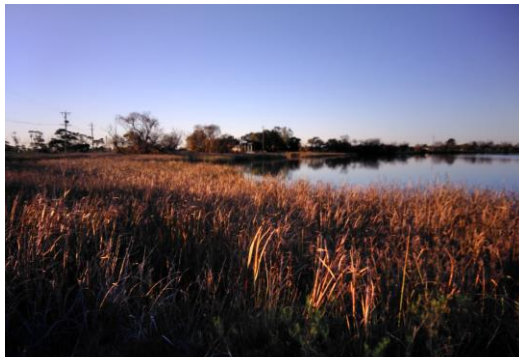


# VHM Ltd Goschen Vertebrate Fauna Technical Report 2023



# **Technical Report: Fauna Ecology**

## **Goschen Rare Earths and Mineral Sands Project**

Client: VHM Ltd  
Prepared by: Rob Gration- EcoAerial Pty Ltd  
23 Rosie Place, Altona 3018

Version: Final 29/10/2023

© EcoAerial - 2023

The concepts, data and information contained in this document are the property of EcoAerial. No part of this document may be reproduced, used, copied, published or adapted for use except in accordance with the provisions of the Copyright Act 1968 or with the consent of EcoAerial.

This document has been prepared for VHM Limited to satisfy the Minister for Planning's Scoping Requirements for the Goschen Mineral Sands Project (the Project) dated May 2019 under the *Environment Effects Act 1978*. EcoAerial accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party. Any third party using and/or relying upon this document accepts sole responsibility and all risk for using and/or relying on this document for any purpose.

This document is based on the information available, and the assumptions made, as at the date of the document. This document is to be read in full. No excerpts are to be taken as representative of the findings without appropriate context.

## Table of Contents

<b>Executive Summary .....</b>	<b>i</b>
<b>1 Introduction .....</b>	<b>1</b>
1.1 Assumed Loss in the Context of Fauna Habitat .....	1
1.2 Requirement for an EES.....	2
<b>2 Project description .....</b>	<b>3</b>
2.1 Project overview .....	3
2.2 Project development .....	3
2.3 Key project components .....	5
<b>3 Scoping.....</b>	<b>9</b>
3.1 EES evaluation objectives and scoping requirements .....	9
<b>4 Evaluation framework .....</b>	<b>11</b>
4.1 Legislation, policy, guidelines and standards .....	11
<b>5 Consultation and engagement.....</b>	<b>15</b>
<b>6 Methodology.....</b>	<b>17</b>
6.1 Overview of method .....	17
6.1.1 Mitigation Hierarchy .....	18
6.1.2 Assessing the Project Impacts.....	18
6.1.3 Cumulative Impacts .....	18
6.1.4 Alternative Options.....	19
6.1.5 Monitoring and Contingency measures.....	19
6.2 Study area .....	19
6.3 Existing environment.....	24
6.3.1 Literature review .....	24
6.3.2 Conservation Significant Fauna.....	25
6.3.3 Survey effort .....	26
6.4 Avoidance and minimisation .....	30
6.4.1 Mine Tenement Area .....	30
6.4.2 Water Pipeline Supply Routes .....	30
6.5 Risk assessment.....	31
6.6 Impact assessment.....	31
6.7 Assessment of Potential impacts on Matters of National Environmental Significance.....	32
6.7.1 Superb Parrot (EPBC Act-Vulnerable; FFG Act-Endangered) .....	32
6.7.2 Regent Parrot (EPBC Act-Vulnerable; FFG Act-Endangered) .....	36
6.7.3 Plains-Wanderer (EPBC Act-Critically Endangered; FFG Act-Critically Endangered) .....	38
6.7.4 Kangaroo Lake (Ramsar Wetland) .....	40

6.7.5	Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions .....	41
6.7.6	Mallee Bird Community of Murray Darling Depression Bioregion .....	42
6.8	<i>Linkages to other technical reports</i> .....	43
<b>7</b>	<b>Results</b> .....	<b>45</b>
7.1	<i>Existing Environment</i> .....	45
7.1.1	Native vegetation .....	45
7.1.2	Threatened vegetation communities .....	46
7.1.3	Land use and disturbance history .....	48
7.2	<i>Fauna</i> .....	48
7.2.1	Conservation Significant Fauna .....	48
7.3	<i>Fauna Habitats</i> .....	60
7.3.1	Mine Tenement .....	60
7.3.2	Pipeline Route Options .....	61
7.3.3	Agricultural Land .....	64
7.3.4	Threatened fauna communities .....	64
7.4	<i>Fauna Species</i> .....	69
7.4.1	Fauna recorded within pipeline options .....	78
7.4.2	Species recorded at Kangaroo Lake .....	80
7.5	<i>Limitations, uncertainties and assumptions</i> .....	81
<b>8</b>	<b>Risk Assessment</b> .....	<b>83</b>
<b>9</b>	<b>Construction Impact Assessment</b> .....	<b>85</b>
9.1	<i>Summary of impact/s</i> .....	85
9.1.1	Mine tenement .....	85
9.1.2	Water Supply Pipeline Route Options .....	85
9.1.3	EES Key Issues .....	86
9.2	<i>Summary of mitigation</i> .....	94
9.3	<i>Summary of residual impacts</i> .....	94
9.3.1	Residual Impacts to fauna due to loss of habitat .....	95
<b>10</b>	<b>Operational Impact Assessment</b> .....	<b>101</b>
10.1	<i>Summary of impacts</i> .....	101
10.1.1	EES Key Issues .....	101
10.2	<i>Assessment of impacts to fauna from processing water pond</i> .....	102
10.3	<i>Tailing Cells - Assessment of impacts to fauna from tailings</i> .....	102
10.4	<i>Summary of mitigation</i> .....	103
10.5	<i>Summary of residual impacts</i> .....	105
<b>11</b>	<b>Decommissioning</b> .....	<b>106</b>
<b>12</b>	<b>Cumulative Impacts with Other Projects</b> .....	<b>107</b>
<b>13</b>	<b>Summary of avoidance and mitigation measures</b> .....	<b>107</b>



13.1	<i>Avoidance and Mitigation measures</i> .....	108
13.2	<i>Monitoring and contingency measures</i> .....	113
<b>14</b>	<b>Summary of Implications Under Relevant Legislation</b> .....	<b>119</b>
14.1	<i>Commonwealth</i> .....	119
14.1.1	Significant Impact Criteria .....	119
14.2	<i>Victorian</i> .....	122
<b>15</b>	<b>Conclusion</b> .....	<b>125</b>
15.1	<i>Existing environment</i> .....	125
15.1.1	Threatened Communities.....	125
15.1.2	Significant Fauna Records.....	125
15.1.3	Fauna habitat.....	126
15.2	<i>Avoid and Mitigation</i> .....	126
15.3	<i>Impact assessment findings</i> .....	127
15.3.1	Mine tenement and pipeline route .....	127
15.3.2	Kangaroo Lake .....	129
15.3.3	Significance of Impacts .....	130
<b>16</b>	<b>References and Bibliography</b> .....	<b>131</b>
	<b>Appendix A – Risk Register</b> .....	<b>141</b>
	<b>Appendix B – Fauna Assemblages</b> .....	<b>149</b>
	<b>Appendix C – Fauna Survey Maps</b> .....	<b>175</b>
	<b>Appendix D- EcoAerial Plains-wanderer Survey Report</b> .....	<b>189</b>
	<b>Appendix E - Treetec Report</b> .....	<b>191</b>
	<b>Appendix F – Aquatica Environmental Report</b> .....	<b>193</b>
	 <b>Figure 2. 1 Project overview- VHM Tenements (Figure supplied by VHM)</b> .....	<b>4</b>
	<b>Figure 2. 2 Mitigation Hierarchy</b> .....	<b>4</b>
	<b>Figure 2. 3 Area 1 Goschen Project (Figure supplied by VHM)</b> .....	<b>5</b>
	<b>Figure 2. 4 Area 3 Goschen Project (Figure supplied by VHM)</b> .....	<b>6</b>
	 <b>Figure 6. 1 Overview of assessment framework</b> .....	<b>17</b>
	<b>Figure 6. 2 Goschen mineral sands project area 2022</b> .....	<b>20</b>
	<b>Figure 6. 3 Goschen mineral sands project area 2021</b> .....	<b>21</b>
	<b>Figure 6. 4 Goschen mineral sands project area 2018</b> .....	<b>22</b>
	<b>Figure 6. 5 Desktop review study area (20km buffer)</b> .....	<b>23</b>
	<b>Figure 6. 6 Regional Superb Parrot records (NatureKit 2019)</b> .....	<b>35</b>
	<b>Figure 6. 7 Regent Parrot breeding areas and distribution (Baker Gabb-Hurley 2011)</b> .....	<b>38</b>
	 <b>Figure 7. 1 Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions</b> .....	<b>47</b>

Figure 7. 2 Plains-wanderer VBA records .....	58
Figure 7. 3 Samphire skink habitat .....	59
Figure 7. 4 Wader Records .....	67
Figure 7. 5 Australasian Bittern & Australian Painted-snipe records .....	68
Figure 7. 6 Significant species observations .....	70
Figure 9. 1 Mine Area 1 Fauna Habitat Removal .....	90
Figure 9. 2 Mine Area 3 Fauna Habitat Removal .....	91
Figure 9. 3 Tree 'loss' on pipeline options .....	92
Figure 9. 4 Connectivity of significant fauna habitat to the 'Project' .....	93
Figure C. 1 Ecoscape sites.....	177
Figure C. 2 Spectrum Ecology Sites.....	178
Figure C. 3 EcoAerial Plains-wanderer transects .....	179
Figure C. 4 EcoAerial Plains-wanderer sound recorders .....	180
Figure C. 5 EcoAerial Hooded scaly-foot surveys .....	181
Figure C. 6 EcoAerial Samphire Skink active search.....	182
Figure C. 7 EcoAerial active reptile search.....	183
Figure C. 8 EcoAerial active reptile search.....	184
Figure C. 9 EcoAerial spotlight surveys.....	185
Figure C. 10 EcoAerial spotlight surveys.....	186
Figure C. 11 EcoAerial bat detector deployment .....	187
Figure C. 12 Bird surveys .....	188
Table 3. 1 Scoping requirements relevant to vertebrate fauna assessment .....	9
Table 4. 1 Legislation, policy, guidelines and standards relevant to the assessment .....	11
Table 5. 1 Stakeholder engagement undertaken for Vertebrate Fauna Technical Study .....	15
Table 6. 1 Likelihood of Occurrence Criteria – Vertebrate Fauna .....	25
Table 6. 2 Threatened species advice and guidelines referred to for surveys .....	25
Table 6. 3 Details of the survey method, targeted species and survey effort for mine tenement.....	27
Table 6. 4 Detail of weather conditions .....	28
Table 6. 5 Detail of weather conditions .....	28
Table 6. 6 Details of the survey method, targeted species and survey effort .....	28
Table 6. 7 Detail of weather conditions .....	29
Table 6. 8 Details of the survey method, targeted species and survey effort .....	30
Table 7. 1 Conservation Significant Species.....	50
Table 7. 2 Mallee Bird Community of Murray Darling Depression Bioregion.....	64
Table 7. 3 Site records from previous desktop reviews / surveys .....	72
Table 7. 4 Species recorded during the 2022 water supply pipeline options assessments.....	78
Table 7. 5 Species recorded at Kangaroo Lake June 2022.....	80
Table 8. 1 Vertebrate Fauna Risks .....	83
Table 13. 1 Mitigation measures relevant to vertebrate fauna and fauna habitat .....	108
Table 13. 2 Monitoring and contingency measures relevant to Vertebrate Fauna Technical Study .....	113

Photograph 1 Superb Parrot recorded from the project area.....	34
Photograph 2 Example of patch in paddock and trees on fenceline. ....	60
Photograph 3 Section of bitumen road on Mystic Park-Beauchamp Rd east of Bael Bael Rd .....	61
Photograph 4 Potential Samphire Skink habitat on southern side of Mystic Park – Beauchamp Road .....	62
Photograph 5 Indicative habitat on Pipeline Route Option 3- Lookout Rd and Teagues Rd.....	62
Photograph 6 Indicative of habitat on Pipeline Route Option 2- Mystic Park-Beauchamp Rd, North / South	63
Photograph 7 Indicative habitat near where Options 1, 2 & 3 merge on Mystic Park Beauchamp Rd .....	63

# Executive Summary

## Overview

The Minister for Planning (the Minister) determined on 10 October 2018 the proposed Goschen Mineral Sands and Rare Earths Project had the potential for a significant impact as defined under the Environment Effects Act 1978 (EE Act). Because of the Ministers determination, VHM Limited (the proponent) is required to prepare an Environment Effects Statement (EES).

The purpose of the EES is to provide a sufficiently detailed description of the project, assess its potential effects on the environment and assess alternative project layouts, designs and approaches to avoid and mitigate effects (DELWP 2019).

The requirements included the following key biodiversity matters to be examined for the EES process.

*“The EES is to document the investigation and avoidance of potential environmental effects of the proposed project, including for any relevant alternatives (such as for the mining extent, methods for mining and processing, water supply and transport of mining outputs), as well as associated environmental mitigation and management measures. The EES should address the following key issues:*

- Direct loss or degradation of native vegetation and associated listed ecological communities, including those listed as threatened under the EPBC Act, the FFG Act.
- Direct loss or degradation of habitat for flora and fauna listed as threatened under the EPBC Act, the FFG Act.
- Disturbance and/or degradation of adjacent or nearby habitat that may support listed species or other protected flora, fauna or ecological communities.
- Indirect habitat loss or degradation resulting from other effects, such as edge effects, surface hydrological changes, groundwater drawdown, groundwater mounding, dust deposition, traffic, noise, vibration, light or the introduction of weeds/ pathogens.
- Disruption to the movement of fauna between areas of habitat across the broader landscape.
- The availability of suitable offsets for the loss of native vegetation and habitat for listed threatened species under the FFG Act and EPBC Act.

The reports primary focus is on terrestrial fauna habitat and fauna. Impacts to native vegetation, aquatic habitat and aquatic species are addressed in separate reports:

1. Nature Advisory 2022. Flora Vegetation Technical Study.
2. Tretec, 2022. Preliminary Arboricultural Impact Assessment.
3. Aquatica Environmental 2023 Draft Version 3. Goschen Mineral Sands and Rare Earth Project Phase 1 Desktop Aquatic Ecology Assessment of Kangaroo Lake.

The Nature Advisory report is included in the EES documentation as an independent report and where relevant referred to within this report. The other two reports whilst referred to within this report, they are also provided in the Appendices.

The technical report draws on the conclusions from reports undertaken prior to and post inception of the EES process:

1. Ecology and Heritage Partners 2018. Ecological Impact Assessment Goschen Mineral Sand Project, Goschen, Victoria. Ver. Draft 1.
2. Ecoscape 2018. Goschen Project: Targeted Conservation Significant Fauna Survey. Ver. Final.
3. Spectrum Ecology 2019. Goschen Project: Vertebrate Fauna. Ver. 2.
4. EcoAerial 2022. Goschen Plains-wanderer survey FINAL Ver 1.0.
5. EcoAerial / Spectrum Ecology 2022. Goschen Project: Vertebrate Fauna. Ver. 4.2.
6. Treetec 2022. Preliminary Arboricultural Impact Assessment.
7. Aquatica Environmental 2022. Goschen Mineral Sands and Rare Earth Project Phase 1 Desktop Aquatic Ecology Assessment of Kangaroo Lake.
8. SLR Consulting Australia Pty Ltd (2022) - Draft Noise Impact Assessment: Goschen Mineral Sands and Rare Earths Project.

### Existing environment

The 'Project Area' is located amongst extensively cleared agricultural land which is used for primary production. Approximately 70 per cent of Victoria's mallee vegetation has been cleared and as a direct consequence of farming practices, the 1930s saw the Victorian Mallee become one of the worst wind eroded areas in Australia (Thackway and Cresswell, 1995). Substantial areas of mallee remain today in the western aeolian dunes, mainly in South Australia and western NSW. Clearing has also been widespread in the north eastern portion of the bioregion in NSW particularly on the undulating plains and relict river channels and lakes associated with the Murray and Darling Rivers (Thackway and Cresswell, 1995)

The 'Project Area'; is in the Interim Biogeographic Regionalisation Australia (IBRA7) Murray Darling Depression Bioregion (MDD7) located in north west Victoria (Thackway and Cresswell, 1995). This region is typified by broad undulating sandy calcareous plains with east-west aligned low sand dunes with intervening heavier textured swales.

The 'Project Area' including the water supply pipeline covers two state bioregions: Murray Mallee to the west of Mystic Park-Beauchamp Rd and Victorian Riverina to the east. Nature Advisory (2022) has mapped six Ecological Vegetation Classes (EVC's) within the Project footprint and road reserves. EcoAerial considered a section on Mystic Park – Beauchamp Rd as Chenopod Grassland / Riverine Chenopod Woodland Mosaic. EVC's present are provided below:

- Chenopod Grassland EVC\_829 (Endangered): 0.1 ha
- Plain's Savannah EVC\_826 (Endangered): 9.70 ha
- Woorinen Mallee EVC\_824 (Vulnerable): 429.85 ha
- Ridged Plains Mallee EVC\_96 (Endangered): 42.52 ha
- Riverine Chenopod Woodland EVC\_103 (Vulnerable): 56.87 ha.
- Semi-arid Woodland EVC\_97 (Vulnerable) 2.5 ha.

Several mallee woodland communities met the criteria of the EPBC Act Critically Endangered, *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community* (NA 2022). Several small areas were mapped as the EPBC Act Endangered *Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions Community* and the one FFG Act (Vic) Threatened *Semi-arid Shrubby Pine-Buloke Woodland Community* (Threatened).

The 'Project' area where *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community* is present, provides habitat for two threatened species (#) observed during the surveys:

1. Superb Parrot: EPBC Act & FFG Act \*
2. Black Falcon: FFG Act #
3. Diamond Firetail: FFG Act
4. Hooded Robin: FFG Act
5. Eastern Bearded Dragon: FFG Act #
6. Eastern Great Egret: FFG Act.

Two of the six species are considered likely to be occasionally present based on database records: Diamond Firetail and Hooded Robin. The Superb Parrot \* observation is considered a vagrant based on a Significant Impact Test that found the habitat is not suitable for the persistence of the species.

One FFG Act species, (Eastern Great Egret), was observed at Kangaroo Lake. Habitat for the FFG Act listed Samphire Skink *Morethia adalaidensis* is considered likely to occur in an area of Chenopod Grassland / Riverine Chenopod Woodland Mosaic, on the road reserve approx., 4km west of Kangaroo Lake.

Sixty-two fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* have been recorded within the mine tenement study area.

Thirty-six fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* have been recorded within the three pipeline route options.

The *Mallee Bird Community of the Murray Darling Depression Bioregion* was listed on the 21 December 2021 as an endangered community under the EPBC Act. Publicly available departmental modelling (Protected Matter Search Tool) suggested that this ecological community was potentially present within the proposed 'Project Area'. A review of birds in relevant databases and those recorded on-site met the Category D threshold for this community.

The listing of both EPBC communities occurred post the '*Controlled Action*' referral decision was made in relation to the proposed action. Therefore, the listings are not a relevant consideration for the Minister in determining if the proposed action should be approved. Under Section 158A of the EPBC Act, a listing made after the EPBC decision on 19 December 2018 cannot be assessed for that referral. Notwithstanding this, the potential impacts to the two EPBC Act communities have been assessed in this report.

The Goschen Project is considered not to provide critical habitat for any listed conservation fauna species. The Plains-wanderer (*Pedionomus torquatus*) was not recorded during the targeted survey undertaken by EcoAerial (2021) and the habitat was assessed as unlikely to support Plains-wanderer. If Plains-wanderer were to utilise the mine tenement on occasions, when crops form suitable temporary habitats, this temporary habitat occurs extensively across the surrounding region and development of the Goschen Project would not cause a significant change in habitat availability.

## Avoidance, mitigation and contingency measures

The objectives are to avoid, mitigate and / or manage the impacts to vertebrate fauna and fauna habitat associated within the 'Project Area'. These measures have been developed in line with relevant Commonwealth / State policies and guidelines to avoid and minimise impacts (e.g., DELWP 2017).

The removal / loss of fauna habitat is based on the Nature Advisory's Flora Technical Report (2022). This report details the removal of native vegetation as per DELWP's Guidelines for the removal, destruction or lopping of native vegetation (2017). The removal of native vegetation takes the form of physical removal or due to potential impacts to the Tree Protection Zone of canopy trees.

The Tree Protection Zone applies to those canopy trees impacted and plants within the dripline if, the trees are within a patch as defined by DELWP (2017). Impacts to the Tree Protection Zone does not involve the removal of vegetation. Whilst canopy trees may be considered lost under the *Clearing of native vegetation- Biodiversity assessment guidelines* (DELWP 2017b), they will be retained in-situ.

The avoid and minimise principle has been strictly applied to fauna habitat / native vegetation within the mine tenement and transport routes. The mining area and associated infrastructure proposed will avoid of 60.629 hectares of native vegetation and 2,843 large trees compared to the 2018 proposal (Nature Advisory 2022).

Mine Area 1 will retain 15.4 ha of native vegetation / fauna habitat and 22 scattered trees. Mine Area 3 will retain 22.7 ha of native vegetation / fauna habitat and 17 scattered trees. The total Impacts to fauna habitat within the mining tenement and road intersections has been restricted to 7.0 ha:

Habitat enhancement strategies will be implemented in areas of fauna habitat to be retained using material from the native vegetation / fauna habitat proposed for removal, for example:

- Woody debris from cleared areas is placed in retained areas of habitat consistent with EVC benchmark.
- Leaf litter from cleared areas is placed in retained areas of habitat consistent with EVC benchmark.
- Hollow branches from cleared areas are placed in tree and on ground in retained areas of habitat.

The pipeline routes have been assessed based on the potential impacts, (herein referred to impact/s), to canopy trees within the Tree Protection Zone. The pipeline will be constructed in the middle of the road network for approx., 30km. Most of the trees within the route options form the canopy component of the EPBC listed *Plains Mallee Box Woodland Community*. The objective of assessing three routes was to ascertain which route will have the least impact. The extent of impact is estimated to be:

- *Option 1*: 112 canopy trees, original route
- *Option 2*: 61 canopy trees
- *Option 3*: 61 canopy trees.

(Treetec 2022)

Route option 3 has been identified as the preferred options to mitigate the impact to canopy trees by half compared to the original route option. Option 2 is located on a constructed gravel road; Option 3 is located on a graded sand-based road. The final determination between Routes was based on the road capacity to support heavy vehicle movements and access to lay-down and parking areas.

With implementation of avoiding, monitoring, mitigation and contingency measures, the residual impacts to roadside vegetation will be confined to the 61 canopy trees calculated as 4.65 ha based on the canopy cover. The impact will be offset by the rehabilitation of habitat if the monitoring of tree health indicates an increased rate of tree decline. It is also expected that natural regrowth will occur and revegetation will be undertaken.

Tree health will be monitored biannually by arborists of the canopy trees identified as impacted within the Tree Protection Zone. Any decline in tree health will trigger, revegetation and habitat rehabilitation in the relevant location.

Revegetation will be undertaken of approx., 853m<sup>2</sup> post construction of the pump station near the intersection of Mystic Park E Rd and Gorton Drive.

Due to the need to have regular access to the process water pond and, the daily activities at the tailing's cells, permanent covers to restrict access to fauna is not a viable option. Options for the design to restrict access to fauna to the processing pond and tailings pits is confined to the use exterior security fence to restrict access to terrestrial fauna. Bird deterrent disks have been successfully deployed on powerlines to alter the flight path of waterbirds. The processing pond will have wires strung across at 10 m intervals with bird deterrent discs hung below the wire at 5 m spacings approximately 50 cm above the water. It is expected this will reduce the level of use of the processing pond. Due to the size of the tailings cells, this option is not viable.

### **Impact assessment findings**

An iterative assessment was undertaken to evaluate potential impacts associated with the project, considering the existing environment within the study area and associated construction, operational and decommissioning activities (Spectrum Ecology 2019).

The assessment identified the following potential impacts:

- Impacts to fauna habitat within the mine areas for mine infrastructure, transport intersections and, on road reserves adjacent to the proposed pipeline alignment.
- Fragmentation of fauna corridors as result of the fauna habitat removal.
- Changes to the ecological character of Kangaroo Lake as an artefact of water extraction.
- Indirect impacts such as fauna / vehicle collisions, dust, light pollution, fauna salvage and noise.

The best fauna habitat was found where native vegetation was mapped by Nature Advisory (2022). Fauna habitat within the mine tenement was limited to native vegetation on paddock fence lines, several small patches extending into paddocks and road reserves. Several conservation significant birds, (e.g., Superb Parrot) and a reptile (Eastern Bearded Dragon) have been recorded using fauna habitat associated with the road reserves.



Fauna corridors are confined to the roadside reserves and patches of fauna habitat acting as 'stepping-stones' within paddocks. Whilst there are impacts to canopy trees because of works within the Tree Protection Zone adjacent to the pipeline route, there will not be a significant direct changes to the existing roadside network of fauna habitat.

The majority of fauna habitat within the mine tenement, transport routes and pipeline route options meet the criteria of the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions*. The listing of this community was post the 'Project' area' (Refer to Figure 6.4), being considered as a 'Controlled Action' under the EPBC Act.

Fauna associated with this community were recorded during the various surveys within the mine tenement, route options and the periphery of Kangaroo Lake. Consideration of the impacts to the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions* under the EPBC Act was undertaken at the request of the Technical Reference Group, notwithstanding it is not applicable to this project.

The removal of vegetation for each of the areas impacted are as follows:

- *Mine Area 1*: 4.1 ha & 11 scattered trees (removal)
- *Mine Area 3*: 2.7 ha & 40 scattered trees (removal)
- *Pipeline Option 3*: 4.6 ha (works within the Tree Protection Zone)
- *Pipeline Pump*: 853m<sup>2</sup> (removal)
- *Intersections*: 0.27 (removal)

Impacts within the mining tenement / transport route has been confined to the direct removal of 7.0 ha of native vegetation patches / fauna habitat including 470 trees, and 51 scattered trees. The removal of 7.0 ha of native vegetation / fauna habitat represents 1.3% of the native vegetation / fauna habitat mapped, (541 ha) within the 'Project' area.

The removal of 470 habitat trees within patches and 51 scattered habitat trees represents 1.13% of the total number of trees, (45,911) estimated within the 'Project' area.

Three potential pipeline routes were assessed, with the aim of avoiding or minimising the removal and / or impacts to fauna habitat / native vegetation. Loss off fauna habitat along the three pipelines options is confined to impacts due to trenching within the Tree Protection Zone of canopy trees. Fauna habitat / native vegetation will not be removed during the trenching activities.

The installing of the pump station at Kangaroo Lake will entail the removal of approx., 853<sup>2</sup>m of native vegetation consisting of 0.0431 ha of Plains Savannah (EVC\_826) and 0.0422 ha of wetland vegetation (NA, 2022) near the intersection of Mystic Park East Rd and Gorton Drive. Kangaroo Lake provides fauna habitat for a range of water dependant species, waterfowl, grebes, cormorant, birds of prey, fish, frogs and turtles. Kangaroo Lake will be maintained at its existing historical levels and will continue to support water dependant birds.

The EPBC Act and FFG Act listed Plains-wanderer (*Pedionomus torquatus*) was not recorded during the targeted surveys undertaken by EcoAerial (2021) and the habitat was assessed as unlikely to support Plains-wanderer. Impacts to fauna habitat, will not impact on

any FFG Act listed Victorian threatened fauna or communities e.g., Victorian Mallee Bird Community.

The 61 trees, understorey flora, leaf litter and woody debris within the pipeline route will remain in-situ and continue to provide habitat for threatened fauna and, fauna associated with Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community.

The removal of 7.0 ha of native vegetation represents 1.3% of fauna habitat mapped, (541 ha), by Nature Advisory (2022) within the 'Project' area. The removal of 470 trees within patches and 51 scattered trees represents 1.13% of the total number of trees, (45,911) estimated by Nature Advisory 2022 within the 'Project' area.

The impacts to threatened fauna and fauna habitat within the mine tenement and pipeline route have been minimised to the extent that there are no significant impacts as described by the DoE (2013). This is on the proviso that all recommended avoid and mitigation measures are implemented and, the monitoring of the Environmental Performance Criteria (EPC's) with the assigned contingency triggers are strictly adhered too.

### ***Residual impacts - Construction, Operational and Decommissioning Phases***

*There will a loss of fauna habitat within the mine areas and, on road reserves adjacent to the proposed pipeline alignment due to impacts to the Tree Protection Zone of canopy trees.*

The residual loss of fauna habitat (6.8 ha) within the two mine areas and 0.27 ha at transport intersections cannot be avoided, although large tracts of habitat will be retained within the mine areas. Native vegetation within the 2 mine areas is consistent with the EPBC Act listed Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community. Fauna associated with this community have been recorded across the study area.

The impact to roadside vegetation / fauna habitat adjacent to the pipeline route is confined to 61 canopy trees that will be retained in-situ. Fauna habitat i.e., understorey, ground cover and woody debris component will also remain in-situ.

If the tree health of the 61 trees declines overtime, the extent of degradation is expected to be staged from no longer producing flowers leading to reduced insect activity. Whilst this will have an impact on nectivorous and insectivorous birds, a by-product of tree health decline is the increased rate of tree hollow creation. The tree/s will continue to provide roosting opportunities for birds, bats and terrestrial mammals. The extent of degradation to fauna habitat will be monitored and will be minimised by implementing the contingency strategies outlined in Section 13.2.

*Changes to the ecological character of Kangaroo Lake as an artefact of water extraction.*

Kangaroo Lake forms part of the Kerang Ramsar wetlands (EPBC Act). It is not expected that there will be any changes from the baseline conditions to the ecological character of Kangaroo Lake.

Goulburn Murray Water has advised that; "VHM taking a peak of 4,700 ML/year during start up and commissioning for approx. 3-months, the impact on Kangaroo Lake would appear marginal. This is based on a daily take of 12.9 ML/d throughout the 365 days of the year, although I accept a higher peak occurs if pumping does not occur daily. At 26 ML/d over 180 days, the impact is low compared to recent discharge to support irrigation".

Kangaroo Lake will be maintained at or near full supply levels to maintain ecological condition of littoral zone, with annual fluctuations of up to 600 mm as per historical management. Salinity levels will be less than 1,000 EC when lake is more than 75% full. It is not envisaged that there will not be any residual impacts associated with Kangaroo Lake and there are no EPBC Act implications.

The habitat (Plains Savannah EVC\_826), at Kangaroo Lake will not be significantly reduced (853<sup>2</sup>m) during the works adjacent to the shoreline. There is approx., 14km of habitat on the shoreline of Kangaroo Lake.

*Indirect impacts such as vehicle collisions, dust, light pollution, access to process pond and noise.*

The extent of indirect impacts, apart from noise (SLR 2022), is currently an unknown, there are limited baseline conditions to compare too. Whilst indirect impacts cannot be eliminated, provisions to minimise the indirect impacts to fauna and fauna habitat fauna, (e.g., fauna salvage during construction, nest box installation, site rehabilitation, revegetation, light inhibitors, restricting access to process pond and, vehicle speed limits), have been developed for input into the Construction / Operational Environmental Management Plan.

SLR (2022) identified the extent of the impact of noise during the various stages of the project are at ambient background noise levels and / or within acceptable limits with the implementation of their recommended mitigation strategies.

**An assessment of the potential residual impacts to fauna at the processing pond and tailing cells, is considered to be low/moderate based on the mitigation strategies and high levels of activity at the processing pond and tailing cells.**

## **Conclusions**

Impacts to fauna habitat within the mine areas and transport intersections will impact on the availability of nesting / perches, hollows and, foraging resources for a range of fauna groups. Enhancing habitat within the remain relatively large tracts of fauna habitat will offset some of these impacts.

Whilst acknowledging that the loss of fauna habitat within the adjoining road reserves can be compounded by poor local government road maintenance and unauthorised firewood harvesting, this is out of the control of VHM. The placing of the water supply in the middle of existing roads will confine the residual impacts to roadside vegetation to 61 canopy trees.

The understorey and groundcover flora and woody debris will not be impacted by works within the Tree Protection Zone. Trees 'assumed lost' will also be retained and will continue to provide habitat for fauna, albeit in potentially a different form, (e.g., nesting and perching as opposed to a foraging resource), should their health decline at a faster rate than normally expected.

Based on the above advice from Goulburn Murray Water, and the proposed monitoring of baseline conditions as described by Goulburn Mallee Water and Aquatica Environmental (2022), it is not envisaged that any changes will be beyond the Limits of Acceptable Change (LAC), as an artefact of water extraction or the construction of the pump station.

The Goschen Project works will not impact habitat critical to the survival of any EPBC Act or FFG Act listed fauna species or communities as described by DoE (2013):

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community including the maintenance of species or ecological communities
- species essential to the survival of the species or ecological community, such as pollinators
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

## Acronyms

BOCA	Birds Observer Club of Australia
CoA	Commonwealth of Australia
DAWE	Commonwealth Department of Agriculture, Water, and the Environment
DoE	Commonwealth Department of Environment
DoEE	Commonwealth Department of Environment and Energy
DELWP	Victorian Department of Environment, Land, Water and Planning
DEWHA	Commonwealth Department of Environment, Water, Heritage, and the Arts
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EE Act	<i>Environment Effects Act 1978</i>
EES	Environment Effects Statement
FFG Act	<i>Flora and Fauna Guarantee Act 1988</i>
IBRA	Interim Biogeographic Regionalisation Australia 7
MNES	Matters National Environmental Significance
NA	Nature Advisory
TPZ	Tree Protection Zone
SRZ	Structural Root Zone
TRG	Technical Reference Group
VBA	Victorian Biodiversity Atlas

## Glossary

Tree Protection Zone	The Tree Protection Zone (TPZ) is the calculated area above and below ground at a given distance from the trunk to provide for the protection of the tree's roots during construction works. The Tree Protection Zone is determined by the diameter of the tree at breast height (DBH). "Breast height" is 1.4m above ground level.
Structural Root Zone	The structural root zone is the critical area required for tree stability and does not consider tree health

# 1 Introduction

Spectrum Ecology was commissioned by VHM Limited to complete a review of the previously conducted Ecological Characterisation Assessment of the Proposed Goschen Mineral Sands Project, Goschen, Victoria (EHP 2018), Goschen Project - Targeted Conservation Significant Fauna Survey (Ecoscape 2018) and complete a targeted survey for conservation significant fauna species including Corben's Long-eared Bat (*Nyctophilus corbeni*).

EcoAerial was commissioned in 2021 to undertake a survey for the *Environment Protection and Biodiversity Conservation Act 1999* and *Flora and Fauna Guarantee Act 1988* Critically Endangered Plains-wanderer in line with the Technical Reference Group (TRG) recommendations. The Plains-wanderer report is provided as a separate document in Appendix D.

In addition, EcoAerial was commissioned on 15 February 2022 to undertake a fauna habitat assessment of the proposed water pipeline route from Kangaroo Lake to the mine site; review the Spectrum Ecology draft report (2019 Ver 3); EcoAerial's Plains-wanderer draft report (2021 Ver 1.2, Appendix D), and update reports (e.g., FFG Act listed species) where applicable and address comments provided by the TRG and, undertake a fauna habitat assessment for two alternative pipeline routes (June 2022).

This report condenses the information from the above reports and site assessments to assess the potential impacts to fauna and fauna habitat within the proposed mine tenement and water supply pipeline alignment.

## 1.1 Assumed Loss in the Context of Fauna Habitat

The removal / loss of fauna habitat is based on the Nature Advisory's Flora Technical Report (2022). This report details the removal of native vegetation as per DELWP's Guidelines for the removal, destruction or lopping of native vegetation (2017). The removal of native vegetation takes two forms, the physical removal and / or assumed loss due to impacts to the Tree Protection Zone (TPZ) of canopy trees.

The Tree Protection Zone only applies to those canopy trees impacted and plants within the dripline if, the trees are within a patch as defined by DELWP (2017). Impacts to the Tree Protection Zone does not involve the removal of vegetation. Whilst canopy trees may be considered a lost under *Clearing of native vegetation- Biodiversity assessment guidelines* (DELWP 2017b), they will be retained in-situ.

Trenching within sections of the proposed water supply alignment may cause indirect losses of native vegetation because of compaction and excavation within the TPZ or Structural Root Zone (SRZ) as defined by the Australian Standard for the protection of trees on development sites AS4970.

DELWP's (2017) Assessor's handbook, Applications to remove, destroy or lop native vegetation defines the tree protection zone as "12 x the diameter at breast height at 1.4M above the ground and a tree will be deemed lost if the encroachment into the Tree Protection Zone / Structural Root Zone is greater than 10%". Impacts to the TPZ are considered as an 'assumed loss'.

Native vegetation / fauna defined as an ‘*assumed loss*’, (herein referred to as impacts / loss), is an administrative’ loss. Canopy trees, understorey and groundcover flora are left in-situ and will continue to provide fauna habitat.

Any reference to impacts to fauna and fauna habitat adjacent to the pipeline route is based on the parameters outlined above. Impacts within the mine tenement and indirect impacts are assessed independently of the above parameters.

## 1.2 Requirement for an EES

The Project was referred to the Minister for Planning to seek advice on the need for an EES under the *Environment Effects Act 1978* (Vic EE Act).

On 10 October 2018, the Minister for Planning decided that an EES was required on the basis that the Project has the potential for a range of significant environmental effects.

On 19 December 2018 the Minister for the Environment decided that the Project is a ‘*Controlled Action*’ under the EPBC Act. The *Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions (critically endangered)* was listed as a threatened community on 10 June 2021. Under Section 158A of the EPBC Act, a listing made after the EPBC decision on 19 December 2018 cannot be assessed for that referral.

DAWE also confirmed the Victorian Government’s advice that the Project will be assessed under a bilateral agreement under the EE Act.

The EES allows stakeholders to understand the likely environmental impacts of the ‘Project’ and how they are proposed to be managed. The Minister’s assessment of the EES will also inform statutory decisions that need to be made on the ‘Project’.

The EES was developed in consultation with members of the Technical Reference Group appointed by the Ministers’ representatives, community members and other relevant stakeholders.

## 2 Project description

### 2.1 *Project overview*

The Goschen Project is a 20-25 year life cycle rare earth and mineral sands mine and processing facility, (Area 1, approx., eight years and Area 3, approx., eleven years). VHM has been developing the 'Project' in the context of a rapidly growing global demand for rare earths. One of the world's largest, highest-grade zircon, rutile and rare earth mineral deposits is in the Loddon Mallee region of Victoria in Australia. VHM intends to establish the mine and process these deposits to market a range of products to national and international consumers.

The mine footprint has been restricted to avoid intersection with groundwater and significant areas of remnant native vegetation. VHM will implement a staged development approach. Initially developing Phase 1 consisting of a mining unit plant (MUP), wet concentrator plant (WCP), Rare Earth Mineral Concentrate (REMC) flotation plant and a hydrometallurgical plant (AREM) that will further refine the REMC that is produced at Goschen. The product suite for Phase 1 consists of a zircon/titania heavy mineral concentrate (HMC) and mixed rare earth carbonate (MREC).

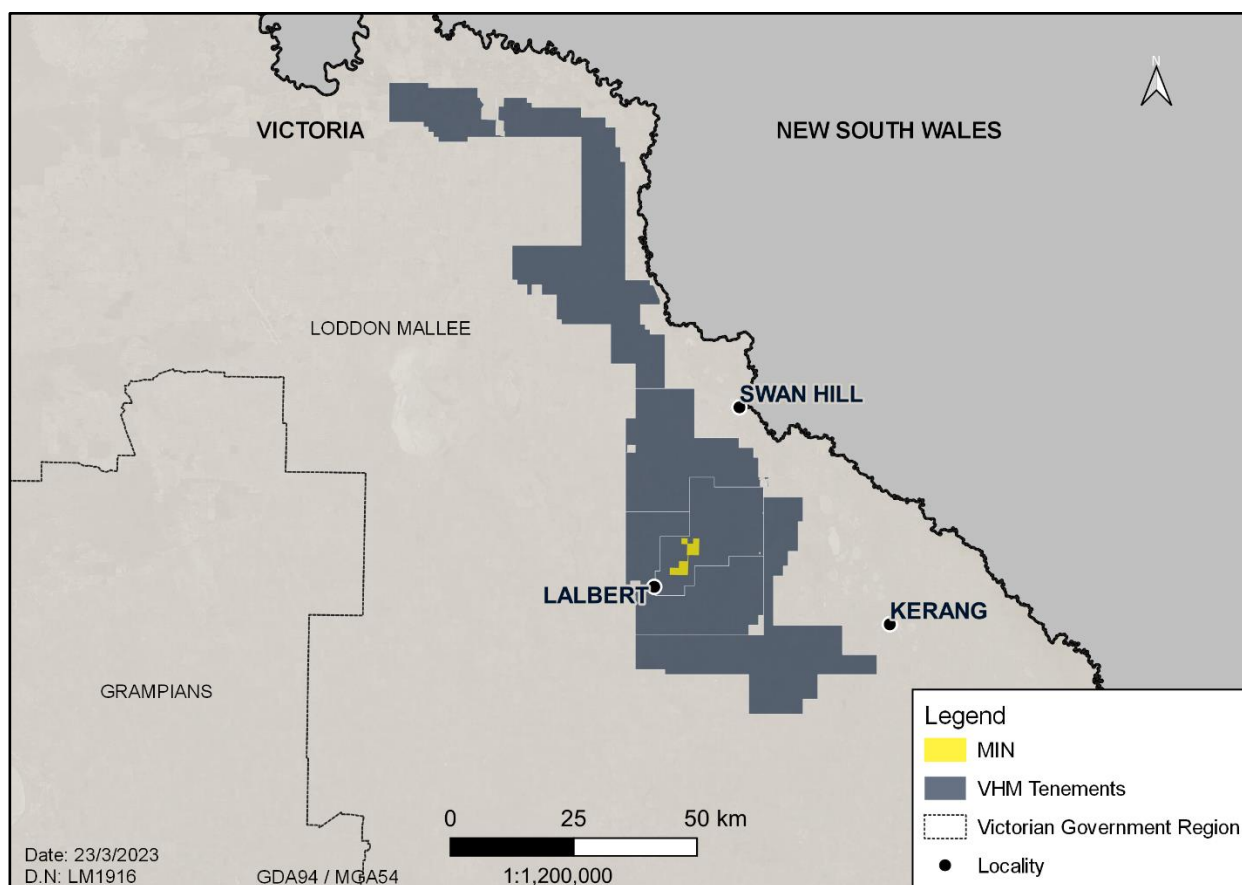
Phase 2 will commence approximately 2 years post-production and consist of an additional mineral separation plant (MSP) and, subject to prevailing market circumstances at that time, hot acid leach (HAL) and chrome removal circuit, that will produce additional products such as premium zircon, zircon concentrate, HiTi rutile, HiTi leucoxene, LoTi leucoxene, low chromium ilmenite.

Goschen Project is located approximately 4 hours' drive (275 kilometres) northwest of Melbourne and 30 minutes (35 km) south of Swan Hill within Gannawarra Shire (refer to Figure 2.1 & Figure 6.2).

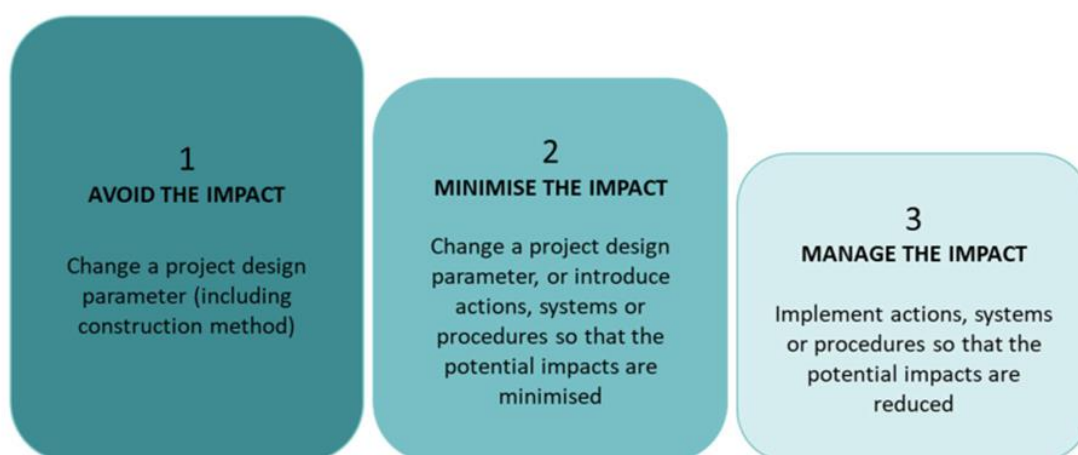
### 2.2 *Project development*

It is recognised that there are opportunities to avoid and minimise environmental impacts during the many stages of project development. During project inception and early design development stages of the project, decisions on the location and extent of the project, its design and construction techniques have enabled impacts to be significantly avoided and minimised in accordance with the hierarchy presented in Figure 2.2.





**Figure 2. 1** Project overview- VHM Tenements (Figure supplied by VHM)



**Figure 2. 2** Mitigation Hierarchy

Avoidance and minimisation of social and environmental impacts is central to the project's decision making and as such, the project will continue to be refined in response to technical requirements and potential environmental and social impacts identified during the development phase. This was considered in the preparation of a project description which is found in Chapter 4 of the Project description of the EES document. A description of how avoidance of impact has informed the design in relation to fauna studies can be found below.

Examples of this include the decision to create vegetation protection zones within the project (mining area), restricting mining operations to daylight hours only to avoid noise related impacts to certain receptors, and restricting mining to depths above the water table to avoid impacts to the groundwater table.

After opportunities to avoid impacts were incorporated into the project, minimisation and rehabilitation measures were developed. These are described in the construction and operation impact assessment sections.

### 2.3 Key project components

The Project site consists of a heavy mineral sand mining and processing operation that will produce several heavy mineral concentrates (HMC) and a range of critical rare earth minerals across two defined mining areas known as Area 1 and Area 3 (refer to Figure 2.3 and 2.4).

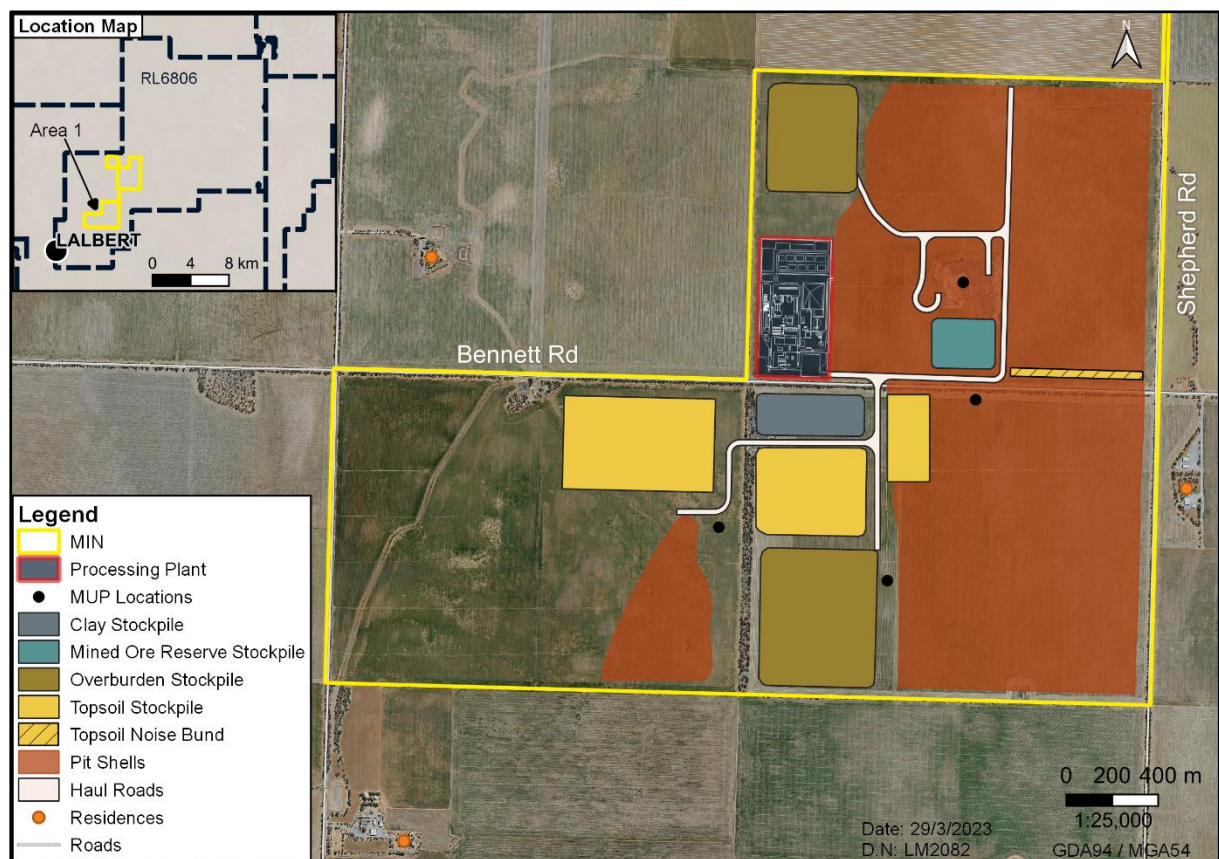
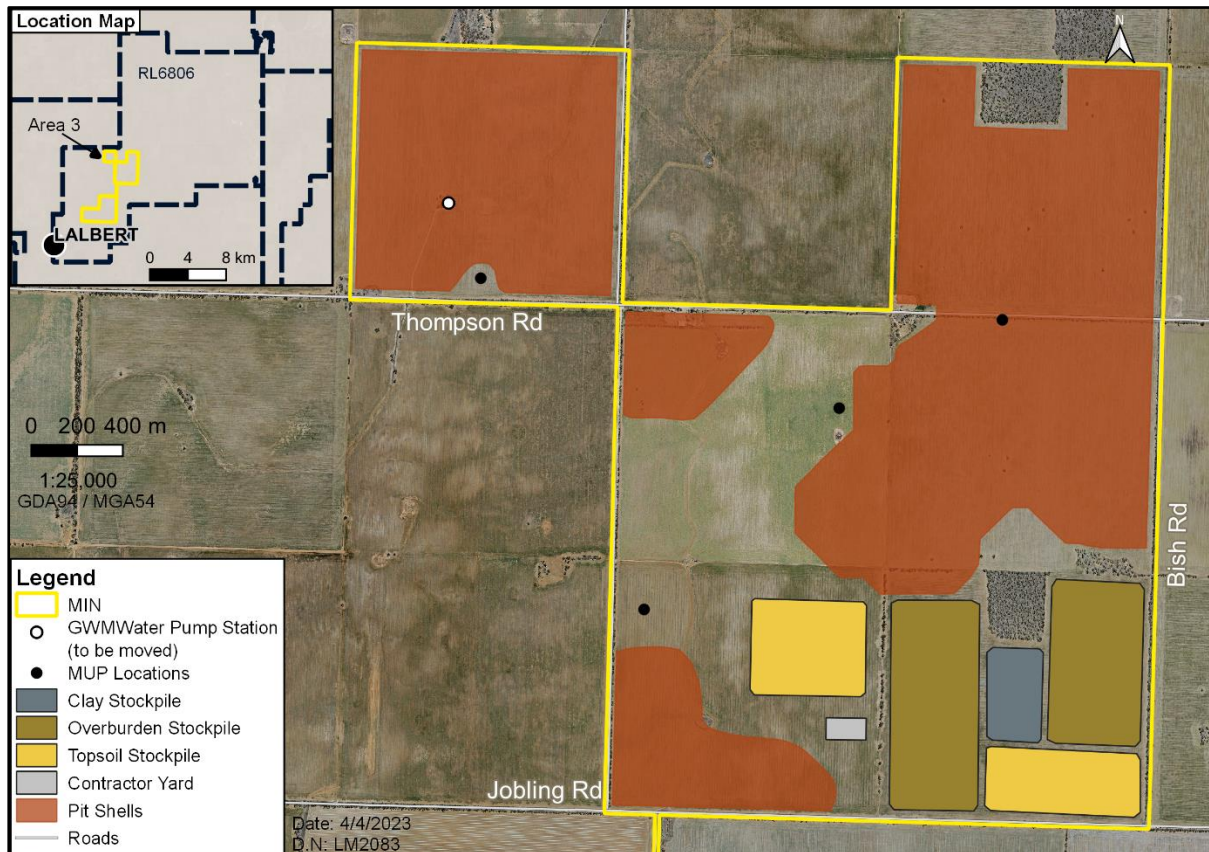


Figure 2.3 Area 1 Goschen Project (Figure supplied by VHM)



**Figure 2. 4** Area 3 Goschen Project (Figure supplied by VHM)

The key components that make up the project are described below.

**Mining** – Mining will take approximately twenty to twenty-five year at 5M tonnes of ore produced per year and will occur only above groundwater (no dewatering) across approximately 1,479 hectares of farmland using conventional open cut mining methods of excavation, load, and haul.

**Processing** – Heavy mineral sands and rare earths ore will be separated via an on-site WCP and MSP to generate a Rare Earth Mineral Concentrate (REMC). Refining of the REMC on-site is limited to hydrometallurgical extraction to produce a mixed rare earth carbonate. Tailings from the various mineral processes will be homogenised and placed back into the ore zone earlier mined.

**Rehabilitation** – The mined areas will be progressively backfilled in a staged manner, with tailings dewatered in-pit to allow overburden and topsoil placement in a profile that reinstates the background soil structure. This will result in the ability for a return to the current agricultural land uses within 3 years.

**Power** – Electrical power needed for mining and processing will be produced on-site from dual fuel diesel/LNG fired power generators, with a gradual evolution over the life of mine to renewables, hydrogen and/or battery as technologies and commercial viability increase. Heat energy for the on-site gas fired appliances shall be provided from an extension of the distribution network from the main LNG storage and regasification system.

**Transport** – Final products shall be containerised in 20ft sealed sea containers on site and exported via Melbourne Port using road and/or rail-based land logistics solutions. Ultima will provide intermodal rail solution, to reach the shipping export ports.

**Water** - Water will be required for construction earthworks, processing, dust suppression and rehabilitation. Up to 3.1 GL a year will be needed for the start-up of the Project. Water will be sourced from Goulburn Murray Water (GMW) from a new pumpstation at Kangaroo Lake via the open water market. A 38 km underground pipeline (Option 3) is proposed beneath existing local road easements as shown in Figure 6.2.





## 3 Scoping

### 3.1 EES evaluation objectives and scoping requirements

The scoping requirements for the Goschen Mineral Sands and Rare Earths Project Environment Effects Statement ('scoping requirements') by the Minister for Planning, set out the specific environmental matters the project must address to satisfy the Victorian assessment and approval requirements.

The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project in accordance with the Ministerial guidelines for assessment of environmental effects under the EE Act. The evaluation objective below provides an overview of the EES outcomes:

*To avoid or minimise potential adverse effects on biodiversity values within and near the site including native fauna and / or fauna habitat, listed threatened species and ecological communities, and habitat for these species and address offset requirements for residual environmental effects consistent with state and commonwealth policies.*

The following scoping requirements are relevant to the Vertebrate Fauna Technical Study.

The key aspects from the scoping requirements relevant to the evaluation objective are shown in Table 3.1 as well as the location where these items have been addressed in this report.

**Table 3. 1** Scoping requirements relevant to vertebrate fauna assessment

Aspect	Scoping requirement	Section addressed
<b>Key issues</b>	Direct loss or degradation of native vegetation and associated listed ecological communities, including those listed as threatened under the EPBC Act, the FFG Act.	Sections 6.6, 6.7, 6.9, 7.1, 14 &15
	Direct loss or degradation of habitat for flora and fauna listed as threatened under the EPBC Act, the FFG Act.	Sections 6.6, 6.7, 6.9, 7.1, 14 &15
	Disturbance and/or degradation of adjacent or nearby habitat that may support listed species or other protected flora, fauna or ecological communities.	Sections 6.6, 6.7, 6.9, 7.1, 14 &15
	Indirect habitat loss or degradation resulting from other effects, such as edge effects, surface hydrological changes, groundwater drawdown, groundwater mounding, dust deposition, traffic, noise, vibration, light or the introduction of weeds/ pathogens.	Sections 6.6, 6.7, 6.9, 7.1, 14 &15
	Disruption to the movement of fauna between areas of habitat across the broader landscape.	Sections 6.6, 6.7, 6.9, 7.1, 14 &15
	The availability of suitable offsets for the loss of native vegetation and habitat for listed threatened species under the FFG Act and EPBC Act.	Sections 6.6, 6.7, 6.9, 7.1, 14 &15
	Characterise the type, distribution and condition of native vegetation,	Sections 7.1, 7.2, 7.3 & 7.4

<b>Existing environment</b>	terrestrial and aquatic habitat and habitat corridors or linkages that could be impacted by the project.	
	Identify the existing or potential presence of any species listed under the EPBC Act and FFG Act.	Sections 7.3
	Describe the biodiversity values that could be affected by the project.	Sections 7.1, 7.2, 7.3 & 7.4.
	Describe the existing threats to biodiversity values.	Section 15
<b>Assessment of likely effects</b>	Assess the effects (including facilitated effects) of the project and feasible alternatives, on protected fauna, and associated habitat and movement corridors, especially for listed threatened fauna species under the EPBC Act and/or FFG Act.	Sections 9, 10 & 11
	Assess the effects (including facilitated effects) of the project, including transport route upgrades and use, on biodiversity values.	Sections 9, 10 & 11
<b>Design and mitigation measures</b>	Identify potential alternatives and proposed design options and measures.	Sections 13.1
	Develop hygiene controls for vehicle and machinery movement to minimise the spread of pathogens and weeds.	Sections 13.1
	Justify and describe the assumptions and level of uncertainty associated with the proposed measures achieving their desired outcomes addressing indirect impacts.	Sections 6.3.3.2; 6.3.3.3 & 6.8
<b>Approach to manage performance</b>	Describe proposed commitments to manage residual effects of the project on biodiversity values, including an outline of an offset strategy and offset management plan that sets out the ability to secure the appropriate offsets to satisfy both commonwealth and state offset policy requirements.	Section 13.2
	Describe the approach to develop contingency measures to be implemented in the event of adverse residual effects on flora and fauna values requiring further management.	Section 13.2
	Identify any further commitments proposed to monitor and manage risks and effects on biodiversity values and native vegetation.	Section 13.2

## 4 Evaluation framework

The assessment will consider legislation, policy and standards relevant to Vertebrate Fauna Technical Study along with specific assessment criteria that have been derived for the purposes of the study.

### 4.1 Legislation, policy, guidelines and standards

The legislation, policy, guidelines and standards relevant to this assessment are summarised in Table 4.1.

**Table 4. 1** Legislation, policy, guidelines and standards relevant to the assessment

Document title	Summary	Relevance to the project
<b>Commonwealth government</b>		
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	<i>The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places—defined in the EPBC Act as matters of national environmental significance.</i>	<i>EPBC act listed fauna predicted to occur in the Protected Matter Search Tool.</i>
<i>EPBC Act Significant Impact Guidelines 1.1 (DoE 2013)</i>	<i>The purpose of these guidelines is to assist any person who proposes to take an action to decide whether they should submit a referral to the Australian Government Department of the Environment (the Department) for a decision by the Australian Government Environment Minister (the minister) on whether assessment and approval is required under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).</i>	<i>Document was used to assess if a significant impact was going to occur to the EPBC Act listed Superb Parrot.</i>
<i>Survey guidelines for Australia's threatened birds (DEWHA 2010b)</i>	<i>The purpose of this document is to provide proponents and assessors with a guideline for surveying Australia's threatened birds listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These guidelines will help you to determine the likelihood of a species' presence or absence at a site. They have been prepared using a variety of expert sources and should be read in conjunction with the Australian Government Department of the Environment's</i>	<i>Referred to for survey methods and effort for threatened birds and, non-threatened expected to occur based on relevant databases.  Survey method / effort was i.e., Area search as described by Hewish and Loyn (1989).</i>



Document title	Summary	Relevance to the project
	<i>Significant impact guidelines 1.1 - Matters of national environmental significance.</i>	
<i>Survey guidelines for Australia's threatened bat species (DEWHA 2010a)</i>	<i>The purpose of this document is to provide proponents and assessors with a guideline for surveying Australia's threatened bat species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These guidelines will help you to determine the likelihood of a species' presence or absence at a site. They have been prepared using a variety of expert sources and should be read in conjunction with the Australian Government Department of the Environment's Significant impact guidelines 1.1 - Matters of national environmental significance.</i>	<i>Referred to for survey methods and effort for targeted surveys for Corben's Long-eared bat.</i>
<i>Survey guidelines for Australia's threatened mammals (DSEWPac 2011a)</i>	<i>The purpose of this document is to provide proponents and assessors with a guideline for surveying Australia's threatened mammals listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These guidelines will help you to determine the likelihood of a species' presence or absence at a site. They have been prepared using a variety of expert sources and should be read in conjunction with the Australian Government Department of the Environment's Significant impact guidelines 1.1 - Matters of national environmental significance.</i>	<i>Referred to for survey methods and effort notwithstanding it was considered, there was no suitable habitat for terrestrial EPBC listed mammals.</i>
<i>Survey guidelines for Australia's threatened reptiles (DSEWPac 2011b)</i>	<i>The purpose of this document is to provide proponents and assessors with a guideline for surveying Australia's threatened reptiles listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These guidelines will help you to determine the likelihood of a species' presence or absence at a site. They have been prepared using a variety of expert sources and should be read in conjunction with the Australian Government Department of the Environment's Significant impact guidelines 1.1 - Matters of national environmental significance.</i>	<i>Referred to for survey methods and effort notwithstanding it was considered, there was no suitable habitat for terrestrial EPBC listed reptiles.</i>
<i>Significant impact guidelines for the vulnerable growling grass frog (Litoria raniformis) Nationally threatened species and ecological</i>	<i>This background paper provides the biological and ecological context to the habitat areas, significant impact thresholds, and</i>	<i>Referred to for habitat description and behavioural characteristics and species threats.</i>

Document title	Summary	Relevance to the project
<i>communities: Background paper to the EPBC Act policy statement 3.14.</i>	<i>mitigation measures defined for the growling grass frog in the policy statement.</i>	
<i>Threatened Species Scientific Committee (TSSC) Conservation Advice Nyctophilus corbeni Corben's long-eared Bat</i>	<i>Provides background information on the ecology and distribution of Corben's long-eared Bat</i>	<i>Referred to for habitat description and behavioural characteristics and species threats.</i>
<i>National Recovery Plan for the Plains-wanderer (Pedionomus torquatus)</i>	<i>This document constitutes the National Recovery Plan for the Plains-wanderer (Pedionomus torquatus). The plan considers the conservation requirements of the species across their range and identifies the actions to be taken to ensure the species' long-term viability in nature, and the parties that will undertake those actions.</i>	<i>Referred to for habitat description, behavioural characteristics, and species threats.</i>
<i>National recovery plan for the superb parrot Polytelis swainsonii.</i>	<i>The plan provides a range of objectives to minimise threats while protecting and restoring the species' habitat across its range.</i>	<i>Referred to for habitat description, behavioural characteristics, and species threats.</i>
<i>Threatened Species Scientific Committee (TSSC) Conservation Advice for the Superb Parrot (Polytelis swainsonii)</i>	<i>Provides background information on the ecology and distribution of Superb Parrot</i>	<i>Referred to for habitat description, behavioural characteristics, and species threats and for conducting Significant Impact Test.</i>
<i>Threatened Species Scientific Committee (TSSC) Conservation Advice for the Mallee Bird Community of the Murray Darling Depression</i>	<i>Provides background information on the species composition and distribution of Mallee Bird Community.</i>	<i>Referred to for location, habitat and threshold for identifying the presence of community.</i>
<b>Victorian government</b>		
<i>Environment Effects Act 1978</i>	<i>The Environment Effects Act 1978 provides for assessment of proposed projects (works) that can have a significant effect on the environment. On 10 October 2018, the Victorian Minister for Planning determined that an EES was required for the Goschen Project due to the potential for significant environmental effects on Commonwealth and State listed flora and associated biodiversity. This impact assessment aims to document the existing conditions within the Project Area, ascertain the likely effects on these existing conditions and outline mitigation measures and performance objectives as they relate to the management of residual effects that cannot be avoided.</i>	<i>Referred to for assessing project impacts for species outlined as at risk.</i>

Document title	Summary	Relevance to the project
<i>Flora and Fauna Guarantee Act 1988 (FFG Act)</i>	<i>The FFG Act is the key Victorian legislation for the conservation of threatened species and communities. The FFG Act focuses on prevention to ensure that more species do not become threatened.</i>	<i>Used to assess conservation status of species predicted to occur or observed with the Project Area.</i>
<i>The Wildlife Act 1975</i>	<i>The Wildlife Act sets the rules around how we protect, conserve, sustainably manage and use wildlife in Victoria</i>	<i>The Wildlife Act is relevant to the research permit issued by DELWP (Salvage activities will require a separate consent / permit from DELWP. Salvage activities will require a separate consent / permit from DELWP.</i>
<b>Other</b>		
<i>The sounds of success for Plains-wanderers (brochure) (Baker-Gabb, D. 2018)</i>	<i>Technical report outlining the use of sound recorders for monitoring Plains-wanderer.</i>	<i>Referred to for survey methods and effort.</i>
<i>Managing native Grasslands for Plains-wanderer (Baker-Gabb, D. 2016).</i>	<i>Brochure providing guidance on grassland management for Plains-wanderer habitat.</i>	<i>Referred to for survey method to conduct a habitat assessment for Plains-wanderer.</i>

## 5 Consultation and engagement

Development of the project and preparation of the EES have been informed by consultation with a range of stakeholders. VHM has undertaken several activities inviting input from the community and the TRG. The dates and feedback from these activities are provided in Table 5.1. A further 12 activities are scheduled from September through to November. 2022.

**Table 5. 1** Stakeholder engagement undertaken for Vertebrate Fauna Technical Study

Community and stakeholder sessions	Comments
<ul style="list-style-type: none"> <li>Gannawarra Air Muster – 26 &amp; 27 March 2022</li> <li>Minerals Council of Victoria – site tour for James Sorahan – 31 March 2022</li> <li>Rotary Club of Kerang Annual Art Show – 15-17 April 2022 (VHM sponsored this event)</li> <li>Murrabit Easter Market – 16 April 2022</li> <li>Cohuna Farmers and Makers Market – 17 April 2022</li> <li>Kerang Community Market – 28 May 2022</li> <li>Murrabit Country Market – 4 June 2022</li> <li>Kerang Community Market – 25 June 2022</li> <li>Mallee Machinery Field Days- 3 &amp; 4 August 2022</li> </ul>	No community member raised any fauna related concerns.
Community drop-in information session; Lalbert Football Facility.	No community member raised any fauna related concerns.
Community drop-in information session; VHM Warehouse Kerang-28 July 2022.10.30AM-2.00PM	No community member raised any fauna related concerns.
Community drop-in information session; Swan Hill Club-28 July 2022. 4.00PM-7.30PM	No community member raised any fauna related concerns.
<p>Project Bulletin's displayed at Shire office Kerang- March 2022 on-going.</p> <p>Project Update 1- March 22: Topic-Goshen Project redefined</p> <p>Project Update 2- March 22: Topic/s- Community engagement team; community engagement and EES process.</p> <p>Project Update 3 - June 22: Topic's- Airbourne geophysical survey; Drilling program; community engagement activities, stage of the EES process &amp; community support.</p>	No community member raised any fauna related concerns.
Technical Reference Group (TRG) Lalbert - May 2019	The TRG provided comments requiring addressing of the Spectrum Ecology 2019; Vertebrate Fauna Technical Report Ver 3.

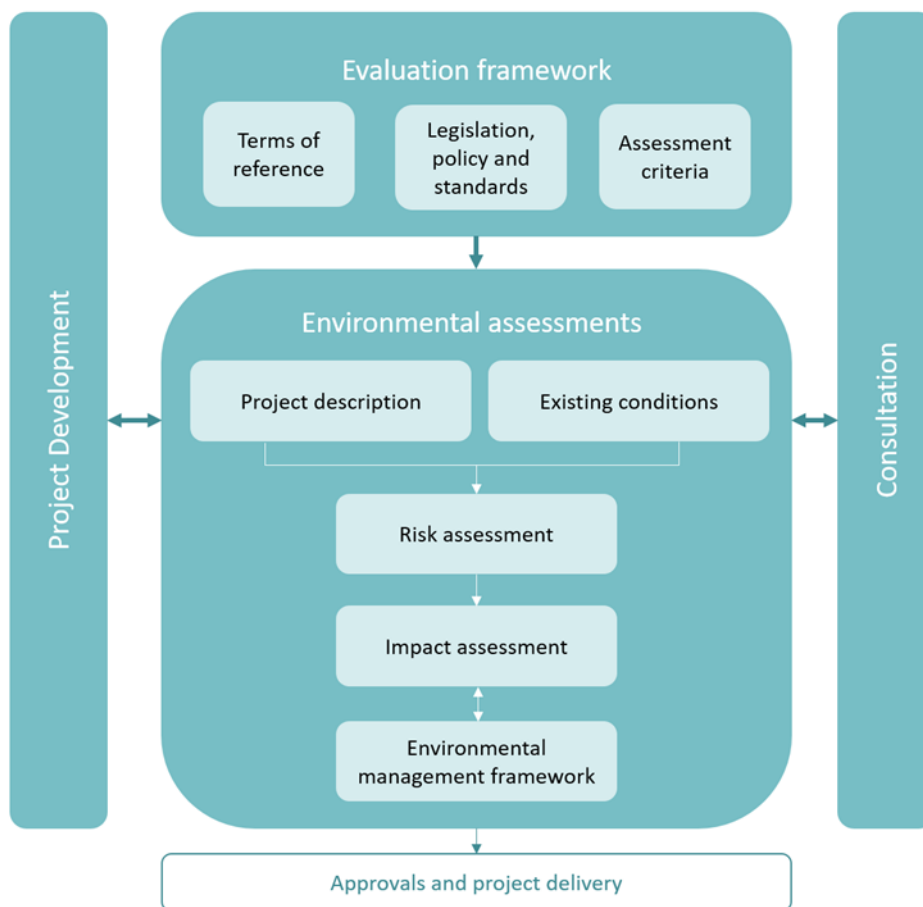
Community and stakeholder sessions	Comments
Technical Reference Group (TRG) Meeting Online Meeting -	Presentation of fauna results to TRG, 22 May 2019

## 6 Methodology

### 6.1 Overview of method

This section describes the method that was used to assess the potential impacts of the project. Figure 6.1 shows an overview of the assessment method. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects.

The approach used in the assessment has been guided by the evaluation framework that applies to the project comprising the regulatory framework (that is, applicable legislation and policy) as well as the scoping requirements set by the Victorian Minister for Planning.



**Figure 6. 1** Overview of assessment framework

The environmental assessments were undertaken according to the following steps:

- Establishment of a study area and characterisation of existing environment.
- Review of the project description, comprising the key project components (including locations and form), proposed construction and operation activities (in the context of existing environment) and where relevant, decommissioning activities to determine the location, type, timing, intensity, duration and spatial distribution of potential project interactions with sensitive receptors
- An initial risk-based analysis to evaluate the potential effects of proposed project activities and their likelihood of occurring (considering initial mitigation measures) to determine the relative importance of environmental impacts associated with the

project. Prioritise issues for attention in the subsequent assessment of impacts. Initial mitigation measures would include measures that are common industry practice or required to meet legislation.

- An assessment of impacts that examines the severity, extent, and duration of the potential impacts and considers the sensitivity and significance of the affected receptors.
- Evaluation of predicted outcomes against benchmarks and criteria such as those described in applicable legislation, policy and standards.
- Evaluation of the potential for cumulative impacts (where relevant) caused by impacts of the project in combination with impacts of other existing and proposed projects that may have an overall significant impact on the same environmental asset.
- Identification of additional mitigation measures where necessary to address potentially significant environmental impacts.
- Evaluation and reporting of the residual environmental impacts including magnitude, duration and extent, considering the proposed mitigation measures and their likely effectiveness.

#### 6.1.1 Mitigation Hierarchy

The design of the mine site and water supply pipeline routes has been guided by the avoid and minimise principal to reduce impacts on native vegetation and as an artefact reducing impacts to fauna and fauna habitat.

Mitigation measures have been developed to address the specific impacts likely to occur during construction, operation and decommissioning of the proposed 'Project'. The mitigation hierarchy is based on avoiding the impacts as the first step. If this is not possible, implement measures to minimise the impact and include supplementary management strategies such as habitat restoration and as a final resort, offsetting to compensate for loss of native vegetation / fauna habitat within the bioregion.

#### 6.1.2 Assessing the Project Impacts

This technical report identifies and assesses potential impacts associated with construction, operations and closure. The methods used to assess impacts included incorporating the findings of other biodiversity technical studies (e.g., native vegetation, aquatic environs etc.), that were relevant to fauna and fauna habitat. Further to this, members of the Technical Reference Group provided advice throughout the various 'Project' iterations. VHM also undertook community engagement to understand and address their concerns in relation to the potential impacts to biodiversity the 'Project' may have.

The extent of impacts was measured against relevant regulatory acts and policy statements and risk assessment documents e.g., Guidelines for mining projects, EPBC Act significant impact test, Guidelines for the removal, destruction or lopping of native vegetation 2017) etc.

#### 6.1.3 Cumulative Impacts

Whilst not linked to any other projects, the loss of fauna habitat on adjoining road reserves of proposed water pipeline can be compounded by existing and ongoing incremental vegetation

disturbance and loss due to local government road maintenance / construction activities and unauthorised firewood harvesting. These impacts are outside the control of VHM.

#### 6.1.4 Alternative Options

The alternative options are based on the mitigation hierarchy process described above i.e., avoid and minimise impacts to native vegetation and fauna habitat. The original study area was 20,862 ha (2018) and based on the recommendations of the relevant technical studies and the available mineral sand resource, the mining tenement area was reduced to 1,474ha.

The conclusions within this report, along with assessments undertaken by the Nature Advisory (2022) and Treetec (2022), have guided by the avoid and minimise approach.

#### 6.1.5 Monitoring and Contingency measures

The findings of this fauna impact assessment have been incorporated into the environmental management framework (EMF) prepared by VHM, with a particular emphasis on monitoring and controlling environmental performance during the construction and operation of the Project. The EMF has specified the committed mitigation measures to avoid, minimise and manage impacts, proposed contingency measures and offset commitments, and describe the roles and responsibilities for implementation throughout projects construction, operation and decommissioning.

Table 13.1 describes the avoid, mitigation, timing and responsibilities specifically for fauna and fauna habitat. Monitoring will be conducted to measure project performance criteria as outlined in Table 13.2 during construction, operations and decommissioning (closure).

Monitoring results would be reviewed by the operations manager as outlined in Table 13.1 and Table 13.2 to detect any non-compliance issues. This review will inform any adaptive management approach required, additional monitoring and contingencies.

Monitoring will be compared with relevant baseline data, if applicable, or triggers as outlined in Table 13.2 and reported in accordance with the conditions of approval, licences and permits and other applicable regulatory requirements.

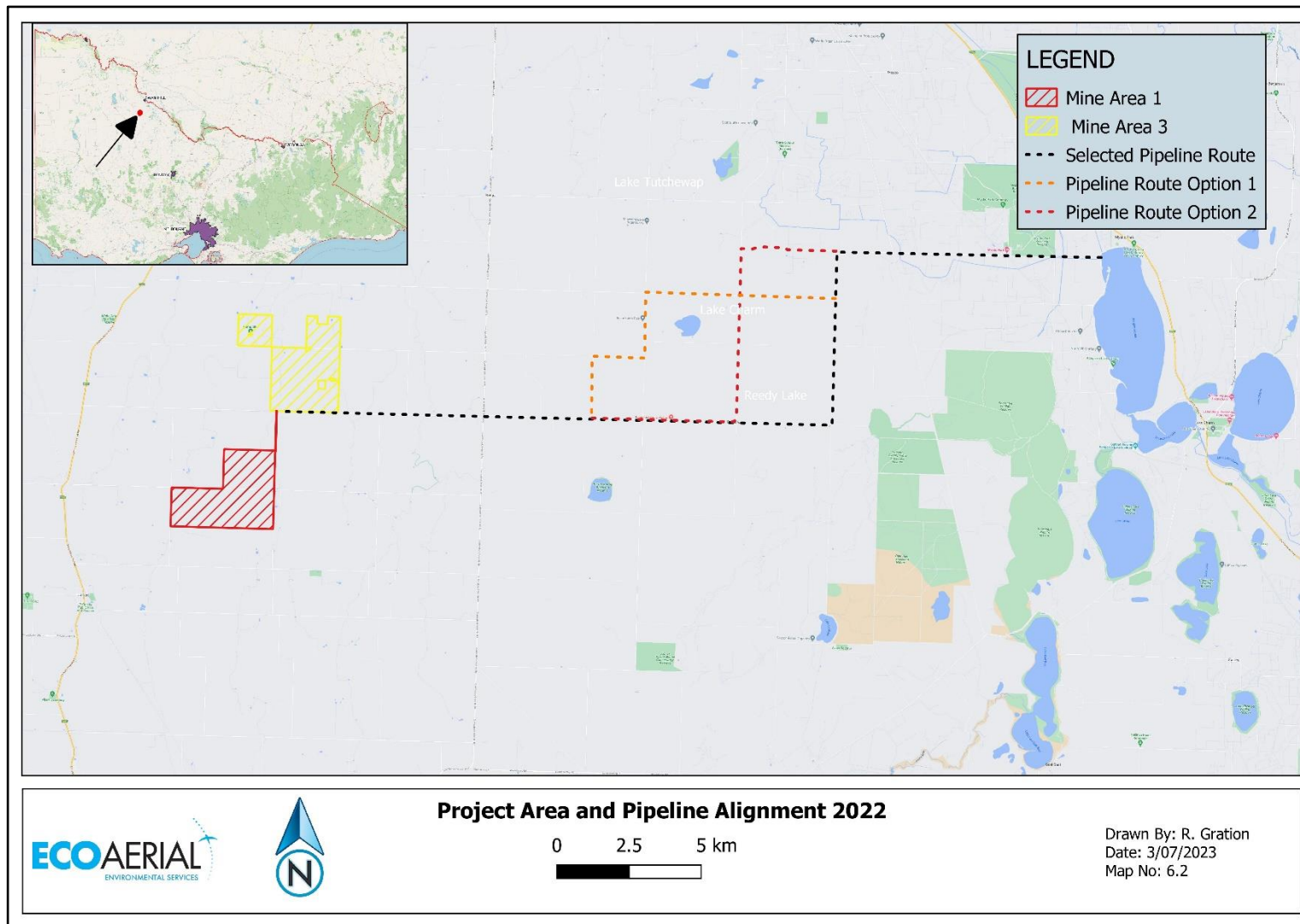
### 6.2 Study area

The Goschen Mineral Sands Project is in the Loddon Mallee Region in northern Victoria approx. 280 km northwest of Melbourne and 35 km south of Swan Hill, (Figure 6.2). The project footprint consists primarily of cropped paddocks with native vegetation confined to road reserves with remnant patches on fence lines extending into the paddocks and small areas within paddocks.

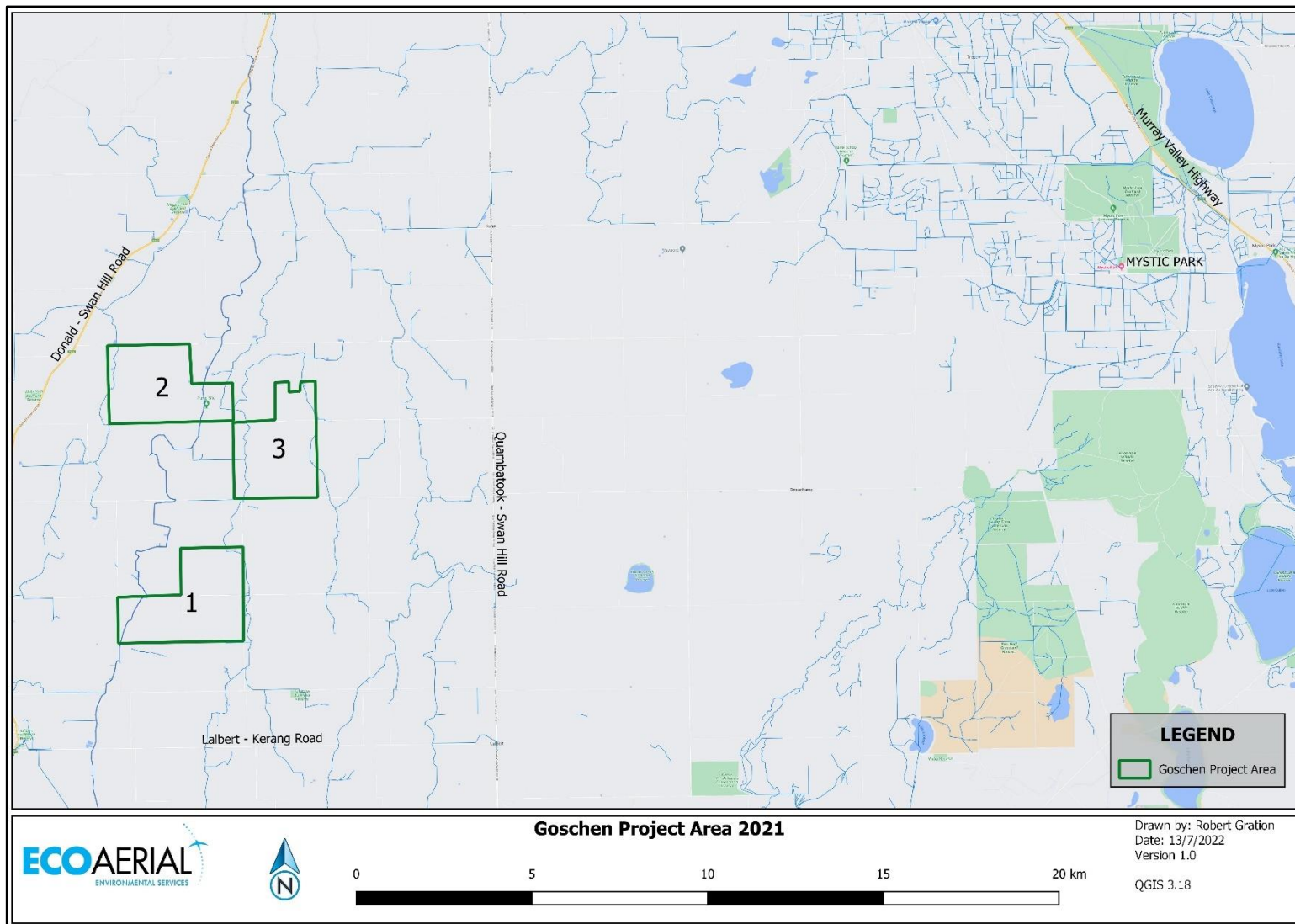
The 'Project Area' has undertaken several iterations since 2018. The current 'Project Area' is 1,474 ha (refer to Figure 6.2), in 2021 when undertaking a Plains-wanderer surveys it was 2,018 ha (refer to Figure 6.3) and the original 'Project Area' in 2018 was 20,862 (refer to Figure 6.4). Note the small area in the northwest corner of Area 3 (Figure 6.2) was previously included in Area 2 (Figure 6.3).

Figure 6.5 and Section 6.3.1 provide details of the buffer area used for the PMST and VBA desktop reviews.

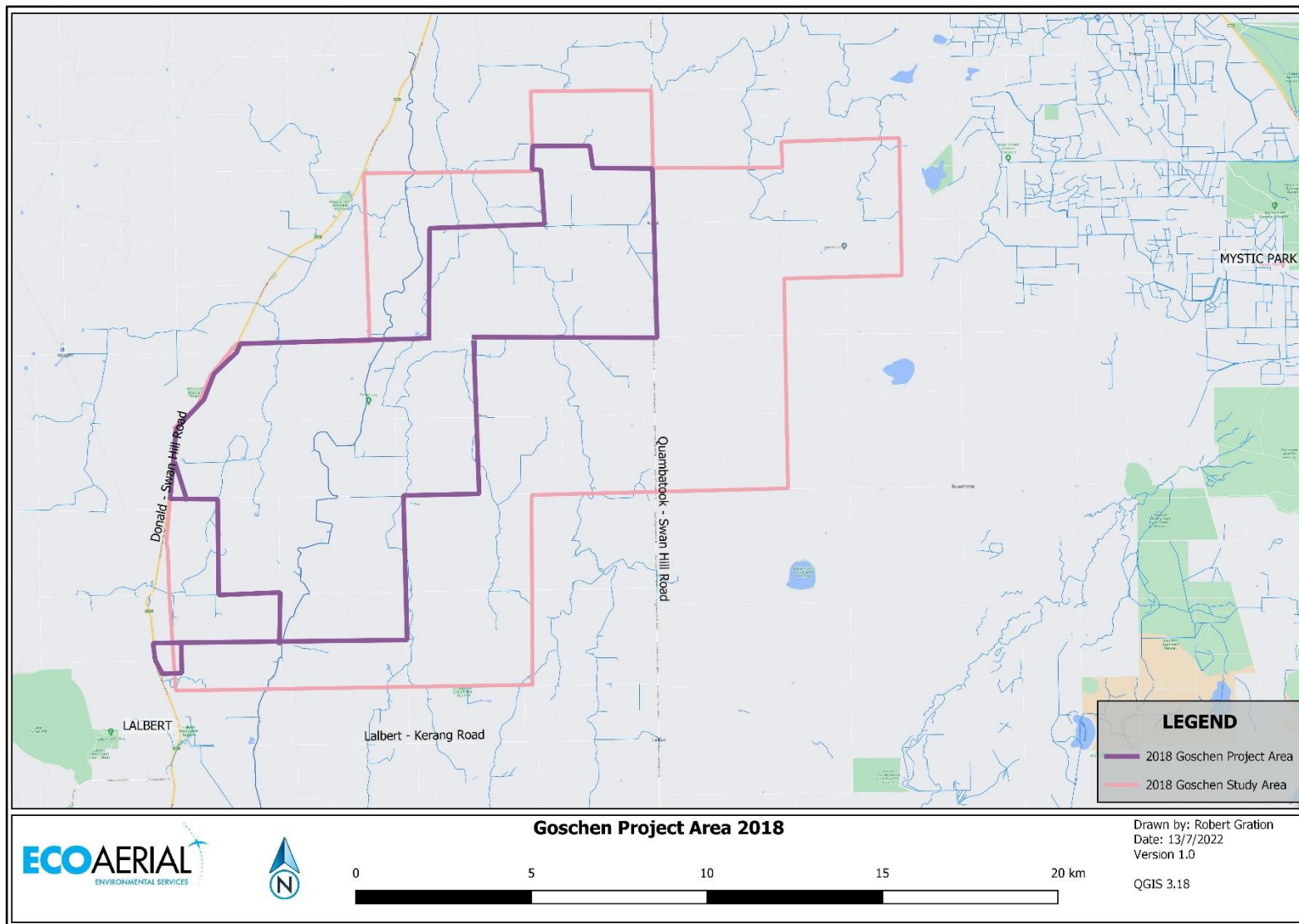




**Figure 6. 2** Goschen mineral sands project area 2022

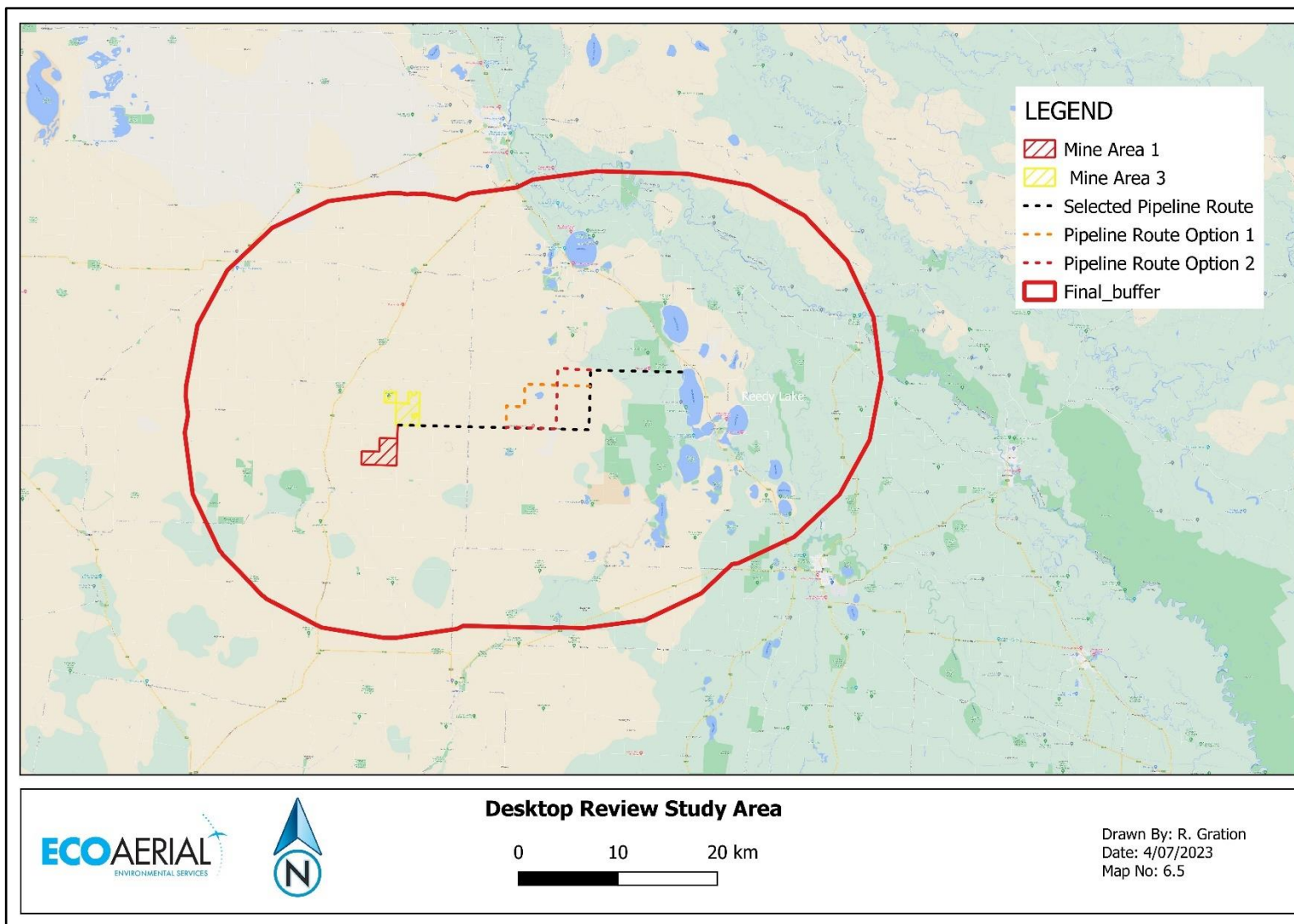


**Figure 6. 3** Goschen mineral sands project area 2021



**Figure 6. 4** Goschen mineral sands project area 2018





**Figure 6. 5** Desktop review study area (20km buffer)

### 6.3 Existing environment

Several studies have been undertaken (Ecology and Heritage Partners 2018; Ecoscape Australia 2018; Spectrum Ecology 2019; EcoAerial 2021) to understand the existing environment of the study area to inform the assessment of the Project's impacts on fauna and fauna habitat. A review of the above studies and database searches were undertaken and updated where applicable.

The survey method and effort of the Ecoscape Australia (2018) and Spectrum Ecology (2019) reports are presented below, and the results presented in Section 7. The survey methods and effort for the Ecology and Heritage Partners (2018) was based on incidental records for fauna.

A summary of the survey methods is provided for the Plains-wanderer survey undertaken by EcoAerial (2021). Due to the suite of the methods deployed and the extent of the survey results, this report has been included in Appendix D if more detail is required.

Sites were selected based on where fauna habitat considered was present to support threatened species identified in desktop reviews, and areas representative of a range of habitat types e.g., derived grassland, chenopod and woodland communities.

#### 6.3.1 Literature review

The pre-2022 literature review objectives were to determine the likely presence of threatened species and / or habitat and any targeted survey requirements. Due to a lack of established permanent wetland habitat within the mining tenement, migratory bird species, obligate wetland bird species and fish that were identified in the PMST and VBA (20km buffer) database search were excluded (Ecoscape 2018). Refer to Figure 6.5 above for buffer area. The potential fauna assemblage based on the desktop review for the mine tenement is provided in Appendix 2

A literature review was undertaken of the Kerang Wetlands (Ecoscape 2018), encompassing Kangaroo Lake, where the pipeline starts and included migratory bird species, obligate wetland bird species that were identified in the PMST and VBA (20km buffer) database search. The potential fauna assemblage based on the desktop review for the Kerang Wetlands is provided in Appendix 2. Whilst the review includes fish in the species list, they are subject to a separate study by Aquatica Environmental (2022), refer to Appendix F.

The review undertaken in 2022 of the Goschen Project – Vertebrate Fauna FINAL Version 4.2 report (Spectrum Ecology 2019) also updated the conservation status of vertebrate fauna. This report is the primary document used for presenting the survey results in the technical report herewith. The advisory list of threatened vertebrate fauna in Victoria (DSE 2013) is now redundant. The *Flora and Fauna Guarantee Act 1988* is now the primary state act outlining the conservation status of both flora and fauna and threatened communities.

The literature review for the pipeline routes was based on a buffer of 20km and overlaps with the desktop review buffers for the Mine Tenement and Kerang Wetlands.

The site investigations and desktop reviews incorporate all iterations of the 'Project Area' footprint, pipeline routes and Kangaroo Lake. Maps showing the location of surveys are provided in Appendix C.

### 6.3.2 Conservation Significant Fauna

The database searches and literature review informed a list of expected species that potentially occur in the study area. This desktop review also aimed to determine if any targeted survey techniques were required for threatened species. The desktop included:

- A review of 3 datasets:
  - NatureKit
  - Protected Matters Search Tool (PMST)
  - Victorian Biodiversity Atlas (VBA)
- Review of literature sources, refer to Reference and Bibliography Section.
- Consultation with TRG and David Baker-Gabb, Plains-wanderer expert:
  - TRG May 2019
  - David Baker-Gabb – 2020.
- Field methods to assess the presence of mammals, birds, and reptiles using relevant survey guidelines. Refer to Table 6.2:

The following information was then included for each threatened species:

- Conservation status (EPBC Act and FFG Act listing)
- Description of species habitat requirements and presence of this habitat within the study area
- Summary of relevant records including source of record (DBCA, previous report etc) and accuracy of the record location; and
- Likelihood of occurrence criteria assigned and justification of likelihood of occurrence that considers known habitats, survey effort etc.

The likelihood of occurrence was determined based on the criteria outlined in Table 6.1.

**Table 6. 1** Likelihood of Occurrence Criteria – Vertebrate Fauna

Likelihood	Criteria
<b>Recorded</b>	Species recorded within the study area within the previous ten years.
<b>High</b>	Species recorded within or in proximity to the study area within the previous 20 years. Suitable habitat occurs in the study area.
<b>Medium</b>	Species recorded within or in proximity to the study area more than 20 years ago. Species recorded outside the study area but within 20 km. Suitable habitat occurs in the study area.
<b>Low</b>	Species rarely or not recorded within 20 km of the study area. Suitable habitat does not occur within or in proximity to the study area. Species' distribution marginally overlaps with study area.
<b>Very Low</b>	Species not recorded within 20 km despite multiple recent surveys. Suitable habitat does not occur within the study area. Species considered locally extinct, or species' distribution does not overlap with study area.

**Table 6. 2** Threatened species advice and guidelines referred to for surveys

Survey Guidelines	Relevant Reports
Survey guidelines for Australia's threatened birds (DEWHA 2010b)	Ecoscape 2018 / Spectrum Ecology 2019
Survey guidelines for Australia's threatened bat species (DEWHA 2010a)	Ecoscape 2018 / Spectrum Ecology 2019
Survey guidelines for Australia's threatened mammals (DSEWPac 2011a)	Ecoscape 2018 / Spectrum Ecology 2019

Survey Guidelines	Relevant Reports
Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b)	Ecoscape 2018 / Spectrum Ecology 2019
Threatened Species Scientific Committee (TSSC) Conservation Advice <i>Nyctophilus corbeni</i> Corben's long-eared Bat (DoE 2015)	Spectrum Ecology 2019
National Recovery Plan for the Superb Parrot <i>Polytelis swainsonii</i> . (Baker-Gabb, D. 2011)	Spectrum Ecology 2019
Threatened Species Scientific Committee (TSSC) Conservation Advice <i>Polytelis swainsonii</i> Superb Parrot (DoE 2016)	Spectrum Ecology 2019
National Recovery Plan for the Plains-wanderer ( <i>Pedionomus torquatus</i> )	EcoAerial 2021
The sounds of success for Plains-wanderers (brochure) (Baker-Gabb, D. 2018)	EcoAerial 2021
Managing native Grasslands for Plains-wanderer (Baker-Gabb, D. 2016).	EcoAerial 2021

### 6.3.3 Survey effort

#### 6.3.3.1 Mine Tenement

A targeted fauna survey was completed from 13 March to 19 March 2018 (Ecoscape Australia 2018) using a variety of survey techniques based on information and requirements described in species specific survey guidelines (DEWHA 2010b, DEWHA 2010a; DSEWPaC 2011a, DSEWPaC 2011b). The survey techniques included:

- Song Meter Ultrasonic Bat Recorders – Eight SM2Bat+ and SM4Bat FS recorders were placed along the edge of woodland habitats or other flyways for four consecutive nights.
- Reconyx Motion Camera – 18 Reconyx HC-500 motion cameras were deployed in areas of suitable remnant vegetation or other travel paths to record the presence of nocturnal/cryptic species.
- Active Searching – Active searching (raking, searching under rocks and wood debris) of 1 ha areas in suitable remnant habitats was searched for 30 minutes. Secondary evidence of any species (scats, tracks, nests/mounds and remains) were also recorded.
- Nocturnal Searches – 20-minute active searches of remnant vegetation sites were completed. In addition, road cruising was completed between search sites and when moving around the site. All species seen during the nocturnal searches were documented. Suitable Plains Wanderer habitat (native grasslands) was located during day searches and then targeted during the nocturnal searches.
- Bird Surveys – standardised 20-minute searches of 2 ha areas were completed during the early morning and late afternoon when bird activity is highest. All bird species and abundances observed were recorded. Any opportunistic sightings of additional bird species were also recorded independently.

During the targeted fauna survey (Ecoscape Australia 2018), bat calls were recorded that belong to a bat call complex of the genus *Nyctophilus*, *Myotis* or *Vespadelus*. Bat calls from the species are very similar and cannot be distinguished by analysing recorded bat calls. Due to these ambiguous records, a targeted bat trapping program was conducted targeting Corben's Long-eared Bat (*Nyctophilus corbeni*). The survey effort for each fauna group is provided in Table 6.3.

**Table 6. 3** Details of the survey method, targeted species and survey effort for mine tenement

Method	Species targeted	Survey effort
Incidental observations	Threatened and non-threatened birds, reptiles, and mammals	96- person hours
Bat detectors	Threatened and non-threatened microbats	32- bat detector nights
Reconyx Motion Camera	Threatened and non-threatened birds, reptiles, and mammals	72- camera nights
Active reptile search	Threatened and non-threatened reptiles	11- person hours
Nocturnal Search – Spotlighting	Threatened and non-threatened mammals and nocturnal birds	7.5 -person hours
Standardised 20-minute Search	Threatened, (Superb Parrot, Regent Parrot & Painted Honeyeater), and non-threatened Birds	27.5- person hours
Targeted harp trap survey	Corben's Long-eared Bat	24- trap nights

Ecoscape Australia 2018; Spectrum Ecology 2019

### ***Corben's Long-eared Bat***

A supplementary targeted survey for Corben's Long-eared Bat was conducted between 17<sup>th</sup> and 23<sup>rd</sup> October 2018 by a team of three experienced zoologists (Spectrum Ecology 2019). The survey method and effort followed advice for Corben's Long-eared bat in the Survey guidelines for Australia's threatened bat species (DEWHA 2010a).

### ***Plains-wanderer survey***

A targeted survey for the EPBC Act / FFG Act Plains-wanderer was undertaken at the recommendation of the TRG in 2021 (EcoAerial 2021). The survey method and effort followed advice in: Survey guidelines for Australia's threatened birds (DEWHA 2010b). A suite of methods was deployed for the survey.

Song Meters (Wildlife Acoustics™) were deployed at 6 locations. The detectors were placed on fence posts at least 200m away from canopy trees that are 8m in height (Baker-Gabb) and, where crop stubble or derived grassland was present. The recorders were in the field from the 28 March 2021 to 2 May 2021 and programmed to record 30-minutes every hour over a 12-hour nightly period.

Nocturnal transect surveys were undertaken on 27, 28, 29 & 30 March 2021. Diurnal surveys were undertaken on 28, 29, 30 & 31 March 2021. Weather conditions are provided in Table 6.4. All sites were surveyed twice. The survey effort totalled 52 person hours and exceeded the Commonwealth Survey guidelines for Australian threatened birds: Plains-wanderer (2010).

Habitat assessments were undertaken in each paddock deploying the quadrat / golf ball method across the tenement. This method is frequently used for assessing the suitability of native grassland structure for Plains-wanderer (Baker-Gabb, 2016). The method entails dropping 18 golf balls into a 1<sup>2</sup>m quadrat with the number of balls seen completely or partially scored. Scoring is based on if a ball is 90% visible it scores 1, less than 90% seen but more than 33% scores 0.5 and, less than 33% is seen it scores zero. Scores of 1-13 are considered too dense with scores of 17.5 and above to sparse. The ideal score is 15 -16.5. A quadrat was placed in each paddock in a location indicative of the paddock stubble structure.



**Table 6. 4** Detail of weather conditions

Date	Min temp (°C)	Max temp (°C)	Rainfall (mm)	AM Temp (°C)	AM wind speed (km/h)	PM Temp (°C)	PM wind speed (km/h)
27/03/2021	12.4	24.8	0	N/A	N/A	24	0
28/03/2021	8.6	23.8	0	17 ~ 20	4 ~ 20	18 ~ 21	0
29/03/2021	9.2	26.4	0	13 ~ 19.5	0 ~ 17	16 ~ 21	0 ~ 4
30/03/2021	7.5	26.2	0	9 ~ 20	9 ~ 16	14 ~ 16.5	0 ~ 7
31/03/2021	8.5	28.9	0	17	17	N/A	N/A

### 6.3.3.2 Pipeline Alignment Option 1

One pipeline option was initially proposed from Kangaroo Lake to the mine (approx. 37km), herein referred to as Option 1 (refer to Figure 6.2). The pipeline is confined to the road apron of Mystic Park-Beauchamp Rd for approx., 7km where it is bitumen and the middle of gravel roads thereafter. A fauna habitat assessment was undertaken over 3-days, 21-23 February 2022.

The survey methods deployed were as follows:

- incidental observations
- bat detectors
- spotlighting
- active search
- targeted active reptile search for Hooded Scaly-foot and Samphire Skink.

Weather conditions were ideal for the reptile surveys, refer to Table 6.5.

**Table 6. 5** Detail of weather conditions

Date	Max temp	Min Temp	Rainfall mm	Cloud cover
21/02/2022	26.2	12.9	0	0
22/02/2022	31.4	11.2	0	0
23/02/2022	34.2	15.5	0	4 *

\* = clouds present in half of viewed sky.

The survey method and effort for the February 2022 survey of the water supply pipeline route Option 1 is provided in Table 6.6.

**Table 6. 6** Details of the survey method, targeted species and survey effort

Method	Species targeted	Survey effort
Incidental observations	Threatened and non-threatened birds, reptiles, and mammals	48-person hours
Bat detectors	Microbats	2-bat detector nights
Spotlighting	Nocturnal birds and mammals	15km / 4 person hours
Active reptile search	Threatened and non-threatened reptiles	4.5km / 8 person hours
Targeted active reptile search	Hooded Scaly-foot	2.5km / 5 person hours
Targeted active reptile search	Samphire Skink	3 km / 6 person hours

In the absence of survey guidelines for Hooded Scaly-foot and Samphire Skink, the survey method, i.e., diurnal hand search, visual search and nocturnal spotlight search were consistent with the Survey guidelines for Australia's threatened reptiles (DSEWPac 2011b).

Hooded Scaly-foot are believed to be crepuscular and / or nocturnal (DSE, 2004). Surveys commenced at dusk and continued after dusk.

### Limitations and Assumptions

EcoAerial was not commissioned to undertake fieldwork until the 15 February 2022, one month prior to delivery of the technical report. The survey effort was based on the time available and focused on the fauna group considered to be of greatest risk as result of trenching for the pipeline. Reptiles were considered a priority due to being terrestrial and considered at greatest risk. Site selection was based on where suitable habitat was present on roadside reserves e.g., woody debris, leaf litter and shrubs were present.

Where native vegetation / fauna habitat adjacent to the pipeline route was present and consistent with that found within the mine tenement area, it is assumed similar fauna assemblages exist.

#### 6.3.3.3 Pipeline Alignment Option 2, Option 3 and Pump Facility

Based on feedback from the TRG, further route Options were explored. Approximately 14km of the 37km route of *Option 2* is on the same route as Option 1 i.e., pump station along Mystic Park-Beauchamp Rd to the Cumnock Rd intersection (refer to Figure 6.2). A 7km section of Mystic Park-Beauchamp Rd from the pump station to 800m west of Bartel Rd is bitumen.

Approximately 14km of the 37km route of *Option 3* is on the same route as Option 1 & 2 i.e., pump station along Mystic Park-Beauchamp Rd to the Cumnock Rd intersection (refer to Figure 6.2). A 7km section of Mystic Park-Beauchamp Rd from the pump station to 800m west of Bartel Rd is bitumen.

A fauna habitat assessment was undertaken over 3-days 28-30 June 2022. Two alternative routes were identified by arborists over 3-days in May 2022 (Treetec 2022). The objective of the assessment was to identify the route/s where the impact to the TPZ would be reduced and therefore, minimise impacts to fauna habitat. Due to the timing of the results of Arboricultural assessment (May 2022), the ecological assessment was confined to:

- habitat assessment – presence of native and non-native vegetation likely to support native fauna
- incidental observations – birds, mammals and amphibians
- bird surveys – terrestrial and water birds.

Bird surveys were undertaken on the shoreline of Kangaroo Lake based on the species accumulation method as described by Watson (2003). This method is based on survey periods of a defined length, (e.g., 5-minutes) continue until two sequential surveys fail to record any new species. The weather conditions and survey effort are provided in Table's 6.7 and 6.8.

**Table 6. 7** Detail of weather conditions

Date	Max temp	Min Temp	Rainfall mm	Cloud cover
28/06/2022	13.8	0.6	0	0
29/06/2022	11.5	1.7	0.2	8
30/06/2022	13.9	1.8	0	5

**Table 6. 8** Details of the survey method, targeted species and survey effort

Method	Species targeted	Survey effort
Habitat assessment	All fauna groups	8-person hours
Incidental observations	Birds and mammals	12-person hours
Species Accumulation Survey	Waterbirds and terrestrial birds	2.5-person hours

### Limitations and Assumptions

EcoAerial was not commissioned to undertake fieldwork until the 26 June 2022. The assessment emphasis was based on comparing fauna habitat along the two alternative pipeline routes with the original proposed pipeline route. Where similar fauna habitat was present adjacent to the pipeline routes, it was assumed fauna assemblages previously recorded within the mine tenement are present.

## 6.4 Avoidance and minimisation

### 6.4.1 Mine Tenement Area

VHM Ltd has applied the avoid and minimisation approach required by DELWP (2017) by retaining native vegetation where reasonably practicable, and otherwise by applying 25m buffers to the placement of infrastructure within the mine tenement area. These buffers have been established on advice from Nature Advisory (2022).

Mine Areas 1 and 3 were chosen for the 'Project' following extensive exploration work undertaken by VHM. The refined mining footprint has been informed by this exploration work. Further details relating to the alternative options are covered in EES Chapter 4-Project Alternatives.

Opportunities to avoid and minimise impacts to native vegetation within Mine Area 1 have been adopted and will result in the retention of 15.45 hectares of native vegetation, including 14.01 hectares of native patches and 22 scattered trees (Nature Advisory 2022).

The same approach was undertaken with Mine Site Area 3 that will result in the retention of 22.70 hectares of native vegetation, including 21.82 hectares of native patches and 17 scattered trees (Nature Advisory 2022).

### 6.4.2 Water Pipeline Supply Routes

VHM Ltd have been given permission from Gannawarra Shire Council to install the water supply pipeline within the existing road network. Approximately 30km of the route will be in the centre of gravel roads. Approximately 7km of the route will be located on the road verge. Impacts because of the construction of the pipeline is limited to the potential impact to the Tree Protection Zone. Clearing of native vegetation is confined to approx. 853<sup>2</sup> m of species associated with Plains Savannah EVC\_826 and aquatic vegetation as a result of the installation of the pump adjacent to Kangaroo Lake.

An assessment was undertaken by arborists, Tretec (2022) to evaluate the original pipeline option and identify alternative routes that will minimise impacts to fauna habitat. f canopy trees. The objective of the arborist assessment was to establish the implications on fauna habitat due to impacts to the Tree Protection Zone.

Trenching within sections of the proposed water supply alignment may cause impacts to canopy trees because of compaction and excavation within the TPZ or SRZ as defined by the Australian Standard for the protection of trees on development sites AS4970.

DELWP's (2017) Assessor's handbook, Applications to remove, destroy or lop native vegetation defines the tree protection zone as *"12 x the diameter at breast height at 1.4m above the ground and a tree or trees will be deemed lost if the encroachment into the Tree Protection Zone / Structural Root Zone is greater than 10%"*.

The TPZ applies to those canopy trees impacted and if the tree is within a patch, the understorey vegetation within the tree dripline. Any impacts to the TPZ does not entail the removal of native vegetation. Whilst canopy trees may be considered lost under Clearing of native vegetation- Biodiversity assessment guidelines (DELWP 2017b), the trees and understorey plants will be retained in-situ.

The first water supply pipeline route, Option 1, was sited to avoid, or where avoidance was not possible, minimise impacts to vegetation. This was achieved via examination of mapped native vegetation along the pipeline route based on a 1m wide pipeline trench within the existing road network.

Two alternative pipeline routes were identified by Treetec (2022) post submission of the first Technical Report Fauna to the TRG. The objective of looking at alternative routes was to assess the best option to minimise impacts to the TPZ of trees. This approach cut the impacts to canopy tree to 61 for routes Option 2 & 3 as opposed to 112 for route Option 1.

The avoid and minimise strategies implemented for native vegetation is relevant to fauna and fauna habitat.

## 6.5 Risk assessment

A risk assessment of the project was performed to prioritise the impact assessments and development of mitigation, monitoring and contingency measures. The risk assessment identified project activities with the potential to affect the environmental assets. Risks were assessed for the construction, operation and decommissioning phases of the 'Project'.

The likelihood and consequence ratings determined during the risk assessment (Appendix A) process and the adopted mitigation measures are presented in Section 13.1 and 13.2. The risk assessment has been undertaken in line with the Preparation of Work Plans and Work Plan Variations Guideline for Mining Projects December 2021 (Version 1.3).

## 6.6 Impact assessment

A change to baseline conditions caused by project activities in any of the project phases (construction, operation or decommissioning) may give rise to impacts.

The impact assessment involved identifying the severity, extent and duration of any impacts, that the project may have on the existing environment.

The significance of the impacts has been assessed in accordance with the evaluation framework, based on applicable legislation, policy and standards and the evaluation objectives and environmental significance guidelines arising from the government terms of reference established to guide the Goschen assessments.

This study has assessed the impacts of construction, operation and decommissioning of the project on vertebrate fauna, fauna habitat, and provided mitigation strategies to protect any remaining fauna habitat assets.

## 6.7 Assessment of Potential impacts on Matters of National Environmental Significance

Potential impacts on Matters of National Environmental Significance (MNES) have been assessed in line with Commonwealth regulatory requirements, including the Significant Impact Guidelines 1.1 (DoE, 2013). The assessment included a systematic evaluation of potential impacts of the project on MNES. Key steps include:

- Desktop and field-based data collection and collation, to inform and describe the existing biodiversity values, including MNES that are potentially affected by the 'Project'.
- Determination of likelihood for the potential for MNES to occur within the projects area of influence.
- Assessment of risk and impacts for relevant MNES values.

The assessment of potential impacts on MNES involved evaluation of predicted outcomes against benchmarks and significant impact criteria such as those described in applicable legislation, policy, and standards.

The EPBC Act listed, Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions (Critically Endangered) is present within the 'Project Area. This community was listed post the project being listed as a 'Controlled Action' under the EPBC Act. Under Section 158A of the EPBC Act, a listing made after the EPBC decision on 19 December 2018 cannot be assessed for that referral. Notwithstanding this determination, the potential impacts to fauna associated with this community has been considered.

Whilst consideration was given for including the information for the species and communities detailed below in Section 7, it has been included in the methods section to provide the logic as to why a significant impact test may or may not have been undertaken.

### 6.7.1 Superb Parrot (EPBC Act-Vulnerable; FFG Act-Endangered)

#### Ecology and Threats

Superb parrots breed between September and December along the Murray River (in Victoria) in areas of mature river red gum *Eucalyptus camaldulensis* (Webster 1988). The Superb Parrot depends on hollows for breeding and appears to prefer trees close to watercourses (25 m), with a large trunk diameter (diameter at breast height >1 m) and hollows in dead trees (Webster 1988; Manning, Lindenmayer and Barry 2004).

Superb parrot is now confined to Barmah Forest area with sightings south to Shepparton and east to Wangaratta and Corryong along the Murray River. Superb parrots disappeared from central and southern Victoria in the early 1900s, and most of northern Victoria by 1930 and are absent from large parts of the Riverina and northern Victoria (Australian Government, 2016).

On the inland slopes of NSW, they use at least six species of eucalyptus but are closely associated with Blakely's red gum *E. blakelyi*. It has also been suggested that Superb Parrot may have a reliance on white box *E. albens* and yellow box *E. melliodora*. Most nest sites are within 10 km of box-gum woodland and, are sometimes found within the box-gum woodland (Australian Government, 2016), refer to Figure 6.6.

After breeding, superb parrots use a variety of woodland types and other habitat types, including artificial habitats such as crops and recreation reserves. They mostly feed on the ground, where they take a variety of native and introduced seeds, but also in shrubs and trees on seeds and blossom (Australian Government, 2016).

The woodlands found in the 'Goschen Project' are confined to canopy trees associated with mallee vegetation communities e.g., red mallee *E. calycogona*, black box *E. largiflorens*, *dumosa* mallee *E. dumosa*, oil mallee *E. oleosa* and bull mallee *E. behriana* that lack the large hollow bearing trees required for breeding (Australian Government, 2016).

After breeding, superb parrots move from the breeding habitat, but habitat use and distribution from mid-January to early April is not clear. Superb parrots foraging areas are located within 10 km of breeding areas and are linked by vegetated corridors.

Parrots typically feed on the ground consuming a variety of seeds and fruits found in woodlands dominated by gum and box eucalypts along the Murray River and tributaries (Australian Government, 2016).

Major threats to the Superb Parrot include habitat clearing and degradation of box woodland throughout the species' distribution. Breeding and foraging habitats, as well as corridors of vegetation used for regular seasonal movements are now fragmented. This process and the specific combination of nesting and foraging habitat required for successful breeding significantly impacts the species, making habitats unsuitable for breeding (Webster, 1988). In addition, clearance of corridors that the species move between for breeding and non-breeding habitats are at threat. Fire also causes degradation of breeding and foraging habitats (Webster and Ahern, 1992). Other threats include grazing by stock, competition with introduced species (such as Common Starling and feral bees) for nest sites, hydrological changes such as regulation of watercourses, and collisions with vehicles when foraging on the ground along road verges (GoA 2019d).





**Photograph 1** Superb Parrot recorded from the project area.

### **Likelihood of Occurrence**

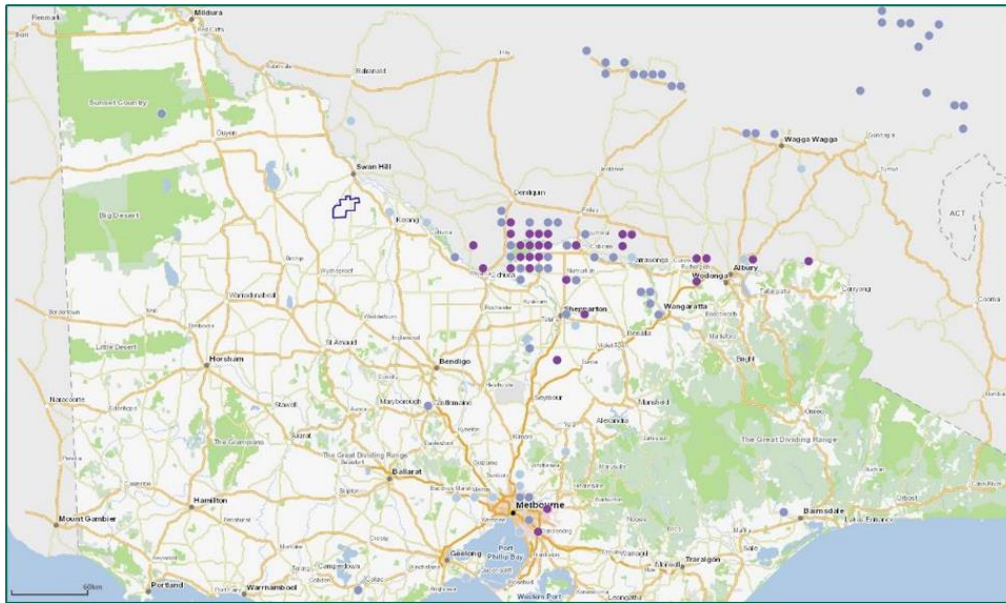
A juvenile Superb Parrot was recorded from the 'Project Area' during a 20-minute 2ha area bird survey, as per the survey guidelines for Australia's threatened birds (DEWHA 2008), in March 2018 by Ecoscape staff.

A single male individual was observed foraging in remnant vegetation along Thompson Rd. The 'Project Area' is located over 100 km to the west of the currently recognised distribution of this species. This record is thought to be an example of an individual that has dispersed away from breeding habitats during the period when the distribution and preferred habitats known (Baker-Gabb 2011). During this time individuals are likely to move along corridors of woodland.

It is expected that this individual has utilised the vegetated road corridors in this region to move away from the Murray River or nearby tributaries such as the Avoca River. A proposition was also put forward during the 30 March 2022 Technical Reference Group meeting by DELWPs Loddon Region Environmental representative, Adrian Martin. Adrian suggested it was an unusual record and the individual could have been an aviary escapee.

The Superb Parrot is unlikely to breed in the survey area. Feeding may occur on an occasional basis along the road verge and fringing crops, and is not restricted to the survey area, or the location where it was recorded. The individual is likely to be moving through the area to more suitable foraging habitat along the Murray River.

Due to the presence of an individual Superb Parrot within the mine tenement, a significant impact test was undertaken. The Significant Impact Test criteria and results of the significant impact test are provided in Section 14.1.1.



**Figure 6. 6** Regional Superb Parrot records (NatureKit 2019)



## 6.7.2 Regent Parrot (EPBC Act-Vulnerable; FFG Act-Endangered)

### Ecology and Threats

The eastern subspecies of the Regent Parrot *Polytelis anthopeplus monarchoides* is restricted to a single population in the lower Murray-Darling basin region of South Australia, New South Wales and Victoria. The eastern Regent Parrot occurs in riverine, mallee woodlands and forests and the population is estimated to be no more than 1,500 adult breeding pairs. Like the Superb Parrot, it is heavily reliant on large River Red Gum trees within the Murray Darling Basin for breeding.

Regent Parrot occurs in the lower Murray-Darling basin region of South Australia, New South Wales and Victoria with three known breeding areas:

1. Wimmera River drainage system in Victoria, predominantly in Wyperfeld National Park, Lake Albacutya and Lake Hindmarsh.
2. Lower Murray River, upstream from Swan Reach in South Australia to north-western Victoria i.e., Lindsay Island.
3. Mid Murray River in Victoria and NSW, between Red Cliffs and Piangil, including the lower Murrumbidgee and Wakool Rivers in NSW.

The Wimmera drainage population has similar traits to other breeding areas in that they have a preference for water courses and wetlands in River Red Gums. An outlying group (six pairs) was discovered breeding in Semi-arid Woodlands at the northern extent in live and dead hollow-bearing Slender Cypress Pine.

The Regent Parrot is predominantly reliant on River Red Gum forests and woodland for breeding. All known breeding colonies are located along the Murray River, Wimmera River floodplains or associated creeks and lakes. Nest trees are typically large (mean 160 cm DBH), tall (mean 28 m), mature, healthy River Red Gums with many hollows, usually close to water. Nests are mainly in hollow branches, 6–36 m above the ground.

Breeding occurs from August to December and males feed their mate near the nest hollow by regurgitation, and females do most of the feeding of young. Breeding Regent Parrots have specific biotic requirements:

- Large River Red Gums for nesting within 120 m of water
- Mallee woodlands within 20 km, ideally within 5 km of nest sites for foraging
- Vegetated flight corridors between these two habitats.

They are known to remain within the Murray-Darling Basin all year round. Some birds however may move away from their riverine breeding areas and will use mallee for foraging up to 100km from the river. Some birds remain closer to the river throughout the year.

They search for food on the ground or rest in large trees along rivers. They may travel long distances between roost sites and feeding grounds outside of the breeding season, however they are reluctant to fly over open areas. This is because they are vulnerable to predation by raptors particularly during the breeding season. Vegetated corridors between nesting and foraging sites are acknowledged as extremely important for movement. They are known to use remnant woodlands along roadsides or in farm paddocks for movement and occasionally foraging, but rarely found in extensively cleared areas. Preferred food sources are seeds,

but also known to eat buds, flowers, and occasionally insects. Most foraging occurs on the ground in mallee.

Major threats include clearing and degradation of nesting and foraging habitat, disturbance around nesting sites, competition for nest hollows, deliberate killing of birds, road kills and accidental poisoning. The main impact associated with their decline is the clearing of mallee foraging habitat within 20 km of nesting colonies along the Murray and other major rivers, removal and degradation of remnant treed vegetation along flight corridors.

### **Likelihood of Occurrence**

Roadside reserves outside of the mining tenement, where the pipeline will be constructed, was surveyed based on the species accumulation method (Watson, 2003). This method uses species diversity, an artefact of the quality of habitat, to dictate the survey effort. This was considered the best approach, along with incidental observations, given the linear non-contiguous form of roadside habitat and to ensure the survey effort was commensurate with the habitat available.

Surveys were repeated for 5-minute periods with only new species being recorded within each period. When there are two consecutive 5-minute periods of no new species, the survey ceases. Further to this a further 24-hours of diurnal incidental observations were undertaken whilst conducting surveys along the proposed pipeline routes.

The nearest recent Regent Parrot public records was three individuals 30km northwest on the Murray River at Swan Hill in 2018 (Ebird 2023) and, 50km southwest near Jill Jill where five individual were recorded in 2023 (Ebird, 2023). The Swan Hill record is likely to be birds from the Redcliffs breeding area that have followed their preferred habitat of River Red Gums along the Murray River. The Jill Jill birds are likely to be from the Wyperfeld breeding population. The location of these records is consistent with the distribution map of Baker-Gabb and Hurley (2011), refer to Figure 6.7 below.

The woodlands found in the 'Goschen Project' are confined to canopy trees associated with mallee vegetation communities e.g., red mallee *E. calycogona*, black box *E. largiflorens*, *dumosa* mallee *E. dumosa*, oil mallee *E. oleosa* and bull mallee *E. behriana*. The 'Project' area lacks the large hollow bearing River Red Gums within 120 m of water and vegetated flight corridors within 20km of the breeding areas. There is no suitable breeding habitat within the mining tenement or pipeline route.

Vegetation connectivity for foraging is well outside acknowledged flight distances of 100km from breeding areas. The Redcliffs breeding area is approx., 200km from the study area and the Wyperfeld National Park breeding area is approx. 155km. There is also a lack of canopy tree connectivity from both these sites due to larger scale clearing of vegetation because of agricultural activities and a lack continuity of canopy trees along roadside reserves.

It should also be noted that the pipeline will be placed in the middle of the existing road network and sited to avoid vegetation in line with the recommendations of the arborist assessment (Treetec 2022).

No Regent Parrot was observed over the duration of the extensive surveys in either the mine tenement or pipeline route. This is considered an artefact of the distance of the 'Project' area from the breeding areas, lack of contiguous roadside vegetation used as flight corridors and behavioural characteristics such as avoiding cleared areas and limited distances flown from their breeding area.

Based on the above information, there were no triggers to undertake a Significant Impact Test and it is considered that the 'Project' will not directly or indirectly impact on Regent Parrot.

Note: the above information was sourced from Baker-Gabb and Hurley (2011b) unless otherwise indicated. For succinctness, the authors Baker-Gabb and Hurley have referred to within Regent Honeyeater Recovery Plan have not been included within the text above.

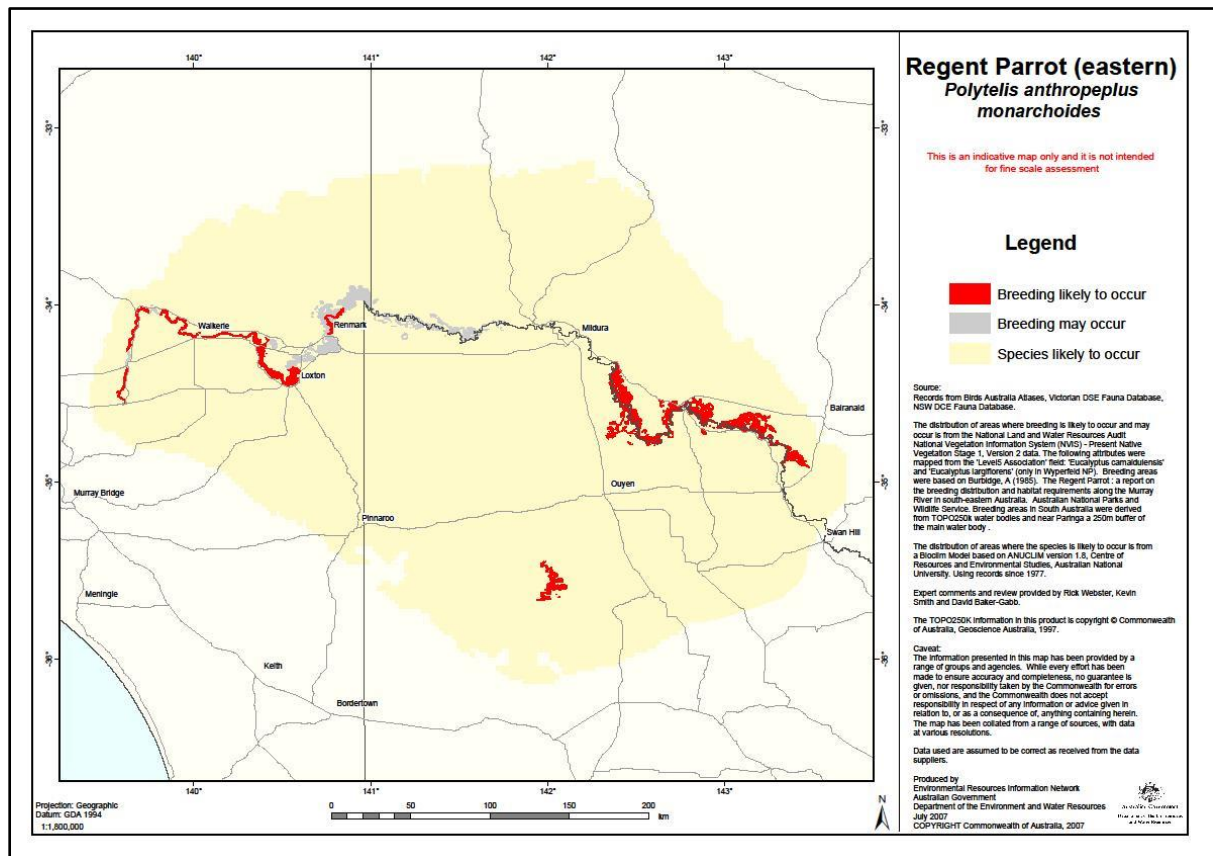


Figure 6. 7 Regent Parrot breeding areas and distribution (Baker-Gabb & Hurley 2011)

### 6.7.3 Plains-Wanderer (EPBC Act-Critically Endangered; FFG Act-Critically Endangered)

#### Ecology and Threats

Plains-wanderer exhibit very strong site fidelity behaviours with average home ranges of 12 ha with about half the home range overlapping with a bird of the opposite sex (Harrington, Maher and Baker-Gabb, 1988). Population density estimates indicate that 9 ha of suitable habitat per bird is required (Harrington, Maher and Baker-Gabb, 1988). If disturbed or displaced, Plains-wanderer are unlikely to return to previously occupied territories. Plains-wanderer breed in spring with clutches of eggs (average five eggs) laid in late August to early November however summer rains may allow a second breeding period in January or February (Harrington, Maher and Baker-Gabb, 1988; Baker-Gabb, Benshemesh and Maher, 1989).

Plains-wanderer diet comprise a mix of fallen grass, chenopod and other seeds (50-60%) and Arthropods (40-50%) with foraging behaviours occurring during the day and dawn and

dusk periods (Baker-Gabb, 1988). The diet and foraging behaviour are linked with their habitat requirements. Plains-wanderer requires bare ground to forage and vegetation clumps to provide cover (Baker-Gabb, 1988).

Major threats for the Plains-wanderer include historical loss of habitat due to clearing or overgrazing by stock. The species has a specific requirement for native grasslands and can be absent from areas where grass becomes too dense or too sparse (Australian Government & Department of the Environment and Energy, 2019c). Due to their ground dwelling behaviour, the Plains-wanderer is also particularly susceptible to predation by feral cats and foxes.

### **Likelihood of Occurrence**

Transect surveys were undertaken at the ideal time for observing Plains-wanderer; *“autumn is the time when the greatest number of juveniles can be found if there has been successful breeding during the previous spring / summer”* (Baker-Gabb et al, 2016).

Plains-wanderer were observed on Parks Victoria (PV) managed land approx. 20km from the study area over the Easter 2021 weekend (2 ~5 April 2021). The observation of adults, sub-adults and juveniles at the PV site supports the timing of the transect surveys at the study area. Figure 7.2 details the VBA records.

Of note was the extent of prey sources as likely predators of Plains-wanderer e.g., birds of prey, foxes, and feral cats. Mice and active mice nests were seen in high density throughout the study area as were rabbits. Foxes or fox activity was seen across the study area and a feral cat was seen in Area 1, refer to Figure 6.3. There would be a considerable amount of predator pressure on ground dwelling birds. Plains-wanderer are considered particularly vulnerable to predation (Birdlife Australia, 2017).

Land management is based on a continuous cycle over the course of the year. The properties within the study area run a 3 to 4-year cropping cycle of wheat and barley and on the 3 or 4<sup>th</sup> year planting a legume for nitrogen fixing in the soil. The stubble is retained for soil stabilisation.

Seeding starts early April onwards using an Air tyne seeder. Herbicide is applied before they seed and as required when the weeds grow within the crop. Fertiliser is applied when seeding occurs. Stripping usually starts in November and goes through to December using a harvester.

There is a continuous cycle of heavy vehicle / equipment activity throughout the year that is likely to limit the suitability of stubble as viable habitat for Plains-wanderer. Based on our research, there has not been a Plains-wanderer record in areas that have a continuous cycle of cropping and soil improvement.

The site managed for Plains-wanderer by PV was previously used for grazing and consists of a mixture of native grassland and introduced pasture. PV manages the site for Plains-wanderer through low pressure grazing (Anon. 2021, pers comm., 2 June).

Based on the above information, a Significant Impact Test was not required.

#### 6.7.4 Kangaroo Lake (Ramsar Wetland)

##### Ecology and Threats

Kangaroo Lake forms part of the Kerang Ramsar Wetlands (EPBC Act). Under the Ramsar Convention, Kangaroo Lake is classified as a “regulated fresh supply for irrigation” and its primary contribution to the Ramsar site is its “special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna” (Australian Government 2011).

The Ramsar convention came into being in Ramsar, Iran on 2 February 1971 and was signed by Australia in May 1974. Ramsar sites are selected based on their international significance in terms of ecology, botany, zoology, limnology and or hydrology (Australian Government 2011).

Kangaroo Lake is a major irrigation supply storage basin. High operational water levels in the lake are required to optimise water supply for regional irrigators with downstream water user demands on the Murray River. Water levels in the lake are managed to both reduce downstream flooding impacts on the Loddon River and prevent foreshore erosion (KBR 2007).

Kangaroo Lake has a surface area of approximately 984 hectares (HA) and maximum depth of 8.4 m and is one of the largest permanent freshwater lakes in the Murray-Loddon region of the Murray-Darling Drainage Division (Aquatica Environmental 2022).

The primary outflow from Kangaroo Lake is the No 7 channel and operates under the Victorian Mid-Murray Storages Plan (VMMS). Kangaroo Lake is one of the four storages that comprise the VMMS (Bailey, M. 2022, pers comm., 2 August).

Kangaroo Lake is maintained at a relatively constant water level via the Kerang Weir located at the confluence of Pyramid Creek and the Loddon River. Freshwater is supplied from diversions at the Murray River that outfalls into Pyramid Creek and flows to the Kerang Weir (Kellogg Brown and Root 2011).

The following threats to the ecological character of the Kerang Ramsar site have been identified (KBR 2011) as:

- altered watering regimes – surface water and groundwater
- climate change
- changes to level and trend in surface water quality, including salinity, nutrients, acid-sulphate soils, turbidity and pH
- loss of wetland connectivity
- bed and bank erosion
- presence of pest plants and animals
- surrounding land-use change, particularly agriculture, grazing and urban development; and
- unsustainable recreational activities.

Based on advice from the entity responsible for water management of Kangaroo Lake, a Goulburn Murray Water representative, (Bailey, M. 2022, pers comm., 2 August), it is not envisaged there will be any changes to existing water levels.

For these reasons a Significant Impact Test was not undertaken. Refer to Section 15.3.2 for details.

### 6.7.5 Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions

#### Ecology and Threats

The community is found in south-west New South Wales, north-west Victoria, and south-east South Australia. It consists of medium to tall open mallee eucalypt woodland with a canopy typically dominated by 'mallee box' (*Eucalyptus*) species with an understorey of tussock grasses, low chenopod shrubs and sparse taller shrubs. In Victoria, it occurs primarily on Woorinen Formation plains from the border with South Australia between the Little Desert and the Big Desert. It extends east to Charlton, Boort and Kerang on the southern boundary, with a northern boundary to the Murray River (Australian Government 2021a).

The prime characteristic species associated with community are *Eucalyptus porosa* (Black Mallee Box) or *E. behriana* (Bull Mallee, Broad-leaved Mallee Box). In broad terms, *E. porosa* typically occurs in the northern and western parts of the ecological community's range. *Allocasuarina luehmannii* (Buloke) and *Casuarina pauper* (Belah) can also be present (Australian Government 2021a). Threats include:

- *Clearing for agriculture*
- *Clearing for mining and quarrying*
- *Clearing for linear infrastructure*
- *Firewood removal*
- *Smaller-scale clearing and "tidying" of bushland*
- *Historic clearance of the ecological community*
- *Edge effects*
- *Grazing by livestock*
- *Altered fire regimes*
- *Invasive species- plants and fauna*
- *Changes in water availability and associated effects*
- *Climate change.*

(Australian Government 2021a)

#### Likelihood of Occurrence

This community was mapped by Nature Advisory (2022), "*where patches were of sufficient quality for listing and where Black Mallee Box, Bull Mallee, Red Mallee or Dumosa Mallee were the dominant species of Eucalyptus. The minimum patch size requirement of 0.5ha in conjunction with other nearby patches was met. It was determined to occur extensively throughout the study area*".

There were sixty-two fauna species associated with this community observed across the mine tenement and within the pipeline footprint.

A referral under the EPBC Act was undertaken for the Goschen Project in 2018 and deemed a "Controlled Action" in 2019. The *Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* (Critically Endangered) was



listed in June 2021. This community does not require assessment under the Act for areas covered by this referral.

There are 61 canopy trees considered to be impacted due to trenching in the road surface on the pipeline route. These trees are considered to form the canopy tree component of the EPBC listed *Plains Mallee box Woodland Community* and fauna habitat for species associated with this community. The 61 trees is extrapolated to an area of 4.7 ha. The trees, understorey and ground cover component remain in-situ. Fauna habitat for species associated with this community will remain in-situ.

We have assessed the impacts to fauna habitat and species associated with this community based on whether there is any direct removal and / or degradation of fauna habitat.

*“The project is not likely to result in a Significant Impact on fauna habitat for species associated with Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina, and Naracoorte Coastal Plain Bioregions.*

The implications of the impact to the 61 canopy trees / understorey associated with the pipeline route is addressed in detail in Section 9 of this report.

#### 6.7.6 Mallee Bird Community of Murray Darling Depression Bioregion

##### Ecology and Threats

The ecological community described in the conservation advice is a fauna community found in the Murray Darling Depression (MDD) bioregion. It is an assemblage of bird species that are dependent on the mallee vegetation (Australian Government 2021b).

The *Mallee Bird Community of Murray Darling Depression Bioregion* was modelled to potentially occur. The community is made up of an assemblage of 20 birds (refer to Table 7.2). Two groups are recognised within the assemblage, specialists, and dependents (AG 2021b).

**Mallee specialists.** Bird species found almost exclusively in mallee habitats, especially within the Murray Darling Basin bioregion. The group comprises eight bird species, all of which are recognised as threatened by at least two State jurisdictions, with five taxa listed as nationally threatened.

*The loss of suitable mallee habitats for these birds can potentially lead to their extinction, certainly at a local or regional scale (Australian Government 2021b).*

**Mallee dependents.** Bird species that are dependent on mallee but can extend into non-mallee woodland and shrubland habitats. The group comprises twelve bird species, five are recognised as threatened in at least one State jurisdiction, and one – the Regent Parrot – is listed as nationally vulnerable.

*The loss of all suitable mallee habitats for these species may not necessarily lead to extinction but could result in substantial declines in abundance in the MDD, as well as loss of ecological diversity in the assemblage (Australian Government 2021b).*

##### Likelihood of Occurrence

Six mallee dependent birds of the twenty species associated with the *Mallee Bird Community of Murray Darling Depression Bioregion* were recorded during field surveys and desktop

reviews, all of which are non-threatened species. We also note that five of the six mallee dependent species are relatively more abundant i.e., Jacky Winter, Spotted Pardalote, White-eared Honeyeater, White-fronted Honeyeater and Yellow-plumed Honeyeater. Splendid Fairy-wren is the species not considered as relatively abundant (Australian Government 2021b).

Section 2.2 of Conservation Advice (Australian Government 2021b) provides the thresholds required to meet the criteria. The location is within the area described in the conservation advice as is the presence of mallee habitat. The presence of 6 mallee dependant species did not meet the threshold of 3 categories:

Category A: At least 5 MBC species, any mix of mallee specialist and dependant species. Note we have interpreted this statement that it requires a mix of both specialist and dependent species.

Category B: 3 to 4 MBC species including at least one mallee specialist species. No mallee specialist species are present based on field surveys or curated database records.

Category C: 3 to 4 MBC plus 5 mallee associated thresholds. Five mallee associated species as per the conservation advice were present based on field surveys or curated database records.

Category D: 3 to 4 MBC species and at least 20 or more terrestrial species, as defined in the survey guidelines in Section 2.3.1. Category D is borderline when species exempted as per the conservation advice, (Section 2.2), are excluded. If, other common / widely distributed species such as Red-rumped Parrot, Musk Lorikeet, Superb Fairy-wren, , Buff-rumped Thornbill, Grey Currawong, Black-faced Cuckoo-shrike, Grey Shrike-thrush etc were excluded, it would not meet the threshold.

*The bird species assemblage recorded in the 'Project Area' does meet the threshold for this community.*

A Significant Impact Test was not undertaken as the listing of this community is post the Projects being deemed a '*Controlled Action*'. Notwithstanding this, impacts to birds within this community have been considered with the avoid and minimise approach in relation to fauna habitat and implications of mitigation strategies.

## 6.8 Linkages to other technical reports

This report has interdependencies with:

1. *Spectrum Ecology / EcoAerial 2022 - Vertebrate Fauna Study.* \*
2. *EcoAerial 2021 – Plains-wanderer Technical Study.*
3. *Nature Advisory 2022 – Flora Vegetation Technical Study.*
4. *Treetec Professional Tree Services 2022 – Preliminary Arboricultural Impact Assessment*
5. *Aquatica Environmental 2022 - Aquatic Ecology Report for Kangaroo Lake Draft V1.*

\* Note this report in a consolidated report incorporating data from the Ecology and Heritage Partners (2018), Ecoscape Australia (2018) and Spectrum Ecology (2019) reports.

The above reports were reviewed to understand the extent of native fauna and fauna habitat present with the mine tenement and water supply pipeline footprint. The reports provided the following information:



1. Records of threatened fauna and / or if habitat likely to support threatened fauna is present.
2. Records of non-threatened species
3. Potential impacts of fauna habitat on road reserves adjacent to the proposed pipeline alignment due to impacts to the tree protection zone of canopy trees.
4. Fragmentation of vegetation corridors as result of native vegetation impacts.
5. Changes to the ecological character of Kangaroo Lake as an artefact of water extraction.

EcoAerial was responsible for evaluating the potential impacts and designing suitable mitigation measures to be adopted for the project based on reviewing the results of the above reports

## 7 Results

### 7.1 Existing Environment

The 'Project' is in the Interim Biogeographic Regionalisation Australia (IBRA7) Murray Darling Depression Bioregion (MDD7) located in the north west of Victoria (Thackway and Cresswell, 1995). The vegetation is dominated by East/West-Dune Mallee with some Chenopod Mallee and Shallow-Sand Mallee. The vegetation is dominated by Gypseous Plains Shrubland, Saline Shrubland (Raak), Plains Grassland and Drainage-line Grassy Woodland. The Murray Mallee bioregion has few surface water bodies due to highly permeable soils and climatic conditions.

#### 7.1.1 Native vegetation

The 'Project Area' including the pipeline routes covers two state bioregions: Murray Mallee to the west of Mystic Park-Beauchamp Rd and Victorian Riverina to the east. Nature Advisory has mapped six Ecological Vegetation Classes within the mine tenement and pipeline options (EVC's):

- Chenopod Grassland EVC\_829 (Endangered): 0.1 ha
- Plain's Savannah EVC\_826 (Endangered): 9.70 ha
- Woorinen Mallee EVC\_824 (Vulnerable): 429.85 ha
- Ridged Plains Mallee EVC\_96 (Endangered): 42.52 ha
- Riverine Chenopod Woodland EVC\_103 (Vulnerable): 56.87 ha.
- Semi-arid Woodland EVC\_97 (Vulnerable) 2.5 ha.

Woorinen Mallee EVC\_824 was the most prevalent vegetation community recorded with patches of remnant vegetation located amongst the agricultural land and as remnant vegetation located along the road reserves (Ecoscape Australia, 2018). The vegetation is characterised by Red Mallee (*Eucalyptus calycogona*), Dumosa Mallee (*E. dumosa*) Oil Mallee (*E. oleosa*) and Bull Mallee (*E. behriana*) open woodland with occasional sparse understorey of *Acacia oswaldii*. The groundcover is seasonal and sparse, consisting of mixed native grasses and a variety of weed species. The roadside reserves also had areas of Riverine Chenopod Woodland EVC\_103 and Plains Savannah EVC\_826. The Nature Advisory report (2022) provides details of the mapped Ecological Vegetation Classes present across the 'Project Area' and pipeline route options. Refer to Nature Advisory Flora Technical Report (2022) for vegetation mapping.

The open woodland provides relatively complex structural layers, tall canopy, low dense shrubs, and open areas. This complexity provides suitable microhabitats for a variety of bird species with populations moving across the landscape. The open understorey and the presence of abundant feral species limits the habitats suitability for small terrestrial mammals, reptiles, and frogs.

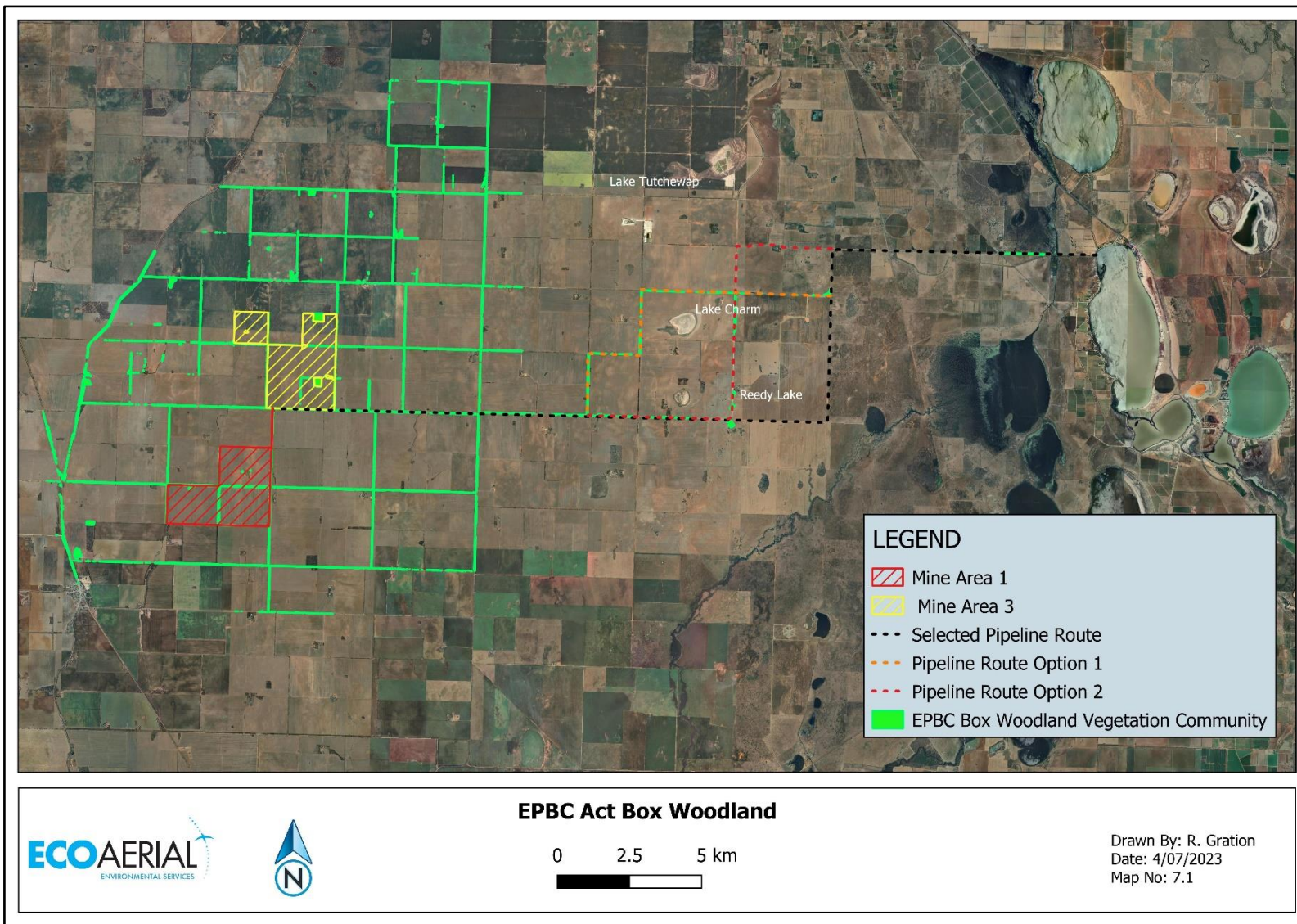
A section of Mystic Park – Beauchamp Rd mapped as Riverine Chenopod Woodland EVC\_103 was absent of canopy trees however shrubs and the ground cover component were present. This area was considered habitat with the potential to support the FFG listed Samphire Skink, (refer to Figure 7.3).

### 7.1.2 Threatened vegetation communities

One EPBC Act community has been identified within / or adjacent to the project footprint; *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina, and Naracoorte Coastal Plain Bioregions* (Critically Endangered), refer to Figure 7.1.

There are 220 species of fauna associated with this community (AG 2021a). Sixty-two fauna species have been recorded across the 'Project' area where the community is present.

Nature Advisory (2022) have also mapped small, isolated patches of one FFG Act listed community; *Semi-arid Shrubby Pine-Buloke Woodland Community*. This community is an open woodland or woodland community composed of a mix of slender cypress-pine Buloke and shrub layer of widespread species such as Ruby Saltbush Slender or Narrow-leaf Hop-bush and Weeping Pittosporum. The community is associated with the EPBC Act-listed community *Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions* (Nature Advisory 2022). These patches will be retained. There are no fauna assemblages outlined in the description of this community (DELWP 2022).



**Figure 7. 1** Plains Mallee Box Woodlands of the Murray Darling Depression, Riverina, and Naracoorte Coastal Plain Bioregions

### 7.1.3 Land use and disturbance history

The 'Project' area is located amongst extensively cleared agricultural land which is used for primary production. Approximately 70 per cent of Victoria's mallee vegetation has been cleared as a direct consequence of farming practices. The 1930s saw a part of the Victorian Mallee become one of the worst wind eroded areas in Australia (Thackway and Cresswell, 1995). Substantial areas of mallee remain today in the western aeolian dunes, mainly in South Australia and western NSW. Clearing has also been widespread in the north eastern portion of the bioregion in NSW particularly on the undulating plains and relict river channels and lakes associated with the Murray and Darling Rivers (Thackway and Cresswell, 1995).

## 7.2 Fauna

The desktop reviews recorded twenty-two mammal (fifteen native and seven introduced), 187 bird (181 native and six introduced), 12 reptile and one amphibian species in the mine tenement and pipeline study area (Spectrum Ecology / EcoAerial 2022).

Nineteen mammal (eight native and eleven introduced), 283 bird (272 native and eleven introduced), eighteen reptiles, nine amphibians and twenty fish (fourteen native and six introduced) species have been recorded from the Kerang Wetlands that also encompasses Kangaroo Lake. Many of the species identified are water dependant species, however a relatively high number of mallee and grassland species were also observed during surveys undertaken in June 22. The Kerang Wetlands includes a diverse range of fauna habitats that can support a wide variety of species (Spectrum Ecology / EcoAerial 2022).

Refer to Appendix B for desktop review results.

### 7.2.1 Conservation Significant Fauna

The desktop review of the PMST and VBA indicates the likelihood of twenty-nine conservation significant species. Thirteen listed under the EPBC Act are potentially present, they include three Critically Endangered, one Endangered, seven Vulnerable and two Migratory listed species. Twenty-eight conservation significant species are listed as threatened under the FFG Act.

Sixty-four species associated with the EPBC listed *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina, and Naracoorte Coastal Plain Bioregions* and, six non-threatened species associated with the EPBC listed *Mallee Bird Community of Murray Darling Depression Bioregion* and, FFG listed *Victorian Mallee Bird Community* are known to occur.

A list of vertebrate fauna species of conservation significance is listed in Table 7.1 for the mine tenement, pipeline routes and Kangaroo Lake. The likelihood of occurrence was determined based on the criteria outlined in Table 6.1. Eleven species are considered to have a low likelihood of occurring, twelve are considered to have a medium likelihood of occurring and six are considered a high likelihood of occurring, four of which were recorded during surveys within in the 'Project Area':

1. *Eastern Great Egret*: FFG Act - Vulnerable.
2. *Superb Parrot*: EPBC Act – Vulnerable; FFG Act - Vulnerable
3. *Black Falcon*: FFG Act – Critically Endangered
4. *Eastern Bearded Dragon*: FFG Act – Vulnerable.

Surveys for Plains-wanderer failed to record their presence. Historical records are shown in Figure 7.2. The summary of the field assessment outcomes is provided below:

- Only common birds known to use derived grasslands and cropped areas were observed. No Plains wanderer were observed.
- Sound recorders recorded only common, non-threatened avifauna. No Plains-wanderer were recorded.
- All paddocks lacked the native / non-native vegetation habitat structure required to support Plains-wanderer.
- All paddocks had evidence of field mice, burrows and, rabbits encouraging high levels of predator activity.
- Birds of prey, foxes and a feral cat were observed within the study area. "Plains-wanderer are considered vulnerable to predation" (Birdlife Australia, 2017).
- The study area has high levels of intensive land management not conducive to support Plains-wanderer habitat (Birdlife Australia, 2017) e.g., cropping cycle of cultivation, seeding, herbicide / pesticide application and crop stripping using heavy vehicles.

Habitat for the FFG listed Samphire Skink is considered present on Mystic Park-Beauchamp Rd, refer to Figure 7.3

Conservation significant species associated with *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina, and Naracoorte Coastal Plain Bioregions* and, species associated with the EPBC listed *Mallee Bird Community of Murray Darling Depression Bioregion* are detailed in Table 7.1.



**Table 7. 1** Conservation Significant Species

Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Mammals								
Corben's Long-eared Bat ( <i>Nyctophilus corbeni</i> )	VU	T	Large woodlands and forests with dense understorey.	-	*	Low Preferred habitat limited and very fragmented in region, no desktop records.	N/A	N/A
Birds								
Curlew Sandpiper ( <i>Calidris ferruginea</i> )	CE	CE	Forages on exposed intertidal mudflats and occasionally on inland freshwater wetlands	*	*	Medium Preferred habitat limited and very fragmented in region, Most recent database records are; 2020 Bael Bael; 2018 at Lake Kelly, Lake Tutchewop-- Northern End and Cullens Lake Wildlife Reserve.	N/A	N/A
Eastern Curlew ( <i>Numenius madagascariensis</i> )	CE	CE	Occurs on exposed intertidal mudflats and occasionally fresh brackish lakes.	*	*	Low Preferred habitat limited and very fragmented in region, no recent desktop records.	N/A	N/A

Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Eastern Great Egret ( <i>Ardea modesta</i> )	-	VU	Feeds in open shallows up to 30cm and in wet pasture, mangroves, and mudflats.	*	*	<b>Recorded</b> One individual recorded from the study area during the June 2022 survey (EcoAerial 2018).	N/A	N/A
Freckled Duck ( <i>Stictonetta naevosa</i> )	-	EN	Feeds in shallow water dabbling and / or filtering crustaceans aquatic seeds and grasses	*	-	<b>High</b> Suitable habitat present, most recent record in 2020 at Lake Charm.	N/A	N/A
Australasian Bittern ( <i>Botaurus poiciloptilus</i> )	END	CE	Prefers vegetated shallow freshwater and brackish swamps.	*	*	<b>Recorded</b> Suitable habitat present, recorded from the study area, some regional records.	N/A	N/A
Australian Painted-snipe ( <i>Rostratula australis</i> )	END	CE	Prefers and breeds in freshwater marshes with temporary water regimes.	*	*	<b>Low</b> No suitable habitat. Remnant habitat present is too open, desktop record 1912.	N/A	N/A
Plains-wanderer ( <i>Pedionomus torquata</i> )	CR	CE	Native grasslands with a suitable mix of vegetation and bare ground.	*	*	<b>Low</b> No suitable habitat present. Some suitable areas to the east of the study area.	N/A	✓
Malleefowl ( <i>Leipoa ocellata</i> )	VU	VU	Dense shrubland and woodland dominated by mallee and wattle species.	-	*	<b>Low</b> No suitable habitat. Remnant habitat present is too open, no desktop records.	✓	✓



Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Diamond Dove ( <i>Geopelia cuneata</i> )	-	VU	Variety of habitats, grassy woodlands, semi-arid grasslands, spinifex and dry mulga	*	*	<b>Low</b> Limited suitable habitat. Not recorded since 1981.	N/A	✓
Superb Parrot ( <i>Polytelis swainsoni</i> )	VU	EN	Variety of habitats, typically forested areas, and adjacent grasslands for foraging	-	-	<b>Recorded</b> One individual recorded from the study area during the initial targeted survey (Ecoscape 2018).	N/A	N/A
Regent Parrot (eastern) ( <i>Polytelis anthopeplus monarchoides</i> )	VU	VU	Riparian vegetation with River Red Gum and adjacent Black Box woodland. Also, farmland with remnant roadside woodland.	-	*	<b>Medium</b> Study area on eastern edge of species' dispersal range; dispersing individuals may pass through study area. No desktop records.	✓	N/A
Painted Honeyeater ( <i>Grantiella picta</i> )	VU	VU	Dry open forest and woodland associated with mistletoe, rivers, plains, and farmland.	-	*	<b>Medium</b> Some suitable habitat present and study area within distribution, no desktop records.	N/A	N/A
Night Parrot ( <i>Pezoporus occidentalis</i> )	EN		Long unburnt spinifex and chenopods in association with salt lakes.	-	* (Locally extinct)	<b>Very Low</b> Study area outside species' known range, no suitable habitat, no regional records.	N/A	N/A

Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Satin Flycatcher ( <i>Myiagra cyanoleuca</i> )	Mi		Heavily vegetated eucalypt forests and tall woodlands, also coastal forests, mangroves, and drier woodlands during migration.	-	*	<b>Low</b> No suitable habitat, no desktop records.	N/A	N/A
Yellow Wagtail ( <i>Motacilla flava</i> )	Mi		Damp or wet habitats, meadows, hay fields, grassy tundras, and marshes.	-	*	<b>Low</b> No suitable habitat due to farmland dominated habitats, no desktop records.	N/A	N/A
Australian Bustard ( <i>Ardeotis australis</i> )		CE	Open grasslands and shrublands across Australia.	*	-	<b>Medium</b> Will utilise remnant mallee habitats and open agricultural areas on occasion, some regional records.	N/A	✓
Grey-crowned Babbler ( <i>Pomastostomus temporalis temporalis</i> )		VU	Open forests and woodlands, little ground cover with plenty of fallen timber and leaf litter.	*	-	<b>Medium</b> Remnant mallee habitats are suitable and previous records adjacent to study area.	N/A	✓
Bush Stone-curlew ( <i>Burhinus grallarius</i> )		CE	Farmlands and grassy woodlands. Often shelters in dense vegetation	*	-	<b>Medium</b> Remnant mallee habitats may provide suitable conditions. Previous records adjacent to study area.	N/A	✓

Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Grey Falcon ( <i>Falco hypoleucos</i> )		VU	Variety of habitats across arid areas of Australia. Lightly treed inland plains	*	-	<b>Low</b> Rarely recorded and not typically associated with agricultural landscapes.	N/A	✓
Ground Cuckoo-shrike ( <i>Coracina maxima</i> )		EN	Variety of open woodlands and shrublands.	*	-	<b>Medium</b> Suitable habitat present, study area in species' distribution, some regional records.	N/A	N/A
Black Falcon ( <i>Falco subniger</i> )		CE	Tree-lined watercourses and isolated woodlands.	*	-	<b>Recorded</b> Suitable habitat present, recorded from the study area, some regional records.	N/A	N/A
Diamond Firetail ( <i>Stagonopleura guttata</i> )		VU	Grassy woodlands, heath, and farmland with scattered trees.	*	-	<b>High</b> Suitable habitat present, study area in species' distribution, some regional records.	N/A	✓
Hooded Robin ( <i>Melanodryas cucullate</i> )		VU	Open forests, acacia shrubland and mallee, preferably diverse.	*	-	<b>Medium</b> Some suitable habitats present. Study area in species' distribution, some regional records.	N/A	✓

Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Inland Dotteral ( <i>Peltohyas australis</i> )		VU	Dry, flat, open landscapes, such as stony gibber plains, claypans and gravel flats, usually with some sparse, stunted saltbush or bluebush	*	-	Low No suitable habitat, or in species distribution.	N/A	N/A
<b>Reptiles</b>								
Pink-tailed Legless Lizard ( <i>Aprasia parapulchella</i> )	VU	EN	Well drained rocky areas in open woodlands with grassy understory	-	*	Low No suitable habitat, no desktop records	N/A	N/A
Samphire Skink ( <i>Morethia adelaidensis</i> )		EN	Inhabits saline or gypseous areas on the margins of freshwater lakes in samphire and chenopod scrublands.	*	-	Medium Suitable habitat present, adjacent to pipeline alignment on Mystic-Park-Beauchamp Rd. Recent regional record 2018.	N/A	✓
Hooded Scaly-foot ( <i>Pygopus schraderi</i> )		CE	Variety of habitats including stony plains, dry woodlands, mallee, and mulga shrublands. Also, spinifex dominated desert grasslands.	*	-	Medium Suitable habitat present, adjacent to pipeline alignment. Recent regional record 2018.	N/A	N/A

Species	Conservation Status		Habitat Preference	Record Source		Likelihood of Occurrence	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act		Desktop	PMST			
Carpet Python ( <i>Morelia spilota metcalfei</i> )		EN	Riverine habitats and rocky areas in mallee shrubland, Callitris woodland and freshwater swamps. High density rabbit populations can attract the species.	*	-	<b>Medium</b> May occur when rabbit density is high, habitat is present and few regional records. Last recorded in 1/01/1993, approx., 17km south of project area near Sand Hills Lake	N/A	N/A
Eastern Bearded Dragon ( <i>Pogona barbata</i> )		VU	Dry woodlands, agricultural land and urban areas.	*	-	<b>Recorded</b> Suitable habitat present, recorded from study area during multiple surveys, regional records.	N/A	N/A
<b>Amphibians</b>								
Growling Grass Frog ( <i>Litoria raniformis</i> )	VU	VU	In vegetation around slow flowing or still water bodies such as lagoons, swamps, lakes and ponds. Typically, in bulrush, reeds and sedges.	*	*	<b>Medium</b> Suitable habitat present within Kangaroo Lake with historical regional records. <i>Assumed present.</i>	N/A	N/A

Legend: \* = Species was referred to during desktop review process. - = Species was not referred to in reports / documents reviewed during desktop review process.



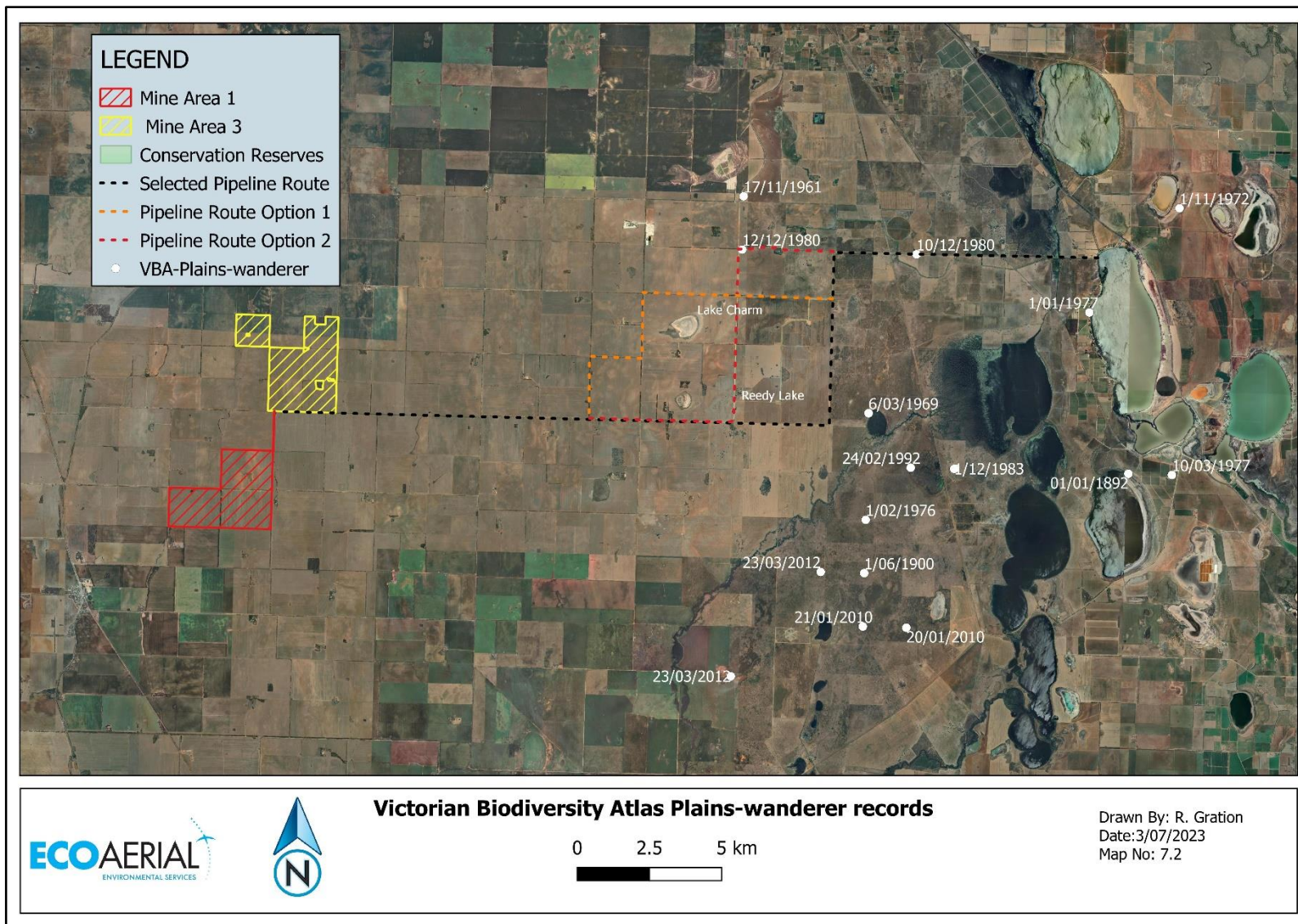


Figure 7. 2 Plains-wanderer VBA records





**Figure 7. 3** Samphire Skink habitat

### 7.3 Fauna Habitats

The fauna assessment undertaken by Ecoscape Australia (2018) identified three broad habitat types within the study area: Agricultural Land, Mallee Woodland and Salt Lake. The agricultural land is the most common habitat type in the study area and covers approx., 20,000ha. The mallee woodland habitat occurs as remnant vegetation along the road reserves and in small pockets of uncleared remnant vegetation.

Whilst cropped paddocks can provide fauna habitat, typically for common species, fauna habitat in this report refers to native vegetation that provides the relevant resources for fauna to successfully breed, forage and disperse.

The Nature Advisory report (2022) details the ground truthed Ecological Vegetation Classes (EVC's) present throughout the 'Project' area. The extent of EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions* is provided in Figure 7.1. A total of 541 ha of native vegetation / fauna habitat was mapped by Nature Advisory (2022) across the mine areas and roadside reserves.

#### 7.3.1 Mine Tenement

Fauna habitat within the mine tenement was confined to fencelines, road reserves and several small patches extending into paddocks (refer to Photograph 2). Nature Advisory (2022) document the principal vegetation community was Woorinen Mallee EVC\_ 824 (430 ha). This EVC is consistent with EPBC Act listed community, *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions*. Fauna species associated with the EPBC community were recorded during the various fauna surveys. Further details are provided in Section 7.4.1.

Mine Area 1 will retain 15.44 hectares of native vegetation, including 22 scattered trees. Opportunities to avoid and minimise impacts to native vegetation within Mine Site Area 3 will retain 22.70 hectares of native vegetation and 17 scattered trees.



**Photograph 2** Example of patch in paddock and trees on fenceline.



### 7.3.2 Pipeline Route Options

Approximately 30km of the 38km pipeline route will be undertaken within the middle of the existing road network on gravel roads. Seven kilometres will be trenched on the northern road verge where bitumen is present along Mystic Park – Beauchamp Rd starting at Kangaroo Lake heading west.

Treetec undertook an assessment of Option 1 and provided advice on two alternative options. The three route options converge at various locations, (refer to Figure 6.2).

The pipeline routes were assessed, with the aim of avoiding or minimising the removal and / or impacts to native vegetation / fauna habitat. Impacts to native vegetation / fauna habitat along the three pipelines options is because of trenching within the TPZ of canopy trees. Fauna habitat will remain in-situ.

Where canopy trees / fauna habitat was present on the road reserves within each of the route options, they meet the description of EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions* (refer to Figure 7.1). Fauna associated with this community were recorded during the various surveys on all 3 route options.

Photograph 3 shows the section of bitumen road relevant to Options 1, 2 & 3. Native vegetation / fauna habitat is highly degraded on the northern side of the road seen on left of photograph. The opposite side of road is habitat with the potential to support the FFG Act listed Samphire Skink (refer to Photograph 4). Photograph 5 is indicative of the degraded habitat on the road reserve along Option 3. Photograph 6 is indicative of native vegetation on the road reserve of Mystic Park-Beauchamp Rd prior to joining Option 1. Photograph 7 is indicative of where the 3 route options converge.



**Photograph 3** Section of bitumen road on Mystic Park-Beauchamp Rd east of Bael Bael Rd



**Photograph 4** Potential Samphire Skink habitat on southern side of Mystic Park – Beauchamp Road



**Photograph 5** Indicative habitat on Pipeline Route Option 3- Lookout Rd and Teagues Rd.





**Photograph 6** Indicative of habitat on Pipeline Route Option 2- Mystic Park-Beauchamp Rd, North / South



**Photograph 7** Indicative habitat near where Options 1, 2 & 3 merge on Mystic Park Beauchamp Rd

### 7.3.3 Agricultural Land

The majority of the study area is dominated by agricultural land (Ecoscape Australia, 2018). This habitat type is of low value for native fauna species due to the homogeneity of the vegetation and the high level of habitat degradation and impact. The availability of resources (food and shelter) is linked to the crop that is present with farming practices (ploughing, seeding, fertiliser & herbicide application and harvesting) creating regular periods of direct impact to any fauna species present. All the agricultural is used for cropping with no pastures (grasslands) observed. Agricultural land is an ever-changing fauna habitat type that provides temporary resources to generally opportunistic fauna species.

### 7.3.4 Threatened fauna communities

The EPBC listed *Mallee Bird Community of the Murray Darling Depression Bioregion* was modelled to potentially occur in the region. The *Mallee Bird Community* consists of an assemblage of 20 birds that are reliant on mallee habitat to persist, refer to Table 7.2. The bird assemblage is also consistent with the FFG Act listed Victorian Mallee Bird Community.

**Table 7. 2** Mallee Bird Community of Murray Darling Depression Bioregion

Common name	Species name	EPBC status	Vic. Status	FFG Act Mallee bird Community
<b>Mallee Specialist</b>				
Black-eared Miner	<i>Manorina melanotis</i>	E	CE	MD
Chestnut Quail-thrush	<i>Cinclosoma castanotum</i>		NT	MD - ssp <i>castanotus</i>
Mallee Emu-wren	<i>Stipiturus mallee</i>	E	E	MD
Malleefowl	<i>Leipoa ocellata</i>	V	E	MD
Red-fored Whistler	<i>Pachycephala rufogularis</i>	V	E	MD
Scarlet-chested Parrot	<i>Neophema splendida</i>		V	
Striated Grasswren	<i>Amytornis striatus</i>		NT	MD
Mallee Western Whipbird	<i>Psophodes nigrogularis</i>	V	CE	MD – ssp <i>leucogaster</i>
<b>Mallee Dependent</b>				
Crested Bellbird	<i>Oreoica gutturalis</i>		NT	MA – ssp <i>gutturalis</i>
Grey-fronted Honeyeater	<i>Ptilotula plumula</i>		V	MD – ssp <i>graingeri</i>
Jacky Winter	<i>Microeca fascians</i>			MD – ssp <i>assimilis</i>
Purple-gaped Honeyeater	<i>Lichenostomus cratitius</i>		V	MD
Regent Parrot	<i>Polytelis anthopeplus</i>	V	V	MD – ssp <i>monarchoides</i>
Shy Heathwren	<i>Calamanthus cautus</i>			MD – ssp <i>cautus</i>
Southern Scrub-robin	<i>Drymodes brunneopygia</i>			MD
Splendid Fairy-wren	<i>Malurus splendens</i>			MD
Spotted Pardalote	<i>Pardalotus punctatus</i>			MD – ssp <i>xanthopyge</i>
White-eared Honeyeater	<i>Nesoptilotis leucotis</i>			MD – ssp <i>novaenorca</i>
White-fronted Honeyeater	<i>Purnella albifrons</i>			MA
Yellow-plumed Honeyeater	<i>Ptilotula ornata</i>			MD

(AG 2021b). MD= Mallee Dependent; MA= Mallee Associated

Six birds associated with the community were recorded over the duration of all surveys, none of which are listed as threatened at a state or commonwealth level.

1. Jacky Winter
2. Splendid Fairy-wren

3. Spotted Pardalote
4. White-fronted Honeyeater
5. White-eared Honeyeater
6. Yellow-plumed Honeyeater.

It is considered that the Category D threshold meets the criteria of the *Mallee Bird Community of the Murray Darling Depression Bioregion*. Refer to Section 6.7.5 for assessment against the Category D threshold.

The FFG listed *Victorian Mallee Bird Community* aligns with the EPBC Mallee Bird Community except it consist of an assemblage of 25 birds. The habitat within the 'Project Area' is unlikely to support the assemblage of 25 birds to meet the criteria of the *Victorian Mallee Bird Community*.

Kangaroo Lake is one of the largest permanent freshwater lakes supplied by the Torrumbarry Irrigation System and forms part of the *Kerang Ramsar Wetlands*. It is on the western side of the Murray Valley Highway and approximately 19km northwest of Kerang and 30km southeast of Swan Hill. Kangaroo Lake is connected to the system via the No. 7 channel and continues northwards from Kangaroo Lake and feeding into the Little River Murray at Fish Point.

Kangaroo Lake is part of the Victorian Mid Murray Storages (VMMS) project and under normal climatic conditions held at its normal operating level during February to enable it to supply Torrumbarry System irrigation demands. Discharges occur during the later months of the irrigation season, i.e., March and April (GMW 2022). The lake is also used for recreational purposes such as fishing and boating.

Kangaroo Lake is a major irrigation supply storage basin with high operational water levels required in the lake to optimise water supply for regional irrigators with downstream water user demands on the Murray River. Water levels in the lake are managed to both reduce downstream flooding impacts on the Loddon River and prevent foreshore erosion (KBR 2011).

Kangaroo Lake has significant environmental values and forms part of the Kerang Wetland Ramsar area. It is known to support flocks of up to 1,000 of the FFG listed (Vulnerable) blue-billed duck (*Oxyura australis*) and 30 species of waterbird (refer to Appendix 2). Records of the EPBC / FFG Act listed Australasian Bittern and Australian Painted-snipe are provided in Figure 7.4 and Figure 7.5.

Notwithstanding two historical records for Curlew Sandpiper at Kangaroo Lake in 1977, (refer to Figure 7.4), habitat at Kangaroo Lake is marginal due to the high-water levels maintained within lake, there is limited areas suitable for smaller waders. "*Deep, open water habitat provides habitat for diving and dabbling ducks and it is these open expanses of water that can provide refuge habitat during moult of primary flight feathers (Butcher and Hale 2016).*" Wader habitat is primarily confined to an isthmus in the southern section of the lake where the littoral zone has a gradient into the lake. Kangaroo Lake is also a recreational lake supporting boating activities such as water-skiing, jet ski's and fishing. These activities primary occur over the spring / summer when waders are in Australia and have a high degree of disturbance due to noise and wave action on the shoreline from the wake of boats.

Any action that has the potential to affect the ecological character of a declared Ramsar wetland has the potential to be a controlling provision under the EPBC Act. The key risks



which threaten the environmental values of Ramsar wetlands include altered water regimes; salinity; pollution; pest plants and animals; resource utilisation; recreation and erosion. These risks can be an artifact of activities in the site wetlands, on land adjacent and in the wetlands' catchments. Any development application should therefore consider and address the risks identified above (PB 2013).

The proposed new pump area will potentially entail the removal of native vegetation / fauna habitat on the road reserve and extraction of water has the potential to alter the existing baseline conditions. Changes to the hydrology also has the potential to impact on aquatic vegetation and conditions suitable for water dependant fauna. An assessment of these potential impacts is discussed in detail in Section 14.1.1 and Section 15.3.2.

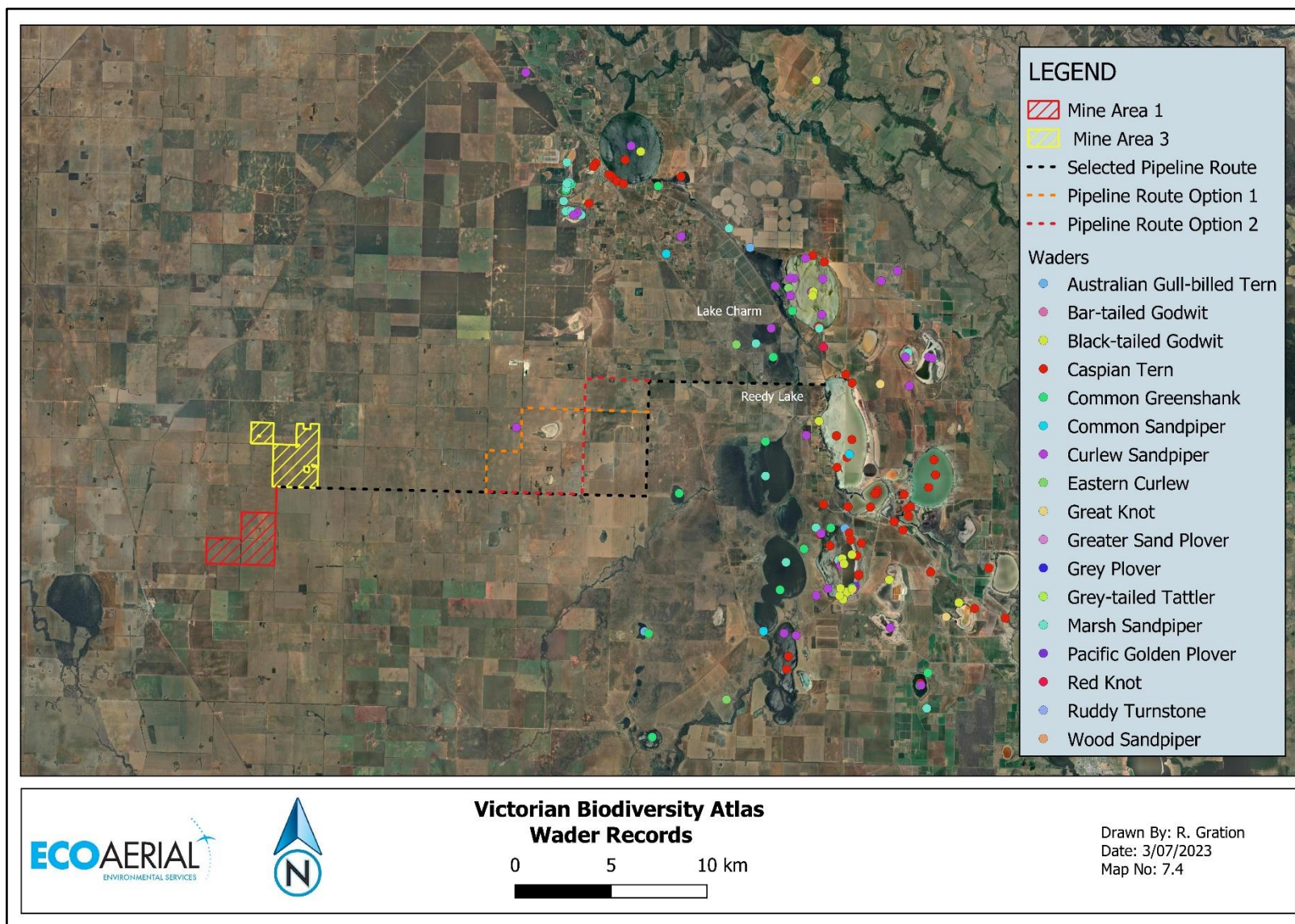
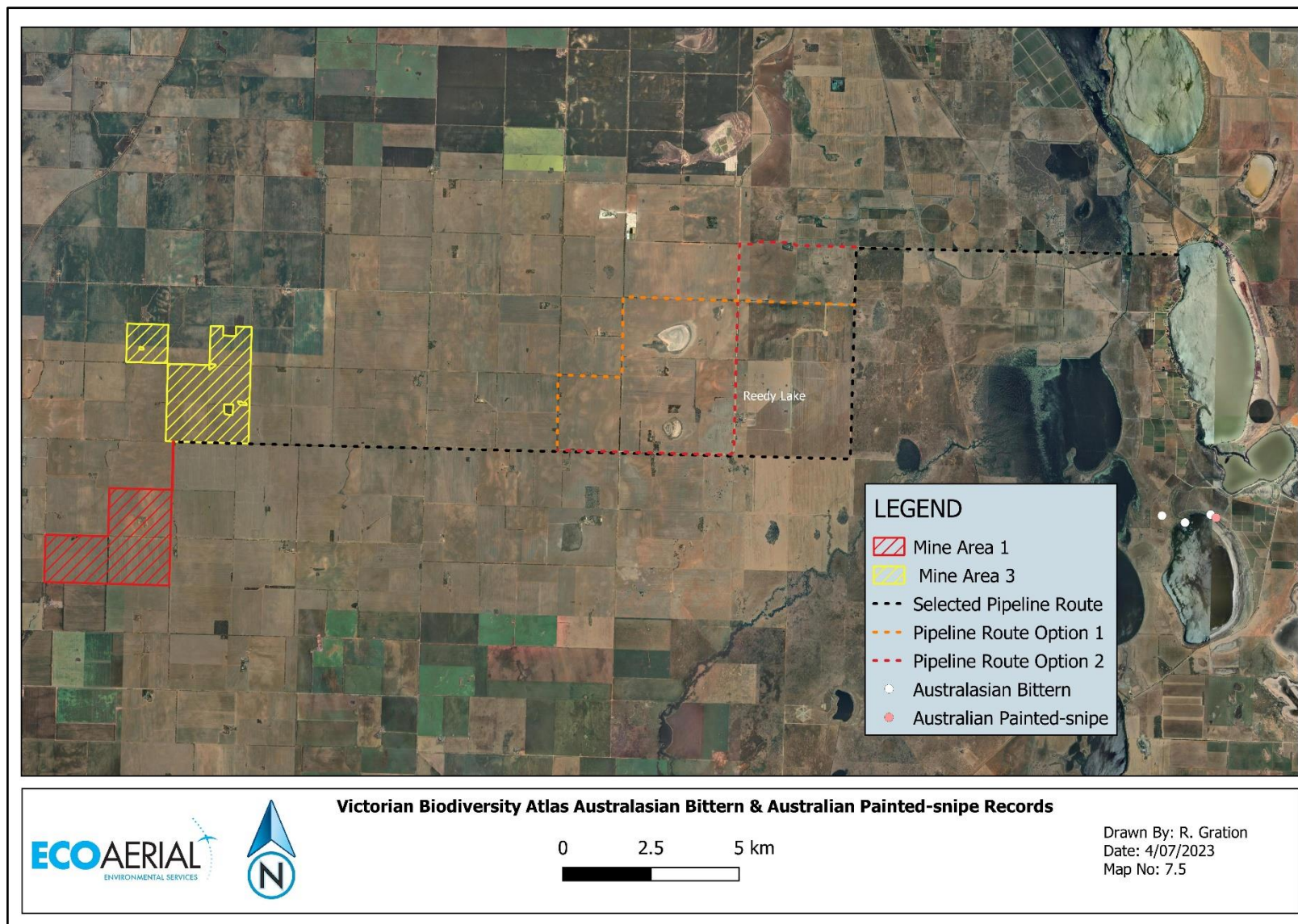


Figure 7. 4 Wader Records





**Figure 7. 5** Australasian Bittern & Australian Painted-snipe records

## 7.4 Fauna Species

A total of 97 species have been recorded across the mine tenement during the surveys undertaken by Ecology and Heritage Partners (2018), Ecoscape (2018) and Spectrum Ecology (2019). The fauna groups included five non-volant native mammals, eight bat species, seven introduced mammal species, sixty-nine native bird species, three introduced bird species and five reptiles, (refer to Table 7.3). The survey site locations referred to in Table 7.3, (e.g., GPBS), are provided in figures in Appendix C.

Sixty-two fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* have been recorded within the mine tenement study area.

Targeted surveys for Corben's long-eared Bat resulted in the capture of six species: two Molossids and four Vespertilids.

- White-striped Freetail Bat (*Austronomus australis*)
- Southern Free-tailed Bat (*Ozimops planiceps*)
- Gould's Wattled Bat (*Chalinolobus gouldii*)
- Lesser Long-eared Bat (*Nyctophilus geoffroyi*)
- Little Forest Bat (*Vespedalus vulturnus*)
- Southern Forest Bat (*Vespedalus regulus*).

The Gould's Wattled Bat (*Chalinolobus gouldii*) was the most caught species with a total of twenty-three individuals from seven sites, followed by the Lesser Long-eared Bat (*Nyctophilus geoffroyi*; nine individuals) and Little Forest Bat (*Vespedalus vulturnus*; six individuals). The record of the White-striped Freetail Bat (*Austronomus australis*) is unusual. This fast-flying species typically hunts 50m or more above the ground, therefore not easily trappable. One individual was captured during the 2018 bat surveys.

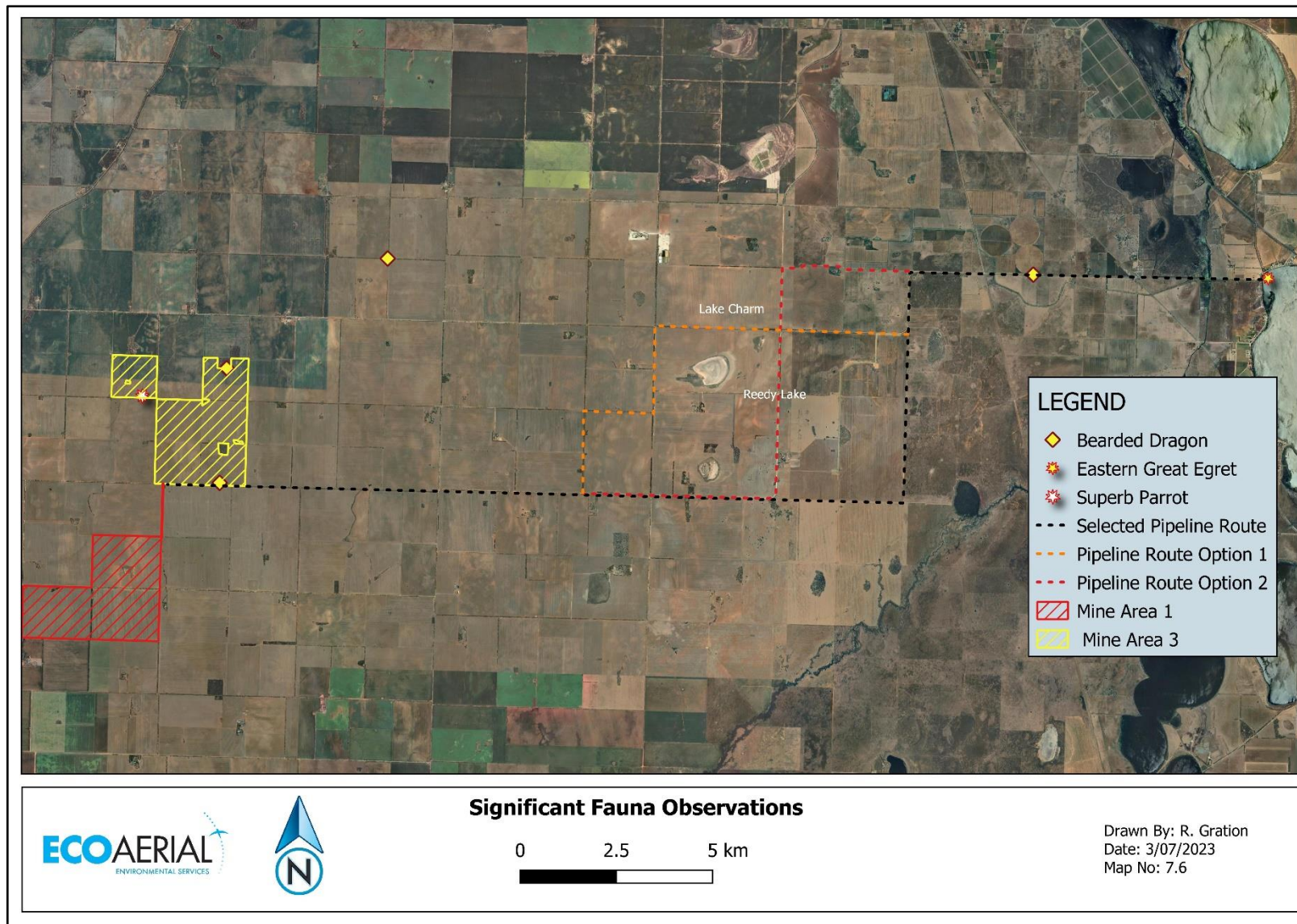
Ambiguous calls in March 2018 (Ecoscape (Australia), 2018) attributed to Ride's Free-tailed Bat (*Ozimops ridei*), Large-footed Myotis (*Myotis macropus*) and Inland Forest Bat (*Vespadelus baverstocki*) were not trapped. The unknown *Nyctophilus* call was likely to be the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) based on the trapping results and habitat.

During the Spectrum Ecology (2019) survey one species of conservation significance was recorded: the Eastern Bearded Dragon *Pogona barbata* (FFG Act – Vulnerable). This species has been recorded during all surveys (EHP 2018; Ecoscape 2018, Spectrum Ecology 2018 and EcoAerial 2021 & 2022). An Eastern Great Egret was also recorded during bird surveys at Kangaroo Lake in June 2022. An additional two species of conservation significance were recorded:

- Superb Parrot (*Polytelis swainsoni*; EPBC Vulnerable, FFG Act – Endangered) – recorded by Ecoscape 2018.
- Black Falcon (*Falco subniger*; FFG Act – Critically Endangered) – recorded by Ecology and Heritage Partners 2018.

Refer to Figure 7.6. Note the location of the Black Falcon record was not available for inclusion.





**Figure 7. 6** Significant species observations



**Table 7. 3** Site records from previous desktop reviews / surveys

Scientific Name	Common Name	Conservation Status		Previous surveys		Spectrum Ecology Surveys November 2018 – Site Number														EPBC Act Mallee Bird Community of the Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
		EPBC Act	FFG Act	EHP 2017	Ecoscape 2018	GP BS1	GP BS2	GP BS3	GP BS4	GP BS5	GP BS6	GP BS7	GP BS8	GP BS9	GP BS10	GP BS11	GP BS12	Opp			
Mammals																					
Tachyglossidae																					
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna				•														N/A	✓	
Phalangeridae																			N/A		
<i>Trichosurus vulpecula</i>	Brush-tailed Possum				•														N/A	✓	
Macropodidae																					
<i>Macropus giganteus</i>	Eastern Grey Kangaroo				•													2	N/A	N/A	
<i>Macropus fuliginosus</i>	Western Grey Kangaroo			•															N/A	✓	
<i>Osphranter rufus</i>	Red Kangaroo			•															N/A	✓	
Molossidae																					
<i>Austronomus australis</i>	White-striped Freetail Bat				•										1				N/A	✓	
<i>Ozimops planiceps</i>	Southern Free-tailed Bat				•						1								N/A	✓	
Vespertilioinidae																					
<i>Chalinolobus gouldii</i>	Gould’s Wattled Bat				•		1	1	3	3	1			6	8				N/A	✓	
<i>Chalinolobus morio</i>	Chocolate Wattled Bat				•														N/A	✓	
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat				•*	3		3						1	2				N/A	✓	
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat				•														N/A	N/A	
<i>Vespedalus vulturnus</i>	Little Forest Bat				•*			1						1	2		2		N/A	N/A	
<i>Vespedalus regulus</i>	Southern Forest Bat					1		1			1						1		N/A	✓	
Introduced Mammals																					
<i>Mus musculus</i>	House Mouse			•	•														N/A	N/A	
<i>Vulpes vulpes</i>	Red Fox			•	•													2	N/A	N/A	
<i>Felis catus</i>	Feral Cat				•			S											N/A	N/A	



Scientific Name	Common Name	Conservation Status		Previous surveys		Spectrum Ecology Surveys November 2018 – Site Number													EPBC Act Mallee Bird Community of the Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
		EPBC Act	FFG Act	EHP 2017	Ecoscape 2018	GP BS1	GP BS2	GP BS3	GP BS4	GP BS5	GP BS6	GP BS7	GP BS8	GP BS9	GP BS10	GP BS11	GP BS12	Opp		
<i>Oryctolagus cuniculus</i>	European Rabbit			•	•													7	N/A	N/A
<i>Lepus europeaus</i>	European Hare			•	•				1									2	N/A	N/A
<i>Ovis aries</i>	Sheep				•													20	N/A	N/A
<i>Bos taurus</i>	Cattle						1											10	N/A	N/A
<b>Birds</b>																				
<b>Podicipedidae</b>																				
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe				•														N/A	N/A
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe				•														N/A	N/A
<b>Accipitridae</b>																				
<i>Elanus caeruleus</i>	Black-shouldered Kite			•	•													2	N/A	N/A
<i>Aquila audax</i>	Wedge-tailed Eagle			•	•														N/A	✓
<i>Accipiter fasciatus</i>	Brown Goshawk			•															N/A	N/A
<i>Milvus migrans</i>	Black Kite				•														N/A	N/A
<i>Haliastur sphenurus</i>	Whistling Kite			•	•														N/A	N/A
<b>Charadriidae</b>																				
<i>Vanellus miles</i>	Masked Lapwing				•														N/A	N/A
<b>Columbidae</b>																				
<i>Phaps chalcoptera</i>	Common Bronzewing			•															N/A	✓
<i>Ocyphaps lophotes</i>	Crested Pigeon			•	•													7	N/A	✓
<i>Geopelia striata</i>	Peaceful Dove			•															N/A	N/A
<b>Podargidae</b>																				
<i>Podargus strigoides</i>	Tawny Frogmouth																	2	N/A	✓
<b>Tytonidae</b>																				
<i>Tyto alba</i>	Eastern Barn Owl			•	•	2												1	N/A	✓
<b>Aegothelidae</b>																				

Scientific Name	Common Name	Conservation Status		Previous surveys		Spectrum Ecology Surveys November 2018 – Site Number													EPBC Act Mallee Bird Community of the Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
		EPBC Act	FFG Act	EHP 2017	Ecoscape 2018	GP BS1	GP BS2	GP BS3	GP BS4	GP BS5	GP BS6	GP BS7	GP BS8	GP BS9	GP BS10	GP BS11	GP BS12	Opp		
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar				•		1												N/A	✓
<b>Falconidae</b>																				
<i>Falco cenchroides</i>	Australian Kestrel			•	•														N/A	✓
<i>Falco berigora</i>	Brown Falcon				•														N/A	✓
<i>Falco subniger</i>	Black Falcon			•															N/A	N/A
<i>Falco peregrinus</i>	Peregrine Falcon			•															N/A	N/A
<b>Cacatuidae</b>																				
<i>Cactua roseicapilla</i>	Galah			•	•		Nest											10	N/A	✓
<i>Cacatua sp.</i>	Corella			•															N/A	✓
<i>Nymphicus hollandicus</i>	Cockatiel				•														N/A	✓
<b>Psittacidae</b>																				
<i>Glossopsitta concinna</i>	Musk Lorikeet				•														N/A	N/A
<i>Platycercus eximius</i>	Eastern Rosella				•				1									17	N/A	N/A
<i>Psephotus varius</i>	Mulga Parrot			•															N/A	N/A
<i>Psephotus haematonotus</i>	Red-rumped Parrot			•	•													4	N/A	N/A
<i>Northiella haematogaster</i>	Blue Bonnet			•	•														N/A	✓
<i>Polytelis swainsoni</i>	Superb Parrot	VU	EN		•														N/A	N/A
<b>Climacteridae</b>																				
<i>Climacteris picumnus</i>	Brown Treecreeper			•															N/A	✓
<b>Maluridae</b>																				
<i>Malurus splendens</i>	Splendid Fairy-wren			•															✓ #	N/A
<i>Malurus cyanues</i>	Superb Fairy-wren			•															N/A	N/A
<i>Malurus leucopterus</i>	White-winged Fairy-wren				•														N/A	✓
<b>Meliphagidae</b>																				

Scientific Name	Common Name	Conservation Status		Previous surveys		Spectrum Ecology Surveys November 2018 – Site Number													EPBC Act Mallee Bird Community of the Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
		EPBC Act	FFG Act	EHP 2017	Ecoscape 2018	GP BS1	GP BS2	GP BS3	GP BS4	GP BS5	GP BS6	GP BS7	GP BS8	GP BS9	GP BS10	GP BS11	GP BS12	Opp		
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill			•															N/A	N/A
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater			•															N/A	✓
<i>Epthianura albifrons</i>	White-fronted Chat			•	•														N/A	✓
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater			•	•														N/A	✓
<i>Anthochaera carunculata</i>	Red Wattlebird			•															N/A	✓
<i>Lichenostomus fuscus</i>	Fuscous Honeyeater			•															N/A	N/A
<i>Lichenostomus leucotis</i>	White-eared Honeyeater			•															✓ #	✓
<i>Purnella albifrons</i>	White-fronted Honeyeater			•	•														✓ #	N/A
<i>Manorina melanocephala</i>	Noisy Miner			•	•	3	3	6										3	N/A	N/A
<i>Manorina flavigula</i>	Yellow-throated Miner			•															N/A	✓
<i>Gavicalis virescens</i>	Singing Honeyeater			•	•														N/A	N/A
<i>Ptilotula ornata</i>	Yellow-plumed Honeyeater			•															✓ #	✓
<i>Ptilotula penicillata</i>	White-plumed Honeyeater			•	•														N/A	✓
<b>Pardalotidae</b>																				
<i>Pardalotus punctatus</i>	Spotted Pardalote			•															N/A	✓
<i>Pardalotus striatus</i>	Striated Pardalote				•													2	N/A	✓
<b>Acanthizidae</b>																				
<i>Smicromis brevirostris</i>	Weebill			•	•														N/A	✓
<i>Acanthiza apicalis</i>	Inland Thornbill			•															N/A	✓
<i>Acanthiza nana</i>	Yellow Thornbill			•															N/A	✓
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill			•															N/A	✓
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill			•															N/A	✓

Scientific Name	Common Name	Conservation Status		Previous surveys		Spectrum Ecology Surveys November 2018 – Site Number													EPBC Act Mallee Bird Community of the Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
		EPBC Act	FFG Act	EHP 2017	Ecoscape 2018	GP BS1	GP BS2	GP BS3	GP BS4	GP BS5	GP BS6	GP BS7	GP BS8	GP BS9	GP BS10	GP BS11	GP BS12	Opp		
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			•	•														N/A	✓
<b>Pomatostomidae</b>																				
<i>Pomatostomus superciliosus</i>	White-browed Babbler			•															N/A	✓
<b>Artamidae</b>																				
<i>Cracticus torquatus</i>	Grey Butcherbird			•															N/A	✓
<i>Cracticus nigrogularis</i>	Pied Butcherbird			•	•													2	N/A	N/A
<i>Strepera graculina</i>	Pied Currawong			•															N/A	✓
<i>Gymnorhina tibicen</i>	Australian Magpie			•	•													17	N/A	✓
<b>Campephagidae</b>																				
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			•	•													6	N/A	✓
<b>Neosittidae</b>																				
<i>Daphoenositta chrysoptera</i>	Varied Sittella			•															N/A	✓
<b>Pachycephalidae</b>																				
<i>Colluricincla harmonica</i>	Grey Shrike-thrush			•															N/A	✓
<b>Rhipiduridae</b>																				
<i>Rhipidura leucophrys</i>	Willie Wagtail			•	•													1	N/A	✓
<b>Monarchidae</b>																				
<i>Grallina cyanoleuca</i>	Magpie-lark			•	•														N/A	✓
<i>Myiagra inquieta</i>	Restless Flycatcher			•															N/A	✓
<b>Megaluridae</b>																				
<i>Cincloramphus mathewsi</i>	Rufous Songlark																	1	N/A	✓
<b>Corvidae</b>																				
<i>Corvus coronoides</i>	Australian Raven			•	•														N/A	✓
<i>Corvus mellor</i>	Little Raven			•	•	2	1											8	N/A	✓
<b>Corcoracidae</b>																				

Scientific Name	Common Name	Conservation Status		Previous surveys		Spectrum Ecology Surveys November 2018 – Site Number													EPBC Act Mallee Bird Community of the Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
		EPBC Act	FFG Act	EHP 2017	Ecoscape 2018	GP BS1	GP BS2	GP BS3	GP BS4	GP BS5	GP BS6	GP BS7	GP BS8	GP BS9	GP BS10	GP BS11	GP BS12	Opp		
<i>Corcorax melanorhamphos</i>	White-winged Chough			•	•													13	N/A	✓
<b>Petroicidae</b>																				
<i>Microeca fascinans</i>	Jacky Winter			•															✓ #	✓
<b>Hirundinidae</b>																				
<i>Hirundo neoxena</i>	Welcome Swallow				•														N/A	✓
<i>Petrochelidon ariel</i>	Fairy Martin			•															N/A	✓
<b>Motacillidae</b>																				
<i>Anthus australis</i>	Australian Pipit				•														N/A	✓
<b>Introduced Birds</b>																				
<i>Columba livia</i>	Domestic Pigeon (Rock Dove)				•														N/A	N/A
<i>Sturnus vulgaris</i>	Common Starling			•	•													2	N/A	N/A
<i>Passer domesticus</i>	House Sparrow			•	•													1	N/A	N/A
<b>Reptiles</b>																				
<b>Diplodactylidae</b>																				
<i>Diplodactylus vittatus</i>	Eastern Stone Gecko			•															N/A	✓
<b>Agamidae</b>																				
<i>Pogona barbata</i>	Eastern Bearded Dragon		VU	•	•													2	N/A	N/A
<b>Scincidae</b>																				
<i>Menetia greyi</i>	Grey's Skink			•															N/A	✓
<i>Morethia boulengeri</i>	Boulenger's Morethia			•															N/A	✓
<i>Pseudonaja textilis</i>	Eastern Brown Snake				•														N/A	✓

°=species recorded outside the study area, \*=species level confirmed during current survey, S=Secondary evidence recorded (scats, tracks, sloughed skin etc.) # = FFG Act Victorian Mallee Bird Community

### 7.4.1 Fauna recorded within pipeline options

A total of 57 species were recorded during the pipeline route fauna assessments (Spectrum Ecology / EcoAerial 2022): two non-volant native mammals, five bat species, four introduced mammal species, thirty-nine native bird species, four introduced bird species and two reptile species and one amphibian (refer to Table 7.4). There was one FFG Act listed species recorded, the carcass of an Eastern Bearded Dragon was found on the road reserve of Mystic Park – Beauchamp Rd.

Thirty-six fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* have been recorded within the pipeline route options. All species observed except for the Bearded Dragon carcass were non-threatened species.

**Table 7. 4** Species recorded during the 2022 water supply pipeline options assessments

Scientific Name	Common Name	Pipeline Route Options	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Fauna Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
<b>Mammals</b>				
<i>Austronomus australis</i>	White-striped Freetail Bat	1	N/A	✓
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	1	N/A	✓
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	1	N/A	✓
<i>Lepus europeaus</i>	European Hare	1,2	N/A	✓
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	1	N/A	✓
<i>Mus musculus</i> #	House Mouse	1, 2	N/A	N/A
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	1	N/A	✓
<i>Oryctolagus cuniculus</i> #	European Rabbit	1, 2	N/A	N/A
<i>Ozimops planiceps</i>	Southern Free-tailed Bat	1	N/A	✓
<i>Trichosurus vulpecula</i>	Brush-tailed Possum	1	N/A	✓
<i>Vulpes vulpes</i> #	Red Fox	1, 2	N/A	N/A
<b>Birds</b>				
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	1, 2	N/A	✓
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	1	N/A	✓
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	1	N/A	✓
<i>Anthochaera carunculata</i>	Red Wattlebird	1, 2	N/A	✓
<i>Anthus australis</i>	Australian Pipit	1	N/A	✓
<i>Cacatua</i> sp.	Corella	1, 2 & 3	N/A	✓
<i>Cactua roseicapilla</i>	Galah	1, 2 & 3	N/A	✓
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	1	N/A	✓
<i>Columba livia</i> #	Domestic Pigeon (Rock Dove)	1	N/A	N/A
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	1, 2	N/A	✓

Scientific Name	Common Name	Pipeline Route Options	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Fauna Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
<i>Corcorax melanorhamphos</i>	White-winged Chough	1	N/A	✓
<i>Corvus coronoides</i>	Australian Raven	1, 2	N/A	✓
<i>Corvus mellor</i>	Little Raven	1	N/A	✓
<i>Cracticus nigrogularis</i>	Pied Butcherbird	1,2	N/A	N/A
<i>Gymnorhina tibicen</i>	Australian Magpie	1, 2	N/A	✓
<i>Cracticus torquatus</i>	Grey Butcherbird	1	N/A	✓
<i>Elanus caeruleus</i>	Black-shouldered Kite	1	N/A	N/A
<i>Falco berigora</i>	Brown Falcon	1	N/A	✓
<i>Falco cenchroides</i>	Australian Kestrel	1, 2 & 3	N/A	✓
<i>Geopelia striata</i>	Peaceful Dove	1, 2	N/A	N/A
<i>Glossopsitta concinna</i>	Musk Lorikeet	1	N/A	N/A
<i>Grallina cyanoleuca</i>	Magpie-lark	1, 2 & 3	N/A	✓
<i>Haliastur sphenurus</i>	Whistling Kite	1, 2	N/A	N/A
<i>Hirundo neoxena</i>	Welcome Swallow	1, 2 & 3	N/A	✓
<i>Lichenostomus fuscus</i>	Fuscous Honeyeater	1, 2	N/A	N/A
<i>Malurus cyanues</i>	Superb Fairy-wren	1, 2	N/A	N/A
<i>Malurus splendens</i>	Splendid Fairy-wren	1	✓	N/A
<i>Manorina melanocephala</i>	Noisy Miner	1, 2	N/A	N/A
<i>Northiella haematogaster</i>	Blue Bonnet	1, 2	N/A	✓
<i>Ocyphaps lophotes</i>	Crested Pigeon	1, 2 & 3	N/A	✓
<i>Pardalotus punctatus</i>	Spotted Pardalote	1, 2	✓	✓
<i>Pardalotus striatus</i>	Striated Pardalote	1	N/A	✓
<i>Passer domesticus</i> #	House Sparrow	1, 2 & 3	N/A	N/A
<i>Petrochelidon ariel</i>	Fairy Martin	1	N/A	✓
<i>Phaps chalcoptera</i>	Common Bronzewing	1	N/A	✓
<i>Platycercus eximius</i>	Eastern Rosella	1, 2	N/A	N/A
<i>Psephotus haematonotus</i>	Red-rumped Parrot	1, 2	N/A	✓
<i>Ptilotula penicillata</i>	White-plumed Honeyeater	1, 2	N/A	N/A
<i>Rhipidura leucophrys</i>	Willie Wagtail	1, 2 & 3	N/A	✓
<i>Strepera graculina</i>	Pied Currawong	1, 2 & 3	N/A	N/A
<i>Sturnus vulgaris</i> #	Common Starling	1	N/A	N/A
<i>Turdus merula</i> #	European Blackbird	1, 2 & 3	N/A	N/A
<i>Tyto alba</i>	Eastern Barn Owl	1	N/A	✓
<b>Reptiles</b>				
<i>Morethia boulengeri</i>	Boulenger's skink	1, 2, 3	N/A	✓



Scientific Name	Common Name	Pipeline Route Options	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Fauna Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
<i>Pogona barbata</i> *	Eastern Bearded Dragon	1, 2, 3	N/A	N/A
<b>Amphibians</b>				
<i>Crinia signifera</i>	Eastern Common Froglet	1, 2, 3	N/A	N/A

\* Listed as vulnerable FFG Act. # Introduced species. Red = where all three routes overlap to the east

## 7.4.2 Species recorded at Kangaroo Lake

A total of 37 species were recorded at Kangaroo Lake, thirty-six birds and one amphibian whilst undertaking surveys in June 2022. One bird species listed as threatened under the FFG Act was recorded. Thirteen birds associated with the EPBC listed *Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions* were recorded. Refer to Table 7.5 for Kangaroo Lake observations.

**Table 7. 5** Species recorded at Kangaroo Lake June 2022

Scientific name	Common Name	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Fauna Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
<b>Birds</b>			
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	N/A	✓
<i>Anas superciliosa</i>	Pacific Black Duck	N/A	N/A
<i>Anhinga novaehollandiae</i>	Darter	N/A	N/A
<i>Anthochaera carunculata</i>	Red Wattlebird	N/A	✓
<i>Ardea modest</i>	Eastern Great Egret *	N/A	N/A
<i>Ardea pacifica</i>	White-necked Heron	N/A	N/A
<i>Cactua roseicapilla</i>	Galah	N/A	✓
<i>Circus approximans</i>	Swamp Harrier	N/A	✓
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	N/A	✓
<i>Cygnus atratus</i>	Black Swan	N/A	N/A
<i>Falco berigora</i>	Brown Falcon	N/A	✓
<i>Grallina cyanoleuca</i>	Magpie-lark	N/A	✓
<i>Gymnorhina tibicen</i>	Australian Magpie	N/A	✓
<i>Haliastur sphenurus</i>	Whistling Kite	N/A	N/A
<i>Hirundo neoxena</i>	Welcome Swallow	N/A	✓

Scientific name	Common Name	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Fauna Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
<i>Lichenostomus fuscus</i>	Fuscous Honeyeater	N/A	N/A
<i>Malurus cyanues</i>	Superb Fairy-wren	N/A	N/A
<i>Manorina melanocephala</i>	Noisy Miner	N/A	N/A
<i>Megalurus grammurus</i>	Little Grassbird	N/A	N/A
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	N/A	N/A
<i>Milvus migrans</i>	Black Kite	N/A	N/A
<i>Pelecanus conspicillatus</i>	Australian Pelican	N/A	N/A
<i>Petrochelidon ariel</i>	Fairy Martin	N/A	✓
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	N/A	N/A
<i>Phaps chalcoptera</i>	Common Bronzewing	N/A	✓
<i>Platycercus eximius</i>	Eastern Rosella	N/A	N/A
<i>Porphyrio melanotus</i>	Purple Swamphen	N/A	N/A
<i>Psephotus haematonotus</i>	Red-rumped Parrot	N/A	✓
<i>Ptilotula penicillata</i>	White-plumed Honeyeater	N/A	N/A
<i>Rhipidura leucophrys</i>	Willie Wagtail	N/A	✓
<i>Sturnus vulgaris</i> #	Common Starling	N/A	N/A
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	N/A	N/A
<i>Tadorna tadornoides</i>	Australian Shelduck	N/A	N/A
<i>Tribonyx ventralis</i>	Black-tailed Native Hen	N/A	N/A
<i>Turdus merula</i> #	European Blackbird	N/A	N/A
<i>Vanellus miles</i>	Masked Lapwing	N/A	N/A
<b>Amphibians</b>			
<i>Crinia signifiera</i>	Eastern Common Froglet	N/A	N/A

\* Listed as vulnerable FFG Act. # Introduced species.

## 7.5 Limitations, uncertainties and assumptions

The following limitations, uncertainties and assumptions apply to this assessment:

- **Limitations:** Surveys were undertaken at the documented times as provided in the relevant survey guideline documents for the mine tenement and Water Supply Pipeline Option 1 route. Fauna presence can vary from year-to-year due to seasonal weather conditions. Surveys undertaken for the Water Supply Pipeline Option 2 & 3 were confined to bird surveys and a habitat assessment due to the time of year.
- Some of the target fauna are cryptic species with low detection rates so may not pick up these species (absence of evidence is not evidence of absence) e.g., Plains Wanderer.

- **Assumption:** *Where fauna habitat adjacent to the pipeline routes Options 1, 2 & 3 of the Water Supply Pipeline was consistent with the mine tenement, it was assumed that the fauna habitat was suitable for fauna assemblages recorded in the mine tenement.*

## 8 Risk Assessment

The EES identifies potential risks to fauna and fauna habitat and the associated residual impacts. Monitoring, mitigation and contingency measures as outlined below in Section 10. The environmental risk assessments outlined below are considered a live document and will be regularly updated to address project activities for the relevant phase of the project.

A risk assessment of project activities was performed as a screening tool to prioritise the focus of the impacts and development of mitigation measures. The risk pathways links project activities (causes) to their potential effects on the environmental assets. Risks were assessed for the construction, operation and decommissioning phases of the 'Project'. The risk assessment process follows: Preparation of Work Plans and Work Plan Variations; Guideline for Mining Projects December 2020 Ver 1.3 (DJPR).

The identified risks and associated residual risk ratings are listed in Table 8.1. The likelihood and consequence ratings determined during the risk assessment process are presented in Appendix A.

**Table 8. 1** Vertebrate Fauna Risks

Risk ID	Potential threat and effects on the environment	Residual risk rating
<b>Construction</b>		
R01	Loss of fauna habitat / fragmentation within mine area and transport routes and on road reserves.	Very High
R02	Changes to the ecological character of Kangaroo Lake because of construction of pump station.	Low
R03	Indirect impacts – Vehicle / wildlife collisions.	Medium
R04	Indirect impacts – Dust	Medium
R05	Indirect impacts – Light pollution	Medium
R06	Indirect impacts – Chemical spills	Medium
R07	Indirect impacts – Noise	Medium
R08	Indirect impacts – Fauna salvage e.g., vegetation clearing and pipeline trench.	Medium
<b>Operation</b>		
R01	Loss and fragmentation of fauna habitat.	Medium
R02	Changes to the ecological character of Kangaroo Lake because water extraction.	Medium
R03	Indirect impacts – Vehicle / wildlife collisions.	Medium
R04	Indirect impacts – Dust	Medium
R05	Indirect impacts – Light pollution	Medium
R06	Indirect impacts – Chemical spills	Medium
R07	Indirect impacts – Noise	Medium

<b>Risk ID</b>	<b>Potential threat and effects on the environment</b>	<b>Residual risk rating</b>
RO8	Indirect Impacts – Ingesting contaminated water from process pond	Medium
RO9	Indirect Impacts – Ingesting contaminated water from tailing cells	Low
<b>Decommissioning</b>		
R01	Loss and fragmentation of fauna habitat.	Medium
R02	Indirect impacts – Vehicle / wildlife collisions.	Medium
R03	Indirect impacts – Dust	Medium
R04	Indirect impacts – Light pollution	Medium
R05	Indirect impacts – Chemical spills	Medium
R06	Indirect impacts – Noise	Medium

## 9 Construction Impact Assessment

This section discusses the potential impacts of the project because of construction activities and the associated mitigation measures that aim to reduce impacts. Avoidance and mitigation measures are detailed in Section 13.1.

### 9.1 Summary of impact/s

VHM's intention is to minimise disturbance to native vegetation with the aim to retain as much native vegetation / fauna habitat as possible. The total extent of vegetation loss is 14.36ha, of which 7.0 ha will be removed, 4.7ha is considered lost, as detailed in Section 1.1. The area of 4.7ha of native vegetation/ fauna habitat will remain in-situ.

A further 3ha is associated with 51 scattered trees to be removed in cropped paddocks. The native vegetation guidelines include a 700<sup>2</sup>m area around each individual large, scattered tree and 314<sup>2</sup>m around each small scattered tree, notwithstanding there is no native vegetation understorey or groundcover.

#### 9.1.1 Mine tenement

The avoid and minimise principle has been applied to native vegetation within the mine tenement and transport routes. The mining area and associated infrastructure proposed will avoid of 60.629 hectares of native vegetation and 2,843 large trees compared to the 2018 proposal (Nature Advisory 2022).

Infrastructure within the mining tenement will be located a minimum of 25-metres from fauna native vegetation / fauna habitat. Impacts within the mining tenement / transport route has been confined to the direct removal of 7.0 ha of native vegetation patches including 470 trees, and 51 scattered trees.

Because the Project design has largely avoided removal of native vegetation and fauna habitat and proposes to buffer these areas in accordance with Nature Advisory advice, the direct and indirect impacts of the Project on fauna are minimised. Mitigation, monitoring and contingencies outlined in section 13.1 describe other actions and strategies to mitigate the effects of the 'Project' on native fauna.

#### 9.1.2 Water Supply Pipeline Route Options

To facilitate the construction of the water supply pipeline, there will be potential impacts due to encroachment within the Tree Protection Zone when digging the trench for the pipeline in some sections of the road.

Arborist's (Treetec 2022) undertook an assessment of the three route options, (refer to Figure 9.3), and details the number of trees impacted due to encroachment within the TPZ because of trenching within 10% of the TPZ:

- Option 1: 112 trees
- Option 2: 61 trees
- Option 3: 61 trees.

**Note:** Trees considered impacted will be left in-situ and there will be no fauna habitat cleared. In the worst-case scenario, canopy trees may senesce at a faster rate. If this was to be the case, tree hollow formation would occur earlier than expected.

The impacts to canopy trees will be reduced by 54% by constructing the pipeline within Option 2 or 3. Option 3 has been identified as the preferred option.

Nature Advisory (2022) has calculated the assumed loss of vegetation as approx., 4.95ha based on the *Guidelines for assessing the removal of native vegetation* (2017). All vegetation will be retained, as will fauna habitat. It is not envisaged that there will be any direct impacts to fauna or fauna habitat and potential indirect impacts are to be managed as described in the mitigation strategies in Section 13.1.

### 9.1.3 EES Key Issues

The 'Project' will entail the removal of 6.8 ha of native vegetation / fauna habitat patches, 440 trees and 51 scattered trees within Mine Area 1 and Mine Area 3 and 0.27 ha, 30 trees for the transport route intersections (Nature Advisory 2022). Most of the native vegetation to be removed is associated with the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community*.

Figure 9.1 and 9.2 details the vegetation to be removed within the mine areas. It has been assumed that native vegetation / fauna habitat in the road reserves of Thompson Rd and Bennett Rd are included in the mine footprint based on maps supplied by VHM, (refer to Figures 2.3 and 2.4) and GIS layers provided by Nature Advisory (2022).

Note due to the small scale of removal at transport intersections and the pump location, figures have not been included.

The impacts to native vegetation / fauna habitat within the pipeline route, (Option 3), has been calculated as 4.7 ha due to impacts to the tree protection zone because of trenching in the road surface.

The Tree Protection Zone applies to those canopy trees directly impacted, (Australian Standard for the protection of trees on development sites AS4970). It is assumed that canopy trees will not survive due to compaction and trenching in the Tree Protection Zone Understorey and groundcover flora and woody debris are not directly impacted by works within the Tree Protection Zone and canopy trees will be left in-situ.

Mitigation of the impacts to fauna and fauna habitat has been further reduced. Arborists undertook an assessment of the original pipeline route option and identified another two routes. The impacts will be reduced with Option 3 used for the pipeline route.

The construction of the pipeline along the 17km pipeline route (Option 3) will not reduce the use of roadside vegetation by fauna. Monitoring will be undertaken every two years by qualified arborist to assess the health of trees identified as '*assumed lost*'. Any changes to their health will trigger contingency measures, such as installing nest boxes, revegetation, and habitat rehabilitation e.g., woody debris etc.

Each of the key EES issues are addressed based on the habitat impacts described above.

*Direct loss or degradation of native vegetation and associated listed ecological communities, including those listed as threatened under the EPBC Act, the FFG Act.*

Whilst the Mine Areas will result in the removal of 6.8 ha of native vegetation / fauna habitat, 440 trees and 51 scattered trees within Mine Area 1 and Mine Area 3 and 0.27 ha and 30 trees for the transport route intersections, the listing of this community occurred post the 'Project' being determined a '*Controlled Action*' and therefore there are no Commonwealth



implications for its removal in the mine areas. There will be no removal of vegetation associated with the FFG listed *Threatened Semi-arid Shrubby Pine-Buloke Woodland Community* Buloke (Nature Advisory 2022).

The EPBC Act *Mallee Bird Community of the Murray Darling Depression Bioregion* (Protected Matter Search Tool) and FFG listed *Victorian Mallee Bird Community* suggested that this ecological community were potentially present within the 'Project Area'. A review of birds in relevant database (VBA) and those recorded on-site met the Category D bird assemblage threshold for the *Mallee Bird Community of the Murray Darling Depression Bioregion*, albeit only marginally.

The impacts to canopy trees on the road reserve from Kangaroo Lake to the mine operations area has the potential to reduce foraging resources for fauna species associated with the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community*. The declining health of canopy trees, (should it occur), is expected to occur overtime. The trees are spread over a length of approx. 17km, refer to Figure 9.3. There are an estimated 45,020 large canopy trees associated with the EPBC community across the study area assessed by Nature Advisory (2022). The impacted trees represents 0.13% of canopy trees available in the study area.

Goulburn Murray Water have advised that; "*VHM taking a peak of 4,700 ML/year during start up and commissioning, approx., 3-months, the impact on Kangaroo Lake would appear marginal. This is based on a daily take of 12.9 ML/d throughout the 365 days of the year, although I accept a higher peak occurs if pumping does not occur daily. At 26 ML/d over 180 days, the impact is low compared to recent discharge to support irrigation*".

Kangaroo Lake forms part of the Kerang Ramsar wetlands (EPBC Act). Kangaroo Lake will be maintained at or near full supply levels to maintain ecological condition of littoral zone, with annual fluctuations of up to 600 mm as per historical management. It is unlikely there will be any changes beyond the Limits of Acceptable Change (LAS), as an artefact of water extraction or the construction of the pump station.

Due to the water levels being maintained as per historical levels at Kangaroo Lake, habitat suitable for migratory waders is confined to a constructed island in the south of the lake. The island will not be impacted by the installation of the pump and subsequent water extraction.

#### *Direct loss or degradation of habitat for flora and fauna listed as threatened under the EPBC Act and FFG Act.*

Conservation significant species i.e., EPBC Act and / or FFG Act listed, Superb Parrot, Black Falcon, Diamond Firetail, Hooded Robin, Samphire Skink and Eastern Bearded Dragon may utilise fauna habitat / remnant vegetation associated with the road reserves as corridors to move across the landscape.

The roadside reserves on Jobling Rd, Option 1 pipeline route, was considered as potentially suitable habitat for the FFG Act listed Hooded Scaly-foot (Critically Endangered). A review of the Hooded Scaly-foot Action Plan indicates that they are unlikely to persist in modified habitats such as those found on the road reserves (DSE 2004). Route Option 3 avoids areas identified as potential Hooded Scaly-foot habitat.

Sections of pipeline route Option 3 where the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community* is present is considered to provide habitat for five threatened species (#).

A FFG listed wetland bird was observed at Kangaroo Lake and habitat suitable for a FFG listed reptile is present on the Mystic Park-Beauchamp Rd road reserve:

1. Superb Parrot: EPBC Act & FFG Act #
2. Black Falcon: FFG Act. #
3. Diamond Firetail: FFG Act #
4. Hooded Robin: FFG Act #
5. Eastern Bearded Dragon: FFG Act #
6. Samphire Skink: FFG Act
7. Eastern Great Egret: FFG Act.

Four of the seven species are considered likely to be recorded across the wider 'Project Area': Black Falcon, Diamond Firetail, Hooded Robin and Eastern Bearded Dragon. The Superb Parrot observation is considered a vagrant for the reasons outlined in Section 6.7.1.

The impact to roadside vegetation is confined to 61 canopy trees. The understorey, ground cover and woody debris component will also remain in-situ. The trees represent 0.13% of all canopy trees available (Nature advisory 2022) across the study area.

It is expected that the tree health of the 61 trees will decline overtime, the extent of degradation is expected to consist of trees no longer producing nectar and reduced insect activity. Whilst this will have an impact on nectivorous and insectivorous birds, trees will continue to provide roosting for birds, bats and mammals. A by-product of tree decline is that the creation of tree hollows is likely to occur quicker than expected.

The extent of degradation to fauna habitat will be monitored and will be minimised by implementing the contingency strategies outlined in Section 13.2.

Eastern Great Egret is also likely to be recorded at Kangaroo Lake on a regular basis. Australian Bittern also has the potential to occur at Kangaroo Lake along the shoreline. The habitat at Kangaroo Lake primarily supports water dependent birds associated with deep water such as ducks, cormorant, darter and grebes. The last VBA record for Australian Painted-snipe was in 1912.

The habitat at Kangaroo Lake will not be reduced during the works on the shoreline. There is approx., 14km of habitat on the shoreline of Kangaroo Lake, the works area is in the order of approx., 75 m on the road reserve adjacent to the shoreline. Water extraction will not impact on existing historical maintained water levels.

The EPBC Act and FFG Act listed Plains-wanderer (*Pedionomus torquatus*) was not recorded during the targeted survey undertaken by EcoAerial (2021) and the habitat was assessed as unlikely to support Plains-wanderer.

Whilst targeted surveys did not record the FFG listed Samphire Skink it was assumed as present based on habitat considered suitable i.e., on southern road reserve where all 3 routes overlap between the railway line and Bael Bael-Boga Rd on Mystic Park-Beauchamp Rd (refer to Figure 7.3). This area was considered suitable habitat based on Samphire Skink records on the Goulburn Murray Highway where similar habitat / vegetation is present.

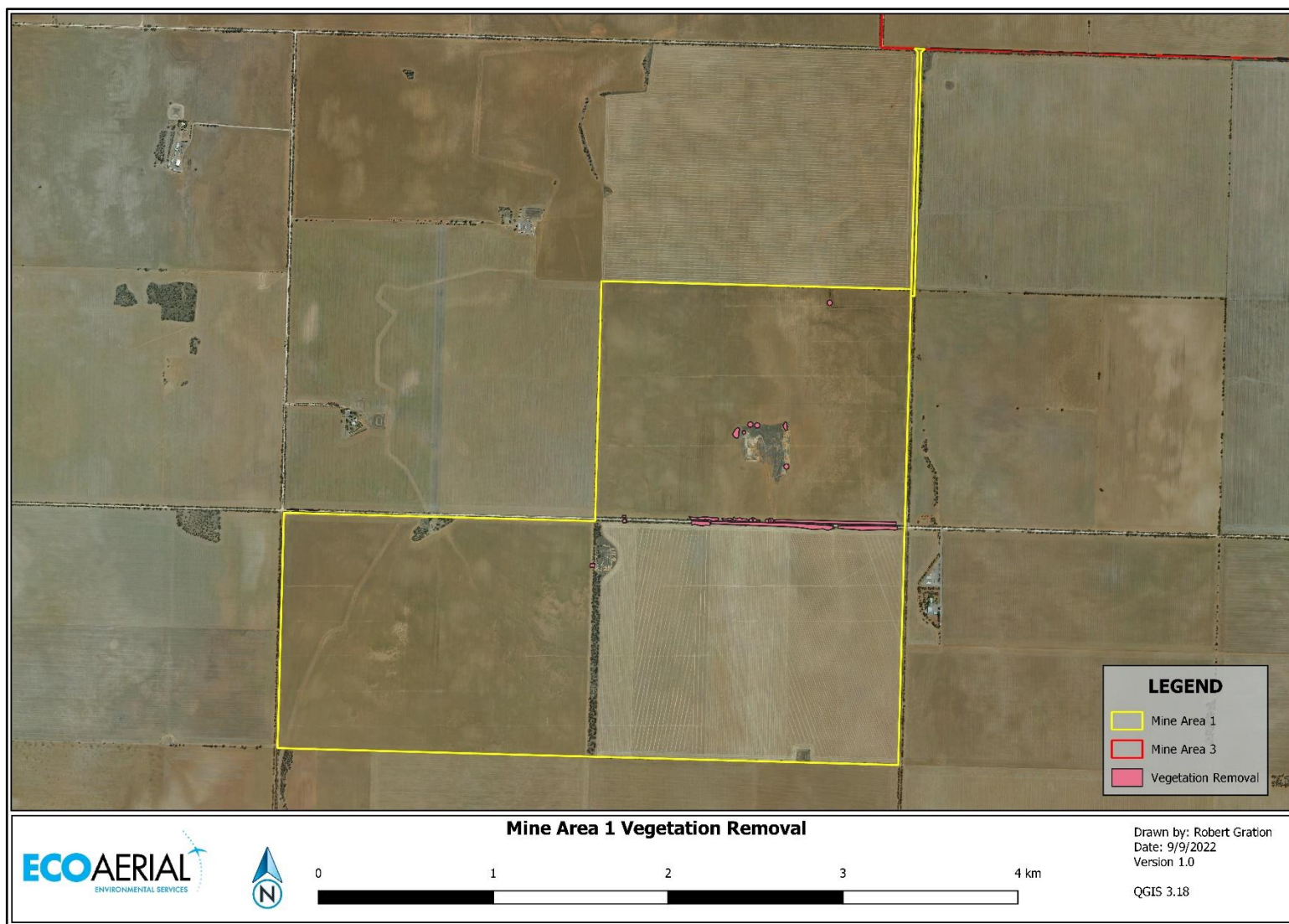
Trenching should be undertaken on the northern side of the road and no-go zones established to ensure there is no encroachment to Samphire Skink habitat.

*Disruption to the movement of fauna between areas of habitat across the broader landscape.*

Despite the heavily modified landscape the road reserves provide the primary fauna habitat linkages across the landscape. The impacts to canopy trees within the pipeline route are spread over approximately 17km of the road reserves. Impacts to the road reserve will not cause any significant change to the network of remnant vegetation along road reserves that allow conservation significant species, in particular birds, to move across the landscape to larger conservation reserves, refer to Figure 9.2.

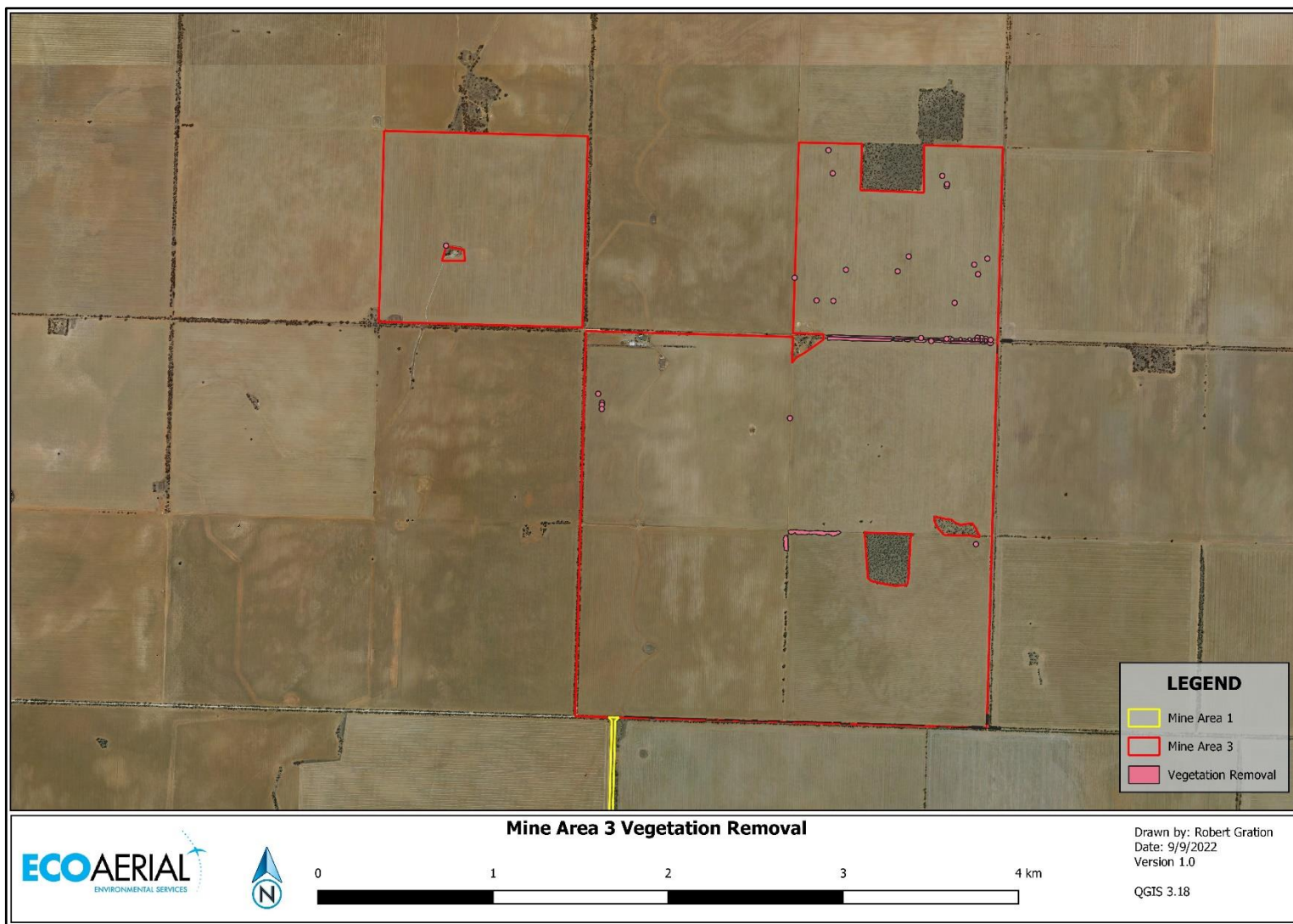
*Indirect habitat loss or degradation resulting from other effects.*

Several indirect impacts have been identified e.g., vehicle / wildlife collisions, dust, chemical spills and lighting (refer to Section 13.1). Whilst indirect impacts cannot be eliminated, the mitigation strategies outlined in Section 13.1 are expected to minimise indirect impacts to fauna and fauna habitat, (fauna salvage, nest box installation, revegetation, noise and light inhibitors, water cart and vehicle speed limits etc).

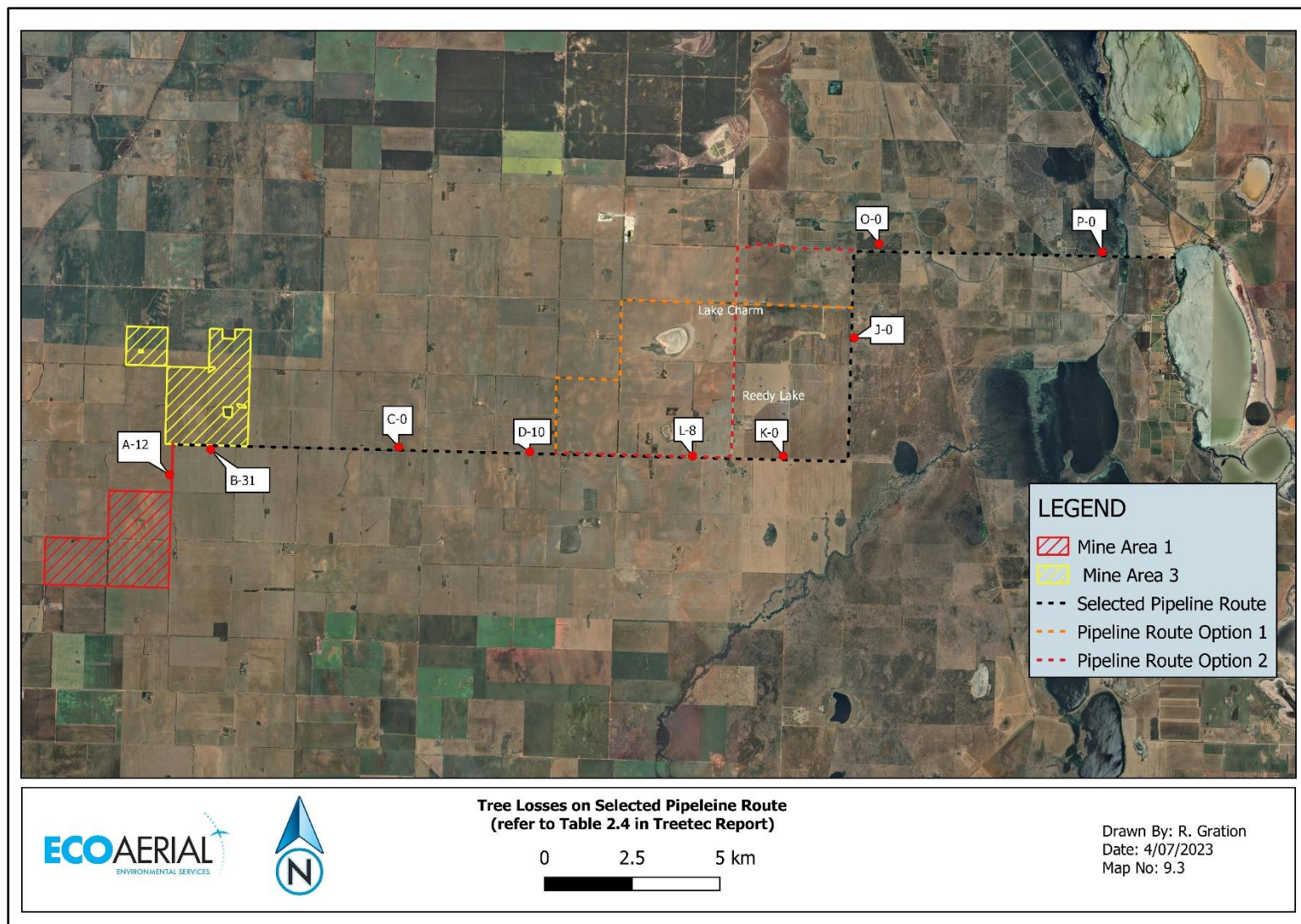


**Figure 9. 1** Mine Area 1 Fauna Habitat Removal



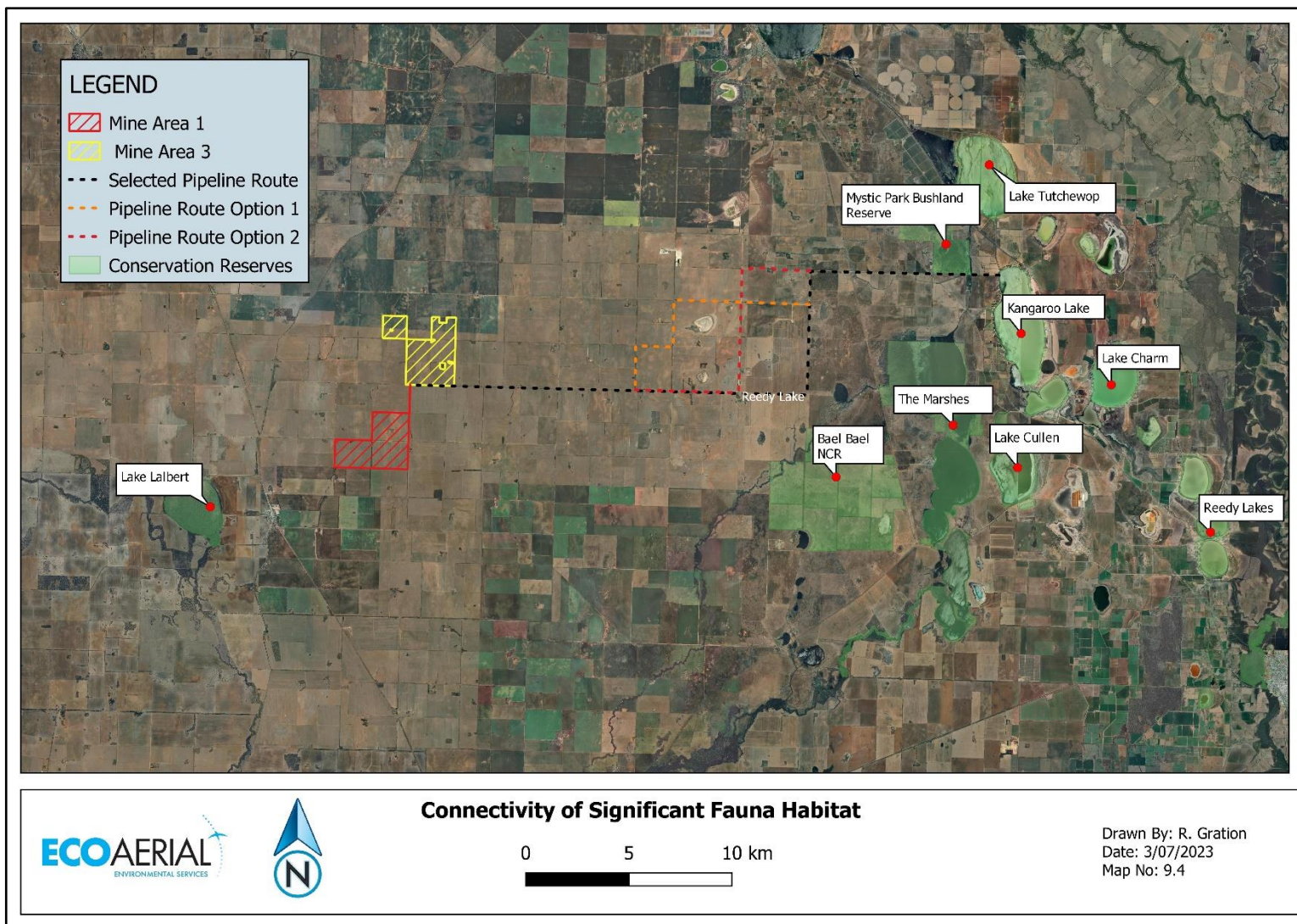


**Figure 9. 2** Mine Area 3 Fauna Habitat Removal



**Figure 9. 3** Tree impacts on selected pipeline route





**Figure 9. 4** Connectivity of significant fauna habitat to the 'Project'

## 9.2 *Summary of mitigation*

All measures available to limit the extent of vegetation/ fauna habitat removal within mine areas, transport intersections and pipeline route have undertaken. To ensure further impacts to native vegetation / fauna habitat are mitigated, strategies such as marking areas where removal has been approved and, restricting vehicle / equipment movement into areas where vegetation is to be retained will be implemented.

The movement of vehicles will be on the existing road network and designated access tracks and laydown areas will be clearly defined during construction phase of the mine areas and pipeline.

Trenching for the pipeline is in the middle of gravel roads except for the section from Kangaroo Lake approx. 6km west of where the road is bitumen. Route Option 3 reduces the number of canopy trees within the TPZ by 51. With implementation of the mitigation measures, the residual impacts to roadside vegetation will be minimised. The impacts will be offset by the rehabilitation of habitat if tree health declines at an increased rate.

Potential impacts will be managed through the implementation of the monitoring, mitigation and contingency strategies outlined in Sections 13.1 & 13.2 for the mine areas, transport intersection, pipeline route and pump station. These actions will be incorporated into Construction / Operational Environmental Management Plan and endorsed by the relevant authorities.

Nature Advisory (2022) have checked the Native Vegetation Credit Register to confirm if there are offsets available. Note that offset requirements are based on the removal of native vegetation and fauna habitat for the following areas:

- Mine Area 1: 4.09 ha
- Mine Area 3: 2.69 ha
- Pipeline Option 3: 4.69 ha
- Intersections: 0.27 ha

(Nature Advisory 2022)

Three sites were registered that will meet the offset requirements.

## 9.3 *Summary of residual impacts*

Residual impacts are those that remain once mitigation and management measures have been implemented. This section describes the potential residual impacts during the construction phase of the project once mitigation and management measures have been considered and applied.

The potential for residual impacts on fauna habitat has been considered independently of vegetation loss as defined under Clause 52.17 of the Planning Scheme for scattered trees, (see below) and impacts to canopy trees due to impacts to the TPZ.

Under Clause 52.17, it is assumed a canopy tree will not survive if there are impacts such as compaction and trenching in the TPZ protection zone, and if within a patch, understorey flora within the dripline of canopy foliage. Canopy trees, understorey and groundcover flora and woody debris will remain in-situ.

There is also a 'loss' associated with the removal of scattered trees even though they are located within cropped paddocks. The native vegetation guidelines include a 700m<sup>2</sup> area around each individual large, scattered tree and 314m<sup>2</sup> around each small, scattered tree, notwithstanding there is unlikely to be native vegetation.

The residual impact has been restricted to the physical removal of native vegetation / fauna habitat and indirect impacts that may impact on fauna habitat use.

The residual impact will entail of the removal of 7.0 ha of the native vegetation / fauna habitat, 470 trees and removal of 51 scattered trees in Mine Area 1 & 3 and transport intersections. Whilst the removal of the 51 scattered trees is calculated as 3 ha, for the reasons outlined above.

The impacts to canopy trees on the pipeline route has not been considered as a residual loss. There will be no removal of vegetation, canopy trees, understorey and groundcover will remain in-situ and continue to provide fauna habitat.

Treetec (2022) has considered a range of conditions to assess the impact to roadside canopy trees. The following conditions are based on the preferred route, Option 3. Section of Mystic-Beauchamp Rd is constructed gravel road with formed road base with high levels of use with high compaction. Sections of Mystic-Beauchamp Rd and Jobling Rd are graded wider sand roads used occasionally with moderate compaction.

The roadside canopy trees are mallee (*Eucalyptus* sp) and Black box (*Eucalyptus largiflorens*). Mallee trees have surface roots at the base of the tree, both species have a deep tap root to reach the water table (Australia Water Environments 2015; Australian National Botanic Gardens 2004).

The trenching for the pipeline does necessarily mean the tree health will decline at a greater than normal rate. The canopy trees will continue to provide fauna habitat whether they are alive, dying or dead. In the scenario tree health of the canopy trees decline at a quicker rate leading to reduced flowering and leaf growth, and eventually death, it is likely to expediate tree hollow formation. The tree/s will continue to be a valuable fauna habitat asset.

### 9.3.1 Residual Impacts to fauna due to loss of habitat

The loss of native vegetation and consequently fauna habitat will reduce the availability of food resources, perches, nesting, basking, refugia and tree hollows in the mine tenement. Native vegetation along the pipeline alignment remains in-situ, (except for the 61 canopy trees considered to be impacted due to trenching in the road surface on the pipeline route), and will continue to provide the availability of food resources, perches, nesting, basking, refugia and tree hollows.

The faunal groups impacted by the loss of native vegetation are birds, mammals, amphibians, and reptiles. Several species are FFG Act listed or associated with the EPBC Act listed Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions. Consideration of the residual impacts to fauna habitat has been considered for all faunal groups that occur, threatened and non-threatened.

The primary residual impacts due to the loss of canopy tree loss will be to birds, possums and microbats. The loss of understorey and groundcover vegetation, leaf litter and woody debris will impact on terrestrial species e.g., white-winged chough, crested pigeon, finches, amphibians and reptiles. Due to the mobility of birds and bats, there is likely to be minimal

impact to these fauna groups as they can freely move across the landscape to meet their resource needs.

Impact will be greatest for species with small home ranges and less mobility i.e., possums and reptiles. Fauna salvage will be a critical component of the vegetation removal and identifying suitable release sites prior to any removal. Whilst there will be residual impacts to fauna habitat, habitat enhancement of native vegetation retained in-situ on roadsides and within the mining tenement forms a key component of reducing residual impacts. Tree hollows from felled trees will be used as nest boxes and woody debris placed at ground level for refugia for terrestrial species.

Table 9.1 below addresses the residual impacts to threatened and non-threatened fauna groups recorded within or, close to the project. The EPBC Significant Impact Test criteria has been used to determine if the residual impacts cause significant impacts (DoE 2013). Refer to Section 15.3.1 for EPBC Act impact criteria.

**Table 9.1** Assessment of Residual Impacts to Threatened and Non-threatened Species

Species	Conservation Status		Habitat	Residual Impacts	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act				
Eastern Great Egret ( <i>Ardea modesta</i> )	-	VU	Feeds in open shallows up to 30cm and in wet pasture, mangroves, and mudflats.	<b>Residual Impact</b> <i>No loss of habitat</i>	N/A	N/A
Freckled Duck ( <i>Stictonetta naevosa</i> )	-	EN	Feeds in shallow water dabbling and / or filtering crustaceans aquatic seeds and grasses	<b>Residual Impact</b> <i>No loss of habitat</i>	N/A	N/A
Australasian Bittern ( <i>Botaurus poiciloptilus</i> )	END	CE	Prefers vegetated shallow freshwater and brackish swamps.	<b>Residual Impact</b> <i>No loss of habitat</i>	N/A	N/A
Superb Parrot ( <i>Polytelis swainsoni</i> )	VU	EN	Variety of habitats, typically forested areas, and adjacent grasslands for foraging	<b>Residual Impact</b> <i>No loss of critical habitat.</i>  Considered a vagrant to the study area. Preferred habitat not present.  Significant Impact Test undertaken, (refer to Section 6.7.1). Outcome of test was that no significant impact will occur.	N/A	N/A



Species	Conservation Status		Habitat	Residual Impacts	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act				
Black Falcon ( <i>Falco subniger</i> )		CE	Tree-lined watercourses and isolated woodlands.	<b>Residual Impact</b> <i>Reduction of foraging roosting, perches and nesting.</i>  Due to the species mobility, and proximity to alternative habitat, it is considered there will not be a significant impact to the species.	N/A	N/A
Diamond Firetail ( <i>Stagonopleura guttata</i> )		VU	Grassy woodlands, heath, and farmland with scattered trees.	<b>Residual Impact</b> <i>Reduction of foraging, perching, roosting and nesting.</i>  Whilst the study area is in species' distribution and, there are some regional records, they are likely to be present only occasionally. On this basis it is considered there will not be a significant impact to the species.	N/A	✓
Hooded Robin ( <i>Melanodryas cucullata</i> )		VU	Open forests, acacia shrubland and mallee, preferably diverse.	<b>Residual Impact</b> <i>Reduction of foraging, perching roosting and nesting.</i>  Whilst the study area is in species' distribution and, there are some regional records, they are likely to be present only occasionally. On this basis it is considered there will not be a significant impact to the species.	N/A	✓
Birds: Non-threatened	N/A	N/A	Woodlands, heath, farmland and waterbodies.	<b>Residual Impact</b> <i>Reduction of foraging, roosting and nesting.</i>  Due to the species mobility, and proximity to alternative habitat, it is considered there will not be a significant impact to the species.	✓	✓

Species	Conservation Status		Habitat	Residual Impacts	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act				
Eastern Bearded Dragon ( <i>Pogona barbata</i> )		VU	Dry woodlands, agricultural land and urban areas.	<b>Residual Impact</b> <i>Reduction of foraging, refugia basking and nesting.</i>  Salvage of the species prior to and during clearing of vegetation will mitigate impacts, resulting in individuals being relocated to areas set aside as described in the Biodiversity Conservation Plan.  On this basis it is considered there will not be a significant impact to the species.	N/A	N/A
Samphire Skink ( <i>Morethia adelaidsensis</i> )		EN	Inhabits saline or gypseous areas on the margins of freshwater lakes in samphire and chenopod scrublands.	<b>Residual Impact</b> <i>No loss of habitat. No vegetation removal is proposed.</i>  However, trenching for the pipeline is near potentially suitable habitat. Environment Management Plan will address requirements for protection of habitat. On this basis it is considered there will not be a significant impact to the species.	N/A	✓
Reptiles Non- threatened	N/A	N/A	Woodlands and grasslands	<b>Residual Impact</b> <i>Reduction of foraging, refugia, basking and nesting.</i>  Salvage of the species prior to and during clearing of vegetation will mitigate impacts, resulting in individuals being relocated to areas set aside as described in the Biodiversity Conservation Plan.  On this basis it is considered there will not be a significant impact to reptiles.	N/A	✓



Species	Conservation Status		Habitat	Residual Impacts	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act				
Growling Grass Frog	VU	VU	In vegetation around slow flowing or still water bodies such as lagoons, swamps, lakes and ponds. Typically, in bulrush, reeds and sedges.	<p><b>Residual Impact</b> <i>No residual impacts are expected.</i></p> <p>The removal of terrestrial vegetation adjacent to Kangaroo Lake is not considered prime habitat and will re-establish at completion of installation of pump.</p> <p>If any individuals are present, they will be relocated to an area as described in the Biodiversity Conservation Plan.</p>		
Amphibians: Non- threatened	N/A	N/A	Woodlands and water courses	<p><b>Residual Impact</b> <i>Reduction of foraging, refugia and soil substrate for burrowing species, (eastern banjo frog) and shrubs and trees; Perons Tree Frog.</i></p> <p>Salvage of the species prior to and during clearing of vegetation will mitigate impacts resulting in individuals being relocated to areas set aside as described in the Biodiversity Conservation Plan.</p> <p>On this basis it is considered there will not be a significant impact to reptiles.</p>	N/A	N/A
Mammals: Non- threatened species; microbats	N/A	N/A		<p><b>Residual Impact</b> <i>Reduction of tree hollows and foraging.</i></p> <p>Salvage during clearing of vegetation will mitigate impacts. Individuals will be relocated to areas set aside as described in the Biodiversity Conservation Plan.</p> <p>Due to microbats mobility and flight proximity to alternative habitat, and salvage, it is considered there will not be a significant impact</p>	N/A	✓

Species	Conservation Status		Habitat	Residual Impacts	EPBC Act Mallee Bird Community of Murray Darling Depression Bioregion	EPBC Act Species Associated with Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions
	EPBC Act	FFG Act				
Mammals: Non- threatened terrestrial species e.g., possums and antechinus.			Woodlands	<p><b>Residual Impact</b> <i>Tree hollows and foraging.</i></p> <p><i>There will be residual impact where suitable habitat has been removed over the life cycle of the mine until remediation has been completed.</i></p> <p>Salvage of the species prior to and during clearing of vegetation will mitigate impacts, resulting in individuals being relocated to areas set aside as described in the Biodiversity Conservation Plan.</p>	N/A	✓

## 10 Operational Impact Assessment

This section discusses the potential impacts because of operations of the project and the associated mitigation measures that aim to reduce impacts to an acceptable level.

### 10.1 Summary of impacts

The following indirect impacts have been identified during for the operational phase and are applicable for mine operations and the pipeline route:

- Vehicles moving of the road surface into the roadside fauna habitat.
- Vehicles parked within the Tree Protection Zone.
- Vehicle / wildlife collisions.
- Noise from vehicles and mine operations changes behaviour of fauna.
- Lights from vehicles and mine operations change behaviour of fauna.
- Fuel / oil spillages egresses into fauna habitat.
- Processing pond/s entrapping fauna or suffering ill health due to poor water quality.
- Dust dispersal within fauna habitat.

#### 10.1.1 EES Key Issues

Each of the key EES issues are addressed based on the description of habitat impacts in Sections 9.1.1. & 9.1.2.

*Direct loss or degradation of native vegetation and associated listed ecological communities, including those listed as threatened under the EPBC Act, the FFG Act.*

It is not envisaged there will any direct loss to EPBC or FFG listed communities during the operation phase.

There is the potential for degradation of the EPBC listed *Plains Mallee Box Woodland* because of vehicles encroaching into roadside fauna habitat / native vegetation, vehicles parked in the Tree Protection Zone, laydown areas not clearly marked etc.

*Direct loss or degradation of habitat for flora and fauna listed as threatened under the EPBC Act and FFG Act.*

It is not envisaged there will any direct loss to EPBC or FFG listed communities during the operation phase.

*Disruption to the movement of fauna between areas of habitat across the broader landscape.*

It is not envisaged there will any significant implications for non-terrestrial species e.g., birds and bats. Increased vehicle movements and indirect impacts such lights, noise and dust may disrupt movement of terrestrial species such as reptiles and mammals.

*Indirect habitat loss or degradation resulting from other effects.*

It is not envisaged that indirect impacts will lead to habitat loss. There is the possibility of degradation of habitat because of increased vehicle movement, dust, lights and noise from vehicles and the mine processing plant.

### *Indirect impacts of processing pond and tailing cells on wildlife health.*

Advice from VHM's engineers is that it is impractical to cover the process pond and tailings cells. Water retained in the processing pond and tailing cells has the potential to cause ill health to wildlife, this is discussed in more detail below.

## *10.2 Assessment of impacts to fauna from processing water pond*

The Groundwater report by CDN Smith (2023) assesses the impact to groundwater receptors as low (refer to Table 11.1 in CDN Smith report). *'Groundwater and connected surface water impacts are considered unlikely considering the current site conditions and proposed mining approaches. Groundwater discharge to surface occurs wherever groundwater flow intercepts the land surface. There are no known permanent surface expressions of groundwater that interact with groundwater within 10 km of the proposed Project area.'*

There is the potential for fauna unencumbered by the perimeter fencing to be attracted to the pond. Due to the pond gradient, (i.e., the lack of shallow water on the perimeters), it is unlikely to be suitable for migratory waders and will lack food in the form of aquatic insects, crustaceans, and plant material.

Waterfowl, waterbirds, (cormorants etc), and microbats are likely to try to access the processing pond if deterrents are not put in place. The ingestion of process water has the potential to cause detrimental health issues if the pond was to contain contaminants of concern. Read (1999) details incidences of waterfowl deaths at gold mining tailing and sewage ponds at Roxby Downs where contaminants were present, and researched strategies for minimising deaths in these water bodies. Strategies trialled included sonic gas gun and rotating beacon that reduced use by waterbirds and waterfowl by up to 90%. Read suggests supplementary strategies such as steep sided lined banks, increased human activity and noise can act as deterrents.

Griffiths (2021) researched drinking activity of microbats to assess the potential for contaminant ingestion of cyanide bearing wastewater ponds. The gold mining tailings decant water at Griffiths study sites were kept below the industry protective concentration limits i.e., 50 mg/L WAD. On this basis Griffiths concluded that if the decant water concentration limits are kept below industry protective standards, the risk was minimal to microbats.

The process water pond will be approximately 100m x 80m (8,000m<sup>2</sup>) within the processing plant of Area 1, located north of Bennett Road. The processing plant will have a 1.8-metre-high chain mesh fence around its perimeter. The pond is a mixture of water recovered from the processing plant and recovered decant tailings water, combined with top up water from Kangaroo Lake. The pond will be constructed with steep gradients on the perimeter and lined with plastic minimising the growth of sedges and reeds. The lining of the processing pond reduces the risk of seepage into the groundwater.

There will be high levels of mining activity within the processing area. This is likely to also reduce the desirability of the processing pond to fauna.

## *10.3 Tailing Cells - Assessment of impacts to fauna from tailings*

The Surface Water report (Hughes & Ollsen 2023) does not identify any significant impacts. *'The lack of waterways and low rainfall leads to a lack of surface water dependent sensitive*

*receptors / environmental values and a lack of reliance on surface water. This also reduces the potential for the development to cause undesirable surface water impacts.*

*'Surface water that flows into the pit will be recycled through the process plant to keep the workings dry during mining operations'.*

The mining blocks available to be filled with tailings are typically 5-10 ha, with each mining block containing 1-2 tailings cells. The mined areas are planned to be progressively backfilled in a staged manner, with tailings deposited and dewatered in-pit. The tailing cell areas will vary, as cells are sufficiently dry, they will receive overburden and topsoil from stockpiles and more cells will be opened. It is anticipated that around 50% of each tailings cell will be either a wet beach area or a decant water pond (<5 ha).

Mine tailings management will be undertaken to effectively dewater the tailings for reuse within the process plant, to reduce groundwater mounding entering the mine pit base or sides and allow for progressive rehabilitation to occur. Water depths within the pits will vary, wet months will carry more water than summer months due to inputs and evaporation.

There will be 24 hour 7 days a week operations and high level of activities within proximity to the tailing cells in the form of diggers, haulage trucks, sprinklers, and watercarts for dust suppression. These activities are likely to reduce the desirability of the tailing cells to fauna.

#### *10.4 Summary of mitigation*

It is not expected there will be any direct impacts to fauna habitat during the operation of the mine. Indirect impacts are considered the most likely threat to fauna and fauna habitat. Mitigation strategies such as the deployment of a water cart to reduce dust, clearly marked laydown / parking areas and no-go zones, speed limits, sensor lights and diffusers will reduce the likelihood of indirect impacts.

It is not envisaged that mitigation strategies are required at Kangaroo Lake for water extraction. The water extraction licence with Goulburn Murray Water (GMW) ensures the lake is maintained at historical levels to maintain ecological condition of littoral zone, with annual fluctuations of up to 600 mm. Salinity levels to be less than 4000 EC when lake is more than 75% full. Advice from GMW is as follows.

*"Our records indicate the design maximum discharge to the No 7 is 1,000 ML/d. This level has not been reached for some time and the current average discharge is generally around 150 ML/d. The highest daily volume reached since 2011 was about 900 ML/d. Irrigation intensity in the Torrumbarry Irrigation Area has decreased since the Millennium Drought".*

*VHM taking a peak of 4,700 ML during start up and commissioning, the impact on Kangaroo Lake would appear marginal. This is based on a daily take of 12.9 ML/d throughout the 365 days of the year, although I accept a higher peak occurs if pumping does not occur daily. At 26 ML/d over 180 days, the impact is low compared to recent discharge to support irrigation".*

There will be no EPBC Act implications or changes to the ecological character of Kangaroo Lake or flow-on effects to fauna or fauna habitat.

Due to the need to have regular access to the process water pond and, the daily activities at the tailing's cells, permanent covers to restrict access to fauna is not a viable option (VHM

2023, pers comm., 15 Feb). There is a lack of options for the design of the processing pond and tailings pits to restrict access to fauna beyond the exterior security fence.

### ***Process pond***

A range of design options were investigated for restricting fauna accessing the process water pond:

- Nets covering the pond:
  - *Issue:* Potential for birds and microbats to get caught in net causing death. This can also have Occupational Health and Safety issue for staff attempting to recover fauna caught in net.
- Automated laser lights:
  - *Issue:* *Early stages of development and unproven.*
- Bird scarers, Scare hawk visual deterrent and gas firing gun:
  - *Issue:* *Fauna gets habituated to deterrent overtime. Noise issues for surrounding residents.*

Bird deterrent disks have been successfully deployed on powerlines at Cheetham Wetlands to alter the flight path of waterbirds. The processing pond will have wires strung across at 10 m intervals with bird deterrent discs hung below the wire at 5 m spacings approximately 50 cm above the water. The discs will also act as an acoustic deterrent to microbats.

### ***Tailing Cells***

Due to the size of the tailing cells, high levels of activity and requirements for daily access to the mining blocks, the use of deterrent wires and bird deterrent discs is not a viable option. There are no other viable design options for the tailing cells. The emphasis will be on ensuring maximising dewatering efforts, monitoring of water quality, recording of any fauna found dead within or adjacent to the cells.

### ***Monitoring and Mitigation Strategies***

- Site induction and toolbox meetings will include the protocols for recording fauna interactions / observations and the relevant contact person.
- Any fauna deaths including exotics will be reported to supervisor and recorded in the company's incident database as part of reporting requirements.
- The surface decant water in the tailing cells and process pond water will be monitored to ensure it is within expected range and will be reviewed against appropriate standards to minimise the risk to staff and the environment.
- Chain mesh fencing will be erected around the perimeter of the mine tenement and processing pond minimising access to terrestrial fauna.

These actions will be incorporated into Construction / Operational Environmental Management Plan and endorsed by the relevant authorities. Potential impacts will be managed through the implementation of the mitigation, monitoring, environmental performance criteria, contingency strategies outlined in Sections 13.1 & 13.2.

### ***Conclusion***

There were very few records of threatened species within the Goshen mine study area. An assessment of the potential impacts to fauna at the processing pond and tailing cells, is



considered not significant, as described by DoE (2013), based on the mitigation strategies and high levels of activity at the processing pond and tailing cells.

The monitoring and mitigation strategies are based on accepted industry standards and the level of uncertainty are considered within acceptable levels. Notwithstanding this, adaptive management will play a key role in identifying any scope for improvement.

The assumptions are measurable and will be documented as part of VHM's regulatory reporting process. Remedial action will be undertaken if any of the assumptions are not met.

**Assumptions:**

- Tailings decant water and process water quality is not known to contain high levels of contaminants likely to be toxic to fauna, with surface water monitoring to identify changes.
- Perimeter fencing is maintained in good condition restricting access to terrestrial fauna.
- Site Induction and toolbox meetings describe the fauna related protocols and monitoring and reporting requirements.

**Level of uncertainty with proposed measures:**

- Low, if monitoring, and mitigation measures are strictly adhered too, and adaptive management is applied where applicable.

### *10.5 Summary of residual impacts*

It is expected the residual impacts will be confined to those that occur during the construction phase, i.e., removal of 6.8 ha within the mine area and transport intersections. Table 9.1 outlines the likelihood of residual impacts to threatened and non-threatened fauna. Residual impacts will be offset by the implementation of rehabilitation activities as outlined in Section 13.2. Arborists will monitor tree health biennially to assess if the canopy trees within the pipeline route have declined at a rate greater than expected in their normal life cycle.

## 11 Decommissioning

The objective of decommissioning is to establish post-closure conditions equivalent to the pre-mining conditions. This may require rehabilitation of the mine area to their pre-mining conditions. Through the avoid and minimise approach (DELWP 2017), there will not be any further direct loss of native vegetation / fauna habitat.

A 25-metre buffer has been applied and as such there will be no impacts during the mine closure providing the operational strategies put in place continue, (e.g., bunting around no go zones etc) are implemented. The construction and operational stage mitigation strategies equally apply to the decommissioning stage.

The mitigation measures provided in Table 13.1 provides advice on the mitigation measures required for decommissioning. Table 13.2 provides details of the monitoring, environmental performance criteria and contingencies requirements for the decommissioning stage.

Each of the key EES issues are addressed based on the description of habitat impacts. Note we have assumed the pipeline will be left in-situ and not removed from beneath the roads.

*Direct loss or degradation of native vegetation and associated listed ecological communities, including those listed as threatened under the EPBC Act, the FFG Act.*

It is not envisaged there will be any direct loss or degradation of EPBC or FFG Act listed communities as result of the decommissioning of the mine. It is expected that the contingencies will have confined impacts to the construction and operational residual impacts.

*Direct loss or degradation of habitat for flora and fauna listed as threatened under the EPBC Act, the FFG Act.*

It is not envisaged there will be any direct loss or degradation for fauna habitat listed under the EPBC Act and FFG Act. The contingencies will have reduced the impact of the construction and operational residual impacts.

*Disruption to the movement of fauna between areas of habitat across the broader landscape.*

It is not envisaged there will be any significant increase to the disruption of movement of fauna to those already occurring during the construction and operational phase of the mining activities.

*Indirect habitat loss or degradation resulting from other effects.*

It is not envisaged there will be any further indirect losses or degradation during decommissioning.

## 12 Cumulative Impacts with Other Projects

Cumulative impacts are not considered applicable to this project. There are no other projects that would add to the recognised identified impacts.

The closest large-scale project to the study area is the *Nyah, Vinifera and Burra Creek Floodplain Restoration Projects* which lies approximately 35km to the north. The project occurs within riparian habitats associated with the Murray River and is not expected to impact on environmental assets impacted by the Goschen Mineral Sands and Rare Earths Project. (Nature Advisory 2022).

Whilst not linked to any other projects, the impact on fauna habitat on road reserves of proposed water pipeline can be compounded by: local government road maintenance / construction activities and unauthorised firewood harvesting. These impacts are outside of the control of VHM.

## 13 Summary of avoidance and mitigation measures

Mitigation, management and contingency strategies are provided in Tables 13.1 below. These strategies will be included in the Construction Environment Management Plan. The strategies outlined will be applied for the full life cycle of the mine.

### 13.1 Avoidance and Mitigation measures

The objectives are to avoid, mitigate or manage the impacts to vertebrate fauna and fauna habitat associated with the project. These measures have been developed in line with relevant Commonwealth / State policies and guidelines to avoid and minimise impacts (e.g., DELWP 2017). The mitigation measures have been developed to specifically address the risks identified in the Risk Register (refer to appendix A).

The mitigation measures for each of the identified risks for each phase of the 'Project' are provided in Table 13.1. The mitigation measures along with the monitoring, environmental performance criteria and contingencies requirements for the decommissioning stage in Table 13.2 will also be included in the Construction / Operational Environmental Management Plan.

The table below forms part of the induction process for employees, contractors and visitors to the mine site. The inductee is required to sign off that they understand the identified risks and measures taken to avoid or minimise impacts.

**Table 13. 1** Mitigation measures relevant to vertebrate fauna and fauna habitat

Risk ID	Identified Risk	Avoid and Mitigation Measures	Phase	Responsibility	Timing	Inductee/s Signature
R01	Loss of fauna habitat / fragmentation within mine area and on road reserves adjacent to the mine tenement and pipeline route.	<ul style="list-style-type: none"> <li>Any proposed vegetation removal is not undertaken until applicable approvals and permits have been issued.</li> <li>Vegetation / habitat offsets, if applicable, are sourced in accordance with Commonwealth and / or State legislation or policy.</li> <li>Fauna salvage to be undertaken where fauna habitat is to be removed.</li> <li>Areas suitable to relocate fauna are identified prior to fauna habitat removal.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	<p>Contracted project ecologist.</p> <p>VHM Limited Site Manager and / or their assigned representative.</p>	3-months prior to commencing any site works/ vehicle and equipment deployment.	

Risk ID	Identified Risk	Avoid and Mitigation Measures	Phase	Responsibility	Timing	Inductee/s Signature
		<ul style="list-style-type: none"> <li>Habitat enhancement strategies are implemented in areas of fauna habitat to be retained:               <ul style="list-style-type: none"> <li>Woody debris from cleared areas is placed in retained areas of habitat consistent with EVC benchmark.</li> <li>Leaf litter from cleared areas is placed in retained areas of habitat consistent with EVC benchmark.</li> <li>Hollow branches from cleared areas is placed in retained areas of habitat.</li> </ul> </li> <li>Turning, passing areas and Tree Protection Zone (TPZ) are clearly identified with bunting.</li> <li>Perimeter bunting erected for no-go zones, designated laydown and parking areas, access routes in paddocks and property access tracks.</li> <li>Traffic Management Plan (TMP) is developed and approved by relevant regulatory authorities. TMP will include the following:               <ul style="list-style-type: none"> <li>Strategy to ensure there are no conflicts with vehicles approaching from opposite directions and vehicles are confined to existing road surface.</li> <li>Drivers are inducted to understand their responsibilities to stay on the road surface within</li> </ul> </li> </ul>				

Risk ID	Identified Risk	Avoid and Mitigation Measures	Phase	Responsibility	Timing	Inductee/s Signature
		<p>the defined vehicle movement routes.</p> <ul style="list-style-type: none"> <li>Drivers are informed of their responsibilities to stay on the road surface within the defined vehicle movement routes.</li> </ul> <p>Vehicles are maintained in roadworthy condition.</p>				
R02	Changes to the ecological character of Kangaroo Lake	<ul style="list-style-type: none"> <li>Soil spoil containment areas are identified in consultation with regulatory authorities prior to the commencement works.</li> <li>Works at the pump site on Kangaroo Lake are undertaken during dry ground conditions. Alternatively bog mats are deployed.</li> <li>A waterproof sealed bund is installed around the pump works area.</li> <li>Chemicals are not to be stored within 1km of Kangaroo Lake.</li> <li>Vehicle movements are kept to the minimum required.</li> <li>Equipment is checked prior to the commencement of works each morning to check for any chemical leaks.</li> <li>Any vehicle / equipment leaking chemicals is withdrawn from the works area immediately.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	3-months prior to commencing any site works.	



Risk ID	Identified Risk	Avoid and Mitigation Measures	Phase	Responsibility	Timing	Inductee/s Signature
R03	Vehicle / fauna interactions.	<ul style="list-style-type: none"> <li>Nearest veterinary clinic and / or wildlife carer contact details are included in CEMP.</li> <li>Speed restrictions i.e., 25km/h are established within the proposed transport routes.</li> <li>All employees and contractors' drivers are informed of the speed limits at the site induction.</li> </ul> <p>If a collision with wildlife occurs:</p> <ul style="list-style-type: none"> <li>If after advice from the veterinarian or wildlife carer is that euthanasia is in the best interest of the animal, a towel will be placed over the head. The animal will be moved out of public view and a blunt instrument used to strike the head with sufficient force to crush the skull.</li> <li>The site manager will be notified of the incident and the carcass returned to the plant site as soon as practicable and placed in a freezer designated for wildlife incidents. The incident will be entered into a wildlife incident register.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	<p>Contracted project wildlife ecologist.</p> <p>VHM Limited Site Manager and / or their assigned representative.</p> <p>Driver of vehicle.</p>	Induction prior to commencing any site works.	
R04	Dust	<ul style="list-style-type: none"> <li>Movement of heavy vehicles is restricted to the minimum required.</li> <li>On days of high winds, a water cart is deployed to ensure dust / gravel is not displaced onto</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Prior to proposed heavy vehicle movements	

Risk ID	Identified Risk	Avoid and Mitigation Measures	Phase	Responsibility	Timing	Inductee/s Signature
		fauna habitat / roadside vegetation. <ul style="list-style-type: none"> <li>EPA dust conditions are adhered to.</li> </ul>				
R05	Lights	<ul style="list-style-type: none"> <li>The Commonwealth Light Pollution Guidelines (2020) are used as guidance for light installation.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Prior to commencing any site works.	
R06	Chemical spills Tailing Ponds	<ul style="list-style-type: none"> <li>EPA conditions are adhered too for the storing and use of chemicals.</li> <li>Tailing ponds are covered to stop use by fauna.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Prior to commencing any site works.	
R07	Noise from vehicles and mine operation area	<ul style="list-style-type: none"> <li>Vehicles exhaust systems are maintained.</li> <li>Buffers in the form of bunds are considered around the mine operations area.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Prior to commencing any works each morning.	
R08	Fauna salvage along water supply pipeline trench	<ul style="list-style-type: none"> <li>Ecologist engaged for the duration of the pipeline construction.</li> <li>A 30cm high fauna fence, (constructed from damp course material), is erected adjacent to both sides of open trenches.</li> <li>Trench is checked prior to commencing trenching each morning and completion of work each day.</li> </ul>	Construction of water supply pipeline.	VHM Limited Site Manager and / or their assigned representative. Contracted project ecologist.	Prior to commencing any works each morning.	

Risk ID	Identified Risk	Avoid and Mitigation Measures	Phase	Responsibility	Timing	Inductee/s Signature
R09	Indirect Impacts – Ingesting contaminated water from process pond	<ul style="list-style-type: none"> <li>Installation of bird deterrent disks on wire at 10m intervals spaced at 5m approx., 50cm above water.</li> <li>Constant 24/7 mining activities makes the cells undesirable fauna habitat.</li> </ul>	Operational phase	Fencing contractor	Completion of construction of process pond	
R010	Indirect Impacts – Ingesting contaminated water from tailing cells	<ul style="list-style-type: none"> <li>No mitigation strategies implemented. Due to constant access requirements.</li> <li>Risk of toxic water being present is considered unlikely based on groundwater and surface water studies.</li> <li>Constant 24/7 mining activities makes the cells undesirable fauna habitat.</li> </ul>	Operational phase	Site environmental officer	During extraction of resource	

### 13.2 Monitoring and contingency measures

The monitoring, Environmental Performance Criteria (EPC) and contingency measures to assess vertebrate fauna impacts associated with the project are detailed below in Table 13.2

**Table 13. 2** Monitoring and contingency measures relevant to Vertebrate Fauna Technical Study

Measure ID	Monitoring	Environmental Performance Criteria	Phase	Responsibility	Contingency
Impacts to roadside vegetation	Daily monitoring that of vegetation / fauna habitat removal is within the approved areas.	<ul style="list-style-type: none"> <li>Native vegetation removal is confined to that approved by regulatory authorities.</li> </ul>	Construction phase	Project ecologist	Where a breach has occurred, it is raised at the Daily Toolbox Meeting. All site staff, contractors and site visitors are informed of their responsibilities. Vegetation offsets are sourced for the area of breach.

Measure ID	Monitoring	Environmental Performance Criteria	Phase	Responsibility	Contingency
	Weekly transport route audit is undertaken.	<ul style="list-style-type: none"> <li>There are no breaches of vehicle movements outside of the designated transport routes.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Where a breach has occurred, it is raised at the Daily Toolbox Meeting. All site staff, contractors and site visitors are informed of their responsibilities.
	Vehicles confined to road surface.	<ul style="list-style-type: none"> <li>Bunting / signs indicating No go zones, laydown and parking areas are in place.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	VHM Limited Site Manager and / or their assigned representative organises for bunting and signs to be replaced during the shift the breach was found.
	Vehicles parking in tree protection zone.	<ul style="list-style-type: none"> <li>There are no breaches of vehicles in no go zones, TPZ or outside of the designated laydown or parking areas</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	If an impact occurs to native vegetation is assessed by the project ecologist and offset / rehabilitation actions implemented. e.g., revegetation, nest box installation. Nest box to suit a range of species likely to use tree hollows. Monitoring to be undertaken by project ecologist.
	Monitoring every 2nd year by an arborist of trees identified as 'assumed lost' due impacts to the Tree Protection Zone.	<ul style="list-style-type: none"> <li>Trees are senescing at the expected normal rate of decline.</li> <li>No trees outside of those identified during the EES stage are declining.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	Project Arborist.	Arborist provides advice on tree health and further mitigation / rehabilitation strategies. Planting of supplementary of trees consistent with the relevant EVC.
	Monitoring of understorey / ground layer if trees 'assumed lost' senesce at higher rate than expected.	<ul style="list-style-type: none"> <li>Health of understorey flora remains at normal levels based as per habitat hectare scores.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	Project ecologist	Planting of understory component consistent with the relevant EVC.

Measure ID	Monitoring	Environmental Performance Criteria	Phase	Responsibility	Contingency
<b>Changes to the Ecological Character of Kangaroo Lake as an artefact of water extraction</b>	Water extraction rates and lake water levels to be monitored monthly as part of VHM Ltd water extractions licence.	<ul style="list-style-type: none"> <li>Water extraction rates are as per licence.</li> <li>Lake water levels remain as per prior extraction levels.</li> <li>Water quality indicators remain as per pre-extraction levels. (Refer to Aquatica Environmental 2022 report).</li> </ul>	Lifecycle of mine construction, operations, and decommissioning	Project Aquatic Ecologist / Hydrologist.	VHM site manager / representative and the project hydrologist meet with GMW representatives quarterly to discuss strategies to meet licence requirements.
<b>Vehicle / wildlife collisions.</b>	Vehicle speeds	<ul style="list-style-type: none"> <li>Weekly random monitoring of vehicle speeds within the transport routes via vehicle GPS modules.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	<p>If speed limits are continually ignored, HR department issues warning to recalcitrant drivers.</p> <p>Speed limiters installed in vehicles travelling within the mine tenement transport routes.</p>
	Process if vehicle / wildlife collision occurs	<ul style="list-style-type: none"> <li>A random staff member is asked to describe the process once a month at toolbox meeting.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	If staff member / contractor does not provide correct answers, run further induction sessions for all staff detailing the process.
	Monitoring of vehicle / wildlife collisions.	<ul style="list-style-type: none"> <li>Collisions are recorded in register and rate collisions monitored. Collisions are confined to 5 per annum.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	If collision rates are above the prescribed EPC (5 per annum), the project ecologist is to investigate strategies to minimise collisions.
<b>Fauna salvage</b>	Bunting erected in no-go zones	<ul style="list-style-type: none"> <li>Bunting erected prior to commencing works</li> </ul>	Construction of pipeline.	Project ecologist.	Project ecologist and / or backup ecologists stops construction activities until bunting is erected.

Measure ID	Monitoring	Environmental Performance Criteria	Phase	Responsibility	Contingency
	Salvage permits are obtained.	<ul style="list-style-type: none"> <li>Permits are current and relevant to the project.</li> </ul>	Construction of pipeline.	Project ecologist.	Back-up ecologist with relevant permits is on call.
	Installation of 30cm damp course plastic fauna exclusion fence sealed at ground level.	<ul style="list-style-type: none"> <li>Fence is installed correctly and maintained to restrict wildlife access to trench</li> </ul>	Construction of pipeline.	Project ecologist.	Ecologist checks exclusion fence is correctly installed.
	Project ecologist checks trench each morning and at completion of days' work.	<ul style="list-style-type: none"> <li>Project ecologist is on-site at the required pre-start times and maintains written records of any wildlife recoveries.</li> </ul>	Construction of pipeline.	Project ecologist.	Work does not commence until an ecologist with the relevant permits undertakes an inspection every morning during the construction of the pipeline. Back-up ecologist is on call.
	Project ecologist on-site for duration of daily work during vegetation / habitat clearing and construction of pipeline trench.	<ul style="list-style-type: none"> <li>Project ecologist is on-site for the duration of daily works maintains written records of wildlife recoveries.</li> </ul>	Construction of pipeline.	Project ecologist.	Back-up ecologist is on call if project ecologist is not available. Work will not commence until ecologist is on site.
<b>Predation of native fauna by pest animals.</b>	Annual monitoring of foxes and cats	<ul style="list-style-type: none"> <li>Sightings of foxes and cats increase from baseline numbers.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	Project ecologist.	Pest animal controller is engaged to reduce numbers to baseline or less.
<b>Noise from vehicles and mine operations impacting on behaviour of wildlife.</b>	Noise levels are monitored as part of daily vehicle checks.	<ul style="list-style-type: none"> <li>Vehicle noise is maintained within the described EPA levels.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	If vehicle/s are outside the prescribed EPA levels, the vehicle is withdrawn from service until it meets the required EPA levels.
	Noise levels are monitored daily.	<ul style="list-style-type: none"> <li>Plant operating noise are maintained within</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	If plant / equipment is operating outside the prescribed EPA levels, the plant /



Measure ID	Monitoring	Environmental Performance Criteria	Phase	Responsibility	Contingency
		the prescribed EPA levels			equipment is withdrawn from service until it meets the required EPA levels.
<b>Indirect impact</b> <b>Fuel and oil spillages egresses into fauna habitat / roadside native vegetation.</b>	Daily vehicle checks.	<ul style="list-style-type: none"> <li>Records are maintained of daily vehicle checks.</li> <li>Spills are dealt with immediately.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	Vehicle driver VHM Limited Site Manager and / or their assigned representative.	Vehicle is withdrawn from service until leak is rectified.
		<ul style="list-style-type: none"> <li>Spill kit is provided in vehicle</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	Vehicle driver	Vehicle remains in parking area until a spill kit is provided for the vehicle.
	Fuel and chemical storage areas.	<ul style="list-style-type: none"> <li>Fuel and chemical holding bays are checked weekly for potential egress points.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	An alternative fuel and chemical holding bay are available.
<b>Indirect impact</b> <b>Lights from vehicles and mine operations impacting on behaviour of wildlife.</b>	Monthly lighting checks	<ul style="list-style-type: none"> <li>Lights ingress into native vegetation is at agreed lux levels.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Movement sensors are operational. Light / baffle orientation is adjusted. Globe intensity is reduced.
	Daily vehicle checks	<ul style="list-style-type: none"> <li>Vehicle lights are confined to standard lights fitted on vehicle.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	Vehicle driver	Daily toolbox meeting reminds staff of vehicle light requirements when travelling within the mine tenement at night.
<b>Indirect impact</b> <b>Dust degrading fauna habitat</b>	Dust monitoring	<ul style="list-style-type: none"> <li>Dust levels are maintained within the prescribed EPA levels.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Water cart is deployed to suppress dust.
<b>Indirect impact</b> <b>Ingesting contaminated water from process pond</b>	Staff working near process pond to monitor for wildlife appearing unwell.	<ul style="list-style-type: none"> <li>Staff notifies VHM Environmental / OHS officer as soon as practicable.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Investigations of water quality is undertaken and rectified if above required standards, e.g., diluted with decanted water.

Measure ID	Monitoring	Environmental Performance Criteria	Phase	Responsibility	Contingency
<b><i>Indirect impact Ingesting contaminated water from tailing pit</i></b>	Staff working near tailing cells to monitor for wildlife appearing unwell.	<ul style="list-style-type: none"> <li>Staff notifies VHM Environmental / OHS officer as soon as practicable.</li> </ul>	Lifecycle of mine construction, operations, and decommissioning.	VHM Limited Site Manager and / or their assigned representative.	Investigations of water quality is undertaken and rectified if above required standards.

## 14 Summary of Implications Under Relevant Legislation

This study has assessed the impacts attributed to the construction and operation of the Goschen project on terrestrial fauna.

The significance of the impacts has been assessed in accordance with the evaluation framework, applicable legislation, policy and standards.

The following sections summarise the identified impacts under the relevant Commonwealth and Victorian legislation in relation to fauna and fauna habitat. Refer to the Nature Advisory Flora Technical Report (2022) for implications on flora and vegetation communities and, Aquatic Environmental (2022) for implications for aquatic species and habitat at Kangaroo Lake.

The construction of the mine will entail the removal of 7.0 ha of native vegetation / fauna habitat within Mine Area 1, Mine Area 3 and transport intersections. There are impacts to 61 canopy trees, due to trenching for the pipeline route (Option 3) and 3.05 ha associated with the removal of 51 scattered trees in cropped paddocks, (refer to Section 9.1).

The mine operations and supporting infrastructure as proposed does not entail any further removal of native vegetation / fauna habitat.

### 14.1 Commonwealth

A significant Impact Test was undertaken for Superb Parrot using the impact criteria for a vulnerable species. This was the only species considered for a significant impact assessment. This is an artefact of an individual bird recorded in the 'Project' area in 2018. The responses to the Significant Impact Assessment are based on information provided in the Superb Parrot National Action Plan (Baker-Gabb 2011) and Conservation Advice of the Threatened Species Scientific Committee (2016).

#### 14.1.1 Significant Impact Criteria

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DoE 2013). A Significant Impact Test was undertaken for the Superb Parrot due to the sighting of a juvenile bird within the 'Project' area by Ecoscape in 2018. The first step is to consider whether the sighting constitutes an '*important population*' as defined by DoE (2013).

An '*important population*' is a population that is necessary for a species' long-term survival and recovery.

This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range DoE (2013).

The observation of an individual Superb Parrot within the 'Project' does not constitute an important population based on the above criteria. Notwithstanding this, an assessment was

undertaken against the Significant Impact Criteria for a Vulnerable species detailed in Matters of National Environmental Significance Significant impact guidelines 1.1 (DoE 2013).

### ***Superb Parrot***

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

1. *Lead to a long-term decrease in the size of an important population of a species.*

There is lack of the Superb Parrot records and their preferred habitat for both feeding and forging i.e., large hollow bearing trees in river red gums (Baker-Gabb 2011), eucalypts associated with box woodland communities, Blakely's red gum, white box and yellow box (AG 2016), and local records (VBA & NatureKit).

It is considered that the project will not lead to a long-term decrease.

2. *Reduce the area of occupancy of an important population.*

The habitat considered important for Superb Parrot is not present within the 'Project Area'. The individual is likely to be a vagrant and / or immature dispersing male. The acknowledged area of occupancy is confined to the Barmah Forest area with occasional sightings south to Shepparton and east to Wangaratta and Corryong along the Murray River. Superb Parrot disappeared from central and southern Victoria in the early 1900s, and most of northern Victoria by 1930. They are absent from large parts of the Riverina and northern Victoria (AG 2016).

It is concluded that there will not be a reduction of the area of occupancy.

3. *Fragment an existing important population into two or more populations.*

The 'Project Area' is located over 100 km to the west of the currently recognised distribution (Baker Gabb 2011; Manning 2004; AG 2016), of this species where it is considered an important population as defined DoE (2013). It is considered the presence of an individual Superb Parrot in the 'Project Area' does not indicate a continuum of the population east of the known distribution of the species. The individual is likely to a vagrant or aviary escapee moving through, before utilising more suitable foraging habitat outside the 'Project Area'.

Fragmentation of an existing important population into two or more populations is not relevant to the 'Project Area'.

4. *Adversely affect habitat critical to the survival of a species.*

The Superb Parrot depend on hollows in dead trees for breeding and prefer trees close to watercourses (25 m), with a large trunk diameter, DBH >1 m (Baker-Gabb 2011).

On the inland slopes of NSW, they use at least six species of eucalyptus but are more closely associated with Blakely's red gum *E. blakelyi*. It has also been suggested that Superb Parrot may have a reliance on white box *E. albens* and yellow box *E. melliodora* (AG 2016). These eucalypt species are not present within the 'Project Area'. Whilst there are food sources within the 'Project Area', (i.e., a seeds and fruits), Superb Parrot habitat is dominated by gum and box eucalypts associated with the Murray River and its tributaries (AG 2016).

The habitat / vegetation in the 'Project Area' is not dominated by gum and box eucalypt communities associated with the Murray River and its tributaries. Canopy trees in the 'Project Area' are dominated by mallee trees e.g., bull mallee and black box.

*5. Disrupt the breeding cycle of an important population.*

Superb Parrots breed between September and December along the Murray River (in Victoria) in areas of mature river red gum, (DBH >1m) close to water courses (Baker-Gabb 2011). Canopy trees in the 'Project Area' are confined to mallee associated species, located 100km west of the known breeding area and distribution of Superb Parrot.

There will not be a disruption to the breeding cycle of Superb Parrot.

*6. Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.*

The impact to native vegetation is limited to approx. 7 ha within the mine areas and transport intersections and the impacts to canopy trees due to trenching within the TPZ. The trees will be left in-situ as will the understorey and groundcover component. Notwithstanding the removal of 7 ha of native vegetation and the potential impacts to 61 canopy trees within the pipeline route, they are located 100km from the known breeding areas and distribution of Superb Parrot.

The loss of canopy trees within the 'Project Area' will not modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

*7. Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.*

Invasive species control measures will be undertaken within the mining tenement. It is not envisaged that invasive species, other than those that already exist, (fox and feral cat), or their numbers will increase as result of the project.

*8. Introduce disease that may cause the species to decline.*

It is known that Superb Parrot are susceptible to psittacine beak and feather disease (PBFD) and the loss of nest hollows is likely to intensify competition and use of nest trees, and may increase the likelihood of transmission of the disease (AG 2016).

The use of tree hollows is confined to gum and box eucalypts associated with the Murray River and its tributaries (AG 2016), none of which are present within the 'Project Area'. The woodlands found in the 'Goschen Project' area lack the large trees with hollows preferred by Superb Parrot (AG 2016). Canopy trees are confined to canopy trees associated with mallee vegetation e.g., dumosa mallee, oil mallee, bull mallee and black box.

The project works will not introduce disease causing a decline in Superb Parrot.

*9. Interfere substantially with the recovery of the species.*

The 'Project Area' is located 100km from the known breeding area and distribution of Superb Parrot. The habitat within the 'Project Area' does not provide suitable habitat for breeding or permanent habitat. The removal of approx. 7 ha of native vegetation and potential impacts to 61 canopy trees, (note these trees are left in-situ and not removed), are not tree species associated with critical habitat for Superb Parrot. The observation of a Superb Parrot is considered an outlier of a dispersing juvenile, or an escapee aviary bird (Martin, A. 2022 pers comm., 30 March).

The project works will not interfere substantially with the recovery of the species.

### **Significant Impact Assessment Conclusions**

The responses to the Significant Impact Assessment are based on information provided in the Superb Parrot National Action Plan (Baker-Gabb 2011) and Conservation Advice of the Threatened Species Scientific Committee (2016).

The responses above provides evidence that the sighting of an individual bird does not constitute an 'Important Population' and the 'Project' will not have a significant impact on Superb Parrot.

### ***Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions***

Impacts to fauna and fauna habitat within the vegetation associated with *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* will occur. The removal of native vegetation is confined to approx., 6.8 ha within the two mine areas and 0.27 ha on the transport intersections.

**Note:** The loss of 6.8 ha is on the basis that Thompsons Rd and Bennett Rd are closed to public and included in the mine areas. Native vegetation / fauna habitat on the road reserve will be removed based on this assumption.

The mine areas and transport intersections were included in the 'Controlled Action' determination. The listing of *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* occurred post this determination and therefore impacts to this community do not have any implications under the EPBC Act.

### ***Kangaroo Lake (Kerang Ramsar Wetlands)***

The ecological character of Kangaroo Lake will be maintained at historical and current conditions (Baker, M. 2022, pers comm., 2 August). It is not envisaged that any changes will be beyond the Limits of Acceptable Change (LAS), as an artefact of water extraction or the construction of the pump station.

A significant Impact test was not undertaken for species associated with the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community* or Kangaroo Lake (Ramsar) for the reasons outlined in Section 6.7.3 and Section 6.7.4.

## **14.2 Victorian**

In relation to the evaluation objectives set out in the EES Scoping Requirements, the 'Project' will have direct residual impacts impact on fauna habitat within the mine area and transport intersections due to the removal of approx., 7 ha. The pipeline route has 61 canopy trees considered as lost and calculated as 4.7 ha based on DELWP's (2017) Guidelines for the removal or lopping of native vegetation.

In the worst-case scenario of declining tree health, will occur overtime. Notwithstanding this, the trees will remain in-situ as will the understorey and groundcover component and will continue to provide habitat in the form of roosting, perch, nesting, foraging and tree hollows.



There no FFG Act listed fauna communities or suitable habitat present in the '*Project*' area. The removal and '*loss*' of fauna habitat, will not impact on any FFG Act listed Victorian threatened fauna community e.g., Victorian Mallee Bird Community.

The residual loss of fauna habitat within the mine areas and transport intersections has the potential to disrupt the movement of fauna, but this is confined to terrestrial fauna. Except for the FFG listed Eastern Bearded Dragon, the threatened species considered likely to occur or observed within the 'Project Area' are highly mobile e.g., birds. Habitat corridors along the road network are expected to continue to facilitate movement of avian fauna across the wider landscape. Terrestrial fauna where native vegetation / fauna habitat removal is to occur will be salvaged and relocated to the 15 ha and 22 ha patches excluded from removal in the mine area.

The *Wildlife Act 1975* is relevant to fauna salvage and will form a major competent of the mitigation strategies where habitat removal is to occur and trenches for along the pipeline route. Authorisation from DELWP will be required to relocate both threatened and non-threatened fauna from impacted areas.

Mitigation strategies and contingencies have been identified to ensure direct and indirect impacts to threatened and non-threatened species are avoided and / or minimised. Monitoring, environmental performance indicators and contingency measures outlined in Section 13.2 will identify when there is a need to take remedial action to minimise the impacts to fauna habitat identify locations where habitat enhancement can occur.



## 15 Conclusion

The purpose of this report is to assess the extent of potential impacts to threatened fauna, fauna habitat / communities and non-threatened species due to the development of Goschen Project. A summary of the key ecological assets and values potentially affected by the project are summarised below.

### 15.1 Existing environment

The 'Project Area' is in an extensively cleared agricultural landscape which is used for primary production. The landscape primarily supports common species, the better fauna habitat is confined to where native vegetation persists on paddock fencelines, roadside reserves, several patches within paddocks and riparian zone of Kangaroo Lake.

#### 15.1.1 Threatened Communities

Nature Advisory (2022) has mapped 6 Ecological Vegetation Classes (EVC's) within the 'Project' footprint and road reserves that support fauna habitat. Several of the EVC's meets the criteria of the EPBC Act listed, (Critically Endangered), *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions*.

The EPBC listed *Mallee Bird Community of the Murray Darling Depression Bioregion* was modelled to potentially occur in the region. The *Mallee Bird Community* consists of an assemblage of 20 birds that are reliant on mallee habitat to persist. Six birds associated with the community were recorded over the duration of all surveys, none of which are listed as threatened at a state or Commonwealth level. It is considered that the Category D threshold is consistent with the *Mallee Bird Community of the Murray Darling Depression Bioregion* based on database records and species recorded during the surveys.

The FFG listed *Victorian Mallee Bird Community* was modelled to potentially occur in the 'Project Area'. The *Victorian Mallee Bird Community* consists of an assemblage of 25 birds and is closely aligned to the EPBC community. Six species associated with this community were recorded within the study area, none of which are listed as threatened at a state level. It is considered that the native vegetation does not support the assemblage of 25 birds to meet the criteria of the *Victorian Mallee Bird Community*.

Kangaroo Lake is one of the largest permanent freshwater lakes supplied by the Torrumbarry Irrigation System and forms part of the *Kerang Ramsar Wetlands* supporting several EPBC and / or FFG listed species.

#### 15.1.2 Significant Fauna Records

A review of the PMST and VBA indicates twenty-nine conservation significant fauna, or their habitat is predicted to occur. Thirteen listed under the EPBC Act are potentially present, they include three Critically Endangered, one Endangered, seven Vulnerable and two Migratory listed species. Twenty-six conservation significant species are listed as threatened under the FFG Act.

Sixty-two fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* have been recorded within the mine tenement study area.

Thirty-six fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* were recorded within the pipeline route options.

Twelve fauna associated with the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* were recorded on the escarpment of Kangaroo Lake.

Most of the species recorded within the *Plain's Mallee Box Woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions* community are relatively common non-threatened species.

Whilst the FFG listed Samphire Skink *Morethia adalaidensis* was not recorded during targeted surveys, a section of Mystic Park – Beauchamp Rd reserve is considered as suitable habitat (refer to Figure 7.3).

### 15.1.3 Fauna habitat

Unsurprisingly the best fauna habitat was found where native vegetation was mapped by Nature Advisory (2022). Fauna habitat within the mine tenement was limited to native vegetation on paddock fencelines, several small patches extending into paddocks and road reserves.

Fauna corridors are confined to roadside reserves. Several conservation significant birds and a reptile have been recorded using the remnant native vegetation / fauna habitat associated with the road reserves. Impacts to the canopy trees, adjacent to the pipeline are minimal and will not cause any significant change to the existing network of fauna habitat.

Kangaroo Lake provides fauna habitat for a range water dependant species, waterfowl, grebes, cormorant, birds of prey, native fish, frogs and turtles.

## 15.2 Avoid and Mitigation

The objectives are to avoid, mitigate or manage the impacts to vertebrate fauna and fauna habitat within the project footprint. These measures have been developed to address relevant Commonwealth and state policies using guidelines to avoid and minimise impacts (e.g., DELWP 2017). The mitigation measures have been developed to specifically address the risks identified in the Risk Register (refer to appendix A).

The avoidance and minimisation approach with respect to native vegetation (DELWP 2017) has been embraced by VHM Ltd. Under advice from Nature Advisory (2022), 25m-buffers have been applied to the placement of infrastructure within the mine from native vegetation.

The avoid and minimise principle approach taken for native vegetation has equally beneficial implications for fauna habitat within the mine tenement and transport routes. The mining area and associated infrastructure proposed will avoid of 60.629 hectares of native vegetation and 2,843 large trees compared to the 2018 proposal (Nature Advisory 2022).

As a result of the avoid and minimise approach, the actual removal of native vegetation is confined to 6.8 ha, 440 trees and 51 scattered trees within Mine Area 1 and Mine Area 3, 0.27 ha and 30 trees on the transport intersections.

There are potential impacts to fauna habitat / native vegetation due to the encroachment within TPZ of 61 canopy trees along the pipeline route.

Nature Advisory (NA) has estimated the loss as 4.7 ha for the understorey and groundcover flora component within the drip zone (DELWP 2022).

The understorey and groundcover component will be left intact, as will be canopy trees. It does not result in the removal of native vegetation / fauna habitat. The canopy trees and understorey will be retained in-situ.

The areas of fauna habitats to be retained in Mine Area 1, 15.4 ha and 22 scattered trees and Mine Area 3, 22.7 ha and 17 scattered trees will be important for connectivity for fauna moving across the landscape. The quality of these retained areas will be enhanced by planting of understorey and ground flora species found in the relevant EVC and using the organic materials of the areas. For example:

- woody debris placed across the retained patches consistent with EVC benchmarks
- leaf litter placed across the retained patch consistent with EVC benchmarks
- hollow branches fixed to non-hollow bearing trees.

These actions have been included in Table 13.1 and are expected to form part of the Native Vegetation Offset Management Plan by the project ecologists engaged to write the Offset management plan.

Restricting wildlife access to any water present in the tailing cells is not possible due to their size and the need for 24/7 access by vehicles and equipment. It is expected the cells will act as wet beach because of decanting water for use at the process plant. The drying out of the cells is a critical component of the operations for the placement of the tailings post processing.

Whilst the processing pond also requires regular access, water will be consistently present likely to attract wildlife. Mitigation measures will be put in place to reduce access and discourage the ponds attractiveness to wildlife. This will take the form of lining the pond to reduce growth of reeds and sedges, steep banks and bird deterrent disks strung across the pond.

### 15.3 Impact assessment findings

#### 15.3.1 Mine tenement and pipeline route

The residual impacts to threatened fauna and fauna habitat within the mine tenement and pipeline route have been minimised to the extent that there are no significant impacts as described DoE (2013), refer to Section 15.3.3. This is on the proviso that all recommended avoid and mitigation measures are implemented and, the monitoring of the Environmental Performance Criteria (EPC's) with the assigned contingency triggers are strictly adhered to.

Areas within the pipeline route options and the mine tenement, meet the criteria of the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions*. Fauna associated with this community were recorded during the various surveys within the mine tenement, the 3 route options and the periphery of Kangaroo Lake. Impacts to the EPBC listed *Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions* under the EPBC Act was undertaken at the request of the TRG to ensure impacts were considered for completeness of the assessment. The listing of this community was 'post' the mining 'Project Area' (refer to Figure 6.4), being determined as a 'Controlled Action' under the EPBC Act.

Infrastructure within the mining tenement will be located a minimum of 25-metres from fauna native vegetation / fauna habitat. Impacts within the mining tenement / transport route has been confined to the direct removal of 7.0 ha of native vegetation patches / fauna habitat including 470 trees, and 51 scattered trees.

The removal of 7.0 ha of native vegetation 1.3% of fauna habitat mapped, (541 ha), by Nature Advisory (2022) within the 'Project Area'. The removal of 470 trees within patches and 51 scattered trees represents 1.13% of the total number of trees, (45,911) estimated by Nature Advisory 2022).

Three potential pipeline routes were assessed, with the aim of avoiding or minimising the removal and / or impacts to native vegetation / fauna habitat. Loss off fauna habitat along the three pipelines options is a result of trenching within the TPZ of canopy trees. Fauna habitat / native vegetation will remain in-situ during the trenching activities.

The canopy trees within the TPZ along the three route options (refer to Figure 9.3.), were assessed by qualified arborists (Treetec 2022), to ascertain which route will have the least impact, Treetec (2022) assessed the impacts for the 3 routes as follows:

- Option 1: 112 canopy trees
- Option 2: 61 canopy trees
- Option 3: 61 canopy trees.

Treetec (2022), Nature Advisory (2022) and EcoAerial (2022) have all concluded that Option 3 in the best route option. This route has less roadside vegetation and more laydown areas than Option 2 and section of the router are less frequently used by vehicles.

The 61 canopy trees are spread across approx.17km of the pipeline route. The trees and understorey, leaf litter and woody debris will remain in-situ and continue to provide habitat for threatened fauna and fauna associated with Plains Mallee Box Woodland of the Murray Darling Depression and Riverina Bioregions Community. These trees represent 0.13% of canopy trees available in the study area.

The Plains-wanderer (*Pedionomus torquatus*) was not recorded during the targeted surveys undertaken by EcoAerial (2021). If Plains-wanderer were to utilise the 'Project Area' on occasions when crops form suitable habitat, this temporary habitat occurs extensively across the surrounding region and development of the Goschen Project would not cause any major change in habitat availability.

The outcomes of the surveys undertaken by EcoAerial (2021) concluded that it is highly unlikely that Plains-wanderer or habitat suitable to support Plains-wanderer is present within the 'Project Area'. The Plains-wanderer report is included in Appendix D.

There is limited direct connection of habitat to larger patches of fauna habitat in the region for terrestrial species. Figure 9.4 details the proximity of the pipeline routes to significant fauna habitat.

Whilst indirect impacts cannot be totally avoided e.g., vehicle / fauna collision, dust, light pollution and noise during all phases of the project, (construction, operational and decommissioning), the strategies outlined in Sections 13.1 and 13.2, e.g., vehicle speed limits, dust suppression, light baffles and sensors are expected to minimise any residual indirect impacts to fauna and fauna habitat.



SLR (2022) identified the extent of the impacts of noise during the various stages of the project are consistent with low ambient background noise levels during construction and / or within acceptable limits with the implementation of their mitigation strategies. A summary of their findings is presented below:

- Construction noise is likely to be below ambient background noise levels.
- Noise from water pipeline construction is likely to be below ambient background noise levels at most receptors, with only several locations in Mystic Park to receive elevated noise level.
- Operational noise in Area 1 mining operations (Year 1 to Year 8) was a moderate exceedance (5-7 dBA), but with a 6m bund around the perimeter reduced to exceedance to 2 dBA and considered a marginal exceedance.
- Area 3 mining will be used as a project operations office and mining to the north. Noise levels are predicted to comply with day-time noise limits.
- Operational noise from the pumping station at Kangaroo Lake is predicted to comply with all noise limits on the proviso a suitably designed acoustic enclosure and silencer is selected for the generator.

Road noise would be avoided, minimised or managed to required standards through the mitigation measures recommend by SLR.

### 15.3.2 Kangaroo Lake

PB (2013) identified a range of risks that threaten the environmental values of Ramsar Wetlands of which Kangaroo Lake is included. The risks include altered water regimes; salinity; pollution; pest plants and animals; resource utilisation; recreation and erosion. These risks can be an artifact of activities in the site wetlands, on land adjacent and in the wetlands' catchments.

Based on advice from the Goulburn Murray Water representative, Mark Bailey, it is unlikely there will be changes beyond the Limits of Acceptable Change (LAS), as an artefact of water extraction or the construction of the pump station.

*"Our records indicate the design maximum discharge to the No 7 is 1,000 ML/d. This level has not been reached for some time and the current average discharge is generally around 150 ML/d. The highest daily volume reached since 2011 was about 900 ML/d. Irrigation intensity in the Torrumbarry Irrigation Area has decreased since the Millennium Drought".*

*"VHM taking a peak of 4,700 ML/year during start up and commissioning, approx. 3-months, the impact on Kangaroo Lake would appear marginal. This is based on a daily take of 12.9 ML/d throughout the 365 days of the year, although I accept a higher peak occurs if pumping does not occur daily. At 26 ML/d over 180 days, the impact is low compared to recent discharge to support irrigation".*

The water extraction licence negotiated with Goulburn Murray Water will ensure Kangaroo Lake is maintained at, or near the historical water level to maintain ecological condition of littoral zone, and permanently inundated, water level to not be < 74.1 m AHD or > 72.9 m AHD for more than two years in a row (Butcher and Hale 2016). A mean salinity level of 360 EC with a maximum of 900EC's and salinity levels will be less than 4000 EC when the lake

is more than 75% full (KBR 2011). Monitoring of baseline conditions of water extraction as described by Aquatica Environmental (2022) will be undertaken.

### 15.3.3 Significance of Impacts

In the absence of a FFG framework for assessing the extent of impacts to threatened fauna communities and / or threatened fauna, the 'significant impact threshold' of the EPBC Act has been used for both EPBC Act and FFG Act listed species and communities.

The Goschen Project will not impact habitat critical to the survival of EPBC Act or FFG Act listed fauna or communities (DoE 2013) on:

- activities such as foraging, breeding, roosting, or dispersal
- the long-term maintenance of the species or ecological community including the maintenance of species or ecological communities
- species essential to the survival of the species or ecological community, such as pollinators
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

If the avoid, minimise, mitigation strategies, monitoring, environmental performance criteria and contingencies are implemented, it is considered the Goschen Project meets the principles of ecologically sustainable development i.e., *to protect biological diversity and maintain essential ecological processes and life-support systems* (DSE 2006).

## 16 References and Bibliography

Antos, M. J. and Bennett, A. F. (2006). 'Foraging ecology of ground-feeding woodland birds in temperate woodlands of southern Australia', *Emu-Austral Ornithology*. Taylor & Francis, 106(1), pp. 29–40.

Australian Government & Department of Agriculture, Water and the Environment. (2021a). Conservation Advice for the Plains mallee box woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plane Bioregions.

Australian Government & Department of Agriculture, Water and the Environment. (2021b). Conservation Advice for the Mallee Bird Community of the Murray Darling Depression Bioregion.

Australian Government & Department of the Environment and Energy. (2019a). Species Profile and Threats Database: *Nyctophilus corbeni* - Corben's Long-eared Bat, South-eastern Long-eared Bat.

Australian Government & Department of the Environment and Energy. (2019b). Species Profile and Threats Database: *Polytelis anthopeplus monarchoides* - Regent Parrot (eastern).

Australian Government & Department of the Environment and Energy. (2019c). Species Profile and Threats Database. *Pedionomus torquatus* - Plains-wanderer.

Australian Government & Department of the Environment and Energy. (2019d). Species Profile and Threats Database *Polytelis swainsonii* - Superb Parrot. Available at: [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=738](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=738) (Accessed: 20 September 2001).

Australian National Botanic Gardens. (2004). Mallee plants-surviving harsh conditions. Australian Government.

Australian Water Environments. (2015). Black Box Health and Management Options. Prepared for the Department of the Environment - Commonwealth Environmental Water Office. AWE Ref 15071.

Australian Wildlife Conservancy. (2018). Species profile - Painted Honeyeater. Available at: <http://www.australianwildlife.org/wildlife/painted-honeyeater.aspx>.

Baker-Gabb, D. J. (1988). 'The Diet and Foraging Behaviour of the Plains-wanderer *Pedionomus torquatus*', *Emu*, 88(2), pp. 115–118.

Baker-Gabb, D. J. (2011). National Recovery Plan for the Superb Parrot *Polytelis swainsonii*.

Baker-Gabb, D. J., Antos, M. and Brown, G. (2016). 'Recent decline of the critically endangered Plains-wanderer (*Pedionomus torquatus*), and the application of a simple method for assessing its cause: major changes in grassland structure.', *Ecological Management & Restoration*, 17(3), pp. 235–242.

Baker-Gabb, D. J., Benshemesh, J. and Maher, P. N. (1989). 'Revision of the Distribution, Status and Management of the Plains-wanderer *Pedionomus torquatus*.', *Emu*, 90, pp. 161–168.

- Baker-Gabb, D. J. and Hurley, V. (2011a). National Recovery Plan for the Regent Parrot (eastern subspecies) *Polytelis anthopeplus monarchoides*. Melbourne.
- Baker-Gabb, D. J. and Hurley, V. (2011b). National Recovery Plan for the Regent Parrot (eastern subspecies) *Polytelis anthopeplus monarchoides*.
- Bamford Consulting. (2005). Survey for the Night Parrot *Pezoporus occidentalis* in the Cloud Break Project Area, Fortescue Metals Group.
- Bamford Consulting. (2008). Fauna Assessment of BC Iron Nullagine Iron Ore Project. Prepared for BC Iron by Bamford Consulting Ecologists, Kingsley.
- Barea, L. P. (2012). 'Habitat influences on nest-site selection by the Painted Honeyeater (*Grantiella picta*): do food resources matter?', *Emu*, 112, pp. 39–45.
- Bell, H. L. (1984). 'A note on communal breeding and dispersal of young of the Hooded Robin *Petroica cucullata*', *Emu*. CSIRO, 84(4), pp. 243–244.
- Benshemesh, J. (2007). National Recovery Plan for Malleefowl *Leipoa ocellata*.
- Birdlife Australia. (2019). Atlas and Birddata.
- Birdlife International. (2016). *Falco subniger*. The IUCN Red List of Threatened Species 2016. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-%0A3.RLTS.T22696484A93567053.en>.
- Birdlife International. (2019). World Database of Key Biodiversity Areas.
- Blackmore, C. J. and Heinsohn, R. (2007). 'Reproductive success and helper effects in the cooperatively breeding grey-crowned babbler', *Journal of Zoology*. Wiley Online Library, 273(3), pp. 326–332.
- Brown, G. and Scroggie, M. (2012). 'Monitoring of the Threatened Hooded Scaly-foot *Pygopus schraderi* in North-central Victoria: Program Establishment and Initial Results', A Report to the Department of Sustainability and Environment, Parks Victoria and Trust for Nature., Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria.
- Brown, G. W. (2008). 'The Status of the Threatened Hooded Scaly-foot at Korrak Grassland Reserve, North-western Victoria, with Notes on Other Vertebrates', Final report to Department of Sustainability and Environment. 'Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria.
- Brown, J. L. et al. (1978). 'Effects of helpers on feeding of nestlings in the grey-crowned babbler (*Pomatostomus temporalis*)', *Behavioural Ecology and Sociobiology*. Springer, 4(1), pp. 43–59.
- Brown, J. L. et al. (1983). 'Socio-ecology of the Grey-crowned Babbler: population structure, unit size and vegetation correlates', *Behavioural Ecology and Sociobiology*. Springer, 13(2), pp. 115–124.
- Butcher, R. and Hale, J. (2016) Addendum to Ecological Character Description for the Kerang Wetlands Ramsar Site. Department of Environment, Land, Water and Planning. East Melbourne.
- CDM Smith. (2013). VHM Limited and as part of the EES process and the Inquiry and Advisory Committee Goschen Project EES – Groundwater. Report for VHM Limited.

- Cogger, H. G. (2014). Reptiles and Amphibians of Australia. 7th Edition. Collingwood, Victoria: CSIRO Publishing.
- Cooney, S. J. N. and Watson, D. M. (2005). 'Diamond Firetails (*Stagonopleura guttata*) preferentially nest in mistletoe', *Emu-Austral Ornithology*. Taylor & Francis, 105(4), pp. 317–322.
- Debus, S. J. S. (2008). 'The effect of Noisy Miners on small bush birds: an unofficial cull and its outcome', *Pacific Conservation Biology*. CSIRO, 14(3), pp. 185–190.
- Department of Environment. (2013). Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999
- Department of Environment and Energy (2020). Light Pollution Guidelines: National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia
- Department of Environment Land Water and Planning. (2019a). NatureKit. Available at: <http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit>.
- Department of Environment Land Water and Planning. (2019b). Victorian Biodiversity Atlas. Available at: <https://vba.dse.vic.gov.au/vba/index.jsp>.
- Department of Parks and Wildlife. (2018). NatureMap: Mapping Western Australia's Biodiversity. Department of Parks and Wildlife. Available at: <https://naturemap.dpaw.wa.gov.au/>.
- Department of Sustainability and Environment. (2013). Advisory List of Threatened Vertebrate Fauna in Victoria.
- Department of Sustainability Environment Water Population and Communities. (2011a). 'Survey Guidelines for Australia's Threatened Mammals. Guidelines for detecting mammals listed as threatened under the EPBC Act'.
- Department of Sustainability Environment Water Population and Communities. (2011b). 'Survey Guidelines for Australia's Threatened Reptiles. Guidelines for detecting reptiles listed as threatened under the EPBC Act'.
- Department of the Environment Water Heritage and the Arts. (2010a). Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999.
- Department of the Environment Water Heritage and the Arts. (2010b). 'Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the EPBC Act'.
- DEPI. (2013). Kerang Wetlands Ramsar Site Boundary Description Technical Report. East Melbourne, Victoria.
- DSE. (2004). Action Statement Flora and Fauna Guarantee Act 1988: Hooded Scaly-Foot *Pygopus nigriceps*.
- Dick, R. and Barker, C. H. (2000). The fauna of Western NSW: The Cobar Peneplain Biogeographic Region.
- EcoAerial. (2021). VHM Ltd Goschen Plains-wanderer Survey. Report for VHM Ltd.

- Ecology & Heritage Partner. (2018). Ecological Characterisation Assessment of the Proposed Goschen Mineral Sands Project, Goschen, Victoria. Desktop review of biodiversity databases and literature, vegetation mapping, and terrestrial fauna surveys.
- Ecoscape (Australia). (2018). Goschen Project - Targeted Conservation Significant Fauna Survey. Unpublished report for VHM.
- Ehmann, H. and Strahan, R. (1992). Encyclopedia of Australian animals: reptiles. Angus & Robertson.
- Emison, W. B. (1987). Atlas of Victorian birds. Department of Conservation, Forests and Lands and the Royal Australasian ....
- Fitri, L. and Ford, H. A. (2003a). 'Breeding biology of Hooded Robins *Melanodryas cucullata* in New England, New South Wales', Corella. AUSTRALIAN BIRD STUDY ASSOCIATION INC., 27(3), pp. 68–74.
- Fitri, L. and Ford, H. A. (2003b). 'Foraging behaviour of Hooded Robins *Melanodryas cucullata* in the northern tablelands of New South Wales', Corella. AUSTRALIAN BIRD STUDY ASSOCIATION INC., 27(3), pp. 61–67.
- Fitri, L. L. and Ford, H. A. (1997). 'Status, habitat preferences and social organisation of the Hooded Robin *Melanodryas cucullata* in the Northern Tablelands of New South Wales', Australian Bird Watcher, 17, pp. 142–155.
- Ford, H. A., Noske, S. and Bridges, L. (1986). 'Foraging of birds in eucalypt woodland in north-eastern New South Wales', Emu. CSIRO, 86(3), pp. 168–179.
- Garnett, S. et al. (1993). 'Notes on Live Night Parrot Sightings in North-western Queensland', Emu, 93, pp. 292–296.
- Garnett, S. T., Szabo, J. and Dutson, G. (2011a). The Action Plan for Australian Birds 2010. Melbourne.
- Garnett, S. T., Szabo, J. and Dutson, G. (2011b). The Action Plan for Australian Birds 2010. Goulburn Valley Water. (12 Feb. 2022) (online). Retrieved via Google Chrome. <https://www.g-mwater.com.au/water-resources/catchments/storages/murray/kangaroooracecourse>
- Geering, A., Agnew, L., and Harding, S. (2007). Shorebirds of Australia. CSIRO Publishing.
- Grice, D., Caughley, G. and Short, J. (1986). 'Density and distribution of the Australian bustard *Ardeotis australis*', Biological Conservation. Elsevier, 35(3), pp. 259–267.
- Griffiths, S.R. (Activity of insectivorous bats at gold mining water bodies: risks associated with consumption of cyanide-bearing waste solutions. Department of Zoology; The University of Melbourne.
- Hanspach, J. et al. (2012). 'Using trait-based filtering as a predictive framework for conservation: a case study of bats on farms in southeastern Australia', Journal of Applied Ecology, 49, pp. 842–850.
- Harewood, G. (2007). Fauna Assessment (Level 1) Lot 105 Old Coast Road Dawesville. Unpublished report on behalf of Cardno BSD Pty Ltd.



- Harrington, G. N., Maher, P. N. and Baker-Gabb, D. J. (1988). 'The biology of the Plains-wanderer on the Riverine Plain of New South Wales during and after drought.', *Corella*, 12, pp. 7–13.
- Heard, G. W. et al. (2006). 'Canid Predation: A Potentially Significant Threat to Relic Populations of the Inland Carpet Python *Morelia spilota metcalfei* (Pythonidae) in Victoria', *Victorian Naturalist*, The Field Naturalists Club of Victoria, 123(2), p. 68.
- Heard, G. W., Black, D. and Robertson, P. (2004). 'Habitat use by the inland carpet python (*Morelia spilota metcalfei*: Pythonidae): seasonal relationships with habitat structure and prey distribution in a rural landscape', *Austral Ecology*. Wiley Online Library, 29(4), pp. 446–460.
- Hughes, B. & Olsson, E. (2013). Technical report: Surface water impact assessment Goschen Mineral Sands and Rare Earths Project. Report for VHM Limited.
- Hutchinson, M. (2010). *Pogona barbata*. The IUCN Red List of Threatened Species 2010.
- Jones, S. R. (1999). Conservation biology of the Pink-tailed Legless Lizard *Aprasia parapulchella*. University of Canberra.
- Kellogg Brown & Root Pty Ltd. (2011). Ecological Character Description for the Kerang Wetlands Ramsar site. Report to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).
- King, B. R. (1980). 'Social organization and behaviour of the Grey-crowned Babbler *Pomatostomus temporalis*', *Emu*. CSIRO, 80(2), pp. 59–76.
- Kirby, A. E. (2017). Kerang Wetlands Ramsar Site Action Plan.
- Koehler, S. (2006). 'New record of a greater long-eared bat in Victoria.', *The Australian Bat Society Newsletter*, 26, pp. 43–44.
- Law, B. et al. (2016). 'Subtle use of a disturbance mosaic by the southeastern long-eared bat (*Nyctophilus corbeni*): an extinction-prone, narrow space bat.', *Wildlife Research*, 43, pp. 153–168.
- Malleefowl Preservation Group Inc. (2011). The Malleefowl.
- Manning, A. D. et al. (2006). 'Multi-scale site and landscape effects on the vulnerable superb parrot of south-eastern Australia during the breeding season.', *Landscape Ecology*, 21, pp. 1119–1133.
- Manning, A. D. et al. (2007). 'Large-scale spatial and temporal dynamics of the vulnerable and highly mobile superb parrot.', *Journal of Biogeography*, 34, pp. 289–304.
- Manning, A. D., Lindenmayer, D. B. and Barry, S. C. (2004). 'The conservation implications of bird reproduction in the agricultural "matrix": a case study of the vulnerable superb parrot of south-eastern Australia.', *Biological Conservation*, 120, pp. 363–374.
- Marchant, S. and Higgins, P. J. (1993). 'Handbook of Australian, New Zealand and Antarctic Birds. Raptors to Lapwings, vol. 2'. Oxford University Press, Melbourne.
- Mazzer, R. et al. (1998). The fauna of Western NSW: The Southern Mallee Region.

- McGuire, A. and Kleindorfer, S. (2007). 'Nesting success and apparent nest-adornment in Diamond Firetails (*Stagonopleura guttata*)', *Emu-Austral Ornithology*. Taylor & Francis, 107(1), pp. 44–51.
- McKilligan, N. (2005). *Heron, Egrets and Bitterns: Their biology and conservation in Australia*. CSIRO Publishing.
- Menkhorst, P., Rogers, D. I. and Clarke, R. (2017). *The Australian bird guide*. CSIRO Publishing.
- Michael, D. R. and Herring, M. W. (2005). 'Habitat of the Pink-tailed worm lizard *Aprasia parapulchella* in Albury, NSW', *Herpetofauna. Australasian Affiliation of Herpetological*, 35(2), pp. 103–111.
- Michael, D. R. and Lindenmayer, D. B. (2008) 'Records of the Inland Carpet Python, *Morelia spilota metcalfei* (Serpentes: Pythonidae), from the South-western Slopes of New South Wales', in *Proceedings of the Linnean Society of New South Wales*. Linnean Society of New South Wales, p. 253.
- Murphy, S. et al. (2018) Night Parrot surveys at Fortescue Marsh, Western Australia: Habitat analyses, survey review and recommendations. Report to Fortescue Metals Group, February 2018.
- Murphy, S. A. et al. (2015). A review of night parrot (*Pezoporus occidentalis*) biology and the identification of research priorities.
- Murphy, S. A., Silcock, J., et al. (2017). 'Movements and habitat use of the night parrot *Pezoporus occidentalis* in south-western Queensland.', *Australian Ecology*, 42, pp. 858–868.
- Murphy, S. A., Austin, J. J., et al. (2017) 'Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland.', *The Emu - Austral Ornithology*, pp. 1–7. Available at: [10.1080/01584197.2017.1292404](https://doi.org/10.1080/01584197.2017.1292404).
- Murphy, S. A., Paltridge, R., et al. (2017). 'Understanding and managing the threats to Night Parrots in south-western Queensland.', *The Emu - Austral Ornithology*.
- Nature Advisory. (2022). 18163\_Goschen\_removal\_220311\_nvr\_clearing\_01.
- Northcote, K. H. et al. (1968). *Atlas of Australian Soils, Sheets 1–10, with explanatory booklets*. Available at: [http://www.ke.tu-darmstadt.de/lehre/arbeiten/studien/2015/Dong\\_Ying.pdf](http://www.ke.tu-darmstadt.de/lehre/arbeiten/studien/2015/Dong_Ying.pdf).
- North Central Catchment Management Authority. (2007). *Kerang Wetlands Ramsar Action Plan 2016-2024*.
- NSW Government & Office of Environment and Heritage. (2018). *Painted Honeyeater – profile*.
- Parker, D. G. and Oliver, D. L. (2006). *Plains-wanderer habitat management guide. A photographic guide for visually assessing the grassland structure of Plains-wanderer habitat*. 2nd Edition.
- Parnaby, H. E. (2009). 'A taxonomic review of Australian Greater Long-eared Bats previously known as *Nyctophilus timoriensis* (Chiroptera: Vespertilionidae) and some associated taxa', *Australian Zoologist*, 35(1), pp. 39–81. Available at: <http://rzsns.w.metapress.com/content/j34wx4727618h118/fulltext.pdf>.

- Parsons Brinkerhoff. (2013). Lake Charm, Kangaroo Lake and Gunbower Creek Environs Strategy. Report for Gannawarra Shire Council.
- Parsons, B. (2008). Malleefowl in the Fragmented Western Australian Wheatbelt: Spatial and Temporal Analysis of a Threatened Species. UWA, Perth.
- Patchell, F. C. and Shine, R. (1986). 'Food habits and reproductive biology of the Australian legless lizards (Pygopodidae)', *Copeia*. JSTOR, pp. 30–39.
- Pizzey, G. and Knight, F. (2000). The Guide to the Birds of Australia. 9th Edition. Sydney, NSW: Harper Collins Publishers.
- Priday, S. D. (2010). 'Beyond the 'woody remnant' paradigm in conservation of woodland birds: habitat requirements of the Hooded Robin (*Melanodryas cucullata cucullata*)', *Emu-Austral Ornithology*. Taylor & Francis, 110(2), pp. 118–124.
- Read, J. L. (1994). 'The diet of three species of firetail finches in temperate South Australia', *Emu-Austral Ornithology*. Taylor & Francis, 94(1), pp. 1–8.
- Read, J. L. (1999). A strategy for minimizing waterfowl deaths on toxic waterbodies. *Journal of Applied Ecology*. **36**: 345-350.
- Roberts, I. and Roberts, J. (2001). Plains-wanderer (*Pedionomus torquatus*) Habitat Mapping including Woody Vegetation and other landscape features. Riverine Plains, NSW. Unpublished report to NSW National Parks and Wildlife Service.
- Robertson, P. (1999). 'Habitat assessment for five species of threatened vertebrates within the former Davies property at Terrick Terrick National Park', Unpublished report to Parks Victoria, Melbourne.
- Robertson, P. and Canessa, S. (2012). 'Review of monitoring of the hooded scaly-foot (*Pygopus schraderi*) at Lake Ranfurly, Mildura, 2002 to 2011', Report to Lower Murray Water by Wildlife Profiles Pty Ltd, Hurstbridge, Victoria.
- Robertson, P. and Heard, G. W. (2008). 'Report on field surveys for the Pink-tailed Worm Lizard (*Aprasia parapulchella*) in the Bendigo region, central Victoria: distribution, habitat, associations and population attributes', Report prepared for Department of Sustainability and Environment. Wildlife Profiles Pty Ltd, Heidelberg, Victoria.
- Robertson, P. and Hurley, V. (2001). 'Habitat of the inland carpet python (*Morelia spilota metcalfei*) in the Mildura Forest management area', A report prepared for the Forests Service of the Department of Natural Resources and the Environment.
- Robertson, P. and Sluiter, I. (2010). 'Monitoring of the Hooded Scaly-foot (*Pygopus schraderi*) at Lake Ranfurly, Mildura, 2009 to 2010', Wildlife Profiles Pty Ltd and Ogyris Pty Ltd, Hurstbridge, Victoria.
- Robinson, D. (2006). 'Is revegetation in the Sheep Pen Creek area, Victoria, improving Grey-crowned Babbler habitat?', *Ecological Management & Restoration*. Wiley Online Library, 7(2), pp. 93–104.
- Robinson, W. (1996). 'Ant Communities in the Grasslands of the Australian Capital Territory and the Role of Ant in the Ecology of the Pink-tailed Legless Lizard, *Aprasia Parapulchella*'. University of Canberra, Faculty of Applied Science.

- Schoenjahn, J. (2010). 'Field Identification of the Grey Falcon *Falco hypoleucos*', Australian Field Ornithology, 27, pp. 49–58.
- Schoenjahn, J. (2011). 'How scarce is the Grey Falcon?', Boobook, 29(1), pp. 24–25.
- Schoenjahn, J. (2013). 'A hot environment and one type of prey: investigating why the Grey Falcon (*Falco hypoleucos*) is Australia's rarest falcon.', Emu, 113(1), pp. 19–25.
- Shine, R. and Fitzgerald, M. (1995). 'Variation in mating systems and sexual size dimorphism between populations of the Australian python *Morelia spilota* (Serpentes: Pythonidae)', Oecologia. Springer, 103(4), pp. 490–498.
- Shine, R. and Llewellyn, L. C. (1994). The Biology and Management of the Diamond Python (*Morelia Spilota Spilota*) and Carpet Python (*MS Variegata*) in NSW. NSW National Parks and Wildlife Service.
- SLR Consulting Australia Pty Ltd (2022). Draft Noise Impact Assessment: Goschen Mineral Sands and Rare Earths Project.
- Spectrum Ecology. (2019). Goschen Project Vertebrate Fauna Ver 3. Report for VHM Ltd
- Spectrum Ecology / EcoAerial. (2022). Goschen Project Vertebrate Fauna Ver 4. Report for VHM Ltd.
- State of Victoria (Agriculture Victoria). (2019). Site 9 Lake Lalbert. Available at: [http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/nthcen\\_enviro\\_monitoring\\_site\\_s9](http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/nthcen_enviro_monitoring_site_s9) (Accessed: 6 May 2019).
- Sullivan, D. (2016). 'The breeding and non-breeding behaviour of the Hooded Robin *Melanodryas cucullata* in Canberra, 1990-1991', Australian Field Ornithology, 15(3).
- Thackway, R. and Cresswell, I. D. (1995). 'An Interim Biogeographic Regionalisation for Australia (IBRA)'.
- Turbill, C. and Ellis, M. (2006). 'Distribution and Abundance of the South-eastern form of the Greater Lingered Bat *Nyctophilus timoriensis*.', Australian Mammalogy, 28, pp. 1–6.
- Val, J., Foster, E. and Le Breton, M. (2001). Biodiversity survey of the Lower Murray Darling.
- Victorian Department of State Development, B. and I. (2014). Victoria - Seamless Geology 2014. Bioregional Assessment Source Dataset.
- Watson, M.D. (2003). 'The standardised search: An improved way to conduct bird surveys'. Austral Ecology 28, 515-525.
- Watson, J. et al. (2002). 'Woodland fragmentation is causing the decline of species and functional groups of birds in southeastern Australia', Pacific Conservation Biology. CSIRO, 8(4), pp. 261–270.
- Webster, R. (1988). Superb Parrot - A survey of the breeding distribution and habitat requirements. Australian National Parks and Wildlife Service, Canberra.
- Webster, R. and Ahern, L. (1992). Management for the conservation of the Superb Parrot *Polytelis swainsonii* in New South Wales and Victoria.
- Wilson, S. and Swan, G. (2017). A Complete Guide to Reptiles of Australia. 5th Edition. Sydney, NSW: New Holland Publishers.

Wong, D. et al. (2011). 'The life history and ecology of the Pink-tailed Worm-lizard *Aprasia parapulchella* Kluge—a review', *Australian Zoologist*. Royal Zoological Society of NSW, 35(4), pp. 927–940.

Technical report: Surface water impact assessment Goschen Mineral Sands and Rare Earths Project

Van der Ree, R, Smith, D.J and Grilo, C. (2015). *Handbook of Road Ecology*. Wiley Blackwell West Sussex United Kingdom.

Ziembicki, M. (2010). *Australian Bustard*. CSIRO PUBLISHING.

Ziembicki, M. and Woinarski, J. C. Z. (2007). 'Monitoring continental movement patterns of the Australian Bustard *Ardeotis australis* through community-based surveys and remote sensing', *Pacific Conservation Biology*. CSIRO, 13(2), pp. 128–142.





## **Appendix A – Risk Register**

Risk ID	Risk pathway [including ID of relevant receptors]	Causes / Background	Initial risk level			Final mitigation	Residual risk level		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Construction									
R01	Loss of fauna habitat within mine area, intersections and, road reserves adjacent to the proposed pipeline alignment.	Removal of native vegetation within mine area and intersections and, 'assumed loss' due to impacts to the tree protection zone of canopy trees along the pipeline route.	Almost certain	Critical	Very high	<ul style="list-style-type: none"><li>Vegetation / fauna habitat to be retained is clearly marked and bunting erected to confine vehicles and equipment to work areas.</li></ul>	Almost certain	Critical	Very high
R02	Changes to the ecological character of Kangaroo Lake	As an artefact of construction of pump station e.g., soil and / or chemical spill etc.	Possible	Moderate	Medium	<ul style="list-style-type: none"><li>Ensure soil spoil is contained to works area.</li><li>Chemicals are stored away from riparian zone of Kangaroo Lake and contained within a waterproof sealed bund.</li></ul>	Unlikely	Minor	Low
R03	Indirect impacts	Vehicle / wildlife collisions.	Likely	Moderate	High	The following mitigation strategies will be deployed: <ul style="list-style-type: none"><li>Speed restrictions are established in areas where native vegetation exists on roadside reserves.</li></ul>	Possible	Minor	Medium

Risk ID	Risk pathway [including ID of relevant receptors]	Causes / Background	Initial risk level			Final mitigation	Residual risk level		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
R04	Indirect impacts	Dust	<i>Likely</i>	<i>Moderate</i>	<i>High</i>	<ul style="list-style-type: none"> <li>Water cart is deployed to ensure dust / gravel is not displaced onto fauna habitat / roadside vegetation and EPA dust conditions are adhered too.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R05	Indirect impacts	Light pollution	<i>Possible</i>	<i>Moderate</i>	<i>Medium</i>	<ul style="list-style-type: none"> <li>The Commonwealth Light Pollution Guidelines: National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020 are used as guidance for lighting installation.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R06	Indirect impacts	Chemical spills	<i>Likely</i>	<i>Moderate</i>	<i>High</i>	<ul style="list-style-type: none"> <li>EPA conditions are adhered to for the storing and use of chemicals.</li> <li>Vehicles are maintained in roadworthy condition.</li> <li>Vehicles exhaust systems are maintained</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R07	Indirect impacts	Noise	<i>Possible</i>	<i>Moderate</i>	<i>Medium</i>	<ul style="list-style-type: none"> <li>Buffers in the form of planted vegetation and / or bunds are considered around the mine operations area.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R08	Indirect impacts	Fauna trapped in trench during installation of water supply pipeline.	<i>Likely</i>	<i>Moderate</i>	<i>Medium</i>	<p>Fauna salvage will entail the following:</p> <ul style="list-style-type: none"> <li>Fauna fence is erected along open trenched and fauna spotter engaged for the duration of the pipeline construction to remove fauna found in pipeline trench.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
<b>Operation</b>									
R01	Loss and / or fragmentation of fauna habitat	Impacts to native vegetation because of	<i>Possible</i>	<i>Moderate</i>	<i>Medium</i>	The following mitigating strategies are to be implemented:	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>

Risk ID	Risk pathway [including ID of relevant receptors]	Causes / Background	Initial risk level			Final mitigation	Residual risk level		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
		vehicles going off the road surface				<ul style="list-style-type: none"> <li>Traffic management plan is developed to ensure there are no conflicts with vehicles approaching from opposite directions.</li> <li>Drivers are informed of their responsibilities to stay on the road surface within the defined vehicle movement routes.</li> <li>Drivers are inducted to understand their responsibilities to stay on the road surface within the defined vehicle movement routes.</li> <li>Turning and passing areas are clearly identified.</li> </ul>			
R02	Changes to the ecological character of Kangaroo Lake	As an artefact of water extraction.	Possible	Moderate	Medium	<ul style="list-style-type: none"> <li>Water extraction licence will be agreed to with Goulburn Murray Water to ensure the lake is maintained at or near full historical levels</li> <li>Maintain ecological condition of littoral zone, and permanently inundated, water level to not be &gt; 74.1 m AHD or &lt; 72.9 m AHD for more than two years in a row.</li> <li>Salinity levels to be less than 4,000 EC when lake is more than 75% full.</li> </ul>	Possible	Minor	Medium
R03	Indirect impacts	Vehicle / wildlife collisions.	Likely	Moderate	High	<p>The following mitigation strategies will be deployed:</p> <ul style="list-style-type: none"> <li>Speed restrictions are established in areas where native vegetation exists on roadside reserves.</li> <li>Signs erected in areas of high collision risk.</li> </ul>	Possible	Minor	Medium
R04	Indirect impacts	Dust	Likely	Moderate	High	<ul style="list-style-type: none"> <li>Water cart is deployed to ensure dust / gravel is not displaced onto fauna habitat / roadside</li> </ul>	Possible	Minor	Medium

Risk ID	Risk pathway [including ID of relevant receptors]	Causes / Background	Initial risk level			Final mitigation	Residual risk level		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						vegetation and EPA dust conditions are adhered too.			
R05	Indirect impacts	Light pollution	Possible	Moderate	Medium	<ul style="list-style-type: none"> <li>The Commonwealth Light Pollution Guidelines: National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020 are used as guidance for lighting installation.</li> </ul>	Possible	Minor	Medium
R06	Indirect impacts	Chemical spills / fauna interactions with chemical spills	Likely	Moderate	High	<ul style="list-style-type: none"> <li>EPA conditions are adhered too for the storing and use of chemicals.</li> <li>Vehicles are maintained in roadworthy condition.</li> <li>Plant and infrastructure are maintained in serviceable condition.</li> <li>Fencing is placed around tailing ponds.</li> <li>Tailing Ponds are covered to restrict birds from accessing tailings.</li> </ul>	Possible	Minor	Medium
R07	Indirect impacts	Noise	Possible	Moderate	Medium	<ul style="list-style-type: none"> <li>Buffers in the form of planted vegetation and / or bunds are considered around the mine operations area.</li> <li>Time restriction for use of heavy vehicles on road network.</li> </ul>	Possible	Minor	Medium
R08	Indirect impacts	Indirect Impacts – Ingesting contaminated	Possible	Moderate	Medium	<ul style="list-style-type: none"> <li>Installation of bird deterrent disks on wire at 10m intervals spaced at 5m approx., 50cm above water.</li> <li>Constant 24/7 mining activities makes the cells undesirable fauna habitat.</li> </ul>	Unlikely	Moderate	Medium

Risk ID	Risk pathway [including ID of relevant receptors]	Causes / Background	Initial risk level			Final mitigation	Residual risk level		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
		water from process pond							
R09	Indirect impacts	Indirect Impacts – Ingesting contaminated water from tailing cells	<i>Unlikely</i>	<i>Minor</i>	<i>Low</i>	<ul style="list-style-type: none"> <li>No mitigation strategies implemented. Due to constant access requirements.</li> <li>Risk of toxic water being present is considered unlikely based on groundwater and surface water studies.</li> <li>Constant 24/7 mining activities makes the cells undesirable fauna habitat.</li> </ul>	<i>Rare</i>	<i>Minor</i>	<i>Low</i>
<b>Decommissioning</b>									
R01	Loss and / or fragmentation of fauna habitat	Impacts to native vegetation because of vehicles going off the road surface	<i>Possible</i>	<i>Moderate</i>	<i>Medium</i>	<p>The following mitigating strategies are to be implemented:</p> <ul style="list-style-type: none"> <li>Traffic management plan is developed to ensure there are no conflicts with vehicles approaching from opposite directions.</li> <li>Drivers are informed of their responsibilities to stay on the road surface within the defined vehicle movement routes.</li> <li>Drivers are inducted to understand their responsibilities to stay on the road surface within the defined vehicle movement routes.</li> <li>Turning and passing areas are clearly identified.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R02	Indirect impacts	Vehicle / wildlife collisions.	<i>Likely</i>	<i>Moderate</i>	<i>High</i>	<p>The following mitigation strategies will be deployed:</p> <ul style="list-style-type: none"> <li>Speed restrictions are established in areas where fauna habitat exists on roadside reserves.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R03	Indirect impacts	Dust	<i>Likely</i>	<i>Moderate</i>	<i>High</i>	<ul style="list-style-type: none"> <li>Water cart is deployed to ensure dust / gravel is not displaced onto fauna habitat / roadside</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>



Risk ID	Risk pathway [including ID of relevant receptors]	Causes / Background	Initial risk level			Final mitigation	Residual risk level		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						vegetation and EPA dust conditions are adhered too.			
R04	Indirect impacts	Light pollution	<i>Possible</i>	<i>Moderate</i>	<i>Medium</i>	<ul style="list-style-type: none"> <li>The Commonwealth Light Pollution Guidelines: National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020 are used as guidance for lighting installation.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R05	Indirect impacts	Chemical spills	<i>Likely</i>	<i>Moderate</i>	<i>High</i>	<ul style="list-style-type: none"> <li>EPA conditions are adhered too for the storing and use of chemicals.</li> <li>Vehicles are maintained in roadworthy condition.</li> <li>Vehicles exhaust systems are maintained</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>
R06	Indirect impacts	Noise	<i>Possible</i>	<i>Moderate</i>	<i>Medium</i>	<ul style="list-style-type: none"> <li>Buffers in the form of planted vegetation and / or bunds are considered around the mine operations area.</li> </ul>	<i>Possible</i>	<i>Minor</i>	<i>Medium</i>



## **Appendix B – Fauna Assemblages**

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
MAMMALS								
Tachyglossidae								
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>						•	
Dasyuridae								
Fat-tailed Dunnart	<i>Sminthopsis crassicaudata</i>				•			
Phalangeridae								
Brush-tailed Possum	<i>Trichosurus vulpecula</i>			•	•		•	
Macropodidae								
Eastern Grey Kangaroo	<i>Macropus giganteus</i>				•		•	•
Western Grey Kangaroo	<i>Macropus fuliginosus</i>				•	•		
Red Kangaroo	<i>Osphranter rufus</i>					•		
Swamp Wallaby	<i>Wallabia bicolor</i>				•			
Molossidae								
White-striped Freetail Bat	<i>Austronomus australis</i>				•		•	•
Southern Free-tailed Bat	<i>Ozimops planiceps</i>						•	•
Vespertilioinidae								
Gould’s Wattled Bat	<i>Chalinolobus gouldii</i>						•	•
Chocolate Wattled Bat	<i>Chalinolobus morio</i>						•	
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>				•		•*	•
Inland Broad-nosed Bat	<i>Scotorepens balstoni</i>						•	
Little Forest Bat	<i>Vespedalus vulturnus</i>				•		•*	•
Southern Forest Bat	<i>Vespedalus regulus</i>							•
Introduced Mammals								
House Mouse	<i>Mus musculus</i>				•	•	•	
Red Fox	<i>Vulpes</i>			•	•	•	•	•
Feral Cat	<i>Felis catus</i>						•	•
European Rabbit	<i>Oryctolagus cuniculus</i>				•	•	•	•
European Hare	<i>Lepus europeaus</i>				•	•	•	•
Sheep	<i>Ovis aries</i>						•	•
Cattle	<i>Bos taurus</i>							•
BIRDS								

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Dromaiidae								
Emu	<i>Dromaius novaehollandiae</i>			•				
Phasianidae								
Stubble Quail	<i>Coturnix pectoralis</i>			•				
Anatidae								
Black Swan	<i>Cygnus atratus</i>			•	•			
Australian Shelduck	<i>Tadorna tadornoides</i>			•	•			
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>			•	•			
Australian Wood Duck	<i>Chenonetta jubata</i>			•	•			
Pacific Black Duck	<i>Anas superciliosa</i>			•	•			
Australasian Shoveler	<i>Spatula rhynchotis</i>		VU	•	•			
Grey Teal	<i>Anas gracilis</i>			•	•			
Hardhead	<i>Aythya australis</i>		VU	•	•			
Blue-billed Duck	<i>Oxyura australis</i>		VU	•	•			
Musk Duck	<i>Biziura lobata</i>		VU	•	•			
Podicipedidae								
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>			•	•		o	
Hoary-headed Grebe	<i>Poliiocephalus</i>			•	•		o	
Great Crested Grebe	<i>Podiceps cristatus</i>			•	•			
Threskiornithidae								
Australian White Ibis#	Threskiornis moluccus			•				
Straw-necked Ibis#	Threskiornis spinicollis			•				
Yellow-billed Spoonbill#	Platalea flavipes			•				
Ardeidae								
Australasian Bittern	<i>Botaurus poiciloptilus</i>	EN	CR		•			
Little Bittern	<i>Ixobrychus minutus</i>				•			
Nankeen Night Heron	<i>Nycticorax caledonicus</i>			•	•			
Cattle Egret	<i>Bubulcus ibis</i>				•			
White-necked Heron	<i>Ardea pacifica</i>			•	•			
Eastern Great Egret	<i>Ardea alba</i>		VU	•	•			
Intermediate Egret	<i>Ardea intermedia</i>				•			

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
White-faced Heron	<i>Egretta novaehollandiae</i>			•	•			
Little Egret	<i>Egretta garzetta</i>		EN		•			
Pelecanidae								
Australian Pelican	<i>Pelecanus conspicillatus</i>			•	•			
Phalacrocoracidae								
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>			•	•			
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>			•	•			
Pied Cormorant	<i>Phalacrocorax varius</i>				•			
Great Cormorant#	<i>Phalacrocorax carbo</i>			•	•			
Anhingidae								
Australasian Darter	<i>Anhinga novaehollandiae</i>			•	•			
Accipitridae								
Black-shouldered Kite	<i>Elanus caeruleus</i>			•	•	•	•	•
Letter-winged Kite	<i>Elanus scriptus</i>				•			
Little Eagle	<i>Hieraaetus morphnoides</i>			•	•			
Wedge-tailed Eagle	<i>Aquila audax</i>			•	•	•	•	
Brown Goshawk	<i>Accipiter fasciatus</i>			•	•	•		
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>			•	•			
Swamp Harrier	<i>Circus approximans</i>				•			
Spotted Harrier	<i>Circus assimilis</i>			•	•			
Black Kite	<i>Milvus migrans</i>			•	•		•	
Whistling Kite	<i>Haliastur sphenurus</i>			•	•	•	•	
Otididae								
Australian Bustard	<i>Ardeotis australis</i>		CR	•	•			
Rallidae								
Australian Spotted Crane	<i>Porzana fluminea</i>				•			
Baillon's Crane	<i>Zapornia pusilla</i>				•			
Spotless Crane	<i>Zapornia tabuensis</i>							
Black-tailed Native-hen	<i>Tribonyx ventralis</i>				•			
Dusky Moorhen	<i>Gallinula tenebrosa</i>				•			
Eurasian Coot	<i>Fulica atra</i>				•			

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Turnicidae								
Little Button-quail	<i>Turnix velox</i>			•	•			
Pedionomidae								
Plains-wanderer	<i>Pedionomus torquatus</i>	CR	CR		•			
Burhinidae								
Bush Stone-curlew	<i>Burhinus grallarius</i>		CR	•				
Recurvirostridae								
Black-winged Stilt	<i>Himantopus leucocephalus</i>			•	•			
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>			•				
Charadriidae								
Banded Lapwing	<i>Vanellus tricolor</i>			•	•			
Masked Lapwing	<i>Vanellus miles</i>			•	•		o	
Inland Dotterel	<i>Peltohyas australis</i>		VU	•				
Red-capped Plover	<i>Charadrius ruficapillus</i>			•	•			
Black-fronted Dotterel	<i>Eseyornis melanops</i>			•	•			
Scolopacidae								
Marsh Sandpiper	<i>Tringa stagnatilis</i>	MI	EN	•				
Red-necked Stint	<i>Calidris ruficollis</i>	MI		•	•			
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	MI		•	•			
Curlew Sandpiper	<i>Calidris ferruginea</i>	CR, MI	CR		•			
Glareolidae								
Silver Gull	<i>Chroicocephalus novaehollandiae</i>			•	•			
Whiskered Tern	<i>Chlidonias hybrida</i>			•	•			
Australian Pratincole	<i>Stiltia isabella</i>			•				
Columbidae								
Peaceful Dove	<i>Geopelia striata</i>			•	•	•		
Diamond Dove	<i>Geopelia cuneata</i>		VU		•			
Common Bronzewing	<i>Phaps chalcoptera</i>			•	•	•		
Crested Pigeon	<i>Ocyphaps lophotes</i>			•	•	•	•	•
Cuculidae								
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>			•	•			



Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Horsfield's Bronze Cuckoo	<i>Chalcites basalis</i>			•	•			
Pallid Cuckoo	<i>Heteroscenes pallidus</i>			•	•			
Tytonidae								
Eastern Barn Owl	<i>Tyto alba</i>			•	•	•	•	•
Strigidae								
Southern Boobook	<i>Ninox boobook</i>			•	•			
Podargidae								
Tawny Frogmouth	<i>Podargus strigoides</i>			•	•			•
Aegothelidae								
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>			•	•		•	•
Alcedinidae								
Laughing Kookaburra	<i>Dacelo novaeguineae</i>			•	•			
Sacred Kingfisher	<i>Todiramphus sanctus</i>			•	•			
Red-backed Kingfisher	<i>Todiramphus pyrrhopygius</i>			•	•			
Meropidae								
Rainbow Bee-eater	<i>Merops ornatus</i>				•			
Falconidae								
Australian Kestrel	<i>Falco cenchroides</i>			•	•	•	•	
Australian Hobby	<i>Falco longipennis</i>			•	•			
Grey Falcon	<i>Falco hypoleucos</i>		VU		•			
Brown Falcon	<i>Falco berigora</i>			•	•		•	
Black Falcon	<i>Falco subniger</i>		CR	•	•	•		
Peregrine Falcon	<i>Falco peregrinus</i>				•	•		
Cacatuidae								
Galah	<i>Cactua roseicapilla</i>			•	•	•	•	•
Corella	<i>Cacatua sp.</i>					•		
Cockatiel	<i>Nymphicus hollandicus</i>			•	•		•	
Psittacidae								
Musk Lorikeet	<i>Glossopsitta concinna</i>				•		•	
Regent Parrot	<i>Polytelis anthopeplus</i>			•	•			
Australian Ringneck	<i>Barnardius zonarius</i>			•	•			

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Eastern Rosella	<i>Platycercus eximius</i>			•	•		•	•
Blue Bonnet	<i>Northiella haematogaster</i>			•	•	•	•	
Red-rumped Parrot	<i>Psephotus haematonotus</i>			•	•	•	•	•
Mulga Parrot	<i>Psephotus varius</i>				•	•		
Blue-winged Parrot	<i>Neophema chrysostoma</i>			•	•			
Superb Parrot	<i>Polytelis swainsoni</i>	VU	EN				•	
Budgerigar	<i>Melopsittacus undulatus</i>			•	•			
Climacteridae								
Brown Treecreeper	<i>Climacteris picumnus</i>			•	•	•		
Maluridae								
Variegated Fairy-wren	<i>Malurus lamberti</i>			•	•			
Splendid Fairy-wren	<i>Malurus splendens</i>			•	•	•		
Superb Fairy-wren	<i>Malurus cyanues</i>			•	•	•		
White-winged Fairy-wren	<i>Malurus leucopterus</i>			•	•		•	
Meliphagidae								
Black Honeyeater	<i>Sugamel niger</i>			•	•			
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>				•	•		
Pied Honeyeater	<i>Certhionyx variegatus</i>				•			
Little Friarbird#	<i>Philemon citreogularis</i>			•	•			
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>				•			
Black-chinned Honeyeater	<i>Melithreptus gularis</i>				•			
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>			•	•	•		
White-fronted Chat	<i>Epthianura albifrons</i>			•	•	•	•	
Orange Chat	<i>Epthianura aurifrons</i>				•			
Crimson Chat	<i>Epthianura tricolor</i>			•	•			
Spiny-cheeked Honeyeater	<i>Acanthagenys rufogularis</i>			•	•	•	•	
Red Wattlebird	<i>Anthochaera carunculata</i>				•	•		
Fuscous Honeyeater	<i>Lichenostomus fuscus</i>				•	•		
White-eared Honeyeater	<i>Lichenostomus leucotis</i>				•	•		
White-fronted Honeyeater	<i>Purnella albifrons</i>			•	•	•	•	
Noisy Miner	<i>Manorina melanocephala</i>			•	•	•	•	•

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Yellow-throated Miner	<i>Manorina flavigula</i>			•	•	•		
Striped Honeyeater	<i>Plectorhyncha lanceolata</i>			•	•			
Singing Honeyeater	<i>Gavicalis virescens</i>			•	•	•	•	
Yellow-plumed Honeyeater	<i>Ptilotula ornata</i>			•	•	•		
White-plumed Honeyeater	<i>Ptilotula penicillata</i>			•	•	•	•	
Pardalotidae								
Spotted Pardalote	<i>Pardalotus punctatus</i>			•	•	•		
Striated Pardalote	<i>Pardalotus striatus</i>			•	•		•	•
Acanthizidae								
Shy Heathwren	<i>Calamanthus cautus</i>				•			
Weebill	<i>Smicromis brevirostris</i>			•	•	•	•	
Western Gerygone	<i>Gerygone fusca</i>				•			
Broad-tailed Thornbill (Inland Thornbill)	<i>Acanthiza apicalis</i>					•		
Yellow Thornbill	<i>Acanthiza nana</i>			•	•	•		
Chestnut-rumped Thornbill	<i>Acanthiza uropygialis</i>			•	•	•		
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>					•		
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>			•	•	•	•	
Southern Whiteface	<i>Aphelocephala leucopsis</i>			•	•			
Pomatostomidae								
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>		VU	•	•	•		
White-browed Babbler	<i>Pomatostomus superciliosus</i>			•	•			
Artamidae								
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>			•	•			
Masked Woodswallow	<i>Artamus personatus</i>			•	•			
White-browed Woodswallow	<i>Artamus superciliosus</i>			•	•			
Black-faced Woodswallow	<i>Artamus cinereus</i>			•	•			
Dusky Woodswallow	<i>Artamus cyanopterus</i>			•	•			
Cacticidae								
Grey Butcherbird	<i>Cracticus torquatus</i>				•	•		
Pied Butcherbird	<i>Cracticus nigrogularis</i>			•	•	•	•	•
Australian Magpie	<i>Cracticus tibicen</i>			•	•	•	•	•

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Pied Currawong	<i>Strepera graculina</i>					•		
Campephagidae								
Ground Cuckoo-shrike	<i>Coracina maxima</i>		EN		•			
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>			•	•	•	•	•
White-winged Triller	<i>Lalage tricolor</i>			•	•			
Neosittidae								
Varied Sittella	<i>Daphoenositta chrysoptera</i>			•	•	•		
Pachycephalidae								
Gilbert's Whistler	<i>Pachycephala inornata</i>				•			
Golden Whistler	<i>Pachycephala pectoralis</i>			•	•			
Rufous Whistler	<i>Pachycephala rufiventris</i>			•	•			
Grey Shrike-thrush	<i>Colluricincla harmonica</i>			•	•	•		
Rhipiduridae								
Willie Wagtail	<i>Rhipidura leucophrys</i>			•	•			
Grey Fantail	<i>Rhipidura fuliginosa</i>			•	•	•	•	•
Monarchidae								
Magpie-lark	<i>Grallina cyanoleuca</i>			•	•	•	•	
Restless Flycatcher	<i>Myiagra inquieta</i>			•	•	•		
Corcoracidae								
White-winged Chough	<i>Corcorax melanorhamphos</i>			•	•	•	•	•
Corvidae								
Australian Raven	<i>Corvus coronoides</i>			•	•	•	•	
Little Raven	<i>Corvus mellor</i>			•	•	•	•	•
Petroicidae								
Hooded Robin#	<i>Melanodryas cucullata</i>		VU	•	•			
Jacky Winter	<i>Microeca fascians</i>			•	•	•		
Red-capped Robin#	<i>Petroica goodenovii</i>			•	•			
Flame Robin	<i>Petroica phoenicea</i>				•			
Alaudidae								
Horsfield's Bushlark	<i>Mirafrja javanica</i>			•	•			
Hirundinidae								

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
White-backed Swallow	<i>Cheramoeca leucosterna</i>			•	•			
Welcome Swallow	<i>Hirundo neoxena</i>			•	•		•	
Fairy Martin	<i>Petrochelidon ariel</i>			•	•			
Tree Martin	<i>Petrochelidon nigricans</i>			•	•	•		
Acrocephalidae								
Australian Reed Warbler	<i>Acrocephalus australis</i>			•				
Locustellidae								
Rufous Songlark	<i>Cinchoramphus mathewsi</i>			•	•			•
Brown Songlark	<i>Cinchoramphus cruralis</i>			•	•			
Little Grassbird	<i>Poodytes gramineus</i>				•			
Zosteropidae								
Grey-breasted White-eye	<i>Zosterops lateralis</i>			•	•			
Estrildidae								
Diamond Firetail	<i>Stagonopleura guttata</i>		VU		•			
Zebra Finch	<i>Taeniopygia guttata</i>			•	•			
Motacillidae								
Australian Pipit	<i>Anthus australis</i>			•	•		•	
Introduced Birds								
Domestic Pigeon (Rock Dove) *	<i>Columba livia</i>			•	•		•	
Eurasian Skylark*	<i>Alauda arvensis</i>			•	•			
Common Starling*	<i>Sturnus vulgaris</i>			•	•	•	•	•
Common Blackbird*	<i>Turdus merula</i>			•	•			
House Sparrow*	<i>Passer domesticus</i>			•	•	•	•	•
European Goldfinch	<i>Carduelis</i>			•				
REPTILES								
Diplodactylidae								
Tessellated Gecko	<i>Diplodactylus tessellatus</i>				•			
Eastern Stone Gecko	<i>Diplodactylus vittatus</i>					•		
Gekkonidae								
Marbled Gecko	<i>Christinus marmoratus</i>				•			
Pygopodidae								

Mine Tenement Fauna Assemblage - 20km buffer								
Common Name	Species name	Conservation Status		Nature Kit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Hooded Scaly-foot	<i>Pygopus schraderi</i>		CR	•	•			
Agamidae								
Common Bearded Dragon	<i>Pogona barbata</i>		VU			•	•	•
Scincidae								
Garden Skink	<i>Lampropholis guichenoti</i>				•			
Grey's Skink	<i>Menetia greyi</i>					•		
Boulenger's Morethia	<i>Morethia boulengeri</i>			•	•	•		
Bougainville's Skink	<i>Lerista bougainvillii</i>				•			
Pythonidae								
Carpet Python	<i>Morelia spilota</i>		EN		•			
Curl Snake	<i>Suta</i>			•	•			
Elapidae								
Eastern Brown Snake	<i>Pseudonaja textilis</i>						•	
AMPHIBIANS								
Hylidae								
Growling Grass Frog	<i>Litoria raniformis</i>	VU	VU	•	•			
FISH								
Atherinidae								
Murray Hardyhead	<i>Craterocephalus fluviatilis</i>	EN	CR	•				
Eleotrididae								
Flat-headed Gudgeon	<i>Philypnodon grandiceps</i>			•				
Introduced Species								
Mosquitofish*	<i>Gambusia holbrooki</i>			•				

° =species recorded outside the study area, \* =species level confirmed during current survey, S=Secondary evidence recorded (scats, tracks, sloughed skin etc.).

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
MAMMALS								
Tachyglossidae								
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>							•
Ornithorhynchidae								
Platypus	<i>Ornithorhynchus anatinus</i>							•
Phascolarctidae								
Koala	<i>Phascolarctos cinereus</i>							•
Dasyuridae								
Fat-tailed Dunnart	<i>Sminthopsis crassicaudata</i>						•	•
Phalangeridae								
Common Brushtail Possum#	<i>Trichosurus vulpecula</i>						•	•
Macropodidae								
Eastern Grey Kangaroo#	<i>Macropus giganteus</i>							•
Pteropodidae								
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	VU	VU					•
Molossidae								
White-striped Freetail Bat#	<i>Austronomus australis</i>					•		•
Vespertilionidae								
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>							•
Little Forest Bat	<i>Vespadelus vulturnus</i>							•
Muridae								
Water Rat	<i>Hydromys chrysogaster</i>					•		•
Mitchell's Hopping-mouse	<i>Notomys mitchellii</i>							•
Introduced Species								
Black Rat*	<i>Rattus rattus</i>							•
Brown Rat*	<i>Rattus norvegicus</i>							•
House Mouse*	<i>Mus musculus</i>						•	•
European Rabbit#*	<i>Oryctolagus cuniculus</i>							•
European Brown Hare#*	<i>Lepus europeaus</i>							•
Cattle (feral)*	<i>Bos taurus</i>						•	•
Sheep (feral)*	<i>Ovis aries</i>							•
Fallow Deer*	<i>Dama dama</i>							•
Dingo & Dog (feral)*	<i>Canis familiaris</i>							•
Domestic Cat (feral)*	<i>Felis catus</i>							•
Red Fox#*	<i>Vulpes</i>						•	•



## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
BIRDS								
Dromaiidae								
Emu	Dromaius novaehollandiae			.			.	.
Phasianidae								
Stubble Quail	Coturnix pectoralis			.			.	.
Brown Quail	Synoicus ypsilophora			.				.
Anseranatidae								
Magpie Goose	Anseranas semipalmata		VU	.				.
Anatidae								
Plumed Whistling Duck	Dendrocygna eytoni			.	.			.
Cape Barren Goose	Cereopsis novaehollandiae							.
Black Swan#	Cygnus atratus			.	.	.	.	.
Freckled Duck	Stictonetta naevosa		EN	.	.		.	.
Australian Shelduck#	Tadorna tadornoides			.	.	.	.	.
Pink-eared Duck#	Malacorhynchus membranaceus			.	.		.	.
Australian Wood Duck#	Chenonetta jubata			.	.	.	.	.
Pacific Black Duck#	Anas superciliosa			.	.	.	.	.
Australasian Shoveler#	Spatula rhynchotis		VU	.	.		.	.
Grey Teal#	Anas gracilis			.	.	.	.	.
Chestnut Teal	Anas castanea			.	.		.	.
Hardhead#	Aythya australis		VU	.	.	.	.	.
Blue-billed Duck#	Oxyura australis		VU	.	.		.	.
Musk Duck#	Biziura lobata		VU	.	.		.	.
Podicipedidae								
Australasian Grebe#	Tachybaptus novaehollandiae			.	.	.	.	.
Hoary-headed Grebe#	Poliocephalus			.	.	.	.	.
Great Crested Grebe#	Podiceps cristatus			.	.	.	.	.
Threskiornithidae								
Australian White Ibis#	Threskiornis moluccus			.	.	.	.	.
Straw-necked Ibis#	Threskiornis spinicollis			.	.	.	.	.
Glossy Ibis	Plegadis falcinellus			.	.		.	.
Royal Spoonbill	Platalea regia			.	.	.	.	.
Yellow-billed Spoonbill#	Platalea flavipes			.	.		.	.

Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer								
Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Ardeidae								
Australasian Bittern	<i>Botaurus poiciloptilus</i>	EN	CR					•
Little Bittern	<i>Ixobrychus minutus</i>			•	•			•
Nankeen Night Heron#	<i>Nycticorax caledonicus</i>			•	•	•	•	•
Cattle Egret	<i>Bubulcus ibis</i>			•				•
White-necked Heron#	<i>Ardea pacifica</i>			•	•	•	•	•
Eastern Great Egret#	<i>Ardea alba</i>		VU	•	•	•	•	•
Intermediate Egret#	<i>Ardea intermedia</i>			•	•			•
White-faced Heron#	<i>Egretta novaehollandiae</i>			•	•	•	•	•
Little Egret	<i>Egretta garzetta</i>		EN	•	•			•
Pelecanidae								
Australian Pelican#	<i>Pelecanus conspicillatus</i>			•	•	•	•	•
Phalacrocoracidae								
Little Pied Cormorant#	<i>Microcarbo melanoleucos</i>			•	•		•	•
Little Black Cormorant#	<i>Phalacrocorax sulcirostris</i>			•	•	•	•	•
Pied Cormorant	<i>Phalacrocorax varius</i>			•	•	•	•	•
Great Cormorant#	<i>Phalacrocorax carbo</i>			•	•	•	•	•
Anhingidae								
Australasian Darter	<i>Anhinga novaehollandiae</i>			•	•	•	•	•
Accipitridae								
Black-shouldered Kite#	<i>Elanus axillaris</i>			•			•	•
Letter-winged Kite	<i>Elanus scriptus</i>							•
Little Eagle	<i>Hieraaetus morphnoides</i>			•			•	•
Wedge-tailed Eagle#	<i>Aquila audax</i>			•			•	•
Grey Goshawk	<i>Accipiter novaehollandiae</i>							•
Brown Goshawk	<i>Accipiter fasciatus</i>			•			•	•
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>			•			•	•
Swamp Harrier	<i>Circus approximans</i>			•	•		•	•
Spotted Harrier	<i>Circus assimilis</i>			•			•	•
Black Kite	<i>Milvus migrans</i>			•	•		•	•
Whistling Kite	<i>Haliastur sphenurus</i>			•			•	•
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>							•
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>		EN	•	•	•	•	•
Otidae								
Australian Bustard	<i>Ardeotis australis</i>		CR					•

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Rallidae								
Lewin's Rail	<i>Lewinia pectoralis</i>		VU					•
Buff-banded Rail	<i>Hypotaenidia philippensis</i>			•	•	•		•
Australian Spotted Crake#	<i>Porzana fluminea</i>			•	•	•		•
Baillon's Crake#	<i>Zapornia pusilla</i>			•	•		•	•
Spotless Crake	<i>Zapornia tabuensis</i>			•		•		•
Black-tailed Native-hen#	<i>Tribonyx ventralis</i>			•	•	•	•	•
Purple Swamphen	<i>Porphyrio</i>			•	•	•	•	•
Dusky Moorhen#	<i>Gallinula tenebrosa</i>			•	•	•	•	•
Eurasian Coot#	<i>Fulica atra</i>			•	•	•	•	•
Gruidae								
Brolga	<i>Antigone rubicunda</i>		EN	•	•		•	•
Turnicidae								
Painted Button-quail	<i>Turnix varia</i>							•
Little Button-quail	<i>Turnix velox</i>							•
Red-chested Button-quail	<i>Turnix pyrrhotorax</i>		EN					•
Pedionomidae								
Plains-wanderer	<i>Pedionomus torquatus</i>	CR	CR					•
Burhinidae								
Bush Stone-curlew	<i>Burhinus grallarius</i>		CR					•
Recurvirostridae								
Black-winged Stilt#	<i>Himantopus leucocephalus</i>			•	•		•	•
Banded Stilt	<i>Cladorhynchus leucocephalus</i>			•	•		•	•
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>			•	•		•	•
Charadriidae								
Banded Lapwing	<i>Vanellus tricolor</i>			•	•		•	•
Masked Lapwing#	<i>Vanellus miles</i>			•	•		•	•
Red-kneed Dotterel	<i>Erythronyx cinctus</i>			•	•		•	•
Inland Dotterel	<i>Peltohyas australis</i>		VU				•	•
Pacific Golden Plover	<i>Pluvialis fulva</i>	MI	VU	•	•			•
Red-capped Plover	<i>Charadrius ruficapillus</i>			•	•		•	•
Double-banded Plover	<i>Charadrius bicinctus</i>	MI		•	•			•
Greater Sand Plover	<i>Charadrius leschenaultii</i>	VU, MI	VU					•
Oriental Plover	<i>Charadrius veredus</i>	MI		•	•			•
Black-fronted Dotterel#	<i>Elsyornis melanops</i>			•	•		•	•

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
Rostratulidae								
Australian Painted Snipe	<i>Rostratula australis</i>	EN	CR	.	.			.
Scolopacidae								
Latham's Snipe	<i>Gallinago hardwickii</i>	MI		.	.		.	.
Short-billed Dowitcher	<i>Limnodromus griseus</i>			.				.
Black-tailed Godwit	<i>Limosa</i>	MI	CR	.	.			.
Bar-tailed Godwit	<i>Limosa lapponica</i>	CR, MI	VU	.				.
Little Curlew	<i>Numenius minutus</i>	MI		.				.
Far Eastern Curlew	<i>Numenius madagascariensis</i>	CR, MI	CR		.		.	.
Marsh Sandpiper	<i>Tringa stagnatilis</i>	MI	EN	.	.		.	.
Common Greenshank	<i>Tringa nebularia</i>	MI	EN	.	.		.	.
Wood Sandpiper	<i>Tringa glareola</i>	MI	EN	.				.
Grey-tailed Tattler	<i>Tringa brevipes</i>	MI	CR					.
Common Sandpiper	<i>Actitis hypoleucos</i>	MI	VU	.	.			.
Ruddy Turnstone	<i>Arenaria interpres</i>	MI	EN	.	.			.
Great Knot	<i>Calidris tenuirostris</i>	CR, MI	CR	.	.			.
Red Knot	<i>Calidris canutus</i>	EN, MI	EN		.			.
Sanderling	<i>Calidris alba</i>	MI			.			.
Red-necked Stint	<i>Calidris ruficollis</i>	MI		.	.		.	.
Long-toed Stint	<i>Calidris subminuta</i>	MI		.				.
Baird's Sandpiper	<i>Calidris bairdii</i>							.
Pectoral Sandpiper	<i>Calidris melanotos</i>	MI		.			.	.
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	MI		.	.		.	.
Curlew Sandpiper	<i>Calidris ferruginea</i>	CR, MI	CR	.	.		.	.
Broad-billed Sandpiper	<i>Limicola falcinellus</i>							.
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>							.
Ruff	<i>Philomachus pugnax</i>	MI		.				.
Red-necked Phalarope	<i>Phalaropus lobatus</i>	MI		.				.
Glareolidae								
Oriental Pratincole	<i>Glareola maldivarum</i>	MI						.
Australian Pratincole	<i>Stiltia isabella</i>			.				.
Laridae								
Silver Gull	<i>Chroicocephalus novaehollandiae</i>			.	.		.	.
Gull-billed tern	<i>Sterna nilotica</i>	MI	EN	.	.			.
Caspian Tern	<i>Hydroprogne caspia</i>	MI	VU	.	.		.	.

# Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
Whiskered Tern	<i>Chlidonias hybrida</i>			•	•	•	•	•
White-winged Black Tern	<i>Chlidonias leucopterus</i>	MI		•	•			•
Columbidae								
Peaceful Dove	<i>Geopelia placida</i>			•			•	•
Diamond Dove	<i>Geopelia cuneata</i>		VU					•
Common Bronzewing#	<i>Phaps chalcoptera</i>			•				•
Crested Pigeon#	<i>Ocyphaps lophotes</i>			•			•	•
Cuculidae								
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>							•
Brush Cuckoo	<i>Cacomantis variolosus</i>							•
Horsfield's Bronze Cuckoo	<i>Chalcites basalis</i>			•			•	•
Black-eared Cuckoo	<i>Chalcites osculans</i>			•				•
Shining Bronze Cuckoo	<i>Chalcites lucidus</i>			•				•
Pallid Cuckoo	<i>Heteroscenes pallidus</i>			•				•
Tytonidae								
Barn Owl	<i>Tyto alba</i>			•				•
Strigidae								
Southern Boobook	<i>Ninox boobook</i>			•				•
Barking Owl	<i>Ninox connivens</i>							•
Podargidae								
Tawny Frogmouth	<i>Podargus strigoides</i>			•				•
Caprimulgidae								
Spotted Nightjar	<i>Eurostopodus argus</i>							•
Aegothelidae								
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>			•				•
Apodidae								
White-throated Needletail	<i>Hirundapus caudacutus</i>	MI	VU	•				•
Fork-tailed Swift	<i>Apus pacificus</i>	MI		•				•
Coraciidae								
Dollarbird	<i>Eurystomus orientalis</i>			•				•
Alcedinidae								
Laughing Kookaburra#	<i>Dacelo novaeguineae</i>			•			•	•
Sacred Kingfisher#	<i>Todiramphus sanctus</i>			•				•
Red-backed Kingfisher	<i>Todiramphus pyrrhopygius</i>			•				•
Azure Kingfisher	<i>Ceyx azureus</i>			•				•

# Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
Meropidae								
Rainbow Bee-eater#	<i>Merops ornatus</i>			•			•	•
Falconidae								
Australian Kestrel	<i>Falco cenchroides</i>			•			•	•
Australian Hobby#	<i>Falco longipennis</i>			•				•
Grey Falcon	<i>Falco hypoleucos</i>		VU					•
Brown Falcon	<i>Falco berigora</i>			•			•	•
Black Falcon	<i>Falco subniger</i>		CR	•			•	•
Peregrine Falcon	<i>Falco peregrinus</i>			•				•
Cacatuidae								
Galah#	<i>Eolophus roseicapilla</i>			•			•	•
Major Mitchell's Cockatoo	<i>Lophocroa leadbeateri</i>		CR					•
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>			•			•	•
Eastern Long-billed Corella	<i>Cacatua tenuirostris</i>			•			•	•
Little Corella	<i>Cacatua sanguinea</i>			•				•
Cockatiel#	<i>Nymphicus hollandicus</i>			•			•	•
Psittacidae								
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>							•
Musk Lorikeet#	<i>Glossopsitta concinna</i>			•				•
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>							•
Little Lorikeet	<i>Glossopsitta pusilla</i>							•
Superb Parrot	<i>Polytelis swainsonii</i>	VU	EN					•
Regent Parrot	<i>Polytelis anthopeplus</i>	VU	VU					•
Australian Ringneck	<i>Barnardius zonarius</i>							•
Crimson Rosella	<i>Platycercus elegans</i>			•			•	•
Eastern Rosella#	<i>Platycercus eximius</i>			•			•	•
Blue Bonnet	<i>Northiella haematogaster</i>			•				•
Red-rumped Parrot#	<i>Psephotus haematonotus</i>			•			•	•
Blue-winged Parrot	<i>Neophema chrysostoma</i>			•				•
Elegant Parrot	<i>Neophema elegans</i>		VU					•
Swift Parrot	<i>Lathamus discolor</i>	CR	CR					•
Budgerigar	<i>Melopsittacus undulatus</i>			•			•	•
Climacteridae								
Brown Treecreeper#	<i>Climacteris picumnus</i>			•			•	•
Maluridae								
Variegated Fairy-wren	<i>Malurus lamberti</i>			•			•	•
Splendid Fairy-wren	<i>Malurus splendens</i>			•				•

# Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
Superb Fairy-wren#	<i>Malurus cyaneus</i>			•			•	•
White-winged Fairy-wren	<i>Malurus leucopterus</i>			•			•	•
Meliphagidae								
Black Honeyeater	<i>Sugamel niger</i>							•
Crescent Honeyeater	<i>Phylidonyris pyrrhoptera</i>							•
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>			•				•
Tawny-crowned Honeyeater	<i>Glyciphila melanops</i>							•
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>							•
Little Friarbird#	<i>Philemon citreogularis</i>			•			•	•
Noisy Friarbird	<i>Philemon corniculatus</i>							•
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>			•			•	•
Black-chinned Honeyeater	<i>Melithreptus gularis</i>							•
White-naped Honeyeater	<i>Melithreptus lunatus</i>							•
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>			•				•
White-fronted Chat	<i>Epthianura albifrons</i>			•			•	•
Orange Chat	<i>Epthianura aurifrons</i>			•			•	•
Crimson Chat	<i>Epthianura tricolor</i>			•			•	•
Spiny-cheeked Honeyeater	<i>Acanthagenys rufogularis</i>			•				•
Red Wattlebird	<i>Anthochaera carunculata</i>			•			•	•
Regent Honeyeater	<i>Anthochaera phrygia</i>							•
Yellow-faced Honeyeater	<i>Caligavis chrysops</i>							•
Yellow-throated Miner	<i>Manorina flavigula</i>			•			•	•
Noisy Miner#	<i>Manorina melanocephala</i>			•			•	•
White-fronted Honeyeater	<i>Purnella albifrons</i>							•
Singing Honeyeater	<i>Gavicalis virescens</i>			•				•
Yellow-tufted Honeyeater	<i>Lichenostomus melanops</i>							•
Striped Honeyeater	<i>Plectorhyncha lanceolata</i>			•				•
Fuscous Honeyeater	<i>Ptilotula fusca</i>							•
Yellow-plumed Honeyeater	<i>Ptilotula ornatus</i>							•
White-plumed Honeyeater#	<i>Ptilotula penicillatus</i>							•
Pardalotidae								



# Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Spotted Pardalote	<i>Pardalotus punctatus</i>			•				•
Striated Pardalote#	<i>Pardalotus striatus</i>			•			•	•
Acanthizidae								
Rufous Fieldwren	<i>Calamanthus campestris</i>						•	•
White-browed Scrubwren	<i>Sericornis frontalis</i>							•
Weebill#	<i>Smicronis brevirostris</i>			•			•	•
Western Gerygone#	<i>Gerygone fusca</i>			•				•
White-throated Gerygone	<i>Gerygone olivacea</i>							•
Brown Thornbill	<i>Acanthiza pusilla</i>			•				•
Striated Thornbill	<i>Acanthiza lineata</i>							•
Inland Thornbill	<i>Acanthiza apicalis</i>							•
Chestnut-rumped Thornbill	<i>Acanthiza uropygialis</i>			•				•
Yellow-rumped Thornbill#	<i>Acanthiza chrysorrhoa</i>			•			•	•
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>			•				•
Yellow Thornbill	<i>Acanthiza nana</i>			•			•	•
Southern Whiteface	<i>Aphelocephala leucopsis</i>			•			•	•
Pomatostomidae								
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>		VU	•				•
White-browed Babbler	<i>Pomatostomus superciliosus</i>			•			•	•
Chestnut-crowned Babbler	<i>Pomatostomus ruficeps</i>							•
Psophodidae								
Chestnut Quail-thrush	<i>Cinclosoma castanotus</i>							•
Artamidae								
White-breasted Woodswallow#	<i>Artamus leucorhynchus</i>			•			•	•
Masked Woodswallow	<i>Artamus personatus</i>			•			•	•
White-browed Woodswallow	<i>Artamus superciliosus</i>			•			•	•
Black-faced Woodswallow	<i>Artamus cinereus</i>			•			•	•
Dusky Woodswallow#	<i>Artamus cyanopterus</i>			•			•	•
Cracticidae								
Grey Butcherbird	<i>Cracticus torquatus</i>			•	•			•
Pied Butcherbird#	<i>Cracticus nigrogularis</i>			•			•	•
Australian Magpie#	<i>Gymnorhina tibicen</i>			•			•	•

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Pied Currawong	<i>Strepera graculina</i>							•
Grey Currawong	<i>Strepera versicolor</i>							•
Campephagidae								
Ground Cuckoo-shrike	<i>Coracina maxima</i>							•
Black-faced Cuckoo-shrike#	<i>Coracina novaehollandiae</i>			•			•	•
White-bellied Cuckoo-shrike	<i>Coracina papuensis</i>							•
White-winged Triller	<i>Lalage tricolor</i>			•			•	•
Neosittidae								
Varied Sittella	<i>Daphoenositta chrysoptera</i>						•	•
Oreoidae								
Crested Bellbird	<i>Oreoica gutturalis</i>							•
Pachycephalidae								
Crested Shrike-tit	<i>Falcunculus frontatus</i>						•	•
Gilbert's Whistler	<i>Pachycephala inornata</i>			•				•
Golden Whistler	<i>Pachycephala pectoralis</i>			•				•
Rufous Whistler#	<i>Pachycephala rufiventris</i>			•			•	•
Grey Shrike-thrush#	<i>Colluricincla harmonica</i>			•			•	•
Rhipiduridae								
Willie Wagtail#	<i>Rhipidura leucophrys</i>			•			•	•
Rufous Fantail	<i>Rhipidura rufifrons</i>							•
Grey Fantail#	<i>Rhipidura fuliginosa</i>			•				•
Monarchidae								
Black-faced Monarch	<i>Monarcha melanopsis</i>							•
Magpie-lark#	<i>Grallina cyanoleuca</i>			•			•	•
Satin Flycatcher	<i>Myiagra cyanoleuca</i>							•
Restless Flycatcher#	<i>Myiagra inquieta</i>			•			•	•
Corcoracidae								
White-winged Chough#	<i>Corcorax melanorhamphos</i>			•				•
Corvidae								
Australian Raven#	<i>Corvus coronoides</i>			•			•	•
Little Raven#	<i>Corvus mellori</i>			•			•	•
Petroicidae								
Hooded Robin#	<i>Melanodryas cucullata</i>		VU	•				•
Jacky Winter#	<i>Microeca fascians</i>			•				•
Red-capped Robin#	<i>Petroica goodenovii</i>			•			•	•
Scarlet Robin	<i>Petroica boodang</i>							•
Rose Robin	<i>Petroica rosea</i>							•

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status						
		EPBC Act	FFG Act	Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
Flame Robin	<i>Petroica phoenicea</i>			•			•	•
Southern Scrub-robin	<i>Drymodes brunneopygia</i>							•
Alaudidae								
Horsfield's Bushlark	<i>Mirafra javanica</i>			•				•
Hirundinidae								
White-backed Swallow	<i>Cheramoeca leucosterna</i>			•				•
Welcome Swallow#	<i>Hirundo neoxena</i>			•			•	•
Fairy Martin#	<i>Petrochelidon ariel</i>			•			•	•
Tree Martin	<i>Petrochelidon nigricans</i>			•			•	•
Acrocephalidae								
Australian Reed Warbler	<i>Acrocephalus australis</i>			•			•	•
Locustellidae								
Rufous Songlark#	<i>Cincloramphus mathewsi</i>			•			•	•
Brown Songlark	<i>Cincloramphus cruralis</i>			•				•
Little Grassbird	<i>Poodytes gramineus</i>			•			•	•
Cisticolidae								
Golden-headed Cisticola	<i>Cisticola exilis</i>			•			•	•
Zosteropidae								
Grey-breasted White-eye	<i>Zosterops lateralis</i>			•			•	•
Dicaeidae								
Mistletoebird	<i>Dicaeum hirundinaceum</i>			•			•	•
Estrildidae								
Red-browed Finch	<i>Neochmia temporalis</i>			•				
Zebra Finch	<i>Taeniopygia guttata</i>			•			•	•
Motacillidae								
White Wagtail	<i>Motacilla alba</i>			•				
Australian Pipit	<i>Anthus novaeseelandiae</i>			•			•	•
Introduced Species								
Domestic Pigeon*	<i>Columba livia</i>			•			•	•
Spotted Turtle-Dove*	<i>Streptopelia chinensis</i>							•
Muscovy Duck*	<i>Cairina moschata</i>			•				•
Northern Mallard*	<i>Anas platyrhynchos</i>							•
Eurasian Skylark*	<i>Alauda arvensis</i>			•				•
Common Myna*	<i>Acridotheres tristis</i>							•
Common Starling*	<i>Sturnus vulgaris</i>			•			•	•
Common Blackbird*	<i>Turdus merula</i>			•			•	•
House Sparrow#*	<i>Passer domesticus</i>			•			•	•

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Eurasian Tree Sparrow*	<i>Passer montanus</i>			•			•	•
European Goldfinch	<i>Carduelis</i>			•			•	•
<b>REPTILES</b>								
Cheluidae								
Murray River Turtle	<i>Emydura macquarii</i>		CR			•		
Eastern Long-necked Turtle	<i>Chelodina longicollis</i>					•		•
Gekkonidae								
Marbled Gecko	<i>Christinus marmoratus</i>							•
Pygopodidae								
Hooded Scaly-foot	<i>Pygopus schraderi</i>		CR					•
Agamidae								
Eastern Bearded Dragon	<i>Pogona barbata</i>		VU					•
Scincidae								
Carnaby's Wall Skink	<i>Cryptoblepharus pannosus</i>							•
Tree Skink	<i>Egernia striolata</i>							•
Garden Skink	<i>Lampropholis guichenoti</i>							•
Samphire Skink	<i>Morethia adelaidensis</i>		EN					•
Boulenger's Skink	<i>Morethia boulengeri</i>						•	•
Common Blue-tongue	<i>Tiliqua scincoides</i>						•	•
Varanidae								
Sand Goanna	<i>Varanus gouldii</i>							•
Lace Monitor	<i>Varanus varius</i>		EN				•	•
Typhlopidae								
Peters's Blind Snake	<i>Anilius bituberculatus</i>							•
Pythonidae								
Carpet Python	<i>Morelia spilota</i>		EN				•	•
Elapidae								
Tiger Snake	<i>Notechis scutatus</i>							•
Curl Snake	<i>Suta suta</i>							•
Bandy	<i>Vermicella annulata</i>		EN					•
<b>AMPHIBIANS</b>								
Limnodynastidae								
Eastern Banjo Frog	<i>Limnodynastes dumerillii</i>					•	•	•
Long-thumbed Frog	<i>Limnodynastes fletcheri</i>					•		•
Spotted Grass Frog	<i>Limnodynastes tasmaniensis</i>					•	•	•
Myobatrachidae								

## Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer

Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Eastern Sign-bearing Froglet	<i>Crinia parinsignifera</i>					•		•
Common Eastern Froglet	<i>Crinia signifera</i>					•	•	•
Sloane's Froglet	<i>Crinia sloanei</i>					•		
Brown Toadlet	<i>Pseudophryne bibroni</i>		EN			•		•
Hylidae								
Peron's Tree Frog	<i>Litoria peronii</i>					•		•
Growling Grass Frog	<i>Litoria raniformis</i>	VU	VU					•
FISH								
Anguillidae								
Southern Shortfin Eel	<i>Anguilla australis</i>							•
Atherinidae								
Murray Hardyhead	<i>Craterocephalus fluviatilis</i>	EN	CR			•		•
Unspecked Hardyhead	<i>Craterocephalus fulvus</i>					•		•
Clupeidae								
Bony Bream	<i>Nematalosa erebi</i>					•	•	•
Eleotrididae								
Western Carp Gudgeon	<i>Hypseleotris klunzingeri</i>					•		•
Flat-headed Gudgeon	<i>Philypnodon grandiceps</i>					•	•	•
Galaxiidae								
Flat-headed Galaxias	<i>Galaxias rostratus</i>	CR	VU					•
Melanotaeniidae								
Murray-Darling Rainbowfish	<i>Melanotaenia duboulayi</i>		EN			•		
Percichthyidae								
Golden Perch	<i>Macquaria ambigua</i>					•	•	•
Macquarie Perch	<i>Macquaria australasica</i>	EN	EN					•
Murray Cod	<i>Maccullochella peelii</i>	VU	EN			•	•	•
Plotosidae								
Freshwater Catfish	<i>Tandanus tandanus</i>		EN				•	•
Retropinnidae								
Australian Smelt	<i>Retropinna semoni</i>					•	•	•
Teraponidae								
Silver Perch	<i>Bidyanus bidyanus</i>	CR	EN				•	•
Introduced Species								
Oriental Weatherloach*	<i>Misgurnus anguillicaudatus</i>					•		
European Carp#*	<i>Cyprinus carpio</i>					•	•	•
Goldfish*	<i>Carassius auratus</i>					•	•	•

Kerang Wetlands (Kangaroo Lake) Fauna Assemblage – 20km Buffer								
Common Name	Species name	Conservation Status		Naturekit	VBA	EHP 2018	Ecoscape 2018	Spectrum 2018
		EPBC Act	FFG Act					
Tench*	<i>Tinca tinca</i>						•	•
Redfin#*	<i>Perca fluviatilis</i>					•	•	•
Mosquitofish*	<i>Gambusia holbrooki</i>					•	•	•

# = Also recorded at Lake Talbot. \* = Introduced species





## **Appendix C – Fauna Survey Maps**



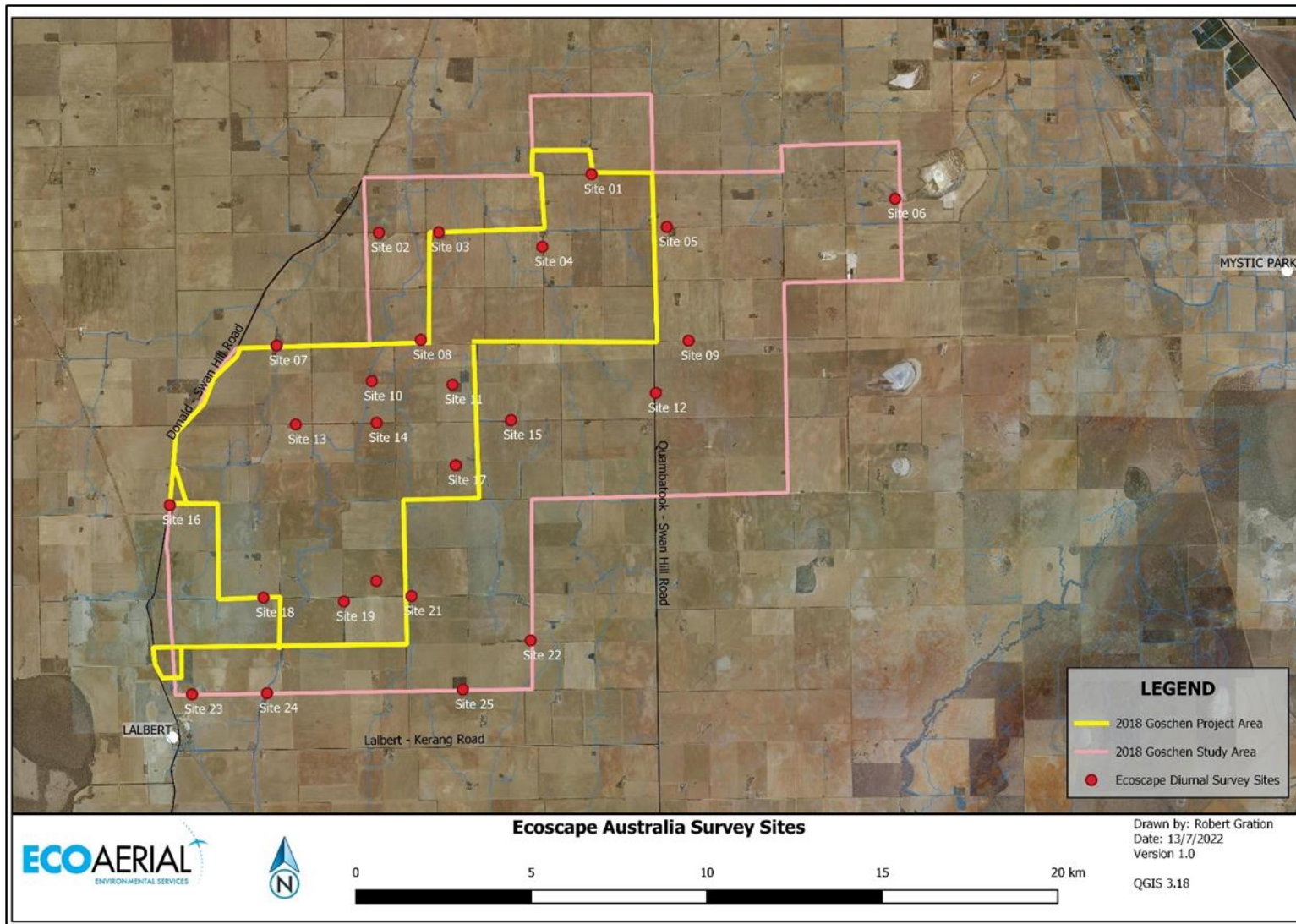
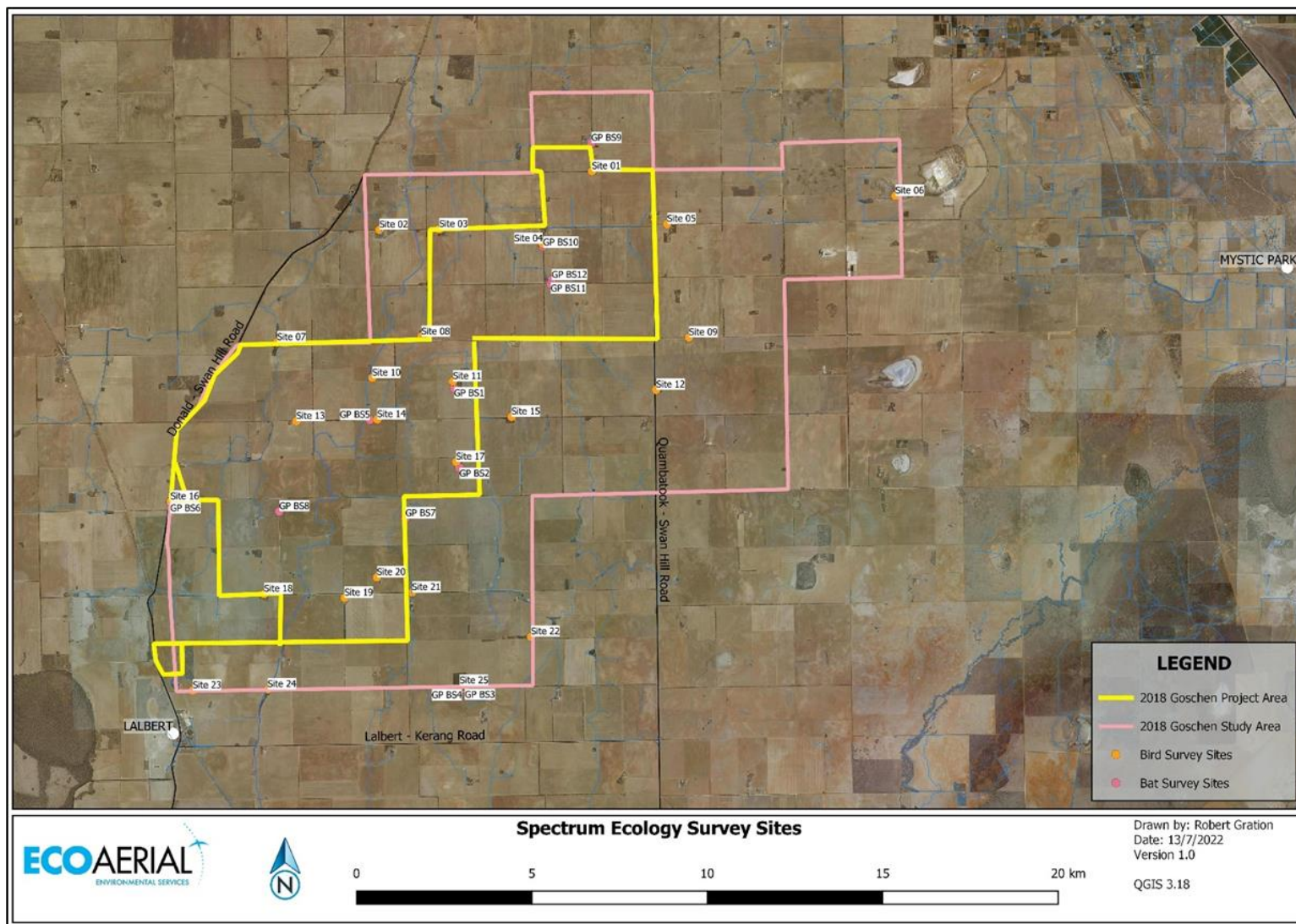


Figure C. 1 Ecoscape sites



**Figure C. 2 Spectrum Ecology Sites**



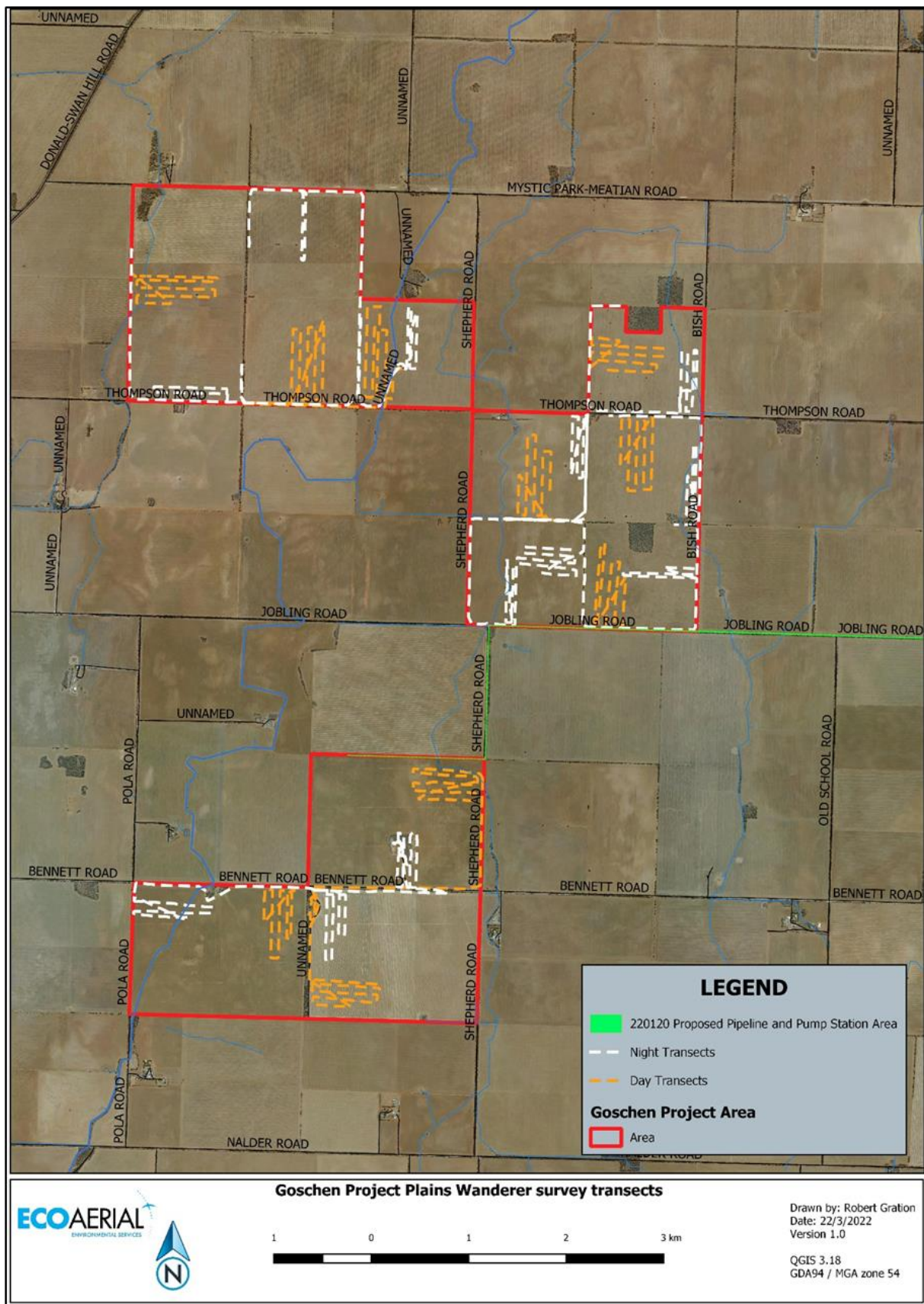
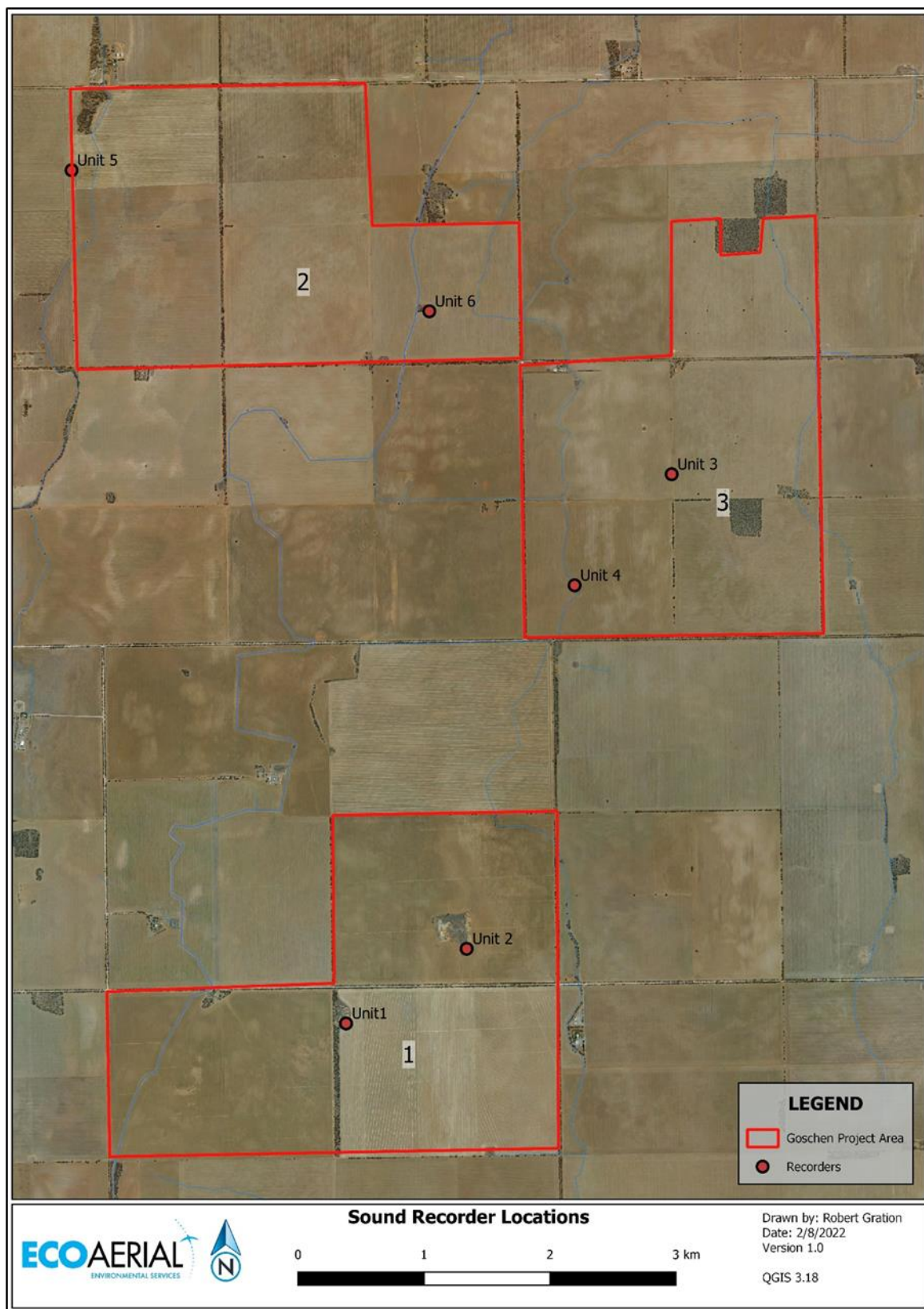


Figure C. 3 EcoAerial Plains-wanderer transects



**Figure C. 4** EcoAerial Plains-wanderer sound recorders



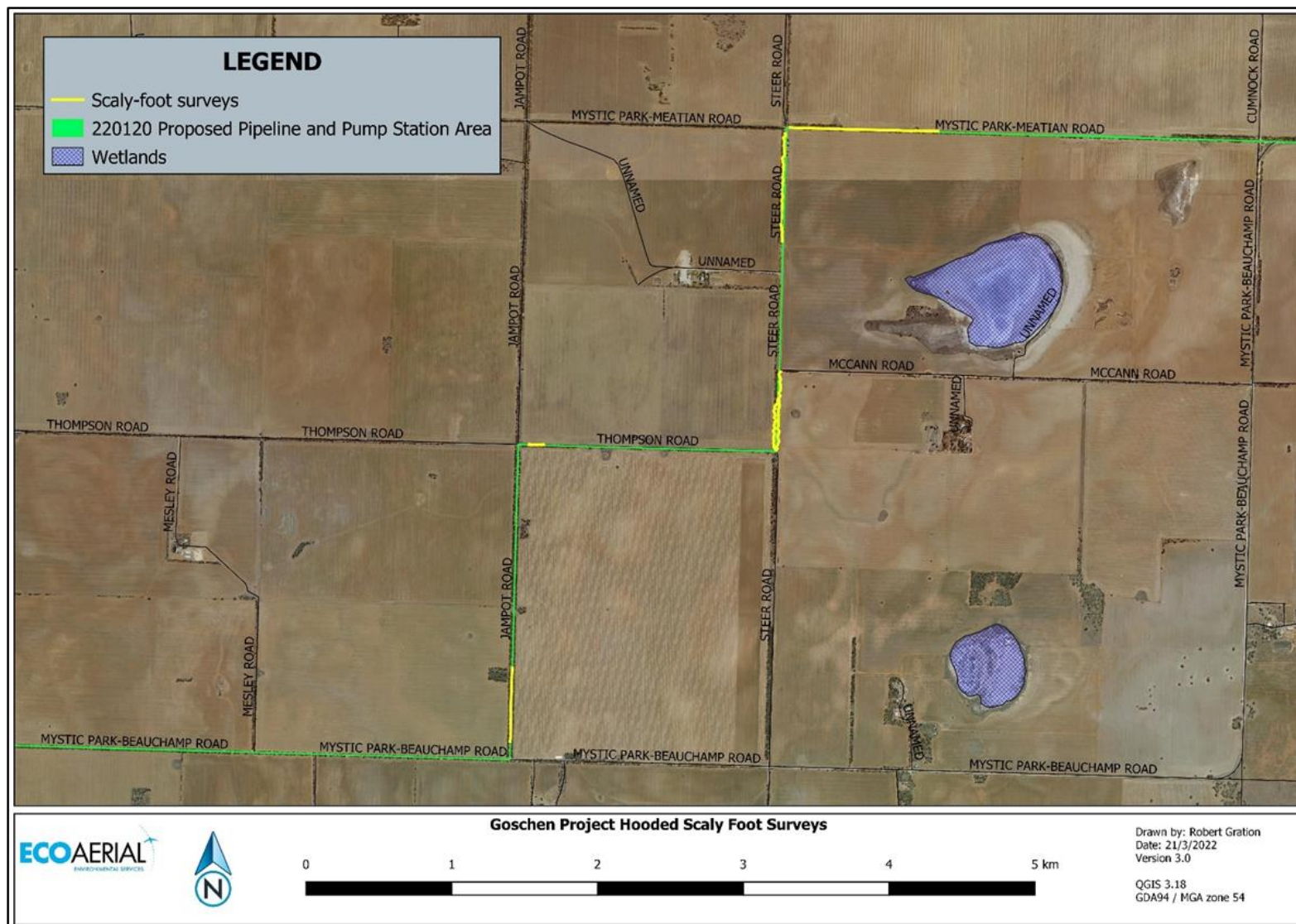
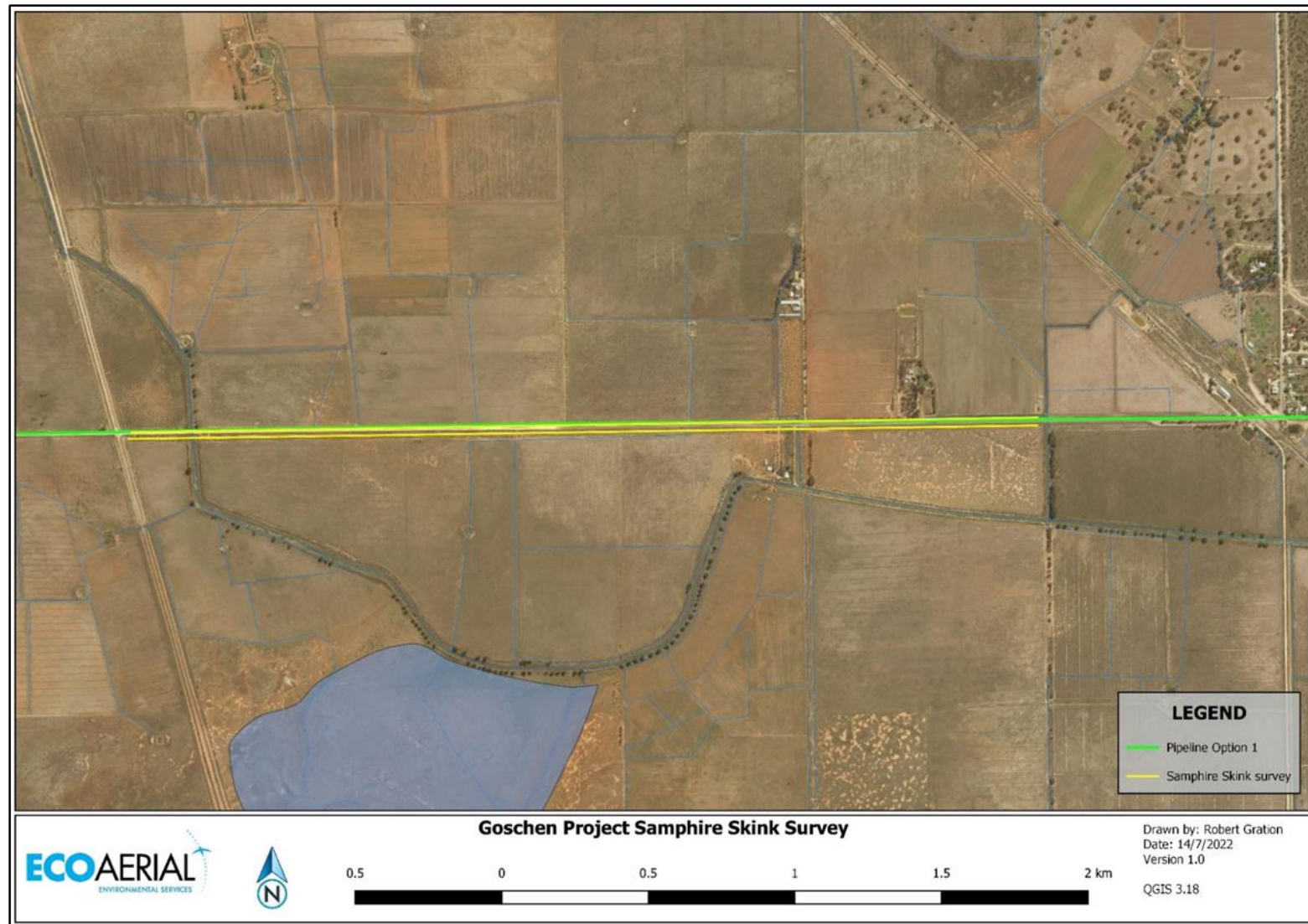


Figure C. 5 EcoAerial Hooded scaly-foot surveys





**Figure C. 6** EcoAerial Samphire Skink active search

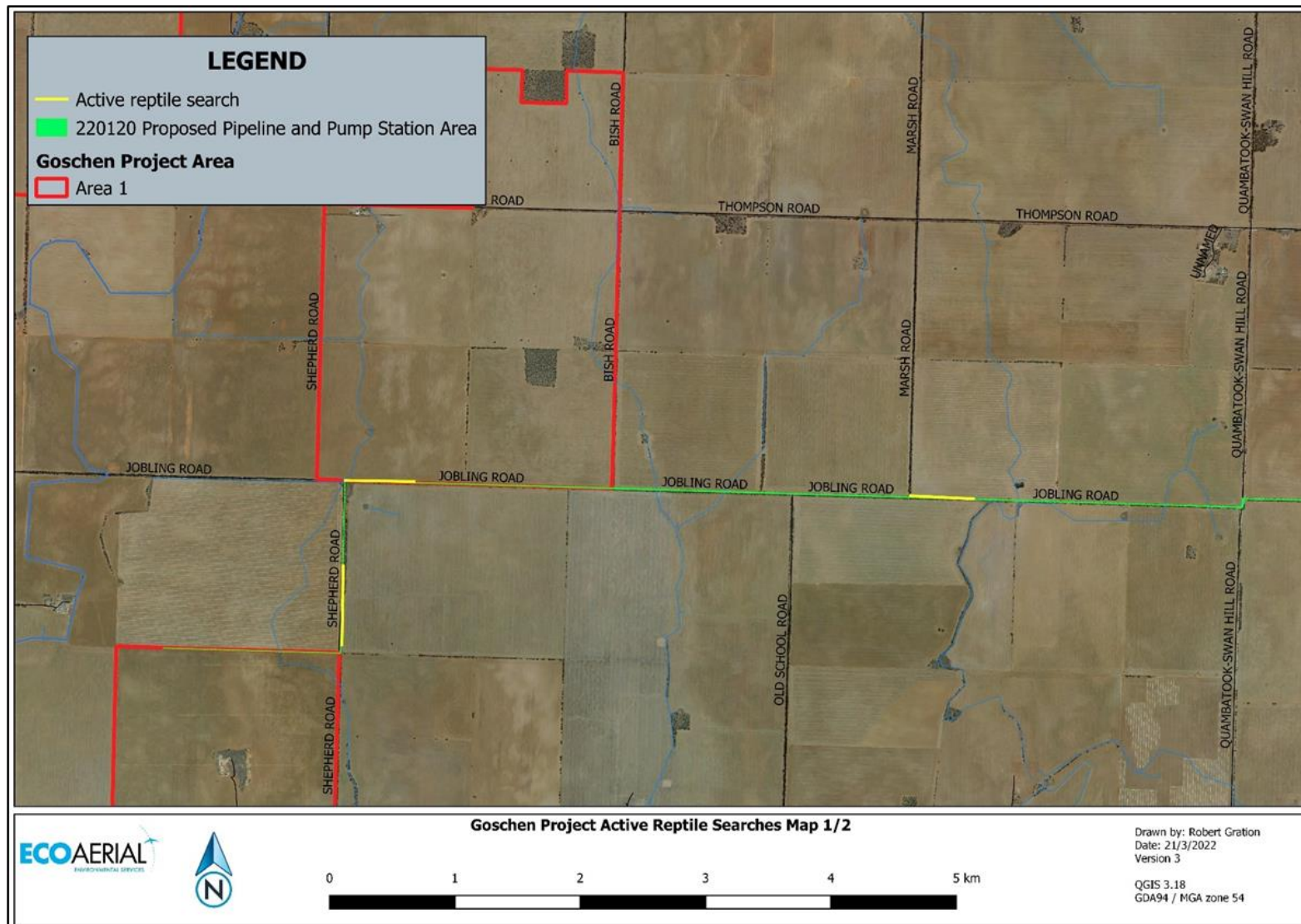


Figure C. 7 EcoAerial active reptile search



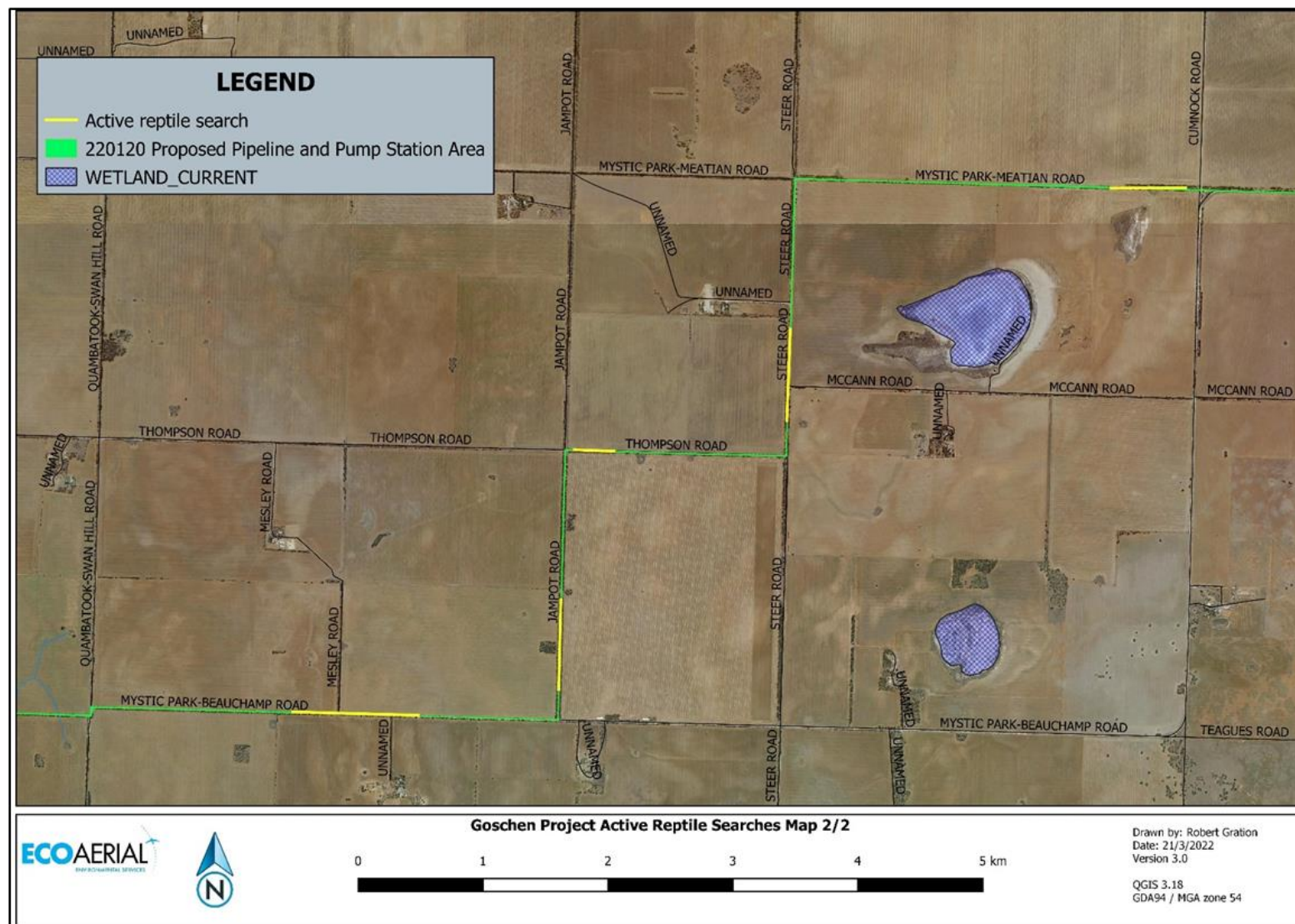
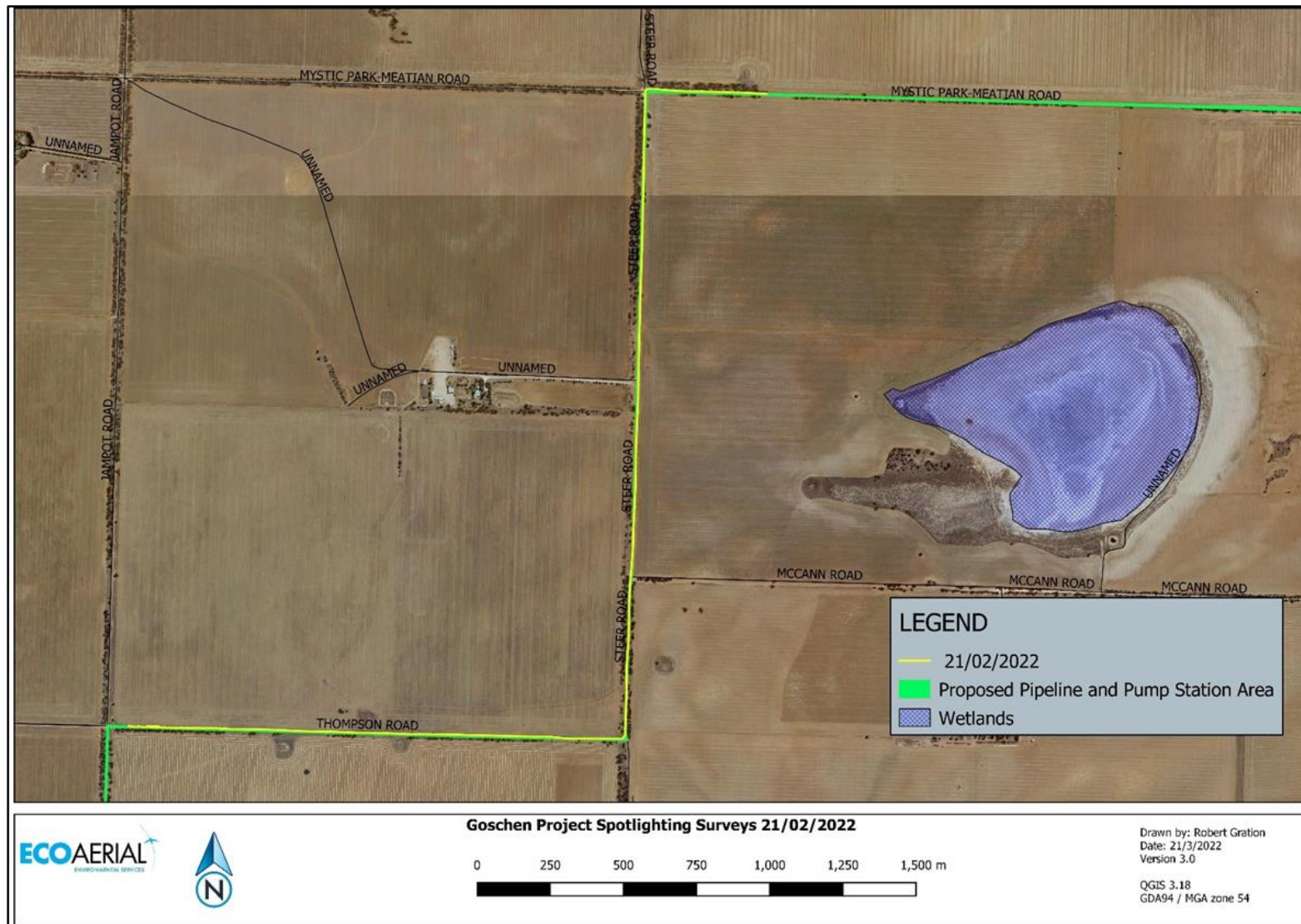
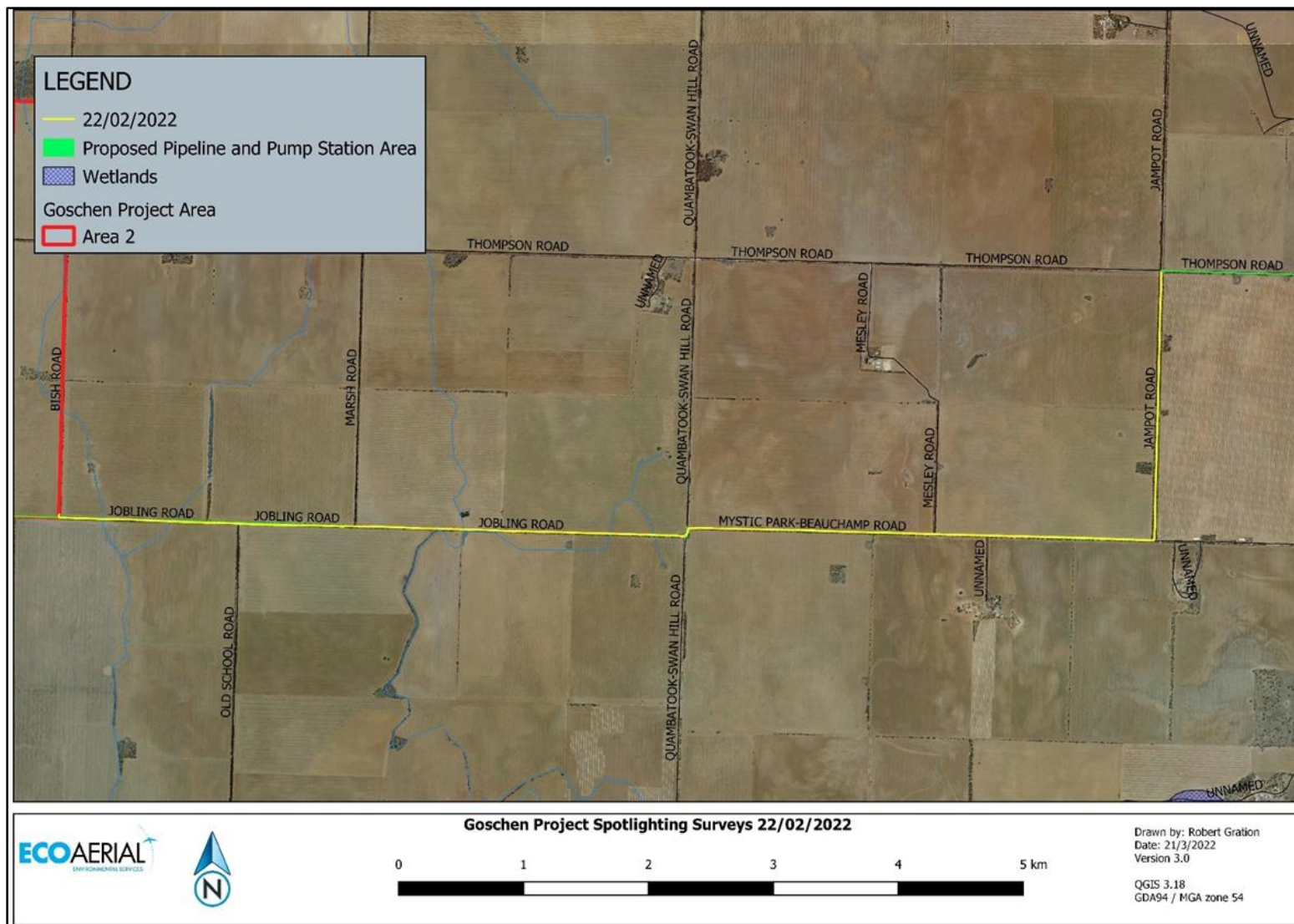


Figure C. 8 EcoAerial active reptile search

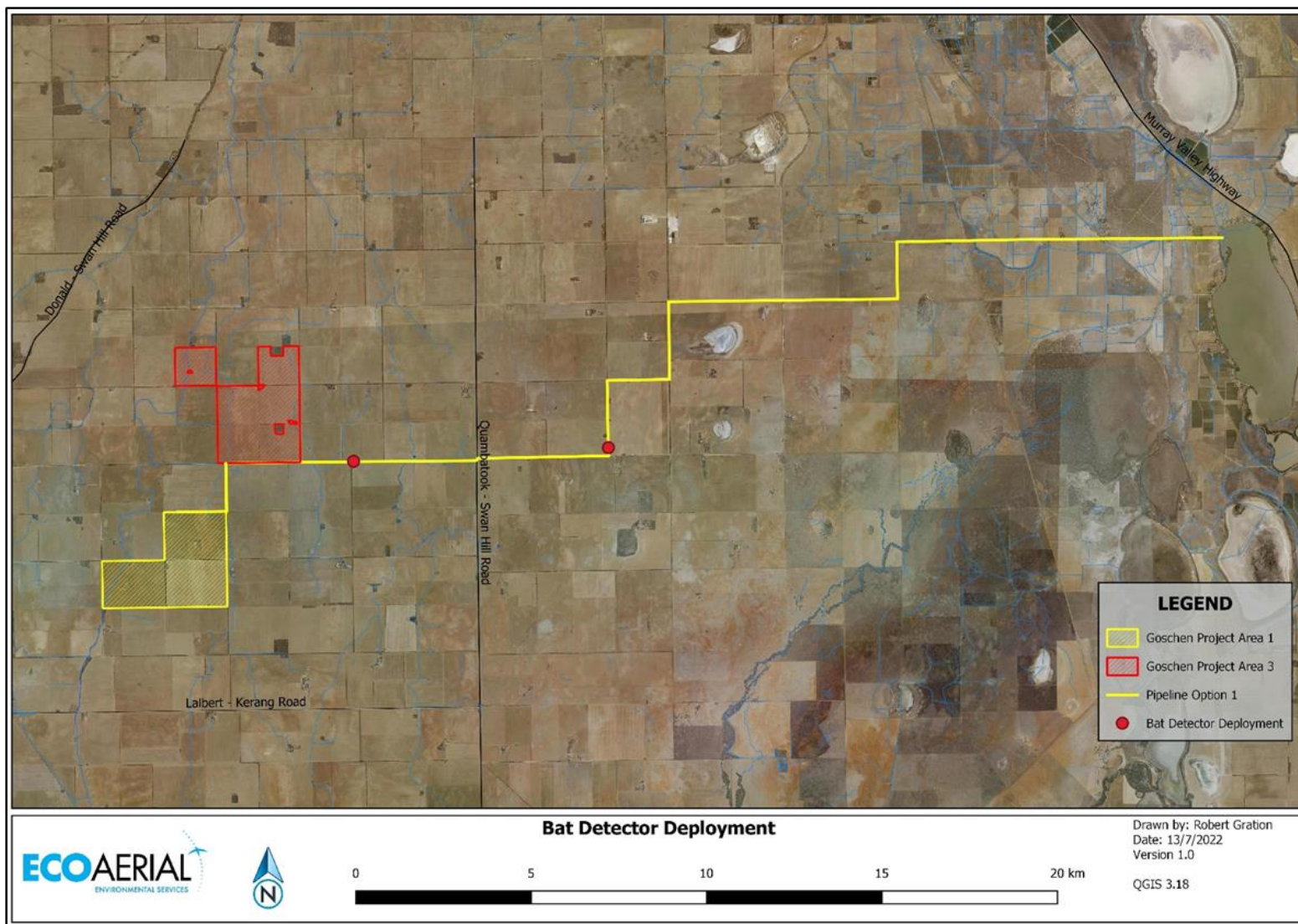


**Figure C. 9** EcoAerial spotlight surveys



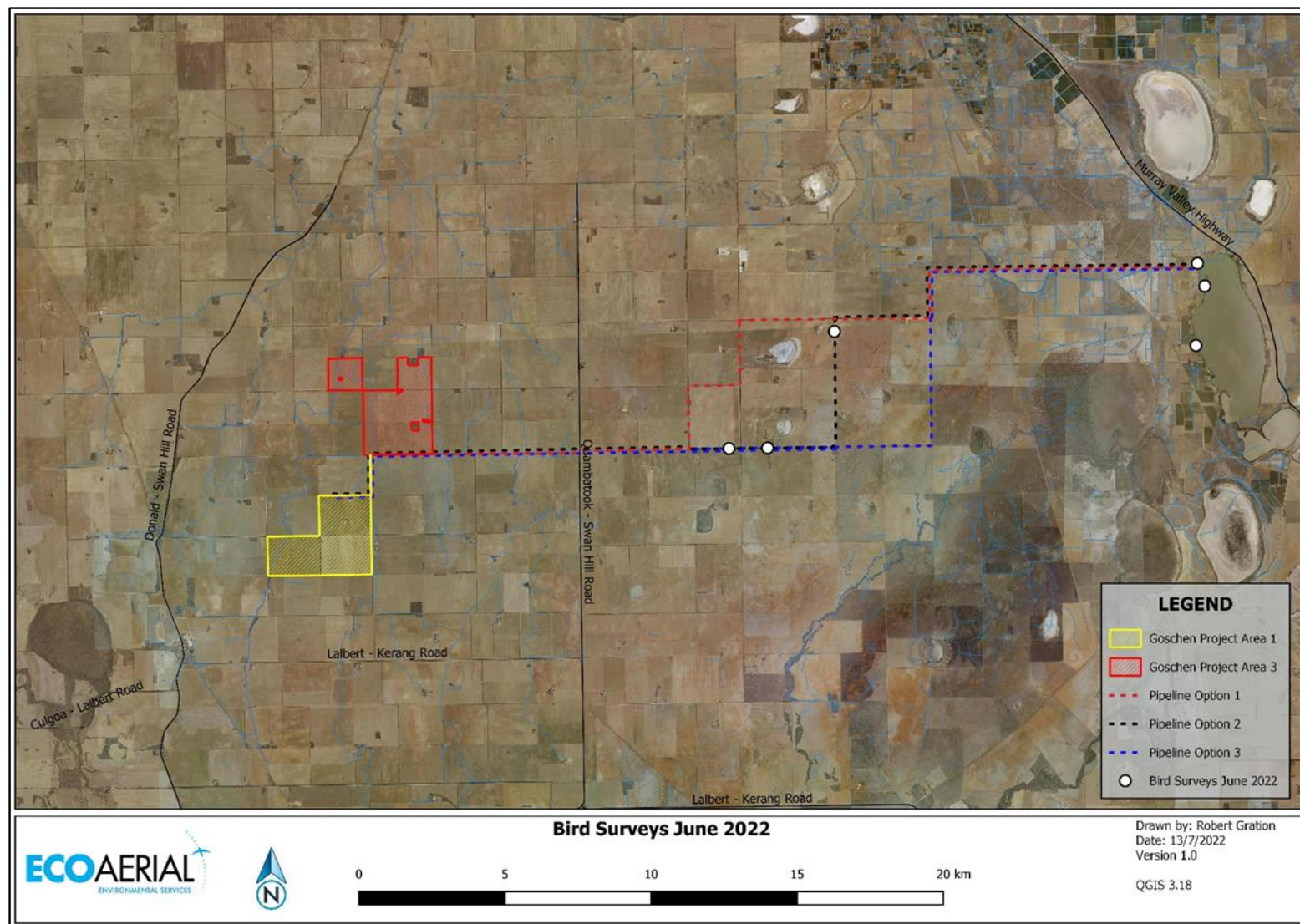


**Figure C. 10** EcoAerial spotlight surveys



**Figure C. 11** EcoAerial bat detector deployment





**Figure C. 12** Bird surveys



## **Appendix D- EcoAerial Plains-wanderer Survey Report**

# VHM Ltd Goschen Plains - wanderer Survey



EcoAerial  
23 Rosie Place  
Altona  
Vic 3018

Phone: 03 9315 4749  
Mobile: 0414 689 853  
Email : rob@ecoaerial.com.au

© EcoAerial - 2022

This document and the information are solely for the use only of the authorised recipient and may not be used, copied, or reproduced in whole or part for any purpose other than that for which it was supplied by EcoAerial. EcoAerial makes no representation and accepts no responsibility to any third party who may use / rely on this document.

Plains-wanderer photo credit on front page: PH

Revision No	Date	Report Actions	Author	Reviewer	Review Date
DRAFT 1	11/06/2021	DRAFT Report	Rob Gration	Damien Cancilla / Erica MacIntyre	
DRAFT 1.2	20/03/2022	Review database records	Rob Gration	James Booth	
FINAL	2/06/2022	Final review	Rob Gration	N/A	

## **Acknowledgments**

AECOM: Vic Buljubasic

Spectrum Ecology: Damien Cancilla; Astrid Heidrich

VHM Ltd: Kurtis Noyce; Ken Adey; Gary Sinagra; Terri Cranny

Landholders for allowing access.

Contents	Page number
Acknowledgments .....	iv
Executive Summary .....	vii
1 Introduction .....	1
1.1 Project Background.....	1
1.2 Scope of Works .....	1
1.3 Study Area .....	1
1.4 Target Species-Plains Wanderer .....	3
2 Methods.....	4
2.1 Sound Recorder Deployment.....	4
2.1.1 <i>Call Analysis</i> .....	4
2.1.2 <i>Call classifier</i> .....	4
2.1.3 <i>Cluster analysis</i> .....	7
2.2 Transect Surveys-Diurnal and Nocturnal.....	8
2.2.1 <i>Plains-wanderer Habitat Assessment</i> .....	8
2.2.2 <i>Plains Wanderer Desktop Review</i> .....	8
3 Results.....	10
3.1 Plains-wanderer Desktop Review .....	10
3.1.1 <i>Victorian Biodiversity Atlas – Plains-wanderer Records</i> .....	10
3.1.2 <i>Personal Communication – Plains Wanderer Records</i> .....	13
3.2 Sound Recorder Surveys .....	13
3.2.1 <i>Plains-wanderer Classifier Results</i> .....	13
3.2.2 <i>Cluster Analysis Results</i> .....	14
3.3 Transect Survey Results- Diurnal and Nocturnal.....	16
3.3.1 <i>Area 1</i> .....	16
3.3.2 <i>Area 2</i> .....	16
3.3.3 <i>Area 3</i> .....	17
3.3.4 <i>Incidentals</i> .....	18
3.3.5 <i>Weather conditions</i> .....	18
3.4 Plains Wanderer Habitat Assessment.....	20
4 Discussion .....	24
4.1.1 <i>Habitat Assessment</i> .....	24
4.1.2 <i>Transect Survey Results</i> .....	25
4.1.3 <i>Sound Recorder Results</i> .....	25
4.1.4 <i>Land management</i> .....	25
5 Conclusion .....	26
6 References and Bibliography .....	27
Appendix A – Song Meter Recorder Deployment.....	29
Appendix B- VBA Records .....	32
Appendix C – Plains-wanderer Classifier Results.....	34

Appendix D- Cluster Analysis Results .....	51
Appendix E – Sound Recorder Images .....	56

Acronym	Description
BOCA	Birds Observer Club of Australia
CoA	Commonwealth of Australia
DAWE	Department of Agriculture, Water, and the Environment
DELWP	Victorian Department of Environment, Land, Water and Planning
DEWHA	Commonwealth Department of Environment, Water, Heritage, and the Arts
E&HP	Ecology and Heritage Partners
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EEA Act	<i>Environment Effects Act 1978</i>
EES	Environmental Effects Statement
FFG Act	<i>Flora and Fauna Guarantee Act 1988</i>
TRG	Technical Reference Group
VBA	Victorian Biodiversity Database



## Executive Summary

EcoAerial was engaged by Spectrum Ecology on behalf of VHM Ltd to undertake targeted surveys for the Commonwealth listed Critically Endangered Plains-wanderer.

VHM Exploration is proposing to develop the Goschen Mineral Sands Project, located in the Loddon Mallee Region in northern Victoria approx. 280 km northwest of Melbourne and 20 km south of Swan Hill (Ecoscape Australia Pty Ltd, 2018). The project will include the development of a mineral sands mine and associated infrastructure using open pit mining.

The Minister for Planning, (10 October 2018) determined that VHM Exploration Limited is to prepare an Environment Effects Statement (EES) for the proposed Goschen Mineral Sands and Rare Earths Project. The purpose of the EES is to provide a sufficiently detailed description of the project, assess its potential effects on the environment and assess alternative project layouts, designs and approaches to avoid and mitigate effects.

The study area at the time of the survey was approx. 2,020ha consisting primarily of cropped paddocks. The study area has since been reduced to 1,474ha but still incorporates the survey area undertaken in 2021. Native vegetation is confined to road reserves with some remnant patches on fence lines extending into the paddocks.

The field assessments entailed diurnal and nocturnal transect surveys; deployment of sound recorders and habitat assessment using the quadrat / golf ball method used for assessing the suitability of habitat for Plains Wanderer. A summary of the field assessment survey effort and outcomes are provided below:

- Transect surveys covered approx. 330ha. No Plains wanderer were observed.
- The transect survey entailed 52 person hours of survey effort over 4-nights / days. Surveys effort exceeded the Commonwealth guidelines (DEWHA 2010).
- Transect surveys were timed to maximise the likelihood of seeing Plains-wanderer: *“autumn is the time when the greatest number of juveniles can be found if there has been successful breeding during the previous spring / summer”* (Baker-Gibb et al, 2016).
- Only common birds known to use derived grasslands and cropped areas were observed.
- Sound detectors recorded only common, non-threatened avifauna. No Plains-wanderer were recorded.
- All paddocks lacked the native / non-native vegetation habitat structure required to support Plains-wanderer.
- All paddocks had evidence of field mice, burrows and, rabbits encouraging high levels of predator activity.
- Birds of prey, foxes and a feral cat were observed within the study area. *“Plains-wander are considered vulnerable to predation”* (Birdlife Australia, 2017).
- The study area has high levels of intensive land management not conducive to support Plains-wanderer habitat (Birdlife Australia, 2017) e.g., cropping cycle of cultivation, seeding, herbicide / pesticide application and crop stripping using heavy vehicles.

Based on the outcomes of the surveys, we conclude that it is highly unlikely that Plains-wanderer or habitat suitable to support Plains-wanderer is present within the study area.



# 1 Introduction

## 1.1 Project Background

VHM Exploration plans to develop the Goschen Mineral Sands Project, located in the Loddon Mallee Region in northern Victoria. The Project is located approx. 280 km northwest of Melbourne and 20 km south of Swan Hill (Ecoscape Australia Pty Ltd 2018).

The project will include the development of a mineral sands mine and associated infrastructure. The proposed mining methods involve open pit mining to extract approx. 5 Metric tonnes (Mt) of ore per annum, increasing to 10 Mt per annum over a projected mine life of 30 years (DELWP, 2019).

The Minister for Planning, (10 October 2018) determined that VHM Exploration Limited is to prepare an environment effects statement (EES) for the proposed Goschen Mineral Sands and Rare Earths Project. The purpose of the EES is to provide a sufficiently detailed description of the project, assess its potential effects on the environment and assess alternative project layouts, designs and approaches to avoid and mitigate effects. The Minister's assessment will inform statutory decision-makers responsible for the project's approvals.

The *Scoping Requirements for Goschen Mineral Sands Project Environment Effects Statement* (DELWP, 2019) require assessments to be undertaken for several *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened species and / or communities and, *Flora and Fauna Guarantee Act 1988* (FFG Act) listed species. There have been several studies undertaken to date; E&HP (2018a), E&HP (2018b), EcoScape (2018) and Spectrum Ecology (2019). The TRG requested further surveys were undertaken for the EPBC Act Critically Endangered and FFG Act listed Plains-wanderer.

## 1.2 Scope of Works

The scope of works was based on communications VHM Ltd had with the Technical Reference Group (TRG) and advice from DELWP regional representatives. Three areas were identified to conduct Plains-wanderer surveys. Specifically, the scope of work required the following:

- Deployment of sound recording strategically deployed across the site.
- Conduct observational transect surveys.

## 1.3 Study Area

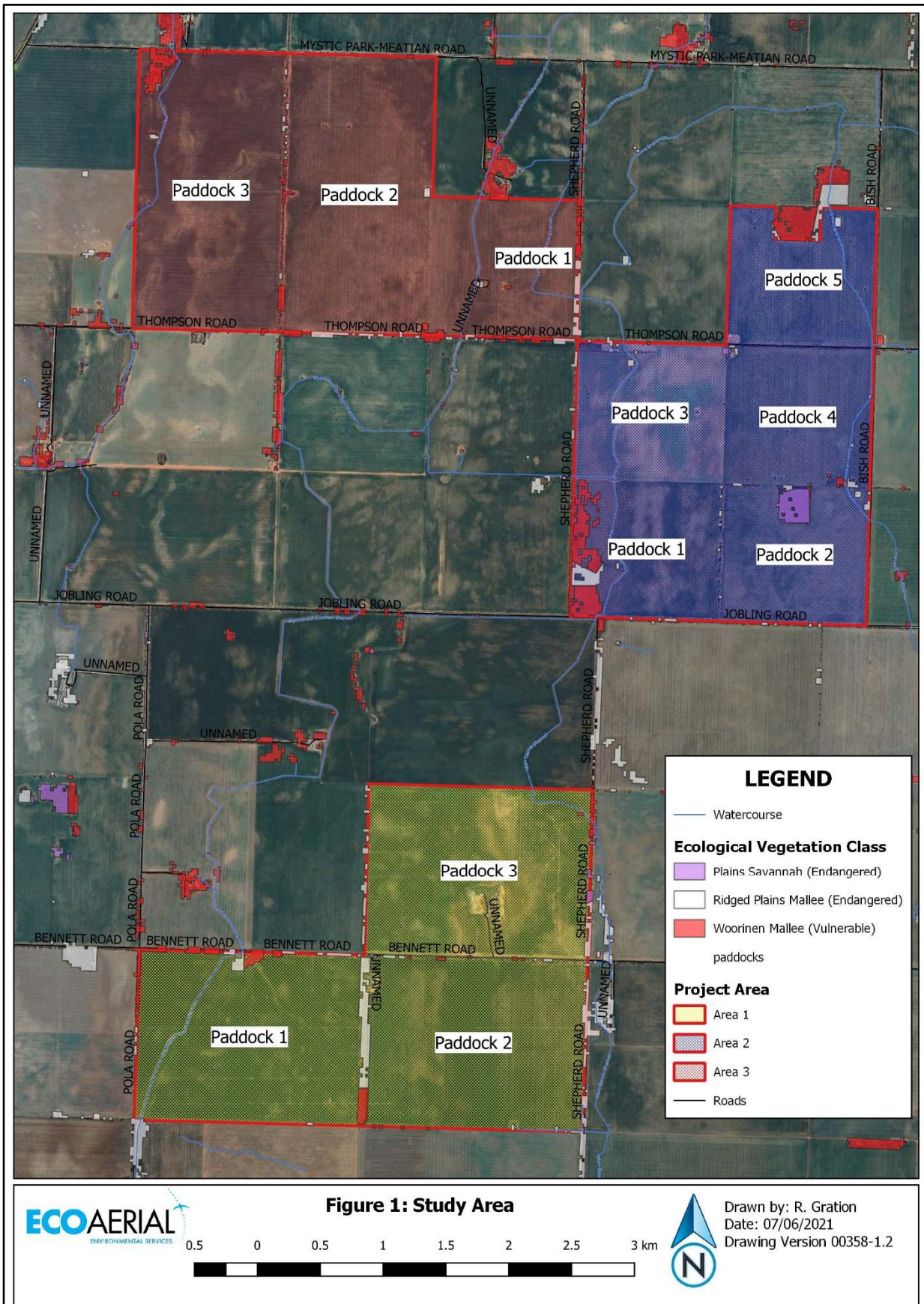
Most of the wider study area (2,020ha) is used for cropping. The reduced study area is provided in Figure 1. Native vegetation is confined to road reserves, except for small pockets of remnant vegetation on fence lines extending into a paddock. There is approximately 23ha of native vegetation present in the paddocks and 9.3ha of derived grassland.

Area 1 is located between Pola Rd (east) and Shepherd Rd (west). There are two paddocks south of Bennett Rd and one paddock to the north of Bennett Rd.

Area 2 has for paddocks located between Jobling Rd (south) and Thompsons (north) and Shepherds (east) and Bish Rd (west) and includes one paddock to the north of Thompsons Rd.



Area 3 has three paddocks located between Thompsons Rd (south) and Mystic Park-Meatian Rd (north) and east of Shepherd Rd.



## 1.4 Target Species-Plains Wanderer

Plains-wanderer are a cryptic species listed as “*critically endangered*” under the Commonwealth EPBC Act and state listed in Victoria under the FFG Act (DELWP 2013). They are quail like ground birds. Unlike quail they have tall, narrow necked stance and the legs are longer than quail. Females have a black spotted neck and rufous breast band. The legs extend past the tail when in flight and, the wing pattern disguises Plains-Wanderer from quail (Moorcombe, 2014). When fully grown they measure 15-19 cm in length, a wing-span of 28-36 cm, with males weighing 40-80 grams and females 55-95g (Marchant & Higgins, 1993).

### Breeding season

Breeding has been recorded in most months but takes place in spring with second and even third clutches laid in summer if sufficient rain falls (Marchant & Higgins 1993), extending to February (Birdlife, 2017).

### Habitat

Plains-wanderer prefer grasslands with the following conditions: about 50 per cent bare ground and 10 per cent fallen litter, with the remaining 40 per cent made up of short herbs and grasses; grass tussocks spaced 10–20 cm apart; most of the vegetation below 5 cm high but some up to a maximum of 30 cm.

Plains-wanderer forages during the day but is cryptic and difficult to detect (Marchant & Higgins 1993), detectability increases markedly at night (Baker-Gabb et al. 2016). Although breeding may occur outside of the peak breeding season (e.g., Spring), Baker-Gibb (2018) deployed recorders with great success over the peak breeding season, (Spring). Baker-Gabb et al. (1990) believes habitat structure is more important than floristics.

## 2 Methods

Several survey methods were used to survey for Plains-wanderer and assess the suitability of habitat. Each of the methods are detailed below.

### 2.1 *Sound Recorder Deployment*

Song Meters (Wildlife Acoustics™) were deployed at each of the six locations shown in Figure 2. Photographs of recorder deployment are provided in Appendix A. The detectors were placed on fence posts at least 200m away from canopy trees that are 8m in height (Baker-Gibb) and, where crop stubble or derived grassland was present. The recorders were in the field from the 28 March 2021 to 2 May 2021 and programmed to record 30-minutes every hour over a 12-hour nightly period. Due to variance in power usage between the recorders, the number of night recording varied from 23-days to 36-days (180-detector nights). A total of 2,270 thirty-minute files (1,135 hours) were analysed. A limitation is that the deployment period of the detectors in late March to April is outside the peak calling period (Baker-Gabb, 2018).

#### 2.1.1 *Call Analysis*

Sound analysis was undertaken using Wildlife Acoustics, Kaleidoscope Pro 5 (Ver 5.1.9) software. Kaleidoscope uses a cluster analysis process whereby vocalisations are grouped together based on their similarity and placed in a cluster named 00 to a maximum of 500. The software also allows developing a classifier based on the unique vocalisation of a species, in this case the Plains-wanderer.

#### 2.1.2 *Call classifier*

Call classifiers were developed from reference vocalisations of the target species. The reference calls (BOCA, 2001; Morcombe, 2018) were played and recorded onto a SongMeter4 to replicate the equipment used in the field.

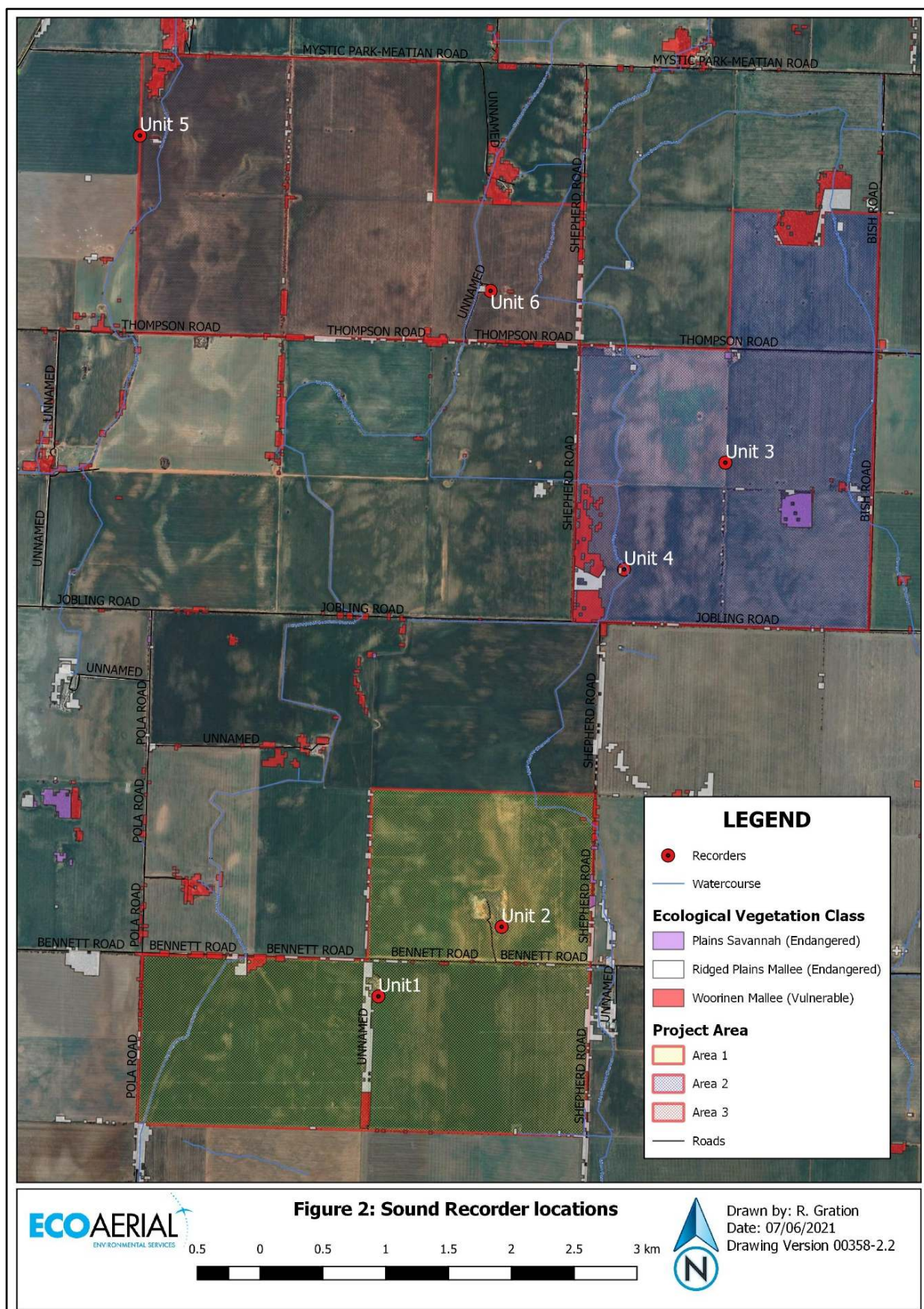
Six reference calls were run through the cluster analysis process in Kaleidoscope. The clusters were reviewed and renamed based on the reference call and saved as an edited csv cluster file. As part of the software analysing process, a kcs is created from the edited csv file. The cluster kcs file contains a statistical representation of the clusters of the reference calls. The edited csv is run through the cluster analysis process again using the kcs classifier file to refine the classifier with pairwise classifiers and saved as a kcs and csv file. The field data is then analysed with the final kcs classifier file.

The classifiers were tested on the reference vocalisations. When the analysis correctly included the reference vocalisations classifier, analysis was undertaken on the full data sets. All reference calls were included with the field data. Analysis includes false positives to ensure any atypical vocalisations of the targeted species are included in the results.

Vocalisations are listed in the statistical order most like the reference call pattern. Each subsequent vocalisation is less like the previous. The results shown in the Tables 1~6 includes recordings that are within an agreed cluster distance threshold shown in the TOP1DIS column, i.e., the statistical order 0.00 ~1.20. With 0.00 being closest ranking to the reference call and 1.20 the furthered statistical distance from the reference call.

Please note that research indicates that the use of call classifiers provides a 90% reliability of extracting vocalisations of the target species (pers comm, Dewar, E., 29 April 2019).







### 2.1.3 Cluster analysis

The recordings of the six Song Meters were run through the cluster analysis process where all similar sound vocalisations were grouped into their relevant clusters based on their statistical similarities. The number of Clusters were set from 00-15. Figures 3 & 4 provide a visual representation of this process.



**Figure 3:** A range of species with varying call vocalisations (Image sourced from Wildlife Acoustics)



**Figure 4:** Species clustered based on their call parameters (Image sourced from Wildlife Acoustics)

## *2.2 Transect Surveys-Diurnal and Nocturnal*

Prior to undertaking the transect surveys, we identified paddocks with crop stubble and any derived grasslands within each of the three locations i.e., Areas 1, 2 & 3. Nocturnal transect surveys were undertaken on 27, 28, 29 & 30 March 2021. Diurnal surveys were undertaken on 28, 29, 30 & 31 March 2021. All sites were surveyed twice. The survey effort totalled fifty-two person hours and exceeded the Commonwealth Survey guidelines for Australian threatened birds: Plains-wanderer (2010).

Thirty metre transects were walked by two field staff during daylight surveys when Plains-wanderer forage and 15-metre transects of a night (refer to Figure 3) when the likelihood of Plains-wanderer sightings increase (Baker-Gabb et al, 2016). The distance between transects differed between the day and night surveys to account for visibility. Led Lenser™ torches and headlamps were used for the nocturnal surveys along with Bushnell 10 x 40mm binoculars.

The daylight surveys were conducted for 1-hour in each paddock at each of the three locations over 4-days totalling 24 person hours including driving between sites and, 1-hour per night at each of the 3 locations over 4 nights totalling 28 person hours including driving between sites.

Transects differed between the daylight and night surveys to maximise the area surveyed. Where possible a vehicle was used of a night along existing vehicle tracks to cover more area in conjunction with foot surveys. A GPS was used for orientation and a range finder to ensure the correct distance between field staff. Surveys were conducted during suitable weather conditions with little to no wind and no rain or light showers.

Please note: Transects surveys are more suitable during the Autumn when young are active (Baker-Gabb et al, 2016). Walking transects were the primary method deployed due to landowners not allowing driving of vehicles across the paddocks.

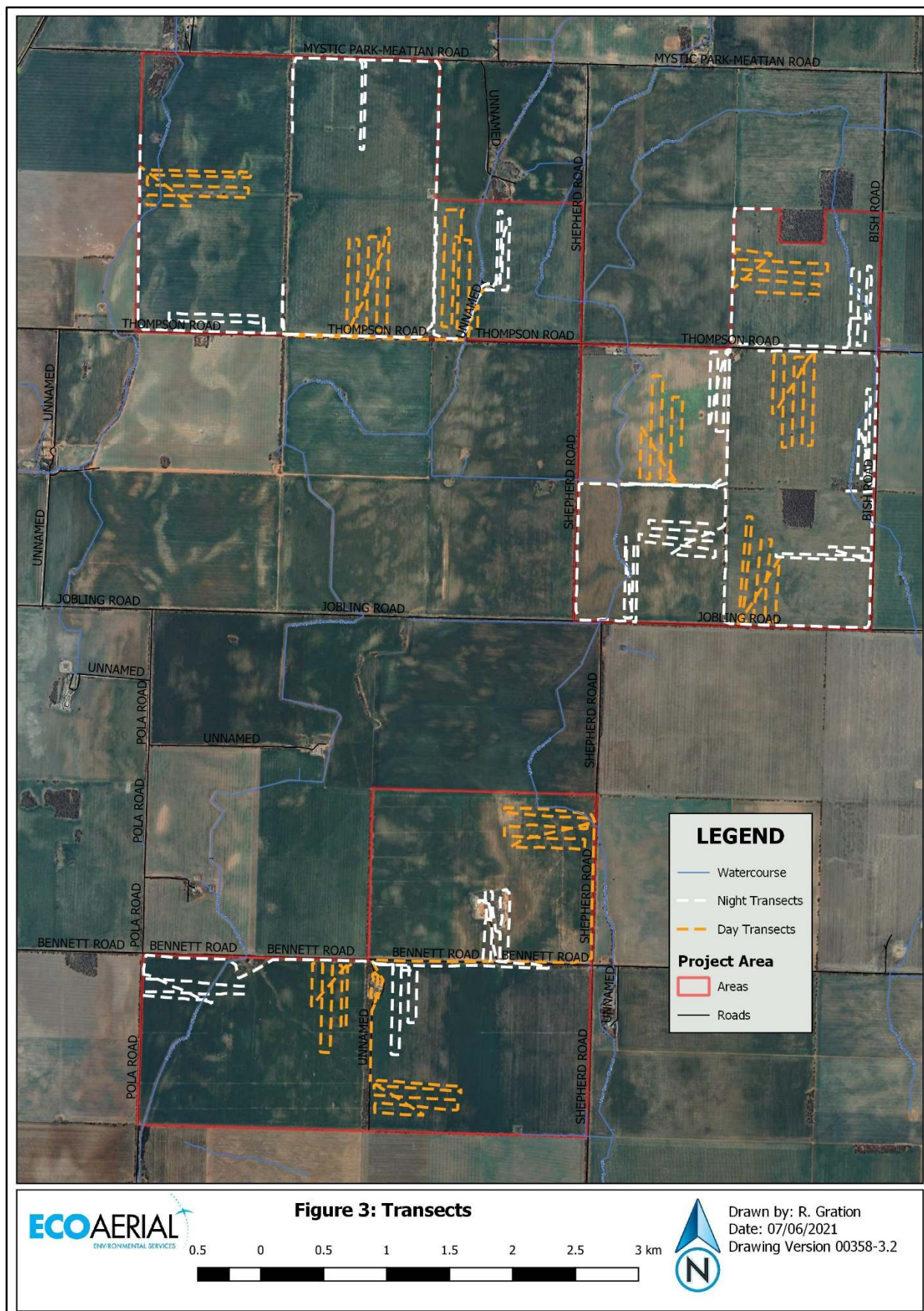
### *2.2.1 Plains-wanderer Habitat Assessment*

Habitat assessments were undertaken in each paddock deploying the quadrat / golf ball method across the tenement. This method is frequently used for assessing the suitability of native grassland structure for Plains-wanderer (Baker-Gabb, 2016). The method entails dropping 18 golf balls into and 1<sup>2</sup>m quadrat with the number of balls seen completely or partially scored. Scoring is based on if a ball is 90% visible it scores 1, less than 90% seen but more than 33% scores 0.5 and, less than 33% is seen, it scores zero. Scores of 1-13 are considered too dense with scores of 17.5 and above to sparse. The ideal score is 15 -16.5. A quadrat was placed in each paddock in a location indicative of the paddock stubble structure.

### *2.2.2 Plains Wanderer Desktop Review*

A database search was undertaken of the Birdlife Live Map, Eremaea Birdlines and Ebird. These databases provide information of birds recorded. Due to the Plains-wanderer status as a sensitive species, site information was not available. The Victorian Biodiversity Database (VBA) was also reviewed. The objective was to monitor for updated records of Plains-wanderer within 30km of the project area. Further to this, any incidental sightings were noted.





## 3 Results

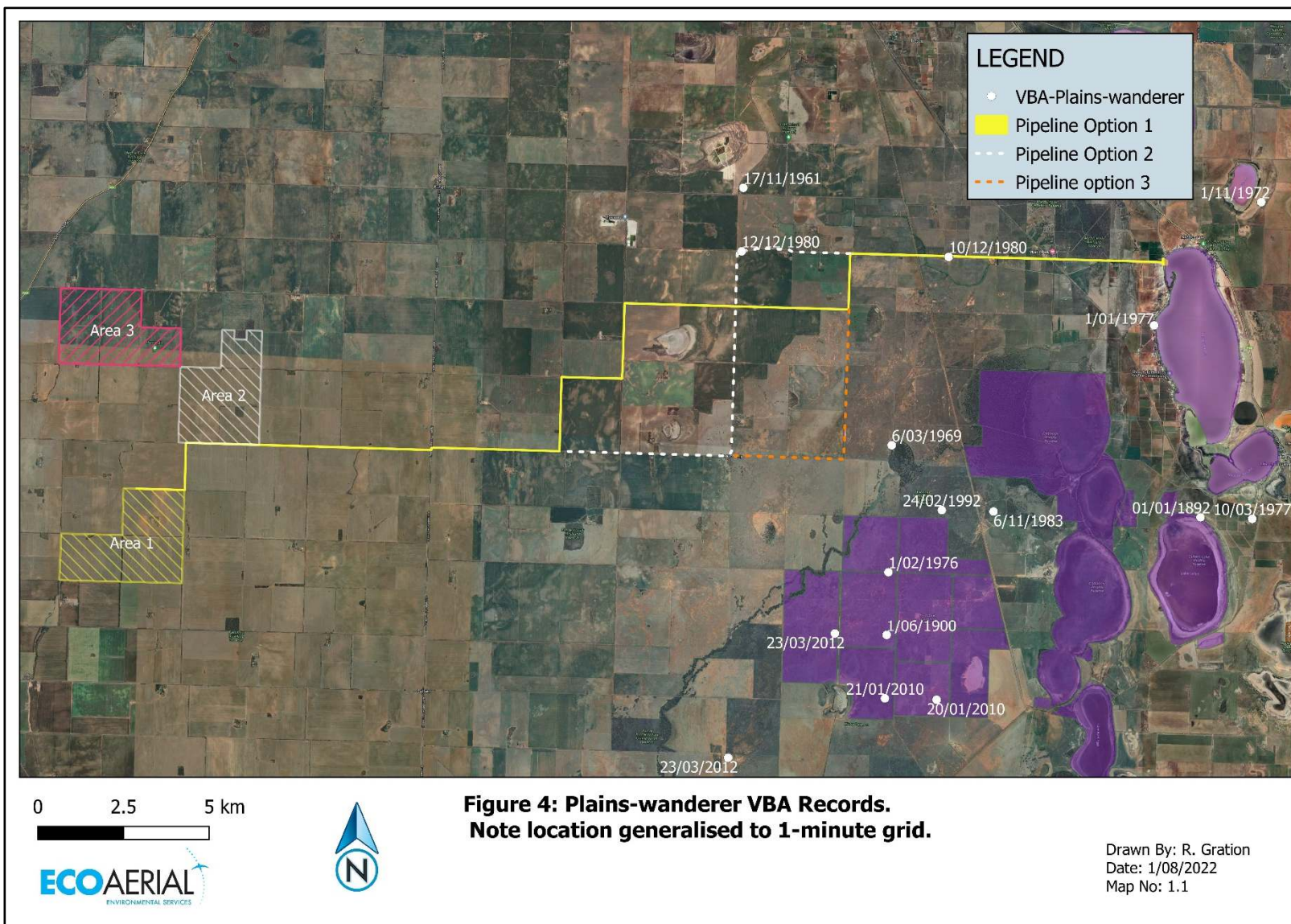
### 3.1 *Plains-wanderer Desktop Review*

Only the VBA databases provided Plains-wanderer information. Other databases normally reviewed, (e.g., Ebird, Birdlife live map and Eremaea Birdlines), did not generate search results due to Plains-wanderer being considered a sensitive species. The desktop review was confined to the VBA and a personal communication.

#### 3.1.1 *Victorian Biodiversity Atlas – Plains-wanderer Records*

DELWP's Victorian Biodiversity Atlas (VBA) was reviewed for Plains-wanderer within a 30km buffer. There are thirty-one records dating from 1892 to the most recent in 2018 (refer to Table 1 in Appendix B). The 2018 record was approx. 20km south-east of the study area. The 2018 record is in the same location as a 2010 record (refer to Figure 4).









### 3.1.2 Personal Communication – Plains Wanderer Records

Seven Plains-wanderer were observed in a Parks Victoria (PV) managed reserve approx., 20km east of the study area over the 2021 Easter weekend (2 April 2021- 5 April 2021). This included at least one sub-adult and two chicks. Habitat consisted of a combination of native grasses and introduced pasture on what were previously farms used for grazing stock. PV uses grazing as the primary tool for managing the reserve for Plains-wanderer (Anon. 2021, pers. comm., 1 June). The exact location of the site has been deliberately withheld due to the species sensitivity.

## 3.2 Sound Recorder Surveys

The following section provides the results of running the field recordings in the Kaleidoscope software using the inbuilt cluster analysis function and analysing with a Plains-wanderer classifier.

The analysis of both the cluster analysis and classifier resulted in only common species being recorded: Boobook Owl, Galah, Noisy Miner, Willy Wagtail, Australian Raven, Raven sp, Crimson Rosella, Lorikeet sp, Grey Fantail and Striated Pardalote.

Apart from Boobook Owl, birds were recorded at dawn and dusk. Crickets and wind noise dominated the recordings during the night and there were also recordings of dogs barking and field workers voices whilst undertaking the transect surveys.

No calls matched the Plains-wanderer reference call when the classifier was used or, the cluster analysis files were manually reviewed.

### 3.2.1 Plains-wanderer Classifier Results

The results in Tables 1~6 is not representative of the total number of vocalisations of a species within each classifier cluster. Appendix C provides the tables of the total vocalisations identified using the Plains-wanderer classifier.

No Plains-wanderer calls were identified.

Table 1: Location 1 - Classifier Results

IN FILE	Fmin	Fmean	Fmax	TOP1MATCH*	MANUAL ID
20210408_190000.wav	375	553.571	750	Plains Wanderer	Boobook Owl
20210408_190000.wav	375	672.554	1593.75	Plains Wanderer	Dog
20210408_190000.wav	281.25	834.375	2812.5	Plains Wanderer	Galah
20210329_070000.wav	656.25	952.621	1218.75	Plains Wanderer	Magpie
20210331_070000.wav	375	832.031	1031.25	Plains Wanderer	Magpie & Galah
20210406_070000.wav	656.25	2189.189	3375	Plains Wanderer	Magpie & Noisy miner
20210410_230000.wav	750	3227.431	7968.75	Plains Wanderer	Wind

Table 2: Location 2 - Classifier Results

IN FILE	Fmin	Fmean	Fmax	TOP1MATCH*	MANUAL ID
20210501_050000.wav	375	476.902	656.25	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	Plains Wanderer	Dog
20210328_190000.wav	1406.25	2136.418	4312.5	Plains Wanderer	Galah
20210410_070000.wav	468.75	727.5	1125	Plains Wanderer	Magpie
20210413_220000.wav	2812.5	6728.059	7968.75	Plains Wanderer	Wind

Table 3: Location 3 - Classifier Results

IN FILE	Fmin	Fmean	Fmax	TOP1MATCH*	MANUAL ID
20210415_230000.wav	437.5	710.938	1000	Plains Wanderer	Boobook Owl
20210416_190000.wav	625	2356.142	4625	Plains Wanderer	Magpie & Galahs
20210402_210000.wav	437.5	581.25	875	Plains Wanderer	Wind

Table 4: Location 4 - Classifier Results

IN FILE	Fmin	Fmean	Fmax	TOP1MATCH*	MANUAL ID
20210404_020000.wav	187.5	517.857	1031.25	Plains Wanderer	Boobook Owl
20210501_000000.wav	281.25	671.875	1218.75	Plains Wanderer	Dog
20210416_190000.wav	843.75	1317.969	1968.75	Plains Wanderer	Magpie
20210406_190000.wav	187.5	4044.181	7968.75	Plains Wanderer	Willy Wagtail
20210414_000000.wav	1781.25	6902.401	7968.75	Plains Wanderer	Wind

Table 5: Location 5 - Classifier Results

IN FILE	Fmin	Fmean	Fmax	TOP1MATCH*	MANUAL ID
20210404_072646.wav	375	567.188	750	Plains Wanderer	Boobook Owl
20210422_072646.wav	1125	4379.883	5718.75	Plains Wanderer	Magpie & Willy Wagtail
20210329_222652.wav	187.5	533.333	3468.75	Plains Wanderer	Voice
20210414_222646.wav	187.5	468.75	5437.5	Plains Wanderer	Wind

Table 6: Location 6 - Classifier Results

IN FILE	Fmin	Fmean	Fmax	TOP1MATCH*	MANUAL ID
20210330_040000.wav	437.5	562.5	687.5	Plains Wanderer	Boobook Owl
20210413_050000.wav	187.5	385.417	1500	Plains Wanderer	Dog
20210418_190000.wav	312.5	1137.908	2437.5	Plains Wanderer	Raven
20210329_190000.wav	187.5	441.071	3937.5	Plains Wanderer	Voice
20210415_220000.wav	187.5	437.5	625	Plains Wanderer	Wind

Refer to Figure 2 for recorder locations.

### 3.2.2 Cluster Analysis Results

The results in Table 7~12 below details the vocalisations identified for each of the 15 clusters (00-14). No Plains-wanderer calls were identified.

Appendix D provides the table of the statistically highest and lowest vocalisation recorded in each cluster. Spectrogram images of all identified calls are provided in Appendix E.

Table 7: Location 1- Cluster Analysis Results

IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210403_060000.wav	656.25	1006.25	1406.25	3/04/2021	Boobook Owl
20210405_000000.wav	4406.25	4963.001	5437.5	5/04/2021	Cricket
20210405_190000.wav	562.5	2702.633	7781.25	5/04/2021	Crimson Rosella
20210402_190000.wav	468.75	1062.643	1968.75	2/04/2021	Magpie
20210401_190000.wav	1593.75	3676.1	5625	1/04/2021	Noisy miner
20210420_190000.wav	1593.75	1798.828	2062.5	20/04/2021	Wind

Table 8: Location 2 - Cluster Analysis Results

IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210408_190000.wav	3750	4046.746	4406.25	8/04/2021	Cricket
20210328_190000.wav	2156.25	3568.269	4968.75	28/03/2021	Galah
20210416_070000.wav	750	1297.775	1968.75	16/04/2021	Magpie
20210404_070000.wav	2531.25	2834.135	3187.5	4/04/2021	Noisy miner
20210414_010000.wav	1218.75	6193.139	7968.75	14/04/2021	Wind

Table 9: Location 3 - Cluster Analysis Results

IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210418_200000.wav	4312.5	4678.75	5125	18/04/2021	Cricket
20210417_190000.wav	562.5	1730.382	4187.5	17/04/2021	Galah
20210418_190000.wav	1562.5	1945.043	2437.5	18/04/2021	Magpie
20210418_190000.wav	625	1878.788	3875	18/04/2021	Raven
20210409_060000.wav	312.5	882.813	1250	9/04/2021	Wind

Table 10: Location 4 - Cluster Analysis Results

IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210406_190000.wav	656.25	1372.018	4781.25	6/04/2021	Australian raven
20210502_190000.wav	4593.75	5089.439	5437.5	2/05/2021	Cricket
20210424_190000.wav	1406.25	1660.714	1968.75	24/04/2021	Magpie
20210418_190000.wav	656.25	1450.368	3656.25	18/04/2021	Raven
20210411_020000.wav	5062.5	7242.188	7968.75	11/04/2021	Wind

Table 11: Location 5 - Cluster Analysis Results

IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210418_072646.wav	2625	2833.333	3093.75	18/04/2021	Crimson Rosella
20210417_072646.wav	1125	3632.813	4687.5	17/04/2021	Galah
20210403_072646.wav	2062.5	4050.907	5531.25	3/04/2021	Grey Fantail
20210412_072646.wav	1218.75	2966.647	5906.25	12/04/2021	Lorikeet
20210331_072646.wav	562.5	1267.857	4031.25	31/03/2021	Magpie
20210404_072646.wav	937.5	1336.765	1687.5	4/04/2021	Pied Butcherbird
20210421_072646.wav	1125	1573.661	2625	21/04/2021	Raven
20210406_072646.wav	2156.25	3074.219	3562.5	6/04/2021	Striated Pardalote
10329_222652.wav	281.25	1647.804	6093.75	29/03/2021	Voice
20210412_072646.wav	2531.25	4136.029	5531.25	12/04/2021	Willy Wagtail
20210410_192646.wav	187.5	843.75	7968.75	10/04/2021	Wind

Table 12: Location 6 - Cluster Analysis Results

IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210412_200000.wav	375	967.391	1187.5	12/04/2021	Boobook Owl
20210329_200000.wav	5187.5	5472.948	5812.5	29/03/2021	Cricket
20210402_200000.wav	312.5	655.488	1125	2/04/2021	Dog
20210407_190000.wav	625	1810.417	3875	7/04/2021	Galah
20210411_190000.wav	1250	1620.192	2062.5	11/04/2021	Magpie
20210409_060000.wav	312.5	605.299	1000	9/04/2021	Metallic noise

20210412_190000.wav	1000	1667.725	2750	12/04/2021	Raven
20210329_190000.wav	187.5	397.321	1875	29/03/2021	Voice
20210414_040000.wav	2062.5	3243.056	4500	14/04/2021	Wind

Refer to Figure 2 for recorder locations.

### 3.3 Transect Survey Results- Diurnal and Nocturnal

The following tables outline the fauna observed whilst undertaking the transect surveys. As was the case with the sound analysis results, only common non-threatened avian fauna was observed within the paddocks i.e., Australasian Pipit, Stubble Quail and Welcome Swallow (refer to Figure 5).

Other avifauna observed included birds of prey, Wedge-tailed Eagle, and Nankeen Kestrel; and the nocturnal Tawny Frogmouth and Australian Owlet-nightjar. Birds of prey have been included as they pose a predatory risk to Plains-wanderer.

There was a high density of active mice nests and rabbits seen across the study area. Mammal predators in the form of foxes and a feral cat were regularly seen over the duration of the transect surveys.

#### 3.3.1 Area 1

Area 1 consists of cereal cropped paddocks with two disused gravel quarries. The quarries consisted of derived grassland i.e., a mixture of non-native and native grasses but not constituting an EVC. Four species of fauna were observed within the paddocks: Brushtail Possum, Australasian Pipit, Welcome Swallow and a Fox. Table 13 details which paddock fauna was observed.

Table 13: Area 1 - fauna observed.

Area / Paddock	Diurnal / Nocturnal Survey	Common Name	Scientific Name
1 / 1	Nocturnal	Brushtail Possum	<i>Trichosurus vulpecula</i>
1 / 1	Nocturnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
1 / 1	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
1 / 2	Diurnal	Fox	<i>Vulpes vulpes</i>
1 / 2	Diurnal	Welcome Swallow	<i>Hirundo neoxena</i>

#### 3.3.2 Area 2

Area 2 consists of cereal and legume cropped paddocks. There is three locations where native vegetation in the form of canopy trees was present. A seven-hectare patch is present on the northern fenceline of Paddock 2, a two-hectare patch on the southern fenceline of Paddock 4, a nine-hectare patch on the northern boundary of Paddock 5 (refer to Figure 1). E&HP (2018) identified these patches as Woorinen Mallee EVC\_824.

Four fauna were observed, feral cat, Australian Pipit, Stubble Quail and evidence of European Fox. Table 14 details which paddock fauna was observed.

Table 14: Area 2 - fauna observed.

Area / Paddock	Diurnal / Nocturnal Survey	Common Name	Scientific Name
2 / 3	Nocturnal	Feral Cat	<i>Felis catus</i>
2 / 3	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
2 / 4	Diurnal	Fox scat	<i>Vulpes vulpes</i>
2 / 4	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
2 / 5	Diurnal	Stubble Quail	<i>Coturnix pectoralis</i>
2 / 5	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
2 / 5	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
2 / 5	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>

### 3.3.3 Area 3

Area 3 consists of cereal cropped paddocks. There are two locations where native vegetation was present. Native vegetation in the form of canopy trees was present in the north-west corner of Paddock 3 that is consistent with Woorinen Mallee EVC\_824 (E&HP, 2018). Three avifauna were observed: Australasian Pipit, Australian Owlet-nightjar, and Wedge-tailed Eagle. Three mammals were observed, European Rabbit, European Fox, and Field Mouse. Table 15 details which paddock fauna was observed.

Table 15: Area 3 - fauna observed.

Area / Paddock	Diurnal / Nocturnal Survey	Common Name	Scientific Name
3 / 1	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
3 / 2	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
3 / 2	Nocturnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
3 / 2	Diurnal	Australasian Pipit x 2	<i>Anthus novaeseelandiae</i>
3 / 2	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
3 / 2	Nocturnal	Rabbits x 6	<i>Oryctolagus cuniculus</i>
3 / 2	Nocturnal	Australian Owlet-nightjar	<i>Aegotheles cristatus</i>
3 / 2	Nocturnal	Field mouse	<i>Mus musculus</i>
3 / 2	Nocturnal	Australian Owlet-nightjar	<i>Aegotheles cristatus</i>
3 / 2	Diurnal	Fox tracks	<i>Vulpes vulpes</i>
3 / 2	Nocturnal	Australian Owlet-nightjar x 2	<i>Aegotheles cristatus</i>
3 / 3	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
3 / 3	Diurnal	Australasian Pipit	<i>Anthus novaeseelandiae</i>
3 / 3	Nocturnal	Fox x 1	<i>Vulpes vulpes</i>
3 / 3	Nocturnal	Australasian Pipit x 2	<i>Anthus novaeseelandiae</i>
3 / 3	Diurnal	Fox den	
3 / 3	Diurnal	Fox scat	<i>Vulpes vulpes</i>
3 / 3	Diurnal	Wedgetail Eagle x 2	<i>Aquila audax</i>

### 3.3.4 Incidentals

The following two avifauna were observed over the course of the survey.

Table 16: Relevant incidental fauna observed.

Area / Paddock	Diurnal / Nocturnal Survey	Common Name	Scientific Name
Incidental	Nocturnal	Tawny Frogmouth	<i>Podargus strigoides</i>
Incidental	Diurnal	Nankeen Kestrel	<i>Falco cenchroides</i>

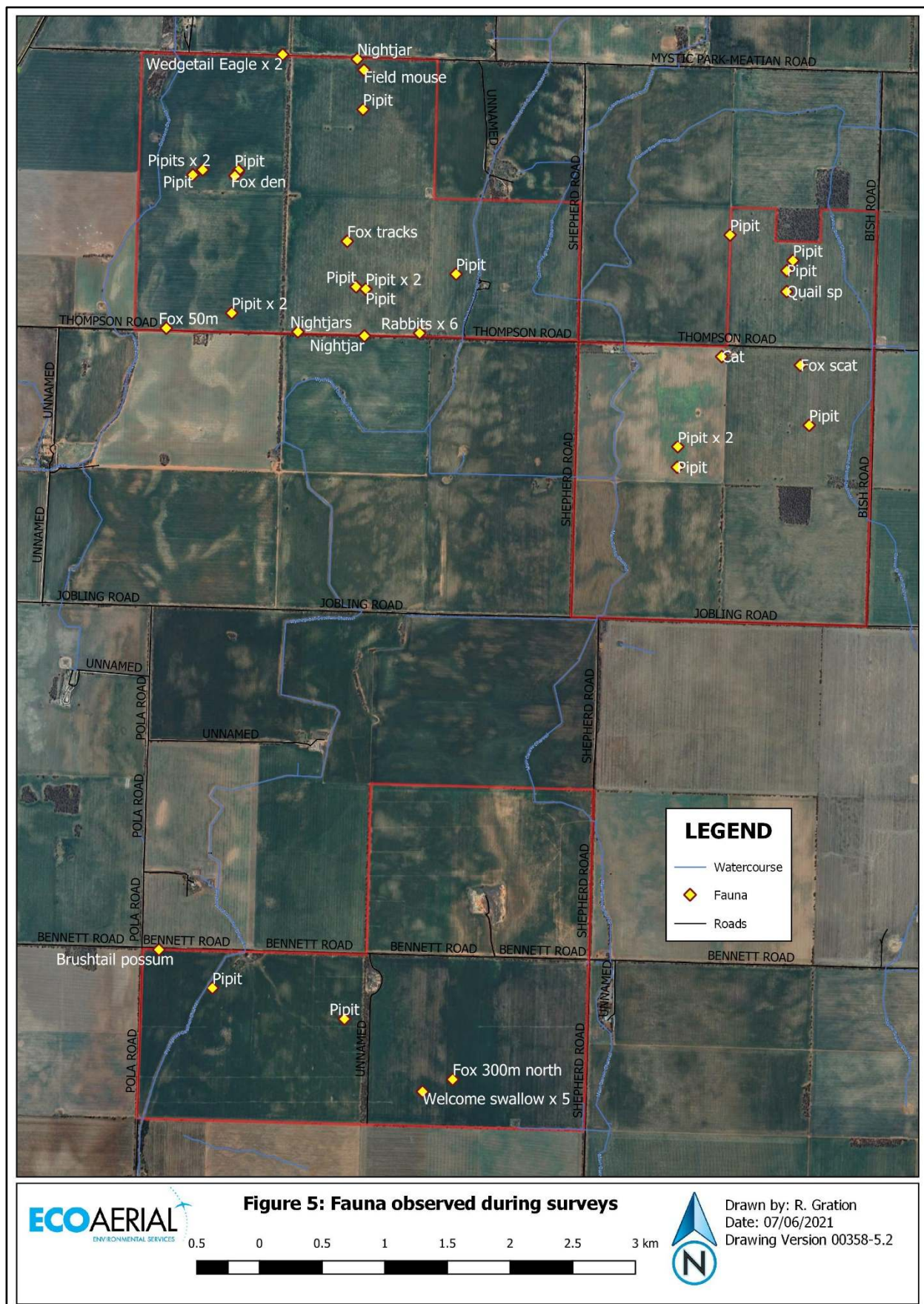
### 3.3.5 Weather conditions

Weather conditions were ideal whilst undertaking the transects surveys, particularly of an evening with little to no winds or rain.

Table 17: Weather conditions during transect surveys.

Date	Min temp (°C)	Max temp (°C)	Rainfall (mm)	AM Temp (°C)	AM wind speed (km/h)	PM Temp (°C)	PM wind speed (km/h)
27/03/2021	12.4	24.8	0	N/A	N/A	24	0
28/03/2021	8.6	23.8	0	17 ~ 20	4 ~ 20	18 ~ 21	0
29/03/2021	9.2	26.4	0	13 ~ 19.5	0 ~ 17	16 ~ 21	0 ~ 4
30/03/2021	7.5	26.2	0	9 ~ 20	9 ~ 16	14 ~ 16.5	0 ~ 7
31/03/2021	8.5	28.9	0	17	17	N/A	N/A









### 3.4 Plains Wanderer Habitat Assessment

The scores indicated that the stubble vegetation structure within the study area, (notwithstanding they are not native grasslands), were for the main part too sparse to support Plains-wanderer. An area of derived grassland with some Wallaby grass was too dense.

Table 17: Plains-wanderer habitat assessment

	<p>Area 1 - Paddock 1 cereal crop stubble.</p> <p>18 golf balls seen indicating the habitat structure is too sparse (Baker-Gabb, 2016).</p>
	<p>Area 1 - Paddock 2 cereal crop stubble.</p> <p>17.5 golf balls seen indicating the habitat structure is too sparse (Baker-Gabb, 2016).</p>





Area 1 – Paddock 2 in area of a disused quarry site with derived grassland.

5.5 golf balls seen indicating the habitat structure is too dense. Area was located within 80m of canopy trees 8m of height.

Plains-wanderer avoid venturing with 200m of trees 8m of height (Baker-Gabb, 2016).



Area 1 - Paddock 3 legume stubble.

18 golf balls seen indicating the habitat structure is too sparse (Baker-Gabb, 2016).



Area 2 - Paddocks 1 & 2 legume stubble.

18 golf balls seen indicating the habitat structure is too sparse (Baker-Gabb, 2016).





Area 2 - Paddock 3 cereal crop stubble.

17.5 golf balls seen indicating the habitat structure is too sparse (Baker-Gabb, 2016).



Area 2 - Paddock 4 cereal crop stubble.

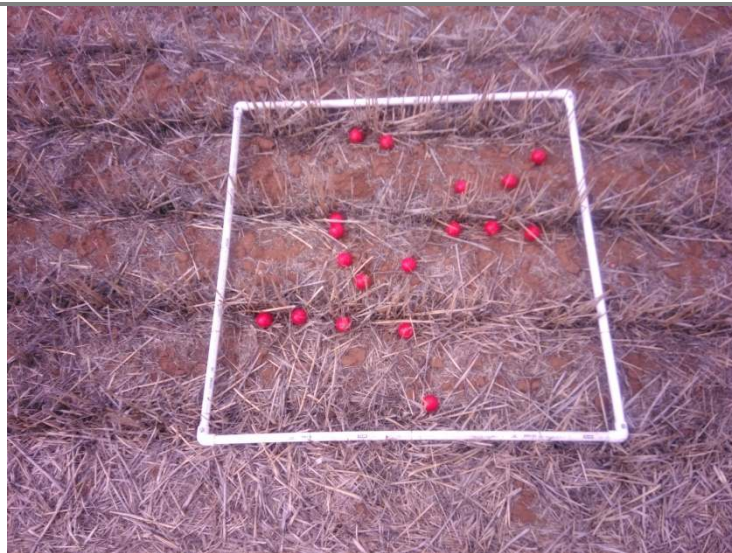
16 golf balls seen indicating the habitat structure is potentially suitable (Baker-Gabb, 2016).



Area 2 - Paddock 5 cereal crop stubble.

17.5 golf balls seen indicating the habitat structure is too sparse (Baker-Gabb, 2016).





Area 3 – Paddock 1 cereal  
crop stubble.

18 golf balls seen indicating  
the habitat structure is too  
sparse (Baker-Gabb, 2016).



Area 3 – Paddock 2 cereal  
crop stubble.

18 golf balls seen indicating  
the habitat structure is too  
sparse (Baker-Gabb, 2016).



Area 3 – Paddock 3 cereal  
crop stubble.

17.5 golf balls seen  
indicating the habitat  
structure is too sparse  
(Baker-Gabb, 2016).

## 4 Discussion

The Plains-wanderer is one of Australia's most threatened birds. Like most threatened fauna species, they are specialists in one or more aspects of their habitat resource requirements. This is before considering other pressures such as predation by feral animals, birds of prey and land management activities.

The Plains-wanderer has specific habitat requirements (Baker-Gabb et al 2016; Baker Gabb 2016); grassland structure is vitally important. They require sparse native grasslands with 30% bare ground, cryptogamic crust and 20% grass cover to a height of 5-15cm and they avoid areas within 200m of tall trees (>8m).

Native grasslands are not present within the study area. We found four locations where there were some derived grasslands dominated by non-native species with the occasional native grass (Wallaby grass).

### 4.1.1 *Habitat Assessment*

Habitat assessments within each paddock were undertaken using the quadrat / golf ball method. This method is frequently used for assessing the suitability of native grassland structure for Plains-wanderer. The scores indicate that the stubble vegetation structure within the tenement, (notwithstanding they are not native grasslands), were too sparse to support Plains-wanderer across the site except for Paddock 4 in Area 2. We note that Baker -Gabb (2016) believes that habitat structure is more important than floristics.

The stubble in Paddock 2 met the criteria for being suitable Plains-wanderer habitat (16 golf balls). However, this paddock had canopy vegetation over 8-metres high on the northern, southern, and eastern fence lines.

An area of derived grassland in a disused quarry in Paddock 2, Area 1 had the occasional Wallaby grass but is considered too dense (5.5 golf balls). Canopy trees 8-metres high were within 80m of this area. Plains-wanderer have not been observed within 200m of trees 8-metres high (Baker-Gabb, 2016).

Most of the paddocks had canopy trees up to 8 metres tall on the fence lines abutting the road reserves. These trees provide ideal viewing points for birds of prey. Birds of prey observed within the study area are as follows:

- March 2018; Nankeen Kestrel, Black-shouldered Kite, Brown Goshawk, Wedge-tailed Eagle, (Cancilla, D. 2021 pers comm., 2 June).
- October 2018; Black-shouldered Kite, (Cancilla, D. 2021 pers comm., 2 June).
- March 2021; Wedge-tailed Eagle and Nankeen Kestrel.
- April 20021; Brown Falcon.

The study area lacks the key habitat components likely to support Plains-wanderer i.e., native vegetation with the right habitat structure and history of land use.



#### 4.1.2 Transect Survey Results

The transect surveys were undertaken at the ideal time for observing Plains-wanderer; *“autumn is the time when the greatest number of juveniles can be found if there has been successful breeding during the previous spring / summer”* (Baker-Gabb et al, 2016).

Plains-wanderer were observed on Parks Victoria (PV) managed land approx. 20km from the study area over the Easter 2021 weekend (2 ~5 April). The observation of adults, sub-adults and juveniles at the PV site supports the timing of the transect surveys at the study area.

Of note was the extent of prey sources for predators of Plains-wanderer e.g., birds of prey, foxes, and feral cats. Mice and active mice nests were seen in high density throughout the study area as were rabbits. Foxes or fox activity was seen across the study area and a feral cat was seen in Area 2.

There would be a considerable amount of predator pressure on ground dwelling birds. Plains-wanderer are considered particularly vulnerable to predation (Birdlife Australia, 2017).

#### 4.1.3 Sound Recorder Results

A limitation of the sound recorder survey was the timing. Baker-Gabb (2018) deployed recorders with great success over the peak breeding season, (Spring). It is likely that breeding had ceased when the recorders were deployed. The sighting of sub-adults and juveniles at the PV site would support that breeding had ceased. It was at the request of the TRG the detectors were deployed from late March 2012 to early May 2021.

There were no Plains-wanderer calls recorded over the duration of the recorder deployment. Avifauna was confined to common non-threatened species that would be expected to be found within the study area. Notwithstanding the timing of the sound recorder surveys, the transects surveys were ideally timed, as evidenced by the PV surveys, and the habitat assessment suggests that the study area will not support Plains-wanderer. We also note that Erica Macintyre (VHM Limited) communicated with Plains-wanderer expert David Baker-Gabb prior to undertaking the survey. David believed Plains-wanderer would not be present within the study area.

#### 4.1.4 Land management

Land management is based on a continuous cycle over the course of the year. The properties within the study area run a 3 to 4-year cropping cycle of wheat and barley and on the 3 or 4<sup>th</sup> year planting a legume for nitrogen fixing in the soil. The stubble is reattained for soil stabilisation.

Seeding starts around early April onwards using an Air tyne seeder. Herbicide is applied before they seed and as required when the weeds grow within the crop. Fertiliser is applied when seeding occurs. Stripping usually starts in November and goes through to December using a harvester.

There is a continuous cycle of heavy vehicle / equipment activity throughout the year that is likely to limit the suitability of stubble as viable habitat for Plains-wanderer. Based on our research, there has not been a Plains-wanderer record in areas that have a continuous cycle of cropping and soil improvement.

The site managed for Plains-wanderer by PV was previously used for grazing and consists of a mixture of native grassland and introduced pasture. PV manages the site for Plains-wanderer through low pressure grazing (Anon. 2021, pers comm., 2 June).

## 5 Conclusion

The summary of the field assessment outcomes is used to support our conclusion below. Summary of the field assessments:

- Transect surveys covered approx. 330ha.
- The transect survey entailed 52 person hours of survey effort.
- Transect surveys were timed to maximise the likelihood of seeing Plains-wanderer if they were to be present: *“autumn is the time when the greatest number of juveniles can be found if there has been successful breeding during the previous spring / summer”* (Baker-Gabb et al, 2016).
- Only common birds known to use derived grasslands and cropped areas were observed. No Plains wanderer were observed.
- Sound detectors recorded only common, non-threatened avifauna. No Plains-wanderer were recorded.
- All paddocks lacked the native / non-native vegetation habitat structure required to support Plains-wanderer.
- All paddocks had evidence of field mice, burrows and, rabbits encouraging high levels of predator activity.
- Birds of prey, foxes and a feral cat were observed within the study area. *“Plains-wander are considered vulnerable to predation”* (Birdlife Australia, 2017).
- The study area has high levels of intensive land management not conducive to support Plains-wanderer habitat (Birdlife Australia, 2017) e.g., cropping cycle of cultivation, seeding, herbicide / pesticide application and crop stripping using heavy vehicles.

Based on the outcomes of the surveys, we conclude that it is highly unlikely that Plains-wanderer or habitat suitable to support Plains-wanderer is present within the study area.

## 6 References and Bibliography

- Baker-Gabb, D. 2018. The sounds of success for Plains-wanderers (brochure). State Government of Victoria.
- Baker-Gabb, D. 2016. Managing native Grasslands for Plains-wanderer. Elanus P/L, Melbourne.
- Baker-Gabb, D. Antos, M. and Brown, G. 2016. Recent decline of the critically endangered Plains-wanderer (*Pedionomus torquatus*), and the application of a simple method for assessing its cause: major changes in grassland structure. *Ecological Management & Restoration* Vol 17 No 3 September 2016.
- Baker-Gabb, D. J., Benshemesh, J. & Maher, P. N. 1990, 'A revision of the distribution, status and management of the Plains-wanderer *Pedionomus torquatus*', *Emu* 90, pp. 161-8.
- Birdlife, 2017. Plains-wanderer and other grassland birds (brochure). 2017. Produced by Birdlife Australia, Melbourne.
- Commonwealth of Australia. 2016. National Recovery Plan for the Plains-wanderer (*Pedionomus torquatus*).
- DELWP, 2019. The State of Victoria Department of Environment, Land, Water and Planning.
- DEWHA, 2010. Survey Guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia.
- DSE, 2013. Advisory List of Threatened Vertebrate Fauna in Victoria. The State of Victoria Department of Sustainability and Environment.
- Ecology and Heritage Partners. 2018a. Flora and Fauna Assessment: Goschen Mineral Sands Project, Goschen, Victoria. Prepared for VHM Exploration Pty Ltd.
- Ecology and Heritage Partners. 2018b. Ecological Impact Assessment: Goschen Mineral Sands Project, Goschen, Victoria. Prepared for VHM Exploration Pty Ltd.
- Ecoscape. 2018. Goschen Project - Targeted Conservation Significant Fauna Survey. Prepared for VHM Limited.
- Marchant, S. & Higgins, P. J. 1993, Handbook of Australian, New Zealand and Antarctic Birds, vol. II, Raptors to Lapwings, OUP, Melbourne.
- Morecombe, M. 2014. Field Guide to Australian Birds. Pascal Press, NSW.
- Spectrum Ecology. 2019. Goschen Project Vertebrate Fauna. Prepared for VHM Limited



## **Appendix A – Song Meter Recorder Deployment**



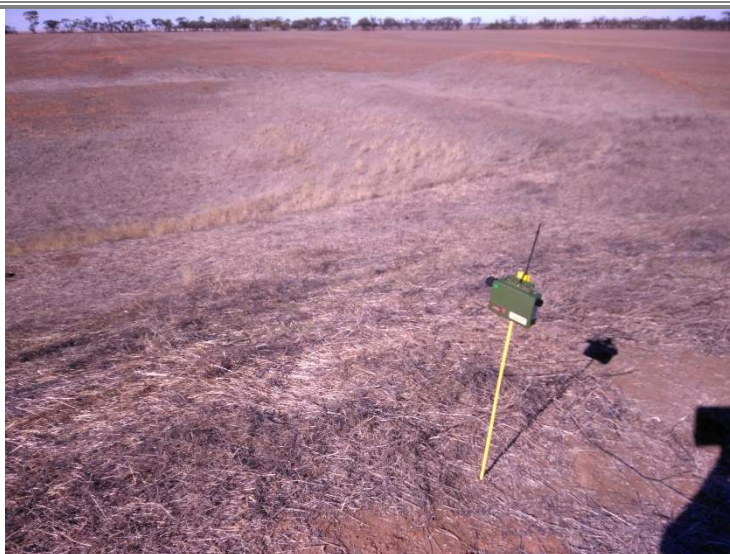
Site 1 / Unit 1  
Deployed in derived grassland at disused gravel quarry.

Refer to Figure 2.



Site 2 / Unit 2  
Deployed in derived grassland at disused gravel quarry.

Refer to Figure 2.



Site 3 / Unit 4  
Deployed on perimeter of dry dam with a small area (approx. 120<sup>2</sup>m) of native grassland (Wallaby grass).

Refer to Figure 2.





#### Site 4 / Unit 3

Deployed on fenceline of 2 cropped paddocks within the study area.

Refer to Figure 2.



#### Site 5 / Unit 6

Deployed on fence of irrigation pump site in the middle of paddock. Derived grassland (approx. 1200<sup>2</sup>m) present within pump site.

Refer to Figure 2.



#### Site 6 / Unit 5

Deployed on fenceline of cropped paddock directed into the study area.

Refer to Figure 2.

## **Appendix B- VBA Records**

## Plains-wanderer VBA records

Scientific Name	Common Name	Count	Date	Survey Method
<i>Pedionomus torquatus</i>	Plains-wanderer		01/01/1892	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer		01/01/1892	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer	2	02/10/1895	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer		1/06/1900	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer	4	1/06/1909	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	1	17/11/1961	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	1	6/03/1969	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	3	6/04/1969	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	4	1/11/1972	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	5	1/01/1975	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer		1/02/1976	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer		1/01/1977	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer	1	10/03/1977	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer		1/09/1980	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer		1/12/1980	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer	1	10/12/1980	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	1	12/12/1980	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	3	1/10/1983	General observations
<i>Pedionomus torquatus</i>	Plains-wanderer	1	6/11/1983	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer	2	1/12/1983	Incidental
<i>Pedionomus torquatus</i>	Plains-wanderer	1	24/02/1992	Plains-wanderer survey
<i>Pedionomus torquatus</i>	Plains-wanderer	1	25/02/1992	Plains-wanderer survey
<i>Pedionomus torquatus</i>	Plains-wanderer	1	20/01/2010	Spotlighting on foot
<i>Pedionomus torquatus</i>	Plains-wanderer	2	20/01/2010	Spotlighting on foot
<i>Pedionomus torquatus</i>	Plains-wanderer	1	21/01/2010	Plains-wanderer survey
<i>Pedionomus torquatus</i>	Plains-wanderer		12/01/2011	Defined Area
<i>Pedionomus torquatus</i>	Plains-wanderer		19/03/2012	Bird transect
<i>Pedionomus torquatus</i>	Plains-wanderer	1	19/03/2012	Plains-wanderer survey
<i>Pedionomus torquatus</i>	Plains-wanderer		23/03/2012	Bird transect
<i>Pedionomus torquatus</i>	Plains-wanderer	1	23/03/2012	Plains-wanderer survey
<i>Pedionomus torquatus</i>	Plains-wanderer	1	17/11/2018	Plains-wanderer survey

## **Appendix C – Plains-wanderer Classifier Results**

Location 1						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210418_200000.wav	375	532.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	281.25	468.75	656.25	19/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	540.179	750	18/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	545.455	750	17/04/2021	Plains Wanderer	Boobook Owl
20210423_230000.wav	375	519.531	750	23/04/2021	Plains Wanderer	Boobook Owl
20210430_020000.wav	375	548.438	750	30/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	517.663	750	18/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	375	562.5	750	25/04/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	375	554.555	750	21/04/2021	Plains Wanderer	Boobook Owl
20210418_000000.wav	281.25	540.179	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_000000.wav	281.25	541.667	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	556.641	750	18/04/2021	Plains Wanderer	Boobook Owl
20210430_020000.wav	375	535.714	750	30/04/2021	Plains Wanderer	Boobook Owl
20210423_230000.wav	375	600.852	843.75	23/04/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	375	554.555	750	21/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	375	559.476	750	25/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	375	562.5	750	21/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	525	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	593.75	1218.75	18/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	281.25	549.375	1031.25	25/04/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	375	562.5	750	21/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	281.25	571.514	1031.25	25/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	281.25	554.688	750	17/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	562.5	843.75	23/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	548.077	750	24/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	375	548.077	656.25	25/04/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	375	603.75	843.75	21/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	621.875	937.5	24/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	375	562.5	937.5	25/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	573.864	937.5	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210502_190000.wav	375	562.5	750	2/05/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	568.966	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	1328.506	5250	2/05/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	697.917	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	559.476	750	23/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	643.466	937.5	24/04/2021	Plains Wanderer	Boobook Owl

Location 1						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	281.25	551.471	750	24/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	628.906	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	562.5	843.75	17/04/2021	Plains Wanderer	Boobook Owl
20210408_190000.wav	375	553.571	750	8/04/2021	Plains Wanderer	Boobook Owl
20210418_000000.wav	375	562.5	937.5	18/04/2021	Plains Wanderer	Boobook Owl
20210418_000000.wav	375	562.5	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	553.125	843.75	17/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	648.214	937.5	18/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	570.313	843.75	23/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210427_200000.wav	375	562.5	750	27/04/2021	Plains Wanderer	Boobook Owl
20210409_220000.wav	375	562.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	587.891	1031.2 5	2/05/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	281.25	653.646	1218.7 5	2/05/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	375	560.32	843.75	21/04/2021	Plains Wanderer	Boobook Owl
20210409_200000.wav	468.75	562.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	713.315	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210421_210000.wav	468.75	562.5	750	21/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210502_190000.wav	375	562.5	750	2/05/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	806.25	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	281.25	556.641	937.5	24/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	580.078	750	24/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	281.25	642.857	1218.7 5	2/05/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	598.558	1031.2 5	23/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	750	1125	24/04/2021	Plains Wanderer	Boobook Owl
20210424_210000.wav	375	617.188	937.5	24/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	588.068	843.75	17/04/2021	Plains Wanderer	Boobook Owl
20210419_060000.wav	187.5	620.404	2343.7 5	19/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	605.769	1031.2 5	23/04/2021	Plains Wanderer	Boobook Owl
20210425_030000.wav	375	830.357	1218.7 5	25/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	562.5	750	2/05/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	869.612	1218.7 5	2/05/2021	Plains Wanderer	Boobook Owl
20210428_200000.wav	468.75	562.5	750	28/04/2021	Plains Wanderer	Boobook Owl



Location 1						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210418_200000.wav	468.75	698.864	1031.2 5	18/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	589.286	937.5	23/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	562.5	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	562.5	1218.7 5	2/05/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	375	553.977	750	2/05/2021	Plains Wanderer	Boobook Owl
20210502_200000.wav	281.25	531.818	937.5	2/05/2021	Plains Wanderer	Dog
20210418_200000.wav	281.25	550.781	750	18/04/2021	Plains Wanderer	Dog
20210408_190000.wav	375	672.554	1593.7 5	8/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	553.125	750	18/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Dog
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	557.292	750	19/04/2021	Plains Wanderer	Dog
20210502_200000.wav	281.25	557.386	1218.7 5	2/05/2021	Plains Wanderer	Dog
20210502_200000.wav	281.25	525.879	1031.2 5	2/05/2021	Plains Wanderer	Dog
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	557.292	750	18/04/2021	Plains Wanderer	Dog
20210502_200000.wav	375	562.5	656.25	2/05/2021	Plains Wanderer	Dog
20210502_200000.wav	375	571.875	1218.7 5	2/05/2021	Plains Wanderer	Dog
20210418_200000.wav	281.25	562.5	843.75	18/04/2021	Plains Wanderer	Dog
20210423_230000.wav	375	545.455	656.25	23/04/2021	Plains Wanderer	Dog
20210421_210000.wav	375	562.5	750	21/04/2021	Plains Wanderer	Dog
20210421_210000.wav	375	562.5	750	21/04/2021	Plains Wanderer	Dog
20210418_000000.wav	375	562.5	937.5	18/04/2021	Plains Wanderer	Dog
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Dog
20210502_200000.wav	281.25	587.372	937.5	2/05/2021	Plains Wanderer	Dog
20210502_190000.wav	375	666.118	1125	2/05/2021	Plains Wanderer	Dog
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Dog
20210417_190000.wav	281.25	550.781	937.5	17/04/2021	Plains Wanderer	Dog
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Dog
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Dog
20210502_190000.wav	375	562.5	750	2/05/2021	Plains Wanderer	Dog
20210502_190000.wav	375	619.792	1031.2 5	2/05/2021	Plains Wanderer	Dog
20210423_200000.wav	375	562.5	750	23/04/2021	Plains Wanderer	Dog
20210408_190000.wav	375	552.632	750	8/04/2021	Plains Wanderer	Dog
20210418_000000.wav	375	562.5	843.75	18/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Dog

Location 1						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210502_190000.wav	375	648.75	1218.7 5	2/05/2021	Plains Wanderer	Dog
20210502_200000.wav	375	562.5	750	2/05/2021	Plains Wanderer	Dog
20210502_190000.wav	375	562.5	750	2/05/2021	Plains Wanderer	Dog
20210502_190000.wav	375	557.566	750	2/05/2021	Plains Wanderer	Dog
20210417_190000.wav	375	588.068	843.75	17/04/2021	Plains Wanderer	Dog
20210502_200000.wav	375	670.037	1406.2 5	2/05/2021	Plains Wanderer	Dog
20210418_200000.wav	281.25	562.5	937.5	18/04/2021	Plains Wanderer	Dog
20210408_190000.wav	468.75	567.188	750	8/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	572.917	937.5	19/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	571.875	937.5	19/04/2021	Plains Wanderer	Dog
20210408_190000.wav	375	582.237	750	8/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	711.648	4031.2 5	19/04/2021	Plains Wanderer	Dog
20210502_200000.wav	375	659.483	1031.2 5	2/05/2021	Plains Wanderer	Dog
20210417_190000.wav	375	604.167	843.75	17/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Dog
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Dog
20210417_190000.wav	375	646.875	937.5	17/04/2021	Plains Wanderer	Dog
20210502_190000.wav	375	562.5	750	2/05/2021	Plains Wanderer / Musk Lorikeet	Dog
20210408_190000.wav	281.25	834.375	2812.5	8/04/2021	Plains Wanderer	Galah
20210419_190000.wav	656.25	3291.667	6187.5	19/04/2021	Plains Wanderer	Galah
20210405_190000.wav	2437.5	3505.435	5343.7 5	5/04/2021	Plains Wanderer	Galah
20210405_190000.wav	562.5	1232.595	1875	5/04/2021	Plains Wanderer	Magpie
20210411_070000.wav	562.5	843.75	1031.2 5	11/04/2021	Plains Wanderer	Magpie
20210408_070000.wav	468.75	1002.404	1500	8/04/2021	Plains Wanderer	Magpie
20210329_070000.wav	656.25	952.621	1218.7 5	29/03/2021	Plains Wanderer	Magpie
20210411_070000.wav	375	683.824	1031.2 5	11/04/2021	Plains Wanderer	Magpie
20210406_070000.wav	375	917.23	1218.7 5	6/04/2021	Plains Wanderer	Magpie
20210330_070000.wav	937.5	1284.684	2531.2 5	30/03/2021	Plains Wanderer	Magpie
20210425_190000.wav	656.25	1258.839	2062.5	25/04/2021	Plains Wanderer	Magpie
20210418_070000.wav	375	663.194	1031.2 5	18/04/2021	Plains Wanderer	Magpie /
20210403_070000.wav	375	800.223	1125	3/04/2021	Plains Wanderer	Magpie /
20210403_070000.wav	375	807.692	1125	3/04/2021	Plains Wanderer	Magpie /
20210421_070000.wav	562.5	988.125	1781.2 5	21/04/2021	Plains Wanderer	Magpie /
20210406_070000.wav	375	680.114	1125	6/04/2021	Plains Wanderer	Magpie /
20210415_070000.wav	375	730.824	1125	15/04/2021	Plains Wanderer	Magpie /
20210424_070000.wav	375	811.422	1125	24/04/2021	Plains Wanderer	Magpie /
20210406_070000.wav	375	697.266	1031.2 5	6/04/2021	Plains Wanderer	Magpie /

Location 1						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210331_070000.wav	562.5	853.795	1125	31/03/2021	Plains Wanderer	Magpie /
20210406_070000.wav	468.75	855	1218.7 5	6/04/2021	Plains Wanderer	Magpie /
20210329_070000.wav	468.75	694.853	937.5	29/03/2021	Plains Wanderer	Magpie /
20210408_070000.wav	656.25	1002.155	1593.7 5	8/04/2021	Plains Wanderer	Magpie /
20210410_070000.wav	562.5	1054.688	1687.5	10/04/2021	Plains Wanderer	Magpie /
20210410_070000.wav	468.75	968.071	1687.5	10/04/2021	Plains Wanderer	Magpie /
20210406_070000.wav	375	754.36	1218.7 5	6/04/2021	Plains Wanderer	Magpie /
20210330_070000.wav	468.75	843.75	1312.5	30/03/2021	Plains Wanderer	Magpie /
20210405_190000.wav	562.5	1041.903	1687.5	5/04/2021	Plains Wanderer	Magpie /
20210406_070000.wav	468.75	855.469	1218.7 5	6/04/2021	Plains Wanderer	Magpie /
20210330_190000.wav	750	1304.899	1968.7 5	30/03/2021	Plains Wanderer	Magpie /
20210330_070000.wav	562.5	1257.813	1968.7 5	30/03/2021	Plains Wanderer	Magpie /
20210403_070000.wav	468.75	997.024	1687.5	3/04/2021	Plains Wanderer	Magpie /
20210411_070000.wav	562.5	843.75	1125	11/04/2021	Plains Wanderer	Magpie /
20210411_070000.wav	2156.2 5	2889.423	6281.2 5	11/04/2021	Plains Wanderer	Magpie /
20210407_070000.wav	375	791.667	1031.2 5	7/04/2021	Plains Wanderer	Magpie /
20210331_070000.wav	375	820.313	1031.2 5	31/03/2021	Plains Wanderer	Magpie /
20210331_070000.wav	468.75	884.375	1500	31/03/2021	Plains Wanderer	Magpie /
20210403_070000.wav	562.5	921.094	1406.2 5	3/04/2021	Plains Wanderer	Magpie /
20210330_070000.wav	468.75	847.222	1500	30/03/2021	Plains Wanderer	Magpie /
20210329_070000.wav	375	679.116	1031.2 5	29/03/2021	Plains Wanderer	Magpie /
20210405_190000.wav	937.5	1748.798	2250	5/04/2021	Plains Wanderer	Magpie /
20210329_070000.wav	468.75	703.125	937.5	29/03/2021	Plains Wanderer	Magpie /
20210407_070000.wav	656.25	1006.25	1593.7 5	7/04/2021	Plains Wanderer	Magpie /
20210405_190000.wav	468.75	1058.036	1687.5	5/04/2021	Plains Wanderer	Magpie /
20210502_200000.wav	375	799.006	1218.7 5	2/05/2021	Plains Wanderer	Magpie /
20210406_070000.wav	562.5	964.939	1312.5	6/04/2021	Plains Wanderer	Magpie /
20210427_190000.wav	562.5	1216.539	2156.2 5	27/04/2021	Plains Wanderer	Magpie /
20210420_070000.wav	468.75	951.172	1593.7 5	20/04/2021	Plains Wanderer	Magpie /
20210411_070000.wav	375	689.941	1031.2 5	11/04/2021	Plains Wanderer	Magpie /
20210411_070000.wav	656.25	930	1218.7 5	11/04/2021	Plains Wanderer	Magpie /
20210411_070000.wav	468.75	900.915	1218.7 5	11/04/2021	Plains Wanderer	Magpie /
20210405_190000.wav	843.75	4243.623	6750	5/04/2021	Plains Wanderer	Magpie / Galah
20210418_190000.wav	468.75	2704.688	6187.5	18/04/2021	Plains Wanderer	Magpie / Galah
20210331_070000.wav	375	832.031	1031.2 5	31/03/2021	Plains Wanderer	Magpie / Galah

Location 1						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210406_070000.wav	750	1110	3093.7 5	6/04/2021	Plains Wanderer	Magpie / Galah
20210406_070000.wav	375	806.25	1125	6/04/2021	Plains Wanderer	Magpie / Galah
20210418_190000.wav	468.75	2860.197	7312.5	18/04/2021	Plains Wanderer	Magpie / Galah
20210406_070000.wav	656.25	2145	3468.7 5	6/04/2021	Plains Wanderer	Magpie / Galah
20210406_070000.wav	656.25	2189.189	3375	6/04/2021	Plains Wanderer	Magpie / Galah
20210502_220000.wav	187.5	308.824	562.5	2/05/2021	Plains Wanderer	Wind
20210417_200000.wav	375	506.25	656.25	17/04/2021	Plains Wanderer	Wind
20210502_220000.wav	187.5	331.25	562.5	2/05/2021	Plains Wanderer	Wind
20210425_010000.wav	187.5	386.719	562.5	25/04/2021	Plains Wanderer	Wind
20210416_010000.wav	187.5	314.063	1218.7 5	16/04/2021	Plains Wanderer	Wind
20210416_010000.wav	187.5	375	1312.5	16/04/2021	Plains Wanderer	Wind
20210410_230000.wav	750	3227.431	7968.7 5	10/04/2021	Plains Wanderer	Wind

Location 2						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210501_050000.wav	375	476.902	656.25	1/05/2021	Plains Wanderer	Boobook Owl
20210330_030000.wav	281.25	468.75	656.25	30/03/2021	Plains Wanderer	Boobook Owl
20210330_030000.wav	281.25	468.75	656.25	30/03/2021	Plains Wanderer	Boobook Owl
20210330_030000.wav	281.25	473.438	656.25	30/03/2021	Plains Wanderer	Boobook Owl
20210501_050000.wav	281.25	473.958	656.25	1/05/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	506.25	656.25	17/04/2021	Plains Wanderer	Boobook Owl
20210330_030000.wav	281.25	468.75	656.25	30/03/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	553.571	656.25	17/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	552.632	656.25	17/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	556.034	843.75	17/04/2021	Plains Wanderer	Boobook Owl
20210330_030000.wav	281.25	468.75	656.25	30/03/2021	Plains Wanderer	Boobook Owl
20210416_200000.wav	375	562.5	750	16/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	542.23	750	24/04/2021	Plains Wanderer	Boobook Owl
20210330_030000.wav	281.25	468.75	656.25	30/03/2021	Plains Wanderer	Boobook Owl
20210502_220000.wav	187.5	369.141	656.25	2/05/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	281.25	545.759	750	24/04/2021	Plains Wanderer	Boobook Owl
20210416_200000.wav	375	562.5	750	16/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	485.795	750	18/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	559.152	750	24/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	545.455	750	18/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	556.641	750	17/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	531.25	656.25	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	478.125	656.25	18/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210419_020000.wav	281.25	468.75	562.5	19/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210409_210000.wav	375	537.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	281.25	533.654	750	24/04/2021	Plains Wanderer	Boobook Owl
20210412_060000.wav	375	558.036	750	12/04/2021	Plains Wanderer	Boobook Owl
20210412_060000.wav	375	562.5	750	12/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	552.632	750	18/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	559.267	750	17/04/2021	Plains Wanderer	Boobook Owl

Location 2						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210416_200000.wav	375	562.5	750	16/04/2021	Plains Wanderer	Boobook Owl
20210424_210000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210425_200000.wav	375	562.5	750	25/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210412_060000.wav	375	551.471	750	12/04/2021	Plains Wanderer	Boobook Owl
20210417_200000.wav	375	555	750	17/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	629.464	1031.25	18/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	281.25	552.632	1031.25	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	551.471	1031.25	18/04/2021	Plains Wanderer	Boobook Owl
20210424_210000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210409_220000.wav	375	562.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Boobook Owl
20210409_220000.wav	375	562.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210412_060000.wav	375	562.5	843.75	12/04/2021	Plains Wanderer	Boobook Owl
20210424_210000.wav	375	545.455	750	24/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	562.5	750	24/04/2021	Plains Wanderer	Boobook Owl
20210405_050000.wav	375	557.292	750	5/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210412_060000.wav	375	562.5	843.75	12/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210425_190000.wav	375	562.5	750	25/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	555.288	750	11/04/2021	Plains Wanderer	Boobook Owl
20210425_190000.wav	375	562.5	750	25/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210427_190000.wav	375	562.5	750	27/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	647.727	1031.25	18/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210428_020000.wav	375	542.411	750	28/04/2021	Plains Wanderer	Boobook Owl
20210502_190000.wav	375	616.071	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	556.641	750	19/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210501_070000.wav	750	1214.12	1593.75	1/05/2021	Plains Wanderer	Magpie
20210418_200000.wav	375	562.5	750	18/04/2021	Plains Wanderer	Boobook Owl



Location 2						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	562.5	750	17/04/2021	Plains Wanderer	Boobook Owl
20210410_070000.wav	468.75	732.639	1031.25	10/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	375	602.679	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210329_190000.wav	375	562.5	750	29/03/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	585.938	750	24/04/2021	Plains Wanderer	Boobook Owl
20210409_220000.wav	375	562.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	716.518	1031.25	17/04/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	468.75	590.625	750	17/04/2021	Plains Wanderer	Boobook Owl
20210502_190000.wav	375	661.765	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210413_220000.wav	2812.5	6728.059	7968.75	13/04/2021	Plains Wanderer	Wind
20210405_050000.wav	375	562.5	750	5/04/2021	Plains Wanderer	Boobook Owl
20210417_190000.wav	375	611.842	750	17/04/2021	Plains Wanderer	Boobook Owl
20210502_190000.wav	375	703.125	1312.5	2/05/2021	Plains Wanderer	Boobook Owl
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	582.589	937.5	24/04/2021	Plains Wanderer	Boobook Owl
20210502_190000.wav	375	721.875	1125	2/05/2021	Plains Wanderer	Boobook Owl
20210408_190000.wav	468.75	562.5	750	8/04/2021	Plains Wanderer	Boobook Owl
20210405_050000.wav	375	565.43	750	5/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210330_190000.wav	1312.5	1842.548	2718.75	30/03/2021	Plains Wanderer	Magpie
20210401_190000.wav	1593.75	2458.008	6750	1/04/2021	Plains Wanderer	Magpie
20210411_200000.wav	375	562.5	750	11/04/2021	Plains Wanderer	Boobook Owl
20210419_210000.wav	375	553.977	750	19/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Boobook Owl
20210424_200000.wav	375	584.135	750	24/04/2021	Plains Wanderer	Boobook Owl
20210420_070000.wav	468.75	764.063	1125	20/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Dog
20210502_190000.wav	375	695.724	937.5	2/05/2021	Plains Wanderer	Boobook Owl
20210331_190000.wav	1593.75	1869.932	2343.75	31/03/2021	Plains Wanderer	Magpie
20210423_200000.wav	375	843.75	3000	23/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	468.75	562.5	750	19/04/2021	Plains Wanderer	Boobook Owl
20210423_200000.wav	375	1113.75	3000	23/04/2021	Plains Wanderer	Boobook Owl
20210328_190000.wav	1406.25	2136.418	4312.5	28/03/2021	Plains Wanderer	Galah
20210402_070000.wav	1125	1320.652	1593.75	2/04/2021	Plains Wanderer	Magpie
20210410_070000.wav	468.75	727.5	1125	10/04/2021	Plains Wanderer	Magpie
20210423_200000.wav	468.75	562.5	750	23/04/2021	Plains Wanderer	Boobook Owl
20210419_190000.wav	375	562.5	750	19/04/2021	Plains Wanderer	Dog

Location 3						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210415_230000.wav	437.5	710.938	1000	15/04/2021	Plains Wanderer	Boobook Owl
20210416_010000.wav	437.5	556.548	687.5	16/04/2021	Plains Wanderer	Boobook Owl
20210418_060000.wav	312.5	595.982	2875	18/04/2021	Plains Wanderer	Boobook Owl
20210418_060000.wav	312.5	422.794	562.5	18/04/2021	Plains Wanderer	Boobook Owl
20210418_200000.wav	437.5	2567.568	4937.5	18/04/2021	Plains Wanderer	Boobook Owl
20210407_210000.wav	187.5	250	375	7/04/2021	Plains Wanderer	Cricket
20210416_190000.wav	625	2356.142	4625	16/04/2021	Plains Wanderer	Magpie / Galahs
20210402_210000.wav	437.5	581.25	875	2/04/2021	Plains Wanderer	Wind
20210405_000000.wav	500	571.429	687.5	5/04/2021	Plains Wanderer	Wind
20210405_010000.wav	437.5	562.5	687.5	5/04/2021	Plains Wanderer	Wind
20210405_210000.wav	500	568.75	750	5/04/2021	Plains Wanderer	Wind
20210405_210000.wav	437.5	562.5	1000	5/04/2021	Plains Wanderer	Wind
20210405_210000.wav	500	562.5	750	5/04/2021	Plains Wanderer	Wind
20210405_210000.wav	500	562.5	687.5	5/04/2021	Plains Wanderer	Wind
20210405_220000.wav	500	568.75	750	5/04/2021	Plains Wanderer	Wind
20210405_220000.wav	500	576.389	750	5/04/2021	Plains Wanderer	Wind
20210406_230000.wav	437.5	573.864	750	6/04/2021	Plains Wanderer	Wind
20210406_230000.wav	500	598.214	750	6/04/2021	Plains Wanderer	Wind
20210407_030000.wav	500	578.125	687.5	7/04/2021	Plains Wanderer	Wind
20210409_020000.wav	187.5	731.25	1187.5	9/04/2021	Plains Wanderer	Wind
20210409_060000.wav	500	694.444	875	9/04/2021	Plains Wanderer	Wind
20210409_060000.wav	437.5	646.802	875	9/04/2021	Plains Wanderer	Wind
20210409_220000.wav	187.5	318.182	562.5	9/04/2021	Plains Wanderer	Wind
0210410_020000.wav	437.5	609.375	812.5	10/04/2021	Plains Wanderer	Wind
20210410_020000.wav	375	531.25	750	10/04/2021	Plains Wanderer	Wind
20210410_020000.wav	500	621.528	812.5	10/04/2021	Plains Wanderer	Wind
20210410_020000.wav	187.5	652.616	875	10/04/2021	Plains Wanderer	Wind
20210410_040000.wav	187.5	613.095	812.5	10/04/2021	Plains Wanderer	Wind
20210410_190000.wav	187.5	187.5	8000	10/04/2021	Plains Wanderer	Wind
20210410_210000.wav	187.5	187.5	8000	10/04/2021	Plains Wanderer	Wind
20210410_210000.wav	187.5	229.167	8000	10/04/2021	Plains Wanderer	Wind
20210410_210000.wav	187.5	214.286	8000	10/04/2021	Plains Wanderer	Wind
20210410_230000.wav	187.5	193.75	8000	10/04/2021	Plains Wanderer	Wind
20210411_000000.wav	187.5	201.389	8000	11/04/2021	Plains Wanderer	Wind
20210411_000000.wav	187.5	208.333	1000	11/04/2021	Plains Wanderer	Wind
20210411_000000.wav	187.5	258.333	8000	11/04/2021	Plains Wanderer	Wind
20210411_010000.wav	187.5	203.125	8000	11/04/2021	Plains Wanderer	Wind
20210411_020000.wav	187.5	206.731	1250	11/04/2021	Plains Wanderer	Wind
20210411_020000.wav	187.5	187.5	8000	11/04/2021	Plains Wanderer	Wind
20210411_030000.wav	187.5	197.917	8000	11/04/2021	Plains Wanderer	Wind
20210411_050000.wav	187.5	218.75	8000	11/04/2021	Plains Wanderer	Wind
20210411_050000.wav	187.5	187.5	8000	11/04/2021	Plains Wanderer	Wind

Location 3						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210411_060000.wav	187.5	209.559	8000	11/04/2021	Plains Wanderer	Wind
20210411_060000.wav	187.5	187.5	8000	11/04/2021	Plains Wanderer	Wind
20210413_210000.wav	187.5	408.654	8000	13/04/2021	Plains Wanderer	Wind
20210414_040000.wav	250	412.5	8000	14/04/2021	Plains Wanderer	Wind
20210414_060000.wav	500	562.5	687.5	14/04/2021	Plains Wanderer	Wind
20210414_190000.wav	187.5	193.75	1125	14/04/2021	Plains Wanderer	Wind
20210414_190000.wav	187.5	196.429	8000	14/04/2021	Plains Wanderer	Wind
20210414_190000.wav	187.5	210.227	1125	14/04/2021	Plains Wanderer	Wind
20210414_190000.wav	187.5	187.5	8000	14/04/2021	Plains Wanderer	Wind
20210414_190000.wav	187.5	1041.667	8000	14/04/2021	Plains Wanderer	Wind
20210414_200000.wav	187.5	187.5	8000	14/04/2021	Plains Wanderer	Wind
20210414_200000.wav	500	609.375	687.5	14/04/2021	Plains Wanderer	Wind
20210414_210000.wav	500	610.577	750	14/04/2021	Plains Wanderer	Wind
20210414_210000.wav	500	600	750	14/04/2021	Plains Wanderer	Wind
20210414_210000.wav	500	617.788	812.5	14/04/2021	Plains Wanderer	Wind
20210414_210000.wav	500	652.778	812.5	14/04/2021	Plains Wanderer	Wind
20210414_220000.wav	500	607.955	750	14/04/2021	Plains Wanderer	Wind
20210414_220000.wav	500	678.922	937.5	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	500	625	750	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	562.5	680.921	937.5	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	500	620.192	750	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	500	625	750	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	562.5	625	687.5	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	500	668.269	875	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	562.5	635.417	750	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	562.5	645.833	812.5	14/04/2021	Plains Wanderer	Wind
20210414_230000.wav	500	625	750	14/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	695.833	1437.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	612.069	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	581.25	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	625	937.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	692.13	1125	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	637.5	875	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	642.857	937.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	592.262	875	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	577.381	1187.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	598.558	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	586.31	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	500	621.711	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	609.375	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	567.308	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	607.955	812.5	15/04/2021	Plains Wanderer	Wind

Location 3						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210415_000000.wav	500	680.556	875	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	597.222	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	697.581	937.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	614.583	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	375	723.958	1062.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	535.714	625	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	650.568	937.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	375	692.708	1000	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	500	615	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	618.75	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	589.286	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	500	609.914	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	579.545	750	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	606.25	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	500	678.571	875	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	312.5	620.37	1000	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	187.5	669.643	1312.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	583.333	812.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	250	700.521	937.5	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	645.833	875	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	500	617.647	875	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	633.929	1000	15/04/2021	Plains Wanderer	Wind
20210415_000000.wav	437.5	600	812.5	15/04/2021	Plains Wanderer	Wind
20210415_190000.wav	500	617.188	812.5	15/04/2021	Plains Wanderer	Wind
20210415_220000.wav	437.5	585.938	812.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	187.5	745.833	1375	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	606.25	812.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	250	609.375	750	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	375	578.125	812.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	600	937.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	500	608.871	812.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	600.962	812.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	187.5	742.188	1062.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	570.313	687.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	500	599.265	750	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	562.5	714.286	875	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	187.5	683.036	1000	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	687.5	937.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	312.5	634.722	937.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	631.944	812.5	15/04/2021	Plains Wanderer	Wind
20210415_230000.wav	437.5	598.214	875	15/04/2021	Plains Wanderer	Wind
20210416_000000.wav	437.5	628.125	1000	16/04/2021	Plains Wanderer	Wind

Location 3						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210416_000000.wav	437.5	615.132	812.5	16/04/2021	Plains Wanderer	Wind
20210416_010000.wav	312.5	400	562.5	16/04/2021	Plains Wanderer	Wind
20210416_010000.wav	375	562.5	750	16/04/2021	Plains Wanderer	Wind
20210416_010000.wav	437.5	609.375	812.5	16/04/2021	Plains Wanderer	Wind
20210416_200000.wav	250	490.741	937.5	16/04/2021	Plains Wanderer	Wind
20210417_230000.wav	187.5	483.696	687.5	17/04/2021	Plains Wanderer	Wind
20210417_230000.wav	375	683.594	2875	17/04/2021	Plains Wanderer	Wind
20210418_050000.wav	187.5	655.585	1000	18/04/2021	Plains Wanderer	Wind
20210418_050000.wav	437.5	640.625	812.5	18/04/2021	Plains Wanderer	Wind
20210420_060000.wav	437.5	550	687.5	20/04/2021	Plains Wanderer	Wind
20210420_200000.wav	187.5	245.192	8000	20/04/2021	Plains Wanderer	Wind
20210420_220000.wav	437.5	600	750	20/04/2021	Plains Wanderer	Wind
20210420_220000.wav	437.5	580.882	750	20/04/2021	Plains Wanderer	Wind
20210420_220000.wav	437.5	591.667	812.5	20/04/2021	Plains Wanderer	Wind
20210420_220000.wav	437.5	713.542	937.5	20/04/2021	Plains Wanderer	Wind

Location 4						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210404_020000.wav	187.5	517.857	1031.25	4/04/2021	Plains Wanderer	Boobook Owl
20210406_030000.wav	375	593.75	843.75	6/04/2021	Plains Wanderer	Boobook Owl
20210418_210000.wav	281.25	534.375	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210418_230000.wav	281.25	468.75	843.75	18/04/2021	Plains Wanderer	Boobook Owl
20210422_070000.wav	281.25	531.25	843.75	22/04/2021	Plains Wanderer	Boobook Owl
20210422_070000.wav	281.25	553.977	750	22/04/2021	Plains Wanderer	Boobook Owl
20210422_070000.wav	375	636.161	843.75	22/04/2021	Plains Wanderer	Boobook Owl
20210501_000000.wav	375	501.563	656.25	1/05/2021	Plains Wanderer	Boobook Owl
20210501_230000.wav	375	562.5	750	1/05/2021	Plains Wanderer	Boobook Owl
20210501_230000.wav	375	562.5	750	1/05/2021	Plains Wanderer	Boobook Owl
20210501_230000.wav	375	623.438	1125	1/05/2021	Plains Wanderer	Boobook Owl
20210403_190000.wav	281.25	468.75	1031.25	3/04/2021	Plains Wanderer	Cricket
20210418_010000.wav	281.25	477.273	1687.5	18/04/2021	Plains Wanderer	Dog
20210418_010000.wav	281.25	480.469	1218.75	18/04/2021	Plains Wanderer	Dog
20210418_230000.wav	281.25	468.75	1218.75	18/04/2021	Plains Wanderer	Dog
20210501_000000.wav	281.25	671.875	1218.75	1/05/2021	Plains Wanderer	Dog
20210416_190000.wav	843.75	1317.969	1968.75	16/04/2021	Plains Wanderer	Magpie
20210416_190000.wav	562.5	1100.166	1968.75	16/04/2021	Plains Wanderer	Magpie
20210419_070000.wav	468.75	763.393	1031.25	19/04/2021	Plains Wanderer	Magpie
20210406_190000.wav	187.5	4044.181	7968.75	6/04/2021	Plains Wanderer	Willy Wagtail
20210414_000000.wav	1781.25	6902.401	7968.75	14/04/2021	Plains Wanderer	Wind
20210414_000000.wav	4125	7244.456	7968.75	14/04/2021	Plains Wanderer	Wind

Location 5						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210404_072646.wav	375	567.188	750	4/04/2021	Plains Wanderer	Boobook Owl
20210407_072646.wav	468.75	630	843.75	7/04/2021	Plains Wanderer	Boobook Owl
20210412_072646.wav	375	605.114	843.75	12/04/2021	Plains Wanderer	Boobook Owl
20210412_072646.wav	375	701.509	1406.25	12/04/2021	Plains Wanderer	Boobook Owl
20210412_072646.wav	281.25	620.192	843.75	12/04/2021	Plains Wanderer	Boobook Owl
20210412_072646.wav	375	611.842	843.75	12/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	539.063	750	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	529.412	750	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	493.75	656.25	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	515.625	750	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	549.107	750	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	515.625	843.75	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	281.25	515.625	656.25	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	553.571	937.5	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	513.393	937.5	17/04/2021	Plains Wanderer	Boobook Owl
20210417_212646.wav	375	512.019	656.25	17/04/2021	Plains Wanderer	Boobook Owl
20210422_072646.wav	1125	4379.883	5718.75	22/04/2021	Plains Wanderer	Maggie / Willy Wagtail
20210329_222652.wav	187.5	533.333	3468.75	29/03/2021	Plains Wanderer	Voice
20210329_222652.wav	187.5	480.263	3187.5	29/03/2021	Plains Wanderer	Voice
20210329_222652.wav	187.5	531.25	4406.25	29/03/2021	Plains Wanderer	Voice
20210329_222652.wav	375	660	7875	29/03/2021	Plains Wanderer	Voice
20210329_222652.wav	187.5	569.853	2531.25	29/03/2021	Plains Wanderer	Voice
20210329_222652.wav	281.25	556.25	1312.5	29/03/2021	Plains Wanderer	Voice
20210329_222652.wav	375	572.917	843.75	29/03/2021	Plains Wanderer	Voice
20210401_012646.wav	187.5	187.5	937.5	1/04/2021	Plains Wanderer	Wind
20210401_212646.wav	187.5	187.5	1031.25	1/04/2021	Plains Wanderer	Wind
20210405_202646.wav	187.5	187.5	750	5/04/2021	Plains Wanderer	Wind
20210405_232646.wav	187.5	187.5	750	5/04/2021	Plains Wanderer	Wind
20210406_002646.wav	187.5	187.5	562.5	6/04/2021	Plains Wanderer	Wind
20210406_232646.wav	187.5	187.5	750	6/04/2021	Plains Wanderer	Wind
20210406_232646.wav	187.5	227.679	1125	6/04/2021	Plains Wanderer	Wind
20210406_232646.wav	187.5	187.5	843.75	6/04/2021	Plains Wanderer	Wind
20210406_232646.wav	187.5	234.375	2812.5	6/04/2021	Plains Wanderer	Wind
20210407_002646.wav	187.5	187.5	937.5	7/04/2021	Plains Wanderer	Wind
20210411_062646.wav	187.5	363.281	7125	11/04/2021	Plains Wanderer	Wind
20210411_072646.wav	2625	5337.148	7968.75	11/04/2021	Plains Wanderer	Wind
20210411_072646.wav	187.5	421.875	7031.25	11/04/2021	Plains Wanderer	Wind
20210414_202646.wav	187.5	250	7968.75	14/04/2021	Plains Wanderer	Wind
20210414_222646.wav	187.5	468.75	5437.5	14/04/2021	Plains Wanderer	Wind



Location 6						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210401_040000.wav	250	473.684	687.5	1/04/2021	Plains Wanderer	Bird
20210401_040000.wav	375	543.561	687.5	1/04/2021	Plains Wanderer	Bird
20210402_040000.wav	312.5	579.545	1000	2/04/2021	Plains Wanderer	Bird
20210403_030000.wav	375	636.364	1125	3/04/2021	Plains Wanderer	Bird
20210330_040000.wav	437.5	562.5	687.5	30/03/2021	Plains Wanderer	Boobook Owl
20210331_190000.wav	375	533.088	687.5	31/03/2021	Plains Wanderer	Boobook Owl
20210401_200000.wav	375	620.192	1187.5	1/04/2021	Plains Wanderer	Boobook Owl
20210401_220000.wav	312.5	459.821	625	1/04/2021	Plains Wanderer	Boobook Owl
20210402_040000.wav	437.5	562.5	687.5	2/04/2021	Plains Wanderer	Boobook Owl
20210402_040000.wav	437.5	562.5	687.5	2/04/2021	Plains Wanderer	Boobook Owl
20210403_030000.wav	312.5	527.778	687.5	3/04/2021	Plains Wanderer	Boobook Owl
20210403_040000.wav	312.5	509.766	1062.5	3/04/2021	Plains Wanderer	Boobook Owl
20210403_200000.wav	437.5	562.5	687.5	3/04/2021	Plains Wanderer	Boobook Owl
20210403_200000.wav	375	555.921	687.5	3/04/2021	Plains Wanderer	Boobook Owl
20210403_200000.wav	375	562.5	875	3/04/2021	Plains Wanderer	Boobook Owl
20210404_030000.wav	375	481.855	625	4/04/2021	Plains Wanderer	Boobook Owl
20210406_030000.wav	375	531.25	687.5	6/04/2021	Plains Wanderer	Boobook Owl
20210407_210000.wav	437.5	562.5	687.5	7/04/2021	Plains Wanderer	Boobook Owl
20210407_210000.wav	437.5	556.818	687.5	7/04/2021	Plains Wanderer	Boobook Owl
20210409_020000.wav	312.5	537.5	750	9/04/2021	Plains Wanderer	Boobook Owl
20210416_020000.wav	375	555.556	687.5	16/04/2021	Plains Wanderer	Boobook Owl
20210416_020000.wav	437.5	552.083	625	16/04/2021	Plains Wanderer	Boobook Owl
20210418_030000.wav	375	569.444	750	18/04/2021	Plains Wanderer	Boobook Owl
20210418_060000.wav	312.5	477.885	687.5	18/04/2021	Plains Wanderer	Boobook Owl
20210418_060000.wav	312.5	469.643	562.5	18/04/2021	Plains Wanderer	Boobook Owl
20210331_200000.wav	187.5	189.338	312.5	31/03/2021	Plains Wanderer	Cricket
20210331_210000.wav	187.5	187.5	312.5	31/03/2021	Plains Wanderer	Cricket
20210331_060000.wav	375	629.808	1250	31/03/2021	Plains Wanderer	Dog
20210331_200000.wav	312.5	696.97	1437.5	31/03/2021	Plains Wanderer	Dog
20210401_010000.wav	312.5	562.5	1312.5	1/04/2021	Plains Wanderer	Dog
20210401_010000.wav	375	590.909	1625	1/04/2021	Plains Wanderer	Dog
20210401_190000.wav	375	716.912	1125	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	375	562.5	687.5	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	312.5	554.688	687.5	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	375	560.185	1062.5	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	437.5	562.5	750	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	375	531.25	687.5	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	437.5	562.5	687.5	1/04/2021	Plains Wanderer	Dog
20210401_200000.wav	375	680.556	1125	1/04/2021	Plains Wanderer	Dog
20210402_040000.wav	312.5	534.314	750	2/04/2021	Plains Wanderer	Dog
20210402_040000.wav	312.5	500	1062.5	2/04/2021	Plains Wanderer	Dog
20210402_040000.wav	312.5	500	687.5	2/04/2021	Plains Wanderer	Dog

Location 6						
IN FILE	Fmin	Fmean	Fmax	DATE	TOP1MATCH*	MANUAL ID
20210402_040000.wav	312.5	550	1187.5	2/04/2021	Plains Wanderer	Dog
20210402_200000.wav	312.5	522.059	1562.5	2/04/2021	Plains Wanderer	Dog
20210402_200000.wav	250	440.665	750	2/04/2021	Plains Wanderer	Dog
20210403_030000.wav	375	819.122	1500	3/04/2021	Plains Wanderer	Dog
20210403_030000.wav	312.5	689.583	1125	3/04/2021	Plains Wanderer	Dog
20210403_040000.wav	250	534.539	1062.5	3/04/2021	Plains Wanderer	Dog
20210403_200000.wav	437.5	567.308	750	3/04/2021	Plains Wanderer	Dog
20210404_030000.wav	312.5	585.138	1250	4/04/2021	Plains Wanderer	Dog
20210404_030000.wav	312.5	561.404	750	4/04/2021	Plains Wanderer	Dog
20210404_030000.wav	312.5	608.99	875	4/04/2021	Plains Wanderer	Dog
20210404_030000.wav	312.5	726.457	1437.5	4/04/2021	Plains Wanderer	Dog
20210404_040000.wav	312.5	550	1875	4/04/2021	Plains Wanderer	Dog
20210406_200000.wav	437.5	596.591	1250	6/04/2021	Plains Wanderer	Dog
20210407_010000.wav	375	553.571	687.5	7/04/2021	Plains Wanderer	Dog
20210407_210000.wav	375	547.794	687.5	7/04/2021	Plains Wanderer	Dog
20210407_210000.wav	437.5	556.548	687.5	7/04/2021	Plains Wanderer	Dog
20210407_210000.wav	437.5	562.5	750	7/04/2021	Plains Wanderer	Dog
20210408_200000.wav	437.5	562.5	687.5	8/04/2021	Plains Wanderer	Dog
20210409_020000.wav	312.5	520.221	687.5	9/04/2021	Plains Wanderer	Dog
20210412_200000.wav	187.5	250.553	1250	12/04/2021	Plains Wanderer	Dog
20210413_050000.wav	187.5	385.417	1500	13/04/2021	Plains Wanderer	Dog
20210418_190000.wav	312.5	1137.908	2437.5	18/04/2021	Plains Wanderer	Raven
20210329_190000.wav	187.5	441.071	3937.5	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	476.716	3750	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	543.269	1312.5	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	513.889	1625	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	569.079	2250	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	639.852	8000	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	417.614	3625	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	535.714	3000	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	559.524	8000	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	598.011	2812.5	29/03/2021	Plains Wanderer	Voice
20210329_190000.wav	187.5	437.5	6875	29/03/2021	Plains Wanderer	Voice
20210410_040000.wav	187.5	250	375	10/04/2021	Plains Wanderer	Wind
20210415_220000.wav	187.5	437.5	625	15/04/2021	Plains Wanderer	Wind

## **Appendix D- Cluster Analysis Results**

Location 1					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210403_060000.wav	656.25	1006.25	1406.25	3/04/2021	Boobook Owl
20210405_000000.wav	4406.25	4963.001	5437.5	5/04/2021	Cricket
20210405_220000.wav	4312.5	4885.817	5625	5/04/2021	Cricket
20210404_030000.wav	4593.75	4944.504	5250	4/04/2021	Cricket
20210403_020000.wav	4687.5	5104.167	5625	3/04/2021	Cricket
20210405_200000.wav	4687.5	5388.281	6468.75	5/04/2021	Cricket
20210329_220000.wav	4312.5	4814.063	5250	29/03/2021	Cricket
20210329_220000.wav	4218.75	4706.25	5062.5	29/03/2021	Cricket
20210426_190000.wav	4031.25	4385.156	4781.25	26/04/2021	Cricket
20210403_190000.wav	656.25	2784.722	4218.75	3/04/2021	Cricket
20210406_190000.wav	5062.5	5743.75	6750	6/04/2021	Cricket
20210406_190000.wav	5250	5743.671	6562.5	6/04/2021	Cricket
20210405_190000.wav	1125	5259.146	6187.5	5/04/2021	Cricket
20210405_190000.wav	562.5	2702.633	7781.25	5/04/2021	Crimson Rosella
20210402_190000.wav	468.75	1062.643	1968.75	2/04/2021	Magpie
20210406_070000.wav	656.25	1337.831	2531.25	6/04/2021	Magpie
20210411_190000.wav	1500	1783.125	2156.25	11/04/2021	Magpie
20210423_190000.wav	1218.75	1913.603	3093.75	23/04/2021	Magpie
20210401_190000.wav	1593.75	3676.1	5625	1/04/2021	Noisy miner
20210420_190000.wav	1593.75	1798.828	2062.5	20/04/2021	Wind
20210414_000000.wav	4218.75	6838.963	7968.75	14/04/2021	Wind
20210414_010000.wav	1125	1853.125	3562.5	14/04/2021	Wind

Location 2					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210408_190000.wav	3750	4046.746	4406.25	8/04/2021	Cricket
20210414_190000.wav	3468.75	3759.073	4031.25	14/04/2021	Cricket
20210413_200000.wav	2906.25	3218.023	3468.75	13/04/2021	Cricket
20210402_190000.wav	2812.5	3829.861	5156.25	2/04/2021	Galah
20210331_190000.wav	2250	3591.146	4593.75	31/03/2021	Galah
20210328_190000.wav	2156.25	3568.269	4968.75	28/03/2021	Galah
20210416_070000.wav	750	1297.775	1968.75	16/04/2021	Magpie
20210329_070000.wav	1125	1619.792	4687.5	29/03/2021	Magpie
20210402_070000.wav	656.25	1204.613	2062.5	2/04/2021	Magpie
20210423_190000.wav	843.75	1780.032	2437.5	23/04/2021	Magpie
20210417_190000.wav	1312.5	1730.469	2062.5	17/04/2021	Magpie
20210417_190000.wav	1218.75	1735.227	3937.5	17/04/2021	Magpie
20210418_070000.wav	1218.75	1891.276	2625	18/04/2021	Magpie
20210407_190000.wav	1593.75	1804.688	2062.5	7/04/2021	Magpie
20210404_070000.wav	2531.25	2834.135	3187.5	4/04/2021	Noisy miner
20210414_010000.wav	1218.75	6193.139	7968.75	14/04/2021	Wind
20210411_000000.wav	3562.5	6736.15	7968.75	11/04/2021	Wind

Location 3					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210418_200000.wav	4312.5	4678.75	5125	18/04/2021	Cricket
20210329_230000.wav	4125	4519.097	4812.5	29/03/2021	Cricket
20210414_020000.wav	4125	4535.714	4875	14/04/2021	Cricket
20210412_200000.wav	4437.5	4856	5437.5	12/04/2021	Cricket
20210405_200000.wav	4562.5	5100.765	5312.5	5/04/2021	Cricket
20210402_000000.wav	4687.5	5483.782	6062.5	2/04/2021	Cricket
20210329_200000.wav	4562.5	5417.339	5812.5	29/03/2021	Cricket
20210330_230000.wav	4687.5	5358.398	5750	30/03/2021	Cricket
20210403_190000.wav	4625	5328.676	5562.5	3/04/2021	Cricket
20210405_190000.wav	3562.5	3829.637	5937.5	5/04/2021	Cricket
20210417_190000.wav	562.5	1730.382	4187.5	17/04/2021	Galah
20210418_190000.wav	1562.5	1945.043	2437.5	18/04/2021	Magpie
20210412_190000.wav	1437.5	1772.727	2875	12/04/2021	Magpie
20210418_190000.wav	625	1878.788	3875	18/04/2021	Raven
20210409_060000.wav	312.5	882.813	1250	9/04/2021	Wind
20210414_230000.wav	187.5	869.318	3000	14/04/2021	Wind
20210414_200000.wav	500	702.148	875	14/04/2021	Wind
20210414_190000.wav	812.5	938.802	1250	14/04/2021	Wind
20210411_040000.wav	187.5	1121.429	1687.5	11/04/2021	Wind
20210411_010000.wav	312.5	1197.115	8000	11/04/2021	Wind
20210410_220000.wav	375	1578.125	6562.5	10/04/2021	Wind

Location 4					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210406_190000.wav	656.25	1372.018	4781.25	6/04/2021	Australian raven
20210502_190000.wav	4593.75	5089.439	5437.5	2/05/2021	Cricket
20210413_230000.wav	750	1156.25	1968.75	13/04/2021	Cricket
20210401_230000.wav	4593.75	5019.326	5437.5	1/04/2021	Cricket
20210404_230000.wav	4781.25	5224.039	5625	4/04/2021	Cricket
20210329_190000.wav	4687.5	5172.414	5625	29/03/2021	Cricket
20210502_190000.wav	4687.5	5129.688	5437.5	2/05/2021	Cricket
20210330_190000.wav	1031.25	4047.322	5437.5	30/03/2021	Cricket
20210405_190000.wav	4781.25	5350.342	5812.5	5/04/2021	Cricket
20210407_070000.wav	937.5	1281.25	1781.25	7/04/2021	Magpie
20210401_070000.wav	1125	1320.313	1593.75	1/04/2021	Magpie
20210422_070000.wav	750	1040.441	1312.5	22/04/2021	Magpie
20210424_070000.wav	656.25	966.033	1218.75	24/04/2021	Magpie
20210331_070000.wav	1312.5	1518.145	1968.75	31/03/2021	Magpie
20210424_190000.wav	1406.25	1660.714	1968.75	24/04/2021	Magpie
20210418_190000.wav	656.25	1450.368	3656.25	18/04/2021	Raven

Location 4					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210411_020000.wav	5062.5	7242.188	7968.75	11/04/2021	Wind
20210411_000000.wav	1500	2839.286	7218.75	11/04/2021	Wind
20210410_190000.wav	187.5	2343.75	7968.75	10/04/2021	Wind
20210411_010000.wav	187.5	1633.929	7968.75	11/04/2021	Wind
20210410_200000.wav	187.5	2437.5	7968.75	10/04/2021	Wind
20210410_190000.wav	1968.75	7167.614	7968.75	10/04/2021	Wind

Location 5					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210418_072646.wav	2625	2833.333	3093.75	18/04/2021	Crimson Rosella
20210417_072646.wav	1125	3632.813	4687.5	17/04/2021	Galah
20210403_072646.wav	2062.5	4050.907	5531.25	3/04/2021	Grey Fantail
20210406_072646.wav	2156.25	3923.864	5437.5	6/04/2021	Grey Fantail
20210403_072646.wav	2062.5	4329.167	5437.5	3/04/2021	Grey Fantail
20210403_072646.wav	2250	4489.956	5531.25	3/04/2021	Grey Fantail
20210412_072646.wav	1218.75	2966.647	5906.25	12/04/2021	Lorikeet
20210331_072646.wav	562.5	1267.857	4031.25	31/03/2021	Magpie
20210418_072646.wav	937.5	1365.993	1875	18/04/2021	Magpie
20210412_072646.wav	843.75	1644.495	7781.25	12/04/2021	Magpie
20210404_072646.wav	937.5	1336.765	1687.5	4/04/2021	Pied Butcherbird
20210421_072646.wav	1125	1573.661	2625	21/04/2021	Raven
20210406_072646.wav	2156.25	3074.219	3562.5	6/04/2021	Straited Pardalote
20210329_222652.wav	281.25	1647.804	6093.75	29/03/2021	Voice
20210412_072646.wav	2531.25	4136.029	5531.25	12/04/2021	Willy Wagtail
20210410_192646.wav	187.5	843.75	7968.75	10/04/2021	Wind
20210410_192646.wav	3000	5872.668	7968.75	10/04/2021	Wind
20210413_212646.wav	3562.5	4000.488	7125	13/04/2021	Wind
20210410_202646.wav	468.75	892.361	2812.5	10/04/2021	Wind

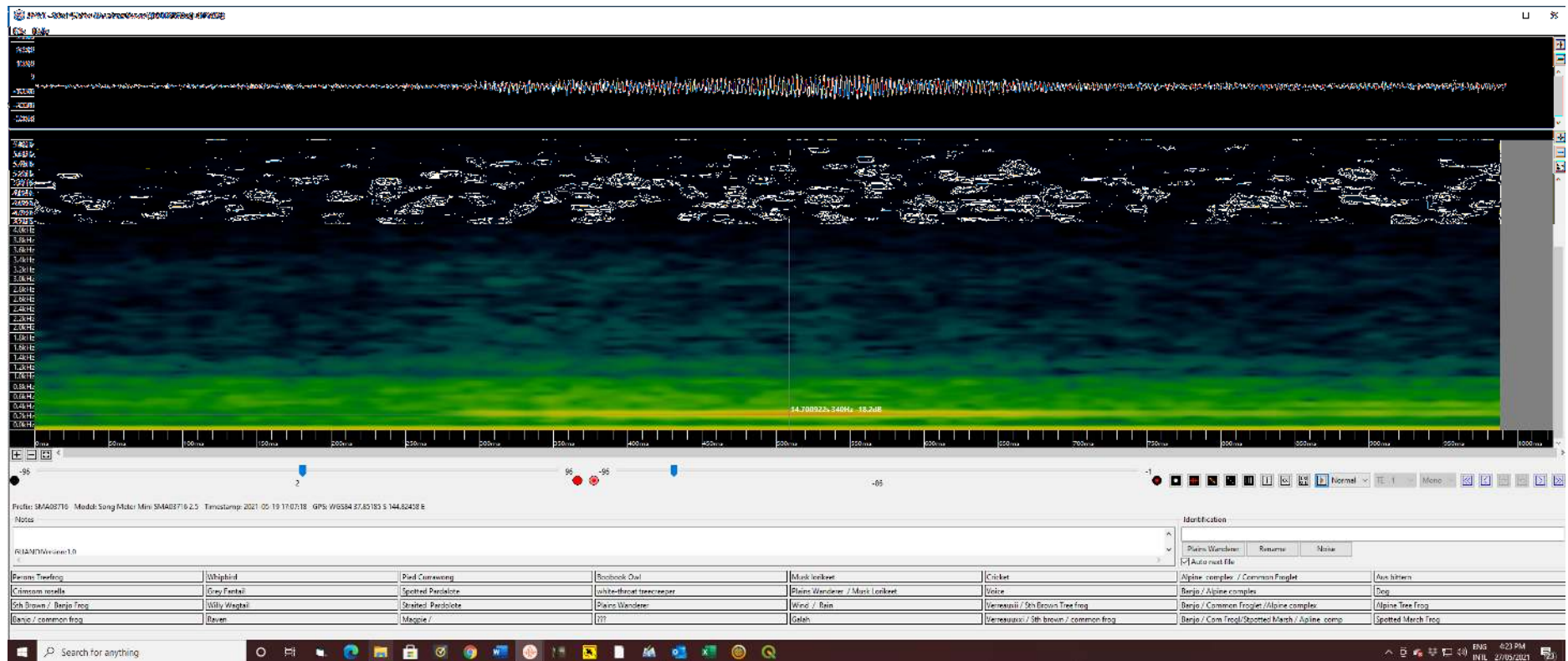
Location 6					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210412_200000.wav	375	967.391	1187.5	12/04/2021	Boobook Owl
20210329_200000.wav	5187.5	5472.948	5812.5	29/03/2021	Cricket
20210402_200000.wav	312.5	655.488	1125	2/04/2021	Dog
20210331_210000.wav	562.5	822.917	1062.5	31/03/2021	Dog
20210401_200000.wav	375	711.268	1125	1/04/2021	Dog
20210401_200000.wav	375	801.698	1437.5	1/04/2021	Dog
20210412_200000.wav	375	957.813	1375	12/04/2021	Dog
20210402_060000.wav	375	958.984	1312.5	2/04/2021	Dog
20210407_190000.wav	625	1810.417	3875	7/04/2021	Galah
20210411_190000.wav	1250	1620.192	2062.5	11/04/2021	Magpie



Location 6					
IN FILE	Fmin	Fmean	Fmax	DATE	MANUAL ID
20210409_060000.wav	312.5	605.299	1000	9/04/2021	Metallic noise
20210412_190000.wav	1000	1667.725	2750	12/04/2021	Raven
20210329_190000.wav	187.5	397.321	1875	29/03/2021	Voice
20210414_040000.wav	2062.5	3243.056	4500	14/04/2021	Wind

## **Appendix E – Sound Recorder Images**



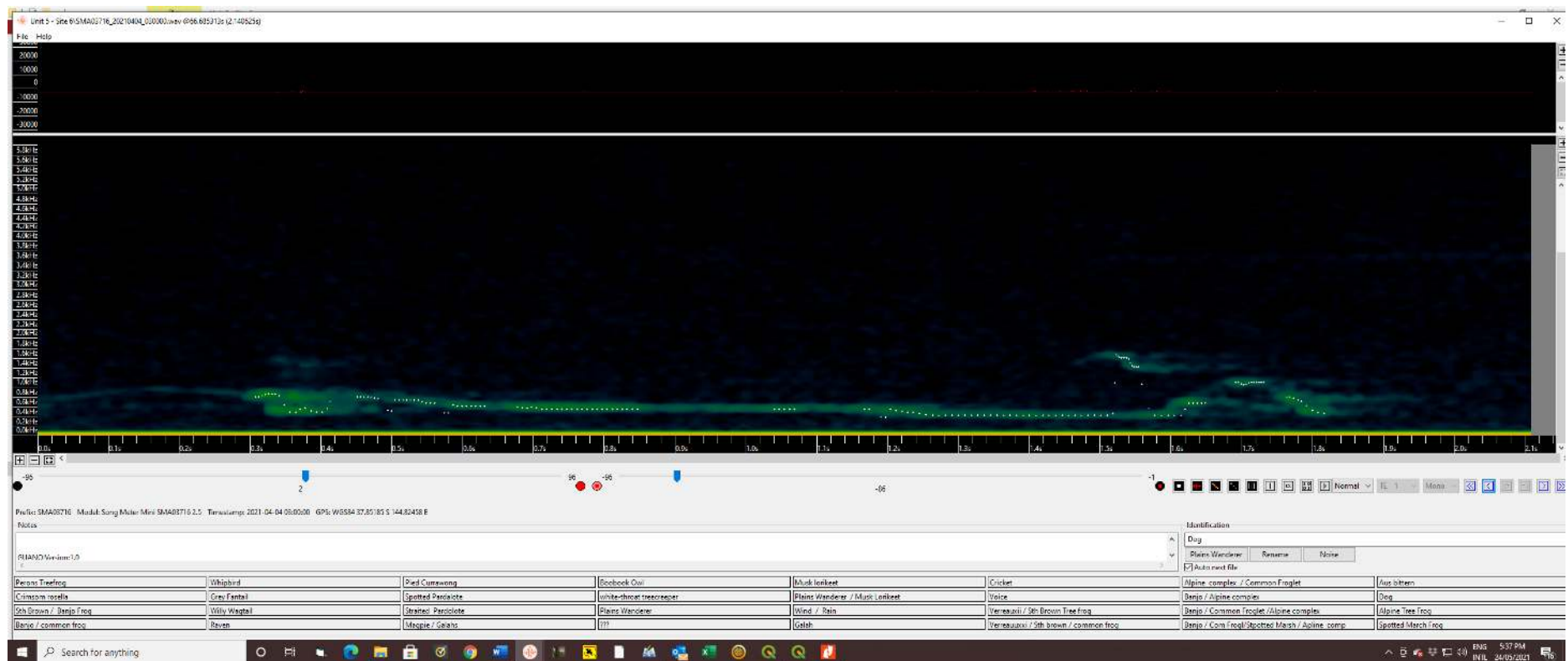


Reference Call Example - Plains-wanderer

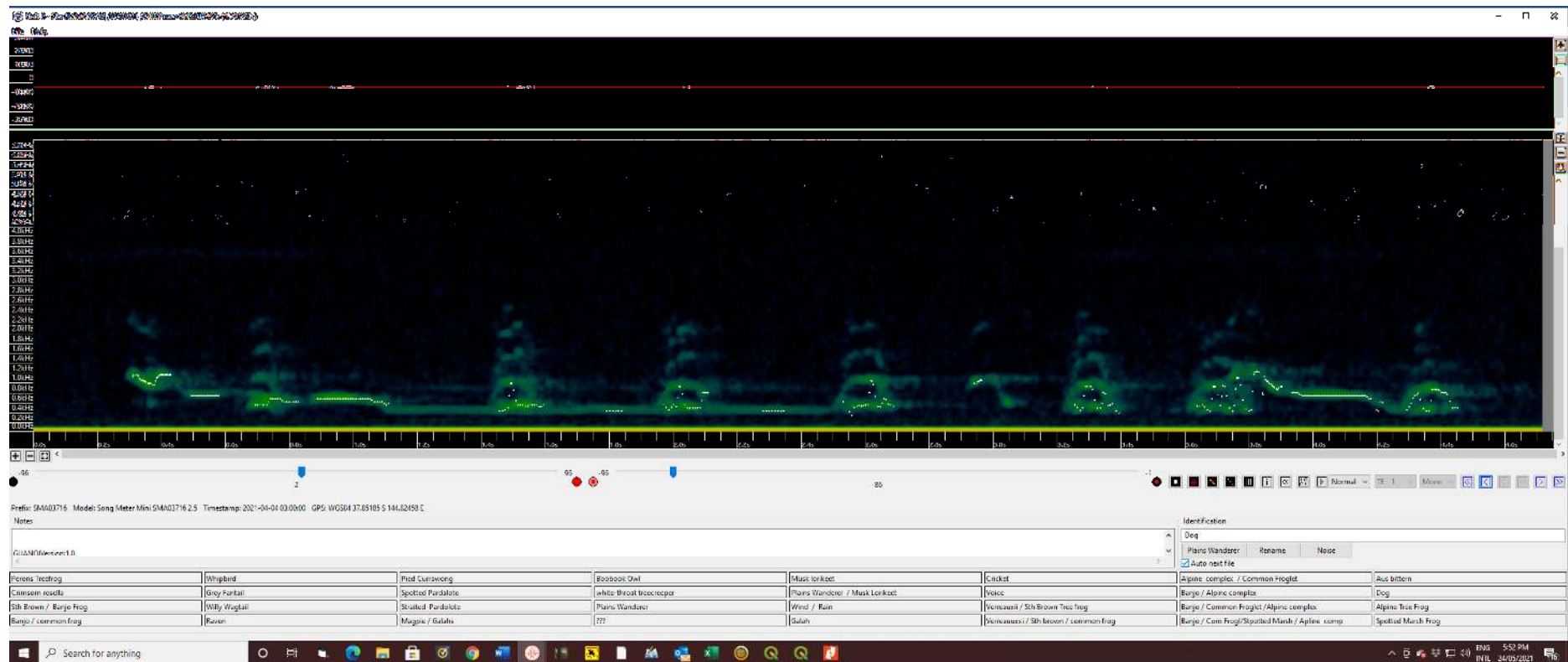




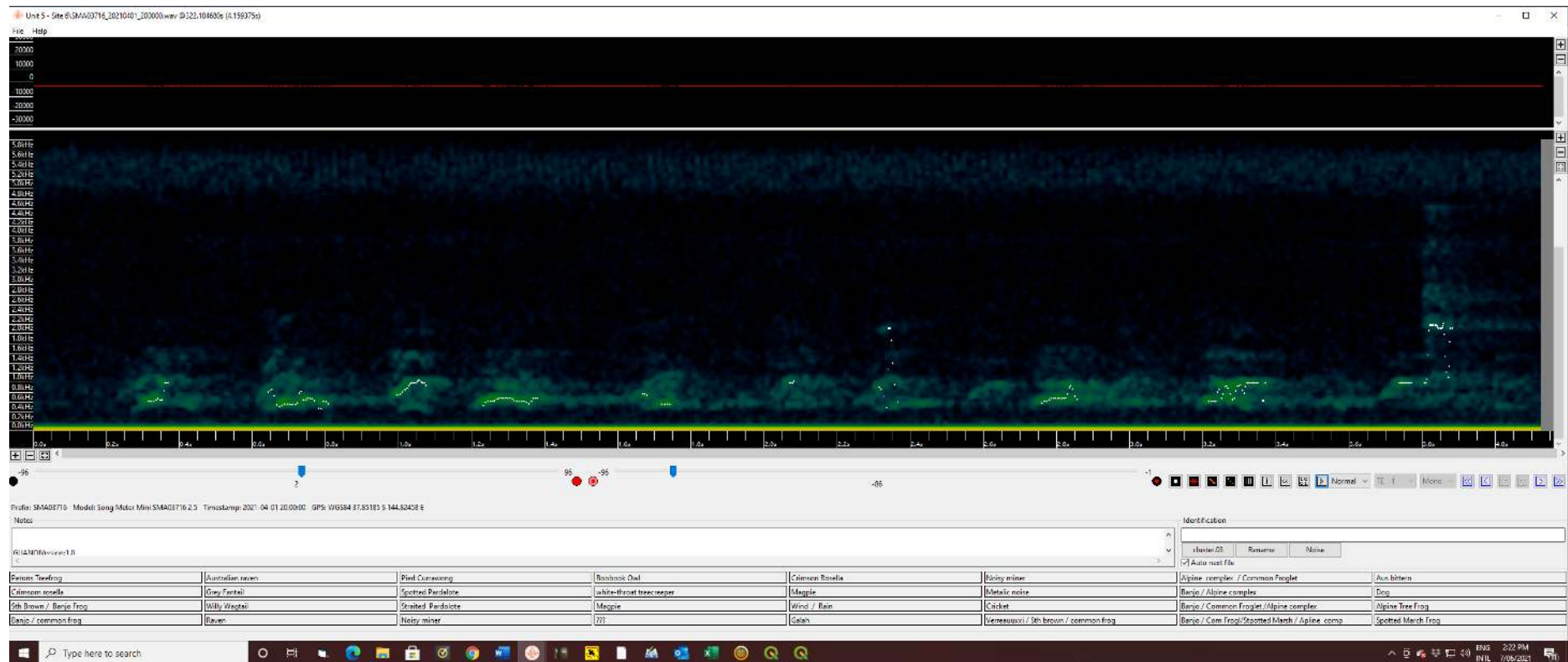




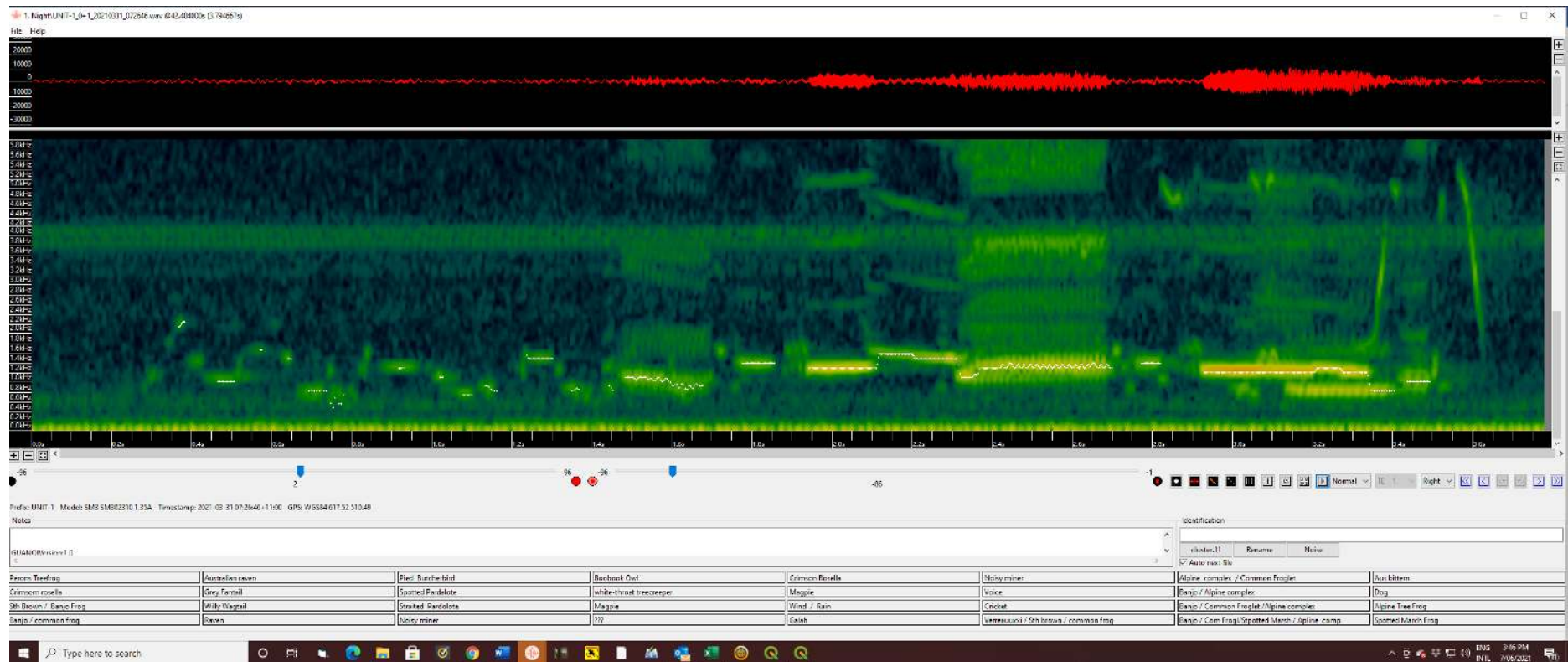
Dog howling



Dog Barking and howling

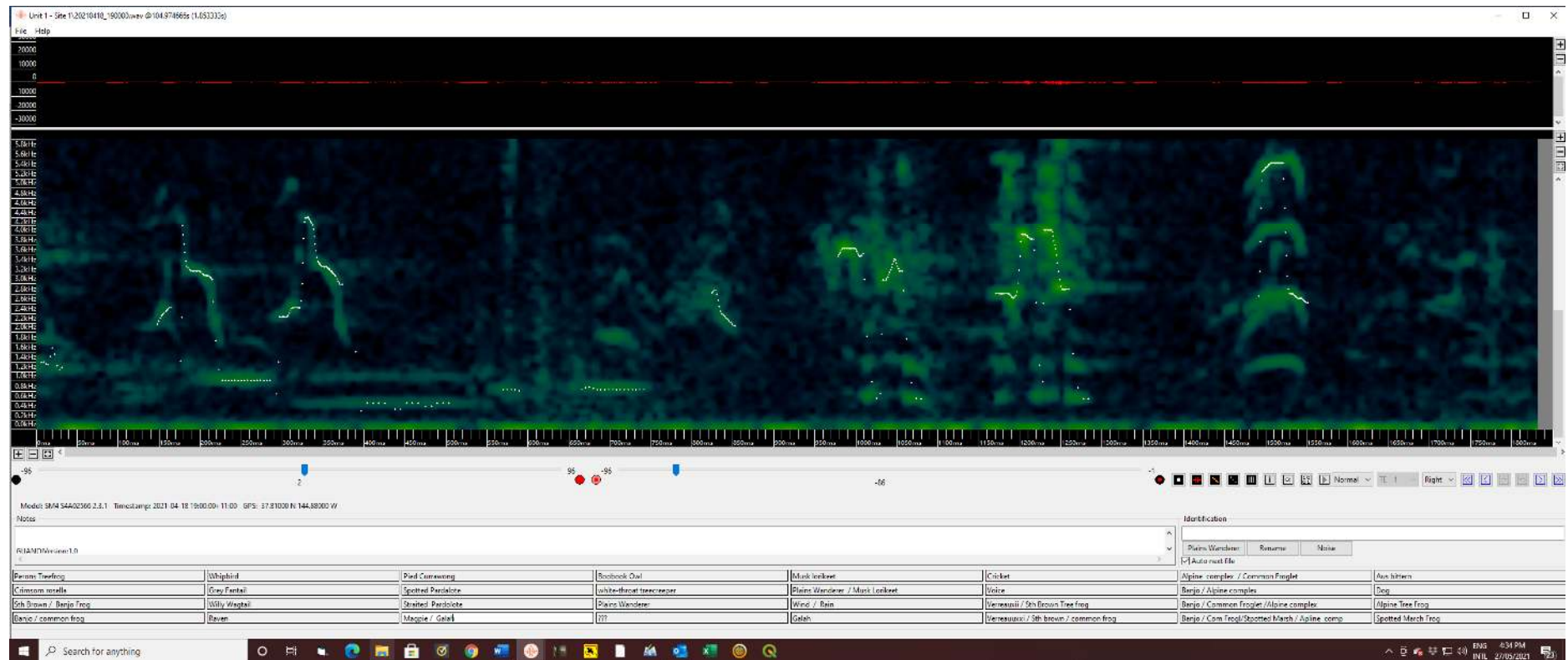


Dog barking

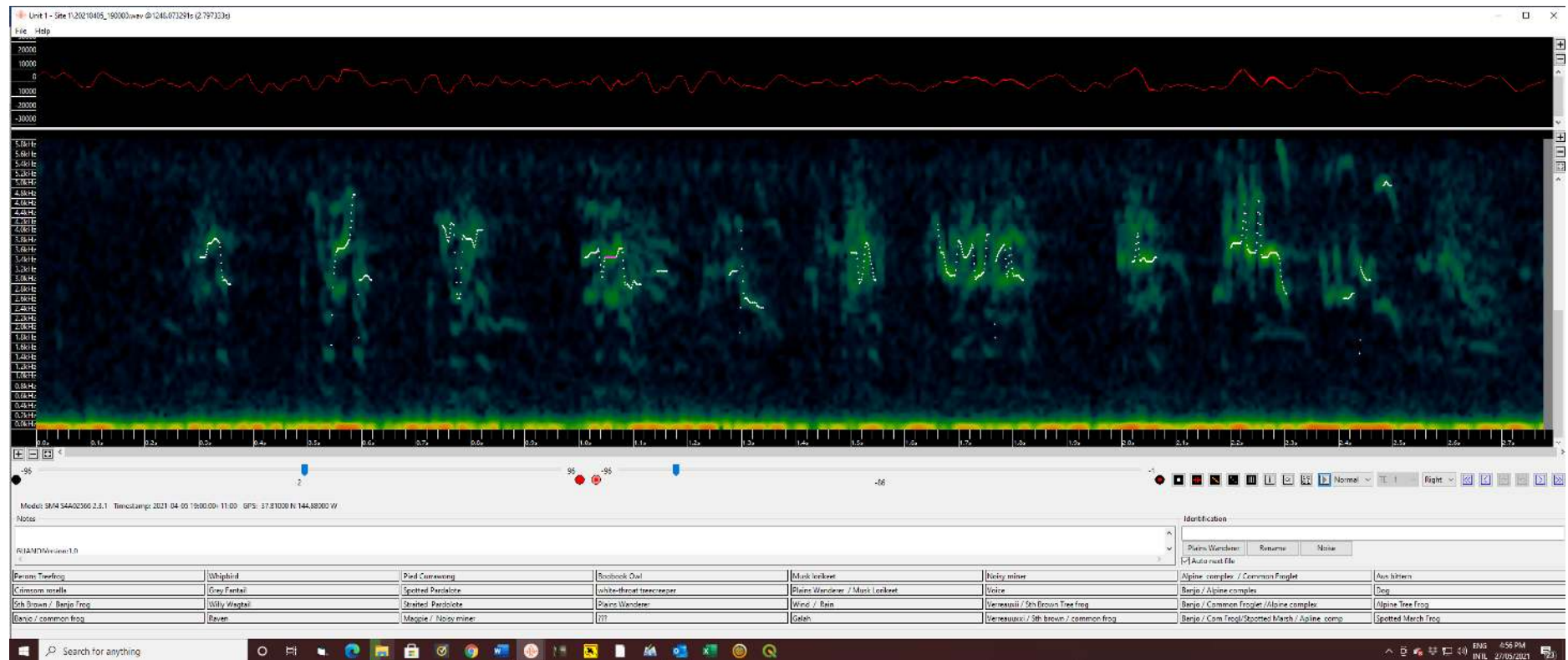


Magpie





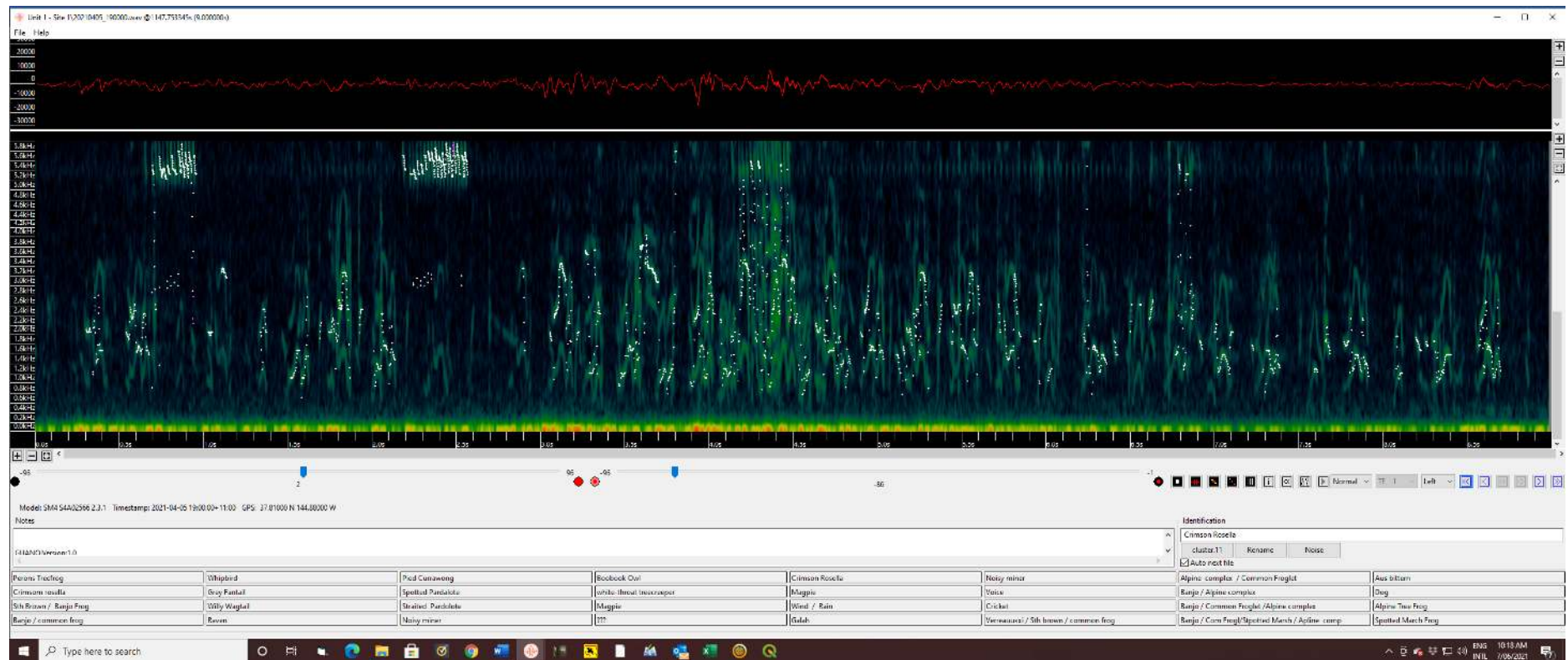
Magpie (lower constant frequency) & Galahs



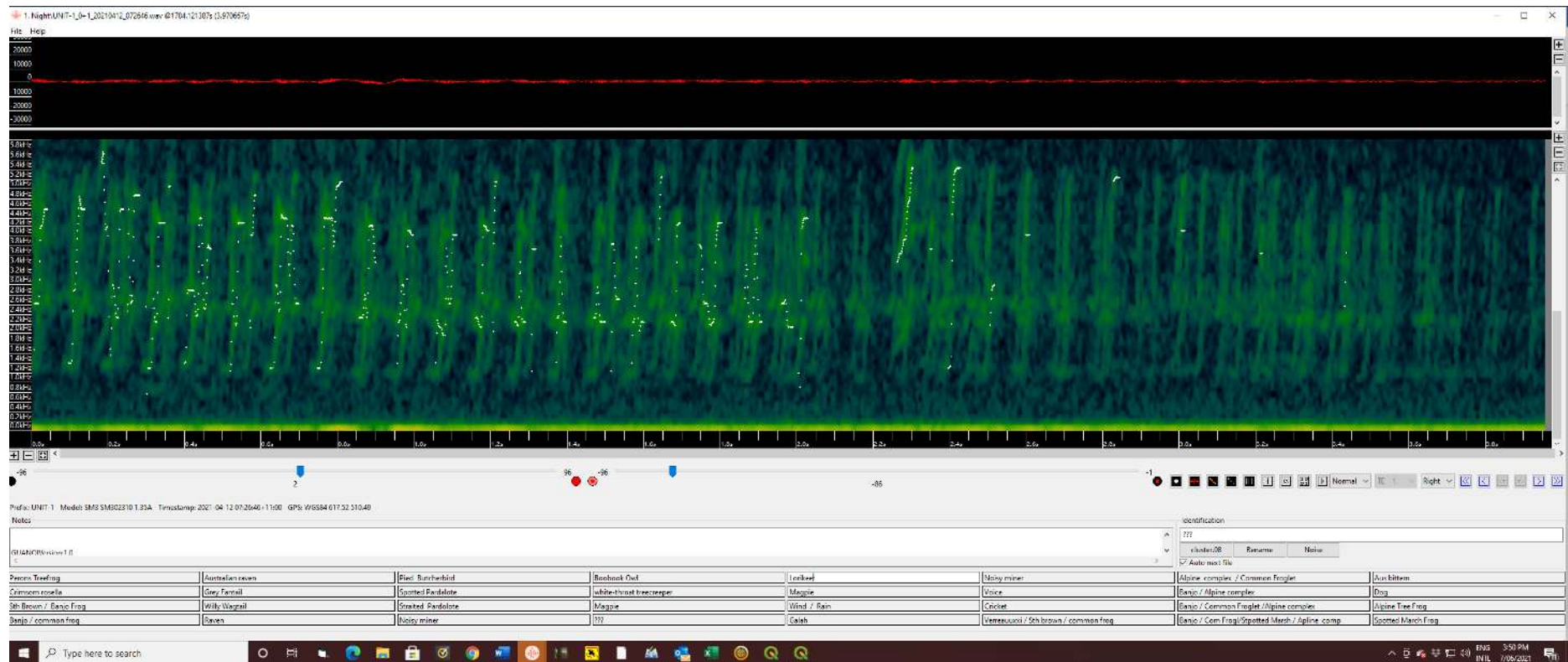
Galah







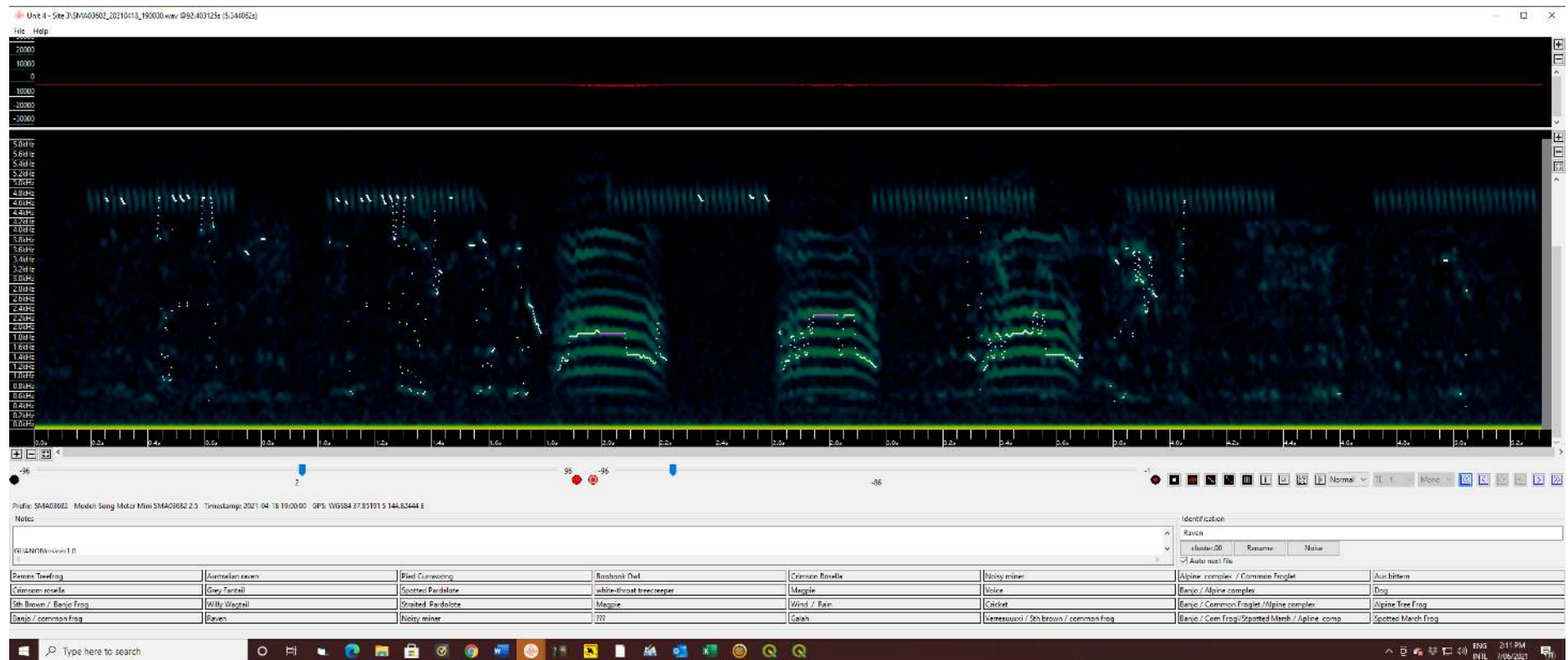
Crimson Rosella



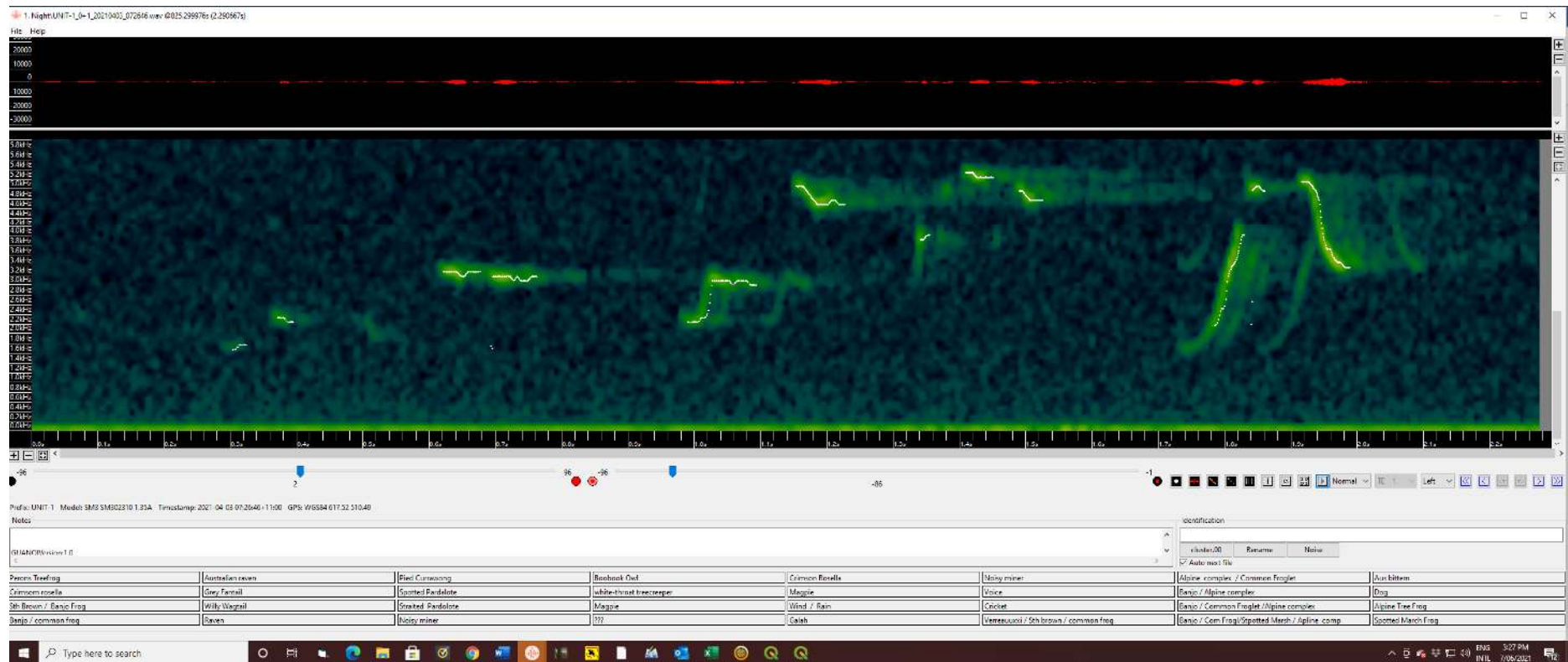
Lorikeet sp





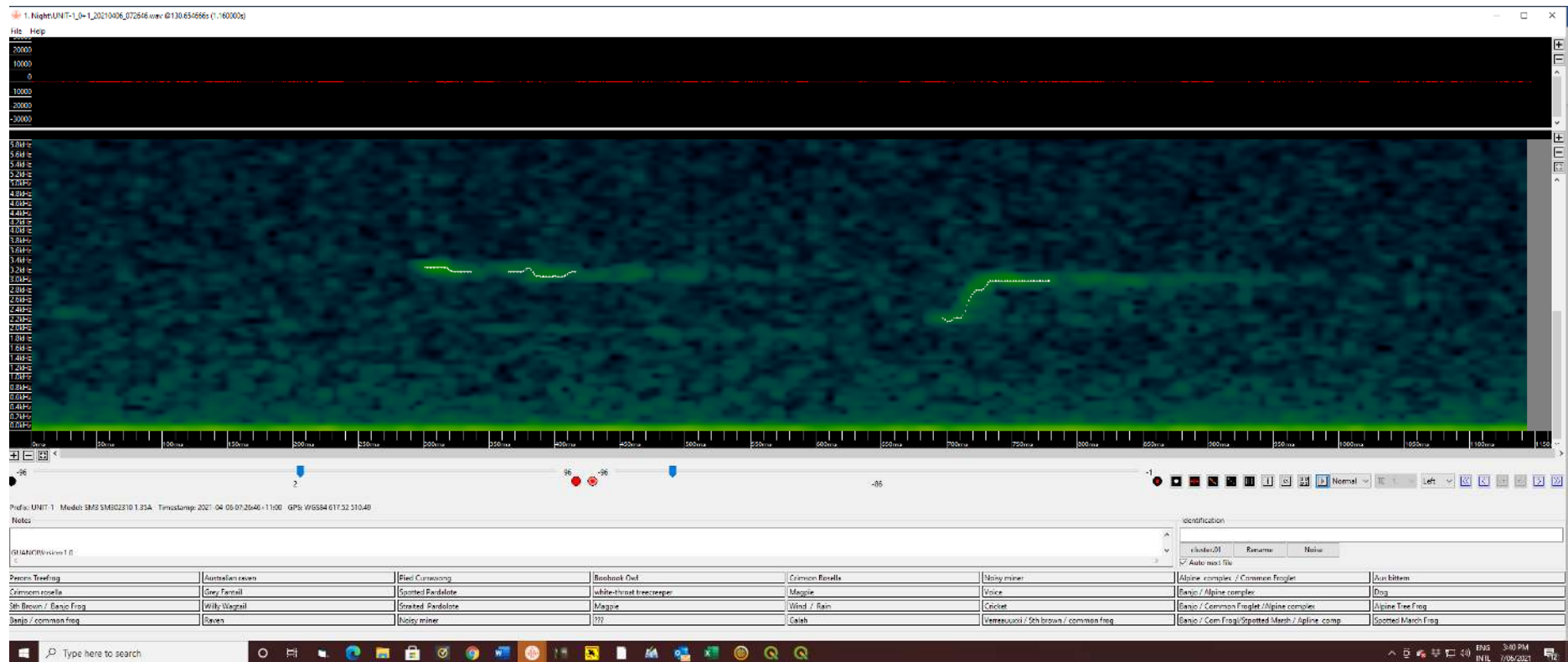


Raven sp

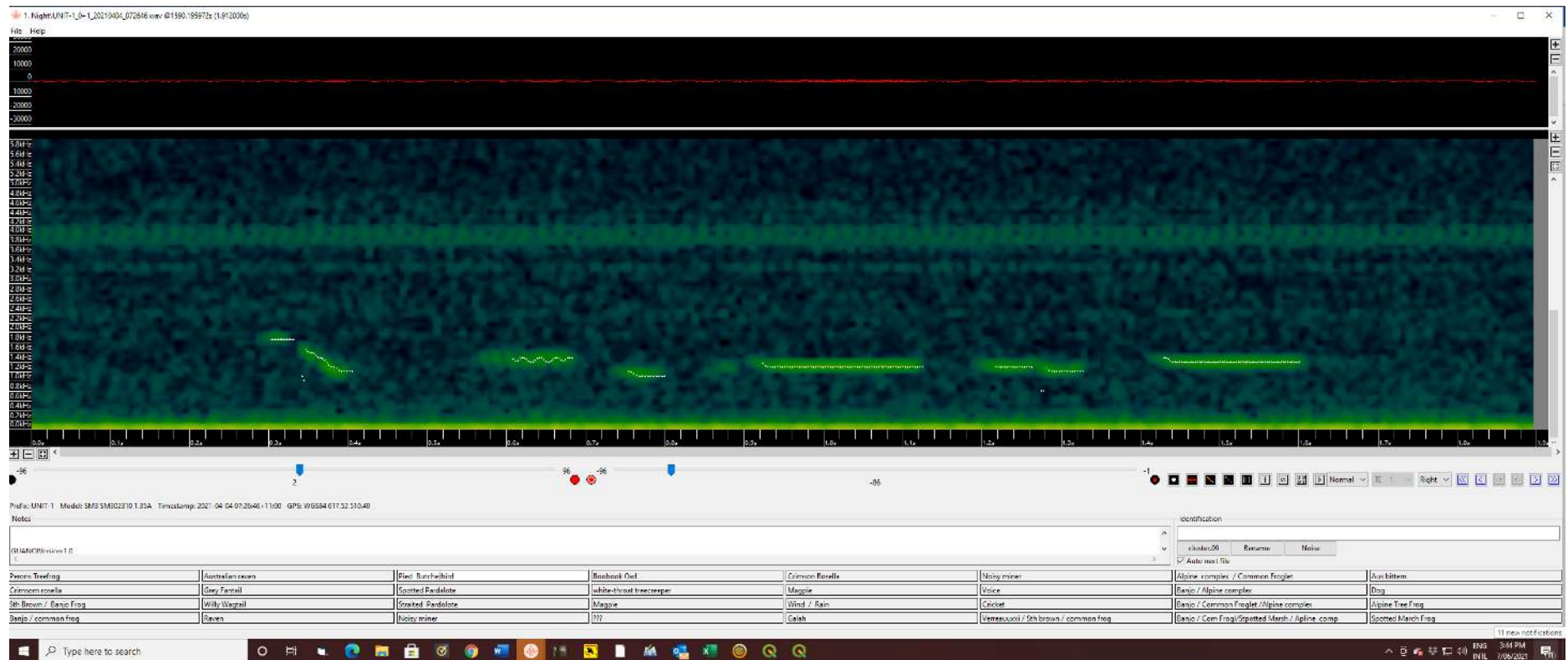


Grey Fantail

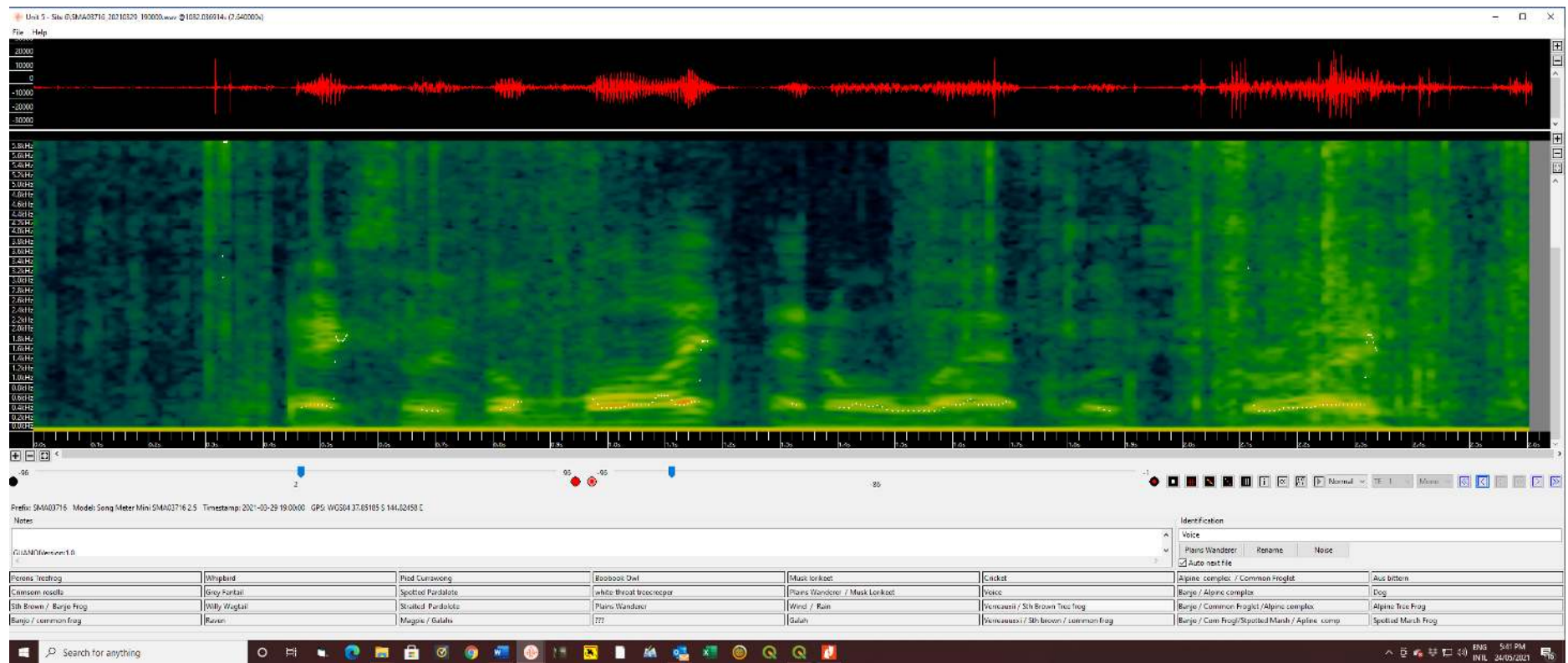




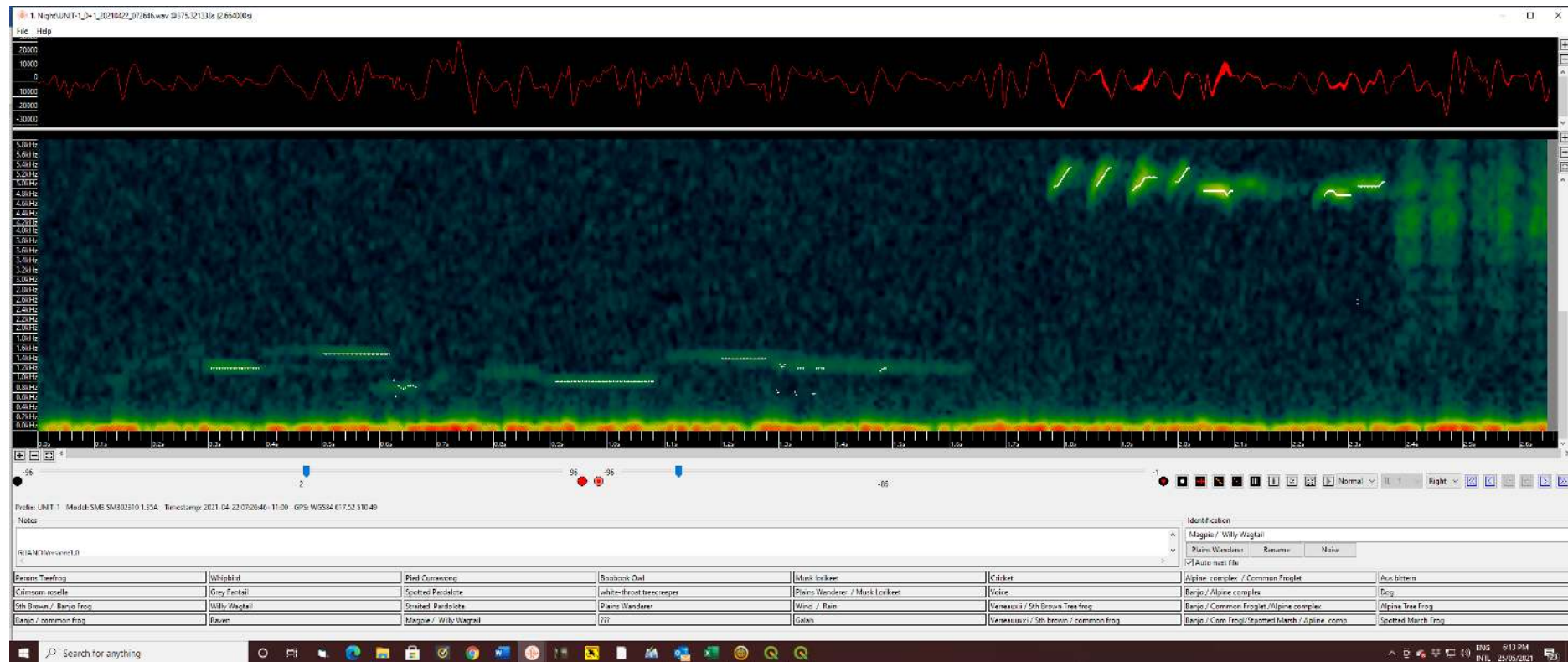
Striated Pardalote



Pied Butcherbird

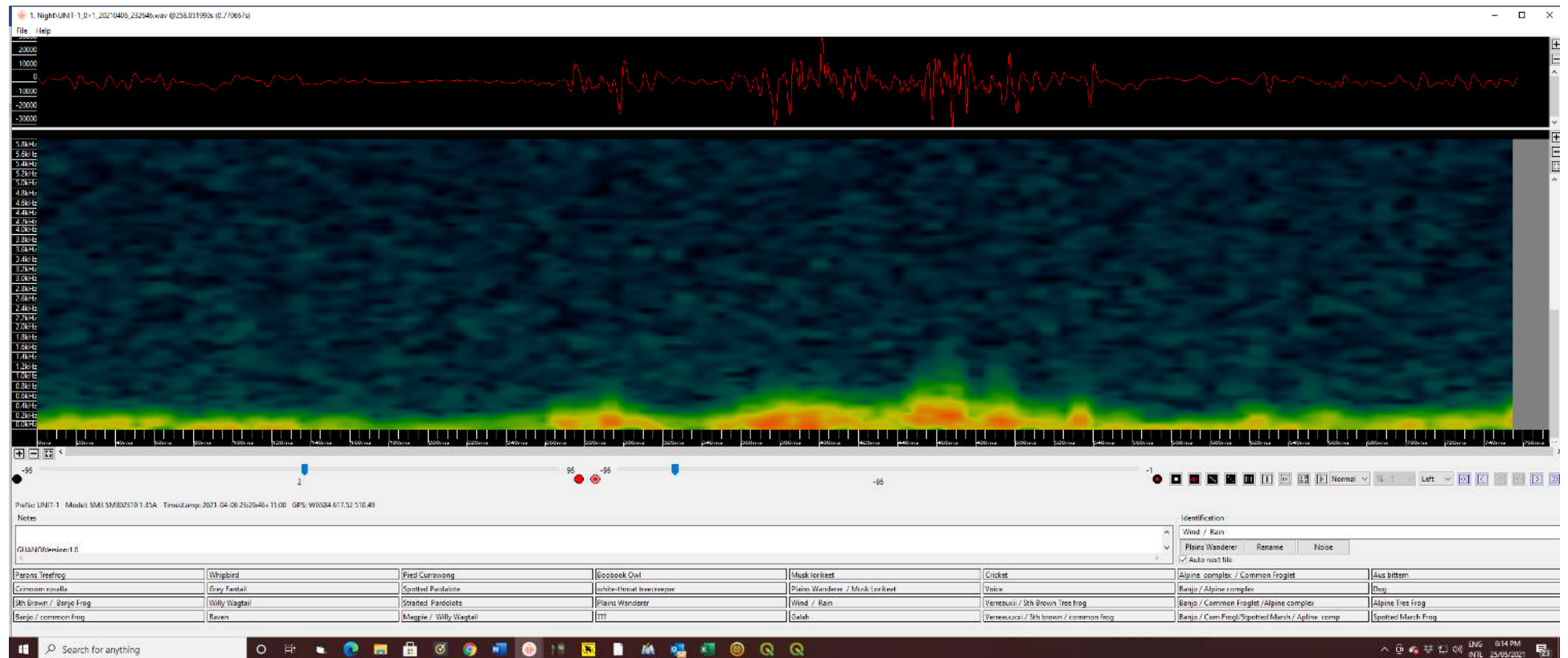


Human voice



Magpie (lower frequency) & Willy Wagtail (upper frequency).





Wind





## **Appendix E - Treetec Report**



## PRELIMINARY ARBORICULTURAL IMPACT ASSESSMENT

**SITE ADDRESS:** Mystic Park-Beauchamp Road  
Mystic Park, Vic. 3579

**REPORT DATE:** 08 November 2023

**TREETEC REFERENCE:** gosc0422to\_AIA

**PREPARED FOR:**

Vic Buljubasic  
AECOM  
0410 190 187  
Vic.Buljubasic@aecom.com

**PREPARED BY:**

Tom Oldmeadow  
Diploma of Arboriculture  
03 8644 8005  
admin@treetec.net.au

And

Mark Cashmore  
Diploma of Arboriculture

DOCUMENT SUMMARY				
STAGE	REPORT REF	PURPOSE	VERSION	DATE
	gosc0422to_AIA	Preliminary impact assessment	Draft	17/05/2022
✓	gosc0422to_AIA	Preliminary impact assessment	1	08/11/2023

## Contents

<b>1</b>	<b>Introduction.....</b>	<b>3</b>
1.1	Purpose.....	3
1.2	Background.....	3
1.3	Scope .....	3
1.4	Method .....	3
1.5	Limitations .....	4
1.6	'Lost' trees .....	4
1.7	Route overview.....	5
<b>2</b>	<b>Findings .....</b>	<b>6</b>
2.1	Route summary .....	6
2.2	Road surfaces .....	6
2.3	Sample tree data .....	8
2.4	Road segment data.....	12
2.5	Route plan .....	14
<b>3</b>	<b>Discussion.....</b>	<b>15</b>
	Trenching encroachment / Impacts on trees .....	15
3.2	Distribution of tree roots.....	15
3.3	Road types and root density .....	15
3.4	Tree damage related to use of machinery .....	15
3.5	Tree canopies .....	16
3.6	Alternate route options.....	16
<b>4</b>	<b>Conclusion .....</b>	<b>17</b>
<b>5</b>	<b>Recommendations .....</b>	<b>17</b>
<b>6</b>	<b>References .....</b>	<b>18</b>
<b>7</b>	<b>Appendix .....</b>	<b>18</b>
7.1	Assumptions & Limitations.....	18
7.2	Glossary .....	19
7.3	General comments .....	22
7.4	Impact on trees.....	22
7.5	Protection of retained trees .....	24
7.6	Road segment photos.....	26

# 1 Introduction

## 1.1 Purpose

Treetec have been engaged to undertake an assessment of trees along a ~37km stretch of road west of Kangaroo Lake, Victoria.

The purpose of this report is to estimate the number of trees likely to be lost as a result of the proposed works and to provide recommendations to minimise these losses.

## 1.2 Background

The Goschen Rare Earth and Mineral Sands Project requires a water source for construction and operations, this will require a waterpipe be laid via an open trench from Kangaroo Lake to the mine site.

The proposed route of the pipe is along a number of regional roads usually positioned beneath the road centre.

## 1.3 Scope

- Provide an indicative number of trees likely to be lost given the planned works, i.e. trenching for underground pipe laying
- Recommend a preferred alignment, choosing between three options to minimise arboricultural impacts
- Provide general recommendations to avoid or minimise tree impacts

## 1.4 Method

Two separate assessments were undertaken:

1. Individual sample trees (7 of) were assessed and detailed, these provide an indication of the types of trees and site context applicable to this assessment. Standard on-ground arboricultural assessment techniques were used.
2. The entire proposed route for the pipe including 2 alternate sections were assessed to determine the number of trees lost, this was primarily undertaken from a vehicle as a drive-by assessment.

The assessment of the approximate number of trees likely to be lost was made with consideration to:

- The site context
- AS 4970-2009 *Protection of trees on development sites*, and
- Guidance document: *Native vegetation removal assessments for linear impacts under the Guidelines for the removal, destruction or lopping of native vegetation* (DELWP)

This assessment assumes the proposed pipeline (trenching) would be positioned in the centre of the roadway.

Key factors in determining tree impacts were:

1. Road type / construction
2. Proximity of trees to the road
3. Size of tree (calculated TPZ)

Assessments were undertaken by Tom Oldmeadow between 4 – 6 May 2022

- All individual tree observations (part 1) were taken at ground level, guided by stage 1 of the Visual Tree Assessment (VTA) method (Mattheck and Breloer 1994)
- Indicative tree data was collected for selected trees across the different road types, including; tree species, dimensions, condition, road type and proximity to the proposed trench
  - Due to multiple stem habit of mallee Eucalypts, the Diameter Above Root Buttress (DARB) used to calculate SRZ, was estimated from the measured DBH
- In accordance with AS4970-2009 *Protection of trees on development sites*, likely impacts were assessed for these sample trees based on a 1m wide trench down the road centre
- A drive by survey of all roads along the route (part 2), including the 2 alternate routes, was undertaken, and with reference to the sample trees, an indicative count of the likely tree losses generated
- Data collected has been categorised in line with definitions found in Appendix- Glossary.

### 1.5 Limitations

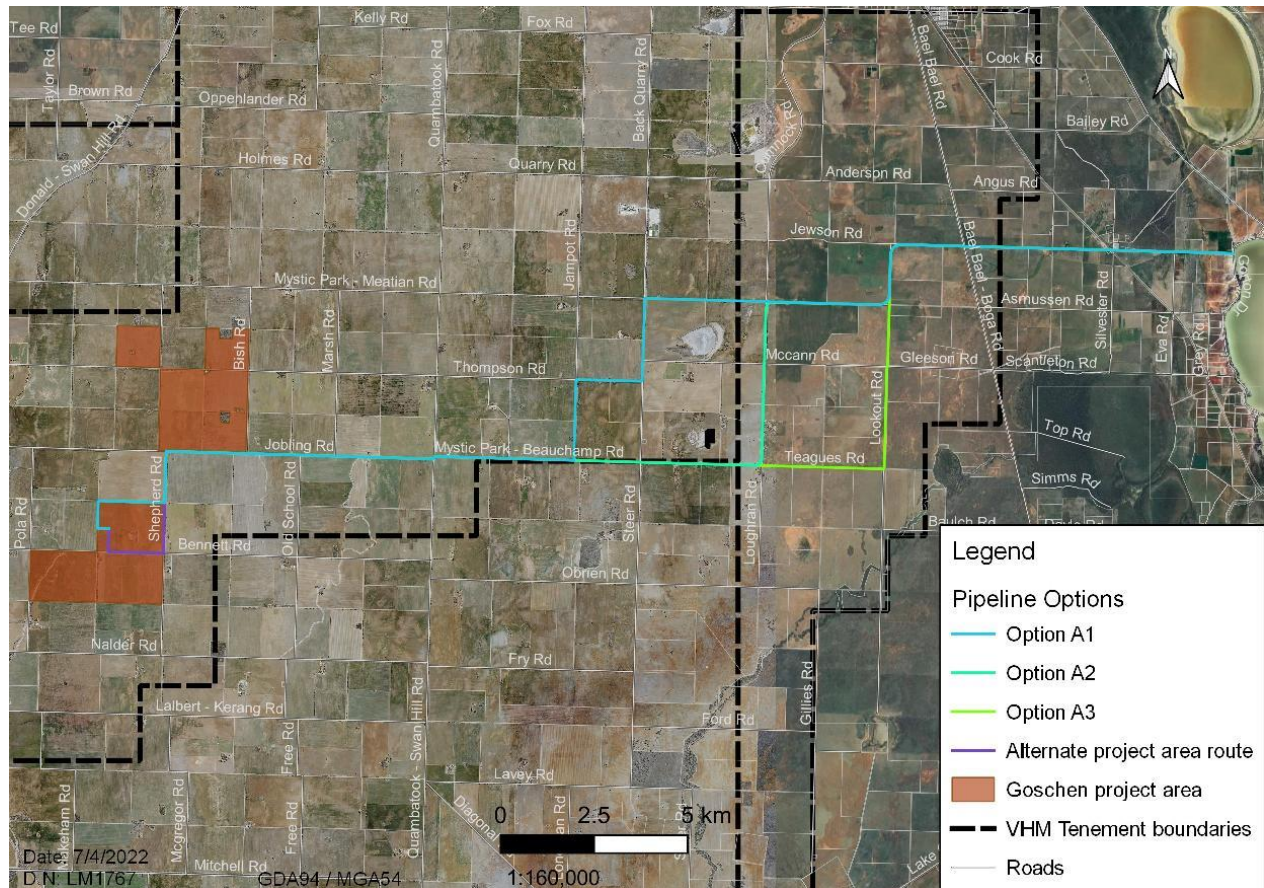
- Root assessment requiring excavation was not undertaken. Therefore, root condition has not been included unless above ground signs such as soil heaving or cracking were observed
- Aerial examination (tree climbing) was not undertaken
- Tree height and canopy width were estimated
- The assessment (part 2) was a cursory, drive-by assessment reliant on expert interpretation of the site, road and trees, not a measured calculation of TPZ areas and encroachments.

For the full list of assumptions and limitations for this report please refer to Appendix 7.1

### 1.6 'Lost' trees

Any trees where a significant proportion of roots, i.e. more than 10%, were likely to be impacted by the proposed works were counted as 'lost'. This assessment was primarily determined by a trees distance from the trench (road centre) and the type of road. It is a very subjective and conservative assessment, meaning that the number of 'lost' trees recorded here will be higher than the actual impacts, if the works proceed.

## 1.7 Route overview





## 2 Findings

### 2.1 Route summary

The proposed route runs from the Projects site boundary on Shepherd Road for approximately 37 Kms to the western side of Kangaroo Lake. The route is likely to follow existing roads with the pipe alignment proposed to be beneath the road centre. Two alternate alignment options are being considered and were included in the assessment.

Treed vegetation along the route is mixed, with dense mallee woodland along the road reserves on the western half of the route and fairly open or scattered trees along the eastern half. Tree species are predominantly indigenous mallee Eucalypts with observed species including: *Eucalyptus oleosa*, *E. calycogona*, *E. dumosa*, *E. behriana*, *E. leptophylla*, *E. largiflorens*, *Pittosporum angustifolium* and *myoporum platycartum*. There were also plantings along sections of Mystic Park-Beauchamp Road of a large range of non-indigenous natives.



Plate 1: Mallee *Eucalypts* spp. along Joblings Road.

### 2.2 Road surfaces

There were a range of road types & surfaces observed along the proposed route. This variation is a result of how the road was constructed and the level of use.

Road types will have a significant influence (see discussion) on the potential impacts to trees from the proposed works and they have been categorised as follows;

- Sandy track, narrow with low level of use and low compaction
- Graded sand, narrow, low level of use and low compaction
- Graded sand, wider, moderate level of use and moderate compaction
- Constructed gravel – secondary road, with formed road base, moderate level of use, high compaction
- Constructed gravel – primary road, wider, with formed road base, high level of use, very high compaction
- Sealed bitumen road, formed road base, very high compaction.



Plate 2: Thompson Road, sandy track.




Plate 3: Jobling Road, graded sand.





Plate 4: Mystic Park-Beauchamp Road, constructed gravel – primary road.




## 2.3 Sample tree data


TREE #	1	
LOCATION	Segment A	
SPECIES	<i>Eucalyptus calycogona</i>	
COMMON NAME	Square-fruited Mallee	
TYPE	Indigenous	
DBH (CM)	41	
HEIGHT (M)	6	
SPREAD (M)	5	
STRUCTURE	Fair	
HEALTH	Fair	
AGE	Mature	
RETENTION VALUE	High	
TPZ (M)	4.9	
SRZ (M)	2.5	
NOTES	Typical tree within segment close to road on east side. Graded sand, narrow road. 1.5m to graded road and 5.5m to road centre.	
IMPACT ASSESSMENT	Low. Trench outside of TPZ however machinery and plant will likely result in increased compaction within the root zone.	


TREE #	2	
LOCATION	Segment B	
SPECIES	<i>Eucalyptus dumosa</i>	
COMMON NAME	White Mallee	
TYPE	Indigenous	
DBH (CM)	38	
HEIGHT (M)	7	
SPREAD (M)	8	
STRUCTURE	Good	
HEALTH	Good	
AGE	Mature	
RETENTION VALUE	High	
TPZ (M)	4.6	
SRZ (M)	2.5	
NOTES	Typical tree close to road. 1.5m to graded road, 4.5m to road centre. Previous grading and road maintenance has reduced road surface to below natural grand level.	
IMPACT ASSESSMENT	Low. Proposed trench will result in a 2% TPZ encroachment. There is some potential for some minor root damage with trench and some additional compaction within root zone from machinery and plant.	


TREE #	3	
LOCATION	Segment D	
SPECIES	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	
COMMON NAME	Red Morrell	
TYPE	Indigenous	
DBH (CM)	82	
HEIGHT (M)	8	
SPREAD (M)	10	
STRUCTURE	Good	
HEALTH	Good	
AGE	Mature	
RETENTION VALUE	Very high	
TPZ (M)	9.8	
SRZ (M)	3.2	
NOTES	Larger tree in segment at higher risk of impact. Constructed gravel– primary road. Very highly compacted 1.5m to road surface and 5.5m to road centre.	
IMPACT ASSESSMENT	Moderate. Proposed trench will result in a 16% TPZ encroachment. Although this is a major encroachment under AS 4970-2009, due to the highly compacted road base, it is not likely there is a high density of roots present and root damage is expected to be lower as a result. Some canopy pruning may also be required for clearance. This tree was counted as ‘lost’	

TREE #	4	
LOCATION	Segment L	
SPECIES	<i>Eucalyptus behriana</i>	
COMMON NAME	Bull Mallee	
TYPE	Indigenous	
DBH (CM)	60	
HEIGHT (M)	7	
SPREAD (M)	6	
STRUCTURE	Good	
HEALTH	Good	
AGE	Mature	
RETENTION VALUE	High	
TPZ (M)	7.2	
SRZ (M)	2.9	
NOTES	Larger tree in segment. Constructed gravel – primary road. Very highly compacted. 8m to road centre.	
IMPACT ASSESSMENT	Low. Proposed trench is outside of the TPZ. Due to the highly compacted road surface, works are unlikely to result in any additional compaction within the root zone.	



TREE #	5	
LOCATION	Segment L (option A2)	
SPECIES	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	
COMMON NAME	Red Morrell	
TYPE	Indigenous	
DBH (CM)	66	
HEIGHT (M)	12	
SPREAD (M)	8	
STRUCTURE	Good	
HEALTH	Good	
AGE	Mature	
RETENTION VALUE	High	
TPZ (M)	7.9	
SRZ (M)	3.0	
NOTES	Larger tree in segment at higher risk of impact. Constructed gravel – primary road. Highly compacted.	
IMPACT ASSESSMENT	Low. Proposed trench will result in a 5.5% TPZ encroachment. Due to the highly compacted road surface, works are unlikely to result in any significant root damage or additional compaction within the root zone	

TREE #	6	
LOCATION	Segment G	
SPECIES	<i>Eucalyptus behriana</i>	
COMMON NAME	Bull Mallee	
TYPE	Indigenous	
DBH (CM)	68	
HEIGHT (M)	10	
SPREAD (M)	12	
STRUCTURE	Good	
HEALTH	Good	
AGE	Mature	
RETENTION VALUE	Very high	
TPZ (M)	8.2	
SRZ (M)	3.0	
NOTES	Larger tree in segment at higher risk of impact. Graded sand, wider road. Moderately compacted. 4m from road.	
IMPACT ASSESSMENT	Low. Proposed trench will result in a 3.5% TPZ encroachment. Some potential of root damage. Works may result in some additional compaction within root zone from machinery and plant	

TREE #	7	
LOCATION	Segment F	
SPECIES	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	
COMMON NAME	Red Morrell	
TYPE	Indigenous	
DBH (CM)	61	
HEIGHT (M)	10	
SPREAD (M)	14	
STRUCTURE	Good	
HEALTH	Fair	
AGE	Mature	
RETENTION VALUE	High	
TPZ (M)	7.3	
SRZ (M)	2.9	
NOTES	Sandy track, narrow. Low existing compaction 4 main stems. 11.4% encroachment. Low limbs over road.	
IMPACT ASSESSMENT	High. Proposed trench will result in an 11% TPZ encroachment. Due to the low level of existing compaction, it is highly likely roots will have colonised the soil profile beneath the road. Therefore, there is potential for significant root damage to occur and additional compaction within root zone from machinery and plant. In addition, pruning of low stem over road will be required for clearance. Counted as 'lost'	



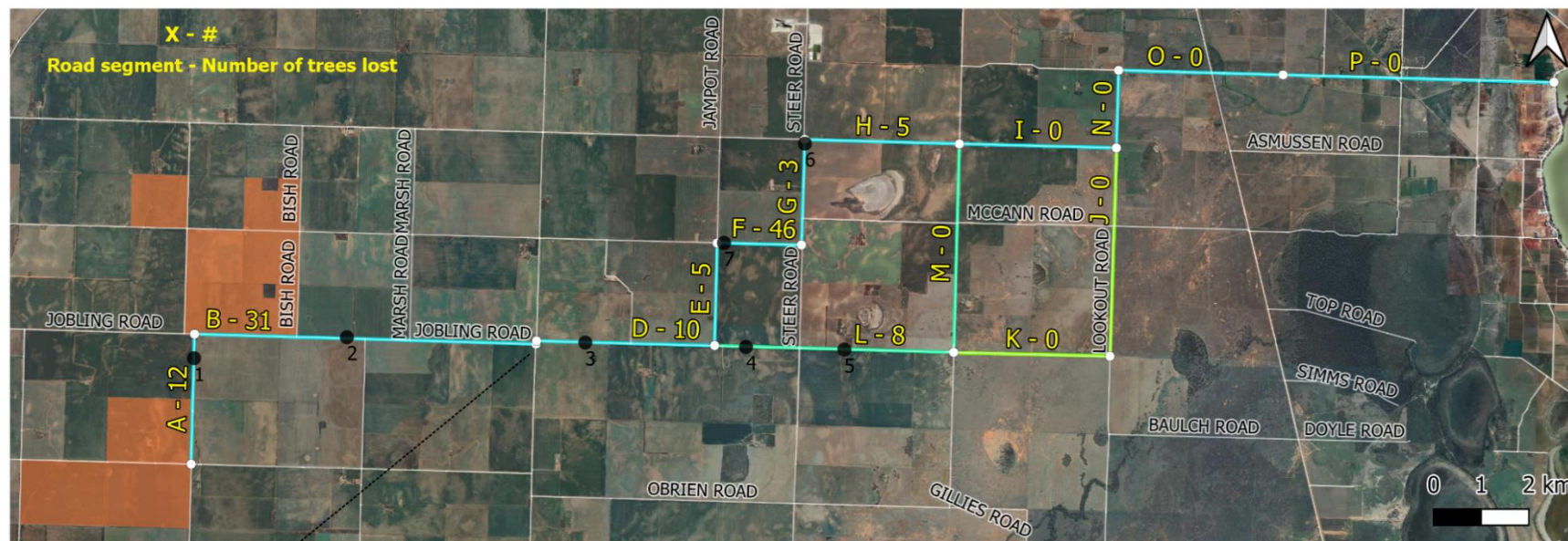
## 2.4 Road segment data

See Appendix 7.6 for photos.

SEGMENT	ROAD NAME	ROAD TYPE	APPROX. WIDTH	TREE DENSITY	TREES LOST	TREE CONCENTRATION	CANOPY OVERHANG	ALTERNATE ALIGNMENT	COMMENTS
<b>A</b>	Shepard Rd.	Graded sand wider, used moderately	7	Medium	12	East of road	no	West of road	Low level of compaction. Dense mallee Eucalypts east side of road. West has narrow reserve and isolated trees.
<b>B</b>	Jobling Rd.	Graded sand wider, used moderately	7	High	31	North and south of road	yes		Majority of graded road surface below NGL. Medium to high density mallee Eucalypts with some open patches on north and at eastern end.
<b>C</b>	Quambatook -Swan Hill Rd.	Bitumen	8	Low	0	NA	NA		No trees
<b>D</b>	Mystic Park-Beauchamp Rd.	Constructed, gravel surface, primary road	8	High	10	North and south of road	no		Very highly compacted road surface. Relatively dense mallee Eucalypts with some larger trees close to road.
<b>E</b>	Jampot Rd.	Graded sand wider, used moderately	7	High	5	East and west of road	no		Low level of compaction. High density of Mallee Eucalypts, mostly smaller trees.
<b>F</b>	Thompson Rd.	Sandy track, narrow, used rarely	5	High	46	North and south of road	yes		Narrow with low level of compaction. Dense tree population at west end with low over hanging canopies and open sections to the east.
<b>G</b>	Steer Rd.	Graded sand wider, used moderately	8	Medium	3	East and west of road	no		Moderately compacted. Trees mostly on west side with open patches on east.
<b>H</b>	Mystic Park-Meatian Rd.	Graded sand wider, used moderately	7	Medium	5	South of road	no		Moderately compacted. Trees patchy on both sides but more on south.
<b>I</b>	Mystic Park-Meatian Rd.	Constructed, gravel surface, primary road	8	Low	0	South of road	no		Wide, highly compacted road. Scattered trees only.
<b>J</b>	Lookout rd – option A3	Sandy track, narrow, used rarely	5	NA	0	NA	NA		No trees.
<b>K</b>	Teagues Rd – option A3	Sandy track, narrow, used rarely	5	NA	0	NA	NA		No trees.

<b>L</b>	Mystic Park-Beauchamp Rd. – option A2	Constructed, gravel surface, primary road	8	Medium	8	South of road	no		Wide, highly compacted road. Tree density focused at west end (Jampot Rd) and open areas at east end.
<b>M</b>	Mystic Park-Beauchamp Rd. – option A2	Constructed, gravel surface, primary road	8	Medium	0	West of road	no	East of road	Tree density concentrated at northern end. Scattered large trees at southern end. Power lines on east side with no large trees.
<b>N</b>	Mystic Park-Beauchamp Rd	Constructed, gravel surface, primary road	8	Low	0	NA	no		No trees
<b>O</b>	Mystic Park-Beauchamp Rd.	Constructed, gravel surface, primary road	8	Low	0	NA	no		No trees
<b>P</b>	Mystic Park-Beauchamp Rd. (sealed)	Bitumen	7	Low	0	North and south of road	no	North then south of road	Wide sealed road. Scattered trees. Alignment could be outside of sealed road surface with minimal losses - north of road to west of rail crossing and south of road east of rail crossing.

## 2.5 Route plan



### Pipeline options

- Sample trees
- Option A1
- Option A2
- Option A3
- Goschen
- Roads



## 3 Discussion

### **Trenching encroachment / Impacts on trees**

Trenching works near trees are highly likely to damage roots, this may result in decay, increased deadwood, thinning foliage, decreased health, instability, failures and death.

The impact on trees from trenching is closely aligned with the proportion of roots damaged.

### **3.2 Distribution of tree roots**

Root growth is opportunistic; that is, roots proliferate in areas conducive for growth. Any variation from the ideal soil profile will result in asymmetric growth. Compaction of soil will significantly impact the direction, distribution and density of roots.

Points of note:

- Constructed roads greatly inhibit root development
- Soil that is primarily sand, is less easily compacted
- Roots of non-juvenile trees are generally shallow (<1m depth) and easily damaged by traffic, road works, grading and trenching

Due to these factors the potential for root damage and resulting impacts, as they relate to this assessment, is more dependent on the type of road than proximity to works i.e. TPZ encroachments.

(see Appendix 7.3 – Impact On Trees for further detail).

### **3.3 Road types and root density**

Road types will have a significant influence on a trees ability to develop or sustain a system of roots in that area. Soil condition will dictate the availability of resources (water, nutrients, gases) to those roots.

Within the highly compacted profile beneath roads such as the Mystic Park-Beauchamp Road, the conditions are likely to be highly unsuited to roots. Therefore, root density will be greatly reduced compared to undisturbed ground or sandy roads such as Jobling Road.

### **3.4 Tree damage related to use of machinery**

Machinery use at this site poses 3 main risks to trees:

1. Physical wounding of roots as a result of trenching
2. Compaction of soil beneath the machine wheels or tracks
3. Wounding to trunk or branches due to contact with the machinery

The issue of highest concern is the trenching, compaction from wheels and tracks will be inconsequential given the scope of works and physical wounding can be avoided entirely if precautions are taken.



### 3.5 Tree canopies

There are a number of road segments where low overhanging canopies may interfere with machinery use during the proposed works, these branches may require careful removal (pruning) prior to commencement. The extent of this pruning will depend on the size of the machinery required for the project, and although this is not expected to require the removal of whole trees, there will likely be impacts to some trees as a result.

### 3.6 Alternate route options

Below details the estimated trees lost for the 3 route options.

COMPARISON OF TREE LOSSES – VARIOUS ALIGNMENTS							
Common sections		Option A1		Option A2		Option A3	
Segment A	12	Segment E	5	Segment L	8	Segment L	8
Segment B	31	Segment F	46	Segment M	0	Segment K	0
Segment C	0	Segment G	3	Segment I	0	Segment J	0
Segment D	10	Segment H	5				
Segment N	0	Segment I	0				
Segment O	0	<b>Section totals</b>	<b>59</b>		<b>8</b>		<b>8</b>
Segment P	0	<b>Common sections</b>	<b>53</b>		<b>53</b>		<b>53</b>
<b>Totals</b>	<b>53</b>		<b>112</b>		<b>61</b>		<b>61</b>

Despite being a short length of road, the vast majority of potential losses are a result of segment F (Thompson Road) this is a very narrow road, with low level compaction, dense tree concentration at the west end and low overhanging canopies.



Segment F



Segment K

Plate 5: comparison of alignments options A1 (Thompson Rd, segment f) and A2 (Teagues Rd, segment K)

In comparison, option A3 provides 2 segments of road (J and K) with no tree and therefore, from an arboricultural perspective, is the preferred route.

## 4 Conclusion

The arboricultural assessment undertaken west of Kangaroo Lake followed a proposed pipeline route along ~37km of road, with 2 alternative sections.

Treed vegetation along the route is mixed, generally with dense mallee woodland along the road reserves on the western half of the route and fairly open or scattered trees along the eastern half.

The dense woodland of the western half of the route are comprised of indigenous Eucalypts, primarily species of, *Eucalyptus oleosa* subsp. *oleosa*, *E. calycogona*, *E. dumosa* and *E. behriana*.

Impacts to trees are likely to result from; damage to roots during excavation, compaction of the soil profile within the root zone due to machinery and plant positioning and the pruning of overhanging canopies to create clearance over the work zone.

The likely root damage and effects of compaction will largely be dependent on the road type rather than encroachment within a calculated TPZ. The very highly compacted and gravelled roads such as The Mystic Park-Beachamp Road will have a much lower potential for impacts to adjacent trees than a graded sand surface, such as Jampot Road.

With an alignment down the centre of the road, plant and machinery should not need to leave the graded road surface aside from possibly at turning points. Designated turning points where there are no trees within the road reserve will be required to prevent compaction and physical damage to roadside trees.

Canopy pruning requirements will depend on the final clearance required over the work zone, however it should not result in significant impacts aside from Thompson Road where the road is narrow with low overhanging canopies.

Based on a detailed assessment of 7 sample trees along the route and a drive-by assessment of the entire route, it is estimated a maximum total of 120 trees would be impacted (lost) by the installation of the pipe. With a proposed alignment down the centre of the road, it is not anticipated that any of these would require removal to facilitate the works however, taking a conservative approach they have been assessed as lost.

The alignment options of A2 and A3 provide an alternative to the heavily treed sections of Jampot Road and Thompson Road and both offer 51 fewer tree losses when compared to A1. Option A3 with less adjacent trees is preferable to option A2.

## 5 Recommendations

**Route alignment options** – Avoid alignment option A1 and preferably utilise option A3 over A2.

**Road alignment** – Retain a centre alignment throughout with the exception of the sealed section of Mystic Park-Beachamp Road, where the alignment could be north of the road to the west of the rail crossing and south of the road to the east of the rail crossing.

**Designated turning points** – Assign designated turning points where there are gaps in the roadside vegetation to prevent compaction and damage near trees.

**Canopy pruning** – Any canopy pruning required should be identified and pruned prior to works commencing to prevent branches being hit or torn off with machinery.



## 6 References

Department of Environment, Land, Water and Planning. VicPlan, Accessed April 2022, Available at: <https://mapshare.vic.gov.au/vicplan/>

Mattheck, C. and Breloer, H. (1994), *The Body Language of Trees: A Handbook for Failure Analysis*, London: HMSO.

Costermans, L. (1981), *Native Trees and Shrubs of South-Eastern Australia*, New Holland publishers (Australia) Pty Ltd, Sydney

Brooker, M.I.H. & Kleining, D.A., (2006), *Field Guide to Eucalypts*, 3<sup>rd</sup> ed., Vol. 1 – South-eastern Australia, Melbourne, Australia: Bloomings Books.

ProofSafe Tree Protection Zone encroachment calculator, available online at: [https://proofsafe.com.au/tpz\\_incursion\\_calculator.html](https://proofsafe.com.au/tpz_incursion_calculator.html)

Standards Australia (2009), AS 4970-2009 Protection of trees on development sites

Standards Australia (2007), AS 4373-2007 Pruning of amenity trees

## 7 Appendix

### 7.1 Assumptions & Limitations

1. **Treetec** does not assume responsibility for legal matters, and assumes that legal descriptions, titles and ownerships are correct and good.
2. **Treetec** assumes that any property or project is not in violation of any applicable codes, ordinances, statutes or other government regulations.
3. **Treetec** takes all reasonable care to ensure all referenced material is accurate and quoted in correct context but does not take responsibility for information quoted or supplied.
4. **Treetec** shall not be required to give testimony or to attend court by reason of this report unless subsequent contractual arrangements are made, including the payment of an additional fee for such services.
5. Loss or alteration of any part of this report invalidates the entire report.
6. Possession of this report, or a copy thereof, does not imply right of publication or use for any purpose by anyone but the person to whom it is addressed, without the prior written consent of **Treetec**.
7. All, or any part of the contents of this report, or any copy thereof, shall not be used for any purpose by anyone but the person to whom it is addressed, without the written consent of **Treetec**.
8. This report shall not be conveyed by anyone, including the client, to the public through advertising, public relations, news, sales or other media, without the written consent of **Treetec**.
9. This report and any values expressed herein represent the opinion of **Treetec** and **Treetec's** fee is in no way contingent upon the reporting of a specified value, the occurrence of a subsequent event, nor upon any finding to be reported.
10. Site plans, diagrams, graphs and photographs in this report, being intended as visual aids, are not necessarily to scale and should not be construed as engineering or architectural reports or surveys.
11. Information in this report covers only those items that were examined in accordance with the Terms of Reference, and reflects the condition of those items that were examined at the time of the inspection.
12. Inspections are limited to visual examination of accessible components unless otherwise stated in the "Method of Inspection".
13. There is no warranty or guarantee, expressed or implied, that the problems or deficiencies of the plants or property in question may not arise in the future.
14. Due to the dynamic nature of trees and development there can be no guarantee that the Useful Life Expectancy (ULE) of the subject tree/s won't be adversely impacted.

## 7.2 Glossary

AGE CATEGORY	The age of the tree is represented as Juvenile, Semi-mature, Mature or Senescent.								
	<table> <tr> <td>Juvenile:</td><td>A young tree, given normal environmental conditions for that tree it will not yet flower or fruit.</td></tr> <tr> <td>Semi-mature:</td><td>Able to reproduce but not yet nearly the size of a mature specimen in that location.</td></tr> <tr> <td>Mature:</td><td>Has reached or nearly reached full size and spread for that species in the given location.</td></tr> <tr> <td>Senescent:</td><td>Health and / or structure is being adversely impacted by the old age of the tree.</td></tr> </table>	Juvenile:	A young tree, given normal environmental conditions for that tree it will not yet flower or fruit.	Semi-mature:	Able to reproduce but not yet nearly the size of a mature specimen in that location.	Mature:	Has reached or nearly reached full size and spread for that species in the given location.	Senescent:	Health and / or structure is being adversely impacted by the old age of the tree.
Juvenile:	A young tree, given normal environmental conditions for that tree it will not yet flower or fruit.								
Semi-mature:	Able to reproduce but not yet nearly the size of a mature specimen in that location.								
Mature:	Has reached or nearly reached full size and spread for that species in the given location.								
Senescent:	Health and / or structure is being adversely impacted by the old age of the tree.								
ARBORICULTURAL VALUES	Values assigned to a tree or group of trees to provide an overview of their significance with consideration to a range of factors (see below)								
RETENTION VALUE	<p>A rating assigned to a tree or group of trees based on; Amenity Value, Useful Life Expectancy (ULE), suitability for the site, location, cultural or historical significance, legislative vegetation controls (such as Planning or Local Law).</p> <p>Age is a primary consideration as it is the determining factor when considering how long it would take to replace the amenity lost when trees are removed.</p> <p>For proposed development, the retention value may help shape decisions to ensure site amenity value is maximised.</p> <p>Tree removal may require a planning permit. Check with your local council prior to removing any vegetation.</p> <table> <tr> <td>Offsite:</td><td>Located outside of the subject site. Must be retained and protected regardless of other factors.</td></tr> <tr> <td>High:</td><td>Worthy of retention and incorporation into any development proposal. Medium or High Amenity Value, 15&gt;40 years or greater Useful Life Expectancy (ULE), rare or endangered/ ecologically valuable.</td></tr> <tr> <td>Medium:</td><td>Should be considered for retention, if practicable. Low or Medium Amenity Value, 15-40 years or less ULE. May be minimal canopy cover in the local area (loss would be detrimental to the landscape).</td></tr> <tr> <td>Low:</td><td>Low Amenity Value, 5-15 years or less ULE, may be problematic to retain. Retain if desired, otherwise consider removal.</td></tr> </table>	Offsite:	Located outside of the subject site. Must be retained and protected regardless of other factors.	High:	Worthy of retention and incorporation into any development proposal. Medium or High Amenity Value, 15>40 years or greater Useful Life Expectancy (ULE), rare or endangered/ ecologically valuable.	Medium:	Should be considered for retention, if practicable. Low or Medium Amenity Value, 15-40 years or less ULE. May be minimal canopy cover in the local area (loss would be detrimental to the landscape).	Low:	Low Amenity Value, 5-15 years or less ULE, may be problematic to retain. Retain if desired, otherwise consider removal.
Offsite:	Located outside of the subject site. Must be retained and protected regardless of other factors.								
High:	Worthy of retention and incorporation into any development proposal. Medium or High Amenity Value, 15>40 years or greater Useful Life Expectancy (ULE), rare or endangered/ ecologically valuable.								
Medium:	Should be considered for retention, if practicable. Low or Medium Amenity Value, 15-40 years or less ULE. May be minimal canopy cover in the local area (loss would be detrimental to the landscape).								
Low:	Low Amenity Value, 5-15 years or less ULE, may be problematic to retain. Retain if desired, otherwise consider removal.								
CANOPY SPREAD	Overall size of the canopy as looking from a plan view. Recorded at the widest point.								
COMMON NAME	A non-scientific name commonly used for that tree.								
CROWN WIDTH	See 'Canopy spread'								
DEAD (AS DEAD)	Cessation of all metabolic processes (or very soon to be)								
DEADWOOD	<p>Deceased above ground tree parts such as stems or branches (varying in size).</p> <ul style="list-style-type: none"> <li>Minor deadwood – less than 40mm diameter</li> <li>Major deadwood – greater than 40mm diameter</li> </ul>								
DEVELOPMENT	The use of land including; the subdivision of land, erection or demolition of a building or works, the carrying out of a work, road works, the installation of utilities and services, and any other act, matter or thing as defined by the relevant legislation.								
DIAMETER AT BREAST HEIGHT (DBH)	<p>The diameter of the trunk measured at or near 1.4m above ground level.</p> <p>Where there is more than 1 stem originating below 1.4m the measurement recorded is calculated as described in AS 4970-2009.</p>								

DIAMETER ABOVE ROOT BUTTRESS (DARB)	<p>The diameter of the trunk measured above the root buttress.</p> <p>This measurement is used to calculate the structural root zone (see SRZ).</p>								
HEALTH	<p>A tree's vigour as exhibited by the crown density, leaf colour, seasonal extension growth, presence of stress indicators, ability to withstand diseases and pests, and the degree of dieback. Where a deciduous tree is inspected without foliage and health is undetermined a '?' will be noted.</p> <table> <tr> <td>Dead:</td><td>Cessation or near cessation of all metabolic processes.</td></tr> <tr> <td>Poor:</td><td>Indicating symptoms of extreme stress such as minimal foliage, or extensively damaged leaves from pests and diseases. Death probable if condition of tree deteriorates.</td></tr> <tr> <td>Fair:</td><td>Some minor deadwood or terminal dieback indicating a stressed condition. Minor leaf damage from pests.</td></tr> <tr> <td>Good:</td><td>Usual for that species given normal environmental conditions – full canopy with only minor deadwood, normal leaf size and extension growth, minimal pest or disease damage</td></tr> </table>	Dead:	Cessation or near cessation of all metabolic processes.	Poor:	Indicating symptoms of extreme stress such as minimal foliage, or extensively damaged leaves from pests and diseases. Death probable if condition of tree deteriorates.	Fair:	Some minor deadwood or terminal dieback indicating a stressed condition. Minor leaf damage from pests.	Good:	Usual for that species given normal environmental conditions – full canopy with only minor deadwood, normal leaf size and extension growth, minimal pest or disease damage
Dead:	Cessation or near cessation of all metabolic processes.								
Poor:	Indicating symptoms of extreme stress such as minimal foliage, or extensively damaged leaves from pests and diseases. Death probable if condition of tree deteriorates.								
Fair:	Some minor deadwood or terminal dieback indicating a stressed condition. Minor leaf damage from pests.								
Good:	Usual for that species given normal environmental conditions – full canopy with only minor deadwood, normal leaf size and extension growth, minimal pest or disease damage								
HEIGHT	<p>The distance in metres from the ground to the highest point in the crown, calculated in the vertical plane. This measurement unless otherwise specified is an estimation only.</p>								
IMPACT ASSESSMENT	<p>An assessment of adverse impact the proposed works are likely to have on a tree or tree group. May be short or long term; usually judged on the likely reduction in ULE directly attributable to the works. Impact usually relates to the level of TPZ encroachment, but also factors the type of impact. One or more factors may apply.</p> <table> <tr> <td>Low:</td><td>Proposed works are outside of the TPZ and impacts are likely to be nil. Or, minor damage may occur such as; smaller roots may be damaged or a small area of canopy pruned. Unlikely to significantly impact tree health, form, or ULE.</td></tr> <tr> <td>Moderate:</td><td>Direct (physical wounding), or indirect (environmental impacts) are possible, root damage may occur, canopy pruning likely, and an occurrence will reduce the ULE.</td></tr> <tr> <td>High:</td><td>Tree/s likely to be lost in the medium or short term, or adversely impacted so that tree health, and therefore, ULE are significantly reduced, or the tree will become unstable and/or present an unacceptable level of risk.</td></tr> <tr> <td>Proposed to be removed:</td><td>Trees that are within the footprint of works and proposed to be removed by the client, or are not viable to retain due to the factors listed in the conclusions of this report. Trees proposed for removal are not always required to be removed.</td></tr> </table>	Low:	Proposed works are outside of the TPZ and impacts are likely to be nil. Or, minor damage may occur such as; smaller roots may be damaged or a small area of canopy pruned. Unlikely to significantly impact tree health, form, or ULE.	Moderate:	Direct (physical wounding), or indirect (environmental impacts) are possible, root damage may occur, canopy pruning likely, and an occurrence will reduce the ULE.	High:	Tree/s likely to be lost in the medium or short term, or adversely impacted so that tree health, and therefore, ULE are significantly reduced, or the tree will become unstable and/or present an unacceptable level of risk.	Proposed to be removed:	Trees that are within the footprint of works and proposed to be removed by the client, or are not viable to retain due to the factors listed in the conclusions of this report. Trees proposed for removal are not always required to be removed.
Low:	Proposed works are outside of the TPZ and impacts are likely to be nil. Or, minor damage may occur such as; smaller roots may be damaged or a small area of canopy pruned. Unlikely to significantly impact tree health, form, or ULE.								
Moderate:	Direct (physical wounding), or indirect (environmental impacts) are possible, root damage may occur, canopy pruning likely, and an occurrence will reduce the ULE.								
High:	Tree/s likely to be lost in the medium or short term, or adversely impacted so that tree health, and therefore, ULE are significantly reduced, or the tree will become unstable and/or present an unacceptable level of risk.								
Proposed to be removed:	Trees that are within the footprint of works and proposed to be removed by the client, or are not viable to retain due to the factors listed in the conclusions of this report. Trees proposed for removal are not always required to be removed.								
PRUNING	<p>Systematic removal of branches of a plant whilst giving consideration to the tree's natural defence systems.</p>								
RESPONSIBLE AUTHORITY	<p>Those bodies, such as councils, responsible for the area to which the report relates to</p>								
STRUCTURAL ROOT ZONE (SRZ)	<p>The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright. The SRZ is nominally circular with the trunk at its centre and is expressed by its radius in metres.</p> <p>This zone considers a tree's structural stability only, this is different from the root zone required for a tree's vigour and long-term viability, which will usually be a much larger area.</p>								

STRUCTURE	Reference to the structural integrity of the tree with consideration of the crown, trunk and roots. Determined using the Visual Tree Assessment (VTA) method (Mattheck and Breloer 1994). The failure of small (<60mm calliper) live or dead limbs is normal and not considered here.
	Very poor: Clear indications that a significant failure is likely in the near future
	Poor: Obvious signs of structural weakness and a failure is likely, one might expect a significant failure event within the next 5 years, possibly tomorrow
	Fair: Signs of weakness present though not obviously significant, likely to become worse over time
	Good: No obvious signs of structural weakness
TREE	Long-lived, woody perennial plant with one or relatively few main, self-supporting, stems or trunks. Greater than (or usually greater than) 3m in height (or as defined by the responsible authority).
TREE NUMBER	Identifying number allocated to individual trees or groups of trees, may be used to locate trees using site plans or tags on trees.
TREE PROTECTION ZONE (TPZ)	An exclusion area radius measured from the centre of the trunk at ground level that allows for protection of canopy and roots; both the structural roots that give the tree stability and the smaller absorption roots. The radius of the TPZ is normally calculated for each tree by multiplying the DBH × 12. The minimum distance will be 2m and maximum 15 as stipulated in AS 4970-2009 – Protection of Trees on Development Sites.
TREETEC REFERENCE	Unique identifier assigned to an individual report by Treetec
TYPE	Status of the species as it relates to the location.
	Indigenous: Naturally occurring to the local area
	Victorian Native: Naturally occurring within Victoria
	Australian Native: Naturally occurring within Australia
	Exotic: Introduced species to Australia
UNION	The point where a branch or stem is attached to another branch or stem.
USEFUL LIFE EXPECTANCY (ULE)	Useful Life Expectancy is an estimation of how many years a tree can reasonably be retained in the landscape provided growing conditions do not significantly worsen and any recommended works are completed. It takes into consideration factors such as risk, species, age, health and site conditions. Usually represented as either 0, <5, 5 - 15, 15 - 40, or >40.
WORKS	Any physical activity in relation to development. See 'development'.

### **7.3 General comments**

#### **Pruning standards/Lopping**

An Australian Standard exists to give guidance on pruning of trees (*AS 4373 2007 - Pruning of Amenity Trees*).

It is important that all remedial works are carried out by a competent contractor in accordance with the Australian Standard.

Lopping, as defined within the standard, is detrimental to trees and often results in decay and poorly attached epicormic shoots. Natural Target Pruning methods should be used wherever possible when removing sections from trees.

### **7.4 Impact on trees**

#### **Physical/Mechanical damage to trees**

Physical damage to tree parts, particularly the trunk, provides entry points for pests and diseases such as fungal infections. This may cause long-term decay and can lead to partial or complete tree failure and death.

#### **Alteration of soil levels**

Alteration of soil levels around trees will affect the root zone and stability of a tree as well as tree metabolism. This may result in reduced tree health, excessive deadwood, thinning foliage and poor vigour. It can take years for impacts to become evident, at which time it is usually irreversible.

#### **Works within a TPZ**

Works such as site cut and fill, re-grading, installation of underground services, building footings or landscaping have the potential to damage tree roots.

It may be possible to work within a TPZ without significantly impacting a tree, however the size and number of roots in the area, and the specifics of the tree and its resilience to impacts, would all need to be reviewed prior to commencement. Design and construction methods may need alteration to minimise adverse impacts.

Site cut and fill has the potential to physically impact roots and thus should be located to ensure minimal disturbance within the TPZ of retained trees. If a shallow cut is proposed within a TPZ, consider increasing fill to eliminate the cut. If the grade is to be raised, the material should be coarser or more porous than the underlying material. If site cuts must occur, avoid batter cuts and instead design a vertical retaining wall to minimise disturbance.

Installation of underground services should also be routed outside TPZs; if there is no other option, they should be installed using non-destructive methods such as air or hydro excavation, or installed by boring under the TPZ at a depth of at least 700 mm (where practicable). The project arborist should assess the likely impacts of boring (including bore pit locations) on retained trees.

Driveways and pathways should not encroach into a TPZ; if encroachment is unavoidable, any hard surfaces should:

- 1) not involve any scraping or excavation – most small absorbing roots are within the upper 100mm of soil.
- 2) be constructed of a permeable material and laid on a base and sub-base specifically designed to allow the movement of water through and into the soil below.

If buildings are permitted within a TPZ, foundations should be suspended on piers leaving the ground undisturbed other than the careful placement of pier holes. The bottom of supporting beams should be above existing ground level or, if this is not possible, beams should run radially away from the tree trunk. There should be no excavation of any description, including piers, within a Structural Root Zone (SRZ).

All works within TPZs must be approved by the responsible authority prior to commencement.

### Description of TPZ encroachment

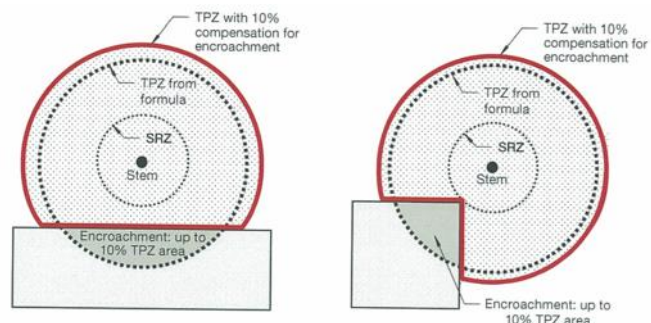
In accordance with *Australian Standard 4970-2009 (Protection of trees on development sites)* encroachment and TPZ variations is determined as per below.

#### General

*It may be possible to encroach into or make variations to the standard TPZ. Encroachment includes excavation, compacted fill and machine trenching.*

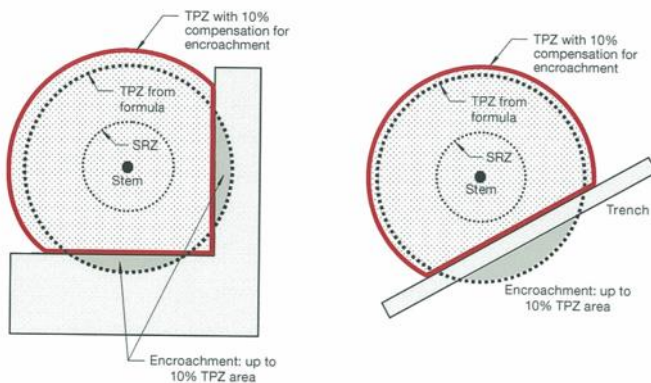
#### Minor encroachment

*If the proposed encroachment is less than 10% of the area of the TPZ and is outside the SRZ detailed root investigations should not be required. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ. Variations must be made by the project arborist considering relevant factors listed in (see standard)...*



#### Major encroachment

*If the proposed encroachment is greater than 10% of the TPZ or inside the SRZ, the project arborist must demonstrate that the tree(s) would remain viable. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ. This may require root investigation by non-destructive methods and consideration of relevant factors listed in (see standard)...*



NOTE: Less than 10% TPZ area and outside SRZ. Any loss of TPZ compensated for elsewhere.

Any additional encroachment that becomes necessary as the site works progress should be reviewed by the project arborist and be approved by the Responsible Authority before being carried out.

Where the project arborist identifies roots to be pruned within or at the outer edge of the TPZ, they should be pruned with a final cut to undamaged wood. Pruning cuts should be made with sharp tools such as secateurs, pruners, handsaws or chainsaws. Pruning wounds should not be treated with dressings or paints.

It is not acceptable for roots within the TPZ to be severed with machinery such as backhoes or excavators.



## 7.5 Protection of retained trees

### Establishment of Tree Protection Zones

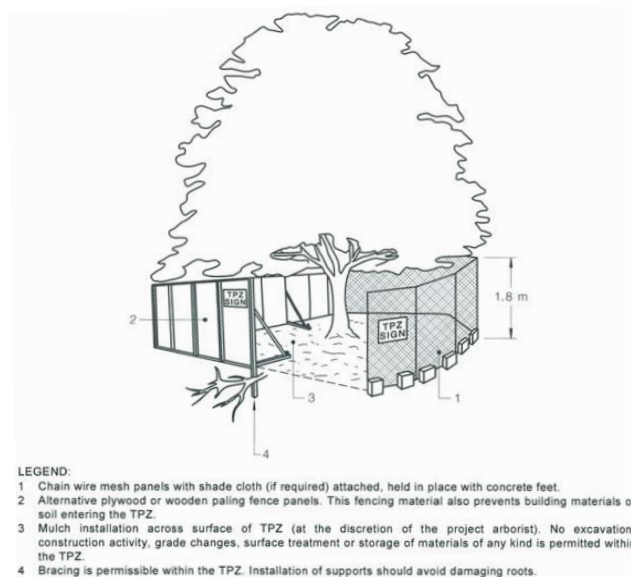
The tree protection zone (TPZ) is the principal means of protecting trees on development sites. Usually fencing will delineate the Tree Protection Zones (TPZ) as defined by AS 4970-2009 *Protection of trees on development sites*.

Fencing is installed following permitted vegetation removal and pruning, but prior to site establishment. Unless stated otherwise and approved by the responsible authority, fencing should be retained until completion of all construction related activity.

### Tree protection zone fencing

The fence must provide high visibility and act as a physical barrier to construction activity. The fence should be adequately signed "Tree Protection Zone – No Access", be sturdy and prevent the entry of heavy equipment, vehicles, workers and the public.

Where feasible, tree protection fencing will consist of chain wire mesh panels held in place with concrete feet. Where chain mesh fencing is impractical to implement, alternate protection measures must be arranged.



### Restricted activities within TPZ

A TPZ area may surround a single tree or group, or a patch of vegetation. Activities that must NOT be carried out within a TPZ unless permitted by the Responsible Authority include, but are not limited to, the following:

- (a) machine excavation including trenching;
- (b) excavation for silt fencing;
- (c) cultivation;
- (d) storage;
- (e) preparation of chemicals, including preparation of cement products;
- (f) parking of vehicles and plant;
- (g) refuelling;
- (h) dumping of waste;
- (i) wash down and cleaning of equipment;
- (j) placement of fill;
- (k) lighting of fires;
- (l) soil level changes;
- (m) vehicle movement – access ways;
- (n) changes of grade;
- (o) temporary or permanent installation of utilities and signs, and
- (p) damage to the tree.

Source – AS 4970-2009 *Protection of trees on development sites*  
(Tree Protection)

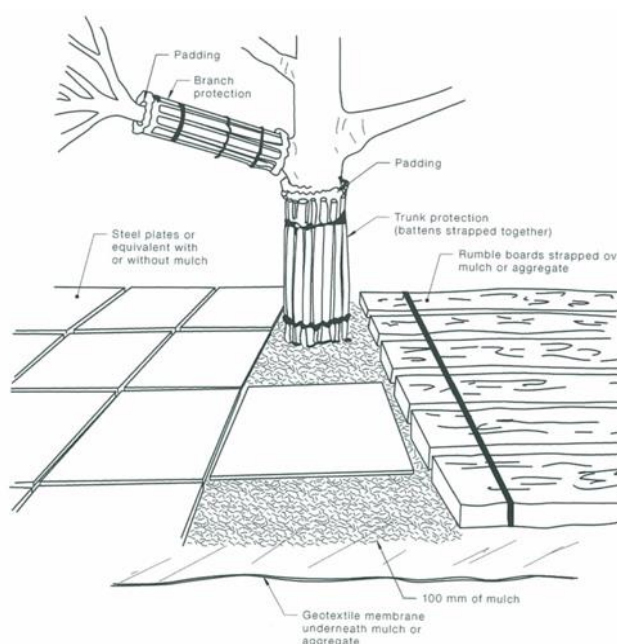
## Alternative protection measures

If temporary access to the TPZ is required, protection for the trunk, branches or ground may be required. The materials and positioning of protection will be specified by the project arborist.

For temporary foot traffic through the TPZ, this may be facilitated using sheets of heavy plywood or similar material; this should not be considered a long term solution.

For machinery access within the TPZ, ground protection should be utilised to prevent root damage and soil compaction. Measures may include a permeable membrane such as geotextile fabric beneath a layer of mulch, or crushed rock below rumble boards or HPDE track mats. These measures may also be applied to root zones beyond the TPZ.

Where roots within the TPZ are exposed during approved works, temporary root protection should be installed to prevent them drying out. This may include jute mesh or hessian sheeting as multiple layers over any exposed roots and the excavated soil profile, extending to the full depth of the root zone. Root protection sheeting should be pegged in place and kept moist at all times.



### NOTES:

- 1 For trunk and branch protection use boards and padding that will prevent damage to bark. Boards are to be strapped to trees, not nailed or screwed.
- 2 Rumble boards should be of a suitable thickness to prevent soil compaction and root damage.

**Source – AS 4970-2009 Protection of trees on development sites**  
(Ground Protection)



## 7.6 Road segment photos



Segment A



Segment B



Segment C



Segment D



Segment E



Segment F





Segment G



Segment H



Segment I



Segment J



Segment K



Segment L





Segment M



Segment N



Segment O



Segment P

## **Appendix F – Aquatica Environmental Report**





**AQUATICA**  
ENVIRONMENTAL



# Goschen Mineral Sands and Rare Earth Project Phase 1 Desktop Aquatic Ecology Assessment of Kangaroo Lake

Report Prepared for VHM Limited  
July 2023



### **Aquatica Environmental**

The trading name for Aquatica Australia Pty Ltd as trustee for Aquatica Trust

ACN 601 326 416

ABN 83 572 211 867

220 Old Eltham Road

Lower Plenty VIC 3093

M: 0413 935 497 E: aaron@aquaticaenvironmental.com.au

www.aquaticaenvironmental.com.au

### **© Aquatica Environmental 2023**

This document is and shall remain the property of Aquatica Environmental and VHM Limited. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

### **Disclaimer**

The concepts, data and information contained in this document are the property of Aquatica Environmental. No part of this document may be reproduced, used, copied, published or adapted for use except in accordance with the provisions of the *Copyright Act 1968* or with the consent of Aquatica Environmental.

This document has been prepared for VHM Limited to satisfy the Minister for Planning's Scoping Requirements for the Goschen Mineral Sands Project (the Project) dated May 2019 under the *Environment Effects Act 1978*. Aquatica Environmental accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party. Any third party using and/or relying upon this document accepts sole responsibility and all risk for using and/or relying on this document for any purpose.

This document is based on the information available, and the assumptions made, as at the date of the document. This document is to be read in full. No excerpts are to be taken as representative of the findings without appropriate context.

**Cover Photograph:** Location of the proposed pump station and the No. 47 channel, 14 June 2022 (A Jenkin)

**Citation:** *Aquatica Environmental (2023). Goschen Mineral Sands and Rare Earth Project, Phase 1 Desktop Aquatic Ecology Assessment of Kangaroo Lake. Report prepared for VHM Limited . 6 July.*

Version	Author	Reviewer	Issued To	Date Issued
Draft V1	A Jenkin	Internal	V. Buljubasic (AECOM)	2 August 2022
Draft V2	A Jenkin	TRG	J. Scicluna (AECOM)	14 November 2022
Draft V3	A Jenkin	VHM	V. Buljubasic (AECOM)	17 May 2023
Final	A Jenkin	Internal	V. Buljubasic (AECOM)	6 July 2023

# CONTENTS

1.	EXECUTIVE SUMMARY.....	5
1.1	Recommendations .....	7
2.	INTRODUCTION .....	8
2.1	Background .....	8
2.2	The Project Area.....	9
2.3	Purpose .....	10
2.4	Scope.....	10
2.5	Acknowledgments.....	11
2.6	Assumptions and Limitations .....	11
3.	METHODOLOGY.....	12
3.1	Desktop Review.....	12
3.2	Agency Consultation .....	12
3.3	Site Inspection.....	12
3.4	Likelihood of Occurrence Assessment .....	13
4.	KANGAROO LAKE DESCRIPTION.....	14
5.	SOUTHERN PURPLE SPOTTED GUDGEON DECIPTION .....	17
5.1	General Description .....	17
5.2	Habitat Requirements .....	17
5.3	Distribution .....	17
5.4	Conservation Status .....	19
5.5	Threats .....	19
6.	RESULTS.....	20
6.1	Desktop Review.....	20
6.2	Agency Consultation .....	20
6.3	Site Inspection.....	22
6.4	Likelihood of Occurrence Assessment .....	24
7.	POTENTIAL IMPACTS AND MITIGATION MEASURES .....	26
7.1	Potential Impacts .....	26
7.2	Mitigation Measures to Avoid and Reduce Impacts .....	26
8.	POLICY AND LEGISLATION IMPLICATIONS .....	29
9.	CONCULSION AND RECOMMENDATIONS .....	33
9.1	Conclusion.....	33

9.2	Recommendations .....	34
10.	REFERENCES .....	35

## Tables

Table 1	Likelihood of Occurrence Assessment criteria .....	13
Table 2	Water quality monitoring parameters and methods .....	27
Table 3	Policy and legislation implications.....	29

## Figures

Figure 1	Goschen Project Location (Source: VHM) .....	9
Figure 2	Kangaroo Lake project area and pump station location .....	10
Figure 3	Schematic Representation of the Kangaroo lake portion of the Torrumbarry Irrigation System (Source: NCCMA) .....	15
Figure 4	Kangaroo Lake water storage for years 2015 to 2022 (Source: GM Water) .....	15
Figure 5	Schematic representation Kangaroo Lake within the (Source: GM Water) .....	16
Figure 6	SPSG Overall distribution based on existing records (Source: ALA 2022) .....	18
Figure 7	SPSG Victorian and Murray River boarder records, red point being the 2020 Kangaroo Lake records (Sources: ALA 2022; VBA 2022; Iervasi, D. 2022, pers. comm. 9 June).....	18

## Photos

Photo 1	Kangaroo Lake with the proposed pump station location and inlet to No. 47 channel in the left foreground (Photo: A Jenkin) .....	14
Photo 2	Adult male SPSG from Reedy Lake (Photo: John Lenagan courtesy Tim Curmi/NFA) .....	17
Photo 3	Location of proposed pump station (centre of image), Kangaroo Lake (top) and inlet to No. 47 channel.....	22
Photo 4	Fringing vegetation and open water at the pump station location.....	23
Photo 5	Location of complex habitat structure in Kangaroo Lake where SPSG were recorded in 2020, looking roughly south towards Racecourse Lake and the connecting channel.....	23
Photo 6	Location of complex habitat structure in Racecourse Lake where SPSG were recorded in 2020, looking roughly south at Racecourse Lake .....	24



# Appendices

Appendix A Proposed Pumphouse and Offtake Structure Design

Appendix B Species records within 10km of the project area (the study area)

Appendix C Likelihood of Occurrence Assessment of Protected Species

# 1. EXECUTIVE SUMMARY

Aquatica Environmental was engaged by Nature Advisory and AECOM, on behalf of VHM Limited (VHM) to undertake a Phase 1 desktop aquatic ecology assessment of Kangaroo Lake, near Kerang, Victoria.

VHM are proposing to develop a rare earth and mineral sands mine near Beauchamp, Victoria. Operation of the mine will require water for construction earthworks, processing, dust suppression and rehabilitation. Up to 4.5 gigalitres a year will be needed for the start-up of the Project. Of the 4.5 gigalitres, 3.1 gigalitres of water will be required during operation under a steady state water supply draw from Kangaroo Lake. Water sourced from Kangaroo Lake will be via a new pumpstation located at the north-eastern tip of the lake and delivered to site via a 38 kilometre underground pipeline to be constructed beneath existing local road easements.

During preparation of the project's Environmental Effects Statement, the Victorian Department of Environment, Land, Water and Planning (DELWP) requested an assessment of impacts to the *Flora and Fauna Guarantee Act 1988* listed Southern Purple-Spotted Gudgeon (*Mogurnda adspersa*), which rediscovered in Kangaroo Lake in 2020 and from which water will be drawn for the operation of the Goschen mine.

This Phase 1 desktop aquatic ecology assessment, involved a desktop review, consultation with relevant agencies and site inspection, and is anticipated will be incorporated into the Project's Fauna Ecology technical report being prepared by Nature Advisory and Eco Aerial.

The desktop review returned 41 aquatic fauna species as either occurring, potentially occurring or potentially having habitat within 10 km of Kangaroo Lake. This included 26 fish, eight amphibians, two aquatic reptiles, one aquatic mammal and one common aquatic invertebrate. The 22 species of fish included six introduced species, of which three were listed as a 'noxious aquatic species' under the Fisheries Act. Within the results were nine state and/or commonwealth protected species, including SPSG.

The site inspection found habitat in Kangaroo Lake was best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (*Phragmites australis*) and Bullrush (*Typha* sp.). In the vicinity of the pump station fringing vegetation consisted of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 47 Channel. Aerial photographs (taken on the day by drone) of the habitat in the southwest corner of Kangaroo Lake and northern end of Racecourse Lake, where SPSG were recently recorded, clearly showed the extent and complexity of the habitat type and structure the species is understood to prefer for residential habitat.

A high-level likelihood of occurrence assessment was undertaken to establish the likelihood of the identified protected species occurring in the lake. The assessment found the following:

- SPSG – Known to occur in Kangaroo Lake
- Murray Cod – Known to occur in Kangaroo Lake with VFA stocking 50,00 in 2020/21
- Silver Perch – Likely present due to historical records in Kangaroo Lake, more recently in Racecourse Lake and noted by VFA (2022) as stated "a few" are present in the lake.
- Murray River Turtle – Likely present due to historical records in Kangaroo Lake and recorded in Third Reedy Lake as recent as 2022 (species is highly mobile).
- Murray Hardyhead – Possibly present due to 2019 records in Third Reedy Lake.
- Growling Grass Frog – Possibly present as, although there are few records in the region, one is recent, there is suitable habitat in Kangaroo Lake and it appears few surveys have been undertaken.

All the remaining state or commonwealth protected species were assessed as unlikely or very unlikely to occur due to lack of habitat, or recent, or nearby records.

Consultation with key agencies (e.g. NCCMA, M-G Water, DELWP/ARI, other ecologists, etc) was able to provide first-hand and reliable information on the current status of SPSG, other aquatic values in the lake, and potential impacts the project could impart. Key points were:

- SPSG are considered extremely difficult to detect due to their propensity for limited movement, other than during the key spawning and breeding season in spring-summer.
- Three SPSG were recorded in higher quality habitat in the southwest corner of Kangaroo lake and northern extent of Racecourse Lake in 2020.
- SPSG appear to preferentially occur in areas that have a denser and complex aquatic flora community. However, it is likely that SPSG utilise a range of habitats in the lake, including that near the pump station and connecting channels, during spawning breeding and dispersal.
- Other protected/higher value species considered possibly present but requiring further research include Flathead Galaxias, Murray Hardyhead, Murray-Darling Rainbowfish, Freshwater Catfish and Murray River Turtle.
- With regards to VHM's proposal key concerns raised were:
  - If the proposed water off take results in changes to water levels within the lake and therefore impacts the lakes aquatic vegetation and habitat.
  - Inappropriate design of the pump intake/inlet could result in fish entrainment and impingement.
  - A small area of aquatic habitat that will be lost for construction of the pump station.
- Although a small number of possible impacts were raised, overall the agencies felt there were no major concerns with VHM's proposal, so long as suitable fish screens were utilised on the pump station inlet.

The assessment considered a range of potential impacts to SPSG and the other both protected and common species, their habitat, and the wider lake values (i.e. passage and water quality). The primary potential impact of concern was the possible entrainment and impingement of fish and other fauna in the pump. This is not only possible with larger fish such as adult Murray Cod, but also smaller fish, such as the approximately 4 mm long larvae of the SPSG. The other key impacts included those to aquatic habitat and vegetation if the water drawdown resulted in an impact to the lake's water levels/height and the loss of habitat for the construction of the pump station. However, both of these were assessed as low risk impacts as (1) it is anticipated the water drawdown will be proportionally negligible to that drawn down for irrigation and (2) the areas of aquatic habitat likely to be lost will be small, of lower quality habitat and negligible in terms of the overall area of habitat available in the lake.

- Direct injury/death of fish and aquatic fauna due to pump entrainment or impingement
- Impact to lake hydrology/water levels
- Loss of habitat
- Unmanaged disturbance to lake bed and banks during construction
- Reduced water quality during construction
- Contamination of waterway: during construction
- Incursion by weeds.

Mitigation measures will need to include those for preventing the entrainment and impingement of fish into the pump as well as more typical work on waterway mitigation measures to prevent sediments and contaminants entering the waterway, trapping of fauna in works structure and delineation and protection of in-water and riparian areas. In our experience these potential impacts can all be adequately managed by the implementation of the recommended measures.

An initial high-level assessment of the potential significance of impact to the EPBC Act protected species potentially present and the Kerang Lakes Ramsar site found the action (or works) are unlikely to result in a significant impact under the guidelines. Accordingly, at this stage, there is no likely need for a referral under the EPBC Act.

## 1.1 Recommendations

Based on the findings of this Phase 1 assessment and including the implementation of the suggested impact management and mitigation measures the following next steps may need consideration:

- VHM will need to obtain a Works on Waterway from CCMA.
- Undertaken a pre-works aquatic fauna/targeted SPSG survey of the area in the vicinity of the pump station to ascertain the actual SPSG and other aquatic fauna usage at that time. Survey to occur in summer to align with SPSG breeding/larvae and would be an opportune time to co-survey for Growling Grass Frog.
- Ensure that the pump station design includes a fish screen on the inlet that is sufficient to protect fish as small as SPSG larva (i.e. 4 mm long) from entrainment and impingement.
- Ensure that a suitably qualified and experienced ecologist is present during initial vegetation clearing and/or earthworks in the water in case aquatic fauna is encountered, injured or trapped in instream structures and requiring salvage.
- Ensure that a suitably qualified and experienced ecologist is available and on call during construction in case any fauna is encountered, injured or trapped in structures and requiring salvage.

## 2. INTRODUCTION

### 2.1 Background

Aquatica Environmental was engaged by Nature Advisory and AECOM, on behalf of VHM Limited (VHM) to undertake a Phase 1 desktop aquatic ecology assessment of Kangaroo Lake, near Kerang, Victoria (Figure 1).

VHM are proposing to develop a rare earth and mineral sands mine near Lalbert, Victoria (the Project). The Project is located approximately 280 kilometres northwest of Melbourne and 30 kilometres south of Swan Hill within Gannawarra Shire (Figure 1).

Operation of the mine will require water for construction earthworks, processing, dust suppression and rehabilitation. Up to 4.5 gigalitres (GL) a year will be needed for the start-up of the Project. Of the 4.5 gigalitres, 3.1 gigalitres of water will be required during operation under a steady state water supply draw from Kangaroo Lake. Water sourced from Kangaroo Lake will be via a new pumpstation located at the north-eastern tip of the lake (Appendix A) and delivered to site via a 38 kilometre underground pipeline to be constructed beneath existing local road easements.

During preparation of the project's Environmental Effects Statement (EES), the Victorian Department of Environment, Land, Water and Planning (DELWP) requested an assessment of impacts to the *Flora and Fauna Guarantee Act 1988* (FFG Act) listed Southern Purple-Spotted Gudgeon (*Mogurnda adspersa*), which has been previously detected in Kangaroo Lake, from which water will be drawn for the operation of the Goschen mine. In order to meet the project's EES scoping requirements the assessment also needed to consider the wider aquatic environment and values of Kangaroo Lake that may be impacted by the project, as well as the potential impacts specifically related to Southern Purple-Spotted Gudgeon (SPSG).

In accordance with AECOM's request this aquatic ecology assessment took the form of a Phase 1 desktop assessment, and involved a desktop review, consultation with relevant agencies, site inspection and will be incorporated (as an appendix) into the overarching Fauna Ecology technical report being prepared by Nature Advisory and Eco Aerial.



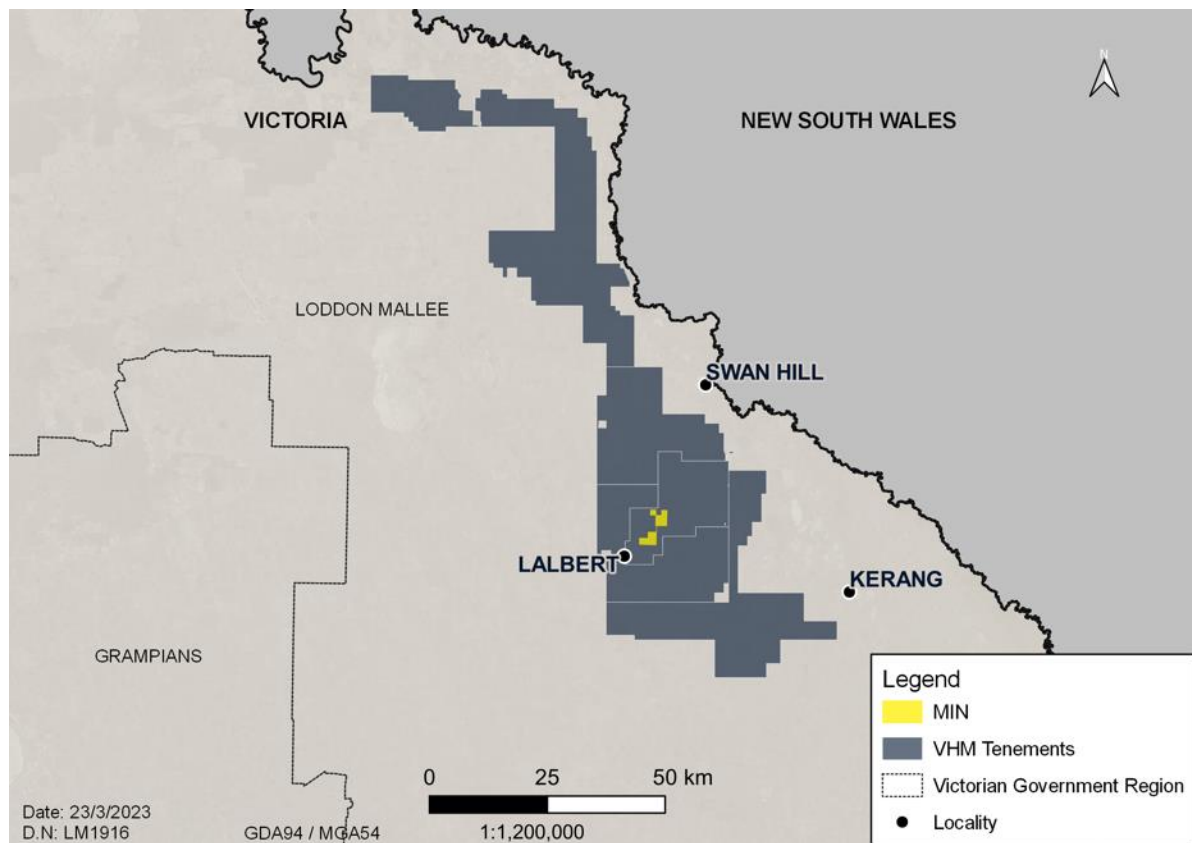


Figure 1 Goschen Project Location (Source: VHM)

## 2.2 The Project Area

The project area for the purposes of this assessment encompasses Kangaroo Lake and the area immediately near the No. 47 Channel, where the proposed pump station is to be located (Figure 2 and Appendix A).

Further details on Kangaroo Lake are provided in Section 4.

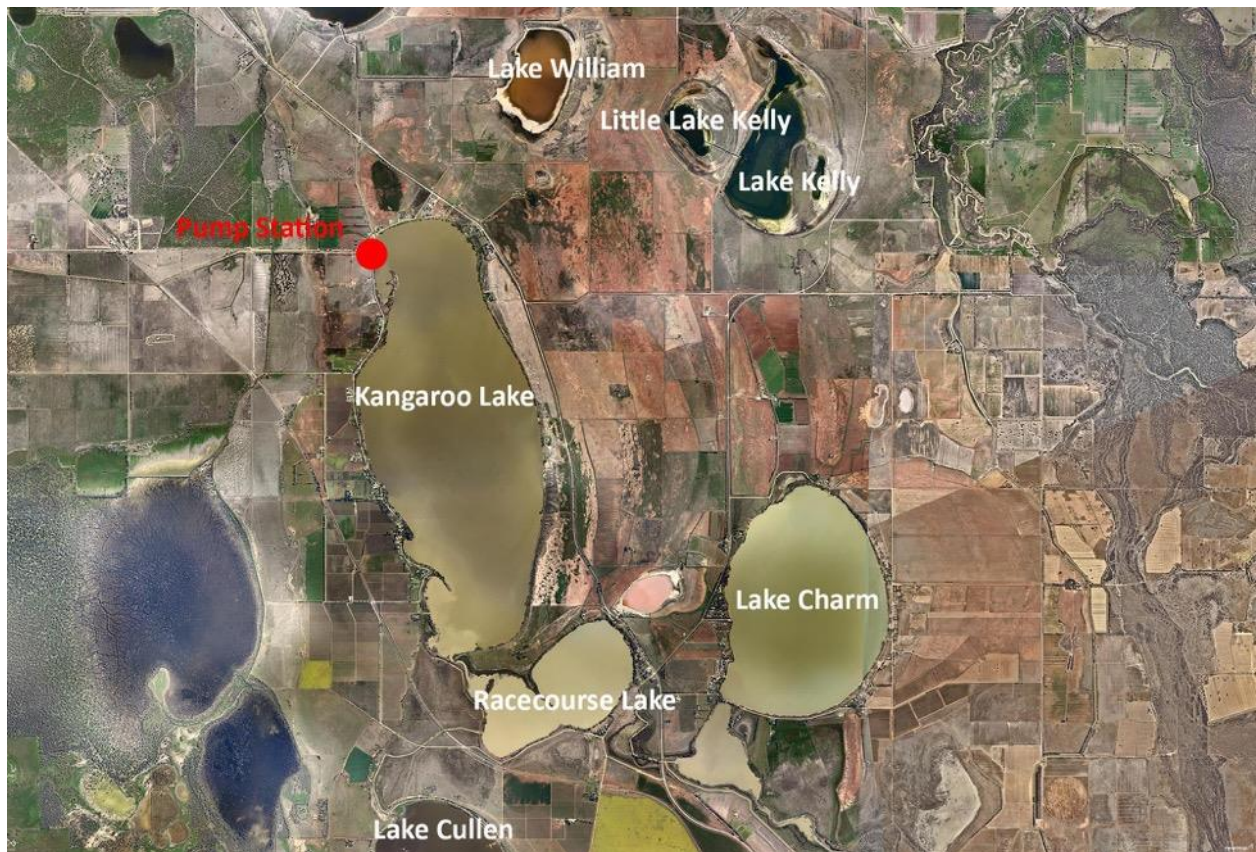


Figure 2 Kangaroo Lake project area and pump station location

### 2.3 Purpose

The purpose of this assessment was to undertake a preliminary or phase 1 investigation of the aquatic biodiversity values of Kangaroo Lake, with particular focus on SPSG, to inform the requirement for (or lack thereof) for targeted species surveys, potential impacts, mitigation measures and potential approvals.

### 2.4 Scope

This project included the following scope of work:

- **Task 1: Desktop Review**

Conduct a review of relevant databases, literature available information to determine existing recorded information relating to aquatic biodiversity and/or rare or protected aquatic species and communities of Kangaroo Lake, particularly any listed under relevant policy and legislation including, but not limited to the *Environment Protection Biodiversity and Conservation Act 1999* (EPBC Act) and *Flora and Fauna Guarantee Act 1988* (FFG Act).

As part of the data and literature review consult with relevant agencies to obtain information on the SPSG and other aquatic ecology values of Kangaroo Lake that may not be currently on the public record.

- **Task 2: Site Inspection**

Completion of a one-day site inspection confirm and validate the results of the desktop review, visually assess the quality and quantity of aquatic habitat in and near the project area against the key habitat requirements of rare or protected species identified during the data and literature review, assist in assessing the requirement to undertake targeted surveys and to collect reference photographs of the project area, aquatic, and other relevant features.

- **Task 3: Reporting**

Completion of this summary report.

## 2.5 Acknowledgments

We would like to acknowledge and thank the following people for their time, assistance and input:

- Peter Rose (North Central CMA)
- Adrian Martins (DELWP Loddon-Mallee)
- Mark Bailey (Goulburn Murray Water)
- Tarmo Raadik (ARI/DELWP)
- Dion Iervasi (Austral Research and Consulting)
- Tim Curmi (Native Fish Australia)
- Vic Buljubasic (AECOM)
- Brett Lane (Nature Advisory)
- Dr Kate Callister (Nature Advisory).

## 2.6 Assumptions and Limitations

This assessment and report are based on the following assumptions and limitations:

- This assessment and report have been developed based on publicly available desktop information, information obtained from other agencies and a single site inspection only. No surveys were completed as part of this assessment.
- The assessment considered only aquatic fauna, excluding waterbirds.
- The assessment effort, combined with information available from other sources, is considered suitable to assess the overall aquatic biodiversity values potentially present in the project area.
- Other sources of information concerning ecological and biodiversity values in the study area may exist (e.g. unpublished reports by private consultancies not available to Aquatica Environmental at the time of preparing this report). More detailed assessments of the study area (if required in the future) may require sourcing additional materials.
- The site inspection was undertaken from publicly accessible points only. No privately owned land was accessed.
- The Likelihood of Occurrence Assessment (Section 6.4) is to be used as a guide and is not to be used as indicating actual species presence or absence.
- The absence of detection of the threatened species during the assessment does not mean absence of the species in the project area. Where possible we have assessed the 'likelihood of occurrence' of potential rare and threatened species that may occur in the project area.
- The information outlined in this report relies on the accuracy of biodiversity database information, GIS layers and spatial imagery. To minimise potential errors, the most current available data was obtained from relevant sources.

## 3. METHODOLOGY

### 3.1 Desktop Review

Aquatica Environmental undertook a desktop review to gain an understanding of the current status of SPSG, aquatic biodiversity and/or rare or protected aquatic species and communities of Kangaroo Lake. In particular the assessment focussed on species listed under relevant policy and legislation including, but not limited to the EPBC Act and FFG Act. Data and information for the desktop review was sourced from the following:

- DELWP's Victorian Biodiversity Atlas (VBA) using a 10 kilometre search radius on the project area;
- Department of Agriculture, Water and the Environment's (DAWE) Protected Matters Search Tool (PMST) using a 10 kilometre search radius on the project area;
- Pest species, diseases and weeds (including Cinnamon Fungus and *Phylloxera*) listed under either the *Fisheries Act 1995* (Fisheries Act), *Catchment and Land Protection Act 1994* (CaLP Act), etc.;
- An internet resources search for reports or other sources of information relevant to the aquatic biodiversity of the project and study area, which included information from the following agencies websites (see References section for details):
  - Victorian Fisheries Authority (VFA),
  - Victorian DELWP
  - DELWP's Arthur Rylah Institute (ARI)
  - Native Fish Australia
  - NSW Department of Primary Industries (NSW DPI)
  - Queensland Department of Environment and Science
  - Goulburn Murray Water
  - Government of SA
  - Murray Darling Basin Authority (MDBA)

### 3.2 Agency Consultation

As part of the data and literature review a number of relevant agencies were contacted to obtain information on the SPSG and other aquatic ecology values of Kangaroo Lake that may not have been on the public record. Agencies that were approached for information included:

- North Central CMA: Peter Rose, Project Officer
- DELWP Loddon-Mallee: Adrian Martins, Program Manager
- ARI/DELWP: Tarmo Raadik, Program Leader, Applied Aquatic Ecology
- Austral Research and Consulting: Dion Iervasi, Aquatic Ecologist
- Goulburn Murray Water: Mark Bailey, Head of Water Resources Water Delivery
- Native Fish Australia: Tim Curmi, President.

### 3.3 Site Inspection

A one-day site inspection was undertaken with the aim being to:

- Confirm and validate the results of database searches and desktop investigations for aquatic fauna species listed under the EPBC Act and/or FFG Act;

- Visually assess the quality and quantity of aquatic habitat in the project area against the key habitat requirements of rare or protected species identified during the data and literature review;
- Assist in assessing the requirement to undertake targeted surveys, as indicated from the desktop data and literature review; and
- Collect reference photographs of the project area, aquatic and other relevant features.

### 3.4 Likelihood of Occurrence Assessment

The likelihood of occurrence for rare or threatened species was assessed using the categories and criteria listed in Table 1, which have been developed by Aquatica Environmental.

Table 1 Likelihood of Occurrence Assessment criteria

Likelihood	Criteria
<b>Known</b>	Recorded in project area during current or recent surveys within past 5 years
	Aquatic species recorded in connected waterbodies within 10 km of the project area during current or recent surveys within past 5 years
<b>Likely</b>	Suitable habitat present in project area
	Project area within species' natural distribution range
	Recorded in project area more than 5 years ago but less than 25
	Suitable good quality habitat present in connected waterbodies within 5 km of the project area
	Recorded within the local area within the past 5 years
<b>Possible</b>	Aspects of habitat present and / or habitat modified
	Aspects of aquatic habitat in connected waterbodies within 10 km of the project area
	Project area within species' natural distribution range
	Numerous records within the local area between 5 to 25 years
	Recorded in project area more than 25 years ago
<b>Unlikely</b>	Limited aspects of habitat present in project area or in connected waterbodies within 5km of project area and / or habitat highly modified
	Historical records within 10 km of project area greater than 25 years
	Project area on fringe or outside species natural distribution range
	No historical records in project area
<b>Very Unlikely</b>	Habitat not present in project area
	Habitat for aquatic species not present in connected waterbodies in proximity to project area (within 5 km)
	Project area is located outside of species natural range
	Considered locally extinct
	No records of the species within the local area in the last 25 years
<b>Unable to determine</b>	Insufficient data to make a determination



## 4. KANGAROO LAKE DESCRIPTION

Kangaroo Lake (Photo 1) lies on the western side of the Murray Valley Highway approximately 18 km north of Kerang and 28 km between Swan Hill and Kerang. It is one of 23 named lakes, marshes and swamps that form the Kerang Wetlands Ramsar site and is considered as being of International Importance under the Ramsar Convention on Wetlands (UNESCO 1994). Under the Ramsar Convention Kangaroo Lake is classified as a “*permanent freshwater lake*” and its primary contribution to the Ramsar site is its “*special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna*”(Australian Government 2011)

With a surface area of approximately 984 hectares (HA) and maximum depth of 8.4 metres (m) Kangaroo Lake is one of the largest and deepest permanent freshwater lakes in the Murray-Loddon region of the Murray-Darling Drainage Division and is located within the Torrumbarry Irrigation System (TIS) area of the Loddon-Campaspe irrigation region.

Kangaroo Lake is connected to the TIS via the No. 7 Lakes Channel system which flows from Reedy, Middle and Third Reedy Lakes, via racecourse Lake into Kangaroo Lake. The No. 6/7 Main Channel flows northwards out of Kangaroo Lake and outfalls into the Little River Murray at Fish Point (Figure 3). Irrigation water is also drawn out of Kangaroo Lake via the No. 47 Channel on the north west of the lake.

Kangaroo Lake has a capacity of 39.7 GL and is generally maintained at greater than 36 GL (Figure 4). The lake has a maximum operating level of 73.9 m Australian Height Datum (ADH) and minimum operating level of 73.12 m ADH (VFA 2013). It is a major irrigation supply storage basin and high operational water levels in the lake are required to optimise water supply for regional irrigators with downstream water user demands on the Murray River. Water levels in the lake are also managed to both reduce downstream flooding impacts on the Loddon River and prevent foreshore erosion (Australian Government 2011).

The primary outflow from Kangaroo Lake is the No 7 Channel in the north of the lake. At the time of preparing this report data and information provided by Goulburn Murray Water indicate the design maximum discharge to the No. 7 Channel is 1 GL/day, with the current average discharge approximately 0.15 GL/day and the highest since 2011 of approximately 0.9 GL/day (Bailey, M. 2022. pers comm. 2 August). The irrigation season operates from August to May each year, leaving three months with zero to low discharge.

Kangaroo Lake is a popular recreational fishing and boating destination, with the VFA regularly stocking Murry Cod (*Maccullochella peelii*) and Golden Perch (*Macquaria ambigua*). Between June 2021 and June 2022 the VFA stocked 50,000 Murray Cod and 100,000 Golden Perch into the lake (VFA 2021).



Photo 1 Kangaroo Lake with the proposed pump station location and inlet to No. 47 channel in the left foreground (Photo: A Jenkin)





Figure 3 Schematic Representation of the Kangaroo lake portion of the Torrumbarry Irrigation System (Source: NCCMA)

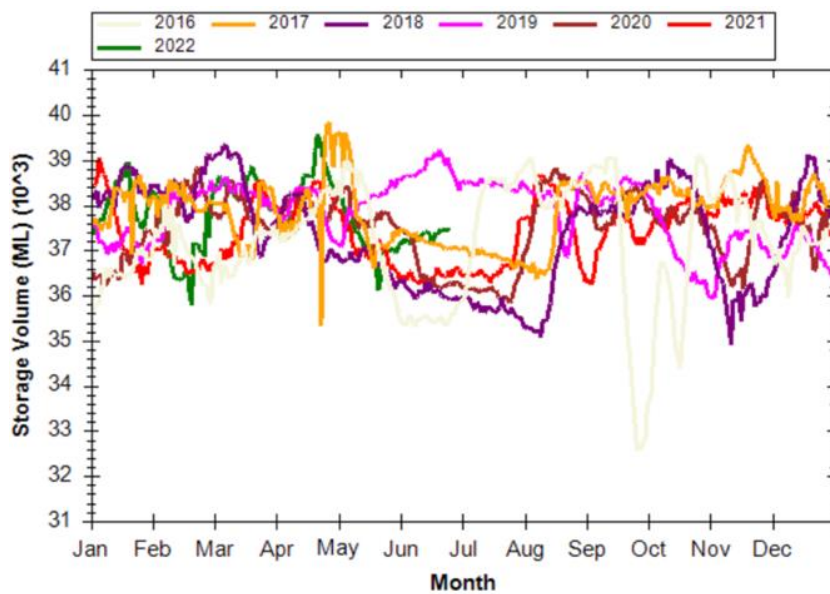


Figure 4 Kangaroo Lake water storage for years 2015 to 2022 (Source: GM Water)

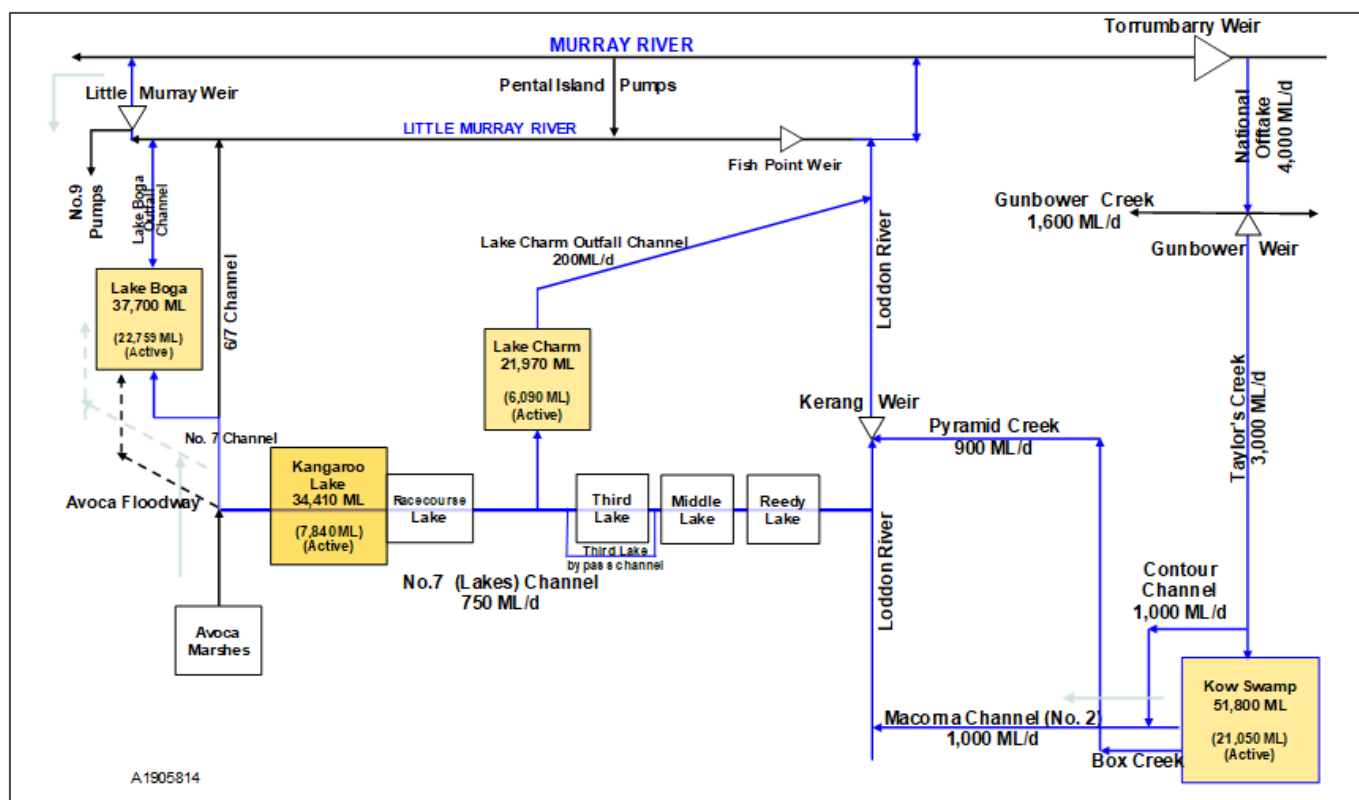


Figure 5 Schematic representation Kangaroo Lake within the (Source: GM Water)

## 5. SOUTHERN PURPLE SPOTTED GUDGEON DESCRIPTION

### 5.1 General Description

The SPSG is a small typically purplish-brown to yellowish-brown small fish with a rounded head and a small mouth (Photo 2). During the breeding season they display bright iridescent colours (usually blue/green dominated ) which the species is best known for. Adults can grow up to 150 millimetres (mm), but are more typically found ranging between 100–120 mm (DELWP 2021).

As a slow-moving ambush predator, the species tends to inhabit the littoral or benthic zone where there is dense aquatic vegetation cover. Its diet consists of small fish and aquatic macroinvertebrates, worms and tadpoles (DELWP 2021).

Breeding and spawning occurs in summer when the water temperature exceeds 20°C (NSW DPI 2022). During this time males are at their most colourful and exercise an elaborate courtship display. Females can spawn several times during a single breeding season where between 280–1,300 eggs are deposited in a single batch. The eggs are adhesive and attached to a rock, log or aquatic plants. The male stays to guard and fan the eggs, which hatch after 3–9 days depending on water temperature. Newly hatched larvae are approximately 4 mm long (DELWP 2021; NSW DPI 2022).

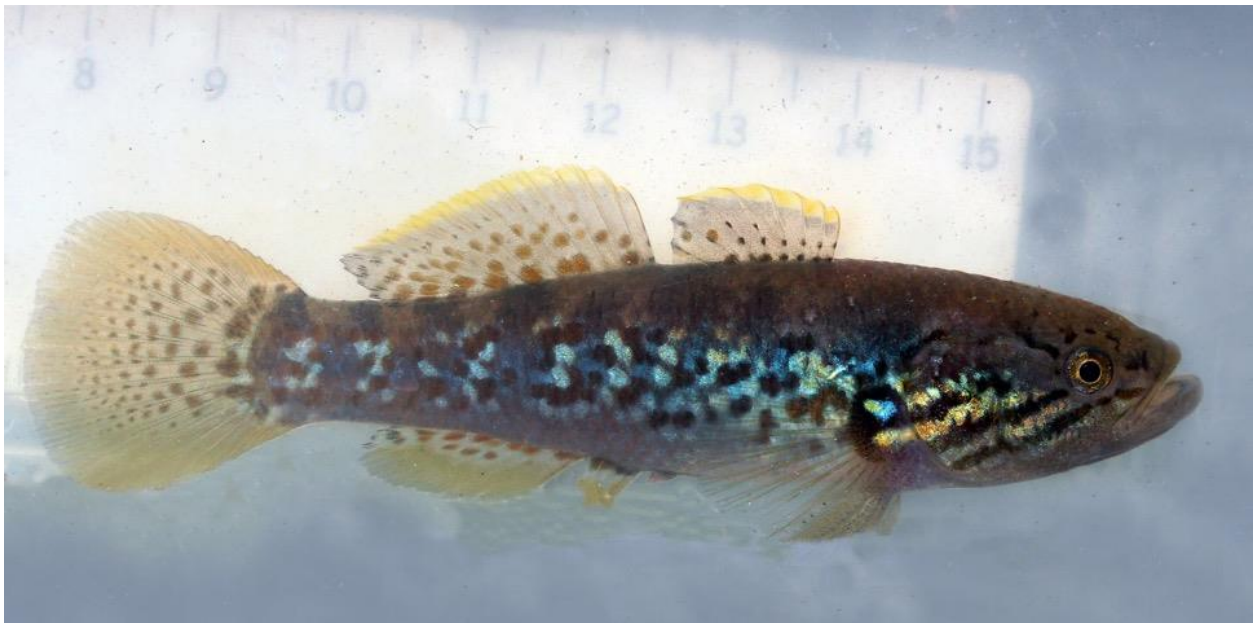


Photo 2 Adult male SPSG from Reedy Lake (Photo: John Lenagan courtesy Tim Curmi/NFA)

### 5.2 Habitat Requirements

SPSG occurs in rivers, creeks, billabongs and lakes, and is usually found in quiet or slow flowing sections over rocks or among dense aquatic vegetation (DELWP 2021).

### 5.3 Distribution

The species occurs in coastal streams of northern NSW and Queensland and the Murray-Darling Basin (DELWP 2021)(Figure 6). The Murray-Darling population is one of three known separate genetic lineages and has undergone significant decline. The species was thought to be extinct in Victoria until 2019, when it was re-discovered in the Reedy lakes system near Kerang.

Within Victoria there is a paucity of records, some historical and likely no longer present (Figure 7).

SPSG are also currently in a number of captive breeding programs across its resident states, including in Victoria where the local program now includes stocking of captive bred fish into private and public water bodies to “establishing 'back up' populations in the landscape at high quality habitat sites with a permanent water supply” (DELWP 2021).

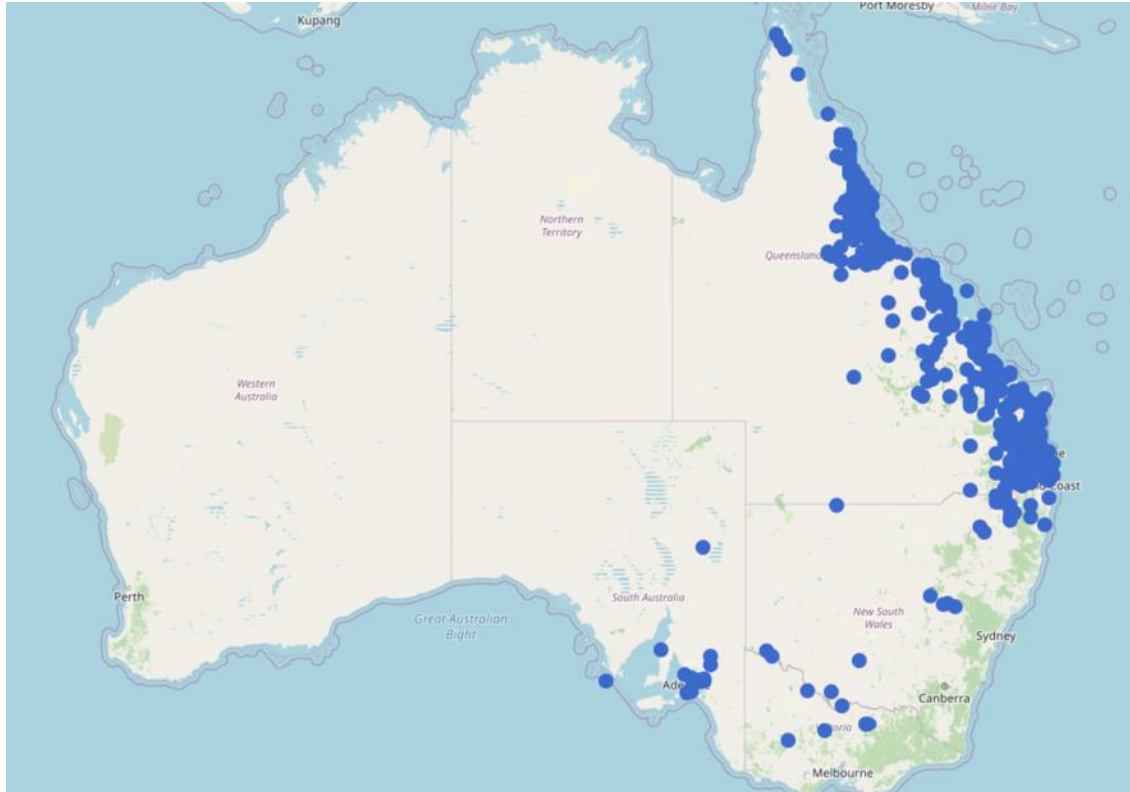


Figure 6 SPSG Overall distribution based on existing records (Source: ALA 2022)

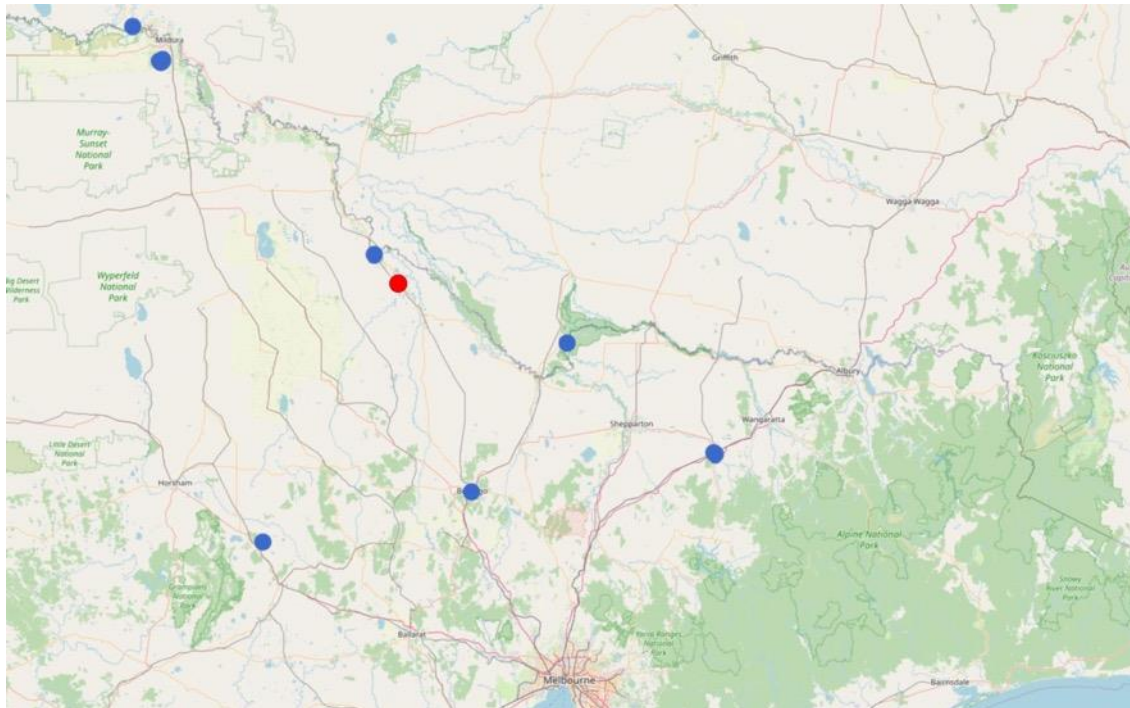


Figure 7 SPSG Victorian and Murray River border records, red point being the 2020 Kangaroo Lake records (Sources: ALA 2022; VBA 2022; Iervasi, D. 2022, pers. comm. 9 June)

## 5.4 Conservation Status

In Victoria, and with its 2019 rediscovery, SPSG is listed as Critically Endangered under the FFG Act.

The species is also listed under the following:

- Endangered in NSW;
- Critically Endangered in South Australia; and
- Listed but of Least Concern on the International Union for Conservation of Nature (IUCN) Red List (Bice et al 2019).

## 5.5 Threats

Key threats posed to the species include (DELWP 2021; NSW DPI 2022, Government of SA 2022):

- Predation and competition with introduced fish such as Eastern Gambusia (*Gambusia holbrooki*) and Redfin Perch (*Perca fluviatilis*)
- Habitat disturbance by European Carp (*Cyprinus carpio*) and damage of stream banks by livestock access
- Fluctuations in water levels and flow due to river regulation
- Increased turbidity (i.e. more fine particles suspended in the water)
- Decreased water quality due to agricultural runoff, siltation and salinisation
- Extreme weather events, such as drought and bushfires
- Loss of aquatic plants
- Local extinctions may not be naturally recolonised because of the species' inability to disperse the long distances required.



## 6. RESULTS

### 6.1 Desktop Review

The desktop review returned 41 aquatic fauna species as either occurring, potentially occurring or potentially having habitat within 10 km of Kangaroo Lake. This included 26 fish, eight amphibians, two aquatic reptiles, one aquatic mammal and one common aquatic invertebrate (Appendix B). The 22 species of fish included six introduced species, of which three were listed as a ‘*noxious aquatic species*’ under the Fisheries Act.

Within the results were nine state and/or commonwealth protected species as follows:

#### Fish

- Flatheaded Galaxias (*Galaxias rostratus*) – EPBC Act Critically Endangered and FFG Act Vulnerable, 2 VBA records as recent as 1963 and associated with Lake Cullen and Third Reedy Lake
- Freshwater Catfish (*Tandanus tandanus*) – FFG Act Endangered, 5 VBA records as recent as 1980/81 in Kangaroo Lake, Third Reedy Lake and Lake Charm
- Murray Cod – EPBC Act Vulnerable and FFG Act Endangered, 16 VBA records as recent as 1981, however VFA stock tens of thousands each year into Kangaroo Lake
- Murray Hardyhead (*Craterocephalus fluviatilis*) – EPBC Act Endangered and FFG Act Critically Endangered, 6 VBA records as recent as 1971, however there is a 2019 record from Third Reedy Lake (Iervasi, D. 2022, pers. comm. 9 June).
- Silver Perch (*Bidyanus bidyanus*) – EPBC Act Critically Endangered and FFG Act Endangered, 21 VBA records as recent as 2021 in Third Reedy Lake, 1983 record in Kangaroo Lake, Racecourse Lake and Lake Charm, also recorded in Loddon River and Lake Tuchewop. Noted as “*a few present*” by the VFA (2022).
- SPSG – FFG Act Critically Endangered, 6 VBA records as recent as 2021 all associated with Third Reedy Lake. Three individuals were recorded in Kangaroo Lake in 2020, as well as Racecourse Lake.
- Trout Cod (*Macullochella macquariensis*) – EPBC Act and FFG Act Endangered, no existing records, species returned on PMST search as “*species or species habitat may occur*”.

#### Amphibians

- Growling Grass Frog (*Litoria raniformis*) – EPBC Act and FFG Act Vulnerable, a single 2021 records of a dead individual being found near Winlaton approximately 8 kilometres north northeast of Kangaroo Lake. Nearest recent/valid records approximately 17 kilometres east at Chapels Crossing.

#### Reptiles

- Murray River Turtle (*Emydura macquarii*) – FFG Act Critically Endangered, 4 VBA records from as recent as 2020 in Third Reedy Lake and 1988 in Kangaroo Lake.

An assessment of the likelihood of these protected species and communities occurring in the project area is provided in Section 6.4.

### 6.2 Agency Consultation

Key personnel from the agencies identified in Sections 2.5 and 3.2 were contacted to obtain information on the aquatic ecology values and the resident SPSG population of kangaroo Lake in addition to that obtained through the desktop review. All agencies were asked whether there were any other matters relating to aquatic ecology, that they felt were a concern regarding the proposal. The following provides a point-form summary of the additional information that was garnered during this process:



- SPSG are considered extremely difficult to detect due to their propensity for limited movement, other than during the key spawning and breeding season in spring-summer. Environmental deoxyribonucleic acid (eDNA) sampling and physical netting/trapping surveys to date, some that have exercised extensive sampling effort, have returned only small numbers of the fish. In particular the high turbidity and low flow of the lake system makes detection of the species challenge unless the fish are actually mobile at the time (Raadik, T. 2022. Pers comm. 24 June).
- Although not yet registered on the VBA, it was confirmed that three (3) SPSG were recorded in Kangaroo Lake in 2020 (Iervasi, D. and Rose, P. 2022, pers. comm. 9 June). They were recorded in the south west corner of the lake, near the channel connecting to Racecourse Lake and where the more protected and complex aquatic habitat occurs (Iervasi, D. 2022, pers. comm. 9 June)(Photo 5).
- In Kangaroo Lake, and other nearby lakes, SPSG appear to preferentially occur in areas that have a denser and complex aquatic flora community. In Kangaroo Lake the three individuals were recorded where Cumbungi (*Typha* sp.) and Common reed (*Phragmites* sp.) form a sheltering barrier, and more a complex floristic community occurred within (Photo 5). Similarly, at Reedy Lake it appears dense stands of Lignum (*Muehlenbeckia* sp.), with its seasonal growth and dieback patterns, form atolls where the fish tend to occur in the protected interior (Photo 6). However, it is likely that SPSG utilise a range of habitats in the lakes and their connecting channels during dispersal, which is supported by the initial rediscovery records in 2019 occurring in one of the connecting channels between lakes (Rose, P. 2022, pers. comm. 9 June).
- In consideration that SPSG have only recently been rediscovered in the lakes system and the connectivity between the various lakes and waterways in the region, there are a number of other historically recorded species that may also be present in Kangaroo Lake such as Flathead Galaxias, Murray Hardyhead, Freshwater Catfish (Rose, P. 2022, pers. comm. 9 June) and Murray River Rainbowfish (Iervasi, D. 2022, pers. comm. 9 June).
- Although there are no recent or actual records in Kangaroo Lake, several agencies suggested that a number of protected species could still be present such as Flathead Galaxias (*Galaxias rostratus*), Murray Hardyhead (*Craterocephalus fluviatilis*), Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*), Freshwater Catfish (*Tandanus tandanus*) and Murray River Turtle (*Emydura macquarii*)(Iervasi, D. 2022, pers. comm. 9 June; Rose, P. 2022, pers. comm. 9 June; Curmi, T. 2022. Pers comm. 6 July).
- With regards to VHM's proposal (i.e. pump station and drawing up to 4.5 GL/year) key concerns raised were:
  - If the proposed water offtake results in changes to water levels within the lake beyond those historically observed, there could be a potential impact to aquatic vegetation of the lake and therefore the area and quality of habitat available to SPSG or other potentially present high value species (Raadik, T. 2022. Pers comm. 24 June). However, it was also considered that the proposed 4.5 GL draw from the lake was "proportionally not significant" compared to the lake's overall holding capacity and existing irrigation water draw, and the water level would be unlikely to vary beyond that already controlled in the lake (Bailey, M. 2022. pers comm. 4 June and 2 August).
  - Inappropriate design of the pump intake/inlet could result in fish entrainment (Rose, P. 2022, pers. comm. 9 June). Pump inlet screen size should also consider mitigating the potential entrainment fish larvae. If the screen is unable to adequately exclude fish larvae, consideration may need to be given to limit water offtake during periods when larvae are expected to be present (Raadik, T. 2022. Pers comm. 24 June).
  - The small area of aquatic habitat that will be lost for construction of the pump station, although negligible in terms of the overall aquatic habitat availability of the lake, should be considered (Raadik, T. 2022. Pers comm. 24 June).
- Several agencies suggested that a pre-works fish survey of the area in the vicinity of the pump station should be undertaken to ascertain the actual aquatic fauna usage at that time (noting that due to the size

of the lake a lake-wide survey was not feasible) ( Raadik, T. 2022. pers comm. 24 June; Rose, P. 2022, pers. comm. 9 June). Optimally the survey could occur during the SPSG breeding season (spring-summer) as to ascertain whether they are utilising the area at that time.

- Although a small number of possible impacts were raised, overall the agencies felt there were no major concerns with VHM’s proposal, so long as suitable fish screens were utilised on the pump station inlet.

### 6.3 Site Inspection

The site inspection of Kangaroo Lake (Photo 1) was undertaken on 14 June 2022. Weather conditions on the day of the inspection were fine, overcast, no rain and daytime temperatures in the low-teens. Kangaroo Lake was inspected on foot and aurally using DJI Phantom 4 Pro aerial drone to capture images of habitat that was not accessible and/or visible from the ground. Although the lake was inspected as a whole, particular focus was given to the aquatic habitat in the immediate vicinity of the proposed pump station (Photo 3 and Photo 4) and aquatic habitat in areas that were known to have records of SPSG (Photo 5).

Habitat in the lake was best characterised as open water mostly fringed by dense emergent vegetation consisting namely of reeds such as Common Reed or Cumbungi (*Phragmites australis*) and Bullrush (*Typha* sp.).

In the vicinity of the pump station fringing vegetation consisted of a 2-4 m wide monoculture of Common Reed, which reduced in thickness and density into the No. 47 Channel (Photo 3 and Photo 4). Aerial photographs of the habitat in the southwest corner of Kangaroo Lake (Photo 5) and northern end of Racecourse Lake (Photo 6) where SPSG were recently recorded clearly shows the extent and complexity of the habitat type and structure the species is understood to prefer for residential habitat.



Photo 3 Location of proposed pump station (centre of image), Kangaroo Lake (top) and inlet to No. 47 channel



Photo 4 Fringing vegetation and open water at the pump station location



Photo 5 Location of complex habitat structure in Kangaroo Lake where SPSG were recorded in 2020, looking roughly south towards Racecourse Lake and the connecting channel





Photo 6 Location of complex habitat structure in Racecourse Lake where SPSG were recorded in 2020, looking roughly south at Racecourse Lake

#### 6.4 Likelihood of Occurrence Assessment

The results of the Likelihood of Occurrence Assessment for the state and/or commonwealth protected species identified in Section 6.1 are detailed in Appendix C.

In summary the initial assessment found the following:

- Species **known** to be present due to recent/nearby records and suitable habitat:
  - SPSG4: Three Individuals were recorded in the southwest corner of Kangaroo Lake during surveys in 2020
  - Murray Cod: Up to 50,000 fish are stocked annually into Kangaroo Lake by VFA as part of the VFA's '10 million fish' recreational fishing stocking program.
- Species **likely** present due to historical/nearby records and aspects of suitable habitat:
  - Silver Perch: There was a 1983 record in Kangaroo lake and more recently in 2007 in Lake Tutchewop, Lake Charm, Racecourse Lake and Middle Lake. Given the direct connectedness of Racecourse Lake it is highly likely if still presents, they would also be in Kangaroo Lake. VFA 2022 also stated “a few” are present in the lake, but this was not able to be confirmed from actual recreational fishing records.
  - Murray River Turtle: Recorded in Kangaroo Lake in 1988, and Third Reedy Lake as recent as 2022. Given the species is highly mobile and there is suitable habitat in Kangaroo Lake it is reasonable to conclude they the species is likely present.
- Species **possibly** present due to historical/regional records and some aspects of suitable habitat:
  - Murray Hardyhead: 2019 records in Third Reedy Lake and historical records (early 1970) in Lakes Cullen and Tutchewop.
  - Growling Grass Frog: 2021 records of a dead individuals approximately 8 kilometres north northeast of Kangaroo Lake, but suitable habitat present and few surveys undertaken in the region.

- All the remaining state or commonwealth protected species were assessed as unlikely or very unlikely to occur due to lack of habitat, or recent, or nearby records.

It is important to note that the likelihood of occurrence assessment was based on existing records and habitat type in Kangaroo Lake assessed against the criteria detailed in Table 1. However, during the agency consultation several agencies suggested (i.e. speculated) that some species with few/no regional records could still possibly be present, but that further intensive surveys, likely involving both physical and eDNA sampling, were required for validation. The species referred by the agencies broadly included:

- Flathead Galaxias
- Murray Hardyhead
- Freshwater Catfish
- Murray River Rainbowfish.

Further, the agencies agreed that the potential impacts and mitigation measures detailed in this report to protect SPSG (see Section 7) would also be suitable for protecting the other known, likely, possible or speculated as presence species.

## 7. POTENTIAL IMPACTS AND MITIGATION MEASURES

### 7.1 Potential Impacts

The following outlines potential impacts to the identified protected (and common) species as well as some of the more common impacts that apply to any project that involves works and water extraction on/in a waterway:

- **Direct injury/death of fish and aquatic fauna due to pump entrainment or impingement:** Entrainment is the unwanted passage of fish through a water intake, which is generally caused by an absent or inadequate screen surrounding the water intake. Impingement is the physical contact of a fish with such a barrier structure (screen) due to intake velocities which are too high to allow the fish to escape. Both scenarios have the potential to cause injury or mortality of fish and other aquatic fauna if they are unable to escape the pump inlet.
- **Impact to lake hydrology/water levels:** Water extraction for the project significantly beyond that already drawn for irrigation purposes has the potential to lower lake water levels beyond historical levels and therefore reduce the area of occupancy for aquatic biota, especially around the lake fringe. The primary concern in this scenario is that lower water levels could result in detrimental changes to the type, structure and quality of aquatic habitat, especially the aquatic vegetation that SPSG and other aquatic biota rely upon.
- **Loss of habitat:** Further to the above point, construction of the pumps station will result in the loss of aquatic and emergent habitat. However, it is acknowledged that the area of loss will only be in the tens of metres, of lower quality habitat and overall negligible compared the overall area of habit in the lake.
- **Unmanaged disturbance to lake bed and banks:** Unmanaged works that impinge on the lake's bed or banks may occur beyond the actual works area. If not appropriately protected/fenced, these works have the potential to result in further disturbance to the lake and its habitat.
- **Reduced water quality:** Construction poses a risk to water quality through the disturbance to earthworks, the removal of vegetation, suspension of sediments or the release of pollutants into the waterway. This has the potential to impact both immediate and more distant aquatic habitat areas and downstream receiving waterways.
- **Contamination of waterway:** Reduced water quality is recognised as a key threat to many aquatic biota. Spills or flood inundation of fuels, oils and other construction-related contaminants are possible during works and have the potential to impact water and habitat quality in the river and its downstream receiving waterways.
- **Incursion by weeds:** Several common weed species are likely present in the project area. Works in the project area and/or insufficient/inappropriate rehabilitation of works areas have the potential to allow further inclusion of weeds if not managed appropriately.

### 7.2 Mitigation Measures to Avoid and Reduce Impacts

This section includes a number of possible avoidance and mitigation measures to address the potential impacts outlined in Section 7.1. They have been based on the range of measures suggested by the consulted agencies and previously used and approved for other similar projects across Victoria.

#### 7.2.1 Design / Pre-construction Phase

- Design the pump station and works area/s to have the smallest footprint possible.
- Design the pump station and works area/s to minimise the need for in-lake works.
- Design the pump station and works area so that stormwater runoff and/or spills from surfaces are not discharged directly into the lake or nearby No. 47 channel.
- Design the pump station to include fish screen on the inlet that are designed to Australian best practice standards and able to effectively protect even smaller fish from entrainment and impingement. Guideline examples include:



- The practical guide to modern fish-protection screening in Australia (NSW DPI 2021b)
- Design specifications for fish-protection screens in Australia (Boys 2021)
- Development of fish screening criteria for water diversions in the Murray-Darling Basin (Boys et al 2012)
- Screening Irrigation Offtakes in the Murray-Darling Basin to Reduce Loss of Native Fish (Blackley 2003)
- If the pump inlet fish screen is unable to adequately exclude fish larvae, consideration may need to be given to limit water offtake during periods when larvae are expected to be present.
- Water quality monitoring should be undertaken to collect baseline data at monitoring sites upstream and downstream of the limits of the project area and at appropriate locations in the lake and nearby No. 47 channel.
- 2-3 daily or weekly samples taken immediately prior to the commencement of construction should be sufficient (i.e. taken during site setup) and should include those parameters outlined in Table 2.

Table 2 Water quality monitoring parameters and methods

Parameter	Units	Method
Turbidity	NTU	Measure with on-site meter
Electrical Conductivity	µS/cm	Measure with on-site meter
pH	pH units	Measure with on-site meter
Dissolved oxygen	% or mg/L	Measure with on-site meter
Temperature -	°C	Measure with on-site meter
Litter (definition, including solid inert waste)	Visual (prevent litter from entering waterways and drainage systems)	
Oils and Greases	Visual (No visible free oil or greases)	
Rainfall	mm per day	Measure with on-site meter capable of logging rainfall at a minimal interval of 10 minutes

### 7.2.2 Construction Phase

- Stage construction so that works ‘ideally’ occur during the lower rainfall time of year.
- Protect retained/unimpacted aquatic and riparian habitat by minimising the construction footprint and installing No Go Zone (NGZ) exclusion and sediment fencing to prevent ingress to protect areas of the lake’s banks and bed.
- Stockpiles of earthworks and pavement materials, and all fuels/oils/chemicals and equipment should be stored away from the lake.
- Fuels, oils and chemicals should be stored in a suitably bunded and protected location.
- The project’s Environmental Management Plan (EMP) should include provision for weather and lake monitoring using data from the Bureau of Meteorology, North Central CMA and/or Goulburn Murray Water.
- Any construction works that occur in/near the lake should include emergency measures within the project’s EMP to as far as reasonably practical protect earthworks and works areas from inundation and/or protocols for site closure for predicted higher rainfall events.
- The project’s EMP include measures in the event that aquatic or other biota are encountered in the works area and require salvage and relocation. The project’s EMP should include details of a readily available

and suitably licenced/permitted person (e.g. ecologist, vet, wildlife handler) to undertake that salvage and relation.

- Implement disease/pest/hygiene controls for all plant and PPE entering site.
- Measures should be implemented to filter any onsite surface water before release to the lake. Water discharged from the works site should not detrimentally impact the quality of water in the lake and water quality monitoring should occur to confirm the relevant water quality requirements of the EPA's Environmental Reference Standard for "*Murray and Western Plains, lowlands of the Loddon basin*" (ERS; EPA 2021).
- For any temporary structure, erosion and sediment controls are to be in place to minimise the amount of erodible surfaces during construction.
- Reinstall aquatic, emergent and riparian habitat after completion of the works.

### 7.2.3 Operational Phase

- Following completion of all construction, monitoring of water quality, revegetation, weeds, earthworks/structures and any remaining controls should continue for a period of time until the project area stabilised and the risk of further impact/s negligible.

## 8. POLICY AND LEGISLATION IMPLICATIONS

Three EPBC and FFG Act protected species (Murray Cod, Silver Perch and Murray Hardyhead) and two FFG Act only protected species (SPSG and Murray River Turtle) were assessed as known, likely or possible present in Kangaroo Lake. Table 3 provides a brief outline of the policy and legislation that is relevant to those species and for the overall project relating to the protection of the waterway and its aquatic biota.

Table 3 Policy and legislation implications

Legislation / Policy	Criteria	Potential Implications for Project
<b>Commonwealth</b>		
<i>Environment Protection and Biodiversity Conservation Act 1999</i>	<p>The <i>Environment Protection and Biodiversity Conservation Act 1999</i> (the EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined in the Act as matters of national environmental significance (MNES). There are nine MNES to which the EPBC Act applies, these are:</p> <ul style="list-style-type: none"> <li>• world heritage properties</li> <li>• national heritage places</li> <li>• wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)</li> <li>• nationally threatened species and ecological communities</li> <li>• migratory species</li> <li>• Commonwealth marine areas</li> <li>• the Great Barrier Reef Marine Park</li> <li>• nuclear actions (including uranium mining)</li> <li>• a water resource, in relation to coal seam gas development and large coal mining development.</li> </ul>	<p>If a project is likely to have a significant impact on one of the nine matters of national environmental significance, the action or proposal must be referred to the Commonwealth Department of the Environment, Heritage and the Arts. This 'referral' is, then released to the public for comment.</p> <p>A significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity.</p> <p>In consideration of the guidelines, the proposal, the findings of this phase 1 assessment and the suggested mitigation measures, an initial high-level assessment is that the proposal (action) is unlikely to result in a significant impact to a matter of national environmental significance.</p>

Legislation / Policy	Criteria	Potential Implications for Project
<b>State</b>		
<i>Flora and Fauna Guarantee Act 1988</i>	<p>The Victorian <i>Flora and Fauna Guarantee Act 1988</i> (FFG Act) and FFG Amendment Act 2019 (FFGA Act) were established to provide a legal framework for enabling and promoting the conservation of all Victoria's native flora and fauna, and to enable management of potentially threatening processes. One of the main features of the FFGA Act is the listing process, whereby native species and communities of flora and fauna, and the processes that threaten native flora and fauna are listed in the schedules of the Act. This assists in identifying those species and communities that require management to survive and identifies the processes that require management to minimise the threat to native flora and fauna species and communities within Victoria.</p>	<p>The present/likely/possibly present SPSG, Murray Cod, Silver Perch, Murray River Turtle and Murray Hardyhead (if confirmed) are all protected under the FFG Act.</p> <p>Schedule 3 of the FFG Act potentially threatening process relevant to the project that have been given consideration in Sections 7 and 7.2).</p> <p>In particular, the project will need to ensure that works do not impede aquatic biota passage.</p> <p>Should any FFG Act protected fauna handling be required (i.e. salvage or relocation) a permit under the FFG Act to 'take protected fauna' will be required.</p>
<i>Wildlife Act 1975</i>	<p>The <i>Wildlife Act 1975</i> forms the procedural, administrative and operational basis for the protection and conservation of native wildlife within Victoria.</p> <p>The purposes of the Act are:</p> <ol style="list-style-type: none"> <li>1. To establish procedures in order to promote: <ul style="list-style-type: none"> <li>• The protection and conservation of wildlife; and</li> <li>• The prevention of taxa wildlife from becoming extinct; and</li> <li>• The sustainable use of and access to wildlife; and</li> </ul> </li> <li>2. To prohibit and regulate the conduct of persons engaged in activities concerning or related to wildlife.</li> </ol> <p>This Act often sits as the default reference for other associated policies regarding wildlife management or other Victorian legislation. For example, the operation of the FFG Act often needs to be considered in conjunction with the provisions and procedures of the Wildlife Act, as some wildlife will be both protected wildlife under the Wildlife Act and listed threatened species under the FFG Act.</p> <p>With the exception of 'pest animals' declared under the CaLP Act or wildlife declared to be 'unprotected wildlife', the Wildlife Act defines certain wildlife as 'protected wildlife'. It is an offence to hunt, take or destroy threatened or protected wildlife without authorisation.</p>	<p>In accordance with this Act, if any native wildlife is located within any area proposed for clearing/excavation/impact, a permit is required from DELWP to take or destroy it, including salvage and translocation.</p> <p>This will also apply to any works on/to waterways that may result in an impact to wildlife, including amphibians, reptiles, mammals, waterbirds, FFG Act listed invertebrates, etc, but excluding fish.</p> <p>If native vegetation is proposed to be impacted/cleared by the works, consideration may need to be given to salvage and translocation of wildlife during those works.</p>

Legislation / Policy	Criteria	Potential Implications for Project
<i>Fisheries Act 1995</i>	<p>One of the objectives of the <i>Fisheries Act 1995</i> (Fisheries Act) is to protect and conserve fisheries resources, habitats and ecosystems including the maintenance of aquatic ecological processes and genetic diversity. One of the provisions of this Act is that a person must not, except as permitted by or under the Fisheries Act or any other Act, create an obstruction across or within a bay, inlet, river or creek or across or around an inter-tidal flat that:</p> <p>“(a) fish will or could be blocked and left stranded; or  (b) immature fish will or could be destroyed; or  (c) the free passage of fish will or could be obstructed.”</p> <p>This act is relevant if there is a likelihood that a development will impact on fish habitat and aquatic ecological processes. Similar to the FFG Act, action statements must outline the process that will be implemented to ensure the long-term protection of fish habitat and/or specific species</p> <p>In addition, Victoria has listed a number of species and genera as noxious under Section 75 of the Fisheries Act. By declaring a particular species noxious, the Victorian Government applies regulations to control the use and potential spread of such animals.</p>	<p>The project will need to ensure that works do not impede aquatic biota passage up or downstream.</p> <p>If fish handling, capture or translocation is required (i.e. capture and release of entrapped fish in any in-water construction structures such as coffer dams for pier construction) an Application for a General Permit for the purpose of research (this includes capture and release or translocation) may be required from the Victorian Fisheries Authority (VFA).</p> <p>Any noxious listed fish that may be encountered in a works area/structure, will require appropriate salvage and euthanising/disposal to prevent their re-release/spread.</p>
<i>Catchment and Land Protection Act 1994</i>	<p>The <i>Catchment and Land Protection Act 1994</i> (CALP Act) is the principal legislation relating to the management of pest plants and animals in Victoria. Under this Act, landowners have a responsibility to avoid causing or contributing to land degradation, including taking all reasonable steps to conserve soil, protect water resources, eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds and where possible, eradicate established pest animals, as declared under the Act.</p> <p>Under the CaLP Act it is prohibited to:</p> <ul style="list-style-type: none"> <li>• Carry out extractive activity unless an authority has been issued;</li> <li>• Move vehicles or machinery from land on to a road without first ensuring precautions are taken to ensure the equipment is free of noxious weeds;</li> <li>• Remove soil, sand, gravel or stone which comes from land on which noxious weeds grow.</li> </ul> <p>The Act outlines and guides the control of state and regionally prohibited weeds and prohibited pest animals.</p>	<p>Measures will need to be outlined in the project’s EMP that detail how the spread of disease, weeds and pests will be managed during construction.</p>



Legislation / Policy	Criteria	Potential Implications for Project
<i>Environment Protection Act 2017</i>	<p>The <i>Environment Protection Act 2017</i> (EP Act) is Victoria's primary environment protection legislation, with a basic philosophy of preventing pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them. Under the EP Act the Environmental reference standard (ERS, EPA 2021) is a tool established to provide more detailed requirements and guidance for the application of the Act to Victoria. The ERS administered by the Environment Protection Authority (EPA) air, noise, land, water (e.g. rivers and stream, wetlands, estuarine and marine environments), groundwater and surface waters.</p>	<p>The EPA administers several regulations under this Act that include, but are not limited to, prescribed waste, noise, vehicle emissions, pollution of water by oil and noxious substances. Any works that may include a potential discharge to the waterway, emissions or noise may require additional consideration of this legislation.</p>
<i>Water Act 1989</i>	<p>The <i>Water Act 1989</i> (Water Act) provides the framework for allocating surface water and groundwater throughout Victoria. In Section 67 of the Act it states that works on waterways, such as the construction of dams, weirs and erosion control structures, are licensed in accordance with the Act. The Act allows conditions to be included in a works licence to protect the "environment, including the riverine and riparian environment".</p> <p>The purpose of the Water Act is to:</p> <ul style="list-style-type: none"> <li>• State the law relating to water in Victoria;</li> <li>• Maximise community involvement in the making and implementing for the use of conservation or management of water resources; and</li> <li>• Provide formal means for the protection and enhancement of the environmental qualities of waterways.</li> </ul>	<p>Under the Act approval must be sort from the local CMA and a "Works on Waterways Permit" is required to "construct, alter, operate, remove or decommission:</p> <ul style="list-style-type: none"> <li>• any works on a waterway a waterway; or</li> <li>• a bore.</li> </ul>

## 9. CONCLUSION AND RECOMMENDATIONS

### 9.1 Conclusion

Overall the desktop review and site inspection found the aquatic environment in the vicinity of the pump station to be typical of a modified shoreline of a regulated lake. Habitat is dominated by open water, a narrow band of fringing reeds, and the inlet to the No. 47 channel.

Key aquatic values that have been taken into consideration were the lake's recently rediscovered SPSG, the lake's recreational fishery including VFA's annual fish stocking of Murray Cod and Golden Perch, recreation, boating and water sports, a small number of other potentially present higher value/protected fish and other aquatic biota species, a range of aquatic habitat types, structure and quality, water quality and the lake's inclusion the Kerang Lake Ramsar site.

Other than open water habitat, aquatic habitat occurs mostly only around the vegetated fringe of the lake. In particular there are larger more complex vegetation and habitat patches along the western and southwestern shorelines where SPSG have been recorded. Likely critical to the long-term maintenance and viability of these habitat areas is that the lake is strongly regulated.

With a maximum depth of 8.4 m, maximum operating height of 73.9 m ADH and minimum of 73.12 m ADH the lake water level is maintained within 0.78 m of its maximum (i.e. a minimal water height fluctuation that would have a negligible impact on the fringing aquatic vegetation). Based on data provided by Goulburn Murray Water the current average lake draw or discharge is approximately 0.15 GL/day, (Bailey, M. 2022. pers comm. 2 August). With the irrigation season operating from August to May (i.e. 274 days) and assuming VHM draws is peak of 4.5 GL/year evenly over 365 days or 0.013 GL/day, the VHM draw represents only a 9% increase on the lake's current average daily demand. Accordingly, VHM's additional draw in the system will likely have negligible impact the lake's water height, beyond that already controlled in the lake, and therefore aquatic vegetation.

The desktop review returned 27 aquatic fauna species as either occurring, potentially occurring or potentially having habitat within 10 kilometres of Kangaroo Lake. This included 23 fish, two aquatic reptiles, one aquatic mammal and one common aquatic invertebrate (Appendix B). The 23 species of fish included six introduced species, of which three were listed as a '*noxious aquatic species*' under the Fisheries Act.

The result included nine FFG Act and/or EPBC Act protected species. A likelihood of occurrence assessment determined the following species as present or potentially present:

- Present: SPSG4 and Murray Cod
- Likely present: Silver Perch and Murray River Turtle
- Possibly present: Murray Hardyhead.

All the remaining state or commonwealth protected species were assessed as unlikely or very unlikely to occur due to lack of habitat, or recent, or nearby records.

It's also important to note that several of the agencies identified there are a number of other higher value or protected fish species that may occur in kangaroo lake. However, it was a great that assessing the potential presence of these is a significant undertaking likely requiring extensive surveys using physical trapping methods and eDNA. Further, even if they species were found to be present, the proposed mitigation measures suggested to protect SPSG and Murray Cod would be sufficient to protect those additional species as well as.

The site inspection confirmed that habitat in the vicinity of the Population was less abundant and of much lower quality than that present in sections of the lake that are known to support SPSG. However, as SPSG have been recorded in some of the connecting channels, it is possible/probable SPSG (and other aquatic biota) utilise this lower quality habitat for shelter from larger predatory fish on the open water areas and disbursal within and between lakes at times.

The assessment considered a range of potential impacts to SPSG and the other both protected and common species, their habitat, and the wider lake values (i.e. passage and water quality). The primary potential impact of concern was the possible entrainment and impingement of fish and other fauna in the pump. This is not only possible with larger fish such as adult Murray Cod, but also smaller fish, such as the approximately 4 mm long larvae of the SPSG. The other key impacts included those to aquatic habitat and vegetation if the water drawdown resulted in an impact to the lake's water levels/height and the loss of habitat for the construction of the pump station. However, both of these were assessed as low risk impacts as (1) it is anticipated the water drawdown will be proportionally negligible to that drawn down for irrigation and (2) the areas of aquatic habitat likely to be lost will be small, of lower quality habitat and negligible in terms of the overall area of habitat available in the lake.

Mitigation measures will need to include those for preventing the entrainment and impingement of fish into the pump as well as more typical work on waterway mitigation measures to prevent sediments and contaminants entering the waterway, trapping of fauna in works structure and delineation and protection of in-water and riparian areas. In our experience these potential impacts can all be adequately managed by the implementation of the recommended measures.

An initial high-level assessment of the potential significance of impact to the EPBC Act protected species potentially present and the Kerang Lakes Ramsar site found the action (or works) are unlikely to result in a significant impact under the guidelines. Accordingly, at this stage, there is no likely need for a referral under the EPBC Act.

## 9.2 Recommendations

Based on the findings of this Phase 1 assessment and including the implementation of the suggested impact management and mitigation measures the following next steps may need consideration:

- VHM will need to obtain a Works on Waterway from CCMA.
- Undertaken a pre-works aquatic fauna/targeted SPSG survey of the area in the vicinity of the pump station to ascertain the actual aquatic fauna usage at that time. The survey can occur at any time, though optimally it would occur during the SPSG breeding season (summer) as to ascertain whether they are utilising the area in the vicinity of the pump station at that time. Summer timing would also allow targeted survey for Growing Grass Frog.
- Ensure that the pump station design includes a fish screen on its inlet that is sufficient to protect fish as small as SPSG larva (i.e. 4 mm long) from entrainment and impingement.
- Ensure that a suitably qualified and experienced ecologist is present during initial vegetation clearing and/or earthworks in the water in case aquatic fauna is encountered, injured or trapped in instream structures and requiring salvage.
- Ensure that a suitably qualified and experienced ecologist is available and on call during construction in case any fauna is encountered, injured or trapped in structures and requiring salvage.

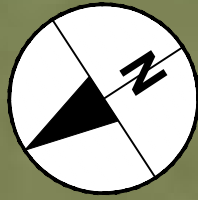
## 10. REFERENCES

- Australian Government (2011). Kerang Wetlands Ramsar site. Ecological Character Description. May 2011. Available online at: [https://www.ffm.vic.gov.au/\\_data/assets/pdf\\_file/0019/8146/Attachment-4-EEA-referral-background-project-summary-v2-07042016.PDF](https://www.ffm.vic.gov.au/_data/assets/pdf_file/0019/8146/Attachment-4-EEA-referral-background-project-summary-v2-07042016.PDF). Last accessed 4 July 2022.
- Backhouse, G., Lyon, J. and Cant, B. (2008). National Recovery Plan for the Murray *Hardyhead Craterocephalus fluviatilis*. Department of Sustainability and Environment, Melbourne.
- Bice, C., Gilligan, D., Raadik, T. & Unmack, P. (2019). *Mogurnda adspersa*. The IUCN Red List of Threatened Species 2019: e.T13609A123378372. <https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T13609A123378372.en>. Accessed on 05 July 2022
- Blackley, T. (2003). Screening Irrigation Offtakes in the Murray-Darling Basin to Reduce Loss of Native Fish. Available online at: <https://www.mdba.gov.au/sites/default/files/archived/native-fish/Screening-Irrigation-offtakes-in-the-MDB.pdf>. Last accessed 6 July 2022.
- Boys, C. A. (2021). Design specifications for fish-protection screens in Australia. Edition 1. NSW Department of Primary Industries. Taylors Beach 12 pp. Available online at: [https://fishscreens.org.au/wp-content/uploads/2021/11/Design-specifications-for-fish-protection-screens\\_FINAL\\_WPA.pdf](https://fishscreens.org.au/wp-content/uploads/2021/11/Design-specifications-for-fish-protection-screens_FINAL_WPA.pdf). Last accessed 6 July 2022.
- Boys, C, Baumgartner, L, Rampano, B, Robinson, W, Alexander, T, Reilly, G, Roswell, M, Fowler, T and Lowry, M. (2012). Development of fish screening criteria for water diversions in the Murray-Darling Basin. Available online at: [https://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0003/545745/FFRS-134\\_Boys-et-al-2012.pdf](https://www.dpi.nsw.gov.au/_data/assets/pdf_file/0003/545745/FFRS-134_Boys-et-al-2012.pdf). Last accessed 6 July 2022.
- DELWP (2021). Southern Purple Spotted Gudgeon. Conserving threatened species. Available online at: <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species/southern-purple-spotted-gudgeon>, Last updated 14 July 2021. Last accessed 4 July 2022.
- Department of Environment and Science, Queensland (2013) Murray River turtle (*Emydura macquarii*), Available online at: <https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/fauna/reptiles/murray-river-turtle.html>. Last accessed 6 July 2022.
- Department of the Environment (2022). *Litoria raniformis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <https://www.environment.gov.au/sprat>. Accessed Mon, 1 Aug 2022 11:21:10 +1000.
- DSE (2005). Freshwater Catfish - Action Statement. Available online at: [https://www.environment.vic.gov.au/\\_data/assets/pdf\\_file/0016/32416/Freshwater\\_Catfish\\_Tandanus\\_tandanus.pdf](https://www.environment.vic.gov.au/_data/assets/pdf_file/0016/32416/Freshwater_Catfish_Tandanus_tandanus.pdf). Last accessed 24 June 2022.
- EPA (2021). Environment Reference Standard. No. S245 Gazette 26 May 2021, as amended by Environment Reference Standard No. S158 Gazette 29 March 2022. Environment Protection Authority, Victoria.
- Government of South Australia (2022). 110125 Fact Sheet – Southern Purple Spotted Gudgeon. Available online at: <https://cdn.environment.sa.gov.au/landscape/docs/cllmm-fact-southernpurplegudgeon-1.pdf>. Last accessed 5 July 2022.
- MDBA (2007a). Factsheet native Flat-Headed Galaxias. Available online at: [https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202\\_factsheet\\_native\\_flat-headed\\_galaxias.pdf](https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202_factsheet_native_flat-headed_galaxias.pdf). Last accessed 24 June 2022.
- MDBA (2007b). Factsheet native Murray-Darling Rainbowfish. Available online at: [https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2203\\_factsheet\\_native\\_murray-darling\\_rainbowfish.pdf](https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2203_factsheet_native_murray-darling_rainbowfish.pdf). Last accessed 24 June 2022.

- NSW DPI (2021a). Threatened Species Lists – Flathead Galaxias. Available online at: <https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/critically-endangered-species/flathead-galaxias>. Last accessed 24 June 2022.
- NSW DPI (2021b). A guide to modern fish-protection screening in Australia. Published by the NSW Department of Primary Industries. Available online at: [https://researchoutput.csu.edu.au/ws/portalfiles/portal/180574914/A\\_guide\\_to\\_modern\\_fish\\_protection\\_screening\\_in\\_Australia\\_FINAL\\_WPA.pdf](https://researchoutput.csu.edu.au/ws/portalfiles/portal/180574914/A_guide_to_modern_fish_protection_screening_in_Australia_FINAL_WPA.pdf). Last accessed 6 July 2022.
- NSW DPI (2022). Threatened Species Lists. Southern Purple Spotted Gudgeon. Available online at: <https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-species2/purple-spotted-gudgeon>. Last accessed 5 July 2022.
- NSW Government (2018). Silver Perch Action Plan. Available online at: [https://www.environment.act.gov.au/\\_data/assets/pdf\\_file/0006/576564/Silver-Perch-Action-Plan.pdf](https://www.environment.act.gov.au/_data/assets/pdf_file/0006/576564/Silver-Perch-Action-Plan.pdf). Last accessed 22 June 2022.
- PMST (2022). Protected Matters Search Tool. Available online at: <https://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf>. Last accessed 25 June 2022.
- VBA (2022). Victorian Biodiversity Atlas. Available online at: <https://vba.dse.vic.gov.au/vba/#/>. Last accessed 25 June 2022.
- VFA (2013). Kerang Lakes Fishery Improvement. Recreational Fishing Grants Program Research Report. Available online at: [https://www.vgls.vic.gov.au/client/en\\_AU/search/asset/1265188/0](https://www.vgls.vic.gov.au/client/en_AU/search/asset/1265188/0), Last accessed 4 July 2022.
- VFA (2021). Fish Stocking Database – Kangaroo Lake. Available online at: <https://vfa.vic.gov.au/db/fishstockdatabase>. Last accessed 9 June 2022.
- VFA (2022). Loddon (North) - Angling Waters. Available online at: <https://vfa.vic.gov.au/recreational-fishing/fishing-locations/inland-angling-guide/areas/loddon-north/loddon-north-angling-waters#kangaroo>. Last accessed 6 July 2022.
- UNESCO (1994). Convention on Wetlands of International Importance Especially as Waterfowl Habitat. Ramsar 2.2.1971. United Nations Educational, Scientific and Cultural Organisation. Available online at: <https://www.ramsar.org/about/the-convention-on-wetlands-and-its-mission>

## Appendix A Proposed Pumphouse and Offtake Structure Design





NOTES

1. REFER TO DRG 60671342-DGCV-2010 AND 2011 FOR DETAILED PUMPSTATION GENERAL ARRANGEMENT.



This drawing is confidential and shall only be used for the purpose of this project. The signing of this title block confirms the design and drafting of this project have been prepared and checked in accordance with the AECOM quality assurance system to ISO 9001-2000.

**AECOM**

CONSULTANT  
AECOM Australia Pty Ltd  
A.B.N 20 093 846 925  
www.aecom.com

PROJECT

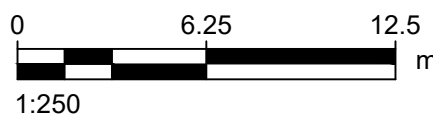
GOSCHEN PROJECT  
MINE WATER SUPPLY

CLIENT

VHM LIMITED  
REGISTERED OFFICE  
LEVEL 2  
389 OXFORD STREET  
MOUNT HAWTHORNE WA 6016  
0484 501 797 tel  
www.vhmtd.com.au  
A.B.N 601 004 102

KEY PLAN

SCALE BAR



SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

- ☐ NO  
☒ YES

NOTES:

1. THIS DESIGN IS CONCEPT FOR DFS ONLY. FULL HAZARD ND RISK ASSESSMENT TO BE UNDERTAKEN IN DETAILED DESIGN PHASE.

(NOT FOR CONSTRUCTION)

PROJECT MANAGEMENT INITIALS

MVW	MET, PL	MVW
DESIGNER	CHECKED	APPROVED

PROJECT DATA

DATUM	GDA 94 AHD	SURVEY	MGA - 54
-------	------------	--------	----------

ISSUE/REVISION

A	09/12/21	ISSUED FOR REVIEW
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60671342

SHEET TITLE

GOSCHEN PROJECT  
MINE WATER SUPPLY  
INTAKE PS - GENERAL  
ARRANGEMENT

SHEET NUMBER

60671342-DGCV-2001

## Appendix B Species records within 10km of the project area (the study area)

Group	Common Name	Scientific Name	Status		Count of Sightings	Last Record	Record Source
			EPBC Act	FFG Act			
Fish	Australian Smelt	<i>Retropinna semoni</i>			12	21/11/2007	VBA 2022, NK 2022
Fish	Bony Herring	<i>Nematalosa erebi</i>			24	17/11/1999	VBA 2022, NK 2022
Fish	Carp Gudgeon	<i>Hypseleotris spp.</i>			2	21/11/2007	VBA 2022
Fish	Eastern Gambusia**	<i>Gambusia holbrooki</i>			2	29/12/1989	VBA 2022
Fish	European Carp**	<i>Cyprinus carpio</i>			32	21/11/2007	VBA 2022, NK 2022, VFA 2022
Fish	Flat-headed Galaxias	<i>Galaxias rostratus</i>	CR	VU	2	19/6/1963	VBA 2022, PMST 2022
Fish	Flatheaded Gudgeon	<i>Philypnodon grandiceps</i>			4	29/12/1989	VBA 2022, NK 2022
Fish	Freshwater Catfish	<i>Tandanus tandanus</i>		EN	5	1/1/1981	VBA 2022, NK 2022, VFA 2022
Fish	Golden Perch	<i>Macquaria ambigua</i>			24	21/11/2007	VBA 2022, NK 2022, NFA 2022
Fish	Goldfish*	<i>Carassius auratus</i>			18	21/11/2007	VBA 2022, NK 2022
Fish	Goldfish/Carp Hybrid**	<i>Carassius x Cyprinus HYBRID</i>			2	1/9/1983	VBA 2022, NK 2022
Fish	Murray Cod	<i>Maccullochella peelii</i>	VU	EN	16	1/1/1981	VBA 2022, PMST 2022, NK 2022, NFA 2022 , VFA 2022
Fish	Murray Hardyhead	<i>Craterocephalus fluviatilis</i>	EN	CR	6	17/10/1971	VBA 2022, PMST 2022
Fish	Murray-Darling Rainbowfish	<i>Melanotaenia fluviatilis</i>		EN	2	24/11/2004	VBA 2022
Fish	Oriental Weather Loach						
Fish	Redfin*	<i>Perca fluviatilis</i>			26	17/11/1999	VBA 2022, NK 2022, VFA 2022
Fish	River Blackfish	<i>Gadopsis marmoratus</i>			1	1/1/1981	VBA 2022
Fish	Silver Perch	<i>Bidyanus bidyanus</i>	CR	EN	21	21/11/2007	VBA 2022, PMST 2022, NK 2022, VFA 2022

Group	Common Name	Scientific Name	Status		Count of Sightings	Last Record	Record Source
			EPBC Act	FFG Act			
Fish	Southern Purple-spotted Gudgeon	<i>Mogurnda adspersa</i>		CR	4	20/4/2021	VBA 2022
Fish	Tench*	<i>Tinca tinca</i>			15	1/1/1981	VBA 2022, NK 2022
Fish	Trout Cod	<i>Maccullochella macquariensis</i>	EN	EN	Species or habitat may occur		PMST 2022
Fish	Unspecked Hardyhead	<i>Craterocephalus stercusmuscarum fulvus</i>			2	24/11/2004	VBA 2022
Fish	Western Carp Gudgeon (Species Complex)	<i>Hypseleotris klunzingeri</i>			1	6/8/1989	VBA 2022
Invertebrate	Common Freshwater Shrimp	<i>Paratya australiensis</i>			2	17/11/1999	VBA 2022
Mammal	Water Rat	<i>Hydromys chrysogaster</i>			4	19/10/1988	VBA 2022
Reptile	Eastern Snake-necked Turtle	<i>Chelodina longicollis</i>			3	6/4/2021	VBA 2022
Reptile	Murray River Turtle	<i>Emydura macquarii</i>		CR	4	7/4/2021	VBA 2022, NK 2022

#### KEY

EPBC/FFG Act Status: CR = Critically endangered, VU = Vulnerable; EN = Endangered

\* Introduced species

\*\* Introduced species and listed as a “noxious aquatic species” under Section 75 *Fisheries Act 1995*



## Appendix C Likelihood of Occurrence Assessment of Protected Species

Common Name	Scientific Name	EPBC Act	FFG Act	Count of Signings	Last Record	Habitat Requirements	Habitat on Site?	Likelihood of Occurrence
Flat-headed Galaxias	<i>Galaxias rostratus</i>	CR	VU	2	1963	Little in know of the species ecology. They are generally found in still or slow moving water bodies such as billabongs, lakes, swamps, wetlands and lowland streams. They are a schooling fish that congregates in mid-water (MDBA 2007). The species is associated with a range of habitats including rock and sandy bottoms and aquatic vegetation. Spawning occurs in spring and they lay slightly adhesive demersal eggs (NSW DPI 2021a).	Yes	<b>Unlikely</b> No records in Kangaroo Lake and only two up to 1963 historical records in Lake Cullen and Third Reedy Lake. Consulted agencies fee they could still be present due to suitable habitat and relatively few surveys of Kangaroo Lake (i.e. further study required to understand actual likelihood of occurrence in Kangaroo Lake)
Freshwater Catfish	<i>Tandanus tandanus</i>	-	EN	5	1981	Freshwater Catfish are benthic found in a range of habitat types such as rivers, creeks, lakes and billabongs. Generally considered more abundant in lakes and backwaters, where they have a preference for low turbidity and abundant aquatic plants, they do inhabit and spawn in flowing streams (DSE 2005).	Yes	<b>Unlikely</b> 1981 records in Kangaroo Lake, and similarly to Flat-headed Galaxias Requires further study to understand actual likelihood of occurrence in Kangaroo Lake.
Murray Cod	<i>Maccullochella peelii</i>	VU	EN	16	2020	Generally associated with deep holes in rivers, the Murray cod prefers habitats with instream cover such as rocks, stumps, fallen trees or undercut banks (MDBA 2007a). They are readily able to adapt to lake environments, especially if there is submerged cover/structures, hence being one of the main species stocked for recreational fishing.	Yes	<b>Known</b> 50,000 were last stocked by VFA into Kangaroo Lake in December 2020.

Common Name	Scientific Name	EPBC Act	FFG Act	Count of Signings	Last Record	Habitat Requirements	Habitat on Site?	Likelihood of Occurrence
Murray Hardyhead	<i>Craterocephalus fluviatilis</i>	EN	CR	6	2019	The Murray Hardyhead occurs in still and slow-flowing waters including billabongs, lakes and margins and backwaters of lowland rivers. In Victoria, most records are from saline ephemeral deflation basin lakes characterised by wind and wave-formed lunettes on their eastern shore 9similar to Kangaroo Lake (Backhouse et al 2008).	Yes	<b>Possible</b> 2019 records in Third Reedy Lake and historical records (early 1970) in Lakes Cullen and Tutchewop. Similarly to previous, requires further study to understand actual likelihood of occurrence in Kangaroo Lake.
Murray-Darling Rainbowfish	<i>Melanotaenia fluviatilis</i>	-	EN	2	2004	Species prefers slow-flowing rivers, wetlands and billabongs. It is a schooling species with schools of 30 or more are commonly seen swimming just below the water surface (MDBA 2007b).	Marginal	<b>Unlikely</b> 2004 records are in the Loddon River and although the potential for presence was noted by one agency (Iervasi, D. 2022, pers. comm. 9 June) the species is more of a riverine specialist compared some of the others highlighted herein as 'possibly' present.
Silver Perch	<i>Bidyanus bidyanus</i>	CR	EN	21	2007	The species is found over a broad area of the Murray–Darling Basin and is often found in similar habitats to Murray Cod and Golden Perch (i.e. lowland, turbid rivers). There are some reports that suggest they prefers faster, open water, but the general scarcity of information on the habitat preferences of the species makes generalisation difficult (NSW Government 2018).	Yes	<b>Likely</b> 1983 record in Kangaroo lake and more recent (2007) in Lake Tutchewop, Lake Charm, Racecourse lake and Middle Lake.

Common Name	Scientific Name	EPBC Act	FFG Act	Count of Signings	Last Record	Habitat Requirements	Habitat on Site?	Likelihood of Occurrence
Southern Purple-spotted Gudgeon	<i>Mogurnda adspersa</i>	-	CR	4	2021	SPSG occurs in rivers, creeks, billabongs and lakes, and is usually found in quiet or slow flowing sections over rocks or among dense aquatic vegetation (DELWP 2021).	Yes	<b>Known</b> Three individuals were recorded in 2019 at the southwestern corner of the lake in dense aquatic vegetation
Trout Cod	<i>Maccullochella macquariensis</i>	EN	EN	Species or species habitat may occur within area		Similar to Murray Cod.	Yes	<b>Unlikely</b> Lack of any records. Species only returned in PMST search as “species or species habitat may occur”.
Growling Grass Frog	<i>Litoria raniformis</i>	VU	VU	2	2021	Prefer still or slow moving water with emergent vegetation around the edges and mats of floating and submerged plants. Can reside in artificial waterbodies, such as farm dams, irrigation channels and disused quarries (Department of the Environment 2022).	Yes	<b>Possible</b> Scattered regional records, suitable habitat is present but few surveys have been undertaken in the region for the species.
Murray River Turtle	<i>Emydura macquarii</i>	-	EN	4	2021	Species occurs primarily in rivers and waterbodies associated with rivers such as backwaters, oxbows, anabranches and deep, permanent waterholes on the floodplains. This species appears to avoid shallow water (Department of Environment and Science, Queensland 2013).	Yes	<b>Likely</b> Recorded in Kangaroo Lake in 1988, and Third Reedy Lake as recent as 2022.

**Key**

EPBC/FFG Act Status: CR = Critically Endangered, VU = Vulnerable; EN = Endangered



[www.AquaticaEnvironmental.com.au](http://www.AquaticaEnvironmental.com.au)

