%, vegetation = 59%.

Species (percent cover): *Abutilon oxycarpum* var. *incanum* (0.3%), *Acacia harpophylla* (0.6%), *Achyranthes aspera* (0.1%), *Alternanthera nana* (0.8%), *Ancistrachne uncinata* (0.1%), *Aristida gracilipes* (0.5%), *Atalaya hemiglauca* (0.1%), *Boerhavia pubescens* (0.1%), *Bothriochloa pertusa** (0.5%), *Brunoniella australis* (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (37%), *Cassia brewsteri* (0.1%), *Cenchrus ciliaris** (5%), *Cheilanthes sieberi* (0.1%), *Chloris divaricata* (6%), *Desmodium varians* (0.1%), *Ehretia membranifolia* (0.1%), *Einadia nutans* (0.1%), *Einadia nutans* subsp. *linifolia* (0.1%), *Eragrostis lacunaria* (1%), *Eremophila mitchellii* (0.1%), *Evolvulus alsinoides* (0.1%), *Grewia latifolia* (0.1%), *Harrisia martinii** (0.1%), *Jacquemontia paniculata* (0.1%), *Maireana microphylla* (0.1%), *Melhania oblongifolia* (0.1%), *Nyssanthes erecta* (0.1%), *Opuntia tomentosa** (0.1%), *Owenia acidula* (0.1%), *Parsonsia lanceolata* (0.1%), *Parthenium hysterophorus** (0.5%), *Paspalidium caespitosum* (0.1%), *Paspalidium distans* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca oleracea** (0.1%), *Portulaca pilosa** (0.1%), *Pseuderanthemum variabile* (0.1%), *Salsola australis* (0.1%), *Sida hackettiana* (0.1%), *Sida rohlenae* (0.1%), *Sporobolus caroli* (0.4%), *Urochloa mosambicensis** (3%), *Urochloa piligera* (0.1%), *Ventilago viminalis* (0.1%).

SECONDARY SITE 20 **HVR 11.5.3**

Latitude, Longitude: -22.3787, 148.2139

Community description: Open forest dominated by *Eucalyptus populnea* on a sand plain.

Dominant species per stratum:

T1: *Eucalyptus populnea.*
T2: *Eucalyptus populnea.*
S1: *Eucalyptus populnea, Erythroxylum australe.*
G: *Bothriochloa pertusa*, Aristida calycina* var. *calycina, Fimbristylis dichotoma.*

Median (and range) canopy height per stratum: T1 = 14.8 m (10.0–15.6 m), T2 = 3.0 m (2.5–4.0 m), S1 = 1.0 m (0.5–1.5 m).

% cover of each stratum: T1 = 58.4%; T2 = 2.1%; S1 = 1.6%; **total = 60.5%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 12.17 m^2/ha **(total = 12.17 m^2/ha)**
T2: *Eucalyptus populnea* < 0.17 **(total < 0.17 m^2/ha)**
S1: *Erythroxylum australe* < 0.17 **(total < 0.17 m^2/ha)**

Landform: Plain **Slope:** 1°NE **Soil:** Yellow-brown sand

Disturbance: Previously cleared; heavily grazed.

Ground cover: Rock = 0%, wood = 2%, bare = 40%, litter = 20%, vegetation = 38%.

Species (percent cover): *Alloteropsis cimicina* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera denticulata* (0.1%), *Alternanthera nana* (0.1%), *Apowollastonia spilanthoides* (0.1%), *Aristida calycina* var. *calycina* (1%), *Boerhavia pubescens* (0.1%), *Bothriochloa pertusa** (26.6%), *Carissa ovata* (0.1%), *Cenchrus ciliaris** (0.3%), *Cheilanthes sieberi* (0.1%), *Chloris divaricata* (3%), *Chloris virgata** (0.1%), *Chrysopogon fallax* (0.1%), *Cyanthillium cinereum* (0.1%), *Cyperus fulvus* (0.1%), *Digitaria longiflora* (0.1%), *Enneapogon lindleyanus* (0.1%), *Eragrostis lacunaria* (1%), *Eragrostis leptostachya* (0.1%), *Eragrostis sororia* (0.1%), *Eremophila debilis* (0.1%), *Erythroxylum australe* (0.1%), *Eucalyptus populnea* (0.1%), *Euphorbia drummondii* (0.1%), *Fimbristylis dichotoma* (2%), *Gomphrena celosioides** (0.1%), *Grewia latifolia* (0.1%), *Ipomoea polymorpha* (0.1%), *Melhania oblongifolia* (0.1%), *Murdannia graminea* (0.1%), *Opuntia tomentosa** (0.1%), *Panicum effusum* (0.1%), *Phyllanthus collinus* (0.1%), *Phyllanthus* sp. (Myra Vale J.J. BruhlJ.J. Bruhl+ 1810) (0.1%), *Portulaca filifolia* (0.1%), *Portulaca pilosa** (0.1%), *Rhynchosia minima* (0.1%), *Rostellularia adscendens* (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (0.1%), *Urochloa mosambicensis** (0.1%), *Vittadinia pustulata* (0.1%), *Zornia areolata* (0.1%).

SECONDARY SITE 21 **11.3.25**

Latitude, Longitude: -22.3736, 148.2149

Community description: Open forest dominated by *Corymbia tessellaris, Melaleuca fluviatilis, Eucalyptus camaldulensis* and *Casuarina cunninghamiana* on the banks of an ephemeral watercourse.

Dominant species per stratum:

T1: *Casuarina cunninghamiana, Corymbia tessellaris, Eucalyptus camaldulensis, Melaleuca fluviatilis.*
S1: *Bauhinia hookeri, Lophostemon grandiflorus.*
G: *Megathyrsus maximus* var. *pubiglumis*, Bothriochloa ewartiana.*

Median (and range) canopy height per stratum: T1 = 24.2 m (21.8–24.4 m), S1 = 5.0 m (3.0–9.6 m).

% cover of each stratum: T1 = 62.4%; S1 = 46.9%; **total = 95.5%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia tessellaris* = 4.33 m^2/ha; *Melaleuca fluviatilis* = 3.17 m^2/ha; *Casuarina cunninghamiana* = 1.17 m^2/ha; *Eucalyptus camaldulensis* = 1.17 m^2/ha; *Cassia brewsteri* = 0.17 m^2/ha **(total = 10.01 m^2/ha).**
S1: *Bauhinia hookeri* = 0.67 m^2/ha; *Casuarina cunninghamiana* = 0.17 m^2/ha; *Lophostemon grandiflorus* = 0.17 m^2/ha; *Melaleuca fluviatilis* = 0.17 m^2/ha **(total = 1.18 m^2/ha).**

Landform: Creek bank **Slope:** 40°N **Soil:** Yellow sand

Disturbance: High weed densities.

Ground cover: Rock = 0%, wood = 1%, bare = 3%, litter = 30%, vegetation = 66%.

Species (percent cover): *Abutilon guineense** (0.1%), *Acacia salicina* (0.1%), *Acanthospermum hispidum** (0.1%), *Achyranthes aspera* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Ageratum conyzoides** (0.1%), *Ajuga australis* (0.1%), *Alloteropsis cimicina* (0.1%), *Bauhinia hookeri* (0.1%), *Bidens pilosa** (0.1%), *Bothriochloa ewartiana* (7%), *Bothriochloa pertusa** (0.2%), *Calyptocarpus vialis* (0.1%), *Cenchrus ciliaris** (0.1%), *Chamaecrista absus* (0.1%), *Cheilanthes sieberi* (0.1%), *Chloris virgata** (0.1%), *Clematicissus opaca* (0.1%), *Clerodendrum floribundum* (0.1%), *Commelina diffusa* (0.7%), *Crotalaria mitchellii* (0.1%), *Cyanthillium cinereum* (0.2%), *Cynodon dactylon** (0.1%), *Cyperus gracilis* (0.1%), *Cyperus leiocaulon* (0.1%), *Digitaria ammophila* (0.1%), *Digitaria eriantha** (0.2%), *Dysphania melanocarpa* forma *melanocarpa* (0.1%), *Emilia sonchifolia** (0.1%), *Euphorbia hirta** (0.1%), *Ficus opposita* (0.1%), *Glycine tomentella* (0.7%), *Grewia retusifolia* (0.1%), *Heteropogon contortus* (0.1%), *Ipomoea plebia* (0.1%), *Lomandra longifolia* (0.1%), *Megathyrsus maximus* var. *pubiglumis** (52%), *Melaleuca fluviatilis* (0.1%), *Oxalis corniculata* (0.1%), *Parthenium hysterophorus** (0.1%), *Pimelea sericostachya* (0.3%), *Rostellularia adscendens* (0.1%), *Senna occidentalis** (0.1%), *Setaria surgens* (0.1%), *Sida cordifolia** (0.1%), *Sida rhombifolia* (0.1%), *Stephania japonica* (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes humilis** (0.1%), *Tinospora smilacina* (0.1%), *Tridax procumbens** (0.1%), *Urochloa foliosa* (0.1%), *Urochloa mosambicensis** (0.1%), *Xanthium occidentale** (0.1%).

SECONDARY SITE 22 **HVR 11.5.9**

Latitude, Longitude: -22.3761, 148.2097

Community description: Woodland dominated by *Eucalyptus melanophloia* on a sand plain.

Dominant species per stratum:

T1: *Eucalyptus melanophloia.*
T2: *Melaleuca nervosa.*
S1: *Melaleuca nervosa.*
G: *Chrysopogon fallax, Bothriochloa pertusa*, Perotis rara, Alloteropsis cimicina.*

Median (and range) canopy height per stratum: T1 = 10.2 m (8.0–11.8 m), T2 = 5.2 m (4.6–5.6 m), S1 = 1.6 m (1.0–2.4 m).

% cover of each stratum: T1 = 37%; T2 < 0.1%; S1 < 0.1%; **total = 37%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus melanophloia* = 9.83 m^2/ha **(total = 9.83 m^2/ha)**
T2: *Melaleuca nervosa* = 0.83 m^2/ha **(total = 0.83 m^2/ha)**
S1: total < 0.17 m^2/ha

Landform: Slight rise. **Slope:** 3°N **Soil:** Yellow sand.

Disturbance: Previously cleared but probably very old regrowth; heavily grazed.

Ground cover: Rock = 0%, wood = 1%, bare = 30%, litter = 18%, vegetation = 51%.

Species (percent cover): *Acanthospermum hispidum** (0.1%), *Alloteropsis cimicina* (8%), *Aristida inaequiglumis* (0.1%), *Bonamia media* (0.1%), *Bothriochloa pertusa** (28%), *Chrysopogon fallax* (8%), *Dactyloctenium radulans* (0.1%), *Digitaria longiflora* (0.1%), *Eragrostis sororia* (0.1%), *Eragrostis speciosa* (0.1%), *Eucalyptus melanophloia* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Heliotropium peninsulare* (0.1%), *Ipomoea polymorpha* (0.1%), *Melaleuca nervosa* (0.1%), *Paspalidium rarum* (0.1%), *Perotis rara* (1%), *Phyllanthus* sp. (Myra Vale.J. Bruhl+ 1810) (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca pilosa** (0.1%), *Setaria surgens* (0.2%), *Sida hackettiana* (0.2%), *Stylosanthes hamata** (3.5%), *Stylosanthes scabra** (0.1%), *Tribulopis angustifolia* (0.1%), *Urochloa piligera* (0.1%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 23 **11.9.2**

Latitude, Longitude: -22.3641, 148.2071

Community description: Open forest dominated by *Eucalyptus orgadophila* on clay soil derived from fine-grained sedimentary rock.

Dominant species per stratum:

T1: *Eucalyptus orgadophila.*
T2: *Acacia excelsa, Corymbia erythrophloia.*
S1: *Erythroxylum australe, Ventilago viminalis.*
G: *Bothriochloa pertusa*, Enneapogon* sp., *Jaquemontia paniculata*, *Melhania oblongifolia*

Median (and range) canopy height per stratum: T1 = 17.6 m (12.4–18.2 m), T2 = 7.6 m (6.8–8.6 m), S1 = 2.3 m (2.0–3.0 m).

% cover of each stratum: T1 = 69.6%; T2 = 5%; S1 = 4.9%; **total = 75.1%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus orgadophila* = 6.5 m^2/ha; *Acacia excelsa* = 2.5 m^2/ha **(total = 9 m^2/ha)**
T2: *Bursaria incana* = 0.17 m^2/ha; *Corymbia erythrophloia* = 0.33 m^2/ha **(total = 0.5 m^2/ha)**
S1: total < 0.17 m^2/ha

Landform: Low rise. **Slope:** 12°S **Soil:** Dark-brown clay-loam imbedded sandstone.

Disturbance: Lightly grazed

Ground cover: Rock = 0.1%, wood = 0.7%, bare = 25%, litter = 55%, vegetation = 19.2%.

Species (percent cover): *Acacia excelsa* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Aristida gracilipes* (0.5%), *Aristida holathera* (0.1%), *Atalaya hemiglauca* (0.1%), *Bothriochloa ewartiana* (0.4%), *Bothriochloa pertusa** (9%), *Brunoniella australis* (0.1%), *Bursaria incana* (0.1%), *Carissa ovata* (0.4%), *Cassytha filiformis* (0.4%), *Cenchrus ciliaris** (0.3%), *Enneapogon* sp. A (2%), *Eucalyptus orgadophila* (0.1%), *Euphorbia drummondii* (0.1%), *Eustrephus latifolius* (0.1%), *Glycine tomentella* (0.1%), *Heteropogon contortus* (0.1%), *Indigofera linifolia* (0.1%), *Indigofera linnaei* (0.1%), *Jacquemontia paniculata* (1%), *Lomandra multiflora* (0.1%), *Melhania oblongifolia* (1.6%), *Melinis repens* (0.1%), *Ocimum caryophyllinum* (0.6%), *Peripleura hispidula* var. *setosa* (0.1%), *Phyllanthus maderaspatensis* (0.1%), *Psydrax oleifolia* (0.1%), *Rostellularia adscendens* (0.4%), *Scleria brownii* (0.1%), *Sida hackettiana* (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes scabra** (0.1%), *Themeda triandra* (0.1%), *Urochloa foliosa* (0.1%), *Vachellia bidwillii* (0.1%), *Ventilago viminalis* (0.1%).

SECONDARY SITE 24 **11.10.1x1**

Latitude, Longitude: -22.3566, 148.1916

Community description: Woodland dominated by *Corymbia aureola* on a low sandstone rise.

Dominant species per stratum:

T1: *Corymbia aureola, Eucalyptus crebra, Eucalyptus melanophloia.*
T2: *Acacia curvinervia, Acacia burdekensis.*
S1: *Erythroxylum australe.*
G: *Alloteropsis cimicina, Melinis repens*.*

Median (and range) canopy height per stratum: T1 = 13.8 m (10.8–15.2 m), T2 = 5.6 m (4.0–6.0 m), S1 = 2.5 m (1.0–3.0 m).

% cover of each stratum: T1 = 33.6%; T2 = 62%; S1 = 15.1%; **total = 84.9%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia aureola* = 2.83 m^2/ha; *Alphitonia excelsa* = 1 m^2/ha; *Acacia burdekensis* = 0.5 m^2/ha; *Eucalyptus crebra* = 0.33 m^2/ha; *Eucalyptus melanophloia* = 0.17 m^2/ha; *Petalostigma pubescens* = 0.17 m^2/ha; **(total = 5 m^2/ha)**
T2: *Acacia curvinervia* = 3 m^2/ha; *Corymbia aureola* = 1 m^2/ha; *Eucalyptus melanophloia* = 0.17 m^2/ha; **(total = 4.17 m^2/ha)**
S1: *Erythroxylum australe* = 1 m^2/ha **(total = 1 m^2/ha)**

Landform: Rocky hillside. **Slope:** 9°NE **Soil:** Yellow-grey sand

Disturbance: Grazed

Ground cover: Rock = 28%, wood = 1.5%, bare = 33%, litter = 20%, vegetation = 17.5%.

Species (percent cover): *Acacia bancroftiorum* (0.1%), *Acacia curvinervia* (0.1%), *Acacia dietrichiana* (0.1%), *Alloteropsis cimicina* (8%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Bonamia media* (0.1%), *Chamaecrista absus* (0.1%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (0.1%), *Corymbia aureola* (0.1%), *Eragrostis lacunaria* (0.1%), *Erythroxylum australe* (0.1%), *Euphorbia bifida* (0.1%), *Euphorbia drummondii* (0.1%), *Evolvulus alsinoides* (0.1%), *Galactia tenuiflora* (0.1%), *Heliotropium peninsulare* (0.1%), *Hibiscus meraukensis* (0.1%), *Ipomoea brownii* (0.1%), *Ipomoea plebia* (0.1%), *Larsenaikia ochreata* (0.1%), *Melinis repens** (1.5%), *Phyllanthus carpentariae* (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Spermacoce brachystema* (0.1%), *Stylosanthes scabra** (0.1%), *Tephrosia filipes* subsp. *filipes* (0.1%), *Tinospora smilacina* (0.1%), *Urochloa piligera* (5.1%), *Xenostegia tridentata* (0.1%).

SECONDARY SITE 25 **Non-remnant**

Latitude, Longitude: -22.3597, 148.1994

Community description: Pasture with scattered *Eucalyptus crebra* on sand plain. Area was likely to formerly have been regional ecosystem 11.5.9.

Dominant species per stratum:

T1: *Eucalyptus crebra, Grevillea striata.*
S1: *Archidendropsis basaltica, Atalaya hemiglauca.*
G: *Urochloa mosambicensis*, Chloris barbata*.*

Median (and range) canopy height per stratum: T1 = 14.8 m (12.4–19 m), S1 = 2.0 m (0.5–4.0 m).

% cover of each stratum: T1 < 0.1%, S1 = 3.4; **total = 3.4%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 3 m^2/ha **(total = 3 m^2/ha).**
S2: *Archidendropsis basaltica* = 0.17 m^2/ha; *Atalaya hemiglauca* = 0.17 m^2/ha **(total = 0.34 m^2/ha).**

Landform: Low rise on sand plain **Slope:** 2°SSE **Soil:** Yellow-sand

Disturbance: Previously cleared, and probably thinned since; heavily grazed.

Ground cover: Rock = 0%, wood = 0.2%, bare = 49.8%, litter = 18%, vegetation = 32%.

Species (percent cover): *Acanthospermum hispidum** (0.1%), *Alloteropsis cimicina* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Archidendropsis basaltica* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Bothriochloa pertusa** (0.9%), *Brunoniella australis* (0.1%), *Cenchrus ciliaris** (0.4%), *Chamaecrista absus* (0.1%), *Cheilanthes sieberi* (0.1%), *Chloris barbata** (6.1%), *Chrysopogon fallax* (0.1%), *Cyanthillium cinereum* (0.1%), *Dactyloctenium radulans* (0.1%), *Digitaria ciliaris* (0.1%), *Dysphania melanocarpa* forma *melanocarpa* (0.1%), *Einadia nutans* (0.1%), *Enteropogon ramosus* (0.1%), *Eragrostis lacunaria* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.8%), *Gomphrena celosioides** (0.1%), *Indigofera colutea* (0.1%), *Ipomoea polymorpha* (0.1%), *Murdannia graminea* (0.1%), *Perotis rara* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus* sp. (Myra Vale.J. Bruhl+ 1810) (0.1%), *Portulaca pilosa** (0.1%), *Sida cordifolia** (0.1%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (1%), *Urochloa mosambicensis** (20%).

SECONDARY SITE 26 **11.5.3**

Latitude, Longitude: -22.3707, 148.2025

Community description: Open forest dominated by *Eucalyptus populnea* on a sand plain.

Dominant species per stratum:

T1: *Eucalyptus populnea.*
T2: *Acacia excelsa, Eremophila mitchellii, Ventilago viminalis.*
S1: *Carissa ovata, Erythroxylum australe.*
G: *Bothriochloa pertusa*, Aristida gracilipes, Cyperus gracilis.*

Median (and range) canopy height per stratum: T1 = 15.6 m (11–16.6 m), T2 = 7.2 m (5.2–9.0 m), S1 = 1.8 m (1.4–2.5 m).

% cover of each stratum: T1 = 53.3%; T2 = 17%; S1 = 49.5%; **total = 88.4%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 8.67 m^2/ha; *Acacia excelsa* = 0.33 m^2/ha **(total = 9 m^2/ha)**
T2: *Eremophila mitchellii* = 3.33 m^2/ha; *Ventilago viminalis* = 2.33 m^2/ha; *Alphitonia excelsa* = 0.17 m^2/ha **(total = 5.83 m^2/ha)**
S1: *Erythroxylum australe* = 0.17 m^2/ha **(total = 0.17 m^2/ha)**

Landform: Plain. Supposed to be land zone 3, but there was no noticeable terrace. It was a high bank from the creek up to the plain.

Slope: 0° **Soil:** Fine yellow-grey sand

Disturbance: Grazed

Ground cover: Rock = 0%, wood = 2%, bare = 31%, litter = 52%, vegetation = 15%.

Species (percent cover): *Abutilon oxycarpum* (0.1%), *Abutilon oxycarpum* var. *incanum* (0.1%), *Acacia excelsa* (0.1%), *Achyranthes aspera* (0.1%), *Alternanthera denticulata* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida gracilipes* (4%), *Atalaya hemiglauca* (0.1%), *Boerhavia pubescens* (0.2%), *Bonamia media* (0.1%), *Bothriochloa pertusa** (3.7%), *Breynia oblongifolia* (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (1%), *Cassia brewsteri* (0.1%), *Cenchrus ciliaris** (0.2%), *Chloris divaricata* (0.1%), *Cyanthillium cinereum* (0.1%), *Cyperus gracilis* (1.7%), *Einadia nutans* (0.2%), *Enneapogon lindleyanus* (0.1%), *Eragrostis lacunaria* (0.2%), *Eremophila mitchellii* (0.1%), *Erythroxylum australe* (0.1%), *Eucalyptus populnea* (0.1%), *Evolvulus alsinoides* (0.1%), *Galactia tenuiflora* (0.1%), *Gomphrena celosioides** (0.1%), *Grewia retusifolia* (0.1%), *Malvastrum americanum** (0.1%), *Melhania oblongifolia* (0.2%), *Nyssanthes erecta* (0.1%), *Parsonsia lanceolata* (0.3%), *Phyllanthus collinus* (0.1%), *Portulaca oleracea** (0.1%), *Salsola australis* (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.2%), *Sporobolus caroli* (0.1%), *Tribulus terrestris** (0.1%), *Ventilago viminalis* (0.1%).

SECONDARY SITE 27 **Non-remnant**

Latitude, Longitude: -22.3803, 148.2550

Community description: Open pasture with scattered *Eucalyptus populnea*

Dominant species per stratum:

T1: *Eucalyptus populnea.*
S1: *Cassia brewsteri.*
G: *Bothriochloa pertusa*, Urochloa mosambicensis*, Fimbristylis dichotoma.*

Median (and range) canopy height per stratum: T1 = 9.1 m (7.2–24.6 m), S1 = 1.5 m (1.0–4.0 m).

% cover of each stratum: T1 = 8.2%; S1 = 2.1%; **total = 10.3%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* =1.17 m^2/ha **(total = 1.17 m^2/ha)**.
S1: *Corymbia tessellaris* = 0.17 m^2/ha **(total = 0.17 m^2/ha)**.

Landform: Plain **Slope:** 1°S **Soil:** Dark-brown clay with sand

Disturbance: Cleared and heavily grazed; high weed density.

Ground cover: Rock = 0%, wood = 0.5%, bare = 10%, litter = 5%, vegetation = 84.5%.

Species (percent cover): *Aristida calycina* var. *calycina* (0.1%), *Bothriochloa pertusa** (76%), *Cassia brewsteri* (0.1%), *Cenchrus ciliaris** (1.1%), *Chrysopogon fallax* (0.1%), *Crinum arenarium* (0.1%), *Dactyloctenium radulans* (0.1%), *Digitaria diminuta* (0.1%), *Eragrostis sororia* (0.1%), *Fimbristylis dichotoma* (2%), *Gomphrena celosioides** (0.1%), *Grewia retusifolia* (0.1%), *Heteropogon contortus* (0.5%), *Indigofera colutea* (0.1%), *Ipomoea polymorpha* (0.1%), *Murdannia graminea* (0.1%), *Neptunia gracilis* (0.1%), *Owenia acidula* (0.1%), *Oxalis corniculata* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca pilosa** (0.1%), *Salsola australis* (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Sphaeromorphaea australis* (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes scabra** (0.5%), *Urochloa mosambicensis** (2%), *Zornia muriculata* subsp. *angustata* (0.1%), *Zornia* sp. (0.1%).

SECONDARY SITE 28 **11.3.2**

Latitude, Longitude: -22.3819, 148.2465

Community description: Woodland dominated by *Eucalyptus populnea* on alluvial flats beside a watercourse.

Dominant species per stratum:

T1: *Eucalyptus populnea, Eucalyptus melanophloia* (subdominant).
T2: *Cassia brewsteri.*
S1: *Carissa ovata.*
G: *Cenchrus ciliaris*, Bothriochloa pertusa*.*

Median (and range) canopy height per stratum: T1 =22 m (15–24 m), T2 = 7.0 m (6.4–9.0 m), S1 = 1.5 m (0.5–2.5 m).

% cover of each stratum: T1 = 30.2%; T2 = 6.4%; S1 = 8.8%; **total = 38.4%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 3.83 m^2/ha; *Eucalyptus camaldulensis* = 0.33 m^2/ha; *Acacia excelsa* = 0.67 m^2/ha; *Eucalyptus melanophloia* = 0.83 **(total = 5.66 m^2/ha).**
T2: *Eucalyptus populnea* = 0.5 m^2/ha; *Cassia brewsteri* = 1 m^2/ha; *Ventilago viminalis* = 0.5 m^2/ha; *Corymbia erythrophloia* = 0.17 m^2/ha; *Bauhinia hookeri* = 0.33 m^2/ha; *Eucalyptus melanophloia* = 0.5 m^2/ha **(total = 3 m^2/ha)**.
S1 < 0.17 m^2/ha

Landform: Plain **Slope:** 1°SW **Soil:** Brown sand.

Disturbance: Grazed; very high weed cover.

Ground cover: Rock = 0%, wood = 1%, bare = 20%, litter = 8%, vegetation = 71%.

Species (percent cover): *Afrohybanthus enneaspermus* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina var. calycina* (0.1%), *Aristida gracilipes* (0.1%), *Atalaya hemiglauca* (0.1%), *Bothriochloa ewartiana* (0.1%), *Bothriochloa pertusa** (9%), *Capparis lasiantha* (0.1%), *Carissa ovata* (0.5%), *Cenchrus ciliaris** (55%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (0.5%), *Cymbidium canaliculatum* (0.1%), *Cyperus fulvus* (0.1%), *Cyperus gracilis* (0.1%), *Desmodium macrocarpum* (0.1%), *Eragrostis sororia* (0.1%), *Eucalyptus melanophloia* (0.1%), *Eucalyptus populnea* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (2%), *Grewia retusifolia* (0.1%), *Harrisia martinii** (0.1%), *Heteropogon contortus* (0.1%), *Jacquemontia paniculata* (0.1%), *Melhania oblongifolia* (0.1%), *Opuntia tomentosa** (0.1%), *Oxalis corniculata* (0.1%), *Panicum effusum* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca pilosa** (0.1%), *Sida cordifolia** (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (0.6%), *Urochloa mosambicensis** (0.1%), *Zornia muriculata* subsp. *angustata* (0.4%).

SECONDARY SITE 29 **11.4.9**

Latitude, Longitude: -22.3827, 148.2447

Community description: Woodland dominated by *Acacia harpophylla* and *Casuarina cristata* on a clay plain.

Dominant species per stratum:

T1: *Acacia harpophylla, Casuarina cristata.*
T2: *Bauhinia hookeri, Eremophila mitchellii, Terminalia oblongata.*
S1: *Acacia harpophylla, Bauhinia hookeri, Carissa ovata.*
G: *Cenchrus ciliaris*.*

Median (and range) canopy height per stratum: T1 =16.4 m (15.2–16.8 m), T2 = 6.2 m (5.0–10.6 m), S1 = 1.0 m (0.5–2.0 m).

% cover of each stratum: T1 = 40.6%; T2 = 26.2%; S1 = 58.8%; **total = 72.8%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Acacia harpophylla* = 2.83 m^2/ha; *Bauhinia carroniii* = 0.33 m^2/ha **(total = 3.16 m^2/ha)**.
T2: *Eremophila mitchellii* = 1.33 m^2/ha; *Bauhinia carronii* = 0.83 m^2/ha; *Casuarina cristata* = 0.5 m^2/ha; *Ventilago viminalis* = 0.83 m^2/ha **(total = 3.49 m^2/ha)**.
S1: *Bauhinia carronii* = 1 m^2/ha; *Casuarina cristata* = 0.5 m^2/ha **(total = 1.5 m^2/ha)**.

Landform: Plain **Slope:** 1°S **Soil:** Dark-brown clay with thin surface covering of sand; shallow gilgais.

Disturbance: Minimal.

Ground cover: Rock = 0%, wood = 7%, bare = 12%, litter = 50%, vegetation = 31%.

Species (percent cover): *Abutilon oxycarpum* var. *incanum* (0.2%), *Alectryon diversifolius* (0.1%), *Alternanthera denticulata* (0.1%), *Amaranthus interruptus* (0.1%), *Amaranthus viridis** (0.1%), *Apophyllum anomalum* (0.1%), *Bauhinia hookeri* (0.1%), *Boerhavia pubescens* (0.1%), *Brunoniella australis* (0.1%), *Carissa ovata* (19.5%), *Cenchrus ciliaris** (8%), *Cheilanthes sieberi* (0.1%), *Cyperus concinnus* (0.1%), *Cyperus gracilis* (0.1%), *Cyperus perangustus* (0.1%), *Dactyloctenium radulans* (0.1%), *Echinochloa colona** (0.1%), *Ehretia membranifolia* (0.1%), *Eragrostis pilosa** (0.1%), *Eriochloa crebra* (0.1%), *Geijera parviflora* (0.1%), *Ipomoea plebia* (0.1%), *Malvastrum americanum** (0.1%), *Marsdenia viridiflora* subsp. *viridiflora* (0.1%), *Owenia acidula* (0.1%), *Parsonsia lanceolata* (0.1%), *Parthenium hysterophorus** (0.1%), *Plumbago zeylanica* (0.1%), *Portulaca oleracea** (0.1%), *Salsola australis* (0.1%), *Senna coronilloides* (0.1%), *Sporobolus caroli* (0.1%), *Sporobolus scabridus* (0.1%), *Tribulus terrestris** (0.1%), *Urochloa foliosa* (0.1%), *Ventilago viminalis* (0.1%).

SECONDARY SITE 30 **11.3.2**

Latitude, Longitude: -22.3672, 148.2353

Community description: Open woodland dominated by *Eucalyptus populnea* on sandy alluvial flat.

Dominant species per stratum:

T1: *Corymbia tessellaris, Eucalyptus populnea.*
T2: *Acacia salicina, Cassia brewsteri.*
S1: *Capparis canescens, Eucalyptus populnea.*
G: *Cenchrus ciliaris**.*

Median (and range) canopy height per stratum: T1 =11.6 m (11.0–19.2 m), T2 = 7.4 m (6.4–8.4 m), S1 = 1.5 m (1.0–3.0 m).

% cover of each stratum: T1 = 15%; T2 = 20.1%; S1 = 2.9%; **total = 32.9%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 6.33 m^2/ha; *Corymbia dallachiana* = 0.33 m^2/ha **(total = 6.66 m^2/ha)**.
T2: *Eucalyptus populnea* = 1.33 m^2/ha; *Corymbia dallachiana* = 0.17 m^2/ha; *Corymbia tessellaris* = 0.5 m^2/ha; *Acacia salicina* = 0.33 m^2/ha; *Cassia brewsteri* = 0.5 m^2/ha **(total = 2.83 m^2/ha).**

Landform: Plain **Slope:** 0° **Soil:** Yellow-brown sand.

Disturbance: Grazed; high weed densities.

Ground cover: Rock = 0%, wood = 1%, bare = 30%, litter = 25%, vegetation = 44%.

Species (percent cover): *Acacia salicina* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida gracilipes* (0.1%), *Boerhavia pubescens* (0.1%), *Bonamia media* (0.1%), *Bothriochloa ewartiana* (0.1%), *Bothriochloa pertusa** (0.1%), *Capparis canescens* (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (0.1%), *Cassia brewsteri* (0.1%), *Cenchrus ciliaris** (40.3%), *Chrysopogon fallax* (0.1%), *Crinum arenarium* (0.1%), *Cyanthillium cinereum* (0.1%), *Eremophila mitchellii* (0.1%), *Eucalyptus populnea* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Glycine tomentella* (0.1%), *Gomphrena celosioides** (0.1%), *Grewia retusifolia* (0.1%), *Harrisia martinii** (0.1%), *Hibiscus sturtii* (0.1%), *Indigofera colutea* (0.1%), *Indigofera linnaei* (0.1%), *Melhania oblongifolia* (0.1%), *Oxalis corniculata* (0.1%), *Parsonsia lanceolata* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca filifolia* (0.1%), *Rostellularia adscendens* (0.1%), *Sida hackettiana* (0.1%), *Sida spinosa** (0.1%), *Stylosanthes humilis** (0.1%), *Stylosanthes scabra** (0.1%).

SECONDARY SITE 31 **11.9.2**

Latitude, Longitude: -22.3656, 148.2267

Community description: Open woodland dominated by *Eucalyptus orgadophila* on a clay plain derived from fine-grained sedimentary rock.

Dominant species per stratum:

- **T1:** *Eucalyptus orgadophila.*
- **T2:** *Cassia brewsteri, Vachellia bidwillii, Ventilago viminalis.*
- **S1:** *Carissa ovata.*
- **G:** *Cenchrus ciliaris*, Bothriochloa pertusa*.*

Median (and range) canopy height per stratum: T1 =13.4 m (9.4–15 m), T2 = 6.2 m (5.2–6.6 m), S1 = 1.5 m (0.5–2.5 m).

% cover of each stratum: T1 = 6%; T2 < 0.1%, S1 < 0.1%; **total = 6%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

- **T1:** *Eucalyptus orgadophila* = 2 m^2/ha **(total = 2 m^2/ha)**.
- **T2:** *Vachellia bidwillii* = 0.33 m^2/ha; *Atalaya hemiglauca* = 0.17 m^2/ha; *Acacia salicina* = 0.17 m^2/ha **(total = 0.67 m^2/ha)**.
- **S1: < 0.17 m^2/ha**

Landform: Plain **Slope:** 2°S **Soil:** Spongy, dark-brown clay-loam.

Disturbance: Many dead trees; heavily grazed; high weed densities.

Ground cover: Rock = 0%, wood = 0%, bare = 10%, litter = 7%, vegetation = 83%.

Species (percent cover): *Acacia salicina* (0.1%), *Atalaya hemiglauca* (0.1%), *Boerhavia pubescens* (0.1%), *Bothriochloa ewartiana* (0.1%), *Bothriochloa pertusa** (76.8%), *Camptacra barbata* (0.3%), *Cenchrus ciliaris** (2%), *Cleome viscosa* (0.1%), *Cyperus rotundus** (0.1%), *Datura leichhardtii** (0.1%), *Digitaria eriantha** (0.1%), *Euphorbia bifida* (0.1%), *Glycine* sp. (Mackay S.B.Andrews+ 43) (0.1%), *Indigofera linifolia* (0.1%), *Lomandra multiflora* (0.1%), *Malvastrum americanum** (0.1%), *Neptunia gracilis* (0.4%), *Parthenium hysterophorus** (0.1%), *Phyllanthus maderaspatensis* (0.1%), *Polymeria pusilla* (0.1%), *Portulaca oleracea** (0.1%), *Rhynchosia minima* (0.1%), *Sida pleiantha* (0.1%), *Sida spinosa** (0.3%), *Stylosanthes scabra** (0.1%), *Tephrosia* sp. B (0.1%), *Tribulus terrestris** (0.1%), *Urochloa mosambicensis** (1%).

SECONDARY SITE 32 **11.5.9**

Latitude, Longitude: -22.3618, 148.217

Community description: Open woodland dominated by *Eucalyptus crebra* and *Corymbia dallachiana* (subdominant) on a sand plain. A small number of sandstone rocks were present, but otherwise the landform was a sand plain.

Dominant species per stratum:

T1: *Corymbia dallachiana, Eucalyptus crebra.*
S1: *Melaleuca nervosa.*
G: *Chrysopogon fallax, Bothriochloa pertusa, Bothriochloa bladhii*

Median (and range) canopy height per stratum: T1 = 13.8 m (12.0–14.4 m), S1 = 0.6 m (0.5–2.5 m).

% cover of each stratum: T1 = 7.8%; S1 = 6.7%; **total = 14.5%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 3 m^2/ha; *Corymbia dallachiana* = 1.67 m^2/ha; *Grevillea striata* = 0.17 m^2/ha **(total = 4.84 m^2/ha)**
S1: <0.17 m^2/ha)

Landform: Low rise on plain. **Slope:** 3°W **Soil:** Dark, yellow-brown sand.

Disturbance: Minimal.

Ground cover: Rock = 0.2%, wood = 0%, bare = 40%, litter = 18%, vegetation = 41.8%.

Species: *Alloteropsis cimicina* (0.4%), *Apowollastonia spilanthoides* (0.1%), *Aristida benthamii* (0.1%), *Aristida calycina* var. *calycina* (0.4%), *Aristida holathera* (0.1%), *Bonamia media* (0.1%), *Bothriochloa pertusa** (30%), *Brunoniella australis* (0.1%), *Cenchrus ciliaris** (0.1%), *Chamaecrista absus* (0.1%), *Chrysopogon fallax* (5%), *Corymbia dallachiana* (0.1%), *Dactyloctenium radulans* (0.1%), *Digitaria divaricatissima* (0.1%), *Eragrostis sororia* (0.1%), *Eriachne mucronata* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Glycine tomentella* (0.1%), *Grewia retusifolia* (0.1%), *Heteropogon contortus* (2%), *Indigofera linnaei* (0.1%), *Ipomoea polymorpha* (0.1%), *Melaleuca nervosa* (0.1%), *Melhania oblongifolia* (0.1%), *Murdannia graminea* (0.3%), *Parthenium hysterophorus** (0.1%), *Perotis rara* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus collinus* (0.1%), *Portulaca pilosa** (0.1%), *Sida hackettiana* (0.1%), *Spermacoce brachystema* (0.1%), *Stylosanthes scabra** (0.7%), *Tephrosia leptoclada* (0.1%), *Urochloa mosambicensis** (0.1%), *Urochloa piligera* (0.1%).

SECONDARY SITE 33 **Non-remnant**

Latitude, Longitude: -22.3607, 148.2331

Community description: Open cleared pasture in what was formerly open *Eucalyptus orgadophila* woodland (regional ecosystem 11.9.2).

Dominant species per stratum:

T1: *Corymbia erythrophloia, Eucalyptus orgadophila.*
S1: *Cassia brewsteri.*
G: *Bothriochloa pertusa*.*

Median (and range) canopy height per stratum: E = 6.8 m (6.8 – 7.8 m), T1 = 1.5 m (0.5 – 2.5 m).

% cover of each stratum: T1 = 1%; S1 = 11.9%; **total = 12.9%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia erythrophloia* = 0.33 m^2/ha; *Eucalyptus orgadophila* = 0.17 m^2/ha **(total = 0.5 m^2/ha)**
S1: <0.15 m^2/ha

Landform: Low rise. **Slope:** 3°SE **Soil:** Dark brown clay-loam.

Disturbance: Cleared and heavily grazed.

Ground cover: Rock = 0%, wood = 0.1%, bare = 10%, litter = 5%, vegetation = 84.9%.

Species (percent cover): *Abutilon guineense** (0.1%), *Acacia salicina* (0.1%), *Archidendropsis basaltica* (0.2%), *Bothriochloa pertusa** (82%), *Brunoniella australis* (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (0.6%), *Cassia brewsteri* (0.1%), *Cenchrus ciliaris** (0.1%), *Clerodendrum floribundum* (0.1%), *Dactyloctenium radulans* (0.1%), *Digitaria eriantha** (0.1%), *Eulalia aurea* (0.1%), *Euphorbia bifida* (0.1%), *Eustrephus latifolius* (0.1%), *Galactia tenuiflora* (0.1%), *Glycine tomentella* (0.1%), *Heliotropium cunninghamii* (0.1%), *Indigofera linifolia* (0.2%), *Indigofera linnaei* (0.1%), *Ipomoea plebia* (0.1%), *Macroptilium atropurpureum** (0.1%), *Neptunia gracilis* (0.1%), *Parthenium hysterophorus** (0.1%), *Phyllanthus maderaspatensis* (0.1%), *Polymeria pusilla* (0.1%), *Portulaca filifolia* (0.1%), *Psydrax oleifolia* (0.1%), *Rhynchosia minima* (0.1%), *Sida hackettiana* (0.1%), *Sida pleiantha* (0.1%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (0.1%), *Tragus australianus* (0.1%), *Urochloa mosambicensis** (0.1%), *Urochloa piligera* (0.1%).

SECONDARY SITE 34 **11.4.8**

Latitude, Longitude: -22.3446, 148.2355

Community description: Tall shrubland dominated by *Acacia harpophylla*, with scattered emergent *Acacia harpophylla* and *Eucalyptus cambageana*.

Dominant species per stratum:

E: *Acacia harpophylla, Eucalyptus cambageana.*
T1: *Acacia harpophylla.*
S1: *Acacia harpophylla, Carissa ovata.*
G: *Cenchrus ciliaris*.*

Median (and range) canopy height per stratum: E = 12 m (11.2–13.2 m), T1 = 4.0 m (3.0–5.4 m), S1 = 1.0 m (0.5–1.5 m).

% cover of each stratum: E = 4%; T1 = 41.1%; S1 = 26.5%; **total = 53.5%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Acacia harpophylla* = 0.3 m^2/ha; *Eucalyptus cambageana* = 0.3 m^2/ha; *Bauhinia carronii* = 0.3 m^2/ha **(total = 1 m^2/ha)**.
T1: *Acacia harpophylla* = 5.33 m^2/ha **(total = 5.33 m^2/ha)**.
S1: <0.17 m^2/ha.

Landform: Plain **Slope:** 0° **Soil:** Dark brown clay-loam; no gilgais; some surface pebbles.

Disturbance: Very few large trees and these were mostly dead. Most of the living vegetation was relatively young regrowth (DBH < 5 cm).

Ground cover: Rock = 0.1%, wood = 1%, bare = 30%, litter = 48.9%, vegetation = 20%.

Species (percent cover): *Abutilon oxycarpum* (0.1%), *Abutilon oxycarpum* var. *incanum* (0.1%), *Acacia harpophylla* (2%), *Apophyllum anomalum* (0.1%), *Boerhavia pubescens* (0.1%), *Brunoniella australis* (0.1%), *Capparis lasiantha* (0.1%), *Carissa ovata* (8%), *Cenchrus ciliaris** (8%), *Cheilanthes sieberi* (0.1%), *Chloris divaricata* (0.1%), *Cyanthillium cinereum* (0.1%), *Cyperus gracilis* (0.1%), *Enchylaena tomentosa* var. *tomentosa* (0.1%), *Eragrostis lacunaria* (0.1%), *Evolvulus alsinoides* (0.1%), *Harrisia martinii** (0.1%), *Paspalidium distans* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca filifolia* (0.1%), *Portulaca oleracea** (0.1%), *Solanum esuriale* (0.1%), *Terminalia oblongata* (0.1%).

SECONDARY SITE 35 **11.5.9**

Latitude, Longitude: -22.3336, 148.2134

Community description: Closed scrub dominated by *Melaleuca nervosa* and *Acacia burdekensis,* with emergent *Corymbia clarksoniana*, on a sand plain. Resembles regional ecosystem 11.5.9 but with a very dense mid-storey. Presumably drainage is impeded by texture contrast soil or shallow bedrock.

Dominant species per stratum:

E: *Corymbia clarksoniana.*
T1: *Acacia burdekensis, Melaleuca nervosa.*
S1: *Alphitonia excelsa, Melaleuca nervosa.*
G: *Eriochloa crebra, Perotis rara, Sida hackettiana, Setaria surgens, Alloteropsis cimicina.*

Median (and range) canopy height per stratum: E = 15.2 m (13.8–16.8 m), T1 = 4.0 m (3.5–4.8 m), S1 = 2.0 m (1.0–2.5 m).

% cover of each stratum: E < 0.1%; T1 = 84.3%; S1 = 16.6%; **total = 90.6%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Corymbia clarksoniana* = 0.17 m^2/ha **(total = 0.17 m^2/ha)**.
T1: *Melaleuca nervosa* = 6.67 m^2/ha; *Acacia burdekensis* = 6.3 m^2/ha; *Alphitonia excelsa* = 0.67 m^2/ha **(total = 13.64 m^2/ha)**.
S1: *Acacia burdekensis* = 0.33 m^2/ha; *Melaleuca nervosa* =0.33 m^2/ha **(total = 0.66 m^2/ha)**.

Landform: Plain. **Slope:** 1°N **Soil:** Grey sand.

Disturbance: Nil.

Ground cover: Rock = 0%, wood = 2%, bare = 10%, litter = 50%, vegetation = 38%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (4%), *Alphitonia excelsa* (0.3%), *Bidens pilosa** (0.1%), *Bonamia media* (0.1%), *Cassytha filiformis* (0.1%), *Cheilanthes sieberi* (0.1%), *Chrysocephalum apiculatum* (0.1%), *Cleome tetrandra* var. *tetrandra* (0.1%), *Crotalaria medicaginea* (0.1%), *Dactyloctenium radulans* (0.1%), *Desmodium filiforme* (0.1%), *Dysphania melanocarpa* forma *melanocarpa* (0.1%), *Emilia sonchifolia** (0.1%), *Eriochloa crebra* (9%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Glycine tomentella* (0.1%), *Indigofera colutea* (0.1%), *Ipomoea polymorpha* (0.4%), *Melaleuca nervosa* (0.1%), *Perotis rara* (3%), *Petalostigma pubescens* (0.1%), *Portulaca pilosa** (0.1%), *Richardia brasiliensis** (0.1%), *Setaria surgens* (9%), *Sida cordifolia** (0.3%), *Sida hackettiana* (1.6%), *Spermacoce brachystema* (0.1%), *Tribulopis angustifolia* (0.1%), *Urochloa piligera* (8%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 36 **11.10.3**

Latitude, Longitude: -22.3434, 148.2104

Community description: Low open forest dominated by *Acacia shirleyi* and *Acacia rhodoxylon*, with emergent *Corymbia clarksoniana*, on the crest of a sandstone rise.

Dominant species per stratum:

E: *Corymbia clarksoniana.*
T1: *Acacia rhodoxylon, Acacia shirleyi.*
S1: *Erythroxylum australe.*
G: *Cleistochloa subjuncea, Alloteropsis cimicina, Thyridolepis xerophila.*

Median (and range) canopy height per stratum: E = 15.2 m (12.2–15.6 m), T1= 5.6 m (5.2–5.6 m), S1 = 2.0 m (1.5–3.5 m).

% cover of each stratum: E = 21.1%; T1 = 58.6%; S1 = 4.3%; **total = 68.5%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Corymbia clarksoniana* = 1.33 m^2/ha **(total = 1.33 m^2/ha)**.
T1: *Acacia shirleyi* = 6 m^2/ha; *Acacia rhodoxylon* = 2.5 m^2/ha; *Lysicarpus angustifolius* = 0.17 m^2/ha; *Corymbia clarksoniana* = 0.17 m^2/ha; *Alphitonia excelsa* = 0.17 m^2/ha **(total = 9.0 m^2/ha)**.
S1: <0.17 m^2/ha.

Landform: Crest **Slope:** 2°NE **Soil:** Yellow-grey sand.

Disturbance: Nil.

Ground cover: Rock = 0%, wood = 4%, bare = 20%, litter = 65%, vegetation = 11%.

Species (percent cover): *Acacia rhodoxylon* (0.1%), *Acacia shirleyi* (0.2%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (1.5%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Cheilanthes sieberi* (0.6%), *Cleistochloa subjuncea* (2%), *Digitaria diminuta* (0.1%), *Eragrostis lacunaria* (0.1%), *Eragrostis sororia* (0.1%), *Larsenaikia ochreata* (0.1%), *Lysicarpus angustifolius* (0.1%), *Murdannia graminea* (0.1%), *Sida hackettiana* (0.1%), Sida sp. (Musselbrook M.B. Thomas+ MRS437) (0.1%), *Stylosanthes scabra** (0.1%), *Thyridolepis xerophila* (5.3%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 37 **11.10.1x1**

Latitude, Longitude: -22.3471, 148.1894

Community description: Woodland dominated by *Corymbia aureola* on a low sandstone rise.

Dominant species per stratum:

- **T1:** *Corymbia aureola*
- **T2:** *Alphitonia excelsa, Acacia flavescens.*
- **S1:** *Erythroxylum australe.*
- **G:** *Melinis repens, Alloteropsis cimicina.*

Median (and range) canopy height per stratum: T1 = 13 m (10.2–14.8 m), T2 = 3.8 m (3.4–5 m), S1 = 1.5 m (0.5–2.5 m).

% cover of each stratum: T1 = 32.8%; T2 = 19.5%; S1 = 3.6%; **total = 45.3%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

- **T1:** *Corymbia aureola* = 4.33 m^2/ha; *Eucalyptus melanophloia* = 0.33 m^2/ha; *Corymbia clarksoniana* = 0.17 m^2/ha; *Larsenaikia ochreata* = 0.17 m^2/ha **(total = 5 m^2/ha)**
- **T2:** *Alphitonia excelsa* = 1.33 m^2/ha; *Acacia flavescens* = 1.33 m^2/ha; *Acacia burdekensis* = 0.33 m^2/ha; **(total = 2.99 m^2/ha)**
- **S1: <0.15 m^2/ha**

Landform: Low rise **Slope:** 3°S **Soil:** Yellow-grey sand with large sandstone boulders.

Disturbance: Grazed.

Ground cover: Rock = 9%, wood = 4%, bare = 33%, litter = 19%, vegetation = 35%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alloteropsis cimicina* (2%), *Alphitonia excelsa* (0.4%), *Aristida calycina* var. *calycina* (0.1%), *Aristida holathera* (0.1%), *Bidens bipinnata** (0.1%), *Bonamia media* (0.1%), *Breynia oblongifolia* (0.1%), *Chamaecrista absus* (0.6%), *Commelina lanceolata* (0.1%), *Corymbia aureola* (0.1%), *Cyperus betchei* (0.1%), *Digitaria longiflora* (0.1%), *Eragrostis sororia* (0.1%), *Eriochloa crebra* (2%), *Erythroxylum australe* (0.1%), *Evolvulus alsinoides* (0.1%), *Glycine tomentella* (0.1%), *Hibiscus meraukensis* (0.1%), *Ipomoea brownii* (0.1%), *Ipomoea plebia* (0.1%), *Ipomoea polymorpha* (0.1%), *Larsenaikia ochreata* (0.1%), *Lomandra longifolia* (1%), *Melinis repens* (20%), *Oxalis corniculata* (0.1%), *Phyllanthus virgatus* (0.1%), *Portulaca filifolia* (0.1%), *Setaria surgens* (0.1%), *Sida hackettiana* (0.8%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (0.1%), *Tephrosia filipes* subsp. *filipes* (0.1%), *Tinospora smilacina* (0.1%), *Trema tomentosa* (0.5%), *Tribulopis angustifolia* (0.1%), *Urochloa piligera* (4%), *Xanthorrhoea johnsonii* (0.7%), *Xenostegia tridentata* (0.1%).

SECONDARY SITE 38 **11.10.7**

Latitude, Longitude: -22.3411, 148.1925

Community description: Open forest dominated by *Eucalyptus crebra* on a flat terrace of a sandstone slope.

Dominant species per stratum:

T1: *Eucalyptus crebra, Corymbia clarksoniana* (subdominant)*, Corymbia dallachiana* (subdominant)*.*
T2: *Acacia burdekensis, Alphitonia excelsa, Petalostigma pubescens.*
S1: *Petalostigma pubescens.*
G: *Chrysopogon fallax, Aristida calycina* var. *calycina, Bothriochloa pertusa*.*

Median (and range) canopy height per stratum: T1 = 15 m (13.6–22 m), T2 = 8.0 m (3.6–9.2 m), S1 = 1.5 m (0.5–1.5 m).

% cover of each stratum: T1 = 75.2%; T2 = 11.5%; S1 = 7.7%; **total = 77.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 5.5 m^2/ha; *Corymbia clarksoniana* = 0.33 m^2/ha; *Corymbia dallachiana* = 0.33 m^2/ha; *Acacia burdekensis* = 0.17 m^2/ha. **(total = 6.33 m^2/ha)**
T2: *Petalostigma pubescens* = 0.33 m^2/ha; *Eucalyptus crebra* = 0.17 m^2/ha; *Corymbia dallachiana* = 0.17 m^2/ha; *Alphitonia excelsa* = 0.17 m^2/ha; **(total =0.84 m^2/ha)**
S1: <0.15 m^2/ha

Landform: Terrace of sandstone slope. **Slope:** 3°E **Soil:** Yellow-grey sand with no rocks.

Disturbance: Numerous dead trees.

Ground cover: Rock = 0%, wood = 0.5%, bare = 35%, litter = 30%, vegetation = 34.5%.

Species (percent cover): *Afrohybanthus stellarioides* (0.1%)*, Alphitonia excelsa* (0.1%)*, Aristida calycina* var. *calycina* (4%)*, Bothriochloa pertusa** (19%)*, Breynia oblongifolia* (0.1%)*, Cenchrus ciliaris** (0.4%)*, Chamaecrista absus* (0.1%)*, Chrysopogon fallax* (8%)*, Cyperus fulvus* (0.1%)*, Digitaria divaricatissima* (0.1%)*, Eragrostis sororia* (0.1%)*, Eriochloa crebra* (0.1%)*, Eucalyptus crebra* (0.1%)*, Evolvulus alsinoides* (0.1%)*, Fimbristylis dichotoma* (0.1%)*, Glycine sp.* (Mackay S.B.Andrews+ 43) (0.1%)*, Grewia retusifolia* (0.3%)*, Heliotropium peninsulare* (0.1%)*, Marsdenia microlepis* (0.1%)*, Panicum effusum* (0.4%)*, Petalostigma pubescens* (0.1%)*, Phyllanthus carpentariae* (0.1%)*, Phyllanthus collinus* (0.1%)*, Pseuderanthemum variabile* (0.1%)*, Scoparia dulcis** (0.1%)*, Sida hackettiana* (0.3%)*, Sida spinosa** (0.1%)*, Stylosanthes scabra** (0.1%)*.*

SECONDARY SITE 39 **11.10.1**

Latitude, Longitude: -22.2909, 148.1633

Community description: Open forest dominated by *Corymbia citriodora, Corymbia trachyphloia* and *Lysicarpus angustifolius* on a steep, sandstone hillside.

Dominant species per stratum:

T1: *Corymbia citriodora, Corymbia trachyphloia, Lysicarpus angustifolius.*
T2: *Lysicarpus angustifolius, Corymbia trachyphloia*
S1: *Acacia dietrichiana, Lysicarpus angustifolius.*
G: *Cleistochloa subjuncea, Scleria sphacelata, Digitaria diminuta, Goodenia* sp. (Mt Castletower M.D. Crisp 2753).

Median (and range) canopy height per stratum: T1 =11.8 m (10.4–18.2 m), T2 = 4.0 m (3.0–5.2 m), S1 = 1.5 m (0.5 – 2.0 m).

% cover of each stratum: T1 = 49.8%; T2 = 8.8%; S1 = 5.2%; **total = 56.6%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Lysicarpus angustifolius* = 4.67 m^2/ha; *Corymbia trachyphloia* = 1.67 m^2/ha; *Acacia shirleyi* = 1.5 m^2/ha; *Corymbia citriodora* = 0.83 m^2/ha; *Eucalyptus crebra* = 0.33 m^2/ha **(total = 9 m^2/ha)**.
T2: *Corymbia trachyphloia* = 0.33 m^2/ha; *Lysicarpus angustifolius* = 0.17 m^2/ha; *Larsenaikia ochreata* = 0.17 m^2/ha **(total = 0.67 m^2/ha)**.
S1: <0.15 m^2/ha.

Landform: Steep rocky slope. **Slope:** 38°S **Soil:** Grey sand with abundant sandstone.

Disturbance: Regular but not recent fire.

Ground cover: Rock = 30%, wood = 0.5%, bare = 1%, litter = 40%, vegetation = 28.5%.

Species (percent cover): *Acacia dietrichiana* (0.1%), *Acacia flavescens* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida gracilipes* (0.1%), *Calotis cuneifolia* (0.1%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (13.5%), *Coelospermum reticulatum* (0.1%), *Commelina lanceolata* (0.1%), *Coronidium oxylepis* (0.1%), *Corymbia trachyphloia* (0.4%), *Cyanthillium cinereum* (0.1%), *Cymbopogon obtectus* (0.5%), *Cyperus betchei* (0.1%), *Daviesia filipes* (0.1%), *Desmodium rhytidophyllum* (0.1%), *Digitaria diminuta* (3%), *Eragrostis spartinoides* (0.1%), *Eriachne obtusa* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Goodenia* sp. (Mt Castletower M.D. Crisp 2753) (4%), *Hovea tholiformis* (0.1%), *Larsenaikia ochreata* (0.1%), *Lysicarpus angustifolius* (0.9%), *Oxalis corniculata* (0.1%), *Panicum effusum* (0.3%), *Persoonia falcata* (0.1%), *Phyllanthus collinus* (0.1%), *Pomax umbellata* (0.1%), *Scleria sphacelata* (2%), *Setaria surgens* (0.1%), *Sorghum leiocladum* (0.1%), *Tephrosia* sp. A (0.1%), *Xanthorrhoea johnsonii* (1%), *Zornia* sp. (0.1%).

SECONDARY SITE 40 **11.10.7**

Latitude, Longitude: -22.2930, 148.1505

Community description: Woodland dominated by *Eucalyptus crebra* and *Eucalyptus melanophloia* growing on a low terrace on a sandstone slope.

Dominant species per stratum:

T1: *Eucalyptus crebra, Eucalyptus melanophloia, Acacia shirleyi.*
T2: *Petalostigma pubescens, Acacia burdekensis.*
S1: *Eucalyptus crebra*
G: *Aristida calycina* var. *calycina, Chrysopogon fallax, Eriochloa crebra.*

Median (and range) canopy height per stratum: T1 = 12.8 m (9.2–14.6 m), T2 = 5.6 m (4.0–7.0 m), S1 = 2 m (0.5–3.0 m).

% cover of each stratum: T1 = 23%; T2 = 8.7%; S1 = 5.1%; **total = 33.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 2.67 m^2/ha; *Eucalyptus melanophloia* = 1.83 m^2/ha; *Acacia shirleyi* = 0.5 m^2/ha; *Corymbia dallachiana* = 0.17 m^2/ha **(total = 5.17 m^2/ha)**
T2: *Petalostigma pubescens* = 1 m^2/ha; *Acacia burdekensis* = 0.5 m^2/ha **(total = 1.5 m^2/ha)**
S1: < 0.17 m^2/ha

Landform: Ledge on foot slope of sandstone ridge. **Slope:** 6°ESE **Soil:** Grey-brown sand with no outcropping rock.

Disturbance: Lightly grazed.

Ground cover: Rock = 0%, wood = 1%, bare = 59%, litter = 20%, vegetation = 20%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (4%), *Cenchrus ciliaris** (0.1%), *Chamaecrista absus* (0.1%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (6.5%), *Corymbia dallachiana* (0.1%), *Cyanthillium cinereum* (0.1%), *Digitaria brownii* (0.1%), *Digitaria diminuta* (0.1%), *Digitaria* sp. A (0.4%), *Eragrostis leptostachya* (0.1%), *Eragrostis sororia* (0.5%), *Eriochloa crebra* (5%), *Erythroxylum australe* (0.1%), *Eucalyptus crebra* (0.1%), *Eucalyptus melanophloia* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Lobelia purpurascens* (0.1%), *Melinis repens** (0.1%), *Murdannia graminea* (0.1%), *Panicum effusum* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus collinus* (0.1%), *Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 1810) (0.1%), *Rostellularia adscendens* (0.1%), *Sida cordifolia** (0.1%), *Sida hackettiana* (0.2%), *Sida spinosa** (0.3%), *Stylosanthes scabra** (0.2%), *Themeda triandra* (0.1%), *Urochloa mosambicensis** (0.1%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 41 **11.10.1**

Latitude, Longitude: -22.2933, 148.1519

Community description: Open forest dominated by *Corymbia citriodora* on a rocky sandstone foot slope.

Dominant species per stratum:

T1: *Corymbia citriodora, Eucalyptus crebra* (subdominant).
T2: *Corymbia citriodora, Corymbia trachyphloia, Eucalyptus crebra.*
S1: *Acacia flavescens, Acacia burdekensis.*
G: *Cymbopogon refractus, Themeda triandra, Melinis repens**.*

Median (and range) canopy height per stratum: T1 = 24.4 m (23–25.8 m), T2 = 11 m (8.4–13 m), S1 = 2.5 m (0.6–4 m).

% cover of each stratum: T1 = 46.2%; T2 = 30.2%; S1 = 14.1%; **total = 69.6%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia citriodora* = 3.17 m^2/ha; *Eucalyptus crebra* = 0.67 m^2/ha **(total = 3.84 m^2/ha)**.
T2: *Eucalyptus crebra* = 4.67 m^2/ha; *Corymbia trachyphloia* = 0.33 m^2/ha **(total = 5 m^2/ha)**.
S1: < 0.17 m^2/ha

Landform: Rocky foot slope next to gully **Slope:** 18°E **Soil:** Grey-brown sand with sandstone boulders

Disturbance: Few weeds and light grazing.

Ground cover: Rock = 35%, wood = 0.5%, bare = 10%, litter = 31.5%, vegetation = 23%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Acacia macradenia* (0.2%), *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.3%), *Aristida benthamii* (0.1%), *Aristida spuria* (0.1%), *Breynia oblongifolia* (0.1%), *Brunoniella australis* (0.1%), *Capparis canescens* (0.1%), *Cenchrus ciliaris** (0.2%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (0.1%), *Coelospermum reticulatum* (0.1%), *Corymbia citriodora* subsp. *citriodora* (0.1%), *Crotalaria montana* (0.1%), *Cyanthillium cinereum* (0.1%), *Cymbopogon refractus* (8.4%), *Dichanthium sericeum* (0.1%), *Enneapogon lindleyanus* (0.1%), *Eriochloa pseudoacrotricha* (0.1%), *Erythroxylum australe* (0.1%), *Eucalyptus crebra* (0.1%), *Eucalyptus melanophloia* (0.1%), *Eustrephus latifolius* (0.1%), *Glycine tomentella* (0.1%), *Grewia latifolia* (0.1%), *Hakea lorea* (0.1%), *Indigofera australis* (0.1%), *Larsenaikia ochreata* (0.1%), *Marsdenia microlepis* (0.1%), *Melhania oblongifolia* (0.1%), *Melinis repens** (2%), *Panicum effusum* (0.1%), *Persoonia falcata* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus virgatus* (0.1%), *Pterocaulon ciliosum* (0.1%), *Pycnospora lutescens* (0.1%), *Rostellularia adscendens* (0.1%), *Scleria sphacelata* (0.1%), *Sida spinosa** (0.1%), *Solanum ellipticum* (0.1%), *Stylosanthes scabra** (0.1%), *Tephrosia juncea* (0.1%), *Themeda triandra* (8%).

SECONDARY SITE 42 **11.10.3**

Latitude, Longitude: -22.2988, 148.1585

Community description: Low open forest dominated by *Acacia shirleyi*, with emergent *Corymbia aureola*, on a terrace of a sandstone ridge.

Dominant species per stratum:

E: *Corymbia aureola.*
T1: *Acacia shirleyi.*
S1: *Alphitonia excelsa, Erythroxylum australe.*
G: *Cleistochloa subjuncea, Eriachne obtusa, Thyridolepis xerophila*

Median (and range) canopy height per stratum: E = 13.2 m (11.8–13.6 m), T1 = 9.8 m (5.6–10.4 m), S1 = 1.5 m (1.0–1.5 m).

% cover of each stratum: E = 21.5%; T1 = 58.2%; S1 = 1.4%; t**otal = 70.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Acacia shirleyi* = 0.5 m^2/ha; *Corymbia aureola* = 0.83 m^2/ha **(total = 1.33 m^2/ha)**.
T1: *Acacia shirleyi* = 5.83 m^2/ha **(total = 5.83 m^2/ha)**.
S1: <0.15 m^2/ha.

Landform: Ledge of sandstone ridge. **Slope:** 8°N **Soil:** Pink-grey sand with many small rocks.

Disturbance: Recent fire seems to have resulted in many large dead *A. shirleyi*.

Ground cover: Rock = 5%, wood = 8%, bare = 28%, litter = 35%, vegetation = 24%.

Species (percent cover): *Acacia shirleyi* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida gracilipes* (0.1%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (17.7%), *Digitaria diminuta* (0.1%), *Eragrostis sororia* (0.1%), *Eriachne obtusa* (4%), *Marsdenia microlepis* (0.1%), *Pseuderanthemum variabile* (0.1%), *Scleria sphacelata* (0.1%), *Solanum parvifolium* (0.1%), *Thyridolepis xerophila* (1%), *Wrightia saligna* (0.1%).

SECONDARY SITE 43 **HVR 11.5.9**

Latitude, Longitude: -22.2852, 148.1759

Community description: Woodland dominated by *Eucalyptus crebra* on a sand plain.

Dominant species per stratum:

T1: *Eucalyptus crebra.*
T2: *Ventilago viminalis, Grevillea parallela, Acacia excelsa.*
S1: *Erythroxylum australe.*
G: *Cenchrus ciliaris*, Bothriochloa pertusa*.*

Median (and range) canopy height per stratum: T1 = 14.8 m (11.2–17.4 m), T2 = 7.8 m (7.4–9.2 m), S1 = 2.0 m (1.0–3.0 m).

% cover of each stratum: T1 = 22.5%; T2 = 16.9%; S1 = 16%; **total = 43.9%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 3.33 m^2/ha; *Grevillea striata* = 0.17 m^2/ha; *Acacia excelsa* = 0.17 m^2/ha **(total = 3.67 m^2/ha)**.
T2: *Ventilago viminalis* = 1.67 m^2/ha *Corymbia dallachiana* = 1.33 m^2/ha; *Corymbia clarksoniana* = 1.17 m^2/ha; **(total = 4.17 m^2/ha)**.
S1: <0.15 m^2/ha.

Landform: Sandy foot slope **Slope:** 2°N **Soil:** Yellow sand

Disturbance: Heavily grazed; evidence of heavy thinning of vegetation; probably previously cleared.

Ground cover: Rock = 0%, wood = 0.5%, bare = 45%, litter = 30%, vegetation = 24.5%.

Species (percent cover): *Acacia excelsa* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Boerhavia pubescens* (0.1%), *Bothriochloa pertusa** (2%), *Capparis canescens* (0.1%), *Cenchrus ciliaris** (18.5%), *Chamaecrista absus* (0.1%), *Chrysopogon fallax* (0.1%), *Clerodendrum floribundum* (0.1%), *Commelina lanceolata* (0.1%), *Dianella nervosa* (0.1%), *Digitaria longiflora* (0.1%), *Eragrostis lacunaria* (0.1%), *Eragrostis spartinoides* (0.1%), *Erythroxylum australe* (0.3%), *Eucalyptus crebra* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Flindersia dissosperma* (0.1%), *Galactia tenuiflora* (0.1%), *Harrisia martinii** (0.1%), *Jacquemontia paniculata* (0.1%), *Melhania oblongifolia* (0.1%), *Murdannia graminea* (0.1%), *Parsonsia lanceolata* (0.4%), *Phyllanthus collinus* (0.1%), *Portulaca oleracea** (0.1%), *Portulaca pilosa** (0.1%), *Pseuderanthemum variabile* (0.1%), *Rostellularia adscendens* (0.1%), *Sida spinosa** (0.1%), *Stylosanthes scabra** (0.1%), *Urochloa mosambicensis** (0.1%), *Ventilago viminalis* (0.1%), *Vittadinia pustulata* (0.1%).

SECONDARY SITE 44 **11.10.1x1**

Latitude, Longitude: -22.2774, 148.1604

Community description: Low woodland dominated by *Corymbia aureola* on a sandstone plateau. Mapped as high-value regrowth, but is probably remnant and naturally stunted by the lack of topsoil. It is improbable that it would have been cleared considering the difficult terrain.

Dominant species per stratum:

T1: *Corymbia aureola.*
S1: *Acacia bancroftiorum, Acacia flavescens, Acacia burdekensis.*
G: *Cleistochloa subjuncea, Melinis repens*

Median (and range) canopy height per stratum: T1 = 9.6 m (6.4–10.4 m), S1 = 2.5 m (0.5–3.5 m).

% cover of each stratum: T1 = 26.2%; S1 = 40.7%; **total = 62.1%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia aureola* = 5 m^2/ha; *Terminalia porphyrocarpa* = 0.17 m^2/ha **(total = 5.17 m^2/ha)**.
S1: *Acacia shirleyi* = 0.17 m^2/ha; *Acacia flavescens* = 0.17 m^2/ha **(total = 0.34 m^2/ha)**.

Landform: Rocky plateau. **Slope:** 12°W **Soil:** Quartz/white sand.

Disturbance: Lightly grazed; many large dead trees appear to have been killed by a severe historical fire. This may be why the site appeared to be non-remnant from aerial imagery.

Ground cover: Rock = 35%, wood = 0.5%, bare = 5%, litter = 43%, vegetation = 17%.

Species (percent cover): *Acacia bancroftiorum* (0.1%), *Acacia burdekensis* (0.2%), *Acacia dietrichiana* (0.1%), *Acacia flavescens* (0.3%), *Acacia shirleyi* (0.2%), *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.1%), *Aristida benthamii* (0.8%), *Cheilanthes sieberi* (0.1%), *Cleistochloa subjuncea* (12%), *Corymbia aureola* (0.1%), *Digitaria diminuta* (0.2%), *Eragrostis spartinoides* (0.1%), *Eriachne obtusa* (0.1%), *Erythroxylum australe* (0.4%), *Euphorbia drummondii* (0.1%), *Evolvulus alsinoides* (0.1%), *Galactia tenuiflora* (0.1%), *Hovea tholiformis* (0.3%), *Larsenaikia ochreata* (0.1%), *Lomandra longifolia* (0.1%), *Melinis repens* (1%), *Panicum effusum* (0.1%), *Solanum ellipticum* (0.1%), *Urochloa piligera* (0.1%).

SECONDARY SITE 45 **HVR 11.10.3**

Latitude, Longitude: -22.2905, 148.1883

Community description: Open forest dominated by *Acacia shirleyi*, with emergent *Eucalyptus crebra* and *Corymbia clarksoniana*, on a low sandstone ridge.

Dominant species per stratum:

E: *Eucalyptus crebra, Corymbia clarksoniana.*
T1: *Acacia shirleyi.*
S1: *Erythroxylum australe***.**
G: *Alloteropsis cimicina, Melinis repens*.*

Median (and range) canopy height per stratum: E = 12.8 m; T1 = 10.6 m (7.4–11.6 m), S1 = 3.0 m (1.0–4.0 m).

% cover of each stratum: E < 0.1%; T1 = 74.2%; S1 = 12%; **total = 76.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Corymbia clarksoniana* = 0.17 m^2/ha **(total = 0.17 m^2/ha)**.
T1: *Acacia shirleyi* = 14.67 m^2/ha **(total = 14.67 m^2/ha)**.
S1: <0.15 m^2/ha.

Landform: Low ridge. **Slope:** 15°S **Soil:** Pink-grey sand with lots of gravel.

Disturbance: Previously cleared; much dumped rubbish.

Ground cover: Rock = 5%, wood = 1%, bare = 20%, litter = 67%, vegetation = 7%.

Species (percent cover): *Acacia shirleyi* (0.1%), *Alloteropsis cimicina* (3.9%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Calotis cuneifolia* (0.1%), *Capparis canescens* (0.1%), *Cheilanthes sieberi* (0.1%), *Cyanthillium cinereum* (0.1%), *Digitaria diminuta* (0.1%), *Eragrostis lacunaria* (0.1%), *Erythroxylum australe* (0.1%), *Harrisia martinii** (0.1%), *Melinis repens* (1%), *Paspalidium gracile* (0.1%), *Portulaca filifolia* (0.1%), *Portulaca oleracea** (0.1%), *Pseuderanthemum variabile* (0.1%), *Ptilotus polystachyus* (0.1%), *Sida* sp. (Musselbrook M.B. Thomas+ MRS437) (0.4%), *Urochloa mosambicensis** (0.1%).

SECONDARY SITE 46 **11.3.25**

Latitude, Longitude: -22.3061, 148.1946

Community description: Closed forest dominated by *Eucalyptus camaldulensis* and *Melaleuca leucadendra* on the bank of an ephemeral watercourse.

Dominant species per stratum:

T1: *Eucalyptus camaldulensis, Melaleuca leucadendra.*
T2: *Alphitonia excelsa.*
S1: *Ficus opposita.*
G: *Bidens pilosa*, Megathyrsus maximus* var. *pubiglumis*, Acanthospermum hispidum*, Richardia brasiliensis*.*

Median (and range) canopy height per stratum: T1 = 21 m (18.4–21.2 m), T2 = 10.8 m (9.2–11 m), S1 = 2.5 m (1.0–4.0 m).

% cover of each stratum: T1 = 87.3%; T2 = 18.8%; S1 = 30.7%; **total = 87.7%**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Melaleuca leucadendra* = 9.83 m^2/ha; *Eucalyptus camaldulensis* = 8 m^2/ha; *Corymbia clarksoniana* = 0.5 m^2/ha **(total = 18.5 m^2/ha)**.
T2: *Alphitonia excelsa* = 0.33 m^2/ha; *Flindersia australis* =0.17 m^2/ha **(total = 0.5 m^2/ha)**.
S1: *Acacia macradenia* = 0.17 m^2/ha; *Ficus opposita* = 0.17 m^2/ha **(total = 0.33 m^2/ha)**.

Landform: Creek bank. **Slope:** 0° **Soil:** Sand.

Disturbance: Very high weed densities.

Ground cover: Rock = 0%, wood = 1%, bare = 15%, litter = 60%, vegetation = 24%.

Species (percent cover): *Acacia macradenia* (0.1%), *Acanthospermum hispidum** (3%), *Ageratum conyzoides** (0.4%), *Albizia canescens* (0.1%), *Alternanthera nana* (0.1%), *Aristolochia thozetii* (0.1%), *Bidens pilosa** (7%), *Bothriochloa pertusa** (0.6%), *Cenchrus ciliaris** (0.1%), *Clerodendrum floribundum* (0.1%), *Commelina diffusa* (0.1%), *Crinum arenarium* (0.1%), *Crotalaria mitchellii* (0.1%), *Crotalaria pallida** (0.1%), *Cryptostegia grandiflora** (0.1%), *Cyanthillium cinereum* (0.1%), *Cyperus gracilis* (0.1%), *Dactyloctenium radulans* (0.1%), *Desmodium filiforme* (0.1%), *Digitaria brownii* (0.1%), *Digitaria eriantha** (0.2%), *Echinochloa colona** (0.1%), *Emilia sonchifolia** (0.2%), *Erythrina vespertilio* (0.1%), *Eucalyptus camaldulensis* (0.1%), *Ficus opposita* (3%), *Ipomoea plebia* (0.1%), *Juncus usitatus* (0.1%), *Lomandra longifolia* (0.1%), *Macroptilium atropurpureum** (0.1%), *Megathyrsus maximus* var. *pubiglumis** (1.4%), *Parthenium hysterophorus** (0.1%), *Passiflora foetida** (0.7%), *Richardia brasiliensis** (3%), *Scoparia dulcis** (0.1%), *Senna occidentalis** (0.1%), *Sida cordifolia** (1%), *Sida hackettiana* (0.1%), *Sida rhombifolia* (0.2%), *Urochloa mosambicensis** (0.5%), *Xanthium occidentale** (0.1%).

SECONDARY SITE 47 **HVR 11.5.3**

Latitude, Longitude: -22.3940, 148.2580

Community description: Woodland dominated by *Eucalyptus populnea* on sand plain. A very small amount of sandstone present at the surface, but otherwise is land zone 5.

Dominant species per stratum:

T1: *Eucalyptus populnea.*
T2: *Alphitonia excelsa, Cassia brewsteri, Melaleuca nervosa.*
S1: *Erythroxylum australe.*
G: *Alloteropsis cimicina, Eriochloa crebra, Sida hackettiana, Stylosanthes scabra*.*

Median (and range) canopy height per stratum: T1 = 15.2 m (11.6–16 m), T2 = 6.6 m (6.2–8.6 m), S1 = 2.5 m (1.0–4.2 m).

% cover of each stratum: T1 = 31.1%; T2 = 16.4%; S1 = 0.6; **total = 44.9%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 6.83 m^2/ha **(total = 6.83 m^2/ha)**.
T2: *Cassia brewsteri* = 0.5 m^2/ha; *Alphitonia excelsa* = 1.67 m^2/ha **(total = 2.17 m^2/ha)**.
S1: <0.15 m^2/ha.

Landform: Plain **Slope:** 1°N **Soil:** Yellow-grey sand.

Disturbance: Previously cleared; grazed.

Ground cover: Rock = 0.1%, wood =0.5%, bare = 45%, litter = 25%, vegetation = 29.4%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Acacia salicina* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Alloteropsis cimicina* (13%), *Alphitonia excelsa* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Aristida holathera* (0.9%), *Bonamia media* (0.1%), *Carissa ovata* (0.1%), *Cenchrus ciliaris** (0.4%), *Cheilanthes sieberi* (0.1%), *Chrysopogon fallax* (0.3%), *Desmodium filiforme* (0.1%), *Digitaria divaricatissima* (0.2%), *Digitaria eriantha** (0.1%), *Diospyros humilis* (0.1%), *Eragrostis lacunaria* (0.1%), *Eragrostis sororia* (0.2%), *Eragrostis speciosa* (0.1%), *Eriachne mucronata* (0.1%), *Eriochloa crebra* (6%), *Erythroxylum australe* (0.3%), *Eucalyptus populnea* (0.1%), *Euphorbia bifida* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (0.1%), *Ipomoea polymorpha* (0.1%), *Melinis repens* (0.1%), *Perotis rara* (0.2%), *Phyllanthus collinus* (0.2%), *Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 1810) (0.2%), *Phyllanthus virgatus* (0.1%), *Portulaca filifolia* (0.1%), *Portulaca oleracea** (0.1%), *Sida hackettiana* (2%), *Sida spinosa** (0.1%), *Stylosanthes hamata** (0.1%), *Stylosanthes scabra** (2%), *Tephrosia leptoclada* (0.2%), *Urochloa mosambicensis** (0.1%), *Zornia* sp. (0.7%)**.**

SECONDARY SITE 48 **11.5.3**

Latitude, Longitude: -22.3895, 148.2367

Community description: Woodland dominated by *Eucalyptus populnea* on a sand plain.

Dominant species per stratum:

T1: *Eucalyptus populnea.*
T2: *Vachellia bidwillii, Eucalyptus populnea.*
S1: *Carissa ovata.*
G: *Scoparia dulcis*, Heteropogon contortus, Fimbristylis dichotoma, Bothriochloa pertusa*, Cenchrus ciliaris*, Urochloa mosambicensis*.*

Median (and range) canopy height per stratum: T1 = 16.8 m (11.6–19.8 m), T2 = 4.2 m (2.8–6.8 m), S1 = 1.0 m (0.5–1.5 m).

% cover of each stratum: T1 = 44.2%; T2 = 3%; S1 = 12.7%; **total = 45.3%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus populnea* = 14.67 m^2/ha; *Corymbia clarksoniana* = 0.33 m^2/ha; *Eucalyptus crebra* = 0.17 m^2/ha; *Eucalyptus melanophloia* = 0.17 m^2/ha **(total = 15.34 m^2/ha)**
T2: *Corymbia dallachiana* = 0.17 m^2/ha; *Cassia brewsteri* = 0.17 m^2/ha; *Vachellia bidwillii* = 0.17 m^2/ha **(total = 0.51 m^2/ha)**
S1: < 0.15 m^2/ha

Landform: Plain. **Slope:** 0° **Soil:** Fine grey-brown sand.

Disturbance: Grazed.

Ground cover: Rock = 0%, wood =0.8%, bare = 25%, litter = 35%, vegetation = 39.2%.

Species (percent cover): *Achyranthes aspera* (0.1%), *Afrohybanthus enneaspermus* (0.1%), *Afrohybanthus stellarioides* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.4%), *Boerhavia pubescens* (0.1%), *Bothriochloa ewartiana* (0.2%), *Bothriochloa pertusa** (4%), *Carissa ovata* (2%), *Cenchrus ciliaris** (5%), *Chamaecrista absus* (0.1%), *Chrysopogon fallax* (0.8%), *Crotalaria juncea** (0.1%), *Cyanthillium cinereum* (0.1%), *Cynodon dactylon** (0.1%), *Cyperus fulvus* (0.1%), *Cyperus gracilis* (0.1%), *Desmodium filiforme* (0.1%), *Enteropogon ramosus* (0.2%), *Eragrostis sororia* (0.1%), *Eriochloa crebra* (0.3%), *Eucalyptus populnea* (0.1%), *Euphorbia drummondii* (0.1%), *Evolvulus alsinoides* (0.1%), *Fimbristylis dichotoma* (3%), *Glycine tomentella* (0.1%), *Grewia retusifolia* (0.2%), *Heteropogon contortus* (3%), *Indigofera colutea* (0.1%), *Ipomoea plebia* (0.1%), *Malvastrum americanum** (0.1%), *Melinis repens* (0.5%), *Phyllanthus collinus* (0.1%), *Polygala triflora* (0.1%), *Scoparia dulcis** (5%), *Sida hackettiana* (0.2%), *Sida spinosa** (0.8%), *Spermacoce brachystema* (0.1%), *Stylosanthes scabra** (2%), *Urochloa mosambicensis** (9%), *Vachellia bidwillii* (0.1%), *Zornia areolata* (0.1%).

SECONDARY SITE 49 **11.4.8**

Latitude, Longitude: -22.3526, 148.2236

Community description: Open forest dominated by *Acacia harpophylla* and *Casuarina cristata*, with emergent *Eucalyptus cambageana*, on a clay plain.

Dominant species per stratum:

E: *Eucalyptus cambageana*.
T1: *Acacia harpophylla*, *Casuarina cristata, Terminalia oblongata.*
T2: *Acacia harpophylla*, *Terminalia oblongata.*
S1: *Carissa ovata, Terminalia oblongata.*
G: *Paspalidium caespitosum*, *Eragrostis lacunaria*.

Median (and range) canopy height per stratum: E = 20.4 m (18.4–24.6 m); T1 = 12.8 m (12.2–16.6 m), T2 = 5.0 m (4.8–5.8 m), S1 = 1.5 m (0.5–3.0 m).

% cover of each stratum: E = 10.6%; T1 = 56.5%; T2 = 12%; S1 = 43.1%; **total = 83.4%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Eucalyptus cambageana* = 0.5 m^2/ha **(total = 0.5 m^2/ha)**.
T1: *Casuarina cristata* = 4.67 m^2/ha; *Acacia harpophylla* = 4.5 m^2/ha; *Terminalia oblongata* = 3 m^2/ha; *Eucalyptus cambageana* = 0.67 m^2/ha; *Ventilago viminalis* = 0.17 m^2/ha **(total = 13.01 m^2/ha)**.
T2: <0.17 m^2/ha.
S1: <0.17 m^2/ha.

Landform: Plain. **Slope:** 2°NE **Soil:** Brown clay loam with some surface pebbles. No obvious gilgais.

Disturbance: Grazed.

Ground cover: Rock = 0.1%, wood = 1%, bare = 24%, litter = 38%, vegetation = 36.9%.

Species (percent cover): *Abutilon oxycarpum* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Bothriochloa pertusa** (0.1%), *Brunoniella australis* (0.1%), *Carissa ovata* (0.1%), *Casuarina cristata* (31.4%), *Cenchrus ciliaris** (0.1%), *Chloris divaricata* (0.1%), *Chrysopogon fallax* (0.1%), *Cymbopogon refractus* (0.1%), *Cynanchum viminale* (0.1%), *Desmodium varians* (0.1%), *Enneapogon* sp. A (0.1%), *Eragrostis lacunaria* (0.4%), *Eremophila mitchellii, Erythroxylum australe, Evolvulus alsinoides, Flindersia dissosperma, Glycine* sp. (Mackay S.B. Andrews+ 43), *Grewia latifolia* (0.1%), *Hibiscus sturtii* (0.1%), *Jacquemontia paniculata* (0.1%), *Jasminum didymum* subsp. *lineare* (0.1%), *Melhania oblongifolia* (0.1%), *Ocimum caryophyllinum* (0.1%), *Paspalidium caespitosum* (0.1%), *Phyllanthus virgatus* (0.1%), *Rhynchosia minima* (0.1%), *Scleria brownii* (0.2%), *Terminalia oblongata* (2%).

SECONDARY SITE 50 **11.10.8**

Latitude, Longitude: -22.2892, 148.1563.
Community description: Low closed forest (semi-evergreen microphyll vine-thicket) dominated by *Planchonella pubescens*, *Geijera salicifolia*, *Gossia bidwillii* and *Hovea longipes* in a sheltered sandstone gorge.

Dominant species per stratum:

E: *Acacia shirleyi, Lophostemon suaveolens, Euroschinus falcatus.*
T1: *Planchonella pubescens, Geijera salicifolia, Drypetes deplanchei, Acronychia laevis, Psydrax odorata.*
S1: *Hovea longipes, Alyxia ruscifolia, Gossia bidwillii.*
G: *Ancistrachne uncinata.*

Median (and range) canopy height per stratum: E =11 m (10–13 m); T1 = 5 m (4–6 m); S1 = 1.5 m (1–2 m).

% cover of each stratum: E = 46.8%; T1 =64.7%; S1 = 30.4%; **total = 92.4%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

E: *Acacia shirleyi* = 0.83 m^2/ha; *Alectryon connatus* = 0.17 m^2/ha; *Bursaria incana* = 0.33 m^2/ha; *Euroschinus falcata* = 0.5 m^2/ha; *Ficus rubiginosa* = 0.17 m^2/ha; *Pleiogynium timoriense* **=** 0.33 m^2/ha; (**total = 2.33 m^2/ha)**.
T1: *Planchonella pubescens* = 3.17 m^2/ha; *Geijera salicifolia* = 2.67 m^2/ha; *Gossia bidwillii* = 1.5 m^2/ha; *Ehretia membranifolia* = 0.5 m^2/ha; *Exocarpos latifolius* = 0.67 m^2/ha; *Drypetes deplanchei* = 0.17 m^2/ha; *Psydrax odorata* subsp. *buxifolia* = 0.17 m^2/ha; **(total = 8.85 m^2/ha)**.
S1: *Hovea longipes* = 1.33 m^2/ha; *Psydrax odorata* subsp. *buxifolia* = 0.67 m^2/ha **(total = 2 m^2/ha)**.

Landform: Rocky gorge. **Slope:** 45°ESE **Soil:** Abundant sandstone boulders.

Disturbance: nil.

Ground cover: Rock = 70%, bare = 2%, litter = 20%, vegetation = 8%.

Species (percent cover): *Abutilon oxycarpum* (0.1%), *Acacia burdekensis* (0.1%), *Acacia shirleyi* (0.1%), *Acronychia laevis* (0.1%), *Alectryon connatus* (0.1%), *Alphitonia excelsa* (0.1%), *Alyxia ruscifolia* (0.7%), *Amyema conspicua* (0.1%), *Ancistrachne uncinata* (0.5%), *Bidens bipinnata** (0.1%), *Bursaria incana* (0.1%), *Capparis lasiantha* (0.1%), *Cassytha filiformis* (0.1%), *Cheilanthes nudiuscula* (0.2%), *Cissus oblonga* (0.1%), *Cleistochloa subjuncea* (0.7%), *Commelina diffusa* (0.2%), *Cyanthillium cinereum* (0.2%), *Deeringia amaranthoides* (0.1%), *Dinebra decipiens* var. *decipiens* (0.1%), *Diospyros humilis* (0.1%), *Drypetes deplanchei* (0.3%), *Ehretia membranifolia* (0.1%), *Exocarpos latifolius* (0.3%), *Ficus rubiginosa* (0.1%), *Gahnia aspera* (0.1%), *Geijera salicifolia* (0.1%), *Gossia bidwillii* (0.2%), *Harrisia martinii** (0.1%), *Hovea longipes* (0.3%), *Jasminum didymum* subsp. *racemosum* (0.1%), *Jasminum simplicifolium* subsp*. australiense* (0.1%), *Larsenaikia ochreata* (0.2%), *Lophostemon suaveolens* (0.1%), *Myrsine variabilis* (0.1%), *Parsonsia lanceolata* (0.1%), *Pavetta granitica* (0.1%), *Planchonella pubescens* (0.1%), *Plectranthus parviflorus* (0.2%), *Pleiogynium timoriense* (0.1%), *Psydrax odorata* subsp. *buxifolia* (0.1%), *Richardia brasiliensis** (0.1%), *Scleria brownii* (0.1%), *Scleria sphacelata* (0.1%), *Scoparia dulcis** (0.1%), *Secamone elliptica* (0.1%), *Setaria surgens* (0.1%), *Sida hackettiana* (0.1%), *Solanum ellipticum* (0.1%), *Tetrastigma nitens* (0.1%), *Trema tomentosa* (0.1%), *Trophis scandens* (0.1%).

SECONDARY SITE 51 **11.10.7**

Date: 1 April 2020

Latitude, Longitude: -22.2798, 148.1368

Community description: *Eucalyptus crebra* open woodland situated on a terrace of a sandstone slope.

Dominant species per stratum:

T1: *Eucalyptus crebra, Eucalyptus melanophloia* (sub-dominant).
S1: *Acacia burdekensis.*
G: *Bothriochloa pertusa*, Chrysopogon fallax*

Median (and range) canopy height per stratum: T1 = 15.8 m (12.3-16 m), S1 = 2.6 m (2.1-8.2 m).

% cover of each stratum (vertical projection along 100 m tape): T1 = 15.2 %, S1 < 0.1%; **total = 15.2%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Eucalyptus crebra* = 3.33 m^2/ha **(total = 3.33 m^2/ha).**

Landform: Terrace of a sandstone slope. **Slope:** 1°W **Soil:** Grey-brown sandy clay.

Disturbance: Many dead trees; high weed density.

Ground cover: rock = 1.5%, litter = 20.5%, bare = 18%, vegetation = 60%.

Species (percent cover): *Acacia burdekensis* (0.1%), *Alloteropsis cimicina* (0.1%), *Alphitonia excelsa* (0.1%), *Alternanthera nana* (0.1%), *Aristida calycina* var. *calycina* (0.1%), *Bothriochloa bladhii* (0.1%), *Bothriochloa decipiens* var. *decipiens* (2%), *Bothriochloa pertusa** (48%), *Brunoniella australis* (0.1%), *Cenchrus ciliaris** (0.1%), *Chrysopogon fallax* (5.5%), *Crotalaria juncea* (0.1%), *Cyanthillium cinereum* (0.1%), *Cyperus fulvus* (0.1%), *Dactyloctenium radulans* (0.1%), *Dichanthium sericeum* (0.1%), *Digitaria ammophila* (0.1%), *Digitaria papposa* (0.5%), *Enteropogon acicularis* (0.1%), *Eragrostis sororia* (0.1%), *Eucalyptus crebra* (0.1%), *Eulalia aurea* (0.1%), *Fimbristylis dichotoma* (0.1%), *Galactia tenuiflora* (0.1%), *Ipomoea polymorpha* (0.1%), *Lobelia concolor* (0.1%), *Marsdenia microlepis* (0.1%), *Melhania oblongifolia* (0.1%), *Melinis repens** (0.1%), *Panicum effusum* (0.1%), *Parthenium hysterphorus** (0.1%), *Phyllanthus virgatus* (0.1%), *Rhynchosia minima* (0.1%), *Sida hackettiana* (0.3%), *Sida rohlenae* subsp. *rohlenae* (0.1%), *Sporobolus caroli* (0.1%), *Stylosanthes scabra** (0.1%), *Themeda triandra* (0.2%), *Tragus australianus* (0.1%), *Urochloa mosambicensis** (0.1%), *Zornia muelleriana* subsp. *muelleriana* (0.1%).

SECONDARY SITE 52 **11.10.1**

Date: 2 April 2020

Latitude, Longitude: -22.2728, 148.1414

Community description: Open forest dominated by *Corymbia citriodora* on sandstone.

Dominant species per stratum:

T1: *Corymbia citriodora, Eucalyptus crebra* (sub-dominant).
T2: *Acacia shirleyi, Alphitonia excelsa, Corymbia citriodora.*
S1: *Acacia bancroftiorum, Acacia flavescens, Erythroxylum australe.*
G: *Cleistochloa subjuncea, Scleria sphacelata.*

Median (and range) canopy height per stratum: T1 = 18.8 m (16.8-21.6 m), T2 = 8.8 m (6.8-10.2 m), S1 = 2 m (1.1-3.6 m).

% cover of each stratum (vertical projection along 100 m tape): T1 = 42.1%, T2 =18.1%, S1 = 23.8%; **total = 73.7%.**

Basal area (using a Bitterlich gauge, measured at three points along the transect)**:**

T1: *Corymbia aureola* = 0.17 m^2/ha; *Corymbia citriodora* = 5.67 m^2/ha **(total = 5.83 m^2/ha).**
T2: *Acacia shirleyi* = 0.83 m^2/ha; *Euroschinus falcata* = 0.17 m^2/ha **(total = 1 m^2/ha).**
S1: *Erythroxylum australe* **=** 0.17 m^2/ha; **(total = 0.17 m^2/ha).**

Landform: Crest of hill slope. **Slope:** 20°S **Soil:** Coarse sand.

Disturbance: Minimal.

Ground cover: rock = 61.8%, litter = 18%, bare = 0.5%, vegetation = 19.7%.

Species (percent cover): *Acacia bancroftiorum* (0.1%), *Acacia flavescens* (0.1%), *Amyema congener* (0.1%), *Blumea axillaris* (0.1%), *Breynia oblongifolia* (0.1%), *Bursaria incana* (0.1%), *Cassytha filiformis* (0.1%), *Cleistochloa subjuncea* (13%), *Clerodendrum floribundum* (0.1%), *Corymbia citriodora* subsp. *citriodora* (0.1%), *Cyanthillium cinereum* (0.1%), *Cyclophyllum coprosmoides* (0.3%), *Cymbopogon obtectus* (0.1%), *Desmodium rhytidophyllum* (0.1%), *Digitaria ramularis* (0.1%), *Dinebra decipiens* var. *decipiens* (0.1%), *Erythroxylum australe* (0.1%), *Euphorbia bifida* (0.1%), *Euphorbia tannensis* (0.1%), *Evolvulus alsinoides* (0.1%), *Galactia tenuiflora* (0.1%), *Goodenia* sp. (Mt Castletower M.D. Crisp 2753) (0.1%), *Hibiscus meraukensis* (0.1%), *Indigofera pratensis* (0.1%), *Ipomoea brownii* (0.1%), *Jasminum didymum* subsp. *lineare* (0.1%), *Marsdenia microlepis* (0.1%), *Melinis repens** (0.1%), *Oxalis corniculata* (0.1%), *Pandorea pandorana* (0.1%), *Parsonsia lanceolata* (0.1%), *Persoonia falcata* (0.1%), *Petalostigma pubescens* (0.1%), *Phyllanthus carpentariae* (0.1%), *Phyllanthus virgatus* (0.1%), *Scleria sphacelata* (3%), *Setaria surgens* (0.1%).

APPENDIX C

FLORA AND FAUNA RECORDED DURING SURVEYS

Appendix C1 Flora recorded during field surveys

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Acanthaceae	*Brunoniella australis*	Blue Trumpet	0	0	100	100	29	33	67	33	0	0	0	0	50
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower; Love Flower	0	0	50	0	0	11	0	33	80	67	0	20	0
Acanthaceae	*Rostellularia adscendens*	Pink Tongues	50	33	0	0	29	22	67	67	0	33	0	0	0
Aizoaceae	*Portulaca bicolor*		0	0	0	0	0	11	0	0	20	33	0	0	0
Aizoaceae	*Portulaca filifolia*		50	0	25	0	57	11	0	0	20	0	0	20	25
Aizoaceae	*Portulaca oleracea**	Common Purslane	0	0	50	100	43	11	33	0	20	33	0	0	0
Aizoaceae	*Portulaca pilosa**	Pink Purslane	50	33	25	0	29	78	0	0	20	33	0	0	75
Aizoaceae	*Trianthema portulacastrum**	Black Pigweed	0	0	0	0	0	0	0	0	0	0	0	0	0
Amaranthaceae	*Achyranthes aspera*	Devil's Horsewhip; Chaff Flower	0	67	25	0	43	0	0	0	20	33	0	20	0
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	0	0	0	100	43	0	0	0	0	0	0	0	0
Amaranthaceae	*Alternanthera nana*	Hairy Joyweed	50	33	25	0	86	44	0	33	40	0	0	0	50
Amaranthaceae	*Alternanthera pungens**	Khaki Weed	0	0	0	0	0	0	0	0	0	0	0	0	0
Amaranthaceae	*Amaranthus interruptus*		0	0	0	100	0	0	0	0	0	33	0	0	0
Amaranthaceae	*Amaranthus viridis**	Green Amaranth	0	0	0	100	0	0	0	0	0	0	0	0	0
Amaranthaceae	*Deeringia amaranthoides*	Redberry; Shrubby Deeringia	0	0	0	0	0	0	0	0	0	0	100	0	0
Amaranthaceae	*Gomphrena celosioides**	Gomphrena Weed	50	33	0	0	57	11	0	0	0	33	0	0	75
Amaranthaceae	*Nyssanthes erecta*		0	0	50	0	14	0	0	0	0	0	0	0	0
Amaranthaceae	*Ptilotus polystachyus*		0	0	0	0	0	0	0	0	40	0	0	0	0
Amaryllidaceae	*Crinum arenarium*	Field Lily	50	67	0	0	0	0	0	0	0	0	0	0	25
Anacardiaceae	*Euroschinus falcata*	Ribbonwood	0	0	0	0	0	0	0	0	0	0	0	0	0
Anacardiaceae	*Pleiogynium timoriense*	Burdekin Plum	0	0	0	0	0	0	0	0	0	0	100	0	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Apiaceae	*Platysace valida*		0	0	0	0	0	0	0	0	0	0	0	0	0
Apocynaceae	*Alstonia constricta*	Bitter Bark; Quinine Bush	0	0	0	0	0	0	0	0	0	0	0	0	0
Apocynaceae	*Alyxia ruscifolia*	Chain Fruit	0	0	0	0	0	0	0	0	0	0	100	0	0
Apocynaceae	*Carissa ovata*	Conkerberry; Currant Bush	100	33	100	100	71	11	67	0	0	0	0	0	50
Apocynaceae	*Cryptostegia grandiflora**	Rubber Vine	0	33	0	0	0	0	0	0	0	0	0	0	0
Apocynaceae	*Cynanchum viminale*	Caustic Vine	0	0	50	0	0	0	0	0	0	0	0	0	0
Apocynaceae	*Marsdenia microlepis*		0	0	0	0	0	0	0	67	80	67	0	20	0
Apocynaceae	*Marsdenia viridiflora* subsp. *viridiflora*	Native Pear	0	0	0	100	0	0	0	0	0	0	0	0	0
Apocynaceae	*Parsonsia lanceolata*	Rough Silkpod	50	0	50	100	29	11	0	0	0	0	100	0	25
Apocynaceae	*Secamone elliptica*	Corky Milk Vine	0	0	0	0	0	0	0	0	0	0	100	0	0
Apocynaceae	*Wrightia saligna*	Milk Wood	0	0	0	0	0	0	0	0	40	0	0	0	0
Aristolochiaceae	*Aristolochia thozetii*	Australian Native Dutchman's Pipe	0	33	0	0	14	0	0	0	0	0	0	0	0
Asteraceae	*Acanthospermum hispidum**	Bristly Star Bur; Goat's Head	0	100	0	0	29	33	0	0	0	0	0	0	25
Asteraceae	*Ageratum conyzoides**	Billygoat Weed	0	67	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Apowollastonia spilanthoides*		0	0	25	0	29	11	0	0	0	0	0	0	25
Asteraceae	*Bidens bipinnata**	Bipinnate Cobbler's Pegs	0	33	0	0	0	0	0	0	20	33	100	20	0
Asteraceae	*Bidens pilosa**	Cobbler's Pegs	0	67	0	0	0	11	0	0	0	33	0	0	0
Asteraceae	*Calotis cuneifolia*	Purple Burr-daisy	0	0	0	0	14	0	0	33	40	0	0	0	0
Asteraceae	*Calyptocarpus vialis*	Creeping Cinderella Weed	0	67	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Camptacra barbata*		0	0	0	0	0	0	33	0	0	0	0	0	0
Asteraceae	*Centipeda minima*	Spreading Sneezeweed	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Chrysocephalum apiculatum*	Billy Buttons	0	0	0	0	0	22	0	0	0	0	0	0	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Asteraceae	*Coronidium oxylepis*	Pointed Everlasting Daisy	0	0	0	0	0	0	0	33	0	0	0	0	0
Asteraceae	*Cyanthillium cinereum*	Vernonia	50	67	25	0	71	22	33	100	60	33	100	20	50
Asteraceae	*Eclipta prostrata**	False Daisy; Eclipta	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Emilia sonchifolia**	Tassel Flower; Emilia	0	67	0	0	0	22	0	0	0	0	0	0	0
Asteraceae	*Parthenium hysterophorus**	Parthenium Weed	0	100	25	100	0	11	33	0	0	0	0	0	25
Asteraceae	*Peripleura hispidula* var. *setosa*		0	0	0	0	0	0	33	0	0	0	0	0	0
Asteraceae	*Pterocaulon ciliosum*		0	0	0	0	0	0	0	33	0	0	0	0	0
Asteraceae	*Sonchus oleraceus**	Common Sowthistle	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Sphaeromorphaea australis*	Spreading Nut-heads	0	0	0	0	0	11	0	0	0	0	0	0	50
Asteraceae	*Tridax procumbens**	Tridax Daisy	0	33	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Verbesina encelioides**	Golden Crownbeard; Butter Daisy	0	33	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Vittadinia pustulata*		0	0	0	0	14	11	0	0	0	0	0	0	0
Asteraceae	*Xanthium occidentale**	Noogoora Burr	0	100	0	0	0	0	0	0	0	0	0	0	0
Bignoniaceae	*Pandorea pandorana*	Wonga Vine	0	0	0	0	0	0	0	0	0	33	0	0	0
Boraginaceae	*Ehretia membranifolia*	Peach Bush; Weeping Koda	0	0	25	100	0	0	0	0	0	0	100	0	0
Boraginaceae	*Heliotropium cunninghamii*		0	0	0	0	0	0	0	0	0	0	0	0	25
Boraginaceae	*Heliotropium peninsulare*		0	0	0	0	0	33	33	0	0	33	0	20	0
Brassicaceae	*Cardamine hirsuta**	Hairy Bittercress	0	0	0	0	0	0	0	0	0	0	0	0	0
Byttneriaceae	*Hannafordia shanesii*		0	0	0	0	0	0	0	0	0	0	0	0	0
Cactaceae	*Harrisia martinii**	Harrisia Cactus	100	0	50	0	0	11	0	0	20	0	100	0	0
Cactaceae	*Opuntia stricta**	Prickly Pear	0	0	0	0	0	0	0	0	0	0	0	0	0
Cactaceae	*Opuntia tomentosa **	Velvet Pear; Wooly Pear	50	0	25	0	14	0	0	0	20	0	0	0	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Caesalpiniaceae	*Bauhinia hookeri*	White Bauhinia	0	67	0	100	0	0	0	0	0	0	0	0	0
Caesalpiniaceae	*Cassia brewsteri*	Brewster's Cassia	50	0	25	0	14	0	0	0	0	0	0	0	50
Caesalpiniaceae	*Chamaecrista absus*	Pig's ear; Sensitive Pea	0	33	0	0	14	44	0	0	20	67	0	40	25
Caesalpiniaceae	*Chamaecrista nomame*		0	0	0	0	0	0	0	0	0	0	0	0	0
Caesalpiniaceae	*Chamaecrista rotundifolia**	Round-leaf Sensitive Pea	0	0	0	0	0	0	0	0	0	33	0	0	0
Caesalpiniaceae	*Petalostylis labicheoides*	Butterfly Bush	0	0	0	0	0	0	0	0	0	0	0	0	0
Caesalpiniaceae	*Senna coronilloides*	Brigalow Senna	0	0	0	100	0	0	0	0	0	0	0	0	0
Caesalpiniaceae	*Senna occidentalis**	Coffee Senna	0	100	0	0	0	0	0	0	0	0	0	0	0
Campanulaceae	*Lobelia purpurascens*	White Root	0	0	0	0	0	0	0	0	0	33	0	0	0
Campanulaceae	*Wahlenbergia gracilis*	Blue Bell	0	0	0	0	0	0	0	0	0	0	0	0	0
Capparaceae	*Apophyllum anomalum*	Warrior Bush; Broom Bush	0	0	25	100	0	0	0	0	0	0	0	0	0
Capparaceae	*Capparis canescens*	Bumble Bush; Wild Orange	50	0	0	0	14	11	0	67	20	0	0	0	0
Capparaceae	*Capparis lasiantha*	Wyjeelah; Nepine	100	0	75	0	29	0	0	0	0	0	100	0	50
Caryophyllaceae	*Polycarpaea corymbosa*		0	0	0	0	0	11	0	0	0	33	0	0	0
Casuarinaceae	*Allocasuarina luehmannii*	Bull Oak	0	0	0	0	0	11	0	0	0	0	0	0	0
Casuarinaceae	*Casuarina cristata*	Belah	0	0	50	0	0	0	0	0	0	0	0	0	0
Celastraceae	*Denhamia cunninghamii*	Yellow-berry Bush	0	0	0	0	0	0	33	0	0	0	0	0	0
Celastraceae	*Denhamia oleaster*		0	0	0	0	0	0	0	0	0	0	0	0	0
Chenopodiaceae	*Dysphania melanocarpa* forma *melanocarpa*	Black Crumbweed	0	33	0	0	14	22	0	0	0	0	0	0	25
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	Climbing Saltbush	0	0	50	0	14	0	0	0	0	0	0	0	25
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	Narrow Climbing Saltbush	0	0	25	0	0	0	0	0	0	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Chenopodiaceae	*Enchylaena tomentosa* var. *tomentosa*	Ruby Saltbush	0	0	50	0	0	0	0	0	0	0	0	0	0
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush	0	0	25	0	0	0	0	0	0	0	0	0	0
Chenopodiaceae	*Salsola australis*	Roly-Poly	0	0	25	100	14	0	0	0	0	0	0	0	25
Chenopodiaceae	*Sclerolaena birchii*	Galvanised Burr	0	0	0	0	0	0	0	0	0	0	0	0	0
Cleomaceae	*Cleome tetrandra* var. *tetrandra*		0	0	0	0	0	22	0	0	0	0	0	0	0
Cleomaceae	*Cleome viscosa*	Tick Weed	0	0	0	0	0	0	33	0	0	33	0	0	0
Combretaceae	*Terminalia oblongata*	Yellow-wood	0	0	50	0	0	0	0	0	0	0	0	0	0
Commelinaceae	*Commelina diffusa*	Climbing Dayflower	0	100	0	0	0	0	0	0	0	0	100	0	0
Commelinaceae	*Commelina lanceolata*		0	0	0	0	0	22	0	33	0	33	0	20	0
Commelinaceae	*Murdannia graminea*	Grass Lily	0	0	0	0	29	67	0	33	0	33	0	20	50
Convolvulaceae	*Bonamia media*		50	0	0	0	43	56	0	0	0	33	0	40	0
Convolvulaceae	*Evolvulus alsinoides*	Dwarf Morning Glory	100	0	100	0	86	67	33	67	40	100	0	80	25
Convolvulaceae	*Ipomoea brownii*		0	0	0	0	0	0	0	0	20	33	0	60	0
Convolvulaceae	*Ipomoea plebia*	Bell Vine	0	100	0	100	14	0	0	0	0	0	0	40	25
Convolvulaceae	*Ipomoea polymorpha*		0	0	0	0	57	78	0	0	0	0	0	20	50
Convolvulaceae	*Jacquemontia paniculata*		50	0	50	0	0	11	33	0	0	0	0	0	0
Convolvulaceae	*Polymeria pusilla*		0	0	0	0	0	0	33	0	0	0	0	0	25
Convolvulaceae	*Xenostegia tridentata*		0	0	0	0	0	0	0	0	20	33	0	60	0
Cyperaceae	*Abildgaardia ovata*		0	0	0	0	0	0	33	0	0	0	0	0	0
Cyperaceae	*Bulbostylis barbata*		0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus betchei*		0	0	0	0	0	0	0	33	20	33	0	20	0
Cyperaceae	*Cyperus concinnus*		0	0	0	100	0	0	0	0	0	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Cyperaceae	*Cyperus conicus* var. *conicus*		0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus difformis*	Variable Flatsedge	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus fulvus*	Sticky Sedge	50	0	0	0	29	11	0	0	0	33	0	0	0
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	50	67	50	100	43	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus leiocaulon*		0	33	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus perangustus*		0	0	0	100	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus rotundus**	Purple Nutsedge	0	0	0	0	0	0	33	0	0	0	0	0	0
Cyperaceae	*Eleocharis acuta*	Common Spikerush	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-sedge	100	0	0	0	71	100	33	33	0	67	0	20	75
Cyperaceae	*Gahnia aspera*	Rough Saw-sedge	0	0	0	0	0	0	0	33	0	0	100	0	0
Cyperaceae	*Scleria brownii*		0	0	25	0	0	0	67	0	0	0	100	20	0
Cyperaceae	*Scleria sphacelata*		0	0	0	0	0	0	0	100	60	0	100	0	0
Ebenaceae	*Diospyros humilis*	Small-leaved Ebony	0	0	0	0	14	0	0	0	0	0	100	0	0
Erythroxylaceae	*Erythroxylum australe*	Australian Cocaine Bush; Dogwood	0	0	50	0	43	33	0	67	80	67	0	80	0
Euphorbiaceae	*Acalypha eremorum*	Soft Acalypha	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphorbiaceae	*Euphorbia bifida*		0	0	0	0	14	0	33	0	0	0	0	20	25
Euphorbiaceae	*Euphorbia drummondii*	Caustic Weed	0	0	0	0	29	0	33	33	20	33	0	60	0
Euphorbiaceae	*Euphorbia hirta**	Asthma Weed	0	33	0	0	0	0	0	0	0	0	0	0	0
Euphorbiaceae	*Euphorbia tannensis*	Desert Spurge	0	0	0	0	0	0	0	33	0	0	0	0	0
Euphorbiaceae	*Jatropha gossypiifolia**	Bellyache Bush	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Aeschynomene brevifolia*		0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Aeschynomene indica*	Indian Jointvetch	0	0	0	0	0	0	0	0	0	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Fabaceae	*Bossiaea carinalis*		0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Crotalaria juncea**	Brown Hemp	0	0	0	0	14	0	0	0	0	0	0	0	25
Fabaceae	*Crotalaria medicaginea*	Trefoil Rattlepod	0	0	0	0	0	22	0	0	0	0	0	0	0
Fabaceae	*Crotalaria mitchellii*	Yellow Rattlepod	0	67	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Crotalaria montana*		0	0	0	0	0	0	0	33	0	0	0	0	0
Fabaceae	*Crotalaria pallida**	Smooth Rattlepod	0	33	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Daviesia filipes*		0	0	0	0	0	0	0	33	0	0	0	0	0
Fabaceae	*Desmodium filiforme*		0	33	0	0	43	11	0	0	0	0	0	0	0
Fabaceae	*Desmodium macrocarpum*	Large-podded Trefoil	50	0	0	0	0	0	0	33	0	0	0	20	0
Fabaceae	*Desmodium rhytidophyllum*	Hairy Trefoil	0	0	0	0	0	0	0	33	0	0	0	0	0
Fabaceae	*Desmodium varians*	Slender Tick-trefoil	0	0	75	0	0	11	33	0	0	0	0	0	0
Fabaceae	*Erythrina vespertilio*	Bat's Wing Coral Tree	0	33	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Galactia tenuiflora*		0	0	0	0	29	44	33	33	20	33	0	60	50
Fabaceae	*Glycine* sp. (Mackay S.B. Andrews+ 43)		0	0	25	0	29	0	33	0	0	33	0	0	0
Fabaceae	*Glycine tomentella*	Woolly Glycine	50	33	0	0	29	44	33	33	0	0	0	20	25
Fabaceae	*Hovea longipes*	Brush Hovea	0	0	0	0	0	0	0	0	0	0	100	0	0
Fabaceae	*Hovea tholiformis*		0	0	0	0	0	0	0	67	0	0	0	20	0
Fabaceae	*Indigofera australis*	Australian Indigo	0	0	0	0	0	0	0	33	0	0	0	0	0
Fabaceae	*Indigofera colutea*	Sticky Indigo	50	0	0	0	14	22	0	0	0	0	0	0	75
Fabaceae	*Indigofera hirsuta*	Hairy Indigo	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Indigofera linifolia*	Narrow-leafed Indigo	0	0	0	0	0	0	100	0	0	0	0	0	25
Fabaceae	*Indigofera linnaei*	Birdsville indigo	50	0	0	0	0	11	67	0	0	0	0	0	50

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Fabaceae	*Indigofera* sp. A		0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Macroptilium atropurpureum**	Siratro	0	33	0	0	0	0	0	0	0	0	0	0	25
Fabaceae	*Pycnospora lutescens*	Pycnospora	0	0	0	0	0	0	0	33	0	0	0	0	0
Fabaceae	*Rhynchosia minima*	Least Snout-bean	0	0	25	0	29	0	67	0	0	0	0	0	50
Fabaceae	*Sesbania cannabina*	Sesbania Pea	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Stylosanthes hamata**	Caribbean Stylo	0	67	0	0	43	33	33	0	0	0	0	0	50
Fabaceae	*Stylosanthes humilis**	Townsville Stylo	50	33	0	0	14	0	0	0	0	0	0	0	25
Fabaceae	*Stylosanthes scabra**	Shrubby Stylo	100	0	0	0	71	89	100	33	20	100	0	80	100
Fabaceae	*Tephrosia dietrichiae*		0	0	0	0	0	11	0	0	0	0	0	0	0
Fabaceae	*Tephrosia filipes* subsp. *filipes*		0	0	0	0	0	0	33	0	0	33	0	40	0
Fabaceae	*Tephrosia juncea*		0	0	0	0	0	0	0	33	0	0	0	20	0
Fabaceae	*Tephrosia leptoclada*		0	0	0	0	29	33	0	0	0	0	0	0	0
Fabaceae	*Tephrosia* sp. A		0	0	0	0	0	0	0	33	0	0	0	0	0
Fabaceae	*Tephrosia* sp. B		0	0	0	0	0	0	33	0	0	0	0	0	0
Fabaceae	*Zornia areolata*		0	0	0	0	43	11	0	0	0	0	0	0	0
Fabaceae	*Zornia muelleriana subsp. muelleriana*		0	0	0	0	14	44	0	0	0	33	0	20	0
Fabaceae	*Zornia muriculata subsp. angustata*		50	33	0	0	0	11	0	0	0	0	0	0	25
Fabaceae	*Zornia* sp.		0	0	0	0	29	11	0	33	0	33	0	0	25
Goodeniaceae	*Goodenia glabra*	Smooth Goodenia	0	0	0	0	0	11	0	0	0	0	0	0	0
Goodeniaceae	*Goodenia grandiflora*	Large-flowered Goodenia	0	0	0	0	0	0	0	0	0	0	0	0	0
Goodeniaceae	*Goodenia* sp. (Mt Castletower M.D. Crisp 2753)		0	0	0	0	0	0	0	67	20	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Hemerocallidaceae	*Dianella nervosa*	Flax Lily	0	0	0	0	0	11	0	0	20	0	0	0	0
Johnsoniaceae	*Tricoryne elatior*	Yellow Autumn-lily	0	0	0	0	0	11	0	0	0	0	0	0	0
Juncaceae	*Juncus polyanthemus*	Australian Grey Rush	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncaceae	*Juncus usitatus*	Common Rush	0	33	0	0	0	0	0	0	0	0	0	0	0
Lamiaceae	*Ajuga australis*	Australian Bugle	0	33	0	0	0	0	0	0	0	0	0	0	0
Lamiaceae	*Anisomeles malabarica*	Catmint	0	0	0	0	0	0	0	0	0	0	0	0	0
Lamiaceae	*Clerodendrum floribundum*	Lolly Bush	0	67	0	0	0	11	0	0	0	0	0	0	25
Lamiaceae	*Clerodendrum tomentosum*	Hairy Lolly Bush	0	0	0	0	14	0	0	0	0	0	0	0	0
Lamiaceae	*Ocimum caryophyllinum*	Holy Basil	0	0	25	0	0	0	33	0	0	0	0	0	0
Lamiaceae	*Plectranthus parviflorus*	Little Spurflower	0	0	0	0	0	0	0	0	0	0	100	0	0
Lauraceae	*Cassytha filiformis*	Love Vine; Dodder Laurel	0	0	0	0	0	11	33	0	0	0	100	0	0
Laxmanniaceae	*Eustrephus latifolius*	Wombat Berry	0	0	0	0	0	0	33	33	0	0	0	0	25
Laxmanniaceae	*Lomandra longifolia*	Spiny-head Mat-rush	0	67	0	0	0	0	0	0	0	0	0	40	0
Laxmanniaceae	*Lomandra multiflora*	Many-flowered Mat-rush	0	0	0	0	0	0	67	33	0	0	0	0	0
Loranthaceae	*Amyema congener*	Variable Mistletoe	0	0	0	0	0	0	0	0	0	0	0	0	0
Loranthaceae	*Amyema conspicua*	Alphitonia Mistletoe	0	0	0	0	0	0	0	0	0	0	100	0	0
Malvaceae	*Abutilon guineense**	Chinese Lantern	0	33	0	0	0	0	0	0	0	0	0	0	25
Malvaceae	*Abutilon oxycarpum*	Lantern Bush	0	0	75	0	29	0	0	0	0	0	100	0	0
Malvaceae	*Abutilon oxycarpum* var. *incanum*	Lantern Bush	0	0	50	100	14	0	0	0	0	0	0	0	0
Malvaceae	*Gossypium australe*	Australian Cotton	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Hibiscus brachysiphonius*	Low Hibiscus	0	0	25	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Hibiscus meraukensis*	Merauke Hibiscus	0	0	0	0	0	11	0	0	20	0	0	60	0

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Malvaceae	*Hibiscus sturtii*	Hill Hibiscus	50	0	50	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Malvastrum americanum**	Spiked Malvastrum	0	0	0	100	29	0	33	0	0	0	0	0	0
Malvaceae	*Malvastrum coromandelianum**	Prickly Malvastrum	0	33	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Sida aprica*		0	0	0	0	0	0	0	0	20	0	0	0	0
Malvaceae	*Sida atherophora*		0	0	0	0	0	0	0	0	20	0	0	0	0
Malvaceae	*Sida cordifolia**	Flannel Weed	50	100	0	0	29	33	0	0	20	33	0	0	25
Malvaceae	*Sida corrugata*	Variable Sida	0	0	25	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Sida hackettiana*	Golden Rod; Spiked Sida	100	33	25	0	100	78	67	0	20	100	100	60	75
Malvaceae	*Sida pleiantha*		0	0	0	0	0	0	33	0	0	0	0	0	25
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	0	100	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Sida rohlenae*	Shrub Sida	0	0	25	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Sida* sp.		0	0	0	0	0	0	0	33	0	0	0	0	0
Malvaceae	*Sida* sp. (Aramac E.J. Thompson+ JER192)		0	0	0	0	0	11	0	0	0	0	0	0	0
Malvaceae	*Sida* sp. (Musselbrook M.B. Thomas+ MRS437)		0	0	0	0	0	11	0	33	60	33	0	40	0
Malvaceae	*Sida spinosa**	Spiny Sida	100	33	0	0	100	22	33	33	20	100	0	40	100
Marsileaceae	*Marsilea sp.*	Nardoo	0	0	0	0	0	0	0	0	0	0	0	0	0
Meliaceae	*Owenia acidula*	Emu Apple	0	0	25	100	14	0	0	0	0	0	0	0	25
Menispermaceae	*Stephania japonica*	Snake Vine	0	33	0	0	0	0	0	0	0	0	0	0	0
Menispermaceae	*Tinospora smilacina*	Heart Vine	0	33	0	0	0	0	0	0	20	0	0	40	0
Menyanthaceae	*Nymphoides* sp.	Water Snowflake	0	0	0	0	0	0	0	0	0	0	0	0	0
Mimosaceae	*Vachellia bidwillii*	Corkwood Wattle	0	0	25	0	14	0	33	0	0	0	0	0	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Mimosaceae	*Acacia bancroftiorum*	Bancroft Wattle	0	0	0	0	0	0	0	0	0	0	0	60	0
Mimosaceae	*Acacia burdekensis*	Burdekin Wattle	0	0	0	0	14	33	0	33	0	33	100	40	0
Mimosaceae	*Acacia curvinervia*		0	0	0	0	0	0	0	0	0	0	0	20	0
Mimosaceae	*Acacia dietrichiana*	Dietrich Wattle	0	0	0	0	0	0	0	33	0	0	0	40	0
Mimosaceae	*Acacia excelsa*	Ironwood Wattle	0	0	0	0	14	11	33	0	0	0	0	0	0
Mimosaceae	*Acacia flavescens*	Red Wattle	0	0	0	0	0	0	0	33	0	33	0	20	0
Mimosaceae	*Acacia harpophylla*	Brigalow	0	0	75	0	0	0	0	0	0	0	0	0	0
Mimosaceae	*Acacia julifera* subsp. *julifera*		0	0	0	0	0	0	0	0	0	0	0	0	0
Mimosaceae	*Acacia macradenia*	Zig-Zag Wattle	0	33	0	0	0	0	0	33	0	0	0	0	0
Mimosaceae	*Acacia rhodoxylon*	Ringy Rosewood	0	0	0	0	0	0	0	0	0	0	0	20	0
Mimosaceae	*Acacia salicina*	Sally Wattle; Willow Wattle	50	33	0	0	14	0	33	0	0	0	0	0	25
Mimosaceae	*Acacia shirleyi*	Lancewood	0	0	0	0	0	0	0	0	80	0	100	60	0
Mimosaceae	*Albizia canescens*	Belmont Siris	0	33	0	0	0	0	0	0	0	0	0	0	0
Mimosaceae	*Archidendropsis basaltica*	Dead Finish	0	0	0	0	14	0	0	0	0	0	0	0	50
Mimosaceae	*Leucaena leucocephala**	Leucaena	0	0	0	0	0	0	0	0	0	0	0	0	0
Mimosaceae	*Neptunia gracilis*	Native Sensitive Plant	0	0	0	0	0	0	67	0	0	0	0	0	75
Molluginaceae	*Glinus lotoides*	Hairy Carpet-weed	0	0	0	0	0	0	0	0	0	0	0	0	0
Moraceae	*Ficus opposita*	Sandpaper Fig	0	100	0	0	0	0	0	0	0	0	0	0	0
Moraceae	*Ficus rubiginosa*	Rock Fig	0	0	0	0	0	0	0	0	0	0	100	0	0
Moraceae	*Trophis scandens*	Burny Vine	0	0	0	0	0	0	0	0	0	0	100	0	0
Myrsinaceae	*Myrsine variabilis*	Muttonwood	0	0	0	0	0	0	0	0	0	0	100	0	0
Myrtaceae	*Corymbia aureola*	Yellowjacket	0	0	0	0	0	0	0	0	0	0	0	80	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Myrtaceae	*Corymbia citriodora* subsp. *citriodora*	Lemon-scented Gum	0	0	0	0	0	0	0	67	0	0	0	0	0
Myrtaceae	*Corymbia clarksoniana*	Clarkson's Bloodwood	0	0	0	0	0	0	0	0	0	0	0	0	0
Myrtaceae	*Corymbia dallachiana*	Ghost Gum	0	0	0	0	0	11	0	0	0	33	0	0	0
Myrtaceae	*Corymbia erythrophloia*	Variable-barked Bloodwood	0	0	0	0	0	0	33	0	0	0	0	0	0
Myrtaceae	*Corymbia tessellaris*	Carbeen; Blackbutt	0	0	0	0	0	0	0	0	0	0	0	0	0
Myrtaceae	*Corymbia trachyphloia*	Brown Bloodwood	0	0	0	0	0	0	0	67	0	0	0	0	0
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	0	67	0	0	0	0	0	0	0	0	0	0	0
Myrtaceae	*Eucalyptus crebra*	Narrow-Leaved Ironbark	0	0	0	0	0	11	0	33	20	67	0	0	0
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark	50	0	0	0	0	22	0	33	0	33	0	20	0
Myrtaceae	*Eucalyptus orgadophila*	Mountain Coolibah	0	0	0	0	0	0	33	0	0	0	0	0	0
Myrtaceae	*Eucalyptus populnea*	Poplar Box	100	0	0	0	71	0	0	0	0	0	0	0	25
Myrtaceae	*Gossia bidwillii*	Python Tree	0	0	0	0	0	0	0	0	0	0	100	0	0
Myrtaceae	*Leptospermum lamellatum*	Weeping Tea-tree	0	0	0	0	0	0	0	33	0	0	0	0	0
Myrtaceae	*Lophostemon grandiflorus*	Northern Swamp Mahogany	0	33	0	0	0	0	0	0	0	0	0	0	0
Myrtaceae	*Lophostemon suaveolens*	Swamp Mahogany	0	0	0	0	0	0	0	0	0	0	100	0	0
Myrtaceae	*Lysicarpus angustifolius*	Budgeroo	0	0	0	0	0	0	0	33	0	0	0	20	0
Myrtaceae	*Melaleuca fluviatilis*	Weeping Paperbark	0	33	0	0	0	0	0	0	0	0	0	0	0
Myrtaceae	*Melaleuca leucadendra*	Paperbark	0	0	0	0	0	0	0	0	0	0	0	0	0
Myrtaceae	*Melaleuca nervosa*	Broad-leaved Paperbark	0	0	0	0	14	78	0	0	0	0	0	0	0
Nyctaginaceae	*Boerhavia pubescens*		50	0	75	100	71	11	33	0	0	0	0	0	25
Olacaceae	*Ximenia americana**	Tallow Wood; Yellow Plum	0	0	0	0	0	0	0	0	0	0	0	0	0
Oleaceae	*Jasminum didymum* subsp. *lineare*	Desert Jasmine	0	0	50	0	0	0	0	0	20	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Oleaceae	*Jasminum didymum* subsp. *racemosum*	Native Jasmine	0	0	0	0	0	0	0	0	0	0	100	0	0
Oleaceae	*Jasminum simplicifolium* subsp. *australiense*	Stiff Jasmine	0	0	0	0	0	0	0	0	0	0	100	0	0
Orchidaceae	*Cymbidium canaliculatum*	Black Orchid	50	0	25	0	0	0	0	0	0	0	0	0	0
Oxalidaceae	*Oxalis corniculata*	Creeping Woodsorrel	100	33	0	0	0	0	0	67	0	0	0	20	25
Passifloraceae	*Passiflora foetida**	Stinking Passionflower	0	33	0	0	0	0	0	0	0	0	0	0	0
Pentapetaceae	*Melhania oblongifolia*		100	0	50	0	29	33	67	33	0	0	0	0	0
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	0	0	0	0	29	0	0	67	0	33	0	20	0
Phyllanthaceae	*Phyllanthus carpentariae*		0	0	0	0	0	22	0	33	20	67	0	40	0
Phyllanthaceae	*Phyllanthus collinus*		0	0	25	0	100	56	0	33	20	100	0	0	0
Phyllanthaceae	*Phyllanthus fuernrohrii*	Sand Spurge	0	0	0	0	0	0	33	0	0	0	0	0	0
Phyllanthaceae	*Phyllanthus maderaspatensis*		0	0	0	0	0	0	67	0	0	0	0	0	25
Phyllanthaceae	*Phyllanthus* sp. (Myra Vale J.J. Bruhl+ 181)		0	0	0	0	43	44	0	0	0	33	0	0	25
Phyllanthaceae	*Phyllanthus virgatus*	Creeping Phyllanthus	100	33	75	0	14	11	0	67	0	0	0	20	50
Picrodendraceae	*Petalostigma pubescens*	Quinine Tree	0	0	0	0	0	44	0	33	0	100	0	20	25
Pittosporaceae	*Bursaria incana*	Prickly Pine	0	0	25	0	0	0	33	33	0	0	100	0	0
Plantaginaceae	*Scoparia dulcis**	Licorice Weed	0	67	0	0	14	11	0	0	0	33	100	0	0
Plumbaginaceae	*Plumbago zeylanica*	Wild Plumbago	0	0	0	100	0	0	0	0	0	0	0	0	0
Poaceae	*Alloteropsis cimicina*	Summer Grass	0	67	0	0	43	67	0	0	60	33	0	80	25
Poaceae	*Alloteropsis semialata*	Cockatoo Grass	0	0	0	0	0	0	33	0	0	0	0	0	0
Poaceae	*Ancistrachne uncinata*	Hooky Grass	0	0	50	0	0	0	0	0	0	0	100	0	0
Poaceae	*Aristida benthamii*	Bentham's Wiregrass	0	0	0	0	0	11	0	67	40	33	0	40	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Poaceae	*Aristida calycina var. calycina*	Dark Wiregrass	100	0	25	0	100	67	0	67	80	100	0	80	50
Poaceae	*Aristida gracilipes*		100	0	50	0	14	0	67	33	20	0	0	0	0
Poaceae	*Aristida holathera*	Tall Kerosene Grass	0	0	0	0	29	44	33	0	0	33	0	20	0
Poaceae	*Aristida inaequiglumis*	Unequal Wiregrass	0	0	0	0	0	11	0	0	0	0	0	0	0
Poaceae	*Aristida spuria*		0	0	0	0	0	0	0	33	0	0	0	0	0
Poaceae	*Arundinella nepalensis*	Reedgrass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Bothriochloa decipiens var. cloncurrensis*	Pitted Bluegrass	0	0	0	0	0	11	0	0	0	0	0	0	0
Poaceae	*Bothriochloa ewartiana*	Desert Bluegrass	100	33	0	0	14	0	100	0	0	0	0	0	25
Poaceae	*Bothriochloa pertusa**	Indian Couch	100	100	75	0	71	44	100	0	0	33	0	0	100
Poaceae	*Capillipedium parviflorum*	Scented-top Grass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Cenchrus ciliaris**	Buffel Grass	100	100	75	100	86	33	100	33	20	67	0	0	100
Poaceae	*Chloris barbata**	Purpletop Chloris	0	0	0	0	0	0	0	0	0	0	0	0	25
Poaceae	*Chloris divaricata*	Slender Chloris	0	0	100	0	29	11	0	0	0	0	0	0	0
Poaceae	*Chloris virgata**	Feathertop Rhodes Grass	0	67	0	0	14	0	0	0	0	0	0	0	0
Poaceae	*Chrysopogon fallax*	Golden Beard Grass	100	0	25	0	86	78	33	33	20	67	0	20	75
Poaceae	*Cleistochloa subjuncea*		0	0	0	0	0	0	0	67	80	0	100	80	0
Poaceae	*Cymbopogon obtectus*	Silkyheads	0	0	0	0	0	0	0	67	0	0	0	0	0
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	0	0	50	0	0	0	0	67	0	0	0	0	0
Poaceae	*Cynodon dactylon**	Bermuda Grass; Green Couch	0	67	0	0	14	0	0	0	0	0	0	0	0
Poaceae	*Dactyloctenium radulans*	Button Grass	0	33	0	100	14	56	0	0	0	0	0	0	75
Poaceae	*Dichanthium sericeum*	Queensland Bluegrass	0	0	0	0	0	0	0	33	0	0	0	0	0
Poaceae	*Digitaria ammophila*	Silky Umbrella Grass	0	33	0	0	0	0	0	0	0	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Poaceae	*Digitaria brownii*	Cotton Panic Grass	0	33	0	0	0	0	0	0	0	33	0	0	0
Poaceae	*Digitaria ciliaris*	Summer Grass	0	0	0	0	0	0	0	0	0	0	0	0	25
Poaceae	*Digitaria diminuta*		0	0	0	0	0	0	0	33	100	33	0	60	25
Poaceae	*Digitaria divaricatissima*	Umbrella Grass	0	0	0	0	14	33	0	0	0	33	0	0	0
Poaceae	*Digitaria eriantha**		0	100	0	0	14	11	33	0	0	33	0	0	50
Poaceae	*Digitaria longiflora*		0	0	0	0	14	22	0	0	0	0	0	20	0
Poaceae	*Digitaria minima*		0	0	0	0	14	0	0	0	0	0	0	0	0
Poaceae	*Digitaria ramularis*		0	0	0	0	0	0	0	0	0	33	0	0	0
Poaceae	*Digitaria* sp. A		0	0	0	0	0	22	0	0	0	33	0	0	0
Poaceae	*Dinebra decipiens* var. *decipiens*	Slender Cane Grass	0	0	0	0	0	0	0	0	0	33	100	0	0
Poaceae	*Dinebra ligulata*		0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Echinochloa colona**	Awnless Barnyard Grass	0	67	0	100	0	0	0	0	0	0	0	0	0
Poaceae	*Eleusine indica**	Indian Crowfoot Grass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Enneapogon lindleyanus*	Conetop Nineawn	0	0	25	0	43	0	0	33	0	0	0	0	0
Poaceae	*Enneapogon* sp. A		0	0	25	0	0	0	67	0	0	0	0	0	0
Poaceae	*Enteropogon ramosus*	Curly Windmill Grass	0	0	0	0	43	0	0	0	0	0	0	0	50
Poaceae	*Eragrostis elongata*	Clustered Lovegrass	0	33	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Eragrostis lacunaria*	Purple Lovegrass	0	0	75	0	57	44	0	0	60	0	0	60	25
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass	0	0	0	0	14	0	0	0	0	33	0	0	0
Poaceae	*Eragrostis parviflora*	Weeping Lovegrass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Eragrostis pilosa**	Soft Lovegrass	0	0	0	100	0	0	0	0	0	0	0	0	0
Poaceae	*Eragrostis sororia*		50	0	0	0	57	78	0	0	20	67	0	60	25

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Poaceae	*Eragrostis spartinoides*		0	0	0	0	14	11	0	67	0	33	0	20	0
Poaceae	*Eragrostis speciosa*	Hansome Lovegrass	0	0	0	0	29	11	0	0	0	0	0	0	0
Poaceae	*Eremochloa bimaculata*	Poverty Grass	0	0	0	0	0	11	0	0	0	0	0	0	0
Poaceae	*Eriachne mucronata*	Mountain Wanderrie Grass	0	0	0	0	14	11	0	0	0	33	0	0	0
Poaceae	*Eriachne obtusa*	Northern Wanderrie Grass	0	0	0	0	0	22	0	33	40	0	0	20	0
Poaceae	*Eriochloa crebra*	Cup Grass	0	0	0	100	29	11	0	0	0	67	0	20	0
Poaceae	*Eriochloa pseudoacrotricha*	Early Spring Grass	0	0	0	0	0	0	0	33	0	0	0	20	0
Poaceae	*Eulalia aurea*	Silky Browntop	0	0	0	0	0	11	0	0	0	0	0	0	25
Poaceae	*Heteropogon contortus*	Black Speargrass	50	33	0	0	14	11	33	0	0	0	0	0	25
Poaceae	*Hymenachne amplexicaulis*	Olive Hymenachne	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Hyparrhenia rufa*	Thatch Grass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Megathyrsus maximus* var. *maximus*	Guinea Grass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Megathyrsus maximus* var. *pubiglumis*	Green Panic	0	100	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Melinis repens*	Red Natal Grass	0	33	0	0	29	11	33	67	40	67	0	80	0
Poaceae	*Panicum effusum*	Hairy Panic	50	0	0	0	14	11	0	100	20	67	0	40	25
Poaceae	*Paspalidium caespitosum*	Brigalow Grass	0	0	50	0	0	0	0	0	20	0	0	0	0
Poaceae	*Paspalidium constricutum*	Knottybutt Grass	0	0	25	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalidium distans*		0	0	50	0	0	0	0	0	0	0	0	0	0
Poaceae	*Paspalidium gracile*	Slender Panic	0	0	0	0	0	0	0	0	60	33	0	20	0
Poaceae	*Paspalidium rarum*	Rare Paspalidium	0	0	0	0	0	33	0	0	0	0	0	0	0
Poaceae	*Perotis rara*	Comet Grass	0	33	0	0	29	56	0	0	20	33	0	0	25

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Poaceae	*Schizachyrium fragile*	Firegrass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria surgens*		0	33	0	0	29	44	0	33	0	33	100	20	0
Poaceae	*Sorghum leiocladum*	Wild Sorghum	0	0	0	0	0	0	0	33	0	0	0	0	0
Poaceae	*Sporobolus caroli*	Fairy Grass	0	0	25	100	29	0	0	0	0	0	0	0	25
Poaceae	*Sporobolus scabridus*		0	0	25	100	0	0	0	0	0	0	0	0	0
Poaceae	*Thellungia advena*	Coolibah Grass	0	0	0	0	0	0	33	0	0	0	0	0	0
Poaceae	*Themeda avenacea*	Native Oatgrass	0	0	25	0	0	0	0	0	0	0	0	0	0
Poaceae	*Themeda triandra*	Kangaroo Grass	0	0	0	0	0	0	67	67	0	33	0	20	0
Poaceae	*Thyridolepis xerophila*		0	0	0	0	0	0	0	0	40	0	0	20	0
Poaceae	*Tragus australianus*	Small Burrgrass	0	0	0	0	0	0	0	0	0	0	0	0	25
Poaceae	*Tripogon loliiformis*	Five-minute Grass	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Urochloa foliosa*	Leafy Panic	0	33	0	100	0	0	33	0	0	0	0	0	0
Poaceae	*Urochloa mosambicensis**	Sabi Grass	50	100	25	0	71	33	33	0	40	67	0	0	100
Poaceae	*Urochloa piligera*	Hairy Armgrass	0	0	25	0	14	78	0	0	20	0	0	60	25
Polygalaceae	*Polygala triflora*		0	0	0	0	14	0	0	0	0	0	0	0	0
Polygonaceae	*Persicaria attenuata*	White Smartweed	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontederiaceae	*Monochoria cyanea*	Native Water Hyacinth	0	0	0	0	0	0	0	0	0	0	0	0	0
Proteaceae	*Grevillea decora*		0	0	0	0	0	0	0	0	0	0	0	0	0
Proteaceae	*Grevillea parallela*	Silver Oak; Beefwood	0	0	0	0	0	0	0	0	0	0	0	0	0
Proteaceae	*Grevillea pteridifolia*	Golden Parrot Tree; Fern-leaved Grevillea	0	0	0	0	0	0	0	0	0	0	0	0	0
Proteaceae	*Grevillea sessilis*		0	0	0	0	0	0	0	0	0	0	0	0	0
Proteaceae	*Grevillea striata*	Beefwood	0	0	0	0	0	11	0	0	0	0	0	0	0

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			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Proteaceae	*Hakea lorea*	Corkwood; Bootlace Oak	0	0	0	0	0	0	0	33	0	0	0	0	0
Proteaceae	*Persoonia amaliae*		0	0	0	0	0	0	0	33	0	0	0	0	0
Proteaceae	*Persoonia falcata*	Wild Pear; Geebung	0	0	0	0	0	0	0	100	20	0	0	0	0
Pteridaceae	*Cheilanthes sieberi*	Poison Rock Fern	50	33	75	100	43	33	0	100	100	67	0	80	25
Pteridaceae	*Cheilanthes nudiuscula*		0	0	0	0	0	0	0	0	0	0	100	0	0
Putranjivaceae	*Drypetes deplanchei*	Yellow Tulip; Grey Boxwood	0	0	0	0	0	0	0	0	0	0	100	0	0
Rhamnaceae	*Alphitonia excelsa*	Red Ash; Soap Tree	50	0	0	0	71	67	0	67	100	100	100	100	25
Rhamnaceae	*Ventilago viminalis*	Vine Tree	0	0	25	100	29	11	33	0	0	0	0	20	0
Rubiaceae	*Coelospermum reticulatum*	Medicine Bush	0	0	0	0	0	0	0	67	0	0	0	0	0
Rubiaceae	*Cyclophyllum coprosmoides*	Coast Canthium; Sweet Susie	0	0	0	0	0	0	0	33	0	0	0	0	0
Rubiaceae	*Larsenaikia ochreata*	Native Gardenia	0	0	0	0	0	0	0	100	20	33	100	80	0
Rubiaceae	*Oldenlandia mitrasacmoides* subsp. *trachymenoides*		0	0	0	0	0	11	0	0	0	0	0	0	0
Rubiaceae	*Pavetta granitica*		0	0	0	0	0	0	0	0	0	33	100	0	0
Rubiaceae	*Pomax umbellata*	Pomax	0	0	0	0	0	0	0	33	0	0	0	0	0
Rubiaceae	*Psydrax odorata* subsp. *buxifolia*	Shiny-leaved Canthium	0	0	0	0	0	0	0	0	0	0	100	0	0
Rubiaceae	*Psydrax oleifolia*	Wild Lemon; Myrtle	0	0	0	0	0	11	33	0	0	0	0	0	25
Rubiaceae	*Richardia brasiliensis**	White Eye; Mexican Clover	0	33	0	0	0	33	0	0	0	0	100	0	0
Rubiaceae	*Spermacoce brachystema*	Stiff-leafed Spermacoce	0	0	0	0	14	44	0	0	20	0	0	40	0
Rutaceae	*Acronychia laevis*	Hard Aspen	0	0	0	0	0	0	0	0	0	0	100	0	0
Rutaceae	*Flindersia australis*	Crow's Ash	0	0	0	0	0	0	0	0	0	0	0	0	0
Rutaceae	*Flindersia dissosperma*	Scrub Leopardwood	0	0	25	0	0	11	0	0	0	0	0	0	0
Rutaceae	*Geijera parviflora*	Wilga	0	0	25	100	0	0	0	0	0	0	0	0	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Rutaceae	*Geijera salicifolia*	Scrub Wilga; Green Satinheart	0	0	0	0	0	0	0	0	0	0	100	0	0
Santalaceae	*Exocarpos latifolius*	Broad-leaved Ballart; Scrub Cherry	0	0	0	0	0	0	0	0	0	0	100	0	0
Santalaceae	*Santalum lanceolatum*	Northern Sandalwood	0	0	0	0	0	0	0	0	0	0	0	0	0
Sapindaceae	*Alectryon connatus*	Grey Bird's-eye	0	0	0	0	0	0	0	0	0	0	100	0	0
Sapindaceae	*Alectryon diversifolius*	Scrub Boonaree	0	0	25	100	0	0	0	0	0	0	0	0	0
Sapindaceae	*Atalaya hemiglauca*	Whitewood	50	0	25	0	14	0	100	0	0	0	0	0	25
Sapindaceae	*Dodonaea lanceolata*	Hop Bush	0	0	0	0	0	0	0	33	0	0	0	0	0
Sapindaceae	*Dodonaea stenophylla*		0	0	0	0	0	0	0	0	0	0	0	0	0
Sapotaceae	*Planchonella pohlmanniana*	Yellow Boxwood	0	0	0	0	0	0	0	0	0	33	0	0	0
Sapotaceae	*Planchonella pubescens*		0	0	0	0	0	0	0	0	0	0	100	0	0
Scrophulariaceae	*Eremophila debilis*	Winter Apple	0	0	0	0	29	0	0	0	0	0	0	0	0
Scrophulariaceae	*Eremophila mitchellii*	False Sandalwood	50	0	75	0	14	0	0	0	0	0	0	0	0
Scrophulariaceae	*Myoporum montanum*	Western Boobialla	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanaceae	*Datura leichhardtii**	Thornapple	0	33	0	0	0	0	33	0	0	0	0	0	0
Solanaceae	*Pimelea sericostachya*		0	33	0	0	0	0	0	0	0	0	0	0	0
Solanaceae	*Solanum ellipticum*	Potato Bush	0	33	25	0	14	0	0	67	0	0	100	20	0
Solanaceae	*Solanum esuriale*	Quena	0	0	25	0	0	0	0	0	0	0	0	0	0
Solanaceae	*Solanum parvifolium*		0	0	25	0	0	0	0	0	40	0	0	0	0
Sparrmanniaceae	*Corchorus trilocularis*	Wild Jute	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparrmanniaceae	*Grewia latifolia*	Dysentery Plant; Dog's Balls	0	0	50	0	29	11	33	33	0	0	0	0	0
Sparrmanniaceae	*Grewia retusifolia*	Dysentery Bush; Emu Berry	100	33	25	0	57	11	0	0	0	33	0	0	50
Stylidiaceae	*Stylidium eglandulosum*	Woolly-stemmed Triggerplant	0	0	0	0	0	0	0	0	0	0	0	0	0

Family	Scientific Name	Common Name	Percentage of secondary sites in each regional ecosystem containing the species												
			11.3.2	11.3.25	11.4.8	11.4.9	11.5.3	11.5.9	11.9.2	11.10.1	11.10.3	11.10.7	11.10.8	11.10.1x1	Non-remnant
Typhaceae	*Typha* sp.	Bulrush	0	0	0	0	0	0	0	0	0	0	0	0	0
Ulmaceae	*Trema tomentosa*	Poison Peach	0	0	0	0	0	0	0	0	0	0	100	20	0
Verbenaceae	*Stachytarpheta jamaicensis**	Snake weed	0	33	0	0	0	0	0	0	0	0	0	0	0
Violaceae	*Pigea enneasperma*	Purple Spade Flower	100	33	0	0	57	11	67	0	0	33	0	0	0
Violaceae	*Pigea stellarioides*	Orange Spade Flower	0	33	0	0	29	56	0	100	40	100	0	80	0
Vitaceae	*Cissus oblonga*	Smooth Water Vine	0	0	0	0	0	0	0	0	0	0	100	0	0
Vitaceae	*Clematicissus opaca*	Pepper Vine	0	33	0	0	0	0	0	0	0	0	0	0	0
Vitaceae	*Tetrastigma nitens*	Native Grape; Three-leaf Water Vine	0	0	0	0	0	0	0	0	0	0	100	0	0
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	0	0	0	0	0	0	0	33	0	0	0	20	0
Zygophyllaceae	*Tribulopis angustifolia*		0	0	0	0	14	33	0	0	0	0	0	20	0
Zygophyllaceae	*Tribulus terrestris**	Goat's Head; Bullhead; Small Caltrop	0	0	0	100	14	0	33	0	0	0	0	0	0

Appendix C2 Fauna recorded during field surveys

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR†
MAMMALS												
Short-beaked Echidna	*Tachyglossus aculeatus*	++		+	+				++	+		+
Eastern Grey Kangaroo	*Macropus giganteus*				++		+	++	+		+	++
Common Wallaroo	*Macropus robustus*		++	++					+++			
Unadorned/Herbert's Rock-wallaby	*Petrogale inornata / herberti*	+++										

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR†
Swamp Wallaby	*Wallabia bicolor*		++	+	+				+++	+		
Rufous Bettong	*Aepyprymnus rufescens*			+		+		++				++
Narrow-nosed Planigale	*Planigale tenuirostris*						+			++		+
Common Planigale	*Planigale maculata*							+				+
Koala	*Phascolarctos cinereus*		+	+	+++	+			+			
Common Brush-tailed Possum	*Trichosurus vulpecula*	+		++	+++	+++	+	++				
Krefft's Glider	*Petaurus notatus*						+			+		
Squirrel Glider	*Petaurus norfolcensis*				++			+				
Central Greater Glider	*Petauroides armillatus*	+	++		+++	++					++	
House Mouse	*Mus musculus*		+	+				+	++			
Delicate Mouse	*Pseudomys delicatulus*		+					++				+
Eastern Pebble Mouse	*Pseudomys patrius*			++				++				
Lakeland Downs Mouse	*Leggadina lakedownensis*		++	++				+				
Water Rat	*Hydromys chrysogaster*											+
European Rabbit	*Oryctolagus cuniculus*		+		++	++	+++	+	+	++		+
Little Red Flying-fox	*Pteropus scapulatus*				++							++
Feral Pig	*Sus scrofa*				+							+
Feral Cat	*Felis catus*			+	+		+	+	+	+		++
Dingo	*Canis lupus dingo*			++	++			++				
Red Fox	*Vulpes vulpes*							+				
Bats												
Gould's Wattle Bat	*Chalinolobus gouldii*		+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Chocolate Wattle Bat	*Chalinolobus morio*		++	++		+	+	++	+++			+++

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
Hoary Wattle Bat	*Chalinolobus nigrogriseus*				++	+				+		
Little Pied Bat	*Chalinolobus picatus*		+++	++	+	-	+	+++	+++	-	+++	+++
Long-eared Bat	*Nyctophilus* sp.			+++	+	++	+	+	+	++		+
Western Broad-nosed Bat	*Scotorepens balstoni*		-	+	++	+++	-	+++	+++	+++	-	+++
Little Broad-nosed bat	*Scotorepens greyii*		+++	+++	+++	+++	+	+++	+++	+++	+++	+++
Inland Forest Bat	*Vespadelus baverstocki*		+	+++	-	-	-	+	++	-		+++
Eastern Cave Bat	*Vespadelus troughtoni*		+	+++		+++	+	+++	+++			+
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*		+++	++	++	+	+	+++	+++		-	
White-striped Freetail-bat	*Austronomus australis*			+								
Greater Northern Freetail-bat	*Chaerephon jobensis*		+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Northern Freetail Bat	*Ozimops lumsdenae*		+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Eastern Freetail Bat	*Ozimops ridei*		++	+++	+++	+++	+++	+++	+++	+++	-	+++
Bristle-faced Freetail Bat	*Setriostris eleryi*		-	-					-			++
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*		-	+++	+++	+++	+	+++	+++	+++	+++	+++
Troughton's Sheathtail-bat	*Taphozous troughtoni*		-	-	-		-	-	-	-		-
BIRDS												
Emu	*Dromaius novaehollandiae*			+					+		+	
Magpie Goose	*Anseranas semipalmata*											++
Plumed Whistling-duck	*Dendrocygna eytoni*				+							++
Australian Wood Duck	*Chenonetta jubata*											++
Pacific Black Duck	*Anas superciliosa*										++	++
Grey Teal	*Anas gracilis*										++	
Hardhead	*Aythya australis*											+

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
Brown Quail	*Synoicus ypsilophorus*			++							+	++
Stubble Quail	*Coturnix pectoralis*											+
Australasian Grebe	*Tachybaptus novaehollandiae*											+
Common Bronzewing	*Phaps chalcoptera*					++			+			
Crested Pigeon	*Ocyphaps lophotes*			+		++	+++	++				++
Squatter Pigeon	*Geophaps scripta*			++		++		+				++
Bar-shouldered Dove	*Geopelia humeralis*				+			++	+			
Diamond Dove	*Geopelia cuneata*			+				+				
Peaceful Dove	*Geopelia placida*			+++	+++	++		+++	+++	++		+++
Australian Bustard	*Ardeotis australis*							++				+
Pheasant Coucal	*Centropus phasianinus*		+	++	++	++	+	++		++		
Channel-billed Cuckoo	*Scythrops novaehollandiae*			+	++		++	++	+	+		+
Horsfield's Bronze-cuckoo	*Chrysococcyx basalis*					+						
Shining Bronze-cuckoo	*Chrysococcyx lucidus*		++						++			
Little Bronze-cuckoo	*Chrysococcyx minutillus*				+							+
Pallid Cuckoo	*Cacomantis pallidus*					+			+			++
Fan-tailed Cuckoo	*Cacomantis flabelliformis*								+			
Pacific Koel	*Eudynamys orientalis*				++	++	+					
Tawny Frogmouth	*Podargus strigoides*	+		+	++			++	+			
Australian Owlet-nightjar	*Aegotheles cristatus*		++	+				+				
White-throated Nightjar	*Eurostopodus mystacalis*	+		+						++		+
White-throated Needletail	*Hirundapus caudacutus*											++
Eurasian Coot	*Fulica atra*											+

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
Brolga	*Antigone rubicunda*											++
Bush Stone-curlew	*Burhinus grallarius*				+				+			
Pied Stilt	*Himantopus himantopus*									+		+
Masked Lapwing	*Vanellus miles*					++						++
Black-fronted Dotterel	*Elseyornis melanops*											++
Painted Buttonquail	*Turnix varius*		++	++				++				++
Little Black Cormorant	*Phalacrocorax sulcirostris*											++
Australasian Darter	*Anhinga novaehollandiae*											+
Australian Pelican	*Pelecanus conspicillatus*											+
Eastern Great Egret	*Ardea alba modesta*				+							+
Intermediate Egret	*Ardea intermedia*											+
White-necked Heron	*Ardea pacifica*											+
Cattle Egret	*Bubulcus ibis*											+
White-faced heron	*Egretta novaehollandiae*											++
Nankeen Night-heron	*Nycticorax caledonicus*											++
Straw-necked Ibis	*Threskiornis spinicollis*											++
Royal Spoonbill	*Platalea regia*											+
Black-shouldered Kite	*Elanus axillaris*									+		
Wedge-tailed Eagle	*Aquila audax*		++	++	+							++
Pacific Baza	*Aviceda subcristata*		+							+		
Brown Goshawk	*Accipiter fasciatus*			+				+				
Black Kite	*Milvus migrans*							++		+		++
Whistling Kite	*Haliastur sphenurus*			+++	+++	+++	+	+++	++	++	+	+++

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
Southern Boobook	*Ninox novaeseelandiae*	+	+	++	++	+++	+	++	+	++		++
Laughing Kookaburra	*Dacelo novaeguineae*		++	+++	+++	+++	+++	+++	+++	+++		+++
Blue-winged Kookaburra	*Dacelo leachii*				++	+	+	++		+++		
Red-backed Kingfisher	*Todiramphus pryrrhopygius*											+
Forest Kingfisher	*Todiramphus macleayii*				+	++			+	+++		
Sacred Kingfisher	*Todiramphus sanctus*		+							+++		
Rainbow Bee-eater	*Merops ornatus*		+	+++	++	++		++	+++	++		++
Dollarbird	*Eurystomus orientalis*				+++	+++				+++		
Nankeen Kestrel	*Falco cenchroides*				+	++						++
Peregrine Falcon	*Falco peregrinus*			+			+					
Brown Falcon	*Falco berigora*		+									
Sulphur-crested Cockatoo	*Cacatua galerita*	+++	+++	+++	+++	+++	++	+++	+++	+++	++	++
Glossy Black-cockatoo	*Calyptorhynchus lathami*									+		
Galah	*Eolophus roseicapilla*			++	++	++	+	++				++
Cockatiel	*Nymphicus hollandicus*						++					+
Red-winged Parrot	*Aprosmictus erythropterus*		++	+++	+++	+++	+++	+++	++	+++		+++
Pale-headed Rosella	*Platycercus adscitus*		++	+++	+++	+++	+++	+++	+++	++	++	++
Budgerigar	*Melopsittacus undulatus*		++	++				+				++
Little Lorikeet	*Glossopsitta pusilla*					+						
Rainbow Lorikeet	*Trichoglossus haematodus*	++	+++	+++	+++	+++	++	+++	+++	+++		++
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*			++								
Spotted Bowerbird	*Chlamydera maculata*			+	++	+++	++	+	+			
Red-backed Fairywren	*Malurus melanocephalus*		++	++	++	+++	+++	++	++	+++	+	+++

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
Purple-backed Fairywren	*Malurus assimilis*				+			++		++		
Noisy Miner	*Manorina melanocephala*		+++	++	+++	+++	++	++	++	+++	++	++
Yellow-throated Miner	*Manorina flavigula*			++		++	+++	++	++			++
Singing Honeyeater	*Gavicalis virescens*			+			+			+		
Scarlet Honeyeater	*Myzomela sanguinolenta*									+		
Brown Honeyeater	*Lichmera indistincta*	+		++	++			+++	+			++
Blue-faced Honeyeater	*Entomyzon cyanotis*		++	+++	+++	+++		+++	++		++	++
White-throated Honeyeater	*Melithreptus albogularis*	+	+++	+++	+++	++	+	+++	++	+	+	
Striped Honeyeater	*Plectorhyncha lanceolata*			++	+			++	+++			
Little Friarbird	*Philemon citreogularis*		+++	+++	+++	++	+++	++	+++	+++	+	++
Noisy Friarbird	*Philemon corniculatus*		+++	+++	+++	+++	++	+++	+++	+++	+	+++
Striated Pardalote	*Pardalotus striatus*		+++	+++	+++	+++	+++	+++	+++	+++	++	+++
Yellow Thornbill	*Acanthiza nana*		++						+++			
Buff-rumped Thornbill	*Acanthiza reguloides*		+++					++	+++	++		
Speckled Warbler	*Pyrrholaemus sagittatus*			+				+				
Weebill	*Smicrornis brevirostris*		+++	+++	+++	+++	+	+++	+++	+++	++	++
White-throated Gerygone	*Gerygone olivacea*	+		+++	++	++		+++	+++	+++		+
Grey-crowned Babbler	*Pomatostomus temporalis*		+++	+++	++	++		+++	+++	+++		
Golden-headed Cisticola	*Cisticola exilis*											+
Silvereye	*Zosterops lateralis*	++								++		
Masked Woodswallow	*Artamus personatus*											++
White-browed Woodswallow	*Artamus superciliosus*				++				++			++
Black-faced Woodswallow	*Artamus cinereus*							+				

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
White-breasted Woodswallow	*Artamus leucorynchus*				++							
Grey Butcherbird	*Cracticus torquatus*		+++	++	+++	++		++	+++	+	+	
Pied Butcherbird	*Cracticus nigrogularis*		++	+++	+++	+++	+++	+++	+++	+++	+	+++
Australian Magpie	*Gymnorhina tibicen*		+++	+++	+++	+++	+++	+++	+++	+++		+++
Pied Currawong	*Strepera graculina*	+++	+++	+++	++	++		+++	+++	+		+
Black-faced Cuckooshrike	*Coracina novaehollandiae*		+++	+++	++	++	+++	+++	+++	+++		+++
White-bellied Cuckooshrike	*Coracina papuensis*			++	+	+	++					
White-winged Triller	*Lalage tricolor*					+		++				
Common Cicadabird	*Edolisoma tenuirostre*								+			
Varied Sitella	*Daphoenositta chrysoptera*		+++		++				++			
Grey Shrikethrush	*Colluricincla harmonica*		+++		++			++	+++			+
Golden Whistler	*Pachycephala pectoralis*	+										
Rufous Whistler	*Pachycephala rufiventris*		++	+++	++	+++	+	+++	+++	+++	+	++
Olive-backed Oriole	*Oriolus sagittatus*		+++	++	++	+	+	+++	++			
Australasian Figbird	*Sphecotheres vieilloti*			++	++	++						
Spangled Drongo	*Dicrurus bracteatus*				+					++		
Grey Fantail	*Rhipidura albiscapa*	+	++	++	++			+++	+++			++
Rufous Fantail	*Rhipidura rufifrons*	+						+				
Willie Wagtail	*Rhipidura leucophrys*		+	+	++	+	+	++	+	++	+	++
Magpie-lark	*Grallina cyanoleuca*			+		+++		++				+++
Leaden Flycatcher	*Myiagra rubecula*	+	+++	+	++		++	++	++	++		
Australian Raven	*Corvus coronoides*			++	+	+						
Torresian Crow	*Corvus orru*		+++	+++	+++	+++	+++	+++	+++	+++		+++

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
White-winged Chough	*Corcorax melanorhamphos*			++	++	+			+			
Apostlebird	*Struthidea cinerea*	+	++	+++	++	+++		++	++		++	++
Jacky Winter	*Microeca fascinans*			+								
Eastern Yellow Robin	*Eopsaltria australis*								+			
Australasian Reed Warbler	*Acrocephalus australis*											+
Brown Songlark	*Megalurus cruralis*											+
Rufous Songlark	*Megalurus mathewsi*						+++		+	+		++
Common Myna	*Acridotheres tristis*											++
Mistletoebird	*Dicaeum hirundinaceum*	+	+	+	+			+	+++		+	
Australasian Pipit	*Anthus novaeseelandiae*											++
Chestnut-breasted Mannikin	*Lonchura castaneothorax*			++								++
Plum-headed Finch	*Neochmia modesta*			++								
Double-barred Finch	*Taeniopygia bichenovii*	+	++	+++	+			+++	++		+	
REPTILES												
Robust Blind Snake	*Anilios ligatus*				+							
Small-headed Blind Snake	*Anilios affinis*					+		+	+			
Spotted Python	*Antaresia maculosa*			+								
Black-headed Python	*Aspidites melanocephalus*									+		
Brown Tree Snake	*Boiga irregularis*				+							
Green Tree Snake	*Dendrelaphis punctulatus*											+
Eastern Brown Snake	*Pseudonaja textilis*											+
Coral Snake	*Brachyurophis australis*			+								
Yellow-faced Whipsnake	*Demansia psammophis*						+			+		

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR†
Curl Snake	*Suta suta*			+								
Burton's Legless Lizard	*Lialis burtonis*		+		+				+			
Eastern Striped Skink	*Ctenotus robustus/spaldingi*		+++	++		+	+	+	++			++
Eastern Barred Wedgesnout Ctenotus	*Ctenotus strauchii*							++		++		
Eastern Mulch-slider	*Lerista fragilis*		+++	++		+		+	+++	+		+
Common Dwarf Skink	*Menetia greyii*			++								
Dwarf Litter-skink	*Pygmaeascincus timlowi*			+	++	++						++
Iridescent Litter-skink	*Lygisaurus foliorum*		+++		++				+++			
Shaded-litter Rainbow-skink	*Carlia munda*			++	++	++		++		+		++
Open-litter Rainbow-skink	*Carlia pectoralis*	+++		++	+++	+++		++	+++			
Robust Rainbow-skink	*Carlia schmeltzii*			+	+		+		+			
Tussock Rainbow-skink	*Carlia vivax*				++					++		
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*		++	++	++	+	+	++				
Fire-tailed Skink	*Morethia taeniopleura*		+++	+++	++	++	+	+	+++			+
Bearded Dragon	*Pogona barbata*			+				+				
Tommy Roundhead	*Diporiphora australis*		++	+++				++	++			
Black-headed Monitor	*Varanus tristis*					+		++				+
Dubious Dtella	*Gehyra dubia*	+		+++	++		+++	++	+++	++		+
Chain-backed Dtella	*Gehyra catenata*				++		+		++	+++		
Bynoe's Gecko	*Heteronotia binoei*	+++	+++	+++	+++	+++	++	+++	+++	+++		+++
Spiny Knob-tail Gecko	*Nephrurus asper*								+			
Box-patterned Gecko	*Lucasium steindachneri*		++	+++		++	++	+++		++		
Eastern Fat-tailed Gecko	*Diplodactylus platyurus*			++		+++			+			

Common Name	Scientific Name	Abundance per Broad Vegetation Group*										
		7a	10a	12a	16a/9e	17a	17b	18b	24a	25a	34d	NR[†]
Wood Gecko	*Diplodactylus vittatus*		+						+++			
Ocellated Velvet Gecko	*Oedura monilis*							+	+	+++		
Ornate Velvet Gecko	*Oedura picta*			++								
Eastern Spiny-tailed Gecko	*Strophurus williamsi*			++			+			+		+
AMPHIBIANS												
Cane Toad	*Rhinella marina*	+		+++	+++	+++	++	+++	+++	++	+++	+++
Spotted Grass Frog	*Limnodynastes tasmaniensis*			+		++	++	+		+		++
Scarlet sided Pobblebonk	*Limnodynastes terraereginae*				++	++					++	
Green Tree-Frog	*Litoria caerulea*			+					++	+	++	
Desert Tree-Frog	*Litoria rubella*							+		++	+++	++
Roth's Tree Frog	*Litoria rothii*										++	
Bumpy Rocket Frog	*Litoria inerma*					++					++	+++
Broad-palmed Frog	*Litoria latopalmata*											+
Ornate Burrowing Frog	*Platyplectrum ornatum*		+	++	+++	+++	++	+++	++	+++	+++	+++
Short-footed Frog	*Cyclorana brevipes*					++	+	++	+	+		
New Holland Frog	*Cyclorana novaehollandiae*					++					+++	++
Green-stripe Frog	*Cyclorana alboguttata*										+	++
Wrinkled Toadlet	*Uperoleia rugosa*							+				+
Major Toadlet	*Pseudophryne major*										++	

*Abundance: + = only one individual recorded; ++ = more than one individual but present in fewer than half the sites surveyed; +++ = present in the majority of sites surveyed.
[†]NR = non-remnant pasture.

APPENDIX D

ANABAT RESULTS

Microbat Call Interpretation Report

Prepared for ("Client"):	METSERVE
Survey location/project name:	Saraji West
Survey dates:	25 October – 3 November 2018
Client project reference:	
Job no.:	MET-1802
Report date:	14 December 2018

Methods

Data received & post-processing

Balance! Environmental received 14 ZCA data files and associated log files, recorded using two Anabat Express detectors (Titley Scientific, Brisbane) over seven consecutive nights (25th October – 2nd November 2018).

The ZCA files were processed with *AnalookW* (Corben 2018) to extract individual Anabat ZC call-sequence files for analysis. This process yielded some 33,000 ZC files; however, when a generic noise filter was applied in *AnalookW*, fewer than 3000 ZC files were found to contain identifiable bat-calls. Most of the noise files were generated from Anabat B (Meserve).

Call analysis and identification

All ZC files that passed the noise filter were analysed in *AnalookW*, with species identification achieved manually by comparing call spectrograms and derived metrics with those of reference calls from central and northern Queensland and/or with published call descriptions (e.g. Reinhold et al. 2001). Consideration was also given to the probability of species' occurrence based on published distribution information (e.g. Churchill 2008; van Dyck *et al.* 2013) and on-line database records (e.g. http://www.ala.org.au).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at http://www.ausbats.org.au/.

Species nomenclature follows Jackson & Groves (2015), which elevates the sub-genus names proposed by Reardon *et al.* (2014) for the *Mormopterus* free-tailed bats to genus level; hence *Ozimops lumsdenae* (syn. *M.* beccarii) and *O. ridei* (syn. *M. ridei* and *M.* 'species 2') are used herein.

Results & Discussion

A total of 2469 individual bat calls were identified in this data set, with 82% (2031) of those recorded by Anabat B (Metserve) and the remainder (438 calls) recorded by Anabat ECO1019.

Reliable identification was achieved on 2191 calls (89% of total), which were attributed to seven unique species and two species pairs, the members of which cannot be differentiated based on call characteristics. The positively-identified species included the following:

- *Chalinolobus gouldii;*
- *Nyctophilus geoffroyi / N. gouldi;*
- *Scotorepens balstoni;*
- *Scotorepens greyii / S. sanborni;*
- *Vespadelus troughtoni;*
- *Chaerephon jobensis;*
- *Ozimops lumsdenae;*
- *Ozimops ridei;* and
- *Saccolaimus flaviventris.*

Eighteen percent (278) of the calls could not be reliably identified due to similarities in call characteristics shared by several species that are likely to occur in the study area. These unresolved calls were allocated to one of the following species groups:

- *Chalinolobus gouldii / Ozimops ridei;*
- *C. gouldii / Scotorepens balstoni;*
- *Scotorepens greyii / Chalinolobus nigrogriseus;*
- *Saccolaimus flaviventris / Chaerephon jobensis;* and
- *S. flaviventris / Ozimops lumsdenae.*

Of these unresolved groups, only one potentially represents an additional species (*i.e. Chalinolobus nigrogriseus*), with the others all containing species that were otherwise positively identified form more typical calls.

Table 1 provides a summary of species' presence on each detector-night throughout the survey. Where unresolved calls were identified, all members of the relevant group are listed as "possible" unless positive identification was achieved on other calls.

Sample spectrograms of each recorded call type are shown at Appendix 1.

References

Churchill, S. (2008). *Australian Bats*. Jacana Books, Allen & Unwin; Sydney.

Corben, C. (2018). AnalookW for bat call analysis using ZCA. Version 4.3x, 19 July 2018.

Jackson, S. and Groves, C. (2015). *Taxonomy of Australian Mammals*. CSIRO Publishing, Melbourne.

Reardon, T. (2003). Standards in bat detector based surveys. *Australasian Bat Society Newsletter* **20**, 41-43.

Reardon, T. B., McKenzie, N. L., Cooper, S. J. B., Appleton, B., Carthew, S. and Adams, M. (2014). A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats *Mormopterus* (Chiroptera : Molossidae). *Australian Journal of Zoology* **62**, 109–136.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Department of Natural Resources and Mines, Brisbane.

van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). *Field Companion to the Mammals of Australia*. New Holland; Sydney.

Table 1. Microbat species recorded during the Saraji West survey, 25 October – 2 November 2018.

♦ = ‘definite’ - at least one call was attributed unequivocally to the species

□ = ‘possible’ - calls similar to those of the species were recorded, but were not reliably identified

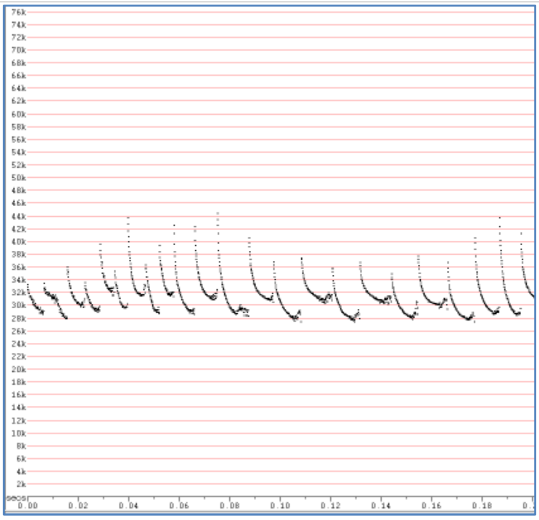
Detector:	Anabat B Metserve							Anabat ECO1019				
Date:	25-Oct	26-Oct	27-Oct	28-Oct	29-Oct	30-Oct	1-Nov	26-Oct	27-Oct	28-Oct	29-Oct	30-Oct
Chalinolobus gouldii	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦	♦
Chalinolobus nigrogriseus	□	□	□			□	□			□		
Nyctophilus species						♦						
Scotorepens balstoni	♦	♦	♦	□	□	♦	♦					♦
Scotorepens greyii / S. sanborni		♦	♦	♦	♦	♦	♦				♦	♦
Vespadelus troughtoni							♦					♦
Chaerephon jobensis	□	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	
Ozimops lumsdenae		♦	♦	♦	♦	♦	♦	♦		♦	♦	♦
Ozimops ridei	□	♦	♦	□	□	♦	♦	♦		♦	□	□
Saccolaimus flaviventris	♦	♦	♦		♦	♦	♦		♦	♦	♦	♦

Glossary

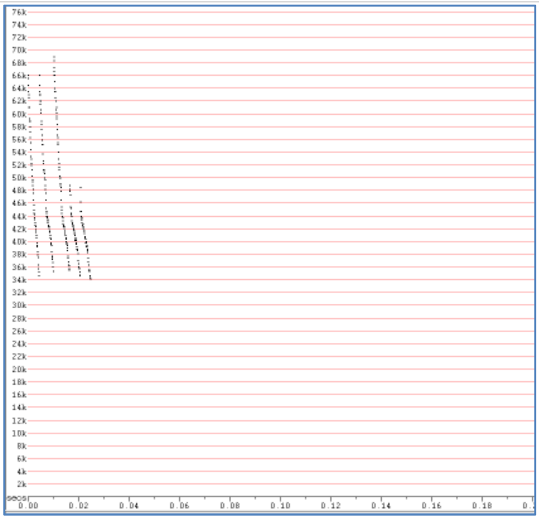
Technical terms used in this report are described in the following table.

Approach phase	The part of a bat *call* emitted as the bat starts to home in on a detected prey item; a transitional series of *pulses* between the *search phase* and *feeding buzz*, that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound *pulses* in one or more *phases* (*search, approach, feeding buzz*).
CF (=Constant Frequency)	A type of *pulse* in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with *shape* appearing flat on the sonogram. Often also contains a brief *FM* component at the beginning and/or end of the CF component (*viz.* FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a *pulse*; usually the lowest frequency reached in the *qCF* component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a *pulse* to the end of the pulse.
Feeding buzz	The terminal part of a *call*, following the *approach phase*, emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of *pulse* in which there is substantial change in frequency from beginning to end; *shape* ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the *characteristic frequency* section of *pulses* within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a *pulse* sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a *pulse* between the initial (usually steeper) frequency sweep and the *characteristic frequency* section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat *call*; the *shape*, *duration* and *characteristic frequency* of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the *pulse* between the *knee* and *tail* and containing the *characteristic frequency* section.
Pulse shape	The general appearance of a *pulse* on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also *CF, qCF* and *FM*.
qCF (=quasi Constant Frequency)	A type of *pulse* in which there is very little change in frequency from beginning to end; *shape* appears to be almost flat. Some pulses also contain an *FM* component at the beginning and/or end of the qCF component (*viz.* FM-qCF).
Search phase	The part of a bat *call* generally required for reliable species diagnosis. A consistent series of *pulses* emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than *approach phase* and *feeding buzz* pulses.
Sequence	Literally, a sequence of *pulses* that may be from one or more bats; but generally refers to a *call* or part (e.g. *phase*) of a call.
Tail	The final component of a *pulse*, following the *characteristic frequency* section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

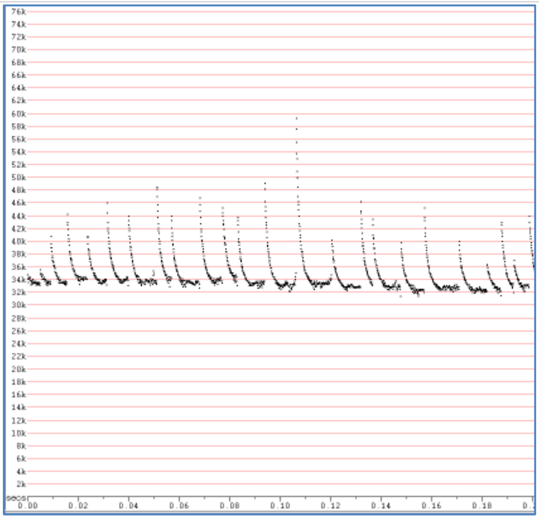
Appendix 1 Representative call sequences from the Saraji West survey, October 2018.
AnalookW spectrograms with time between pulses removed pulses



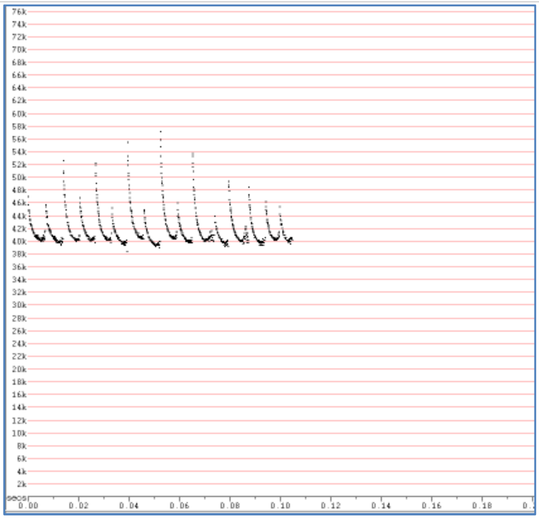
Chalinolobus gouldii



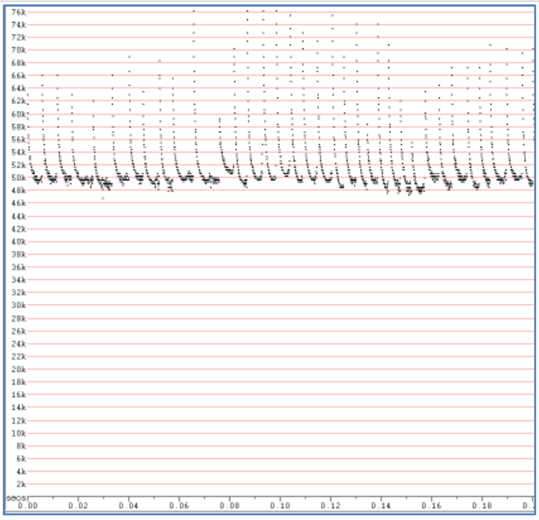
Nyctophilus species



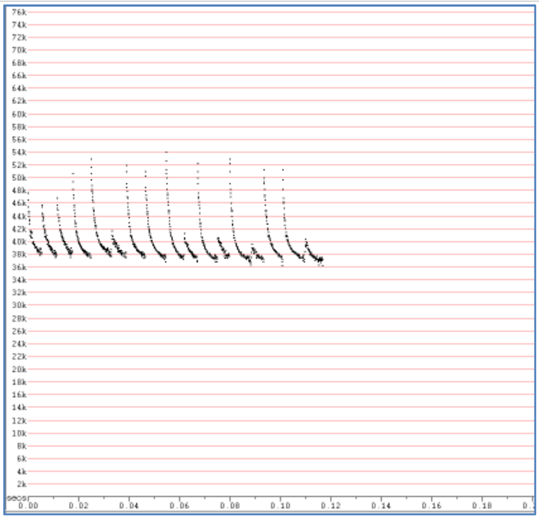
Scotorepens balstoni



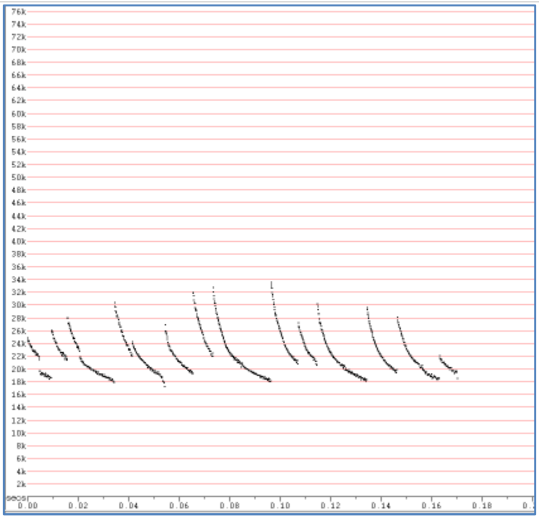
Scotorepens greyii / S. sanborni



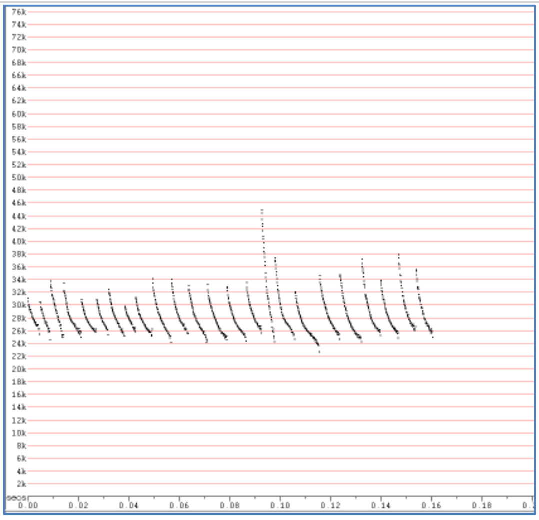
Vespadelus troughtoni



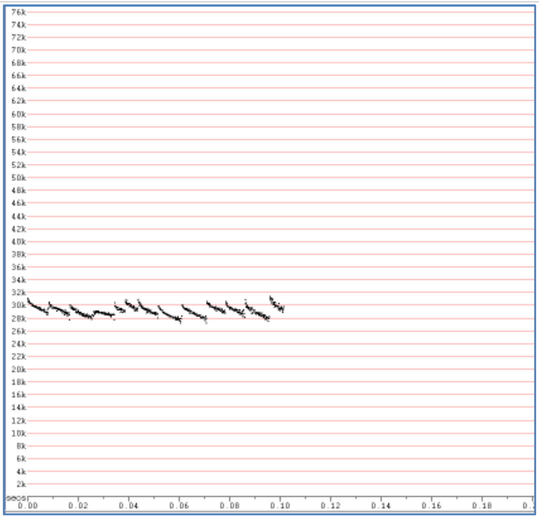
Scotorepens spp. or *Chalinolobus nigrogriseus*



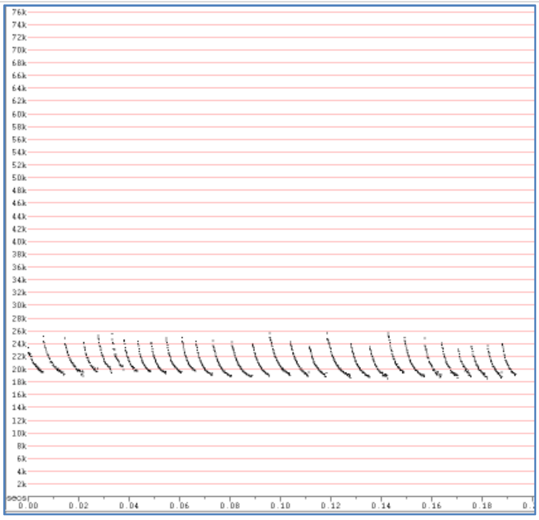
Chaerephon jobensis



Ozimops lumsdenae



Ozimops ridei



Saccolaimus flaviventris

Microbat Call Interpretation Report

Prepared for ("Client"):	METSERVE
Survey location/project name:	Saraji West
Survey dates:	26 March – 7 May 2019
Client project reference:	
Job no.:	MET-1901
Report date:	19 August 2019

Methods

Data received & post-processing

Balance! Environmental received 30 ZCA data files and associated log files, recorded using two Anabat Express detectors (Titley Scientific, Brisbane) over three survey periods: 26-28 March; 8-15 April; and 30 April – 7 May 2019.

Deployment locations for the two detectors were extracted from the included LOG files. These are plotted on the map at **Figure 1**, with the GPS data extract for each detector listed in **Appendix 1**.

The ZCA files were processed with *Anabat Insight* (version 1.8.9; Titley Scientific) to extract individual Anabat ZC call-sequence files for analysis. This process yielded 37,660 ZC files; however, 33,931 of those files were discarded by the application of a noise filter to remove those files containing only non-bat sounds (e.g. from insects, wind, etc.).

Call analysis and identification

All ZC files that passed the noise filter were analysed in *Anabat Insight*. First-pass call identification was achieved using a Decision Tree analysis to group and label similar calls based primarily on frequency characteristics. Species identities within each group were then verified and/or altered manually by reviewing call spectrograms and derived metrics and comparing them with those of reference calls from central and northern Queensland and/or with published call descriptions (e.g. Reinhold et al. 2001). Consideration was also given to the probability of species' occurrence based on published distribution information (e.g. Churchill 2008; van Dyck *et al.* 2013) and on-line database records (e.g. http://www.ala.org.au).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at http://www.ausbats.org.au/.

Species nomenclature follows Jackson & Groves (2015).

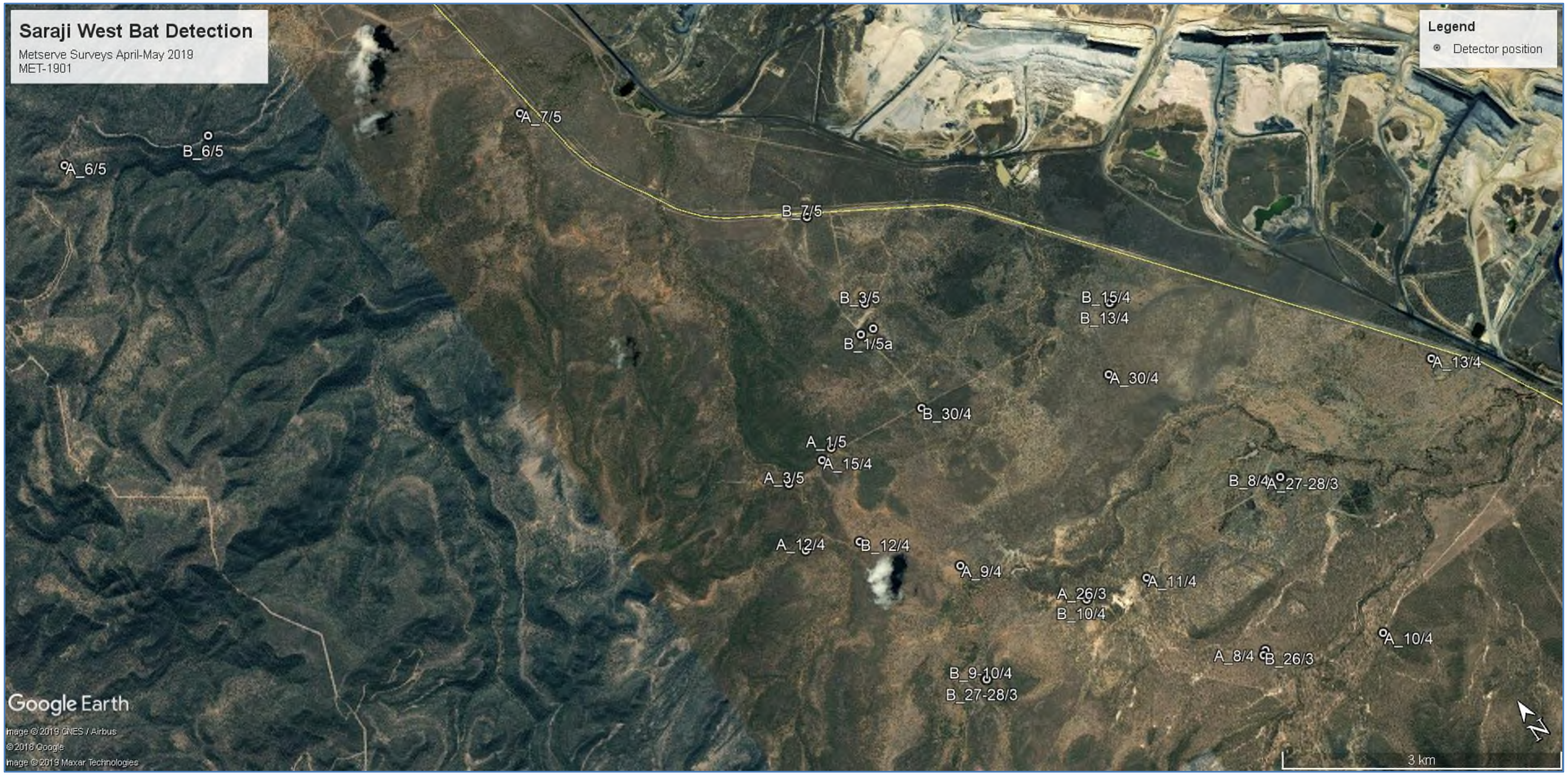


Figure 1 Bat detector deployment locations – Saraji West surveys, March, April and May 2019.

Results & Discussion

Detector A recorded no bat-call data on the nights of 28th March and 10th April; and Detector B failed to record any bat calls on the nights of 27th March and 10th April. A total of 3737 individual bat calls were identified across the remaining detector-nights.

Reliable identification was achieved on 1636 calls (44% of total detected calls), which were attributed to the following 11 unique species and two indistinguishable species pairs:

- *Chalinolobus gouldii;*
- *Chalinolobus morio;*
- *Chalinolobus picatus;*
- *Nyctophilus geoffroyi / N. gouldi;*
- *Scotorepens balstoni;*
- *Scotorepens greyii / S. sanborni;*
- *Vespadelus troughtoni;*
- *Miniopterus orianae oceanensis;*
- *Austronomus australis;*
- *Chaerephon jobensis;*
- *Ozimops lumsdenae;*
- *Ozimops ridei;* and
- *Saccolaimus flaviventris.*

Fifty-six percent (2101) of the calls could not be reliably identified due to similarities in call characteristics shared by several species that are likely to occur in the study area. These unresolved calls were allocated to one of several multi-species groups, including:

- *C. gouldii / O. ridei;*
- *C. gouldii / S. balstoni;*
- *C. morio / V. troughtoni;*
- *C. picatus / M. o. oceanensis;*
- *C. picatus / S. greyii / S. sanborni;*
- *C. picatus / Vespadelus baverstocki;*
- *S. flaviventris / C. jobensis;*
- *S. flaviventris / O. lumsdenae;* and
- *O. lumsdenae / Taphozous troughtoni.*

Two of these unresolved groups represent potential additional species (*i.e. C. picatus /* ***V. baverstocki*** and *O. lumsdenae /* ***T. troughtoni***); however, it is considered unlikely that *V. baverstocki* would occur in the study area. The latter species, *T. troughtoni*, may be present if suitable subterranean roost sites exist in the broader study area.

Table 1 provides a summary of species' presence on each detector-night throughout the survey. Where unresolved calls were identified, all members of the relevant group are listed as "possible" unless positive identification was achieved on other calls.

Sample spectrograms of each recorded call type are shown at **Appendix 2**.

References

Churchill, S. (2008). *Australian Bats*. Jacana Books, Allen & Unwin; Sydney.

Corben, C. (2018). AnalookW for bat call analysis using ZCA. Version 4.3x, 19 July 2018.

Jackson, S. and Groves, C. (2015). *Taxonomy of Australian Mammals*. CSIRO Publishing, Melbourne.

Reardon, T. (2003). Standards in bat detector based surveys. *Australasian Bat Society Newsletter* **20**, 41-43.

Reardon, T. B., McKenzie, N. L., Cooper, S. J. B., Appleton, B., Carthew, S. and Adams, M. (2014). A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats *Mormopterus* (Chiroptera : Molossidae). *Australian Journal of Zoology* **62**, 109–136.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Department of Natural Resources and Mines, Brisbane.

van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). *Field Companion to the Mammals of Australia*. New Holland; Sydney.

Table 1-A. Microbat species recorded during the Saraji West survey, March-May 2019 – **Detector A**.

♦ = 'definite' - at least one call was attributed unequivocally to the species

□ = 'possible' - calls similar to those of the species were recorded, but were not reliably identified

Detector - serial number:	**A - SN318011**														
Detector-night:	26/3	27/3	28/3	08/4	09/4	10/4	11/4	12/4	13/4	15/4	30/4	01/5	03/5	06/5	07/5
Chalinolobus gouldii	♦	♦		♦	♦		♦		♦	♦	♦	♦	□	♦	□
Chalinolobus morio	♦				□					□	□	♦			
Chalinolobus picatus	□				□		♦		□	□	♦	♦	♦		♦
Nyctophilus sp.	♦				♦				♦				♦		
Scotorepens balstoni	♦			♦	□		□				□	♦			♦
Scotorepens greyii	♦				♦		♦		♦	♦	□	♦	♦		□
Vespadelus baverstocki	□				□				□	□	□		□		
Vespadelus troughtoni	♦				♦				♦	□	□	♦		♦	♦
Miniopterus orianae oceanensis	♦						□			♦		♦	♦		♦
Austronomus australis								♦							
Chaerephon jobensis	♦	♦		♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦
Ozimops lumsdenae	♦	□		♦	♦		♦	♦	♦	♦	♦	♦		♦	
Ozimops ridei	♦	□		□	□		□		□	♦	♦	□	□	♦	□
Saccolaimus flaviventris	♦	□		♦	♦		♦	□	□		□	□	□	♦	
Taphozous troughtoni												□	□		

Table 1-B. Microbat species recorded during the Saraji West survey, March-May 2019 – **Detector B**.

♦ = 'definite' - at least one call was attributed unequivocally to the species

□ = 'possible' - calls similar to those of the species were recorded, but were not reliably identified

Detector - serial number:	**B - SN324680**														
Detector-night:	26/3	27/3	28/3	08/4	09/4	10/4	11/4	12/4	13/4	15/4	30/4	01/5	03/5	06/5	07/5
Chalinolobus gouldii	♦		♦	♦	♦		♦	♦	♦	♦	□	♦	♦	♦	♦
Chalinolobus morio								□	□	♦	□	♦	♦	□	
Chalinolobus picatus	□			□			□	□	□	□	□	♦	♦	♦	□
Nyctophilus sp.			♦	♦					♦			♦		♦	
Scotorepens balstoni	□		□	□	□							♦	□		
Scotorepens greyii	□			♦			□	♦	♦	♦	□	♦	♦	♦	□
Vespadelus baverstocki				□				□	□			□	□		
Vespadelus troughtoni								♦	♦	♦	□		♦	♦	
Miniopterus orianae oceanensis			♦					♦	♦	♦	♦	♦	♦	♦	♦
Austronomus australis															
Chaerephon jobensis	♦		♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦
Ozimops lumsdenae	♦		♦	♦	♦		♦		♦	♦	♦	♦	♦		♦
Ozimops ridei	♦		♦	♦	♦		♦	♦	♦	♦	♦	♦	♦	□	□
Saccolaimus flaviventris			♦	♦			♦	♦	♦	♦	□	♦	♦	□	□
Taphozous troughtoni				□						□			□		□

Glossary

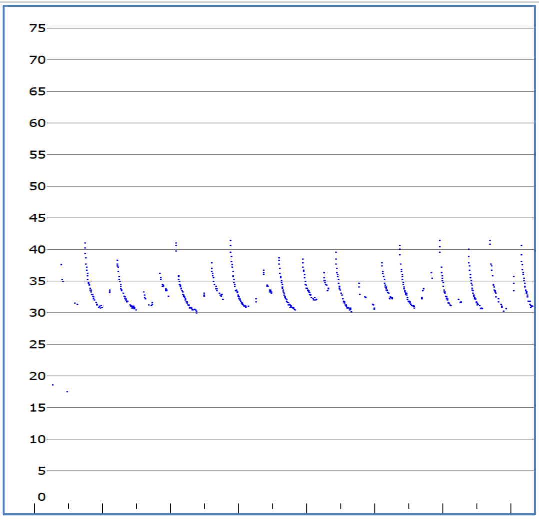
Technical terms used in this report are described in the following table.

Approach phase	The part of a bat *call* emitted as the bat starts to home in on a detected prey item; a transitional series of *pulses* between the *search phase* and *feeding buzz*, that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound *pulses* in one or more *phases* (*search, approach, feeding buzz*).
CF (=Constant Frequency)	A type of *pulse* in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with *shape* appearing flat on the sonogram. Often also contains a brief *FM* component at the beginning and/or end of the CF component (*viz.* FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a *pulse*; usually the lowest frequency reached in the *qCF* component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a *pulse* to the end of the pulse.
Feeding buzz	The terminal part of a *call*, following the *approach phase*, emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of *pulse* in which there is substantial change in frequency from beginning to end; *shape* ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the *characteristic frequency* section of *pulses* within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a *pulse* sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a *pulse* between the initial (usually steeper) frequency sweep and the *characteristic frequency* section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat *call*; the *shape*, *duration* and *characteristic frequency* of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the *pulse* between the *knee* and *tail* and containing the *characteristic frequency* section.
Pulse shape	The general appearance of a *pulse* on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also *CF, qCF* and *FM*.
qCF (=quasi Constant Frequency)	A type of *pulse* in which there is very little change in frequency from beginning to end; *shape* appears to be almost flat. Some pulses also contain an *FM* component at the beginning and/or end of the qCF component (*viz.* FM-qCF).
Search phase	The part of a bat *call* generally required for reliable species diagnosis. A consistent series of *pulses* emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than *approach phase* and *feeding buzz* pulses.
Sequence	Literally, a sequence of *pulses* that may be from one or more bats; but generally refers to a *call* or part (e.g. *phase*) of a call.
Tail	The final component of a *pulse*, following the *characteristic frequency* section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

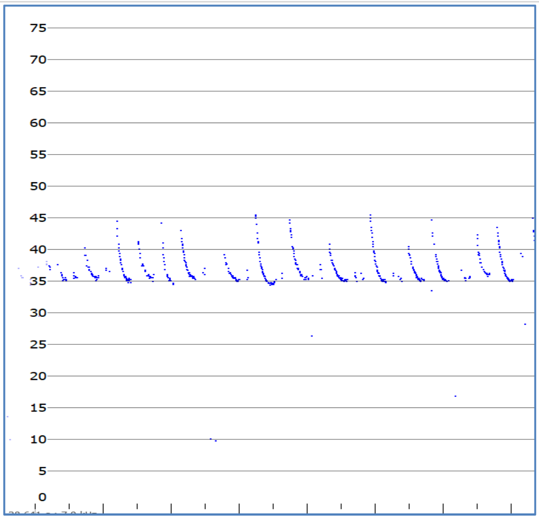
Appendix 1 GPS coordinates derived from detector LOG files.

Detector name	Serial Number	Date	Latitude	Longitude
A	SN318011	26/03/2019	-22.37716	148.21459
		27/03/2019	-22.37623	148.23676
		28/03/2019	-22.37618	148.23673
		8/04/2019	-22.39008	148.22679
		9/04/2019	-22.3665	148.20516
		10/04/2019	-22.39518	148.23804
		11/04/2019	-22.37769	148.22077
		12/04/2019	-22.35665	148.19285
		13/04/2019	-22.37584	148.25864
		15/04/2019	-22.35043	148.19961
		30/04/2019	-22.35911	148.2297
		1/05/2019	-22.34987	148.20114
		3/05/2019	-22.35026	148.19531
		6/05/2019	-22.28541	148.15191
		7/05/2019	-22.30574	148.19387
B	SN324680	26/03/2019	-22.3904	148.22627
		27/03/2019	-22.37693	148.20079
		28/03/2019	-22.37695	148.20086
		8/04/2019	-22.37699	148.20077
		9/04/2019	-22.37691	148.20069
		10/04/2019	-22.37602	148.2143
		11/04/2019	-22.37597	148.21452
		12/04/2019	-22.35903	148.1982
		13/04/2019	-22.35358	148.23393
		15/04/2019	-22.3537	148.23395
		30/04/2019	-22.35166	148.21131
		1/05/2019	-22.34241	148.21047
		3/05/2019	-22.34033	148.21277
		6/05/2019	-22.29084	148.16613
		7/05/2019	-22.33003	148.21279

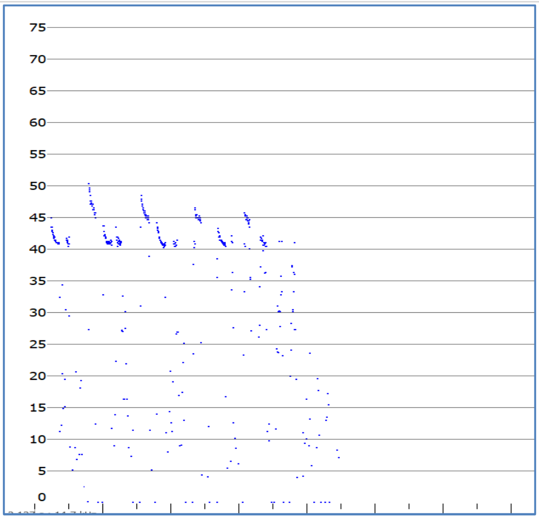
Appendix 2 Representative call sequences from the Saraji West surveys, March-May 2019. *AnalookW* spectrograms with time between pulses removed pulses



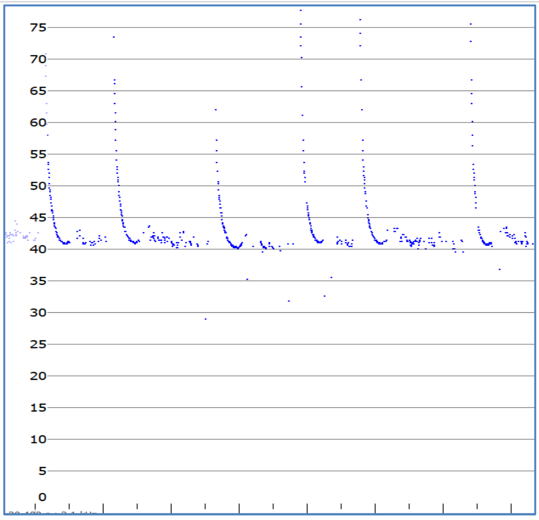
Chalinolobus gouldii



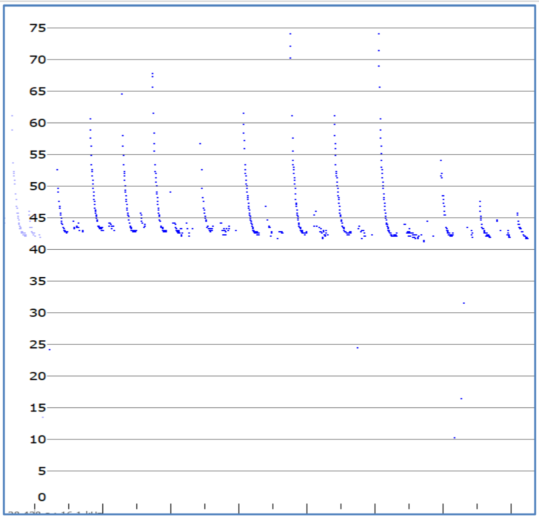
Scotorepens balstoni



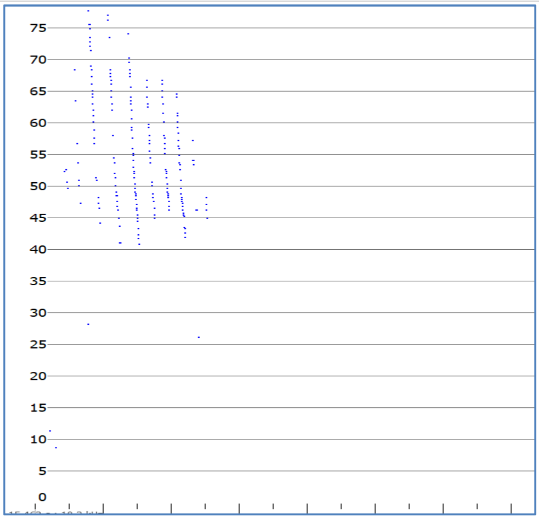
Chalinolobus picatus



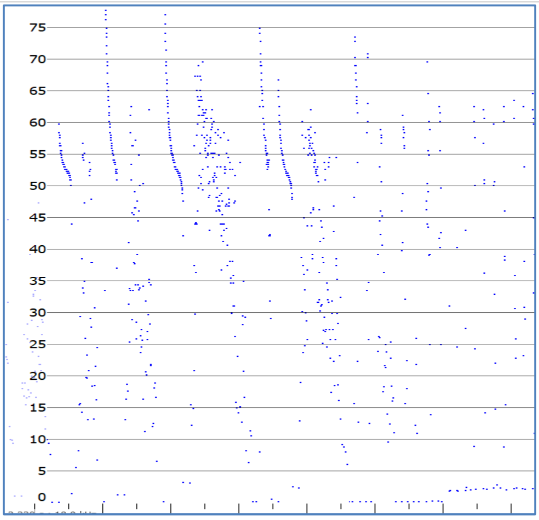
Scotorepens greyii / S. sanborni



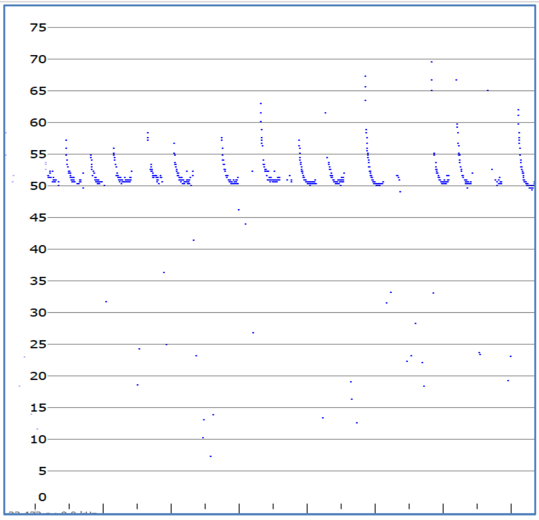
C. picatus or *Vespadelus baverstocki*



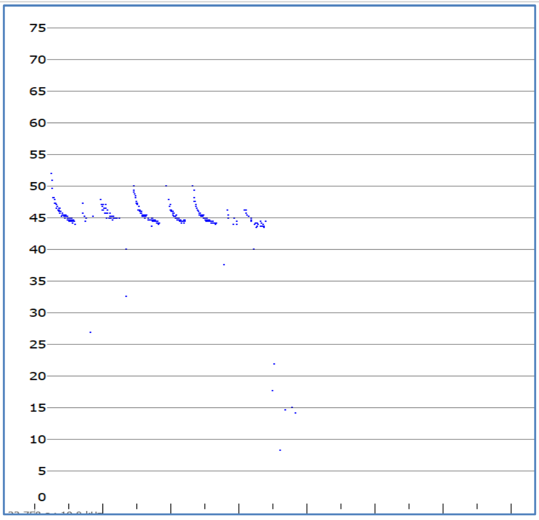
Nyctophilus sp.



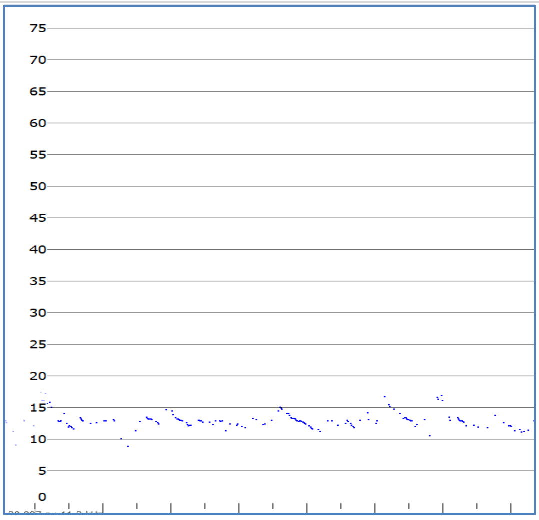
Chalinolobus morio



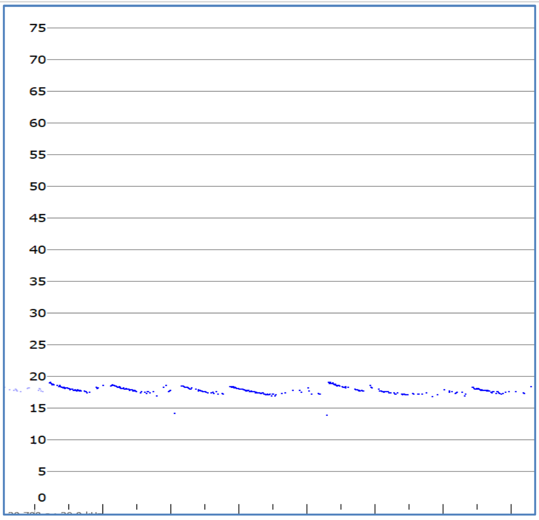
Vespadelus troughtoni



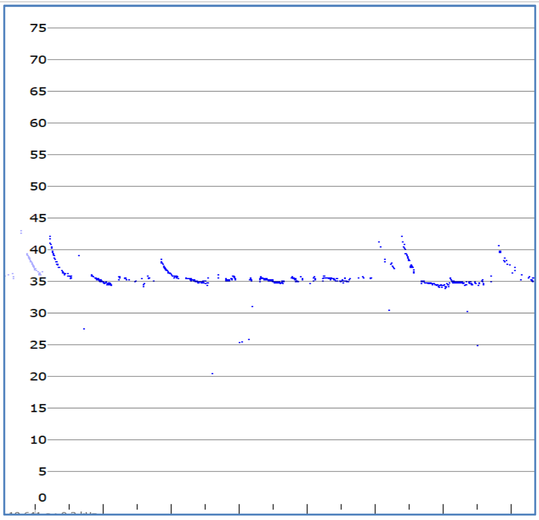
Miniopterus orianae oceanensis



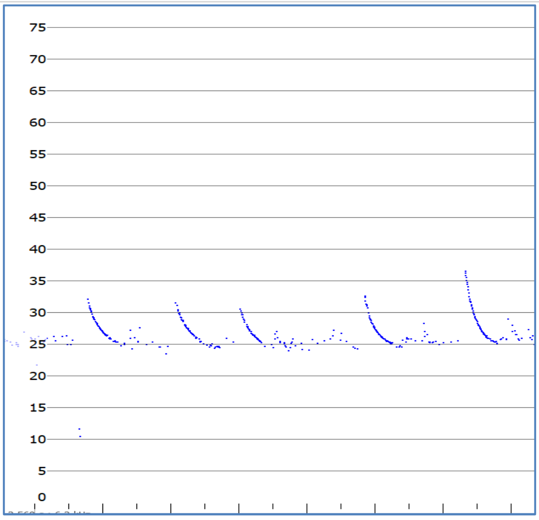
Austronomus australis



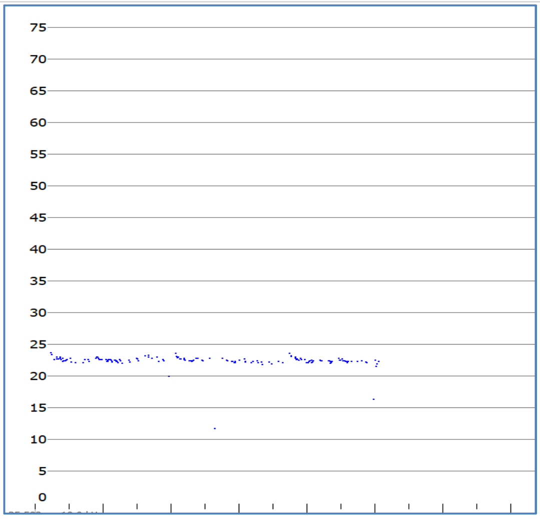
Chaerephon jobensis



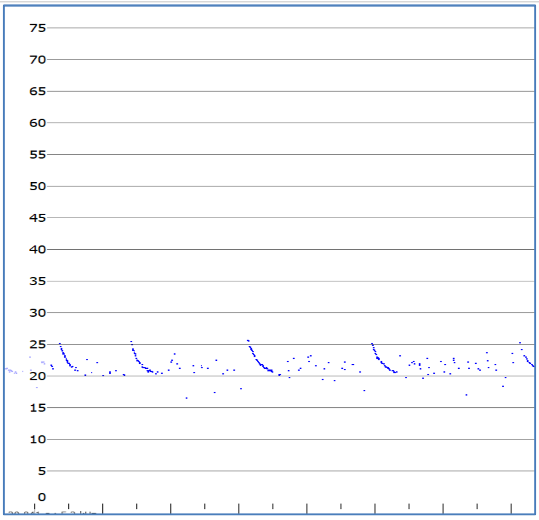
Ozimops ridei



Ozimops lumsdenae



O. lumsdenae or *Taphozous troughtoni*



Saccolaimus flaviventris

Microbat Call Interpretation Report

Prepared for ("Client"):	METSERVE
Survey location/project name:	Dysart area
Survey dates:	23-30 September 2019
Client project reference:	
Job no.:	MET-1902
Report date:	4 December 2019

Methods

Data received & post-processing

Balance! Environmental received 13 ZCA data files and associated log files, recorded using two Anabat Express detectors (Titley Scientific, Brisbane) deployed over eight consecutive nights (23-30 September 2019). The raw data files were named according to the site numbers at which each detector was deployed. These deployment details are summarised in **Table 1**.

The ZCA files were processed with *Anabat Insight* (version 1.9.1; Titley Scientific) to extract individual Anabat ZC call-sequence files for analysis. This process yielded 23,231 ZC files; however, 19,620 of those files were discarded by the application of a noise filter to remove files containing only non-bat sounds (e.g. from insects, wind, etc.).

Call analysis and identification

All ZC files that passed the noise filter were analysed in *Anabat Insight*. First-pass call identification was achieved using a Decision Tree analysis to group and label similar calls based primarily on frequency characteristics. Species identities within each group were then verified and/or altered manually by reviewing call spectrograms and derived metrics and comparing them with those of reference calls from central and northern Queensland and/or with published call descriptions (e.g. Reinhold et al. 2001). Consideration was also given to the probability of species' occurrence based on published distribution information (e.g. Churchill 2008; van Dyck *et al.* 2013) and on-line database records (e.g. http://www.ala.org.au).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at http://www.ausbats.org.au/.

Species nomenclature follows Jackson & Groves (2015).

Table 1 Bat detector deployment details extracted from the data files.

Detector:	Anabat A - SN318011						Anabat B - SN324680						
Date:	24/9	25/9	26/9	27/9	28/9	29/9	23/9	24/9	25/9	27/9	28/9	29/9	30/9
Site:	S27	A7	A8	A9	S32	S34	S26	S28	S29	S31	S30	S33	A10

Results & Discussion

Of the 3,611 ZC files passed the noise filter, 913 were found to contain only brief and/or weak and/or highly-fragmented bat calls that were of no use for species identification. From the 2,698 files that remained a total of 2881 bat calls were identified.

Reliable identification was achieved on 2184 calls (76% of total), which were attributed to 12 unique species and two indistinguishable species pairs. These positively identified species included:

- *Chalinolobus gouldii;*
- *Chalinolobus morio;*
- *Chalinolobus picatus;*
- *Nyctophilus geoffroyi / N. gouldi;*
- *Scotorepens balstoni;*
- *Scotorepens greyii / S. sanborni;*
- *Vespadelus baverstocki;*
- *Vespadelus troughtoni;*
- *Miniopterus orianae oceanensis;*
- *Chaerephon jobensis;*
- *Ozimops lumsdenae;*
- *Ozimops ridei;*
- *Setirostris eleryi;* and
- *Saccolaimus flaviventris*.

The other 697 calls could not be reliably identified due to similarities in call characteristics shared by several species. These unresolved calls were allocated to one of the following multi-species groups:

- *C. gouldii / O. ridei / S. balstoni;*
- *C. morio / V. troughtoni;*
- *C. picatus / S. greyii / S. sanborni;*
- *S. greyii / S. eleryi;*
- *S. flaviventris / C. jobensis;*
- *S. flaviventris / O. lumsdenae;* and
- *O. lumsdenae / Taphozous troughtoni.*

The above groups mostly represent species that were also identified positively from more typical calls. The last group potentially represents an additional species for this survey. *Taphozous troughtoni* is likely present in the study area, but it's calls can be difficult to distinguish from those of *O. lumsdenae*. Calls allocated to the group had shorter duration, more uniform pulses than those allocated positively to *O. lumsdenae*, but it was still not possible to reliably attribute them to *T. troughtoni*.

Table 2 provides a summary of species' presence per site. Where unresolved calls were identified, all members of the relevant group are listed as "possible" unless positive identification was achieved on other calls. Sample spectrograms of each recorded call type are shown at **Appendix 1**.

References

Churchill, S. (2008). *Australian Bats*. Jacana Books, Allen & Unwin; Sydney.

Jackson, S. and Groves, C. (2015). *Taxonomy of Australian Mammals*. CSIRO Publishing, Melbourne.

Reardon, T. (2003). Standards in bat detector based surveys. *Australasian Bat Society Newsletter* **20**, 41-43.

van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). *Field Companion to the Mammals of Australia*. New Holland; Sydney.

Table 2. Microbat species recorded during the Dysart surveys, 23-30 September 2019.

♦ = ‘definite’ - at least one call was attributed unequivocally to the species

□ = ‘possible’ - calls similar to those of the species were recorded, but were not reliably identified

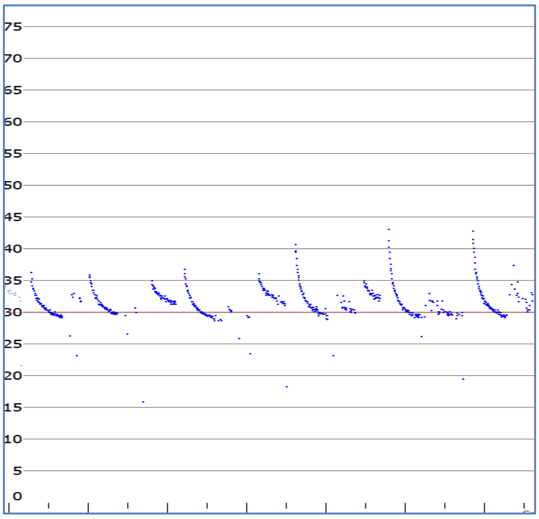
Site:	A7	A8	A9	A10	S26	S27	S28	S29	S30	S31	S32	S33	S34
Chalinolobus gouldii	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	□
Chalinolobus morio		♦	♦	♦	♦	□	♦		□	♦	♦	♦	□
Chalinolobus picatus	♦	♦	♦	♦	□	□	□	□	♦	♦	□	♦	□
Nyctophilus sp.			♦			♦				♦	♦	♦	
Scotorepens balstoni	□	♦	♦	♦		□	□	♦			♦	♦	♦
Scotorepens greyii	♦	♦	♦	♦	□	♦	♦	♦	♦	♦	♦	♦	♦
Vespadelus baverstocki		♦		♦	♦	♦		♦	♦	♦	♦	♦	
Vespadelus troughtoni			♦	□		□			□	♦	♦	♦	♦
Miniopterus orianae oceanensis	♦								♦	□			□
Chaerephon jobensis	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Ozimops lumsdenae	♦		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
Ozimops ridei	□	♦	♦	♦	♦	□	♦	♦	♦	□	□	♦	♦
Setirostris eleryi		□	♦	□	□	□		□	□	□	□		□
Saccolaimus flaviventris		♦	♦	♦	♦	□		♦	♦	♦	♦	♦	♦
Taphozous troughtoni	□		□			□	□		□	□	□	□	□

Glossary

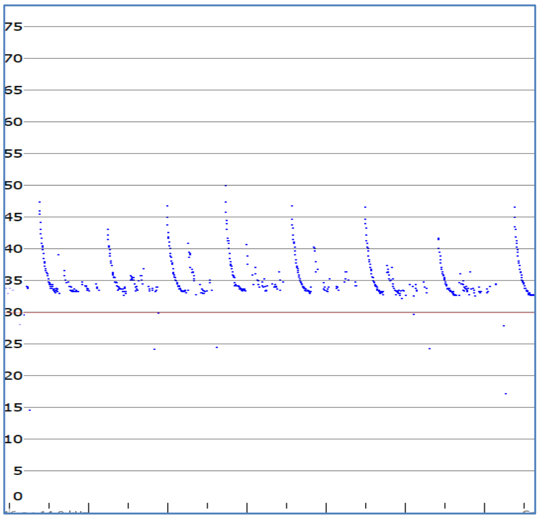
Technical terms used in this report are described in the following table.

Approach phase	The part of a bat *call* emitted as the bat starts to home in on a detected prey item; a transitional series of *pulses* between the *search phase* and *feeding buzz*, that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound *pulses* in one or more *phases* (*search, approach, feeding buzz*).
CF (=Constant Frequency)	A type of *pulse* in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with *shape* appearing flat on the sonogram. Often also contains a brief *FM* component at the beginning and/or end of the CF component (*viz.* FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a *pulse*; usually the lowest frequency reached in the *qCF* component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a *pulse* to the end of the pulse.
Feeding buzz	The terminal part of a *call*, following the *approach phase*, emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of *pulse* in which there is substantial change in frequency from beginning to end; *shape* ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the *characteristic frequency* section of *pulses* within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a *pulse* sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a *pulse* between the initial (usually steeper) frequency sweep and the *characteristic frequency* section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat *call*; the *shape*, *duration* and *characteristic frequency* of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the *pulse* between the *knee* and *tail* and containing the *characteristic frequency* section.
Pulse shape	The general appearance of a *pulse* on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also *CF, qCF* and *FM*.
qCF (=quasi Constant Frequency)	A type of *pulse* in which there is very little change in frequency from beginning to end; *shape* appears to be almost flat. Some pulses also contain an *FM* component at the beginning and/or end of the qCF component (*viz.* FM-qCF).
Search phase	The part of a bat *call* generally required for reliable species diagnosis. A consistent series of *pulses* emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than *approach phase* and *feeding buzz* pulses.
Sequence	Literally, a sequence of *pulses* that may be from one or more bats; but generally refers to a *call* or part (e.g. *phase*) of a call.
Tail	The final component of a *pulse*, following the *characteristic frequency* section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

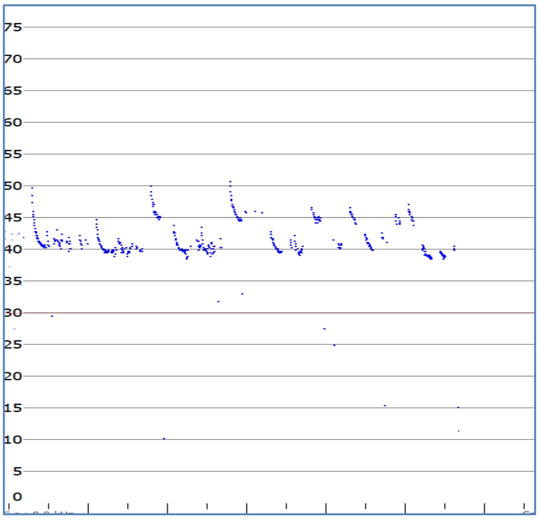
Appendix 1 Representative call sequences from the Dysart survey, 23-30 September 2019.
Time scale (*x*-axis) = 10ms per tick; time between pulses removed



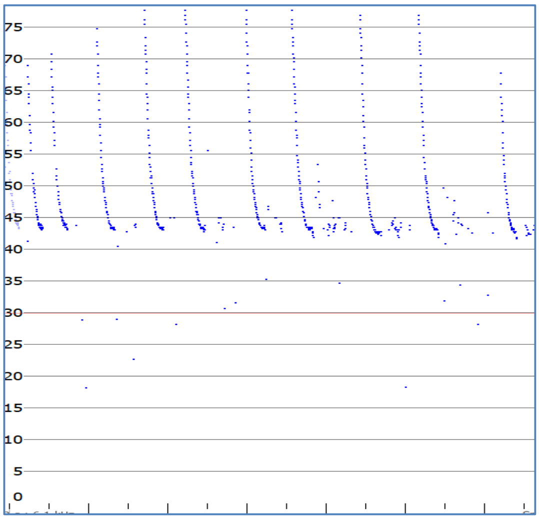
Chalinolobus gouldii



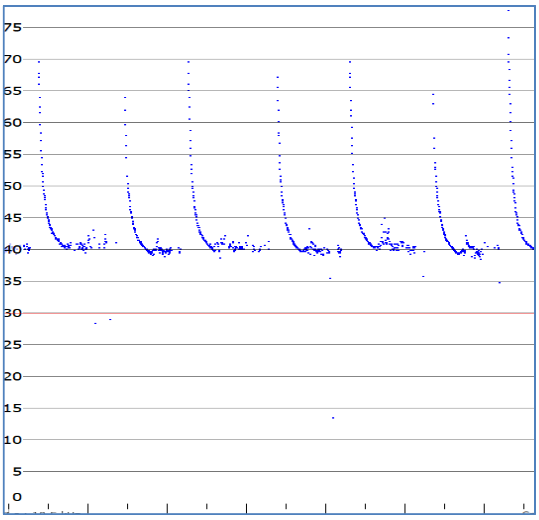
Scotorepens balstoni



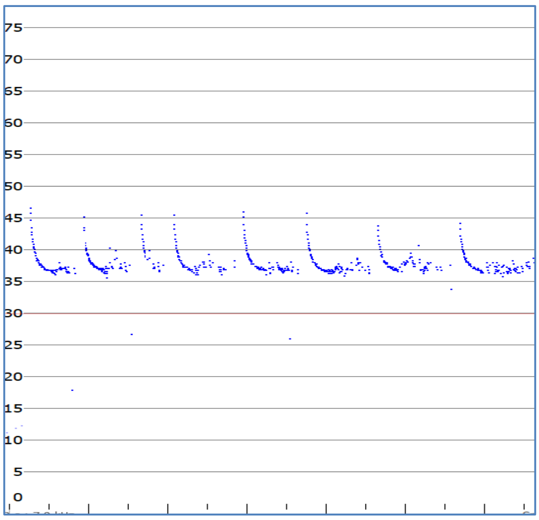
Chalinolobus picatus



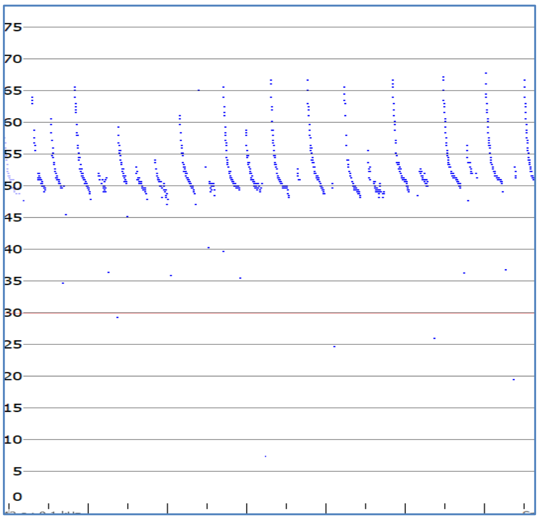
Vespadelus baverstocki



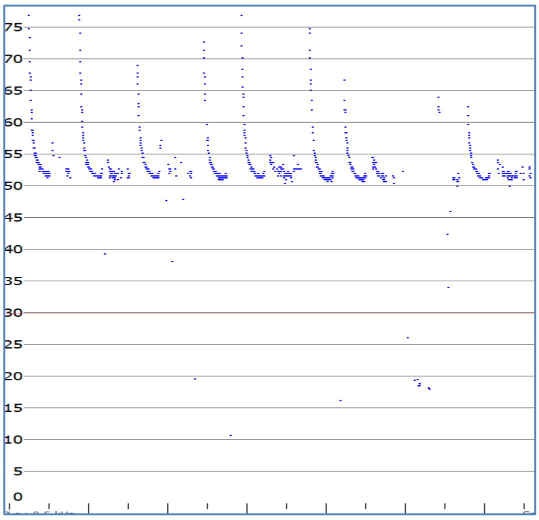
Scotorepens greyii / S. sanborni



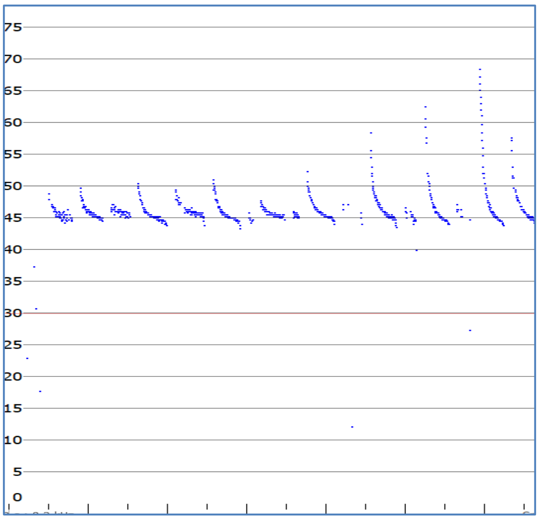
Setirostris eleryi



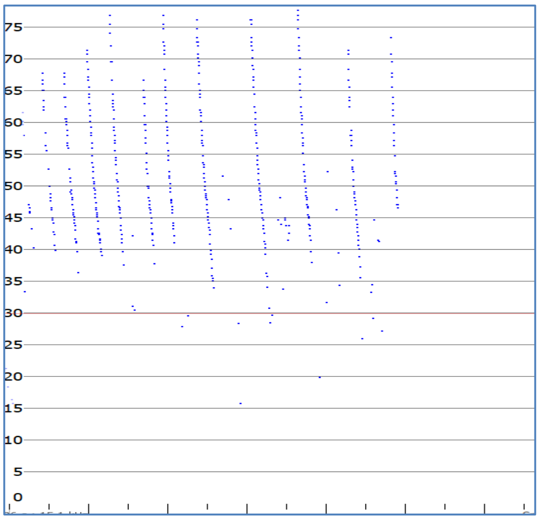
Chalinolobus morio



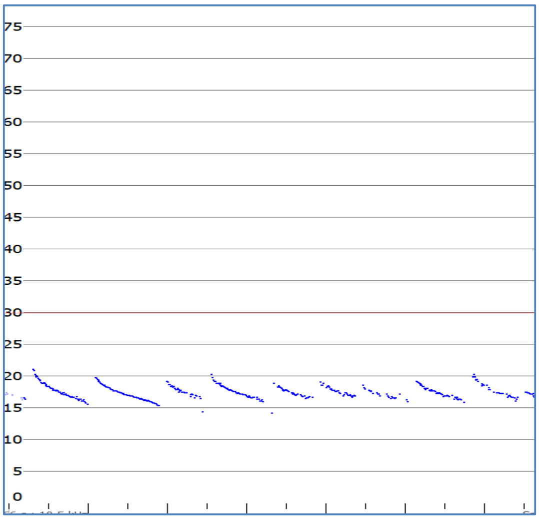
Vespadelus troughtoni



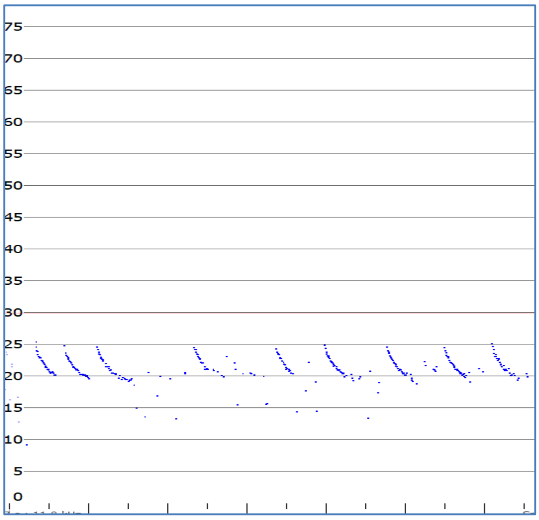
Miniopterus orianae oceanensis



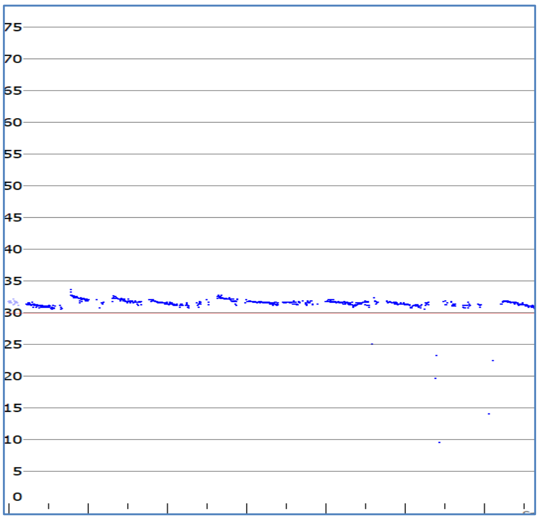
Nyctophilus sp.



Chaerephon jobensis



Saccolaimus flaviventris



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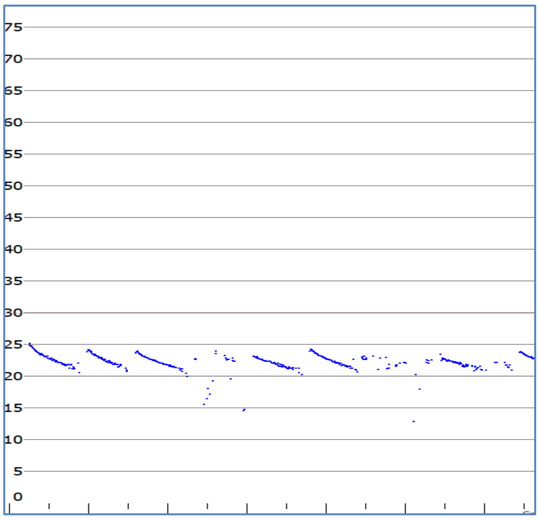

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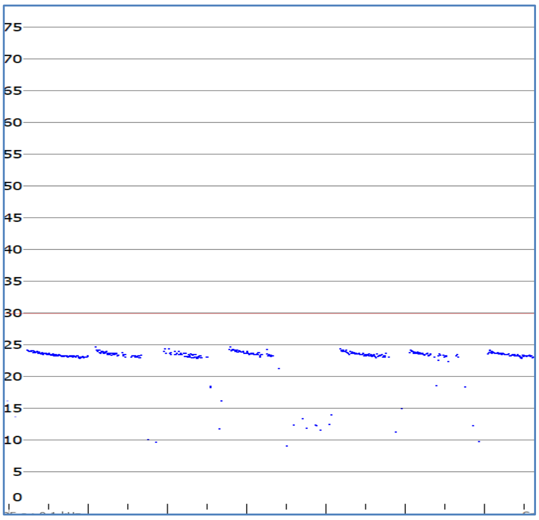

O. lumsdenae / Taphozous troughtoni

APPENDIX E

CUMULATIVE IMPACT ASSESSMENT

REPORT

Ecological Cumulative Impact Assessment – Vulcan South

for Vitrinite Pty Ltd

12/08/2024

VITRINITE
BRIGHTER COAL

METSERVE
Mining & Energy Technical Services Pty Ltd

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Client Contact	Michael Callan
Client Email	michael@vitrinite.com.au
Client Organisation	Vitrinite Pty Ltd
Project Name	Vulcan South

Mining and Energy Technical Services Pty Ltd (METServe)
310 Edward St Brisbane City QLD 4000
ABN 94 143 463 316

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1 Introduction

Vulcan South (the Project) is a new small-scale coal-mining operation proposed by Vitrinite Pty Ltd; owner of Qld Coal Aust No.1 Pty Ltd and Callan Coking Coal Pty Ltd (Vitrinite). A site-specific Environmental Authority (EA) and Progressive Rehabilitation and Closure Plan (PRCP) application (A-EA-NEW-100265025) was lodged on 6 June 2022 with the Department of Environment and Science (DES). DES has requested additional information be provided to assess the proposed Project's cumulative impacts; including other major projects or developments of which Vitrinite is reasonably aware.

This ecological cumulative impact assessment quantifies impacts to terrestrial ecological values, as outlined in the Vulcan South Terrestrial Ecological Assessment, to comparable projects in the broader region to outline the expected quantum of total impacts to these values in a regional context. Please refer to **Figure 2-1** below.

2 Scope

This assessment will consider the impacts of projects within:

- The Brigalow Belt North bioregion as defined by the Queensland Government IBRA dataset, with particular attention to the:
    - Northern Bowen Basin sub-bioregion; and
    - The Isaac - Comet Downs sub-bioregion.

In addition, this assessment will consider impacts of projects approved and/or commenced within the following time frames:

- No earlier than 01/01/2013; and
- No later than 01/01/2033.

The scale of projects will also be considered, limited to those considered "Major" by their inclusion in the project lists outlined in Section 4 and therefore comparable to Vulcan South.

Matters identified as key matters in this Project, on a State and/or Commonwealth level, have been included based on the results of field assessments confirming their presence within the Study Area, as outlined in the Terrestrial Ecology Assessment.

Figure 2-1 Projects included in the Cumulative Impact Assessment

2.1 Limitations

It should be noted that matters discussed in this assessment may not have been listed as Threatened under the *Nature Conservation Act 1992* (NC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) at the time of publication of the various EIS documents, and therefore not considered in older impact statements. Habitat values could not be quantified for these species.

It was also observed that projects listed as "currently going through the EIS process" may not have any publicly available data at the time of writing, and therefore impacts could not be quantified.

This assessment does not take into consideration the quality or carrying capacity of habitat for species as this data is generally not available in the source material.

Matters not confirmed as present have not been included. This includes species that are likely or known to occupy the airspace above the Project and are therefore unlikely to directly interact with the impact area, for example, White-throated Needletail (*Hirundapus caudacutus*).

As the Brigalow Threatened Ecological Community (TEC) is not mapped in detail by the Commonwealth, relevant State mapped Regional Ecosystems (REs) considered as equivalent to this TEC, which are mapped in the Vulcan South footprint, have been used to quantify impacts where available. In some cases, the data used in this assessment was presented in the source material as REs, so in these cases the individual REs were presented. In other cases, the TEC was presented as a final estimate without a breakdown of component REs. It should therefore be acknowledged that in these instances, component REs may differ.

It should also be noted that habitat quality and utility to matters have not been separated in this assessment as these are generally not separated in supporting documents, so are calculated as a whole for each matter.

2.1.1 Matters addressed in this assessment

The relevant matters for Vulcan South, as identified in the Vulcan South Terrestrial Ecological Assessment, are outlined in **Table 2-1**.

Table 2-1 Matters relevant to Vulcan South

Matter	Scientific name	Listing under State legislation	Listing under Commonwealth legislation (EPBC Act)
Koala	*Phascolarctos cinerus*	Endangered (NC Act)	Endangered
Greater glider	*Petauroides volans*	Endangered (NC Act)	Endangered
Squatter pigeon (Southern)	*Geophaps scripta scripta*	Vulnerable (NC Act)	Vulnerable
Brigalow TEC	N/A	As relevant Endangered or Of Concern Regional Ecosystems (Vegetation Management Act 1999)	Endangered

3 Methodology

Government databases were searched to locate lists of projects and ascertain which of these meet the criteria outlined in **Section 2**. These are outlined in **Table 3-1** below.

Table 3-1 Sources of Project listings

Source	Date Accessed	Notes
Completed EIS processes	06/09/2023 1130 GMT + 10	Available at: https://www.qld.gov.au/environment/management/environmental/eis-process/projects/completed
Coordinated projects	07/09/2023 0900 GMT + 10	Available at: https://www.statedevelopment.qld.gov.au/coordinator-general/assessments-and-approvals/coordinated-projects

Each project deemed relevant to the purposes of this assessment were searched for impact data within the following documents in order of preference:

- EIS Assessment Reports;
- Significant Impact Assessments (SIA); and
- Environmental Authorities (EA).

The relevant information relating to each Matter outlined in **Section 2.1** was compiled in **Section 4**. The areas of impact were added together to quantify the total, or cumulative impact of the assessed projects.

4 Assessment of Cumulative Impacts

Cumulative impacts to Endangered and Of Concern REs and TECs, for each identified project, are outlined in **Table 4-1**.

Table 4-1 Cumulative impacts to Endangered and of Concern Regional Ecosystems (ha)

Project	Area of Endangered REs under the VM Act *and* Biodiversity Status equivalent to the Brigalow TEC (ha)			Area of TEC if quantified in source document (ha)	Total area (ha)	Notes
	11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	**11.4.8** *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	**11.4.9** *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains			
Adani Mine Project	-	-	-	195.0	195.0	
Bowen Gas Project	44.1	35.6	179.9	-	259.6	
Carmichael Rail Project	-	-	-	117.1	117.1	Quantum provided in revised MNES report
Drake Coal	-	-	-	8.9	8.9	
Ensham Life Of Mine Extension Project	-	-	-	-	0	
Foxleigh Plains Project	-	-	-	83.7	83.7	
Galilee Coal	-	-	-	81.0	81.0	
Hillalong Project	-	-	-	-	0	
Isaac Downs / Plains Project	-	-	-	8.2	8.2	
Minyango Project	-	-	-	-	0	
Newlands Coal Expansion Project	15.0	-	-	-	15.0	
Olive Downs Coking Coal Project	-	-	-	13.0	13.0	
Red Hill Mining Lease	-	-	-	188.0	188.0	
Rolleston Coal Expansion Project		2.0	48.0	-	50.0	
Springsure Creek Coalmine Project	161.8	-	11.2	-	173.0	Heterogenous polygons in the assessment report are assumed to be evenly divided among REs.
Taroborah	-	-	-	2.8	2.8	

Project	Area of Endangered REs under the VM Act *and* Biodiversity Status equivalent to the Brigalow TEC (ha)			Area of TEC if quantified in source document (ha)	Total area (ha)	Notes
	11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	**11.4.8** *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	**11.4.9** *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains			
Vulcan Coal Mine	-	-	-	-	0	
Vulcan South	0	66.9 (remnant) 4.0 (High value regrowth)	0.2 ha	-	71.1	

Cumulative impacts to Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES), for identified projects, are outlined in **Table 4-2**. As Greater Glider habitat was not quantified for a number of assessed projects, Koala habitat calculations have been used a proxy due to the similarity in habitat features and composition.

Table 4-2 Cumulative impacts to MNES and MSES Threatened species

Project	Koala habitat (ha)	Greater Glider habitat (ha)	Squatter Pigeon (Southern) habitat (ha)	Project Bioregion	Notes
Adani Mine	30.0	Not mapped/quantified 30.0*	30.0	Brigalow Belt North	
Bowen Gas Project	2466.0	Not mapped/quantified 2466.0*	1415.2	Northern Bowen Basin	
Carmichael Rail Project	1433.3	Not mapped/quantified 1433.3*	145.7	Brigalow Belt North	Quantum from revised MNES report
Drake Coal	176.5	Not mapped/quantified 176.5*	176.5	Brigalow Belt North	
Ensham Life of Mine Extension Project	Negligible	Negligible	Negligible	Isaac – Comet Downs	
Foxleigh Plains Project	Not mapped/quantified	Not mapped/quantified	201.0	Isaac – Comet Downs	Combined total habitat (remnant and non-remnant)

Project	Koala habitat (ha)	Greater Glider habitat (ha)	Squatter Pigeon (Southern) habitat (ha)	Project Bioregion	Notes
Hillalong Project	603.2	Not mapped/quantified 603.2*	485.6	Brigalow Belt North	
Isaac Downs Project	131.9	120.9	122.1	Northern Bowen Basin	
Minyango Project	Not mapped/quantified	Not mapped/quantified	Mentioned but no quantum given	Isaac – Comet Downs	
Newlands Coal Extension Project	No suitable habitat	Not mapped/quantified	546	Northern Bowen Basin	
Olive Downs Coking Coal Project	5,583.5	5,583.5	5,610.0	Isaac – Comet Downs	
Red Hill Mining Lease	946.0	Not mapped/quantified 946.0*	Not mapped/quantified	Northern Bowen Basin	
Rolleston Coal Expansion Project	158.0	Not mapped/quantified 158.0*	2,891.0	Brigalow Belt North	
Springsure Creek Coalmine Project	Mentioned but no habitat quantum given	Not mapped/quantified	Not mapped/quantified	Brigalow Belt North	Koala considered SLC in the EIS Assessment Report, dated 2013
Taroborah	Not mapped/quantified	Not mapped/quantified	Mentioned but not considered likely to occur	Brigalow Belt North	
Vulcan Coal Mine	93.1 ha of foraging/shelter/dispersal	93.1 ha of breeding/shelter/foraging/dispersal habitat	93.1 ha of foraging habitat (76.4 ha of which are also breeding habitat)	Northern Bowen Basin	
Vulcan South	938.6 ha of foraging/shelter/dispersal 45.5 ha of shelter/dispersal 182.8 ha of dispersal	1056.8 (total) ha of breeding/shelter/foraging/dispersal	858.8 ha of breeding and foraging 338.6 ha of foraging only 1318.1 ha of dispersal	Northern Bowen Basin/Isaac – Comet Downs	

* denotes where Koala habitat calculations have been used as a proxy in place of lacking data.

5 Impact in the context of the 2020 – 2021 SLATS Report and the REDD Database

The Statewide Landcover and Trees Study (SLATS) monitors woody vegetation extent in Queensland using Sentinel-2 satellite imagery as a primary monitoring tool from 2018 to 2021.

Data summaries are presented in the most recent SLATS report by bioregion. Sub-bioregions are not considered in these reports, therefore comparisons in clearing extent for this Project will be made against the Brigalow Belt bioregion as a whole.

Of the state's 13 bioregions, the Brigalow Belt (52% or 180,283ha) accounted for over half of the state's woody vegetation clearing activity, where over 90% of the clearing activity was mapped as full clearing.

Clearing activity is defined below, taken directly from the 2020-2021 SLATS report:

- *Full clearing refers to areas which have been converted from woody to non-woody (i.e. less than 10% crown cover remains).*
- *Partial (major) are clearing areas where the woody vegetation has been significantly modified but remains woody (i.e. greater than 10% crown cover remains but more than 50% of the area has been affected by the clearing).*
- *Partial (minor) are clearing areas where some modification of the woody vegetation has occurred, remaining woody (i.e. greater than 10% crown cover remains but less than 50% of the area has been affected by the clearing).*

From 2018–19 to 2020–21, the total quantum of clearing within the Brigalow Belt has decreased overall, refer to the graph in **Figure 5-1**.

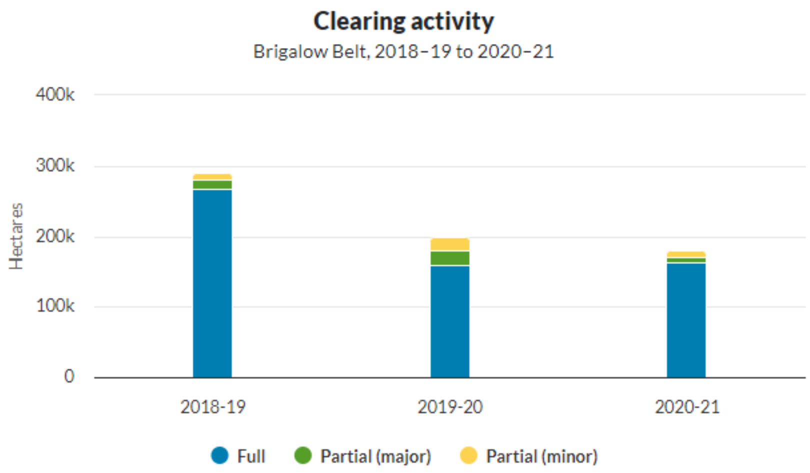

Figure 5-1 Clearing activity taken directly from the 2021 SLATS report

The data illustrated in **Figure 5-1** (above) is presented in **Table 5-1** below, compared to the total clearing undertaken during each reporting period.

Table 5-1 Total clearing of all REs within the Brigalow Belt bioregion by SLATS reporting period

Year	Full clearing	Partial clearing (major)	Partial clearing (minor)	Total	Total Vulcan South clearing footprint (1,476.44) as % of total compared to each SLATS period
2018-2019	266,597	13,926	10,430	290,953	0.5
2019-2020	158,456	21,440	19,322	199,218	0.74
2020-2021	163,535	7,276	9,472	180,283	0.81

The information above in **Table 5-1** is useful for comparing clearing in the context of a particular year, however the proposed Vulcan South clearing footprint compared to pre-clearing total vegetation cover and 2021 remnant vegetation, is more useful for quantifying impacts in a regional context.

The Regional Ecosystem Description Database (REDD) was queried for information on estimated pre-clear and 2021 remnant extents. These are expressed as the total for the entire RE extent statewide and clipped to the subregion extents using shapefiles downloaded from the QSpatial Catalogue and processed with ArcGIS with respect to percentages of cover contained in heterogenous polygons.

Remnant vegetation in each sub-bioregion compared to pre-clearing estimates and current remnant estimates are presented in **Table 5-2** below.

Table 5-2 Estimated remnant vegetation for all REs- pre-clearing and as of 2021

Subregion	Pre-clearing (ha)	Remnant 2021 (ha) (percent remnant)
Northern Bowen Basin	1,316,957	774,921 (58.79%)
Isaac – Comet Downs	2,693,397	570,968 (21.29%)

These datasets were further clipped and compared to the clearing footprint for Vulcan South in **Table 5-3** below.

Table 5-3 Estimated extents of clearing of Brigalow TEC equivalent Regional Ecosystems

Regional Ecosystem	Estimated pre-clear extent (total ha)	Estimated pre-clear extent within sub-bioregion						Estimated remnant extent 2021 (total ha)	Estimated remnant extent 2021 within sub-bioregion					
		Brigalow Belt North		Northern Bowen Basin		Isaac – Comet Downs			Brigalow Belt North		Northern Bowen Basin		Isaac – Comet Downs	
		Total (ha)	% impacted by Vulcan South	Total (ha)	% impacted by Vulcan South	Total (ha)	% impacted by Vulcan South		Total (ha)	% impacted by Vulcan South	Total (ha)	% impacted by Vulcan South	Total (ha)	% impacted by Vulcan South
11.3.1	785,000	428,507	0	19,034	0	276,559	0	80,000	58,528	0	5,980	0	21,350	0
11.4.8	728,000	578,722	0.011	22,987	0.291	315,009	0.021	67,000	63,304	0.105	3,120	2.144	19,294	0.346
11.4.9	989,000	870,844	<0.000	60,150	0.033	412,924	0.004	89,000	82,328	0.024	6,170	0.324	23,138	0.086
Total	2,502,000	1,878,073	0.011	1,02171	0.324	1,004,492	0.025	236,000	204,160	0.129	15,270	2.468	63,782	9

6 Discussion

The Project will contribute to impacts to the matters listed within this document, however it should be noted that data for these matters is absent prior to their listings as threatened. It follows that project impact assessments that occurred prior to listings will not have provided useful comparative data. Therefore, an incomplete picture of impacts will be provided in the absence of a more thorough investigation of total habitat values for each of these matters, with consideration to unmapped habitat aspects such as connectivity, availability of hollows and other complex attributes being required.

For example, the Greater Glider was not listed as threatened under the category of vulnerable under the EPBC Act until 2016, then in Queensland under the NC Act in 2019. Furthermore, it was treated as a single species until 2022. In 2022, the split into three species was formally recognised, all of which occur in Queensland and were updated to endangered under the EPBC Act and the NC Act. Studies conducted prior to 2016, therefore will not consider Greater Glider habitat.

In addition, the Koala was not listed as vulnerable under the EPBC Act until 2016 or under the NC Act until 2019, being upgraded to endangered in 2022.

The Squatter Pigeon (southern) was classed as vulnerable under the EPBC Act in 2015 and under the NC Act in 2019.

Therefore, the comparisons could only be made where data was available.

With the impact areas being disconnected and often separated by considerable distances, the likelihood of the Project contributing to impacts greater than the sum of itself and neighbouring projects, and to a lesser extent the more distant projects is negligible. The impacts therefore are likely to be additive rather than cumulative.

7 Conclusion

The Project will contribute to an impact on the following matters, where data is available:

- Brigalow TEC equivalent REs contained within Vulcan South clearing footprint by:
  - 11.3.1
    - 0% of the remnant extent in Isaac – Comet Downs
    - 0% of the remnant extent in the Northern Bowen Basin
    - 0% of the remnant extent in the total Brigalow Belt North;
  - 11.4.8
    - 0.346% of the remnant extent in Isaac – Comet Downs
    - 2.144% of the remnant extent in the Northern Bowen Basin
    - 0.105% of the remnant extent in the total Brigalow Belt North; and
  - 11.4.9
    - 0.086% of the remnant extent in Isaac – Comet Downs
    - 0.324% of the remnant extent in the Northern Bowen Basin
    - 0.024% of the remnant extent in the total Brigalow Belt North.

For the quantifiable habitat clearing for major projects within the Brigalow Belt North sub bioregion (including Isaac-Comet Downs and the Northern Bowen Basin) since January 2013, Vulcan South will include a conservative maximum of:

- 7.4% of the total Koala habitat cleared by similar projects (assessed in **Table 4-2**);

    - 6.8% of the total Squatter Pigeon (southern) habitat cleared by similar projects; and
    - 8.3% of the total Greater Glider habitat cleared by similar projects.
- These impacts in respect to Vulcan South and nearby projects are likely to be additive as the quantum of impacts is unlikely to be greater than the sum of the individual impacts as these are generally widely separated.

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METSERVE
Mining & Energy Technical Services Pty Ltd

Office Address
310 Edward Street
Brisbane City QLD 4000

Postal Address
310 Edward Street
Brisbane City QLD 4000

1300 078 518
enquiries@metserve.com.au
metserve.com.au