Contents

1. Proposed Activities 4
1.1 Location 4
1.2 Clearing Envelope 4
2. Environmental Setting 8
2.1 Climate 8
2.2 Landscape 9
2.2.1 Bioregion 9
2.2.2 Soils 9
2.3 Biodiversity 13
2.3.1 Biological Surveys 13
2.3.2 Vegetation 15
2.3.3 Flora 20
2.3.4 Fauna 20
2.4 Hydrology 24
2.5 Hydrogeology 24
2.6 Heritage 26
2.6.1 Native Title 26
2.6.2 Aboriginal Heritage 26
2.6.3 European Heritage 26
3. Assessment Against Clearing Principles 27
4. Clearing Process 29
4.1 Equipment 29
4.2 Methodology 29
4.3 Rehabilitation 29
5. Environmental Management 30
5.1 Air quality 30
5.2 Land and soils 30
5.3 Fauna 30
5.4 Vegetation 31
5.5 Weeds 31
5.6 Surface Water 31

6. References....32
7. Appendices....34

Tables

Table 1. Tenement Details....4
Table 2. Regional Soil & Landform Units....10
Table 3. Land systems and associated indicative soil qualities at Crusader-Templar according to DPIRD (2018)....10
Table 4. Biological Surveys....13
Table 5. Pre-European Vegetation Associations....15
Table 6. Vegetation Types....15
Table 7. Fauna Habitats....21
Table 8. Fauna Likelihood of Occurrence....22
Table 9. Clearing Principles Assessment....27

Figures

Figure 1. Regional Location....5
Figure 2. Clearing Area....6
Figure 3. Indicative Site Plan....7
Figure 4. Mean rainfall and climatic data for Kalgoorlie-Boulder 1939-2024....8
Figure 5. Regional Soil Landscapes....12
Figure 6. Flora & Fauna Survey Area....14
Figure 7. Vegetation Type....16
Figure 8. Vegetation Condition....18
Figure 9: Environmentally sensitive areas....19
Figure 10. Surface Water Flows....25

1. Proposed Activities

Nexus Minerals (Nexus) is a resource company with a portfolio of gold projects, including a highly prospective tenement package in the Eastern Goldfields, and is the operator of its Wallbrook Gold Project. Nexus plan to develop and mine the Templar-Crusader open pit gold deposit pending a positive scoping study.

Nexus will require clearing of native vegetation to be conducted to commence the Crusader-Templar open pit project. Clearing is also required for supporting mine activities including:

- Mining void;
- Waste dump or overburden stockpile;
- Run-of-mine pad;
- Water dams;
- Offices or buildings;
- Diversion channel or drain;
- Laydown or hardstand areas;
- Topsoil stockpile;
- Transport or service infrastructure corridors; and
- Workshop.

A Mining Proposal for the Project will be submitted to Department of Energy, Mines, Industry Regulation and Safety (DEMIRS) in conjunction with other supporting approvals required under applicable legislation prior to commencement of activities.

1.1 Location

Crusader-Templar is located approximately 130 kilometres (km) north-east of Kalgoorlie-Boulder and 125 km east of Menzies. The Project is within the Shire of Menzies local government area, in the north-eastern Goldfields region of Western Australia. Crusader-Templar is situated several hundred metres north of the Wallbrook Gold Mine, operated by Northern Star Resources (Northern Star) and approximately 5 km south of Northern Star's Porphyry operations. A map of the Project is provided in Figure 1**.**

The Project requires clearing on two tenements as detailed in Table 1 below. Proof of ownership of these tenements is provided in **Appendix A.**

Table 1. Tenement Details

Tenement ID	Holder 1	Area (ha)	Expiry
M31/251	Nexus Wallbrook Pty Ltd	115.150	01/05/2029
M31/231	Nexus Wallbrook Pty Ltd	870.90	06/01/2029

1.2 Clearing Envelope

Nexus is requesting a total allowable clearing area of 120 ha within a disturbance envelope of 176 ha as depicted in Figure 2 and Figure 3 (Note: proposed infrastructure layout is indicative only and may change within the bounds of an approved mining proposal).

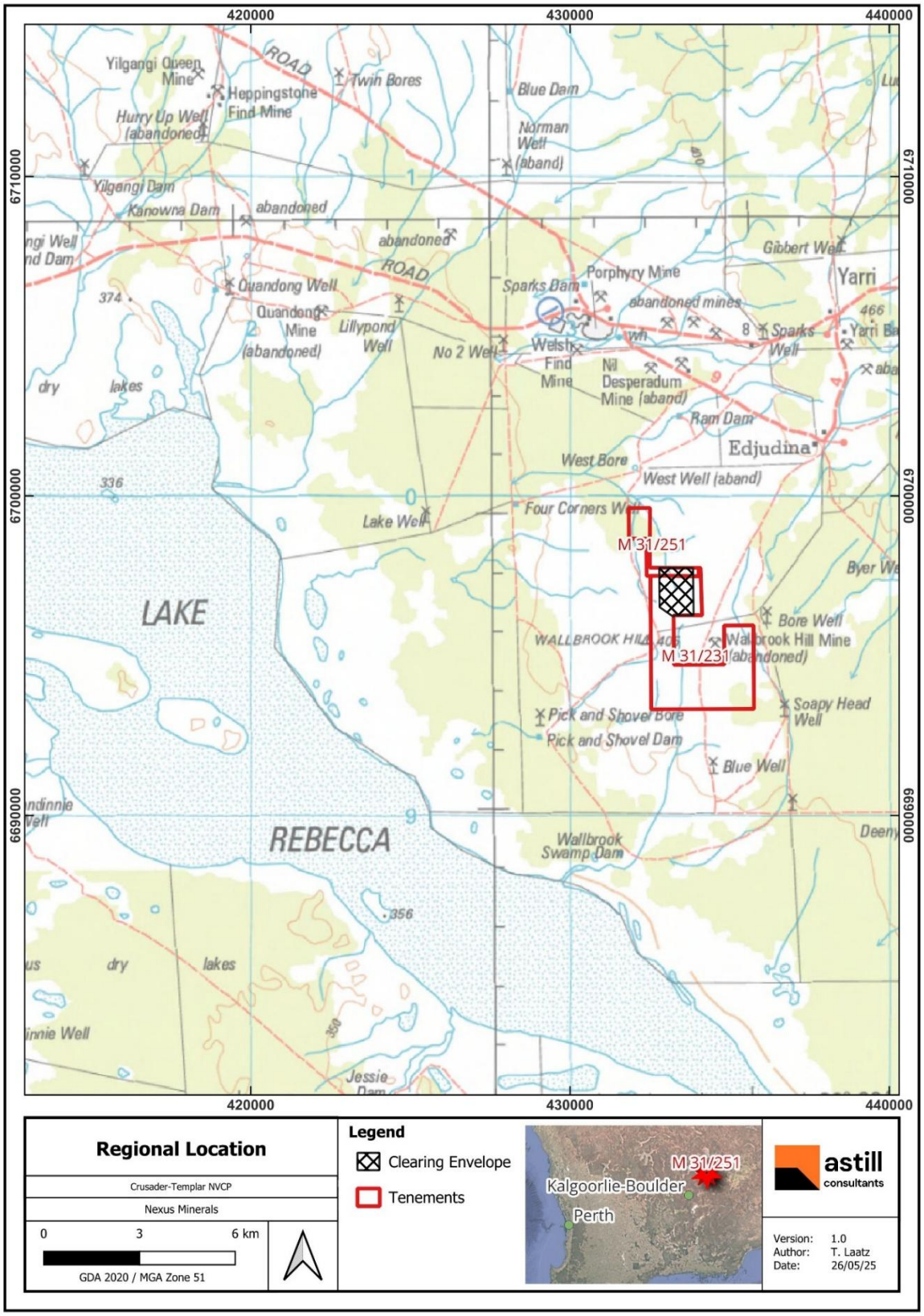


Figure 1. Regional Location

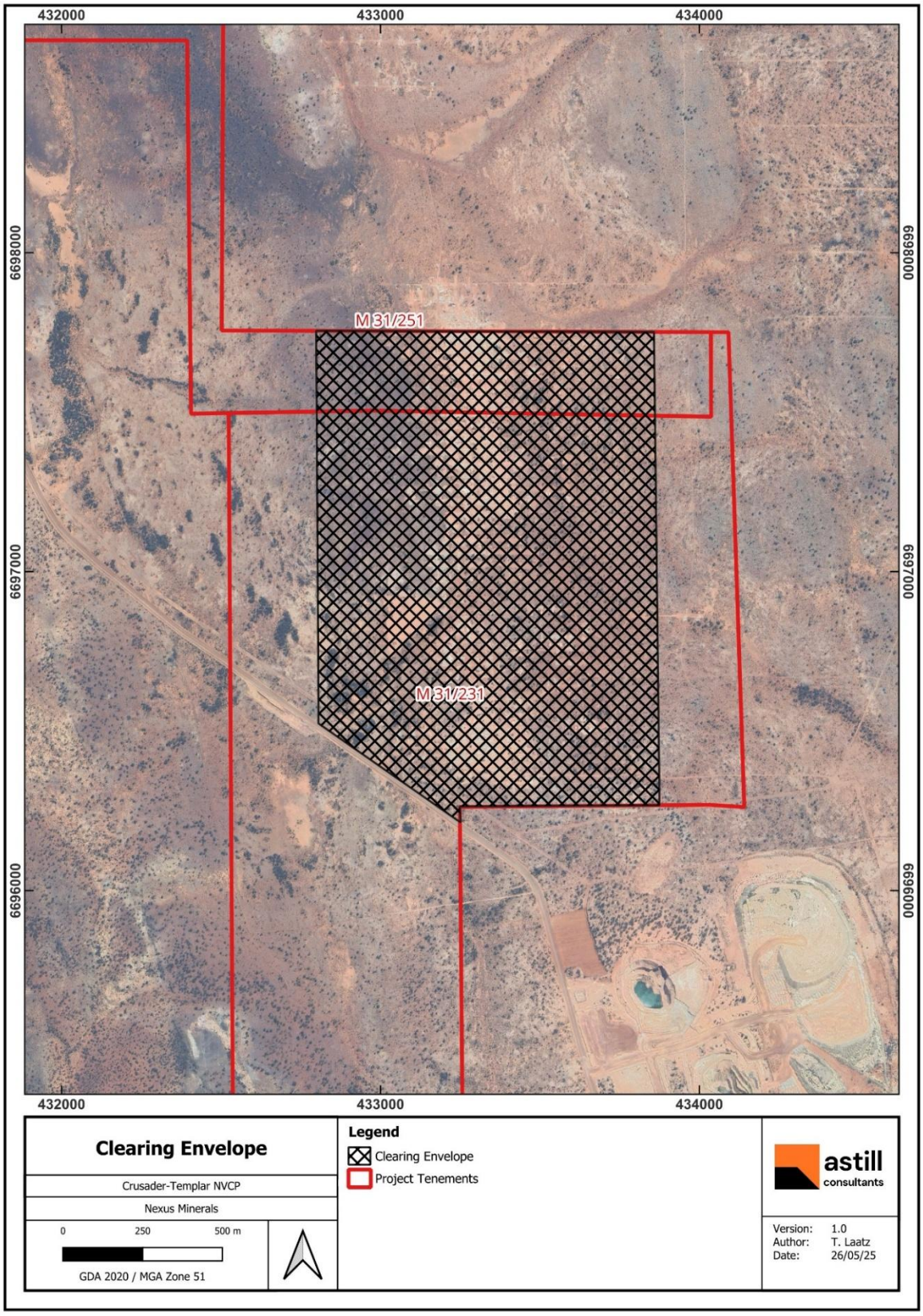


Figure 2. Clearing Area

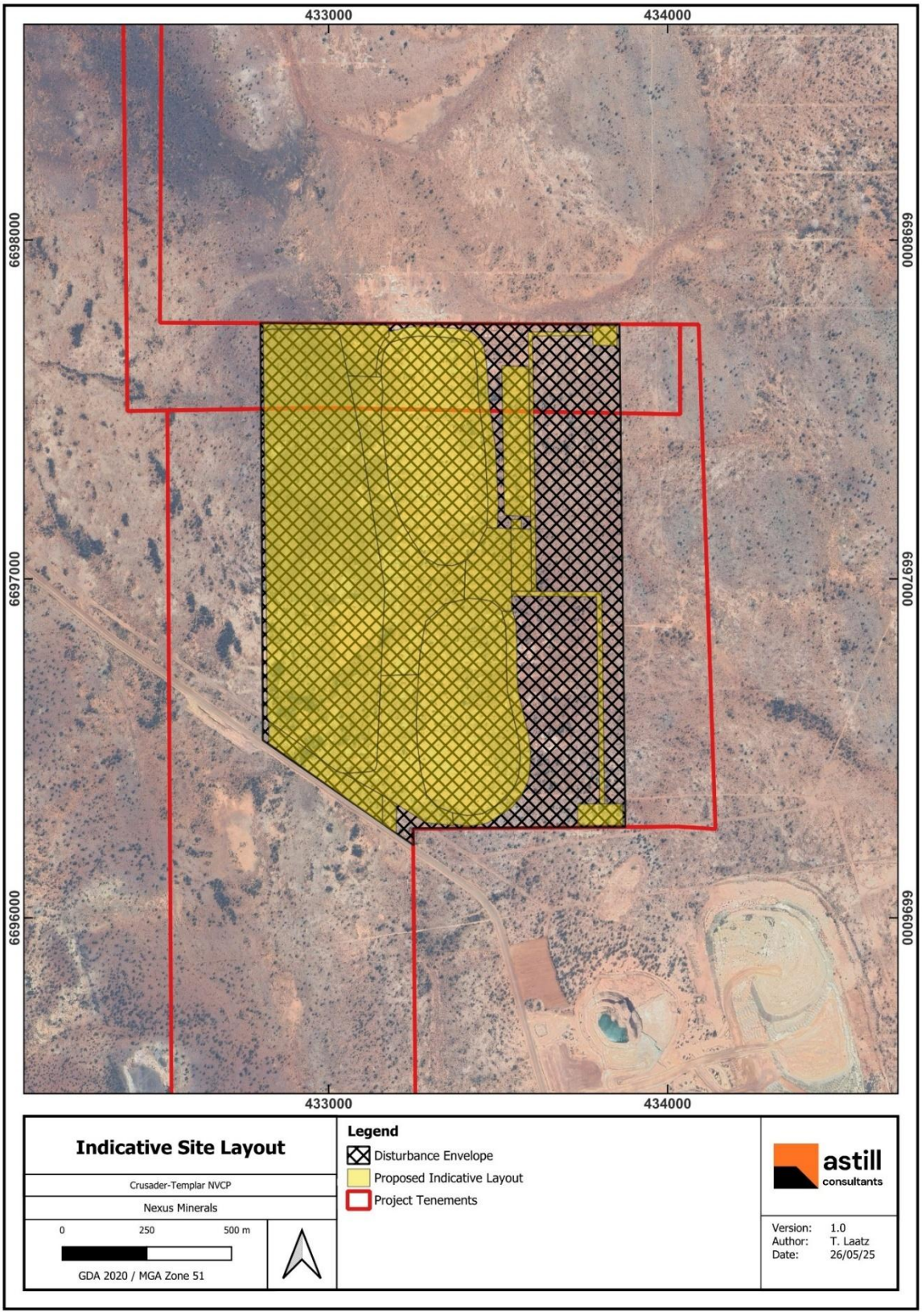


Figure 3. Indicative Site Plan

2. Environmental Setting

2.1 Climate

Crusader-Templar is situated in the south of the Murchison bioregion, within the Goldfields region of Western Australia. Climate in this region is arid to semi-arid with hot, dry summers and cool, wet winters (Cowan, 2001). The nearest Bureau of Meteorology (BOM) weather station is located approximately 125 km south-west at Kalgoorlie-Boulder Airport (Station ID 12038) (BOM, 2025).

Mean maximum temperatures in Kalgoorlie-Boulder range from 33.7°C in January, to 16.9°C in July; mean minimum temperatures range from 18.4°C in January, to 5.1 °C in July (BoM, 2024).

Rainfall is irregular but with a relatively even distribution over the year, with mean annual rainfall approximately 265 mm with a mean of 39.1 days of rain per year (≥1 mm) (BoM, 2024). Cyclonic activities in the north of Western Australia can occasionally cause heavy rainfall events and flooding in this area during summer months. Climate data from the Kalgoorlie-Boulder Airport weather station (12038) between 1939 and 2024 (BoM, 2024) is presented in Figure 4 below.

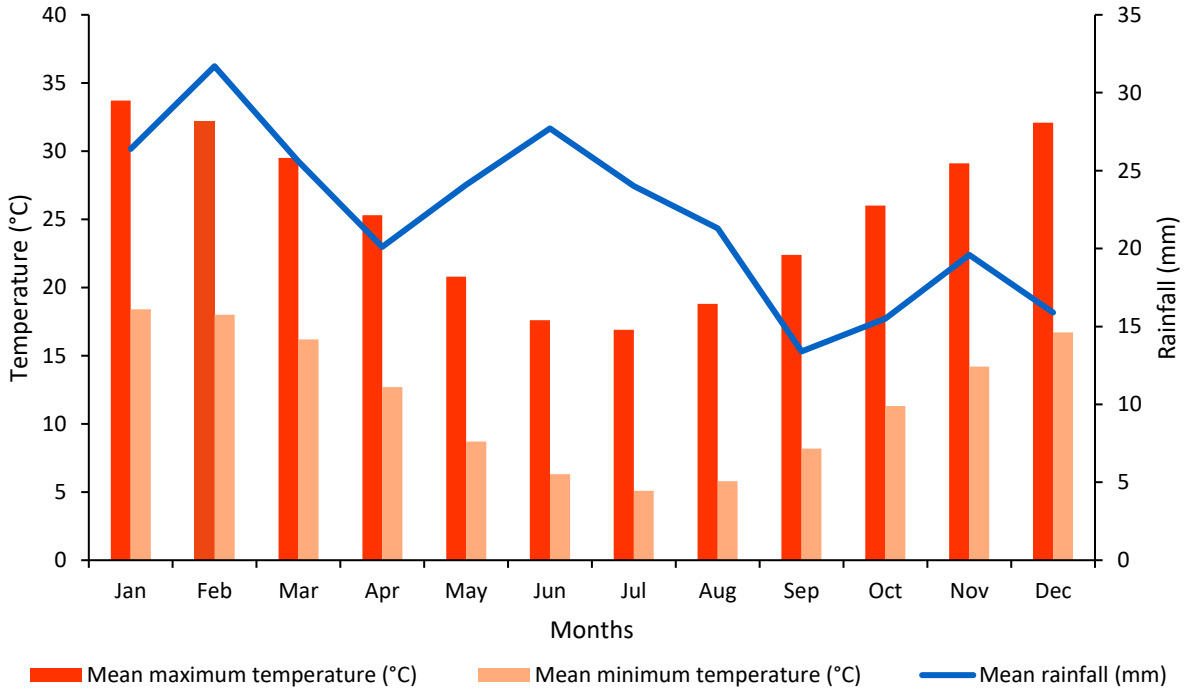


Figure 4. Mean rainfall and climatic data for Kalgoorlie-Boulder 1939-2024

Annual Exceedance Probability (AEP) is defined as the chance that an extreme rainfall event will occur in any given year. Based on AEP calculations by BOM, there is a 1 in 100 (1%) chance that the Kalgoorlie area will receive 52 mm of rain for a 1-hour period, 159 mm for a 24-hour period and 206 mm for a 72-hour period based on AEP calculations (BOM, 2024).

Average long-term annual rainfall is exceeded by average annual evaporation rate (approximately 2,600 mm) by a factor of almost 10 to 1. Evaporation exceeds rainfall in all

months of the year, with June having the lowest daily evaporation and January having the highest daily evaporation.

Wind conditions from Kalgoorlie-Boulder airport weather station (#12038) show that morning wind conditions are predominantly easterlies, north-easterlies, and south-easterlies averaging between 12 and 17 km/hr. Afternoon wind direction is variable, and predominantly westerlies, easterlies and south-easterlies averaging between 13 and 18 km/hr.

2.2 Landscape

2.2.1 Bioregion

The Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into 89 bioregions based on major biological, geographical and geological attributes. These bioregions are subdivided into 419 subregions as part of a refinement of the IBRA framework (IBRA 2010).

Crusader-Templar is located within the Austin Botanical District and is part of the Eremaean Botanical Province (Beard, 1976). The Project occurs within the Murchison bioregion and Eastern Murchison subregion (MUR01). The Eastern Murchison subregion lies on northern parts of the Yilgarn Craton, within the Kalgoorlie Province soil-landscape (Tille, 2007). Red/brown calcareous loamy earths are the dominant surface soil group. Located on greenstone and granitic rocks, the relief of this province is subdued and comprises of flat to undulating plains with small valleys. Hills, ranges, salt lakes and stony plains occasionally feature in the landscape. Underlying basement geology is of granite, gneiss and greenstone. Geology of the Eastern Murchison bioregion characteristically features internal drainage, extensive areas of elevated red desert sandplains, broad plains of red-brown soils with breakaways, and paleo-drainage salt lakes. Crusader-Templar is situated at a local topographical high point from where surface drainage flows towards Lake Rebecca, located to the south-west. Ephemeral watercourses are present in the landscape but no permanent rivers, creeks or lakes within the region.

Vegetation of the Eastern Murchison subregion is characterised by low woodlands of eucalyptus and mulga. Eucalypts dominate towards the south and mulga dominates increasingly towards the north. The study area features mulga woodlands, eucalypts, eremophilas, hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (Cowan, 2001). Diverse eucalyptus woodlands are present in valleys, on ranges and around salt lakes.

2.2.2 Soils

The Project is located within the Salinaland Plains Zone of the Kalgoorlie Province soil-landscape according to Tille (2007). Soils characteristic of the Salinaland Plains are red sandy earths, red deep sands, red loamy earths and red shallow loams which sometimes feature hardpans. These soils are in association with sandplains including hardpan wash plains, mesas, stony plains and salt lakes on granitic rocks of the Yilgarn Craton.

A search of NRInfo (natural resource information) database (DPIRD, 2018) provided general soils data for Crusader-Templar. The Project area is within the Gundockerta and Nubev land systems, encompassed by the greater North-Eastern Goldfields soil-landscapes as classified by the soil landscapes and land mapping system (DPIRD, 2018). The Gundockerta system is associated with extensive, gently undulating calcareous stony plains supporting bluebush shrublands, while

the Nubev system is characterised by gently undulating stony plains, minor limonitic low rises and drainage floors supporting mulga and halophytic shrublands (DPIRD, 2018). These plains may be susceptible to soil erosion if protective shrub, soil surface or mantle cover is impacted (DPIRD, 2018).

Soil and landform unit descriptions for the different land systems are summarised below in Table 2 and presented visually in Figure 5.

Table 2. Regional Soil & Landform Units

Soil and Landform Unit	Code	Description
Gundockerta	279Gu	Calcareous loamy earths, red shallow sandy duplexes, stony soils, red-brown hardpan shallow loam, red-brown non-cracking clay.
Nubev	279Nu	Red shallow loams, red shallow sandy duplexes and red shallow sands.

8.1.1 Soil characterisation

Soil types at Crusader-Templar vary, with calcareous loamy earth and red shallow loam dominant (DPIRD, 2018). Soils across Crusader-Templar are indicated to be neutral to slightly alkaline pH, with low surface salinity between 50-300 mS/m. Organic carbon content is expected to be low with susceptibility to soil structure degradation being variable. Indicative soil characterisation of Crusader-Templar is shown in Table 3.

Table 3. Land systems and associated indicative soil qualities at Crusader-Templar according to DPIRD (2018)

Soil Groups	% of Land System	pH at 20 cm Depth	Surface Salinity (mS/m)	Organic Carbon Content	Structure Degradation Susceptibility
Gundockerta Land System					
Calcareous loamy earth	55	8.5	250	Low	Moderate
Red shallow sandy duplex	25	7	300	Low	Low
Stony soil	10	7	50	Low	Low
Friable non-cracking clay	5	7.5	150	Low	High
Red-brown hardpan shallow loam	5	7	250	Low	High
Nubev Land System					
Red shallow loam	50	7	100	Low	High
Red shallow sandy duplex	30	7	300	Low	Low
Red shallow sand	20	7	75	Low	Moderate

Previous studies of the neighbouring Wallbrook Mine assessed soil properties of the area that can be broadly attributed to Crusader-Templar. Topsoil was described to be relatively coarse textured, ranging from clayey sand to gravelly silty clay loam while subsoil was described as clayey fine sand to sandy loam (MBS Environmental, 2009). Soil analysis indicated neutral to slightly alkaline pH and generally low salinity with concentrations of 20-85 mS/m. Total sulphur content was identified to be low and potential for acid generation and associated heavy metal leaching was considered low. Concentrations of plant nutrients were considered typical of the region and adequate for establishment of native vegetation. Concentrations of heavy metals were at concentrations considered unlikely to impact the environment (MBS Environmental, 2009).

During construction of proposed activities, topsoil will be stripped to a minimum depth of approximately 150 mm and stockpiled for rehabilitation purposes. Native plants in the region are well adapted to soil properties detailed above therefore they should not impede vegetation growth.

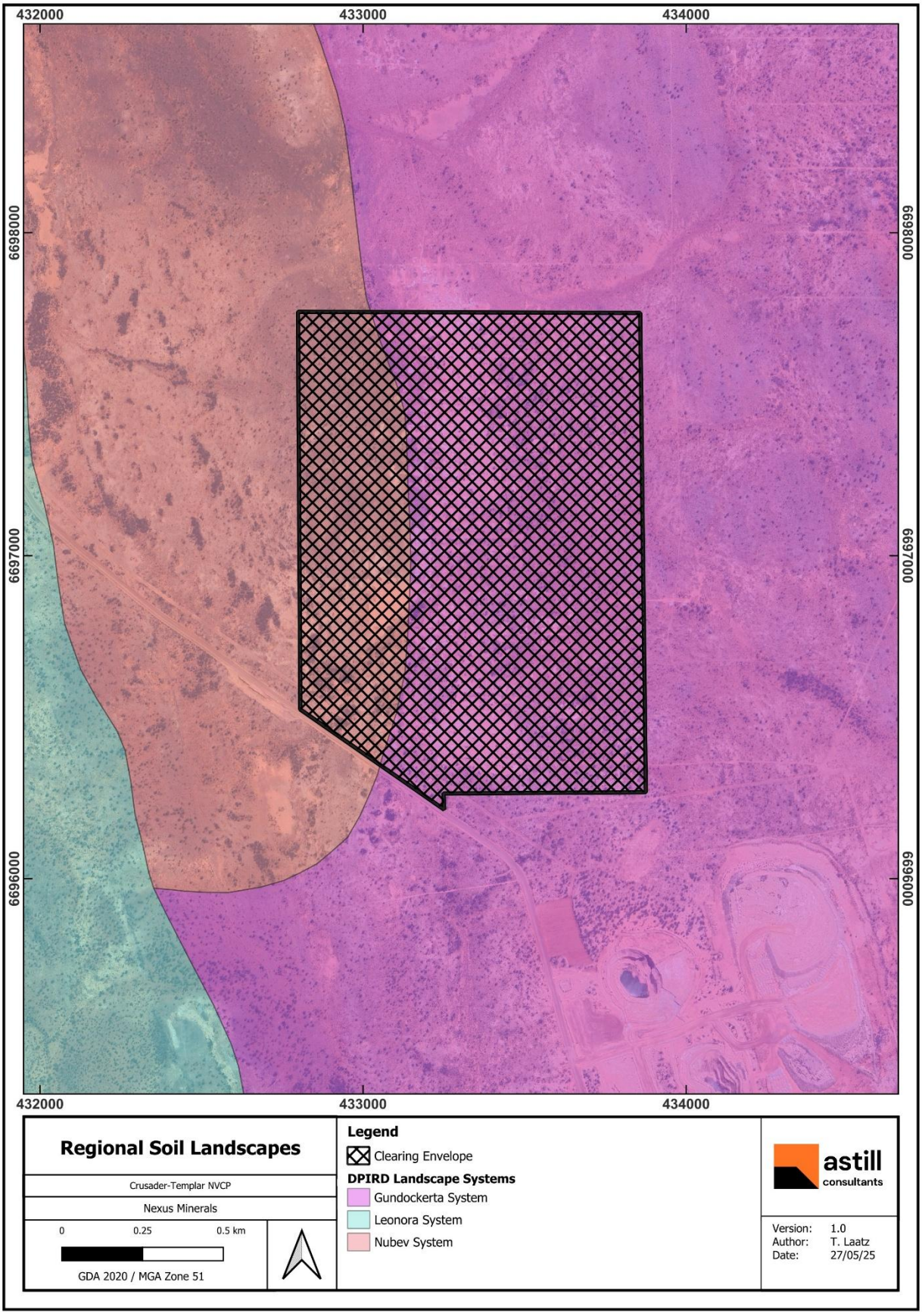


Figure 5. Regional Soil Landscapes

2.3 Biodiversity

2.3.1 Biological Surveys

Native vegetation clearing is required to facilitate development of the Project. To support this, biological surveys have been undertaken over the project area with a summary of surveys detailed in Table 4 below. Biological survey area is shown in Figure 6. Relevant biological surveys are provided in **Appendix B**.

Table 4. Biological Surveys

Survey title	Fieldwork date	Limitations identified	Author / reference
Detailed Flora and Vegetation Survey of the Wallbrook Project Area	May 2022	N/A	Native Vegetation Solutions
Vertebrate Fauna Reconnaissance Survey and Risk Assessment	February 2022	N/A	Terrestrial Ecosystems
Environmental Assessment: Proposed Wallbrook Mine Sites and Surrounds	March 2009	N/A	Alexander Holm & Associates



Figure 6. Flora & Fauna Survey Area

2.3.2 Vegetation

Pre-European vegetation association dataset (DPIRD, 2019) indicates that the Project area is located within one vegetation association. Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered "endangered". As shown in Table 5, the vegetation association within the disturbance envelope is Barlee 400 and it retains > 99% of the pre-European extent (Beard et al 2013). Therefore, development within the disturbance envelope will not significantly reduce the extent of pre-European vegetation associations or increase risk of loss. As concluded from previous flora and vegetation surveys, majority of vegetation represents broader vegetation associations and are not considered regionally significant.

Table 5. Pre-European Vegetation Associations

Vegetation Association	Extent Remaining (%)	Structural Description	Floristic Description
Barlee 400	99.45	Succulent steppe with open low woodland. Saltbush and/or bluebush with scattered low trees	Mulga, other wattle, Casuarina, *Atriplex* spp. *Maireana* spp. with *Acacia aneura, A. papyrocarpa, Allocasuarina cristata*.

2.3.2.1 Vegetation Groups

Native Vegetation Solutions carried out a Detailed Flora and Vegetation survey of the project area in 2022 which defined a total of four vegetation types at Crusader-Templar as described in Table 6 and shown in Error! Reference source not found. Additionally, a bare clay pan comprising 0.93% of the survey area was identified where no vegetation was recorded.

Vegetation in the survey area has been subjected to historical exploration activities and grazing. Vegetation condition was predominantly assessed as "Good" to "Very Good", with some areas of disturbance which were assessed as "Degraded" (Native Vegetation Solutions, 2022). Observed vegetation disturbance was attributed mainly to access tracks and exploration activities. No flora and vegetation types within the survey area were assessed to be pristine (Native Vegetation Solutions, 2022).

Table 6. Vegetation Types

Vegetation Group Description	Percentage of Survey Area (%)
Mulga over *Maireana sedifolia* shrubland	51.26
Mulga over sclerophyll shrubland	8.28
Open chenopod shrubland with occasional *Mulga*	28.36
Casuarina pauper over *Maireana sedifolia* and *Eremophila pantonii* shrubland on ironstone rocky rises	11.16



Figure 7. Vegetation Type

2.3.2.2 Vegetation Condition

Vegetation in the survey area has been subjected to historic exploration activities and grazing.

In accordance with the Keighery (1994) scale, most of the sites/quadrats inspected were in Good to Very Good condition.

Disturbed areas were present within the survey area, mostly attributed to access tracks and exploration activities. The vegetation more than 0.5m off these tracks was mostly in Good condition (Keighery 1994).

Vegetation condition is shown below in Figure 8.

2.3.2.3 Conservation Significant Vegetation

No significant vegetation including representatives of Threatened or Priority Ecological Communities (T/PECs) were identified within the disturbance envelope (Alexander Holm & Associates, 2009; Native Vegetation Solutions, 2022).

No Environmentally Sensitive Areas are identified in the vicinity of the Crusader-Templar project, as shown in Figure 9.

2.3.2.1 Environmentally Sensitive Areas and Conservation Reserves

The survey area does not lie within or contain any ESA's or Conservation Reserves (DWER, 2022).



Figure 8. Vegetation Condition

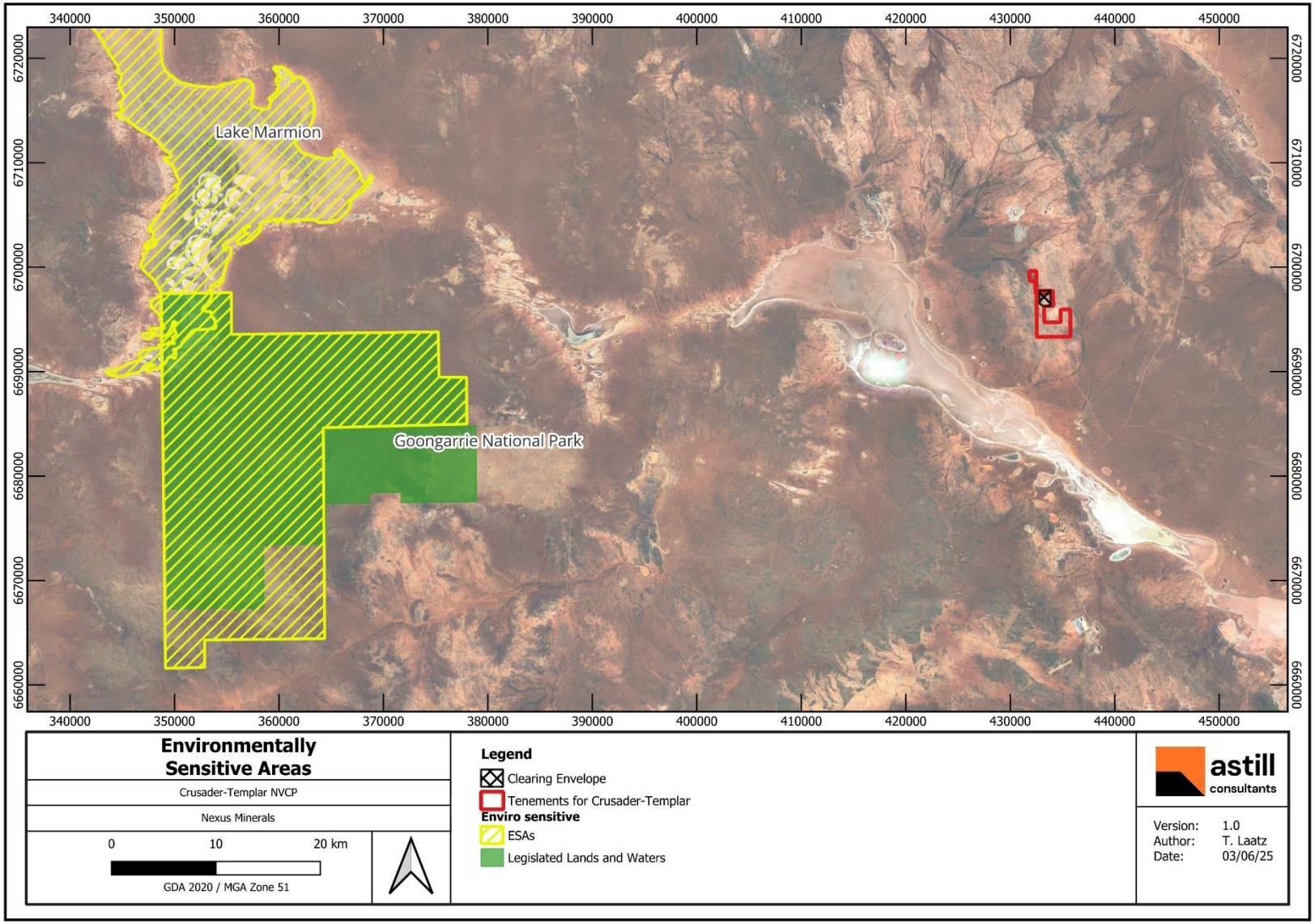


Figure 9: Environmentally sensitive areas

2.3.3 Flora

Native Vegetation Solutions (2022) recorded 54 species within the survey area with 49 species recorded within quadrats. Eighteen families and 27 genera were recorded overall. Of the native species, Chenopodiaceae had the highest representation, with 15 species from six genera. The next best represented families were *Fabaceae* with 12 species and Scrophulariaceae with seven species.

The most common and widespread species were *Ptilotus obovatus*, *Atriplex vescaria*, *Maireana georgei*, *Maireana sedifolia*, *Maireana tomentosa* and *Maireana triptera* which were all recorded within all 12 quadrats. Quadrat 12 had the richest species list with 31 taxa recorded.

2.3.3.1 Conservation Significant Species

There were no Priority of Threatened flora recorded during the survey.

2.3.3.2 Introduced Flora

No introduced weed species were detected within the survey area.

2.3.4 Fauna

A vertebrate fauna reconnaissance survey and risk assessment was carried out by Terrestrial Ecosystems in 2022.

Three broad fauna habitats were mapped within the disturbance envelope: clay pan, scattered Mulga and Casuarina over mixed shrubs and chenopods over a rocky substrate, and scattered Mulga over mixed shrubs and chenopods over sand and clay (Terrestrial Ecosystems, 2022). Some disturbed area was observed, linked to recent exploration activity and historical disturbance associated with exploration and pastoralism. Fauna habitats are broadly described and pictured below in Table 7**.**

Fauna habitats observed in the Project area are considered well represented more broadly in the region. Therefore, fauna assemblage identified in the Project area is likely to be present abundantly in the broader region. As such, proposed activities in the disturbance envelope are unlikely to impact regional fauna biodiversity value.

Primary impacts to fauna in the area are predicted to be direct loss of habitat from clearing of native vegetation and habitat fragmentation. Other impacts of operations include displacement due to noise, dust, light and introduced fauna and weeds, and mortality due to vehicle/fauna interactions.

Table 7. Fauna Habitats

Survey	Habitat type	Example image
Terrestrial Ecosystems (2022)	Clay pan	
	Scattered Mulga and Casuarina over mixed shrubs and chenopods over a rocky substrate	
	Scattered Mulga over mixed shrubs and chenopods over sand and clay	

2.3.4.1 Significant fauna

No evidence of conservation significant fauna species was observed in the Terrestrial Ecosystems (2022) survey.

Based on desktop and field results, 11 fauna species of conservation significance were identified as potentially occurring in the general area during favourable conditions, or as part of a wider foraging range. An assessment was carried out to determine likelihood of significant fauna species occurring in the Project area (Table 8). Eight species of conservation significance were deemed highly unlikely to occur in the Project area and three species were regarded as may infrequently/very infrequently be seen in the region. Assessment concluded a low potential to impact on any of these species in the Project area.

Table 8. Fauna Likelihood of Occurrence

Species	Conservation Status		Assessment	Likelihood
	DBCA Schedule / Priority	EPBC Act		
Night Parrot *Pezoporus occidentalis*	Critically Endangered	Endangered	Highly unlikely to be in the project area, due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.	Would not occur
Sandhill Dunnart *Sminthopsis psammophila*	Endangered	Endangered	Highly unlikely to be in the project area, due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.	Would not occur
Malleefowl *Leipoa ocellata*	Vulnerable	Vulnerable	Highly unlikely to be in the project area due to a lack of suitable habitat and prevalence of feral and pest fauna. No evidence of malleefowl activity (inactive or active mounds, tracks, feathers or bird observations etc.) were observed within the survey area. The potential for impacting on this species is therefore very low.	Would not occur
Grey Falcon *Falco hypoleucos*	Vulnerable	Vulnerable	Highly unlikely to be in the project area due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.	Would not occur
Great Desert Skink *Liopholis kintorei*	Vulnerable	Vulnerable	Highly unlikely to be in the project area due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.	Would not occur
Chuditch *Dasyurus geoffroii*	Vulnerable	Vulnerable	Highly unlikely to occur in the project area. The potential for impacting on this species is therefore very low.	Low
Princess Parrot *Polytelis alexandrae*	Priority 4	Vulnerable	May infrequently be seen in the region, however, clearing vegetation is unlikely to impact on this species.	Medium
Mulgara *Dasycercus blythi*	Priority 4		Highly unlikely to be in the project area due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.	Would not occur
Fork-tailed Swift *Apus pacificus*	Migratory	Migratory	May very infrequently be seen in the region, however, clearing vegetation is unlikely to impact on this aerial species.	Low
Grey Wagtail *Motacilla cinereal*	Migratory	Migratory	Highly unlikely to be present in the project area. The potential for impacting on this species is therefore low.	Low
Peregrine falcon *Falco peregrinus*	OS		May very infrequently be seen in the region, however, clearing vegetation is unlikely to impact on this aerial species.	Low

2.3.4.2 Short Range Endemics

Habitat types in the Project area are regionally common and with a high degree of habitat connectivity, and therefore it is unlikely that any short-range endemic (SRE) species is restricted to the Project area.

2.3.4.3 Subterranean fauna

There have been limited subterranean fauna studies conducted in the vicinity of Crusader-Templar. Typically, stygofauna are found in karstic or fractured formations such as calcretes, limestones and alluvial systems (Humphreys, 2000). Within the arid portion of the Yilgarn Craton where Crusader-Templar is located, significant stygal communities have been associated with major calcrete systems in palaeodrainages (Humphreys, 2000). Stygofauna are dependent on less saline groundwater, typically precluded where salinity is greater than >60,000 mg/L (EPA, 2016; Humphreys, 2008).

The broader Crusader-Templar area is characterised by hypersaline groundwater and a lack of calcrete, meaning it is unlikely stygofauna are present at Crusader-Templar.

2.3.4.4 Introduced fauna

House mice, cats and wild dogs are known to be established in the area.

2.4 Hydrology

Crusader-Templar is located within the interior of Western Australia where the climate is arid, resulting in surface water being insignificant and only present ephemerally. The Project is not located near defined rivers, with several local-scale, ephemeral drainage lines traversing the Project tenements. Drainage lines are typically areas of natural depression and remain dry for a greater part of the year.

Crusader-Templar is positioned at a local topographical high point within moderately hilly terrain, with surface drainage flowing from the Project area towards the main local receptor, Lake Rebecca. Lake Rebecca is located approximately 10 km south-west and spans approximately 115 km in length in a north-west to south-east orientation.

The Project is within the Raeside-Ponton catchment, which is part of the Salt Lake Basin of the Western Plateau division. Within this catchment, water is lost to evaporation and seepage enroute to, and in terminal salt lakes. Salt lakes retain most runoff from surrounding catchments, and only overspill after a particularly high rainfall event.

Proposed operations within watercourses are generally likely to have minor impacts due to the nature of ephemeral drainage lines. Drainage diversion infrastructure will be installed where necessary to ensure that flood risks to the Project at a local scale are mitigated whilst preserving natural flow paths.

There are limited beneficial users of surface water within vicinity of the Project area. Cattle on underlying pastoral leases obtain water from surface water dams located throughout the region.

A map of regional surface water drainage is provided in Figure 10.

2.5 Hydrogeology

Crusader-Templar is located within the Eastern Murchison subregion, which is associated with fractured bedrock aquifers. In this area, groundwater predominantly resides in weathered rock zones near fresh rock interfaces, and within ancient alluvial paleochannel aquifer complexes as part of salt lake systems. Groundwater is primarily replenished by infrequent, high intensity rainfall events, with water entering aquifers directly via salt lake basins and gravitationally via basement rock fractures (Kern, 1995).

Groundwater in the area was identified to be brackish, with Total Dissolved Solids (TDS) of 3,920 mg/L and EC at 25˚C of 7050 µS/cm (Rockwater, 2024a). pH was indicated to be slightly alkaline with a value of 7.98. Mineral content was predominantly sodium, chloride and bicarbonate.

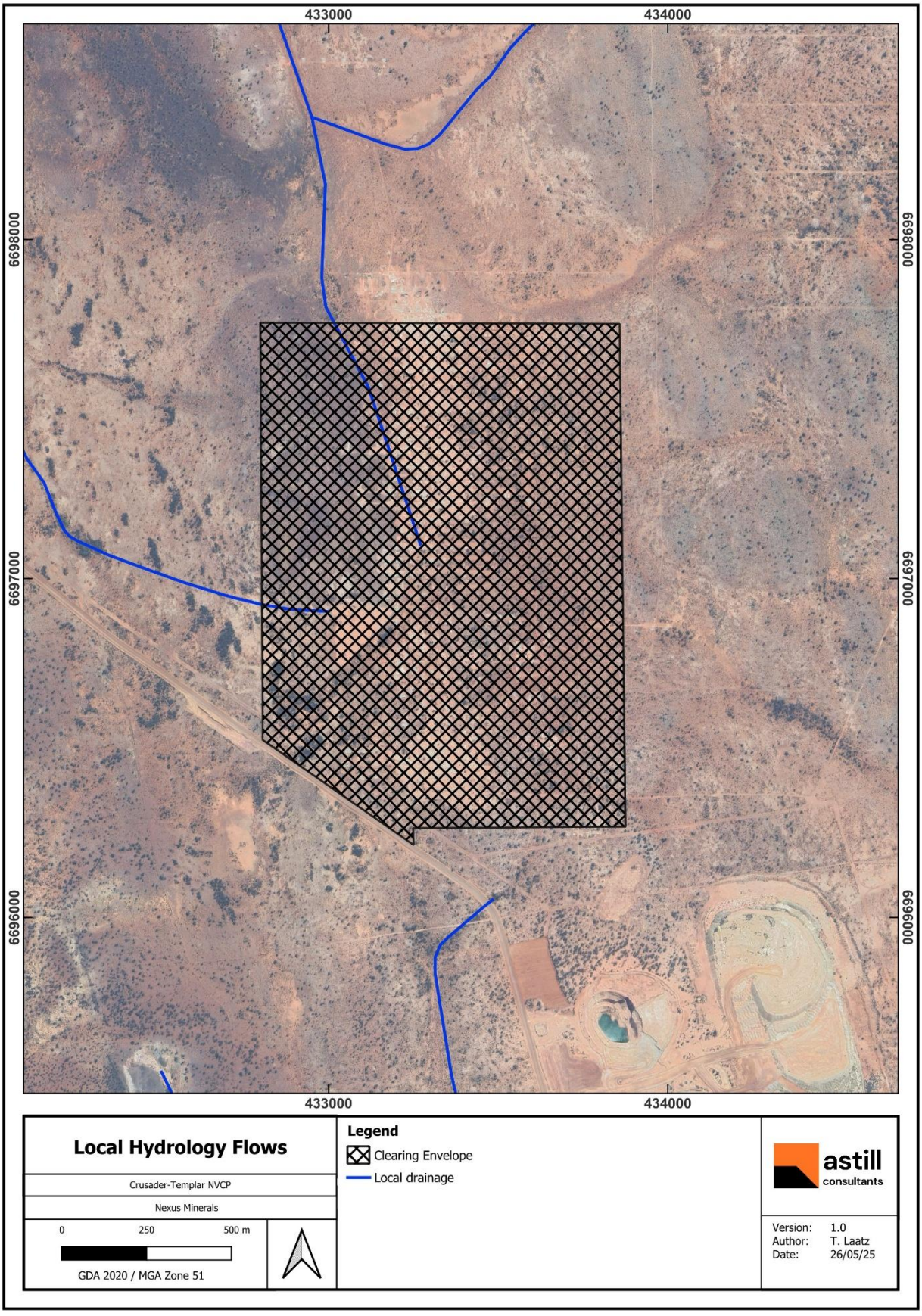


Figure 10. Surface Water Flows

2.6 Heritage

2.6.1 Native Title

There is currently one determined Native Title group over the Project area, Nyalpa Pirniku (WC2019/002) determination. Nexus has consulted with the Nyalpa Pirniku group in relation to the Project and maintains appropriate engagement with relevant knowledge holders and the Native Title group.

2.6.2 Aboriginal Heritage

A search of DPLH Aboriginal Heritage Inquiry System (ACHIS) indicated no places of Aboriginal Heritage significance within 4 km of the clearing area.

An Aboriginal heritage survey was carried out for the Project in 2024 by Daniel de Gand and Associates Pty Ltd with Aboriginal Heritage Consultants of the Nyalpa Pirniku Native Title Group (WC2019/002). Aboriginal Heritage Consultants confirmed no Aboriginal heritage sites, Lodged Places nor Historical places occur on proposed Crusader-Templar Project tenure and consent was given to proceed with proposed works (Daniel de Gand and Associates, 2024).

2.6.3 European Heritage

All European heritage places listed in the WA State Register are protected under the *Heritage Act 2018*. A search of DPLH's inHerit database shows there are no heritage places located in vicinity of the Project. The closest heritage place (included in the State Heritage Register) is Niagara Dam (Place no. 1557) located approximately 98 km north-west of the Project.

No European heritage places will be impacted due to mining operations.

3. Assessment Against Clearing Principles

An assessment against each of the ten clearing principles as defined under Schedule 5 of the EP Act demonstrates that proposed clearing is unlikely to be at variance with any of principles as outlined in Table 9 below.

Table 9. Clearing Principles Assessment

Clearing principle	Assessment	Outcome
a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	Fifty-four species were recorded within the survey area with 49 species recorded within quadrats. Eighteen families and 27 genera were recorded overall. Species composition and vegetation types within the application area are typical of the local region and not considered to be unusually diverse. Based on the low level of disturbance, the lack of fragmentation of vegetation and vegetation condition generally rated as 'Good' to 'Very Good' on the Keighery scale (Keighery, 1994), the area proposed to be cleared is not considered to be remnant vegetation. No Threatened or Priority Ecological Communities were identified within the survey area. No weed species were identified within the survey area.	Unlikely to be at variance to this principle.
b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	The project area does not support conservation significant fauna or a conservation significant ecosystem (Terrestrial Ecosystems, 2022).	Unlikely to be at variance to this principle.
c) Native vegetation should not be cleared if it includes or is necessary for the continued existence of rare flora.	The DBCA database searches revealed a potential for no Threatened and 2 Priority Flora species to occur within a 20 km radius of the survey area (DBCA, 2022a). No known locations of Threatened or Priority Flora occur within the survey area, with the closest Priority Flora located approximately 4.7 km northeast of the survey area. NVS recorded no Priority or Threatened flora during the survey.	Unlikely to be at variance to this principle
d) Native vegetation should not be cleared if it comprises the whole or a part of or is necessary for the maintenance of a threatened ecological community.	There are no known Threatened or Priority Ecological communities previously recorded in the survey area and none were recorded in NVS survey.	Not at variance to this principle
e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared	One Beard vegetation association falls within the survey area, and covers less than 1% of the total association extent inside the survey area at all scales. The relevant vegetation association is above the 30% threshold of their known spatial area remaining post European settlement at a state, bioregional and subregional level, and are not adversely affected by extensive clearing.	Not at variance to this principle

f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	The survey area contains no watercourses or wetlands. The closest waterbody lies 10 km west of the survey area (DWER, 2025).	Unlikely to be at variance to this principle
g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The Crusader-Templar project is relatively small scale and is not expected to result in appreciable land degradation from the clearing of native vegetation.	Unlikely to be at variance to this principle
h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	No conservation areas occur within or adjacent to the survey area.	Not at variance to this principle.
i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	There are no permanent surface water features in the Project area. Groundwater in the region is brackish to saline and has limited uses outside of the mining industry. Groundwater recharge is slow and will not be impacted by clearing activities.	Unlikely to be at variance to this principle
j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	The climate is semi-arid with an average annual rainfall under 300 mm. Surface water is insignificant and only present ephemerally. The Project is not located near defined rivers, with several local-scale, ephemeral drainage lines traversing the Project tenements. Drainage diversion infrastructure will be installed where required to ensure that flood risks to the Project are mitigated whilst preserving natural surface water flow paths.	Unlikely to be at variance to this principle

4. Clearing Process

Vegetation will be cleared by mechanical clearing. Clearing areas will be kept to the minimum required for mine activities and undertaken progressively as required. Existing disturbances will be utilised where possible.

Nexus maintain an internal clearing procedure which will be adhered to for all clearing activities conducted.

4.1 Equipment

Equipment required to undertake and support clearing activities may include a combination of:

- Dozer;
- Loader;
- Excavator;
- Water Cart; and
- Service Vehicles.

4.2 Methodology

Clearing will be authorised by under a clearing permit or valid clearing exemption (i.e., Regulation 20 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*).

Proposed clearing will be demarcated by a surveyor using high visibility tape / survey pegs to ensure clear visual boundaries for operators prior to clearing commencement or alternatively a spotter with handheld GPS will guide clearing. A toolbox meeting will be held between the supervisor and clearing operator to ensure awareness of clearing areas and any areas to be avoided.

Where practicable, raised blade clearing will be used. Where this is not practicable, topsoil will be stripped to 200 mm depth and stockpiled for use in rehabilitation, along with removed vegetation.

Once clearing has been completed, surveyors will complete a pickup of cleared areas and provide the data for records and external reporting obligations.

4.3 Rehabilitation

Rehabilitation of cleared areas will occur in accordance with the Crusader-Templar Mine Closure Plan (MCP) which is being submitted in tandem with the mining proposal application.

5. Environmental Management

Nexus maintains an Environmental Management System (EMS) and implement management strategies and procedures for key environmental areas including those that related to clearing activities (i.e., air quality, fauna, land and soils, vegetation, and weeds). Applicable management measures are summarised below.

5.1 Air quality

Dust is generated from clearing activities, topsoil stripping and spreading. Excessive dust can increase local particulate levels, impacting surrounding vegetation and sensitive receptors.

The following management measures will be implemented to mitigate air quality impacts:

- Weather conditions are monitored, and dust impacts are assessed during clearing;
- Topsoil stripping and spreading activities will be restricted if dust cannot be adequately controlled during periods of high winds; and
- Water carts are available and utilised for wetting down of soils as required.

5.2 Land and soils

Land and soils may be impacted by clearing activities including minor hydrocarbon spills and poor topsoil stripping and handling practises. These impacts may have long term effects on rehabilitation performance.

The following management measures will be implemented to conserve land and soil resources:

- Regular inspections and maintenance of machinery including daily pre-starts;
- Spill kits closely available during clearing activities;
- Stripping topsoil to a maximum depth of up to 200 mm;
- Topsoil stripping to be undertaken as close as possible to commencement of activities; and
- Soils to be paddock-dumped into stockpiles of no greater than 2 m in height and have adequate distance between them to create a series of mounds and troughs.

5.3 Fauna

Fauna impacts (vehicle strike) during clearing activities may result in injury or death of native fauna or livestock. Whilst not all incidents are avoidable, impacts can be minimised.

The following management measures will be implemented to reduce the risk to fauna:

- Speed limits will be signed and enforced;
- Any injury or death of fauna will be recorded and investigated;
- Access to food wastes will be minimised by ensuring effective storage and disposal; and
- Personnel are prohibited from direct contact with fauna, including feeding.

5.4 Vegetation

Vegetation clearing can be minimised through design controls and ensuring that clearing only occurs as required.

The following management measures will be implemented to minimise vegetation clearing:

- Utilising existing disturbances where possible for mine infrastructure;
- Choosing paths of least resistance through vegetation when siting roads and other linear infrastructure (where practicable); and
- Retention of canopy trees where possible.

5.5 Weeds

Activities which disturb land and soils including clearing have the potential to create favourable conditions for weed infestation. Weeds can be difficult to eradicate once introduced and prevention of weed infestation has long term benefits for rehabilitation outcomes.

The following management measures will be implemented to manage weed impacts:

- All vehicles and equipment arriving on site will be free of soil, seeds, and vegetative matter;
- Movement of vehicles and equipment will be restricted to areas to be cleared; and
- Weed spray programs may be implemented on a seasonal basis to eradicate identified weed infestations.

5.6 Surface Water

Storm water runoff around the mine area and associated infrastructure must be managed to limit environmental impacts of mine operations on surface water regime and reduce impacts of flooding on safe mine operations. From a risk management perspective, surface water management infrastructure should reduce total risk of an unwanted event occurring such that it becomes acceptable based on DEMIRS environmental objectives and can be appropriately managed. As such, the general management objectives for the Project relating to surface water are as follows:

- Maintain existing hydrological regime as much as is practicable;
- Mitigate impacts on surface water quality from construction and operations and contain or treat any contaminated water on-site; and
- Ensure quality of the water released from site will not lead to significant deterioration of water resources and environment downstream.

6. References

Alexander Holm & Associates (2009). Environmental Assessment: Proposed Wallbrook Mine Sites and Surrounds. Prepared for Nexus Minerals, July 2009.

Beard JS (1976). Vegetation Survey of Western Australia: Murchison'. University of Western Australia Press: Nedlands, WA.

Beard, J.S. (1990). Plant Life of Western Australia. Kangaroo Press, NSW.

Beard, J. S., Beeston, G.R., Harvey, J.M., Hopkins, A. J. M. and Shepherd, D. P. (2013). The Vegetation of Western Australia at the 1:3,000,000 scale. Explanatory memoir. Second edition. Conservation Science Western Australia 9: 1-152.

Bureau of Meteorology (BoM 2024). Climate statistics for Australian locations – Kalgoorlie (#12038). Retrieved from http://www.bom.gov.au/climate/data/index.shtml

Cowan, M. (2001). A Biodiversity Audit of Western Australia's 53 Biogeographical Region in 2001; Murchison 1 (MUR1 – East Murchison subregion), Department of Conservation and Land Management, August 2001.

de Gand, D. (Daniel de Gand and Associates Pty Ltd) (2024). Report on the Aboriginal Ethnographic Heritage Field Assessment of the Wallbrook Project Areas Located Near Edjudina Station in Western Australia. Prepared for Nexus Minerals, April 2024.

Department of Planning, Lands and Heritage (DPLH, 2025). Aboriginal Cultural Heritage Inquiry System. Retrieved from: https://espatial.dplh.wa.gov.au/ACHIS/index.html?viewer=ACHIS

Department of Planning, Lands and Heritage (DPLH 2025). The State Register and Other Heritage Listings inHerit. WA Government. Retrieved from: http://inherit.stateheritage.wa.gov.au/public

DPIRD (Department of Primary Industries and Regional Development) (DPIRD 2018). Soil Landscape Mapping - Systems (DPIRD-064). Retrieved from: https://catalogue.data.wa.gov.au/dataset/soil-landscape-mapping-systems

Department of Primary Industries and Regional Development (DPIRD 2019). Pre-European Vegetation Associations (DPIRD-006). Retrieved from: https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006

Department of Water and Environmental Regulation (2025). Clearing Permit System. Available to view at: https://cps.dwer.wa.gov.au/main.html

EPA, Environmental Protection Authority (2016). Technical Guidance: Sampling Methods for Subterranean Fauna Survey. Government of Western Australia.

Humphreys, W.F. (2000). Groundwater calcrete aquifers in the Australian arid zone: the context to an unfolding plethora of stygal diversity. Records of the Western Australian Museum Supplement 64: 233-234.

Humphreys, W. F. (2008). Rising from Down Under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective. *Invertebrate Systematics* 22: 85–101.

Interim Biogeographic Regionalisation for Australia (IBRA 2010). Interim Biogeographic Regionalisation for Australia Version 6.1, Department of the Environment, Water, Heritage and the Arts.

Keighery, B. (1994). Bushland Plant Survey: A Guide to Plant Community Survey for the Community. Floreat, Western Australia.

Kern A. M. (1995). Hydrogeology of the Kalgoorlie 1:250 000 sheet: Western Australia Geological Survey,1 :250 000 Hydrogeological Series Explanatory Notes, 16p.

MBS Environmental (2009). Enterprise and Wallbrook Gold Projects – Waste Characterisation and Acid Rock Drainage Management. Prepared for Saracen Gold Mines Pty Ltd, 2009.

MBS Environmental (2024). Wallbrook Gold Project Waste Rock Characterisation. Prepared for Nexus Minerals.

Native Vegetation Solutions (2022). Detailed Flora and Vegetation Survey of the Wallbrook Project Area – May 2022. Prepared for Nexus Minerals, August 2022.

Rockwater (2024a). H2 Hydrogeological Assessment for Dewatering of Crusader-Templar Deposit. Prepared for Nexus Minerals, July 2024.

Terrestrial Ecosystems (2022). Vertebrate Fauna Reconnaissance Survey and Risk Assessment Edjudina Project Area. Prepared for Nexus Minerals, August 2022.

Tille, P. (2007) Resource Management Technical Report 313. Soil-Landscapes of Western Australia's Rangelands and Arid Interior. Department of Agriculture and Food Government of Western Australia.

7. Appendices

Appendix A: Proof of ownership

Appendix B: Biological surveys

1. Detailed Flora and Vegetation Survey of the Wallbrook Project Area (Native Vegetation Solutions, May 2022)
2. Vertebrate Fauna Reconnaissance Survey and Risk Assessment (Terrestrial Ecosystems, February 2022)
3. Environmental Assessment: Proposed Wallbrook Mine Sites and Surrounds (Alexander Holm & Associates, March 2009)

Appendix B: Biological surveys

DETAILED FLORA AND VEGETATION SURVEY OF THE WALLBROOK PROJECT AREA

May 2022

Prepared for: NEXUSMINERALS

Prepared by: **Native Vegetation Solutions**
PO Box 41
KALGOORLIE WA 6430
Telephone: 08 9021 5818
Mobile: 0407 998 953
E-mail: eren@nativevegsolutions.com.au
ABN: 63 584 896 400

FINAL
V2.0
August 2022

EXECUTIVE SUMMARY

Nexus Minerals (ASX: NXM) is a resource company with a portfolio of gold projects including a highly prospective tenement package in the Eastern Goldfields and is the operator of its Wallbrook Gold Project in Western Australia. Nexus Minerals provided Native Vegetation Solutions (NVS) with a survey area which encompasses mining areas as well as other infrastructure related to mining the Wallbrook mineral resource. The location of this survey area is approximately 130 km northeast of Kalgoorlie-Boulder in the Murchison Bioregion of Western Australia (Figure 1).

The survey area, for the purposes of this report, covers an area totalling approximately 188.84 ha. The area encompasses sections of land within Exploration License E 31/1108 and Mining Licences M 31/0231 and M 31/0251. At this stage, the final footprint of mining related disturbances is yet to be finalised, however will be entirely within the survey area, and is expected to be less than 188.84 hectares.

The survey area is located in the Eastern Murchison Interim Biogeographic Regionalisation for Australia (IBRA) subregion. The vegetation of the Eastern Murchison botanical subregion consists of Mulga woodlands often rich in ephemerals. Vegetation is dominated by hummock grasslands, saltbush and Halosarcia shrublands (CALM, 2002).

The *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters Search Tool revealed that the survey area may contain habitat for the invasive weed species *Carrichtera annua* (Ward's Weed) and *Cenchrus ciliaris* (Buffel Grass) (DAWE, 2022a). The EPBC Protected Matters report indicated no Threatened Ecological Communities (TECs) or Commonwealth Reserves within the requested search area.

The Western Australian Department of Biodiversity Conservation and Attractions (DBCA) database searches revealed a potential for no Threatened and 2 Priority Flora species to occur within a 20 km radius of the survey area (DBCA, 2022a). No known locations of Threatened or Priority Flora occur within the survey area, with the closest Priority Flora located approximately 4.7 km northeast of the survey area.

The Priority Ecological Communities (PEC) and Threatened Ecological Communities (TEC) search revealed no PEC/TECs within the survey area (DBCA, 2022).

The survey area does not lie within or contain any Environmentally Sensitive Areas (ESA) or Conservation Reserves (DWER, 2022).

No water bodies were identified within the survey area via the Clearing Permit System (CPS) Map Viewer (DWER, 2022).

The survey area lies south of the 26th parallel, however receives average annual rainfall of approximately 265.6 mm (BOM, 2022). There is no record of *Phytophthora cinnamomi* (Dieback) establishing in natural ecosystems in regions receiving <400mm rainfall per annum (CALM, 2003). Therefore, Dieback is not considered an issue for this survey area, however all measures should be taken to prevent any possible soil contamination (seeds of non-native species *etc*.) which poses a risk in the survey area during seasonally favourable conditions.

Four vegetation groups were identified during this survey, largely following topographical features and dominant species. Mapping of the four vegetation groups, as well as the quadrat locations can be seen in Appendix C. Photographs of each quadrat and the relevant vegetation group can be seen in Appendix F.

Fifty-four species were recorded within the survey area with 49 species recorded within quadrats. Eighteen families and 27 genera were recorded overall. These are listed in Appendix E, per Quadrat as well as per vegetation group. Of the native species, Chenopodiaceae had the highest

representation, with 15 species from 6 genera. The next best represented families were Fabaceae with 12 species and Scrophulariaceae with 7 species.

No introduced weed species were detected within the survey area.

The most common and widespread species were *Ptilotus obovatus, Atriplex vescaria, Maireana georgei, Maireana sedifolia, Maireana tomentosa* and *Maireana triptera* which were all recorded within all 12 quadrats.

Quadrat 12 had the richest species list with 31 taxa recorded.

There were no Priority or Threatened flora recorded during the survey.

Vegetation condition was generally 'Good' to 'Very Good' (Keighery 1994). Disturbance was present within the survey area mostly attributed to, access tracks and exploration related activities.

The Environmental Protection Authority's (EPA) objective for flora and vegetation is to maintain the abundance, species diversity and geographical distribution of flora and vegetation as well as protect Threatened flora, consistent with the provisions of the *Biodiversity Conservation Act 2016.*

The proposed clearing of vegetation will result in the loss of some individuals from the local area; however, the impact will not be great enough to remove whole communities or populations. Most of the species and communities recorded during this survey are widespread throughout the Eastern Murchison subregion and adjoining regions, and therefore the loss of a small proportion from this area will not be significant.

This report summarises the results of a detailed flora and vegetation survey, incorporating the Autumn survey of 2022.

TABLE OF CONTENTS

Page No.

EXECUTIVESUMMARY ..... **i**

1 INTRODUCTION ***1***

1.1 BACKGROUND 1
1.2 PURPOSE AND SCOPE 3
1.3 STATUTORY FRAMEWORK AND GUIDANCE 3
1.3.1 Western Australian Biodiversity Conservation Act 2016 ..... *4*
1.3.2 Environmental Protection Act 1986 ..... *4*
1.3.3 Environment Protection and Biodiversity Conservation Act 1999 ..... *4*
1.3.4 Flora *4*
1.3.5 Ecological Communities and Vegetation *5*

2 EXISTING ENVIRONMENT ***7***

2.1 CLIMATE 7
2.1.1 Temperature *7*
2.1.2 Rainfall *7*
2.2 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA (IBRA) REGION 8
2.3 LANDFORMS AND SOILS 8
2.4 BOTANICAL SUBREGION AND EXISTING VEGETATION 8

3 METHODS ***9***

3.1 PERSONNEL AND REPORTING 9
3.2 PRELIMINARY DESKTOP STUDY 9
3.2.1 Environment Protection and Biodiversity Conservation Act Protected Matters *9*
3.2.2 Threatened Flora and Communities *9*
3.2.3 Environmentally Sensitive Areas (ESAs) and Conservation Reserves *9*
3.2.4 Land Systems *9*
3.2.5 Vegetation Type, Extent and Status *10*
3.2.6 Wetlands *10*
3.2.7 Dieback *10*
3.3 SITE INVESTIGATION 10
3.3.1 Licenses *10*
3.3.2 Field Methods *10*
3.3.3 Post-Field Methods *11*
3.3.4 Mapping *12*
3.3.5 IBSA Data Package *12*
3.4 NOMENCLATURE AND TAXONOMY 12
3.5 LIMITATIONS 13

4 RESULTS ***14***

4.1 PRELIMINARY DESKTOP ASSESSMENT 14
4.1.1 EPBC Protected Matters Search Tool *14*
4.1.2 Threatened Flora and Communities *14*
4.1.3 Environmentally Sensitive Areas and Conservation Reserves *14*
4.1.4 Land Systems *14*
4.1.5 Vegetation Type, Extent and Status *15*
4.1.6 Wetlands *16*
4.1.7 Dieback *16*
4.2 FIELD ASSESSMENT 16
4.2.1 Vegetation of the Survey Area *16*
4.2.2 Flora of the Survey Area *19*
4.3 ASSESSMENT OF THE CLEARING PRINCIPLES 21

5 DISCUSSION ***23***

IMPACT ASSESSMENT ***24***

5.1 THREATENING PROCESSES 24

6 CONCLUSIONS 25

7 REFERENCES 26

8 GLOSSARY 28

FIGURES

Figure 1: Regional Location of the Wallbrook Project Area 2
Figure 2: Mean temperature ranges for Kalgoorlie-Boulder Airport Meteorological Station (BOM, 2022) 7
Figure 3: Rainfall data for the Kalgoorlie-Boulder Airport Meteorological Station (BOM, 2022) 8
Figure 4: PATN Analysis of Dominant Species into four groups 17
Figure 5: PATN Analysis of All Species into four groups 18
Figure 6: Species Accumulation Curve for the 12 sampled quadrats 20

TABLES

Table 1: List of potential survey limitations 13
Table 2: Land Systems occurring within the survey area (DPIRD, 2017) 15
Table 3: Extent of Beard Association within the survey area 15
Table 4: Summary of information regarding Pre-European and current vegetation extent of vegetation association 400 within the survey area 15
Table 5: Vegetation Group Extent within Survey Area 16

APPENDICES

Appendix A - EPBC and Other Government Database Search Results 31
Appendix B - Vegetation Definitions 41
Appendix C - Mapping 44
Appendix D - Threatened Flora Database Search Results 51
Appendix E - Species Recorded During the May 2022 Survey 53
Appendix F - Site Descriptions 58

1 INTRODUCTION

1.1 BACKGROUND

Nexus Minerals (ASX: NXM) is a resource company with a portfolio of gold projects including a highly prospective tenement package in the Eastern Goldfields and is the operator of its Wallbrook Gold Project in Western Australia. Nexus Minerals provided Native Vegetation Solutions (NVS) with a survey area which encompasses mining areas as well as other infrastructure related to mining the Wallbrook mineral resource. The location of this survey area is approximately 130 km northeast of Kalgoorlie-Boulder in the Murchison Bioregion of Western Australia (Figure 1).

This report will support numerous applications including mining proposals and clearing permits submitted to relative Government Departments.

The survey area, for the purposes of this report, covers an area totalling approximately 188.84 ha. The area encompasses sections of land within Exploration License E 31/1108 and Mining Licences M 31/0231 and M 31/0251. At this stage, the final footprint of mining related disturbances is yet to be finalised, however will be entirely within the survey area, and is expected to be less than 188.84 hectares.



Figure 1: Regional Location of the Wallbrook Project Area

1.2 PURPOSE AND SCOPE

The objective of this report is to record and analyse the results of the flora and vegetation component of a Detailed assessment conducted in accordance with the following documents:

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

A Detailed Flora and Vegetation Survey has two components:

1) Reconnaissance Survey
   a) Desktop study which includes a literature review and a search of the relevant databases; and
   b) Reconnaissance survey of the subject area to verify the desktop survey, undertake low impact sampling, define vegetation groups present in the area, search for species of conservation significance and to determine potential sensitivity to impact.

2) Detailed Plot Based Survey
   a) Detailed survey, comprising multiple visits in main flowering seasons or other seasons and replication of plots in vegetation units incorporating greater coverage than a reconnaissance survey; and
   b) Comprehensive survey when necessary to: enhance the level of knowledge at the locality or sub-regional scale, in order to provide wider context for the local scale.

Therefore, the scope of work for the Detailed flora and vegetation survey was to:

- Conduct a desktop study that includes a literature review and search of relevant databases
- Conduct a plot-based survey within the survey area (incorporating 20m x 20m quadrats)
- Prepare an inventory of species occurring in the study area
- Conduct PATN© analysis of quadrat-based presence/absence data
- Quantify survey intensity via a Species Accumulation Curve
- Describe the vegetation associations in the survey area
- Identify any vegetation communities or flora species of particular conservation significance
- Map broad-scale vegetation groups found within the survey area, including vegetation condition; and
- Provide recommendations, including the management of perceived impacts to flora and vegetation, particularly flora of conservation significance, within the study area.

1.3 STATUTORY FRAMEWORK AND GUIDANCE

This assessment took into account relevant sections of Commonwealth and State legislation and guidelines:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Environmental Protection Act 1986* (EP Act)
- *Biodiversity Conservation Act 2016* (BC Act)
- *Biosecurity and Agriculture Management Act 2007* (BAM Act)

The Minister for the Environment publishes lists of flora species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listings were published in the Government Gazette on 5 December 2018 (Smith and Jones, 2018) and were taken into account.

As well as those listed above, the assessment took into account relevant sections of:

- EPA (2016) *Statement of Environmental Principles, Factors and Objectives*; and
- EPA (2016a) *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*, known as *Flora and Vegetation Technical Guidance*

1.3.1 Western Australian *Biodiversity Conservation Act 2016*

The Western Australian *Biodiversity Conservation Act 2016* (BC Act, the Act) provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. The BC Act replaces the *Wildlife Conservation Act 1950*.

Threatened species (both flora and fauna) that meet the categories listed within the Act are highly protected and require authorisation by the Ministerial to take or disturb. These are known as Threatened Flora and Threatened Fauna. The conservation categories of Critically Endangered, Endangered and Vulnerable have been aligned with those detailed in the EPBC Act, as below.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species in the Act.

Threatened Ecological Communities (TECs) are also protected under the Act and are categorised using the same criteria as threatened species.

1.3.2 Environmental Protection Act 1986

The *EP Act 1986* was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information included in environmental assessments and provided by the proponent), initiates measures to protect the environment and provides advice to the Minister responsible for environmental matters.

1.3.3 Environment Protection and Biodiversity Conservation Act 1999

At a Commonwealth level, Threatened taxa are protected under the EPBC Act, which lists species and ecological communities that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, or Extinct in the Wild (Section 6 below).

1.3.4 Flora

1.3.4.1 Threatened and Priority Flora

Conservation significant flora species are those that are listed as TF (Threatened Flora) and (within Western Australia) as PF (Priority Flora). TF species are listed as threatened by the

Western Australian Department of Biodiversity Conservation and Attractions (DBCA) and protected under the provisions of the BC Act. Some State-listed TF are provided with additional protection as they are also listed under the Commonwealth EPBC Act.

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and these have a greater level of protection than unlisted species.

There are seven categories covering State-listed TF and PF species (DBCA, 2019) which are defined in Section 8 below. PF for Western Australia are regularly reviewed by DBCA whenever new information becomes available, with species status altered or removed from the list (Smith and Jones, 2018) when data indicates that they no longer meet the requirements outlined in Section 8 below.

1.3.4.2 Other Significant Flora

According to the Flora and Vegetation Technical Guidance (EPA 2016a) other than being listed as Threatened or Priority Flora, a species can be considered as significant if it is considered to be:

- locally endemic or association with a restricted habitat type (e.g., surface water or groundwater dependent ecosystems)
- a new species or has anomalous features that indicate a potential new species
- at the extremes of range, recently discovered range extensions (generally considered greater than 100 km or in a different bioregion), or isolated outliers of the main range
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids and
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

1.3.5 Ecological Communities and Vegetation

1.3.5.1 Threatened and Priority Ecological Communities

Nationally Listed Threatened Ecological Communities
An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. The complex range of interactions between the component species provides an important level of biological diversity in addition to genetics and species. At Commonwealth level, Threatened Flora and Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. An ecological community may be categorised into one of the three subcategories:

- Critically Endangered, if it is facing an extremely high risk of extinction in the wild in the immediate future
- Endangered, if it is not critically endangered and is facing a very high risk of extinction in the wild in the near future and
- Vulnerable, if it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

State Listed Threatened Ecological Communities
The Western Australian DBCA also maintains a list of TECs which are further categorised into three subcategories much like those of the EPBC Act.

State Listed Priority Ecological Communities
DBCA maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined.

1.3.5.2 Other Significant Vegetation

According to the Flora and Vegetation Technical Guidance (EPA 2016a), other than being listed as a TEC or PEC, vegetation can be considered as significant if it is considered to have:

- restricted distribution
- a degree of historical impact from threatening processes
- a role as a refuge; and/or
- provides an important function required to maintain ecological integrity of a significant ecosystem.

1.3.5.3 Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories, or exempt:

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage; or
- Exempt (no category).

2 EXISTING ENVIRONMENT

2.1 CLIMATE

The subregion climate is Arid with 200-300 mm of rainfall, sometimes in summer but usually in winter (CALM, 2002). The nearest official meteorological weather station with the most complete and up to date information is Kalgoorlie- Boulder Airport, which is located approximately 131.3 km southwest of the survey area. Recordings of the local climatic conditions commenced at Kalgoorlie-Boulder in 1939 (BOM, 2022) and data collected at this station 012038 was used for this report.

2.1.1 Temperature

Mean annual minimum temperature at Kalgoorlie is 11.8°C and mean annual maximum temperature is 25.3°C. The coldest temperatures occur in July (mean minimum temperature 5.1°C), the hottest is January (mean maximum temperature 33.7°C) and diurnal temperature variations are relatively consistent throughout the year (Figure 2).

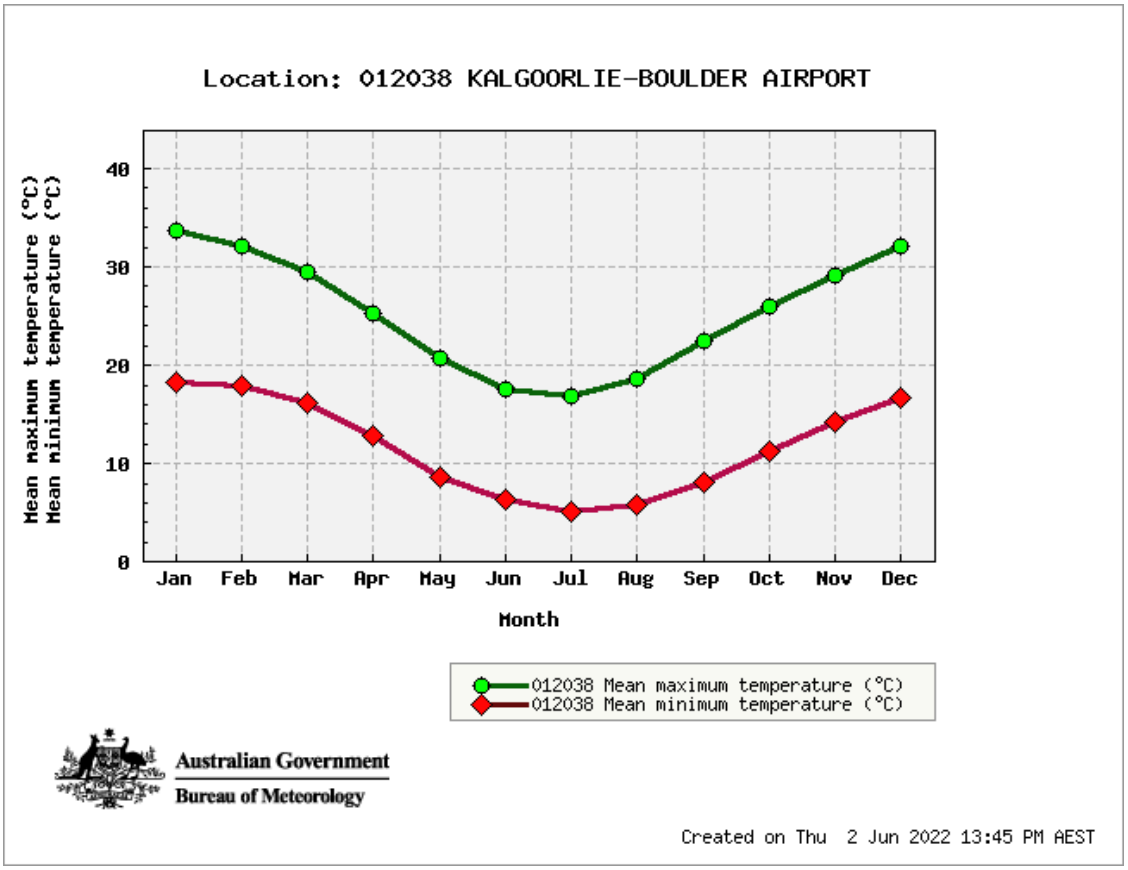


Figure 2: Mean temperature ranges for Kalgoorlie-Boulder Airport Meteorological Station (BOM, 2022)

2.1.2 Rainfall

The annual average rainfall at Kalgoorlie-Boulder Airport is 265.6 mm over an average of 39 rain days (BOM, 2022). Average rainfall varies across the months, with slightly larger rainfall events falling between January to March and May to July (Figure 3). Rainfall for 2022 was above average for the month of April and below average for all other months prior to the survey.

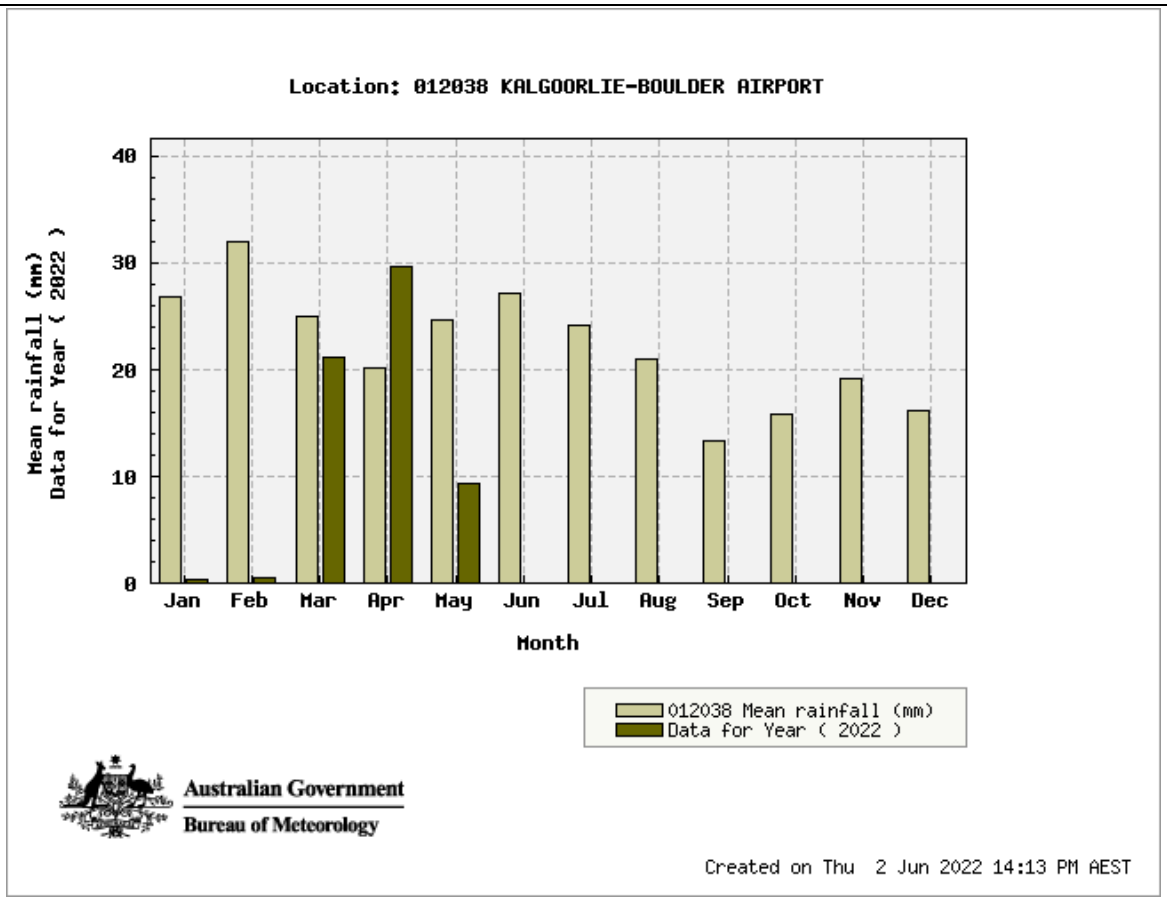


Figure 3: Rainfall data for the Kalgoorlie-Boulder Airport Meteorological Station (BOM, 2022)

2.2 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA (IBRA) REGION

The IBRA recognises 89 bioregions within Australia and 419 subregions (DAWE, 2022). The project is located in the Eastern Murchison IBRA subregion (MUR01) which totals over 7 million hectares (CALM, 2002). The Eastern Murchison subregion is characterised by extensive areas of elevated red desert sandplains with minimal dune development and internal drainage. (CALM 2002).

2.3 LANDFORMS AND SOILS

The Eastern Murchison comprises the northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terrains of the Yilgarn Craton. The occluded Paleodrainage system generates Salt Lake systems. Other features include broad plains of red-brown soils, breakaway complexes, and red sandplains (CALM 2002).

2.4 BOTANICAL SUBREGION AND EXISTING VEGETATION

The vegetation of the Eastern Murchison botanical subregion consists of Mulga woodlands often rich in ephemerals. Vegetation is dominated by hummock grasslands, saltbush and Halosarcia shrublands (CALM, 2002).

3 METHODS

3.1 PERSONNEL AND REPORTING

The following personnel were involved in the single season detailed flora and vegetation survey (May 2022):

- Mr Eren Reid (*BSc*- Biological Science), Principal Botanist, Native Vegetation Solutions (NVS), undertook field work of the detailed survey in May 2022, vegetation mapping, data collation, identification of flora during field work and preparation and review of the report
- Ms Adele Thomasz (*BSc*- Conservation and Wildlife Biology), Native Vegetation Solutions, data collation and preparation of the report; and
- Mr Frank Obbens (*BSc*) Consultant Botanist, Bushtech Consultancy, undertook the identification of unknown flora samples collected by NVS in the field. Threatened flora range extensions and new locations were submitted to the WAHERB as per the EPA Technical Guidelines (EPA 2016a).

3.2 PRELIMINARY DESKTOP STUDY

A preliminary assessment of the survey area and its potential constraints was undertaken by reviewing relevant government agency managed databases (Sections 3.2.1 to 3.2.6, and Appendices A & D) and consulting with government agencies where necessary. The following sections provide a summary of desktop searches undertaken for the project.

3.2.1 *Environment Protection and Biodiversity Conservation Act* Protected Matters

The *EPBC Act* Protected Matters Search tool was utilised to provide results for matters of National Environmental Significance within the survey area using the coordinates displayed within the search results (Appendix A) with a 1 km buffer (DAWE, 2022a).

3.2.2 Threatened Flora and Communities

The Threatened and Priority Flora Database managed by the Department of Biodiversity, Conservation and Attractions (DBCA) was searched for threatened and priority flora within a 20 km radial area of the survey area shapefile (DBCA, 2022a).

The presence of Threatened and Priority Ecological Communities (TECs & PECs) was determined by examining Geographic Information System (GIS) data supplied by the DBCA upon request within a 50 km buffer of the survey area shapefile (DBCA, 2022).

3.2.3 Environmentally Sensitive Areas (ESAs) and Conservation Reserves

The Department of Water and Environmental Regulation (DWER) Clearing Permit System (CPS) Map Viewer was used to determine the location of any ESAs and Conservation Reserves (DWER, 2022).

3.2.4 Land Systems

As part of the Rangeland resource surveys, the Department of Agriculture mapped the Land Systems of Western Australia (DPIRD, 2017). The purpose of the survey was to provide comprehensive description and mapping of the biophysical resources of the region, together with an evaluation of the condition of the soils and vegetation throughout. The report and the accompanying series of maps at 1:250,000 scale, are primarily intended as a reference for land managers, land management advisers and land administrators, that is, the people most involved in planning and implementing land management practices. The report and complementary maps

also provide researchers and the public with a basic reference on the landscape resources in Western Australia.

3.2.5 Vegetation Type, Extent and Status

Vegetation extent and status data was sourced from the Department of Agriculture and Food (DAFWA) report and its associated GIS file (Shepherd *et al*, 2002). This data comprises Beard's Pre-European vegetation groups.

DBCA's Statewide Vegetation Statistics (DBCA, 2019) was also referenced for the current extent of Beard's Vegetation Groups. The purpose of examining this information is to determine if the survey area lies within any vegetation groups defined by Beard that may have been subjected to widescale clearing for European settlement. The national objectives and targets for biodiversity conservation recognise that the retention of 30% or more of the pre-clearing extent of a Beard vegetation association is necessary if Australia's biological diversity is to be protected.

3.2.6 Wetlands

The potential of wetlands within the project area was determined by examining DWER's Clearing Permit System Map Viewer (DWER, 2022).

3.2.7 Dieback

Dieback is only considered a potential issue for any project if both of the below factors are relevant for the project (CALM, 2003):

- The project area lies within the South West Land Division; and
- the mean annual rainfall of the area is greater than 400 mm.

3.3 SITE INVESTIGATION

The field survey was conducted by Mr. Eren Reid, Botanist of Native Vegetation Solutions (NVS), on the 6th of May 2022. NVS established 12 quadrats within the survey area, recording 54 vascular plant species within four vegetation groups.

A total of 8 hours was spent on site traversing the survey area in May 2022. While a vehicle was used to reach the site, all traverses were made on foot or via a Yamaha Viking.

The survey was conducted in accordance with relevant EPA's Statements and Guidelines (Section 1.2).

The EPA uses the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for Environmental Impact Assessment decision making in relation to the conservation of biodiversity. Given the scale and nature of the proposed disturbance as well as the existing disturbance, and that the survey area is located within the Murchison IBRA region, a detailed flora and vegetation survey was deemed appropriate.

3.3.1 Licenses

Flora was collected for identification under the Scientific Collection License FB62000171, held by Mr Eren Reid with expiry 08/10/2022.

3.3.2 Field Methods

Prior to the field work, the aerial photography was examined and representative sample sites for quadrat locations were chosen to provide coverage over all viable vegetation types.

20 x 20m quadrats were established at these sites in appropriate locations, taking into account representation of surrounding vegetation and vegetation boundaries.

Each quadrat site was marked in all corners with a 97cm galvanized fence dropper and was defined by tape measures. The location of the North-East (NE) corner was captured on a TwoNav Aventura GPS at ±4m accuracy, using Universal Transverse Mercator location on GDA2020 datum. Digital photographs were taken of each quadrat site from the NE corner.

Data collected at each of the 12 quadrats included:

- Species Present
- Topography
- Rock Type
- Soil Colour and Type
- % Bare Ground and Litter
- Disturbance Level
- Vegetation Condition

A complete list of all species encountered was also recorded, detailing the average height and estimated coverage of the dominant species from the three stratum levels (Tallest, Mid and Lower).

Specimens of taxa not recognised by the Botanist were collected and pressed along with specimens of taxa recognised as, or thought to be, conservation-significant species.

The vegetation structure was assessed using the method developed by Muir (1977). Definitions of the vegetation structure are presented in Appendix B.

The condition of each quadrat was assessed using the method developed by Keighery (1994). Definitions of the condition scale are presented in Appendix B.

Vegetation groups were mapped (section 3.3.4 below).

Relevé sites were used between quadrat sampling points, via wandering traverses, for opportunistic sampling of plant taxa, to collect flora specimens and to aid vegetation group mapping in the survey area. Opportunistic sampled plant taxa are listed in the table “Species List per Vegetation Group” in Appendix E.

Maps of all sample sites are included in Appendix C, Map 2, with detailed quadrat information listed in Appendix F.

3.3.3 Post-Field Methods

Unknown specimens collected in the field were identified post field work by Eren Reid and Frank Obbens with reference to published keys and samples held in the Reference Section of the Western Australian Herbarium (WAHERB). Threatened flora range extensions and new locations were submitted to the WAHERB as per the EPA Technical Guidelines (EPA 2016a).

Species information was transferred into Microsoft Excel® worksheets in preparation for PATN analysis (Belbin, 1994), via Bray and Curtis Flexible unweighted pair group method with arithmetic mean (UPGMA).

PATN Analysis was completed on both the dominant species and all species recorded within each quadrat. PATN is a software package that aims to try and display patterns in complex data. Complex in PATN's terms, requires a minimum of 6 objects (i.e., different species) and a suite of more than 4 variables (i.e., different quadrats) that describe the objects. The vegetation groups listed in Section 4.2.1.2 show the grouping of quadrats based on similarities in the flora species

that are present or absent in each quadrat. This data is entered into the PATN Analysis software which produces a quantitative estimate of the relationship between species composition of each quadrat.

A Species Accumulation Curve is also generated via input into a computer program (Seaby & Henderson, 2006).

3.3.4 Mapping

Vegetation mapping was produced via GPS recorded information in the field, cross-referenced with vegetation descriptions made in the field, overlaid on aerial imagery of the survey area. The GPS utilized (TwoNav Aventura GPS) displayed aerial imagery, hence real-time mapping of vegetation groups was available during field work.

GPS tracks and waypoints recorded during field work are presented in Appendix C. Vegetation Health Condition was assessed in the field with reference to Keighery (1994).

3.3.5 IBSA Data Package

The Environmental Protection Authority (EPA), Department of Water and Environmental Regulation (DWER) and Department of Mines, Industry Regulation and Safety (DMIRS) require Index of Biodiversity Surveys for Assessments (IBSA) Data Packages to be submitted to support assessment and compliance under the *Environmental Protection Act 1986.*

An IBSA data package is a single file in .zip format, containing:

- one **Metadata and Licensing Statement** in .pdf format
- one **survey report** in .pdf format
- one **plain-text survey report** in .txt format; and
- a set of electronic data files, comprising:
    - one **survey details** spatial dataset in shapefile (.shp, etc.) or Mapinfo (.tab, etc.) format; and
    - one or more **survey data** spatial datasets, as required, in shapefile (.shp, etc.) or Mapinfo (.tab, etc.) format.

The IBSA Data package for this survey has been submitted via the DWER IBSA Submission Portal.

3.4 NOMENCLATURE AND TAXONOMY

Nomenclature follows that used by the WAHERB.

The WAHERB has updated its sequence and arrangement of collections to conform to the systematic sequence of the Angiosperm Phylogeny Group (APGIII), with the result that many Families and Genera have been moved or renamed. This report attempts to follow those changes in relation to species recorded during this survey. Definitions of Threatened Flora are also included in Section 8 below.

3.5 LIMITATIONS

Table 1 lists potential limitations that may have affected the survey.

Table 1: List of potential survey limitations

Possible Limitation	Constraint	Comment
Competency/experience of the consultant carrying out the survey	No	Experienced and competent personnel conducted the survey. Eren Reid has over 18 years' experience in botanical surveys throughout the Goldfields and over a variety of environments across Western Australia.
Scope	No	The Scope of work was adequately defined. Vascular flora species were the focus of the survey and were thoroughly sampled.
Proportion of flora identified, recorded and/or collected	No	All taxa not identified in the field were collected and pressed, and later identified by Eren Reid or Frank Obbens. New Threatened flora locations or range extensions were submitted to the WAHERB as per the EPA Technical Guidelines (EPA 2016a). See also Species Accumulation Curves in section 4.2.2.2.
Sources of information	No	Information on flora and vegetation of the region and local area was available from publicly available databases, books and reports.
Proportion of the tasks achieved	No	All tasks completed.
Timing/season	No	This survey was undertaken in May 2022. Local rainfall in 2022 was below average for most months prior to the survey excluding April, however, the survey coincided with flowering of many flora species.
Disturbance in survey area	No	Minimal disturbance (historical access tracks and exploration) was observed within the survey area, however, did not compromise the results of the survey as these areas were avoided whilst collecting data.
Intensity of survey effort	No	The survey intensity is considered to have been sufficient for a detailed survey according to EPA (2016) guidelines. Areas most likely to contain threatened and priority species were targeted. Vegetation mapping sites were selected to provide adequate coverage of the survey area.
Resources	No	Resources, in terms of time, equipment, support and personnel were adequate to undertake and complete the detailed survey.
Remoteness and/or access problems	No	All the areas in need of survey were easily accessible from existing tracks, or by foot.
Availability of contextual information for the region	No	Contextual information regarding vegetation and flora around the Eastern Murchison subregion is readily available. Adequate information was able to be accessed from available databases.

4 RESULTS

4.1 PRELIMINARY DESKTOP ASSESSMENT

4.1.1 EPBC Protected Matters Search Tool

The EPBC Protected Matters Search Tool revealed that the survey area may contain habitat for the invasive weed species *Carrichtera annua* (Ward's Weed) and *Cenchrus ciliaris* (Buffel Grass) (DAWE, 2022a).

Carrichtera annua was introduced into Australia from the eastern Mediterranean, and is now widespread throughout South Australia, the Interior, and Western Australia (Lamp & Collet, 1999). This species is not listed as a declared plant by DPIRD (2022), however according to the EPBC search tool this invasive weed species is considered a threat to the rangeland biodiversity within the Southern Australian Sheep and Cattle Grazing Land Management Zone (DAWE, 2022a).

Cenchrus ciliaris is native to Africa and India, was widely planted in Western Australian pastoral regions as a pasture grass, and has become a widespread weed of roadsides, creeklines, river edges and most vegetation types from Geraldton to the Pilbara, Kimberley and adjacent desert (Hussey *etc*. 2007). In the Murchison region it often colonises roadside table drains, excluding native everlastings. It seriously alters the fire characteristics of invaded plant cover by generating highly flammable fuel that is prone to more frequent fires.

The EPBC Protected Matters report indicated no TECs or Commonwealth Reserves within the requested search area.

The results of the EPBC Protected Matters search are included in Appendix A.

4.1.2 Threatened Flora and Communities

The DBCA database searches revealed a potential for no Threatened and 2 Priority Flora species to occur within a 20 km radius of the survey area (DBCA, 2022a). No known locations of Threatened or Priority Flora occur within the survey area, with the closest Priority Flora located approximately 4.7 km northeast of the survey area.

Results of the threatened flora database search are included in Appendix D.

The PEC/TEC search revealed no PEC/TECs within the survey area (DBCA, 2022).

4.1.3 Environmentally Sensitive Areas and Conservation Reserves

The survey area does not lie within or contain any ESA's or Conservation Reserves (DWER, 2022).

4.1.4 Land Systems

As part of the Rangeland resource surveys, the Department of Agriculture mapped the Land Systems of Western Australia (DPIRD, 2017). The Land Systems occurring within the survey area are listed in Table 2 below, and displayed in Appendix C.

Table 2: Land Systems occurring within the survey area (DPIRD, 2017)

Land System	Description	Extent of Survey Area (ha)	% Of Survey Area (%)
Nubev System	Gently undulating stony plains, minor limonitic low rises and drainage floors supporting mulga and halophytic shrublands.	47.37	25.13
Gundockerta System	Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.	141.13	74.87

4.1.5 Vegetation Type, Extent and Status

One vegetation unit defined by Beard (1990) was identified as part of the desktop assessment. Vegetation units identify the Pre-European extent of vegetation, as mapped by Beard (1990). The national objectives and targets for biodiversity conservation recognise that the retention of 30% or more of the pre-clearing extent of Beard's vegetation associations is necessary if Australia's biological diversity is to be protected.

Information relating to the known Beard (1990) vegetation unit within the survey area has been summarised in Tables 3 and 4 below. This information has been compiled through both desktop assessments and the site visit. The extent of Beard vegetation unit 400 within the survey area is less than 1% of the total area at each scale (Table 3), and each are above the 30% threshold at a State, bioregional and subregional level (Table 4).

Table 3: Extent of Beard Association within the survey area

Beard Vegetation Association	Extent within survey area (ha)	% of survey area (%)	% of extent at each scale^
400	188.84	100.00%	<1%

^ **By Association** (WA) (Shepherd et al., 2002), **By Association** (WA), **By IBRA Region** (Coolgardie), **By IBRA Sub-region** (Eastern Goldfield) and **By LGA** (Shire of Coolgardie) (DBCA, 2019).

Table 4: Summary of information regarding Pre-European and current vegetation extent of vegetation association 400 within the survey area

Factor	Value				
Beard Vegetation Association*	400				
Vegetation Association Description*	Succulent steppe with open low woodland; mulga over bluebush				
Pre-European Extent (ha)	**Scale**				
	By Association *(WA)*	***By Association*** *(WA)*	***By IBRA Region*** *(Murchison)*	***By IBRA Sub-region*** *(Eastern Murchison)*	***By LGA*** *(Shire of Menzies)*
	192,391*	190,823.50**	190,823.50**	190,823.50**	111,745.37**
% Pre-European Extent Remaining	*100.00%**	99.39%**	99.39%**	99.39%**	99.26%**
Surrounding Land Use***	Mining, Exploration, Prospecting, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DBCA, (2019)
*** Source: Field Assessment

4.1.6 Wetlands

No water bodies were identified within the survey area via the CPS Map Viewer. The closest waterbody lies 2.7 km east of the survey area (DWER, 2022).

4.1.7 Dieback

The survey area receives average annual rainfall of approximately 265.6 mm (BOM, 2022). There is no record of *Phytophthora cinnamomi* establishing in natural ecosystems in regions receiving less than 400mm of rainfall per annum (CALM, 2003).

Given the above, Dieback is not considered an issue for this survey area, however all measures should be taken to prevent any possible soil contamination (seeds of non-native species *etc*.) which poses a risk in the survey area during seasonally favourable conditions.

4.2 FIELD ASSESSMENT

4.2.1 Vegetation of the Survey Area

Beard's vegetation associations are very broad and are used over large areas in which there is also a large amount of variation at a more local level. The vegetation groups described below for the survey area fit into the broader Beard description above in section 4.1.4.

The vegetation groups described below were determined visually based on dominant species and topographical features, to form the descriptions taken at the time of the field survey.

Descriptions of all 12 sites/quadrats are presented in Appendix F. For each of these sites, the physical features, vegetation description and unit, along with the species lists for the 20 x 20m plots with typical canopy cover and height, are provided.

4.2.1.1 Vegetation Groups

Four vegetation groups were identified during this survey, largely following topographical features and dominant species. The survey area also contained a bare clay pan where no vegetation was recorded. Table 8 summarises the vegetation group extent and relative Quadrat and flora information. Mapping of the four vegetation groups, as well as the quadrat locations can be seen in Appendix C, Maps 4 and 5. Photographs of each quadrat and the relevant vegetation group can be seen in Appendix F.

Table 5: Vegetation Group Extent within Survey Area

Vegetation Group	Vegetation Group Code	Quadrats	Family	Genera	Species	Area (ha)	Percentage of Survey Area (%)
Mulga over Maireana sedifolia shrubland	A	Q1, Q2, Q8	10	14	29	96.79	51.26
Mulga over sclerophyll shrubland	B	Q4, Q5, Q12	14	19	31	15.64	8.28
Open Chenopod shrubland with occasional Mulga	C	Q3, Q9, Q11	7	9	21	53.56	28.36
Casuarina pauper over Maireana sedifolia and Eremophila pantonii shrubland on ironstone rocky rises	D	Q6, Q7, Q10	10	15	21	21.08	11.16
Bare Clay Pan	NA	NA	NA	NA	NA	1.76	0.93
		Total	18*	27*	54*	188.8#	100%#

*Denotes total recorded in the survey area (not sum of column)
# Denotes sum of column

4.2.1.2 PATN Analysis of Quadrat Data

PATN analysis was used to determine the similarities or differences between and within the delineated vegetation groups. The results are supplied below in Figure 4 and Figure 5 as dendrograms. Dendrograms demonstrate the hierarchical relationship between objects.

Quadrats representing similar vegetation groups (as depicted in field work by NVS) are based on species composition, density, topographical features and/or lithology. The PATN analysis does not take these factors into account, and only demonstrates similarities based on presence/absence data within each quadrat. Therefore, PATN analysis groupings are not necessarily distinct, when defining vegetation groups. Hence quadrats depicted as outliers are expected when variations in species composition occurs between quadrats of the same predetermined vegetation grouping.

The PATN analysis dendrogram of the dominant species in Figure 4, displays each quadrat with like symbols representing the NVS mapped vegetation groups, and coloured lines depicting PATN defined vegetation groups. The dendrogram shows a very good association between vegetation groups described in section 4.2.1.1, as there were no outliers. Outliers are quadrats that do not show a good association with other quadrats in the same NVS mapped vegetation group.

Outliers are expected to occur for most vegetation groups. In most cases one or two dominant species will be present within a 20x20 quadrat, but it will not contain all the varieties of dominant species that will occur across that vegetation type, and as such some quadrats of the same vegetation group will be separated when assessed by the PATN Analysis.

All four vegetation groups were well represented via dominant species PATN Analysis, with all NVS grouped quadrats forming in the analysis. Although all four groups contain dominant species *Acacia mulganeura* and *Maireana sedifolia*, and Vegetation Groups A, B and D also all contain *Casuarina pauper* and *Atriplex vesicaria*, differentiation in species represented in each group becomes more unique for the remaining dominant species.

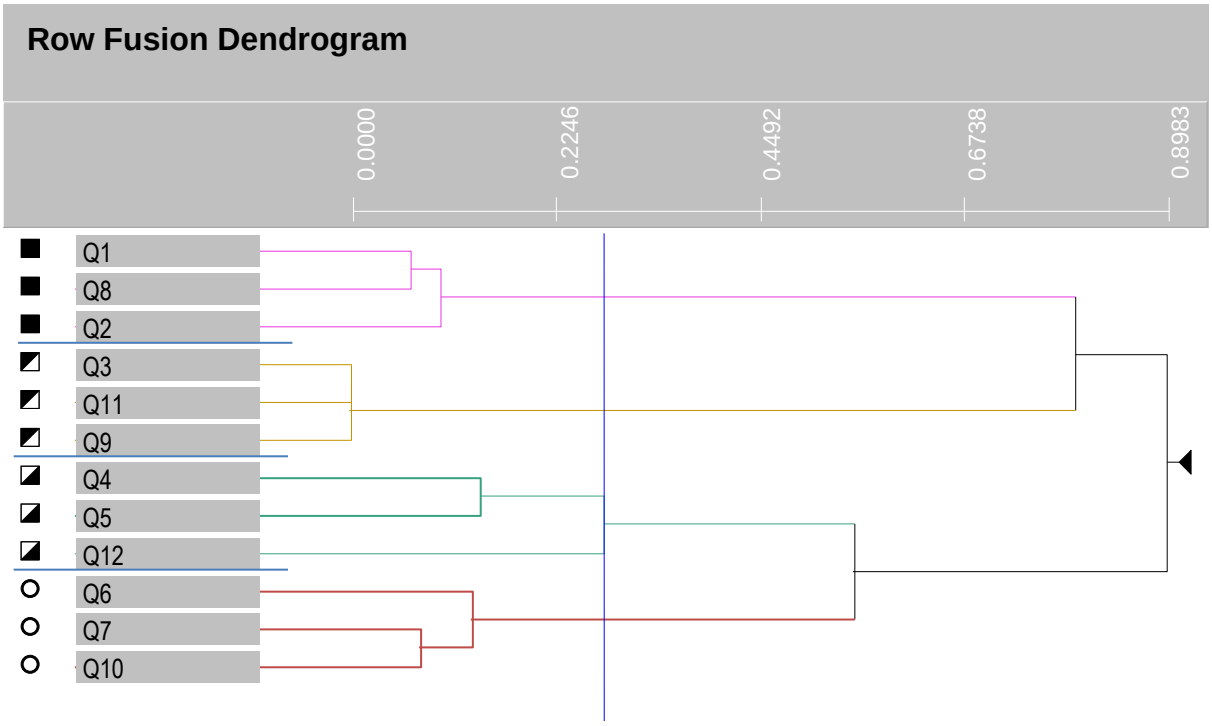


Figure 4: PATN Analysis of Dominant Species into four groups

The dendrogram below (Figure 5) of the analysis of all species shows a correlation to pre-grouped quadrats described in section 4.2.1.1. The dendrogram displays each quadrat with like symbols representing NVS mapped vegetation groups, and coloured lines depicting PATN defined vegetation groups. The All species PATN analysis shows a very good association between vegetation groups as there were no outliers (Figure 5). Outliers are quadrats that do not show a good association with other quadrats in the same NVS mapped vegetation group, which is expected due to the unweighted nature of PATN analysis, which does not take into account topographical/lithological features or the density of key species defining the vegetation group.

All four vegetation groups were well represented via all species PATN Analysis, with all NVS grouped quadrats forming in the analysis. Of the 49 species detected within Quadrats, only seven are shared across all four Vegetation Groups (14.2%), while 23 species are only represented in one of four Vegetation groups (46.9%). Therefore, the vegetation groups mapped by NVS paired with the PATN analysis demonstrate distinct vegetation groups are present in the survey area.

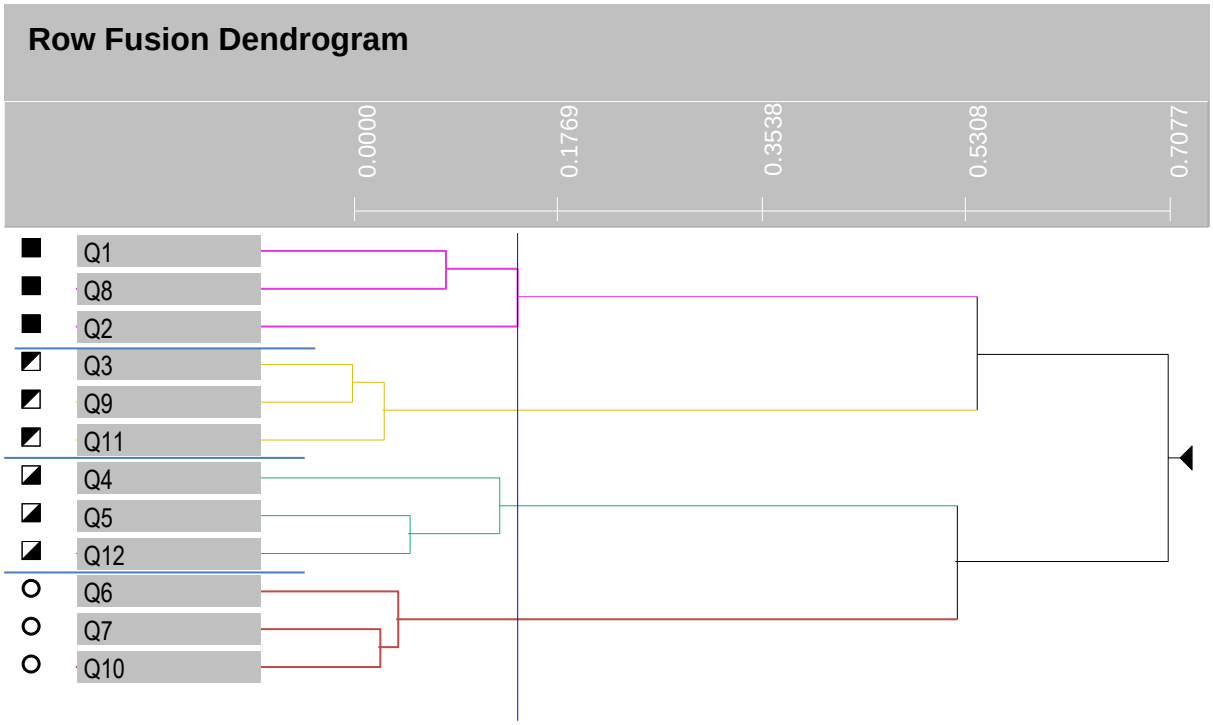


Figure 5: PATN Analysis of All Species into four groups

4.2.1.3 Vegetation Condition

Vegetation in the survey area has been subjected to historic exploration activities and grazing.

In accordance with the Keighery (1994) scale, most of the sites/quadrats inspected were in Good to Very Good condition (Appendix F). Disturbed areas were present within the survey area, mostly attributed to access tracks and exploration activities. The vegetation more than 0.5m off these tracks was mostly in Good to condition (Keighery 1994).

As discussed below in Section 4.2.2.4, there were no non-native species recorded in the quadrats, and no non-native species recorded elsewhere within the survey area.

4.2.2 Flora of the Survey Area

4.2.2.1 General

Fifty-four species were recorded within the survey area with 49 species recorded within quadrats. Eighteen families and 27 genera were recorded overall. These are listed in Appendix E, per Quadrat as well as per vegetation group. Of the native species, Chenopodiaceae had the highest representation, with 15 species from 6 genera. The next best represented families were Fabaceae with 12 species and Scrophulariaceae with 7 species.

No introduced weed species were detected within the survey area.

The most common and widespread species were *Ptilotus obovatus, Atriplex vescaria, Maireana georgei, Maireana sedifolia, Maireana tomentosa* and *Maireana triptera* which were all recorded within all 12 quadrats.

Quadrat 12 had the richest species list with 31 taxa recorded.

4.2.2.2 Species Accumulation Curve

A Species Accumulation Curve was generated using the computer programme Species Diversity and Richness- Version 4.1.2 (Seaby & Henderson, 2006). The model assumed 12 random selections of sample order. This curve was then fitted to a logarithmic curve in Excel® (Figure 6). The logarithmic trend line and R^2 values were generated in Excel®. According to the Species Accumulation Curve below, the R^2 value (0.986) shows an acceptable fit for a logarithmic curve of the total accumulated species per number of quadrats established (Figure 6).

Sufficient sampling was inferred via the effort of intensity (number of quadrats established) versus the return of species collected (total accumulated species). From this fitted logarithmic curve formula, sufficient sampling was determined where the gain of new species was less than 1% for every new quadrat established. Based on this reasoning, sufficient sampling would be reached at 21 quadrats, at which the extrapolated total accumulated number of species was 56. Therefore the 49 species collected within the 12 quadrats represents 86.6% of the predicted total abundance.

Hence sufficient quadrat sampling can be assumed for the survey area.

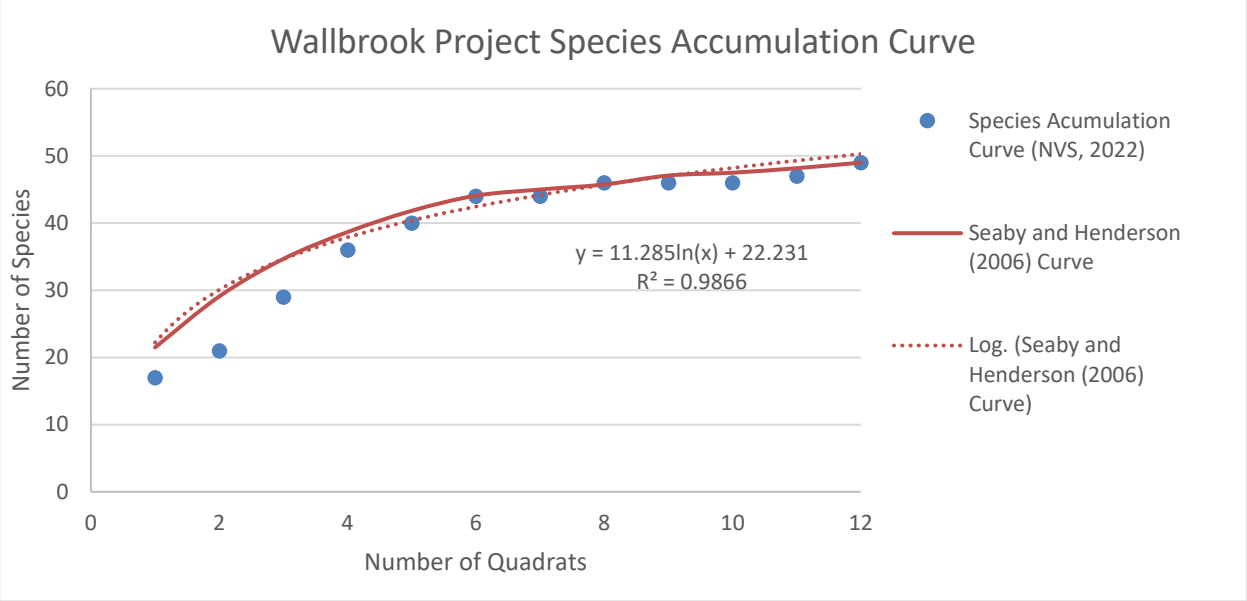


Figure 6: Species Accumulation Curve for the 12 sampled quadrats

4.2.2.3 Conservation significant species

There were no Priority or Threatened flora recorded during the survey.

4.2.2.4 Introduced species

No introduced weed species were detected within the survey area.

4.3 ASSESSMENT OF THE CLEARING PRINCIPLES

The DMIRS and DWER assess clearing permits against ten principles relating to the effect of clearing. NVS submits the following comments regarding the clearing principles specifically related to Native Vegetation.

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

Fifty-four species were recorded within the survey area with 49 species recorded within quadrats. Eighteen families and 27 genera were recorded overall. Species composition and vegetation types within the application area are typical of the local region and not considered to be unusually diverse. Based on the low level of disturbance, the lack of fragmentation of vegetation and vegetation condition generally rated as 'Good' to 'Very Good' on the Keighery scale (Keighery, 1994), the area proposed to be cleared is not considered to be remnant vegetation.

No Threatened or Priority Ecological Communities were identified within the survey area.

No weed species were identified within the survey area.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

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

Not addressed in this assessment.

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

The DBCA database searches revealed a potential for no Threatened and 2 Priority Flora species to occur within a 20 km radius of the survey area (DBCA, 2022a). No known locations of Threatened or Priority Flora occur within the survey area, with the closest Priority Flora located approximately 4.7 km northeast of the survey area.

NVS recorded no Priority or Threatened flora during the survey.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

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

There are no known Threatened or Priority Ecological communities previously recorded in the survey area and none were recorded in this survey.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

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

As demonstrated in section 4.1.4, one beard vegetation association falls within the survey area, and covers less than 1% of the total association extent inside the survey area at all scales. The relevant vegetation association is above the 30% threshold of their known spatial area remaining post European settlement at a state, bioregional and subregional level, and are not adversely affected by extensive clearing.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

f). Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland

The survey area contains no watercourses or wetlands. The closest waterbody lies 2.7 km east of the survey area (DWER, 2022).

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

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

Not addressed in this assessment.

h). Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area

No conservation areas occur within the survey area.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

i). Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water

Not addressed in this assessment.

5 DISCUSSION

The survey area is located within the Eastern Murchison subregion (CALM, 2002). Results of this survey indicate that the majority of the flora within the survey area is not unique and is in fact common throughout the Eastern Murchison subregion and adjoining regions.

Fifty-four species were recorded within the survey area with 49 species recorded within quadrats. Eighteen families and 27 genera were recorded overall. These are listed in Appendix E, per Quadrat as well as per vegetation group. Of the native species, Chenopodiaceae had the highest representation, with 15 species from 6 genera. The next best represented families were Fabaceae with 12 species and Scrophulariaceae with 7 species.

No introduced weed species were detected within the survey area.

The most common and widespread species were *Ptilotus obovatus, Atriplex vescaria, Maireana georgei, Maireana sedifolia, Maireana tomentosa* and *Maireana triptera* which were all recorded within all 12 quadrats.

Quadrat 12 demonstrated the largest species richness with 31 taxa recorded from within a single site.

The DBCA database searches revealed a potential for no Threatened and 2 Priority Flora species to occur within a 20 km radius of the survey area (DBCA, 2022a). No known locations of Threatened or Priority Flora occur within the survey area, with the closest Priority Flora located approximately 4.7 km northeast of the survey area.

No Priority or Threatened flora were recorded during the survey.

The PEC/TEC search revealed no PEC/TECs within the survey area (DBCA, 2022).

Vegetation condition was generally ‘Good’ to ‘Very Good’ (Keighery 1994). Disturbance was present within the survey area and mostly attributed to access tracks, exploration related activities.

Given the above it is not expected that the proposed clearing will result in significant impacts such as vegetation fragmentation or the loss of vegetation associations or species that may be unique. This is partially due to the relevant size of the proposed clearing in comparison to similar abundant vegetation and habitat represented and retained outside of the survey area.

IMPACT ASSESSMENT

5.1 THREATENING PROCESSES

The processes that may impact the Flora within the survey area as a result of the proposed clearing include:

- Localised vegetation clearing resulting in a reduction in biodiversity in the immediate area, however it is adequately represented in the surrounding vegetation in the local area and region
- Vehicle use damaging vegetation if existing tracks are not adhered to
- The introduction and increased abundance of non-native species
- Dust generated during clearing of native vegetation and associated activities may settle on adjacent native vegetation, causing possible stress and perhaps death, especially during drier months; and
- Accidental fire arising from clearing and associated activities, may affect vegetation in surrounding areas.

6 CONCLUSIONS

This report summarises the results of a detailed flora and vegetation survey.

The survey established that the condition of most of the vegetation in the survey area is overall ’Good’ to ‘Very Good’ condition. No Threatened Flora were recorded in the area. No PEC/TECs were recorded in the survey area.

There were no Priority or Threatened flora recorded during the survey

The EPA objective for flora and vegetation is to maintain the abundance, species diversity and geographical distribution of flora and vegetation as well as protect Threatened flora consistent with the provisions of the *Biodiversity Conservation Act 2016.* The proposed clearing of vegetation will result in the loss of some individuals from the local area; however, the impact will not be great enough to remove whole communities or populations. Most of the species and communities recorded during this survey are widespread throughout the Eastern Murchison subregion and adjoining regions, and therefore the loss of a small proportion from this area will not be significant.

7 REFERENCES

Beard, J.S. (1990). *Plant life of Western Australia.* Kangaroo Press, NSW

Belbin, L. (1994). *PATN: pattern analysis package: Technical reference*, Division of Wildlife and Ecology, CSIRO

BOM, (2022), *Climate Data Online,* Bureau of Meteorology
http://www.bom.gov.au/climate/data/
Accessed: 2/06/2022

CALM, (2002), *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002 (MUR01 – Eastern Murchison Subregion)*, Department of Conservation and Land Management

CALM, (2003), *Phytophthora cinnamomi and Diseases Caused by It, Volume 1-Management Guidelines,* Department of Conservation and Land Management
https://library.dbca.wa.gov.au/FullTextFiles/021873.pdf
Accessed: 21/05/2022

DAWE, (2022*), Interim Biogeographic Regionalisation for Australia* (IBRA), Department of Agriculture, Water and the Environment, Australian Government
https://www.environment.gov.au/land/nrs/science/ibra
Accessed: 8/06/2022

DAWE, (2022a), *Protected Matters Search Tool*, Department of Agriculture, Water and the Environment
http://www.environment.gov.au/webgis-framework/apps/pmst/pmst-coordinate.jsf
Accessed: 7/06/2022

DBCA, (2019), *2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report)- Current as of March 2019*, WA Department of Biodiversity, Conservation and Attractions, Perth,
https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics
Accessed: 8/06/2022

DBCA, (2019a) Conservation Codes for Western Australian Flora and Fauna. Department of Biodiversity, Conservation and Attractions, Western Australia, January 2019

DBCA, (2022), *TEC/PEC Database Results Ref: 12-0622EC,* Department of Biodiversity, Conservation and Attractions

DBCA, (2022a), *Threatened Flora Database Results Ref: 28-0622FL,* Department of Biodiversity, Conservation and Attractions

DPIRD, (2022), *Declared Plants Database,* Department of Primary Industries and Regional Development, Western Australia
https://www.agric.wa.gov.au/pests-weeds-diseases/weeds/declared-plants
Accessed: 8/06/2022

DPIRD, (2017), *NRInfo Digital Mapping*, Department of Primary Industries and Regional Development
https://maps.agric.wa.gov.au/nrm-info/
Accessed: 08/06/2022

DWER, (2022), *Clearing Permit System Map Viewer*, Department of Water and Environmental Regulation
https://cps.der.wa.gov.au/main.html
Accessed: 7/06/2022

EPA, (2016), *Environmental Factor Guideline: Flora and Vegetation,* Environmental Protection Authority, Western Australia

EPA, (2016a), *Technical Guidance- Flora and Vegetation Surveys for Environmental Impact Assessment,* Environmental Protection Authority, Western Australia

Hussey, B M J, G J, Cousens, R D Dodd, J and Lloyd S G, (2007), *Western Weeds- A guide to the Weeds of Western Australia (Second Edition)*, The Weed Society of Western Australia, Perth WA

Keighery, B.J., (1994), *Bushland Plant Survey; A guide to plant community survey for the Community,* Wildflower Society of Western Australia (Inc.) Nedlands

Lamp, C.A. and Collet, F., (1989), *Field Guide to Weeds in Australia,* Inkata Press

Muir, B.G. (1977), *Biological Survey of the Western Australian Wheatbelt. Pt. 2. Vegetation and habitat of the Bendering Reserve*. Records of the Western Australian Museum Supplement 3

Seaby R. M. & Henderson, P. A., (2006), *Species Diversity and Richness Version 4.1.2,* Pisces Conservation Ltd., Lymington, England.

Shepherd, D.P., Beeston, G.R., and A.J.M. Hopkins, (2002), *Land-Use and Vegetation in Western Australia- National Land and Water Resources Audit Report*, Technical Report 250, Department of Agriculture Western Australia

Smith, M.G., Jones, A., (2018) *Threatened and priority flora list for Western Australia*, Department of Biodiversity, Conservation and Attractions

WAHERB, (2022), *FloraBase- the Western Australian Flora*, Department of Parks and Wildlife
http://florabase.dpaw.wa.gov.au/
Accessed: 8/06/2022

8 GLOSSARY

Acronyms:

BAM Act	*Biosecurity and Agriculture Management Act 2007,* Western Australia
BC Act	*Biodiversity Conservation Act 2016* (partly enacted), Western Australia
BOM	Bureau of Meteorology, Australian Government
BSc	Bachelor of Science
CALM	Department of Conservation and Land Management (now DBCA)
CPS	Clearing Permit System (DWER)
DAWE	Department of Agriculture, Water and the Environment, Australian Government
DBCA	Department of Biodiversity, Conservation and Attractions, Western Australia
DMIRS	Department of Mines, Industry Regulation and Safety, Western Australia
DPAW	Department of Parks and Wildlife, Western Australia (now DBCA)
DPIRD	Department of Primary Industries and Regional Development, Western Australia
DRF	Declared Rare Flora
DWER	Department of Water and Environmental Regulation, Western Australia
EPA	Environmental Protection Authority, Western Australia
EP Act	*Environmental Protection Act 1986*, Western Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth Act)
ESA	Environmentally Sensitive Area
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
IBRA	Interim Biogeographic Regionalisation for Australia, DAWE
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union
km	Kilometres
m	Metres
MUR	Murchison Bioregion, IBRA
MUR01	Eastern Murchison Subregion, IBRA
NVS	Native Vegetation Solutions
PEC	Priority Ecological Community, Western Australia
Ramsar	A wetland site designated of international importance under the Ramsar Convention (UNESCO)
TEC	Threatened Ecological Community
UNESCO	United Nations Educational, Scientific and Cultural Organization
WA	Western Australia
WAHERB	Western Australian Herbarium, DBCA
WAOL	Western Australian Organism List
WC Act	*Wildlife Conservation Act 1950*, Western Australia

Definitions:

{DBCA (2019a) Conservation Codes for Western Australian Flora and Fauna. Department of Biodiversity, Conservation and Attractions, Western Australia, January 2019}: -

T Threatened species:
Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

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

CR Critically endangered species
Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially*

Protected Fauna) Notice 2018 for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN Endangered species

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct species:

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018.*

P <u>Priority Species</u>

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

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

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

Priority 1: Poorly known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g., agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

Priority 2: Poorly known species

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

Priority 3: Poorly known species

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

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

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix A - EPBC and Other Government Database Search Results

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

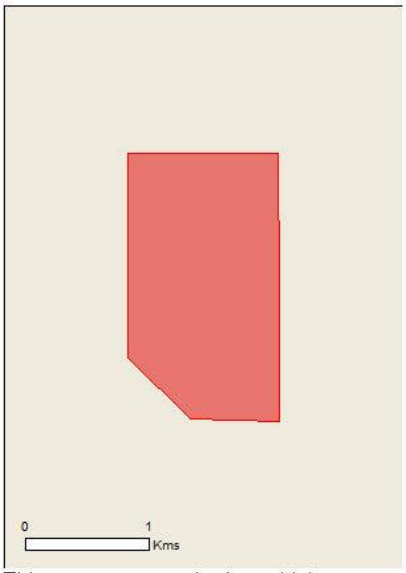
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 07/06/22 17:25:12

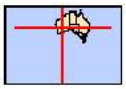
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 2.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	6
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	8
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	9
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans		
Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-29.84586 122.30429,-29.84586 122.31523,-29.86276 122.31534,-29.86264 122.30886,-29.85872 122.30429,-29.84586 122.30429

Acknowledgements

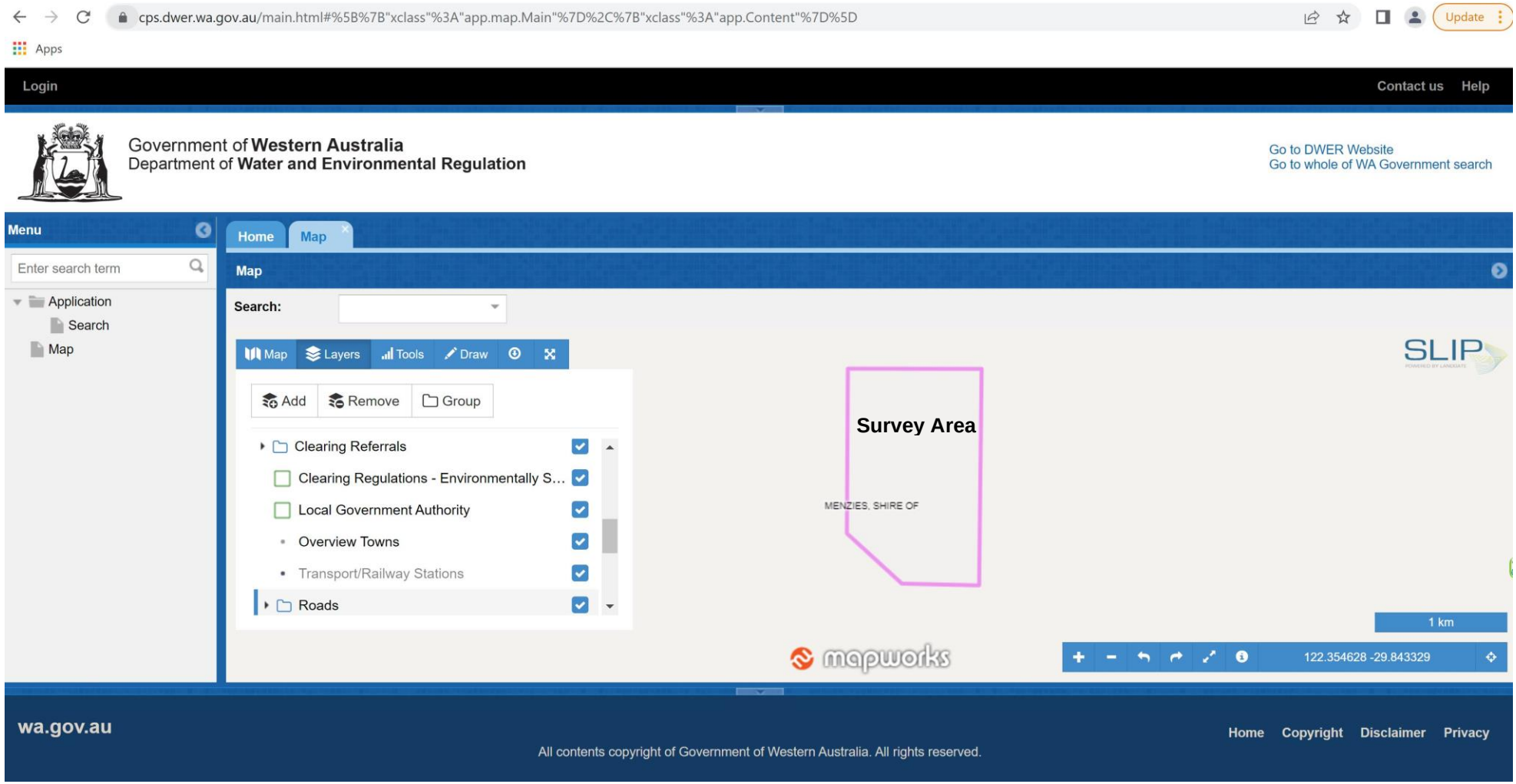
This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

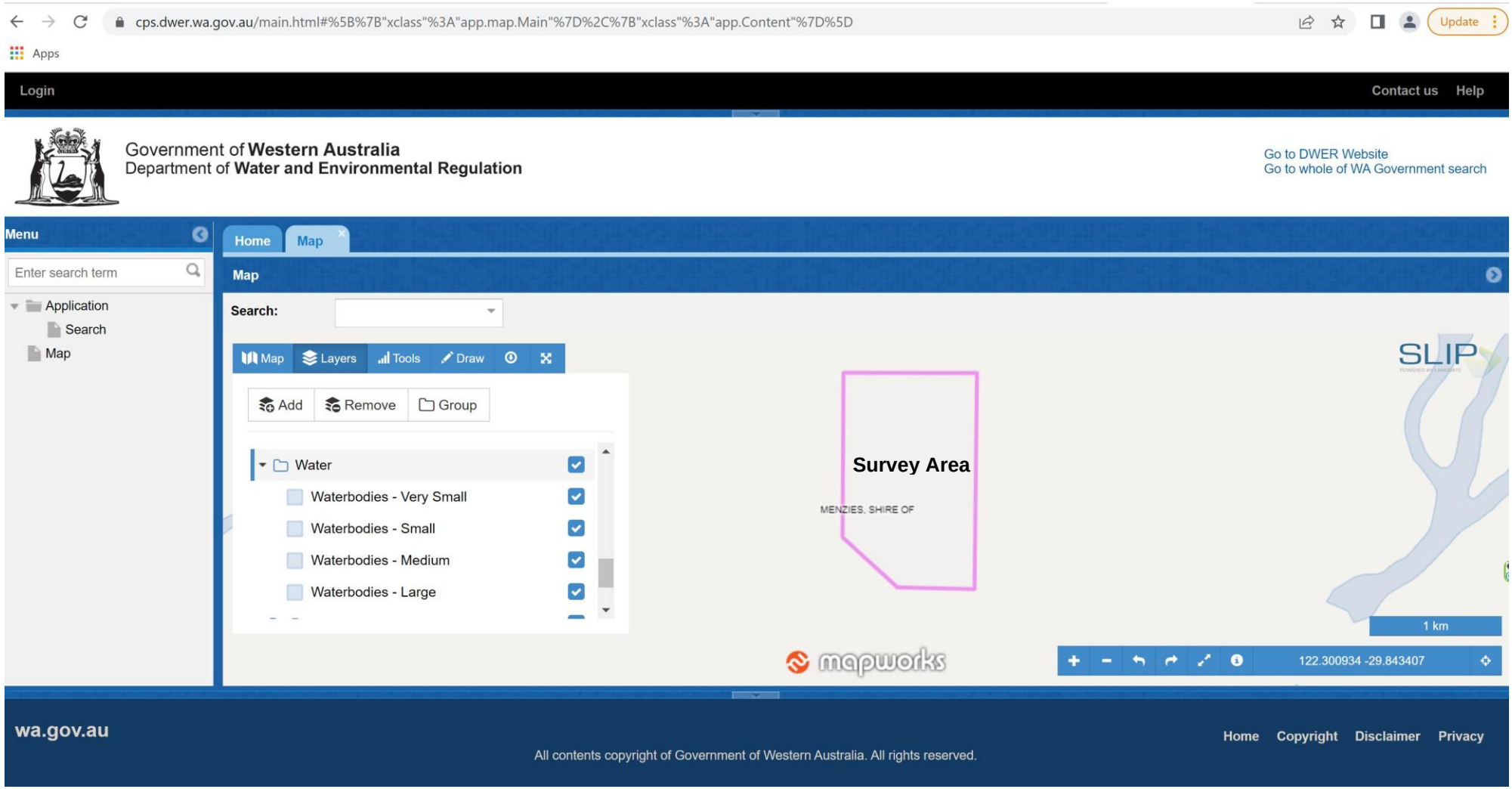
The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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

© Commonwealth of Australia
Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111



DWER CPS Map Viewer - showing no ESA's (dark green shaded areas) within the survey area (pink polygons) (DWER, 2022)



DWER CPS Map Viewer - showing no water bodies within the survey area (pink polygons) (DWER, 2022)

Appendix B - Vegetation Definitions

Vegetation Condition Definitions (Keighery, 1994)

Pristine (1). Pristine or nearly so, no obvious signs of disturbance.

Excellent (2). Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

Very Good (3). Vegetation structure altered, obvious signs of disturbance.
For example, disturbance to vegetation structure caused by repeating fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Good (4). Vegetation structure significantly altered by very obvious signs of multiple disturbance.
Retains basic vegetation structure or ability to regenerate it.
For example, disturbance to vegetation structure caused by frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (5). Basic vegetation structure severely impacted by disturbance.
Scope for regeneration but not to a state approaching good condition without intensive management.
For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.
These areas are often described as 'parkland cleared' with the flora compromising weed or crop species with isolated trees or shrubs.

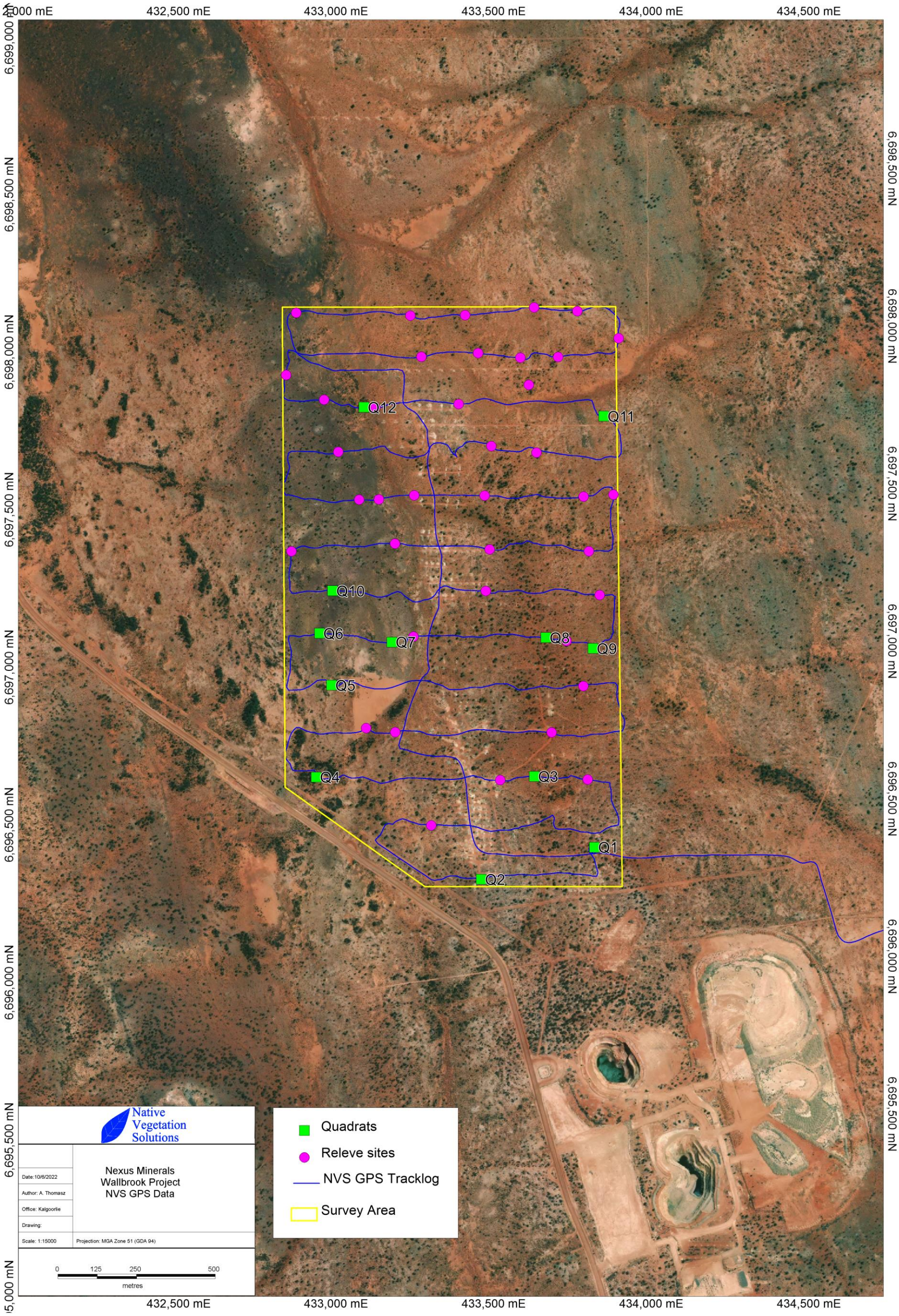
Vegetation Structure Definitions (Muir, 1977)

Life Form/Height Class	Canopy Cover			
	Dense 70-100% d	Mid-Dense 30-70% c	Sparse 10-30% i	Very Sparse 2-10% r
T Trees>30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
M Trees 15-30m	Dense Forest	Forest	Woodland	Open Woodlnd
LA Trees 5-15m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
LB Trees<5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
KT Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
KS Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
S Shrubs>2m	Dense Thicket	Thicket	Scrub	Open Scrub
SA Shrubs 1.5-2.0m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
SB Shrubs 1.0-1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
SC Shrubs 0.5-1.0m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
SD Shrubs 0.0-0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
P Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
H Hummock Grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
GT Bunch grass >0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
GL Bunch grass <0.5m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
J Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
VT Sedges >0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
VL Sedges <0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
X Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverwort	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

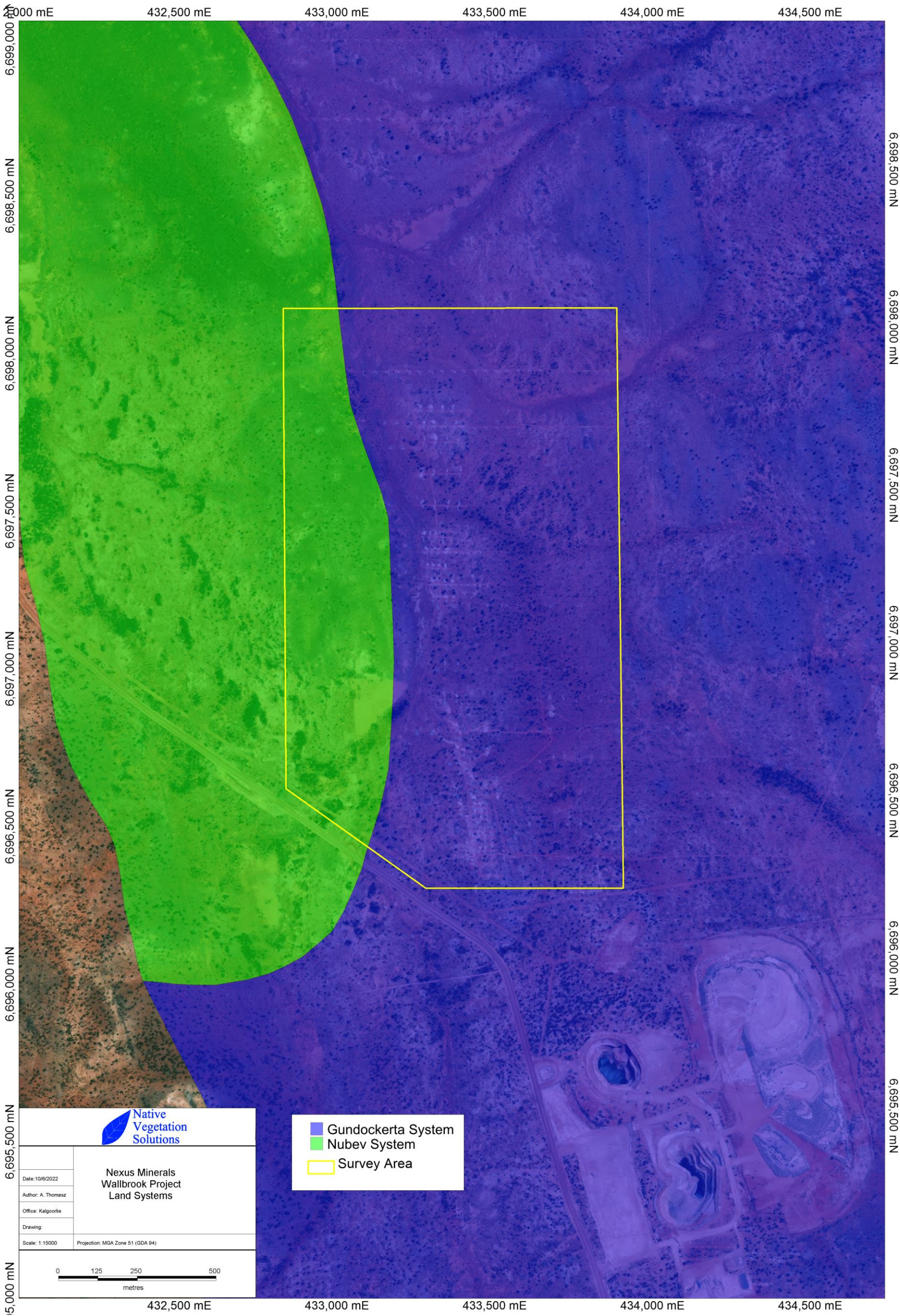
Appendix C - Mapping



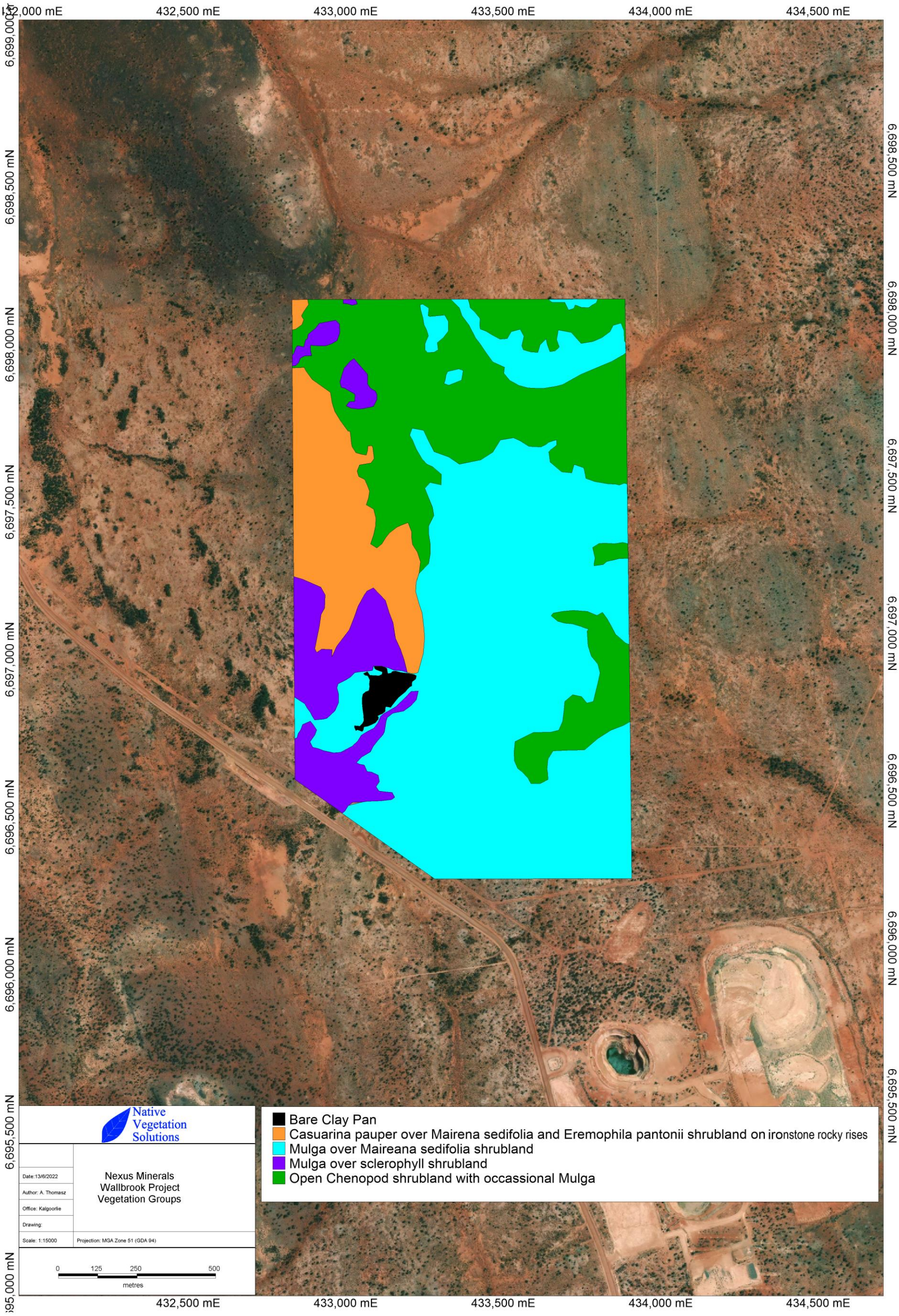
Map 1: Wallbrook Project Survey Area



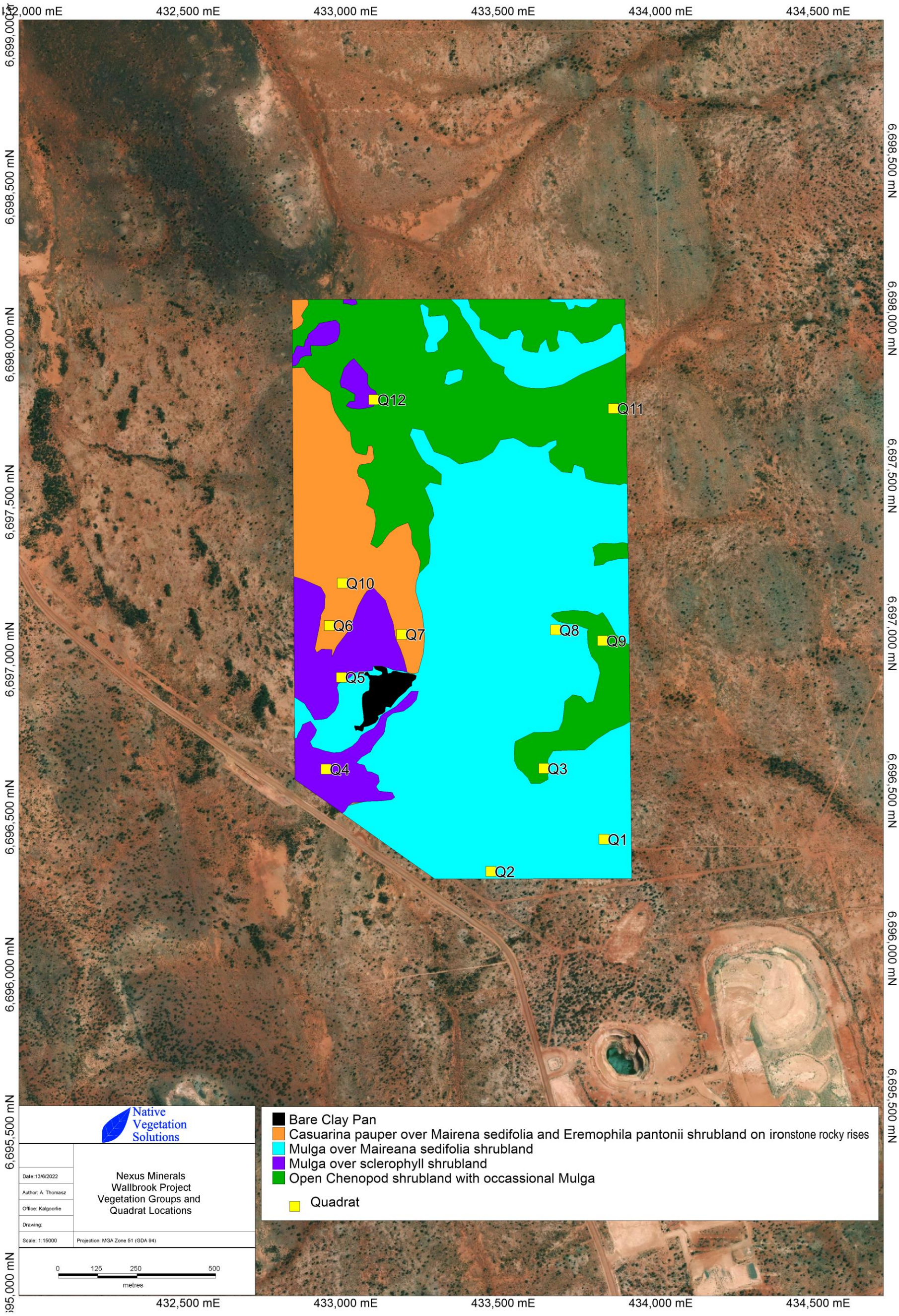
Map 2: NVS GPS Data for Wallbrook Project



Map 3: Land Systems for Wallbrook Project



Map 4: Vegetation Groups for the Wallbrook Project



Map 5: Vegetation Groups and Quadrat Locations for the Wallbrook Project



Map 6: Vegetation Condition for Wallbrook Project

Appendix D - Threatened Flora Database Search Results

TAXON	CONS_CODE	Likelihood of occurring in survey area- Comment post field work
Acacia eremophila var. Numerous-nerved variant (A.S. George 11924)	P3	Unlikely- No suitable habitat
Thryptomene eremaea	P2	Unlikely- No suitable habitat

Appendix E - Species Recorded During the May 2022 Survey

Species List per Quadrat

Family	Genus	Taxon	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Amaranthaceae	*Ptilotus*	*Ptilotus obovatus*	*	*	*	*	*	*	*	*	*	*	*	*
Apocynaceae	*Leichhardtia*	*Leichhardtia australis*				*	*							*
Asteraceae	*Cratystylis*	*Cratystylis subspinescens*												*
Casuarinaceae	*Casuarina*	*Casuarina pauper*	*	*		*	*	*	*	*		*		
Chenopodiaceae	*Atriplex*	*Atriplex bunburyana*			*					*	*		*	
Chenopodiaceae	*Atriplex*	*Atriplex nummularia* subsp. *spathulata*	*	*						*				
Chenopodiaceae	*Atriplex*	*Atriplex stipitata*	*	*			*			*				*
Chenopodiaceae	*Atriplex*	*Atriplex vesicaria*	*	*	*	*	*	*	*	*	*	*	*	*
Chenopodiaceae	*Enchylaena*	*Enchylaena tomentosa* var. *tomentosa*		*		*	*							*
Chenopodiaceae	*Maireana*	*Maireana georgei*	*	*	*	*	*	*	*	*	*	*	*	*
Chenopodiaceae	*Maireana*	*Maireana pyramidata*	*	*	*	*	*			*	*		*	*
Chenopodiaceae	*Maireana*	*Maireana sedifolia*	*	*	*	*	*	*	*	*	*	*	*	*
Chenopodiaceae	*Maireana*	*Maireana tomentosa*	*	*	*	*	*	*	*	*	*	*	*	*
Chenopodiaceae	*Maireana*	*Maireana triptera*	*	*	*	*	*	*	*	*	*	*	*	*
Chenopodiaceae	*Salsola*	*Salsola australis*						*	*			*		
Chenopodiaceae	*Sclerolaena*	*Sclerolaena cuneata*				*	*	*	*			*		*
Chenopodiaceae	*Sclerolaena*	*Sclerolaena diacantha*	*	*					*	*		*		
Chenopodiaceae	*Sclerolaena*	*Sclerolaena patenticuspis*				*	*	*	*			*		*
Chenopodiaceae	*Tecticornia*	*Tecticornia disarticulata*					*							*
Fabaceae	*Acacia*	*Acacia aneura*			*						*		*	
Fabaceae	*Acacia*	*Acacia craspedocarpa*								*				
Fabaceae	*Acacia*	*Acacia mulganeura*	*	*	*	*	*			*	*	*	*	*
Fabaceae	*Acacia*	*Acacia oswaldii*					*							*
Fabaceae	*Acacia*	*Acacia ramulosa var. ramulosa*			*						*		*	
Fabaceae	*Acacia*	*Acacia tetragonophylla*	*	*	*	*	*			*	*		*	*
Fabaceae	*Senna*	*Senna artemisioides* subsp. *×sturtii*		*										
Fabaceae	*Senna*	*Senna artemisioides* subsp. *filifolia*	*	*		*	*	*	*	*		*		*
Fabaceae	*Senna*	*Senna cardiosperma*						*	*			*		
Frankeniaceae	*Frankenia*	*Frankenia setosa*					*	*	*			*		*
Goodeniaceae	*Scaevola*	*Scaevola spinescens*	*	*		*	*	*	*	*		*		*
Loranthaceae	*Amyema*	*Amyema* preissii								*				
Malvaceae	*Sida*	*Sida ectogama*	*	*	*					*	*		*	
Pittosporaceae	*Pittosporum*	*Pittosporum angustifolium*												*
Poaceae	*Aristida*	*Aristida contorta*						*	*			*		
Poaceae	*Enneapogon*	*Enneapogon caerulescens*						*	*			*		
Poaceae	*Eriachne*	*Eriachne pulchella* subsp. *pulchella*											*	

Family	Genus	Taxon	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Poaceae	*Monachather*	*Monachather paradoxus*	*	*	*					*	*		*	
Proteaceae	*Hakea*	*Hakea preissii*				*	*							*
Santalaceae	*Santalum*	*Santalum spicatum*				*	*							*
Sapindaceae	*Dodonaea*	*Dodonaea lobulata*					*	*	*			*		*
Scrophulariaceae	*Eremophila*	*Eremophila glabra* subsp. *glabra*				*	*							*
Scrophulariaceae	*Eremophila*	*Eremophila glutinosa*			*	*	*				*		*	*
Scrophulariaceae	*Eremophila*	*Eremophila latrobei* subsp. *latrobei*		*										
Scrophulariaceae	*Eremophila*	*Eremophila longifolia*			*						*		*	
Scrophulariaceae	*Eremophila*	*Eremophila oldfieldii* subsp. *angustifolia*			*	*	*				*		*	*
Scrophulariaceae	*Eremophila*	*Eremophila oppositifolia* subsp. *angustifolia*				*	*							*
Scrophulariaceae	*Eremophila*	*Eremophila pantonii*		*		*	*	*	*			*		*
Solanaceae	*Solanum*	*Solanum lasiophyllum*			*	*	*	*	*		*	*	*	*
Solanaceae	*Solanum*	*Solanum plicatile*			*						*		*	

Species List per Vegetation Group (Quadrat data including opportunistic sampled species - Identified in Bold type)

Family	Genus	Taxon	A	B	C	D
Amaranthaceae	Ptilotus	Ptilotus obovatus	*	*	*	*
Apocynaceae	Leichhardtia	Leichhardtia australis		*		
Asteraceae	Cratystylis	Cratystylis subspinescens		*		
Casuarinaceae	Casuarina	Casuarina pauper	*	*		*
Chenopodiaceae	Atriplex	Atriplex bunburyana	*		*	
Chenopodiaceae	Atriplex	Atriplex nummularia subsp. spathulata	*			
Chenopodiaceae	Atriplex	Atriplex stipitata	*	*		
Chenopodiaceae	Atriplex	Atriplex vesicaria	*	*	*	*
Chenopodiaceae	Enchylaena	Enchylaena tomentosa var. tomentosa	*	*		
Chenopodiaceae	Maireana	Maireana georgei	*	*	*	*
Chenopodiaceae	Maireana	Maireana pyramidata	*	*	*	
Chenopodiaceae	Maireana	Maireana sedifolia	*	*	*	*
Chenopodiaceae	Maireana	Maireana tomentosa	*	*	*	*
Chenopodiaceae	Maireana	Maireana triptera	*	*	*	*
Chenopodiaceae	Salsola	Salsola australis				*
Chenopodiaceae	Sclerolaena	Sclerolaena cuneata		*		*
Chenopodiaceae	Sclerolaena	Sclerolaena diacantha	*			*
Chenopodiaceae	Sclerolaena	Sclerolaena patenticuspis		*		*
Chenopodiaceae	Tecticornia	Tecticornia disarticulata		*		
Fabaceae	Acacia	Acacia aneura			*	
Fabaceae	**Acacia**	**Acacia burkittii**	*		*	
Fabaceae	Acacia	Acacia craspedocarpa	*			
Fabaceae	Acacia	Acacia mulganeura	*	*	*	*
Fabaceae	Acacia	Acacia oswaldii		*		
Fabaceae	**Acacia**	**Acacia pteraneura**	*			
Fabaceae	Acacia	Acacia ramulosa var. ramulosa			*	
Fabaceae	Acacia	Acacia tetragonophylla	*	*	*	
Fabaceae	**Senna**	**Senna artemisioides subsp. ×artemisioides**	*			
Fabaceae	Senna	Senna artemisioides subsp. ×sturtii	*			
Fabaceae	Senna	Senna artemisioides subsp. filifolia	*	*		*
Fabaceae	Senna	Senna cardiosperma				*
Frankeniaceae	Frankenia	Frankenia setosa		*		*
Goodeniaceae	Scaevola	Scaevola spinescens	*	*		*
Loranthaceae	Amyema	Amyema preissii	*			
Malvaceae	**Sida**	**Sida calyxhymenia**	*			
Malvaceae	Sida	Sida ectogama	*		*	

Family	Genus	Taxon	A	B	C	D
Myrtaceae	**Eucalyptus**	**Eucalyptus oleosa subsp. oleosa**	*			
Pittosporaceae	Pittosporum	Pittosporum angustifolium		*		
Poaceae	Aristida	Aristida contorta				*
Poaceae	Enneapogon	Enneapogon caerulescens				*
Poaceae	Eriachne	Eriachne pulchella subsp. pulchella			*	
Poaceae	Monachather	Monachather paradoxus	*		*	
Proteaceae	Hakea	Hakea preissii		*		
Santalaceae	Santalum	Santalum spicatum		*		
Sapindaceae	Dodonaea	Dodonaea lobulata		*		*
Scrophulariaceae	Eremophila	Eremophila glabra subsp. glabra		*		
Scrophulariaceae	Eremophila	Eremophila glutinosa		*	*	
Scrophulariaceae	Eremophila	Eremophila latrobei subsp. latrobei	*			
Scrophulariaceae	Eremophila	Eremophila longifolia			*	
Scrophulariaceae	Eremophila	Eremophila oldfieldii subsp. angustifolia		*	*	
Scrophulariaceae	Eremophila	Eremophila oppositifolia subsp. angustifolia		*		
Scrophulariaceae	Eremophila	Eremophila pantonii	*	*		*
Solanaceae	Solanum	Solanum lasiophyllum		*	*	*
Solanaceae	Solanum	Solanum plicatile			*	

Appendix F - Site Descriptions

Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.314443	-29.861274	**Quadrat:**	Q1
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Mulga and casuarina pauper over Maireana sedifolia			
Vegetation condition:	Good			
WP:	1			
Photo number:			1	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire History:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Moderately; many/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			20	
% Cover bare ground:			70	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	S Shrub	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	6-12m	**Height:**	0.5-1m	**Height:**	0.25-0.5m
Crown cover %:	V <10	**Crown cover %:**	S 10-30	**Crown cover %:**	V <10
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Maireana sedifolia		Maireana triptera	
Acacia mulganeura		Atriplex nummularia subsp. spathulata		Maireana georgei	
		Maireana pyramidata			

ALL SPECIES
Casuarina pauper
Acacia mulganeura
Maireana sedifolia
Atriplex nummularia subsp. spathulata
Maireana pyramidata
Maireana triptera
Maireana georgei
Atriplex vesicaria
Sida ectogama
Ptilotus obovatus
Acacia tetragonophylla
Scaevola spinescens
Senna artemisioides subsp. filifolia
Maireana tomentosa
Sclerolaena diacantha
Monachather paradoxus
Atriplex stipitata
Outside
Senna artemisioides subsp. artemisioides
Solanum lasiophyllum



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.310715	-29.862174	**Quadrat:**	Q2
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Same as g1			
Vegetation condition:	Good			
WP:	2			
Photo number:			2	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Moderately; many/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			20	
% Cover bare ground:			70	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	S Shrub	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	6-12m	**Height:**	0.5-1m	**Height:**	0.25-0.5m
Crown cover %:	V <10	**Crown cover %:**	S 10-30	**Crown cover %:**	V <10
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Maireana sedifolia		Maireana triptera	
Acacia mulganeura		Atriplex nummularia subsp. spathulata		Maireana georgei	
		Maireana pyramidata		Atriplex vesicaria	

ALL SPECIES
Casuarina pauper
Acacia mulganeura
Maireana sedifolia
Atriplex nummularia subsp. spathulata
Maireana pyramidata
Maireana triptera
Maireana georgei
Atriplex vesicaria
Sida ectogama
Ptilotus obovatus
Acacia tetragonophylla
Scaevola spinescens
Senna artemisioides subsp. filifolia
Maireana tomentosa
Sclerolaena diacantha
Monachather paradoxus
Atriplex stipitata
Senna artemisioides subsp. ×sturtii
Enchylaena tomentosa var. tomentosa
Eremophila pantonii
Eremophila latrobei subsp. latrobei
Outside
Eremophila oppositifolia subsp. angustifolia
Eucalyptus oleosa subsp. oleosa



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.312478	-29.859234	**Quadrat:**	Q3
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Chenopod shrubland with occasional Mulga			
Vegetation condition:	Good			
WP:	5			
Photo number:			5	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Moderately; many/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			10	
% Cover bare ground:			80	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	S Shrub	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	3-6m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	I <1	**Crown cover %:**	I <1	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Acacia aneura		Eremophila oldfieldii subsp. angustifolia		Maireana sedifolia	
Acacia mulganeura		Acacia ramulosa var. ramulosa		Maireana pyramidata	
				Ptilotus obovatus	

ALL SPECIES
Acacia aneura
Acacia mulganeura
Eremophila oldfieldii subsp. angustifolia
Acacia ramulosa var. ramulosa
Maireana sedifolia
Maireana pyramidata
Ptilotus obovatus
Eremophila glutinosa
Acacia tetragonophylla
Atriplex bunburyana
Atriplex vesicaria
Maireana tomentosa
Eremophila longifolia
Maireana triptera
Maireana georgei
Solanum lasiophyllum
Monachather paradoxus
Sida ectogama
Solanum plicatile
Outside
Senna artemisioides subsp. filifolia
Senna cardiosperma



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.30532	-29.859218	**Quadrat:**	Q4
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Mulga over sclerophyll shrubland			
Vegetation condition:	Very Good			
WP:	7			
Photo number:			6	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			No coarse fragments	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			40	
% Cover bare ground:			20	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	Y Shrub Mallee (< 8m)	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	6-12m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	M 30-70	**Crown cover %:**	S 10-30	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Senna artemisioides subsp. filifolia		Maireana sedifolia	
Acacia mulganeura		Eremophila pantonii		Eremophila glutinosa	
				Ptilotus obovatus	

ALL SPECIES
Casuarina pauper
Acacia mulganeura
Senna artemisioides subsp. filifolia
Eremophila pantonii
Maireana sedifolia
Eremophila glutinosa
Ptilotus obovatus
Leichhardtia australis
Eremophila oldfieldii subsp. angustifolia
Maireana triptera
Maireana georgei
Atriplex vesicaria
Enchylaena tomentosa var. tomentosa
Santalum spicatum
Eremophila glabra subsp. glabra
Eremophila oppositifolia subsp. angustifolia
Hakea preissii
Scaevola spinescens
Sclerolaena cuneata
Sclerolaena patenticuspis
Maireana tomentosa
Maireana pyramidata
Solanum lasiophyllum
Acacia tetragonophylla
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.305842	-29.856589	**Quadrat:**	Q5
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Same as q4			
Vegetation condition:	Very Good			
WP:	12			
Photo number:			8	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Slightly; few/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			30	
% Cover bare ground:			40	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	Y Shrub Mallee (< 8m)	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	6-12m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	M 30-70	**Crown cover %:**	S 10-30	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Senna artemisioides subsp. filifolia		Maireana sedifolia	
Acacia mulganeura		Eremophila pantonii		Atriplex vesicaria	
				Ptilotus obovatus	

ALL SPECIES
Casuarina pauper
Acacia mulganeura
Senna artemisioides subsp. filifolia
Eremophila pantonii
Maireana sedifolia
Atriplex vesicaria
Ptilotus obovatus
Leichhardtia australis
Eremophila oldfieldii subsp. angustifolia
Maireana triptera
Maireana georgei
Atriplex stipitata
Enchylaena tomentosa var. tomentosa
Santalum spicatum
Eremophila glabra subsp. glabra
Eremophila oppositifolia subsp. angustifolia
Hakea preissii
Scaevola spinescens
Sclerolaena cuneata
Sclerolaena patenticuspis
Maireana tomentosa
Maireana pyramidata
Solanum lasiophyllum
Dodonaea lobulata
Acacia oswaldii
Acacia tetragonophylla
Eremophila glutinosa
Tecticornia disarticulata
Frankenia setosa
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.305457	-29.855101	**Quadrat:**	Q6
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Casuarina pauper over Maireana sedifolia on rocky ironstone rises			
Vegetation condition:	Good			
WP:	13			
Photo number:			9	
Landform:			Hillock/Mound	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Very; abundant/Coarse gravelly; large pebbles/Angular	
Rock outcrop (abundance/runoff):			Very slightly rocky/Slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Hard setting	
% Cover leaf litter:			5	
% Cover bare ground:			80	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	Y Shrub Mallee (< 8m)	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	3-6m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	I <1	**Crown cover %:**	V <10	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Eremophila pantonii		Maireana sedifolia	
				Atriplex vesicaria	
				Frankenia setosa	

ALL SPECIES
Casuarina pauper
Eremophila pantonii
Maireana sedifolia
Atriplex vesicaria
Frankenia setosa
Ptilotus obovatus
Senna artemisioides subsp. filifolia
Maireana tomentosa
Dodonaea lobulata
Sclerolaena cuneata
Sclerolaena patenticuspis
Salsola australis
Senna cardiosperma
Enneapogon caerulescens
Scaevola spinescens
Maireana georgei
Solanum lasiophyllum
Aristida contorta
Maireana triptera
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.307827	-29.855366	**Quadrat:**	Q7
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Same as q6			
Vegetation condition:	Good			
WP:	14			
Photo number:			10	
Landform:			Hillock/Mound	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Very; abundant/Coarse gravelly; large pebbles/Angular	
Rock outcrop (abundance/runoff):			Very slightly rocky/Slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Hard setting	
% Cover leaf litter:			5	
% Cover bare ground:			80	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	Y Shrub Mallee (< 8m)	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	3-6m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	I <1	**Crown cover %:**	V <10	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Eremophila pantonii		Maireana sedifolia	
		Scaevola spinescens		Atriplex vesicaria	
				Frankenia setosa	

ALL SPECIES
Casuarina pauper
Eremophila pantonii
Scaevola spinescens
Maireana sedifolia
Atriplex vesicaria
Frankenia setosa
Ptilotus obovatus
Senna artemisioides subsp. filifolia
Maireana tomentosa
Dodonaea lobulata
Sclerolaena cuneata
Sclerolaena patenticuspis
Salsola australis
Senna cardiosperma
Enneapogon caerulescens
Sclerolaena diacantha
Maireana georgei
Solanum lasiophyllum
Aristida contorta
Maireana triptera
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.312888	-29.855266	**Quadrat:**	Q8
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Same as g1			
Vegetation condition:	Good			
WP:	16			
Photo number:			11	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Moderately; many/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			20	
% Cover bare ground:			70	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	S Shrub	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	6-12m	**Height:**	0.5-1m	**Height:**	0.25-0.5m
Crown cover %:	V <10	**Crown cover %:**	S 10-30	**Crown cover %:**	V <10
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Maireana sedifolia		Maireana triptera	
Acacia mulganeura		Atriplex nummularia subsp. spathulata		Maireana georgei	
Acacia craspedocarpa		Maireana pyramidata			

ALL SPECIES
Casuarina pauper
Acacia mulganeura
Acacia craspedocarpa
Maireana sedifolia
Atriplex nummularia subsp. spathulata
Maireana pyramidata
Maireana triptera
Maireana georgei
Atriplex vesicaria
Sida ectogama
Ptilotus obovatus
Acacia tetragonophylla
Scaevola spinescens
Senna artemisioides subsp. filifolia
Maireana tomentosa
Sclerolaena diacantha
Monachather paradoxus
Atriplex stipitata
Atriplex bunburyana
Amyema preissii
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.31443	-29.855584	**Quadrat:**	Q9
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Same as g3			
Vegetation condition:	Good			
WP:	18			
Photo number:			14	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Moderately; many/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			10	
% Cover bare ground:			80	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	S Shrub	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	3-6m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	I <1	**Crown cover %:**	I <1	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Acacia aneura		Eremophila oldfieldii subsp. angustifolia		Maireana sedifolia	
Acacia mulganeura		Acacia ramulosa var. ramulosa		Maireana pyramidata	
				Ptilotus obovatus	

ALL SPECIES
Acacia aneura
Acacia mulganeura
Eremophila oldfieldii subsp. angustifolia
Acacia ramulosa var. ramulosa
Maireana sedifolia
Maireana pyramidata
Ptilotus obovatus
Eremophila glutinosa
Acacia tetragonophylla
Atriplex bunburyana
Atriplex vesicaria
Maireana tomentosa
Eremophila longifolia
Maireana triptera
Maireana georgei
Solanum lasiophyllum
Monachather paradoxus
Sida ectogama
Solanum plicatile
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.30589	-29.853889	**Quadrat:**	Q10
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Same as q6			
Vegetation condition:	Good			
WP:	21			
Photo number:			15	
Landform:			Hillock/Mound	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Very; abundant/Coarse gravelly; large pebbles/Angular	
Rock outcrop (abundance/runoff):			Very slightly rocky/Slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Hard setting	
% Cover leaf litter:			5	
% Cover bare ground:			80	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	Y Shrub Mallee (< 8m)	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	3-6m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	I <1	**Crown cover %:**	V <10	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Casuarina pauper		Eremophila pantonii		Maireana sedifolia	
Acacia mulganeura		Scaevola spinescens		Atriplex vesicaria	
				Frankenia setosa	

ALL SPECIES
Casuarina pauper
Acacia mulganeura
Eremophila pantonii
Scaevola spinescens
Maireana sedifolia
Atriplex vesicaria
Frankenia setosa
Ptilotus obovatus
Senna artemisioides subsp. filifolia
Maireana tomentosa
Dodonaea lobulata
Sclerolaena cuneata
Sclerolaena patenticuspis
Salsola australis
Senna cardiosperma
Enneapogon caerulescens
Sclerolaena diacantha
Maireana georgei
Solanum lasiophyllum
Aristida contorta
Maireana triptera
Outside



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.314833	-29.848933	**Quadrat:**	Q11
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Veg c			
Vegetation condition:	Good			
WP:	35			
Photo number:			16	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Moderately; many/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			10	
% Cover bare ground:			80	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	S Shrub	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	3-6m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	I <1	**Crown cover %:**	I <1	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Acacia aneura		Eremophila oldfieldii subsp. angustifolia		Maireana sedifolia	
Acacia mulganeura		Acacia ramulosa var. ramulosa		Maireana pyramidata	
				Ptilotus obovatus	

ALL SPECIES
Acacia aneura
Acacia mulganeura
Eremophila oldfieldii subsp. angustifolia
Acacia ramulosa var. ramulosa
Maireana sedifolia
Maireana pyramidata
Ptilotus obovatus
Eremophila glutinosa
Acacia tetragonophylla
Atriplex bunburyana
Atriplex vesicaria
Maireana tomentosa
Eremophila longifolia
Maireana triptera
Maireana georgei
Solanum lasiophyllum
Monachather paradoxus
Sida ectogama
Solanum plicatile
Eriachne pulchella subsp. pulchella
Outside
Acacia burkittii



Project Name: Wallbrook Project				
Date:	6/05/2022		**Botanist:**	Eren Reid
Location (Longitude/Latitude):	122.306957	-29.848639	**Quadrat:**	Q12
Quadrat size:	20x20 m			
Quadrat marking method:	Fence dropper at each corner. TwoNav Aventura GPS waypoint @ NE corner (±4 m accuracy). Using GDA2020 datum			
Vegetation group:	Veg b			
Vegetation condition:	Very Good			
WP:	39			
Photo number:			17	
Landform:			Flat/Plain	
Land surface/disturbance:			No effective disturbance	
Fire history:			Greater than 10 years	
Coarse fragments on the surface (abundance/size/shape):			Slightly; few/Coarse gravelly; large pebbles/Subangular	
Rock outcrop (abundance/runoff):			No bedrock exposed/Very slow	
Soil (profile/field texture/soil surface):			Uniform/Sandy clay loam/Surface crust	
% Cover leaf litter:			30	
% Cover bare ground:			40	

Tallest stratum		Mid-stratum		Lower stratum	
Growth form:	Y Shrub Mallee (< 8m)	**Growth form:**	S Shrub	**Growth form:**	S Shrub
Height:	6-12m	**Height:**	1-3m	**Height:**	0.5-1m
Crown cover %:	M 30-70	**Crown cover %:**	S 10-30	**Crown cover %:**	S 10-30
Dominant taxa:		**Dominant taxa:**		**Dominant taxa:**	
Pittosporum angustifolium		Senna artemisioides subsp. filifolia		Maireana sedifolia	
Acacia mulganeura		Eremophila pantonii		Atriplex vesicaria	
		Hakea preissii		Ptilotus obovatus	

ALL SPECIES
Pittosporum angustifolium
Acacia mulganeura
Senna artemisioides subsp. filifolia
Eremophila pantonii
Hakea preissii
Maireana sedifolia
Atriplex vesicaria
Ptilotus obovatus
Leichhardtia australis
Eremophila oldfieldii subsp. angustifolia
Maireana triptera
Maireana georgei
Atriplex stipitata
Enchylaena tomentosa var. tomentosa
Santalum spicatum
Eremophila glabra subsp. glabra
Eremophila oppositifolia subsp. angustifolia
Cratystylis subspinescens
Scaevola spinescens
Sclerolaena cuneata
Sclerolaena patenticuspis
Maireana tomentosa
Maireana pyramidata
Solanum lasiophyllum
Dodonaea lobulata
Acacia oswaldii
Acacia tetragonophylla
Eremophila glutinosa
Tecticornia disarticulata
Frankenia setosa
Outside



Vertebrate fauna reconnaissance survey and risk assessment

Edjudina Project Area

Prepared for: Nexus Minerals Ltd

Version 1. August, 2022





RECORD OF DISTRIBUTION

No. of copies	Report File Name	Report Status	Date	Prepared for:	Initials
Electronic	2022-0013-002-GT V1.DOCX	DRAFT	1 August 2022	Nexus Minerals Ltd	GT

Suggested Citation: Terrestrial Ecosystems 2022 *Vertebrate fauna reconnaissance survey and risk assessment for the Edjudina Project Area*, Unpublished report for Nexus Minerals Ltd, Perth.

Prepared For:
Nexus Minerals Ltd
41-47 Colin Street
West Perth, WA 6005

Prepared By:
Terrestrial Ecosystems
10 Houston Place
Mt Claremont WA 6010
Phone: 08 9385 2398, 0407 385 289
Website: www.terrestrialecosystems.com
ABN: 40921131346

DISCLAIMER
This document is prepared in accordance with and subject to an agreement between G & S Thompson Pty Ltd as Trustee for the Thompson Family Trust trading as Terrestrial Ecosystems and the client, Nexus Minerals Ltd. It has been prepared and is restricted to those issues that have been raised by the client in its engagement of Terrestrial Ecosystems and prepared using the standard of skill and care ordinarily exercised by environmental scientists in the preparation of such reports.

Persons or agencies that rely on or use this document for purposes or reasons other than those agreed by Terrestrial Ecosystems and its client without first obtaining prior consent, do so at their own risk and Terrestrial Ecosystems denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence.

REPORT CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION 1

1.1 Background 1
1.2 Project objectives and scope of works 1

2. EXISTING ENVIRONMENT 2

2.1 Location of project area 2
2.2 Land use history 2
2.3 Climate 2
2.4 Regional biological fauna context of project area 3
2.5 Fauna species at risk 3

3. METHODOLOGY 4

3.1 Database searches 4
3.2 Site inspection and fauna habitat assessment 4
3.3 Reporting staff 7
3.4 Taxonomy and nomenclature 7
3.5 Limitations 8

4. RESULTS 10

4.1 Fauna habitat 10
4.2 Bioregional vertebrate fauna assemblage 11
4.3 Conservation significant fauna 18

5. DISCUSSION 24

5.1 Adequacy of the fauna survey data for fauna habitats represented in the project area 24
5.1.1 Amphibians 24
5.1.2 Reptiles 24
5.1.3 Birds 24
5.1.4 Mammals 25
5.2 Biodiversity value 25
5.2.1 Ecological functional value at the ecosystem level 25
5.2.2 Maintenance of threatened ecological communities 25
5.2.3 Condition of fauna habitat 25
5.2.4 Ecological linkages 26
5.2.5 Size and scale of the proposed disturbance 26
5.2.6 Abundance and distribution of similar habitat in the adjacent areas 26
5.2.7 Potential impacts on ecosystem function 26

6. POTENTIAL ENVIRONMENTAL IMPACTS 27

6.1 Direct impacts 27
6.1.1 Animal deaths during the clearing process and displacement of fauna 27
6.1.2 Reduction or loss of activity areas and closure of burrows 27
6.2 Indirect impacts 27

6.2.1 Habitat fragmentation 28
6.2.2 Introduced fauna and weeds 28
6.2.3 Road fauna deaths 28
6.2.4 Fire 28
6.2.5 Anthropogenic activity 29
6.2.6 Dust 29
6.2.7 Risk assessment 29
6.3 Native vegetation clearing principles as they pertain to vertebrate fauna 33
6.4 Referral under the EPBC Act 33
7. SUMMARY 34
8. MANAGEMENT STRATEGIES 35
8.1 Induction and awareness 35
8.2 Dust 35
8.3 Minimising secondary impacts to fauna and fauna habitat 35
9. REFERENCES 36

LIST OF CHARTS

Chart 1. Climatic averages for Kalgoorlie 2

LIST OF PLATES

Plate 1. Fauna habitat 10
Plate 2. Fauna habitat 10
Plate 3. Fauna habitat 10
Plate 4. Fauna habitat 10
Plate 5. Disturbed area 11
Plate 6. Disturbed area 11
Plate 7. Disturbed area 11
Plate 8. Disturbed area 11
Plate 9. Range and actual reported sightings of the Fork-tailed Swift 22
Plate 10. Reported sightings of the Grey Wagtail 23

LIST OF TABLES

Table 1. Fauna habitat assessment variables 4
Table 2. Fauna survey limitations and constraints 9
Table 3. Birds potentially found near the project area 11
Table 4. Amphibians potentially found near the project area 14
Table 5. Mammals potentially found near the project area 15
Table 6. Reptiles potentially found near the project area 15
Table 7. Assessment of the potential presence of a conservation significant fauna species in the project area 18
Table 8. Fauna impact risk assessment descriptors 30
Table 9. Levels of acceptable risk 30
Table 10. A risk assessment of the impact of ground disturbance activity on fauna 31
Table 11. Assessment of impact using the native vegetation clearing principles 33

LIST OF FIGURES

Figure 1. Regional location 41
Figure 2. Fauna habitat types 41

LIST OF APPENDICES

Appendix A. Results of the *EPBC Act* Protected Matters Search

Appendix B. Vertebrate Fauna Recorded in Biological Surveys in the Region

Appendix C. Definitions of Significant Fauna under the WA *Biodiversity Conservation Act 2016* and Priority Species

Appendix D. Fauna habitat assessment results

EXECUTIVE SUMMARY

Nexus Minerals requested a Basic vertebrate fauna assessment of the proposed Edjudina Project (project area). The project area is approximately 188.5ha and 125km north, north-east of Kalgoorlie. There are three broad fauna habitats: clay pan; scattered Mulga and Casuarina over mixed shrubs and chenopods over a rocky substrate; and scattered Mulga over mixed shrubs and chenopods over sand and clay. There was significant recent exploration activity and historical disturbance associated with exploration and pastoral activity. Undisturbed areas are generally in good condition, but disturbed areas have mostly had the vegetation removed and are highly degraded.

Potential impacts on the vertebrate fauna include vegetation clearing and the subsequent loss of habitat, edge effects that increase the disturbance footprint, habitat fragmentation, introduction of weeds and changes to the natural habitat and impacts of anthropogenic activity. The anthropogenic impacts (e.g. unnatural noises, vibrations, artificial light sources and vehicle and human movement in an area) may be sufficient to force individuals or fauna species to move from adjacent areas, or alter their activity periods. There is a lower potential for an increase in feral pest species [e.g. house mice (*Mus musculus*), feral cats (*Felis catus*) and wild dogs (*Canis lupus*)], and an increase in road fauna deaths where new roads/tracks are constructed or upgraded, in particular, affecting kangaroos, nocturnal birds and ground dwelling large carnivorous predators. Species such as goannas and raptors are attracted to carrion on road verges and therefore, there is an increased propensity for these species to be killed by vehicles.

Clearing native vegetation in the project area is likely to result in the loss of small vertebrate fauna on-site that are unable to move away during the clearing process, however, this loss is not likely to be significant when viewed in a bioregional context. The few larger animals, such as kangaroos, large goannas and snakes, and most of the birds will move into adjacent areas once vegetation clearing commences, so potential impacts will be low. There may be an on-going loss of small native fauna to vehicle strikes on access tracks, but overall, this impact will be very low. Forced fauna migrants because of vegetation clearing increase competition for resources, which may result in the subsequent loss of migrants or local individuals. Individuals shifted out of their established activity areas are also vulnerable to predation until they have become established in their new areas.

Impacts on vertebrate fauna associated with clearing vegetation in the project area in a landscape or bioregional context are likely to be low as there are vast tracts of similar fauna habitat in adjacent areas, and the sparseness of the vegetation and ground cover mean the abundance of terrestrial vertebrate in the project area will be low.

It is highly unlikely that any conservation significant species will be impacted by the vegetation clearing, development and operation of a mine, so a referral under the *EPBC Act 1999* is not required.

Recommendations

It is recommended that the client:

(a) provides a mandatory induction program that includes a component on managing vertebrate fauna for staff working in the project area;
(b) manages and monitors the impact of dust on adjacent vegetation and fauna habitat against appropriate KPIs and in accordance with the clients' Construction Environmental Management Plan; and
(c) prepares a Vertebrate Fauna Management.

1. INTRODUCTION

1.1 BACKGROUND

Nexus Minerals requested a Basic vertebrate fauna assessment of the proposed Edjudina Mining Project (project area). The project area is 188.5ha and approximately 125km north, north-east of Kalgoorlie and 34km east of Kookynie (Figure 1).

1.2 PROJECT OBJECTIVES AND SCOPE OF WORKS

Terrestrial Ecosystems was commissioned by Nexus Minerals to undertake a Basic vertebrate fauna risk assessment for the proposed Edjudina Mining Project. The purpose of this fauna risk assessment was to provide information to the proponent on the potential impacts on the vertebrate fauna assemblage in the project area to enable the proposed development to be adequately assessed and to support a mining proposal to the environmental regulators. The methodology broadly follows that described in the Environmental Protection Authority (2020) *Technical Guidance Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*.

This Basic vertebrate fauna survey and risk assessment involved a desktop review and an on-site assessment with the objectives to:

- provide an indication of the vertebrate fauna assemblage (reptiles, amphibians, mammals and birds) on and near the project area, so that potential impacts on the fauna and fauna assemblage might be adequately assessed;
- identify the presence and/or potential risk of impacts on species of conservation significance that are present or likely to be present in the project area;
- assess the impact and environmental risks associated with the proposed development on the vertebrate fauna assemblage;
- determine if any additional surveys are required to assess the potential impact on vertebrate fauna assemblage in the project area including impacts on species of conservation significance; and
- make recommendations that avoid, mitigate or minimise potential impacts on resident fauna.

To achieve these objectives, Terrestrial Ecosystems:

- reviewed Terrestrial Ecosystems' database (includes Atlas of Living Australia) to identify potential vertebrate fauna within the area;
- searched the Commonwealth Governments database of fauna of national environmental significance to identify species potentially occurring within the area that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*) or international migratory bird agreements (JAMBA/CAMBA);
- reviewed previous fauna surveys conducted near the project area and in similar habitat;
- undertook a site visit to assess fauna habitat types and habitat quality;
- undertook an assessment of the potential risks to the fauna associated with clearing areas of native vegetation;
- discussed the likelihood of *EPBC Act 1999* and *Biodiversity Conservation Act 2016* (*BC Act 2016*) listed species being present in the project area; and
- provided management recommendations to avoid, mitigate and minimise potential impacts on the fauna in the project area.

2. EXISTING ENVIRONMENT

2.1 LOCATION OF PROJECT AREA

The project area is in the Murchison 1 (MUR1 - East Murchison subregion) IBRA bioregion. Cowan (2001) described the subregion as mostly dominated by mulga woodlands that are often rich in ephemerals; hummock grasslands, salt bush shrub lands and haloscarcia shrub lands. Cowan (2001) recorded no threatened ecological communities in the vicinity of the project areas. Threatening process for conservation significant fauna were listed by Cowan (2001) as foxes and cats.

2.2 LAND USE HISTORY

The dominant land uses for the bioregion are native pasture to support grazing on pastoral leases and crown land reserves, and to a lesser extent mining and exploration. The region surrounding the project area has been relatively disturbed by mining and exploration.

2.3 CLIMATE

The project area is characterised as semi-arid. Kalgoorlie, 125km to the south, south-west, has an annual rainfall of approximately 266mm, although this varies considerably from year-to-year. The highest mean maximum and minimum temperatures in Kalgoorlie are in January with an average of 34°C and 19°C, respectively (Bureau of Meteorology, 2022). The lowest mean daily maximum and minimum temperatures occur in July (Chart 1). Average monthly rainfall is heaviest in February. Summer rain is unpredictable and often results from thunderstorms coming from the north and the west or decaying cyclonic activity as low-pressure cells move from the Pilbara through the Goldfields.

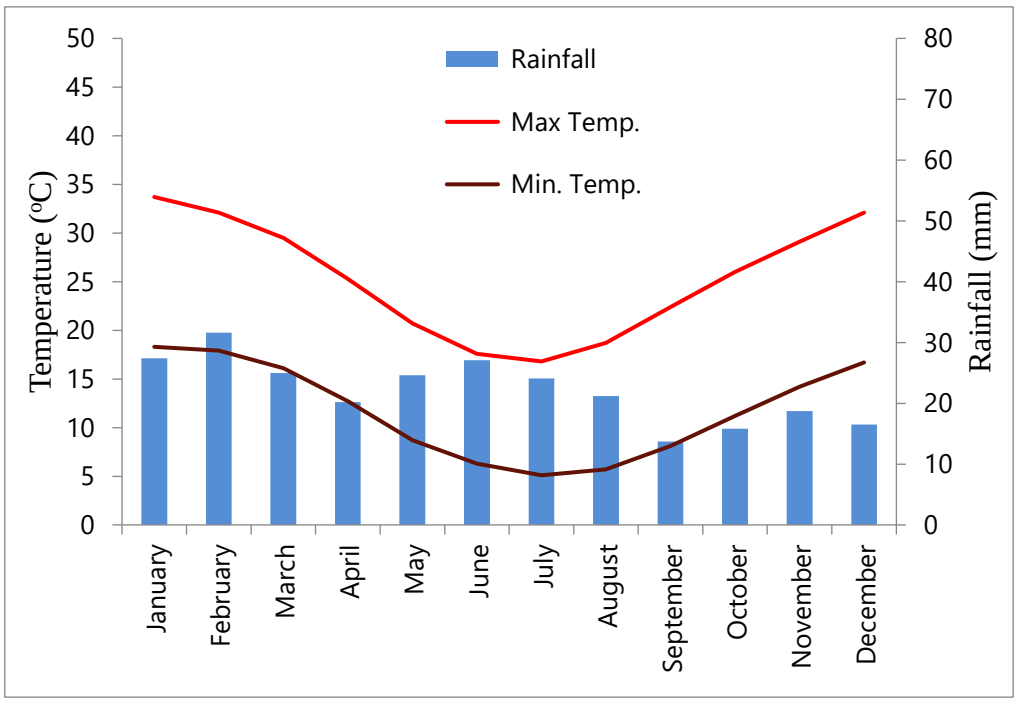


Chart 1. Climatic averages for Kalgoorlie

2.4 REGIONAL BIOLOGICAL FAUNA CONTEXT OF PROJECT AREA

The region around the project area has been poorly surveyed, although there are individual records for fauna contained in the Atlas of Living Australia, which incorporates data from the Western Australian Museum collection that have also been accessed.

Fauna survey data used to provide contextual information come from:

- Cowan, M.A. and How, R.A. (2004) Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. *Records of the Western Australian Museum*, 22, 91-100.
- McKenzie, N.L., Rolfe, J.K. and Youngson, W.K. (1992) Vertebrate fauna. In: The Biological Survey of the Eastern Goldfields of Western Australia; Part 8; Kurnalpi - Kalgoorlie Study Area. *Records of the Western Australian Museum,* Supplement No 41, 37-65.
- Dell, J and How, R.A. (1988) Vertebrate fauna. In: The biological Survey of the Eastern Goldfields of Western Australia, Part 5, Edjudina - Menzies Study Area. *Records of the Western Australian Museum*, Supplement No 31., pp. 38-77.
- Hart, Simpson and Associates (2000) *Anaconda Nickel Ltd, Cawse Expansion Project, Fauna Survey*. Unpublished report for Anaconda Nickel Ltd, Perth.
- Bell, D.T., Bell, R.C. and Loneragan, W.A. (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. *Journal of the Royal Society of Western Australia* 90, 219-227.
- Thompson, S. (Thompson 2004) PhD project and subsequently collected data for the area about Ora Banda.

The most relevant and useful data from the list about are the fauna records collected by Thompson as part of his PhD and the work immediately after the conclusion of this study. Although Thompson's study areas were approximately 100km to the south-west, the fauna habitats are very similar, and this is the most comprehensive vertebrate fauna survey data available for this part of the Goldfields. The surveys by McKenzie et al. (1992) for the Kurnalpi – Kalgoorlie region and Dell and How (1988) Edjudina – Menzies region as part of the eastern Goldfields regional government surveys also provide useful supporting information. Hart et al.'s (2000) data came from a pre-EIA survey for the Cawse mine, which is within the area surveyed by Thompson.

These fauna surveys, when considered together, provide a near complete list of the vertebrate species likely to be found in the project area. The composition of vertebrate fauna assemblages varies from habitat-to-habitat and site-to-site within the bioregion, but the survey data contained in the attached appendices provide a good indication of the vertebrate fauna assemblage that is likely to be found in the project area. These data therefore provide a good regional context and indicate the extent of fauna assemblage variation that might be anticipated from site-to-site and temporally.

2.5 FAUNA SPECIES AT RISK

Cowan (2003) reported the fauna species at risk in the East Murchison subregion as Bilby (*Macrotis lagotis*), Marsupial Mole (*Notoryctes typhlops*), Mulgara (*Dasycercus cristicauda / blythi*), Malleefowl (*Leipoa ocellata*), Princess Parrot (*Polytelis alexandrae*), Slender-billed Thornbill (*Acanthiza iredalei iredalei*), Giant Desert Skink (*Liopholis kintorei*) and Peregrine Falcon (*Falco peregrinus*). This report assesses the potential for these species to be found in the project area and the potential impact that the proposed development might have on these species, and other conservation significant fauna. The Cowan (2001) report is now very dated, but the DBCA has not updated the biodiversity audit for Western Australia since that report. Since 2001, the Night Parrot (*Pezoporus occidentalis*) has been rediscovered in Western Australia and is also considered a species at risk in the region and the critically endangered Arid Bronze Azure (*Ogyris subterrestris petrina*) has also been added to the threatened species list for this bioregion.

3. METHODOLOGY

3.1 DATABASE SEARCHES

A review of the *EPBC Act 1999* list of protected species was undertaken to identify species of conservation interest to the Commonwealth Government. The search polygon was focussed around the project area. In addition, a desktop search of Terrestrial Ecosystems' fauna survey database was used to develop an appreciation of the vertebrate fauna assemblages in the relevant section of the bioregion near the project area.

Other more general texts were also used to provide supplementary information on vertebrates in the bioregion, including Tyler et al. (2000) for frogs; Storr et al. (1983, 1990, 1999, 2002) and Thompson and Thompson (2006) for reptiles; Johnstone and Storr (1998, 2004) for birds; and Van Dyck and Strahan (2008) for mammals.

Collectively these sources of information were used to create lists of species expected to utilise the project area and broader bioregion. It should be noted that these lists will include species that have been recorded in the general region but are possibly vagrants and they will not generally be found in the project area due to a lack of suitable habitat (e.g. wetland and shore birds). Vagrants can be recorded almost anywhere. Many of the government database records are historical and the species is no longer present in the area (e.g. Malleefowl). Many of the bird, mammal, reptile and amphibian species have specific habitat requirements that may be present in the general area but not in the project area. Also, the ecology of many of these species is often not well understood and it can sometimes be difficult to indicate those species whose specific habitat requirements are not present in the project area. Therefore, many species will be included in the lists produced from database searches but will not be present in the actual project area.

There are errors in most databases, including Atlas of Living Australia and the Western Australian Museum (WAM) collection. These errors occur because of a misidentification of individuals, taxonomic name changes and incorrect coordinates being entered into the database. Terrestrial Ecosystems was unable to verify the primary records, so it has used the information provided. Readers should therefore appreciate that species lists, and fauna surveys reported in the appendices may include these errors.

3.2 SITE INSPECTION AND FAUNA HABITAT ASSESSMENT

A site visit was undertaken on 14 February 2022 to assess fauna habitat types and condition in the project area. This information included a description of the habitat structure, habitat condition, landform, soils and vegetation and time since last fire.

The fauna habitat assessment had two foci:

- assessing fauna habitat types and their condition; and
- assessing the possible presence of and recording evidence of conservation significant fauna.

Dr Scott Thompson, who undertook the site assessment, stopped at multiple locations within the project area and recorded a suite of data about the fauna habitat and its condition. Table 1 indicates the variables recorded at each location.

Table 1. Fauna habitat assessment variables

Observer's Name:	
Coordinates of the location as UTM (GDA94):	

Observer's Name:	
Fire history – options	
☐ > 5 years	
☐ 1-5 years	
☐ < 1 year	
Landform – options	
☐ Beach	☐ Lower slope
☐ Clay plain	☐ Mid slope
☐ Cliff	☐ Ridge
☐ Creek line	☐ River
☐ Dam	☐ Rocky outcrop / breakaway
☐ Drainage line	☐ Salt lake
☐ Dune crest	☐ Sand dune
☐ Dune slope	☐ Sand plain
☐ Dune swale	☐ Stony plain
☐ Escarpment	☐ Swamp
☐ Flat	☐ Undulating
☐ Gorge	☐ Upper slope
☐ Gully	☐ Wetland
☐ Intertidal / mangrove	☐ Water hole
☐ Lake / lake edge	
Habitat quality – options	
☐ *High quality fauna habitat* – These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.	
☐ *Very good fauna habitat* - These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally effected by disturbance.	
☐ *Good fauna habitat* – These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.	
☐ *Disturbed fauna habitat*– These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, containing weeds or have been damaged by vehicle or machinery. Habitats are	

Observer's Name:	
	fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.
☐	*Highly degraded fauna habitat* – These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited or no fauna habitat connectivity. Fauna assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance.

Habitat structure – combined into habitat description	
Upper stratum	
☐ Tall open woodland	☐ Scattered tall trees
☐ Tall woodland	☐ Scattered trees
☐ Open woodland	☐ Scattered low trees
☐ Woodland	☐ Low closed forest
☐ Open forest	☐ Low open forest
☐ Closed forest	☐ Low woodland
☐ Tall closed forest	☐ Low open woodland
☐ Tall open forest	
Middle stratum	
☐ Shrubland	☐ Open heath
☐ Tall shrubland	☐ Low closed heath
☐ Tall open shrubland	☐ Low open heath
☐ Low shrubland	☐ Tall closed scrub
☐ Scattered low shrubs	☐ Tall open scrub
☐ Low open shrubland	☐ Scattered tall shrubs
☐ Scattered tall shrubs	☐ Open shrubland
☐ Closed heath	☐ Scattered shrubs
Lower stratum	
☐ Closed hummock grassland	☐ Closed tussock grassland / sedgeland / herbland
☐ Mid-dense hummock grassland	☐ Tussock grass land / sedgeland / herbland
☐ Hummock grassland	☐ Open tussock grassland / sedgeland / herbland
☐ Open hummock grassland	☐ Scattered tussock / grasses / sedges / herbs
☐ Scattered hummock grassland	☐ Very open tussock grassland / herbland

Observer's Name:	
Soil Type – options	
☐ Sand	☐ Silty loam
☐ Loamy sand	☐ Sand clay loam
☐ Clayey sand	☐ Clay
☐ Clay loam	☐ Peat / organic
☐ Silty clay loam	☐ Stony
☐ Sandy loam	
Soil colour - options	
☐ Black	☐ Red
☐ Brown	☐ White
☐ Grey	☐ Yellow
☐ Orange	
Surface stones – options	
☐ None	☐ Boulders (>250mm)
☐ Pebbles (0-50mm)	☐ Rocks
☐ Cobbles (51-250)	

3.3 REPORTING STAFF

Dr Graham Thompson prepared this report and Dr Scott Thompson reviewed the report before it was sent to the client. Both senior scientists have appropriate relevant post-graduate qualifications, extensive experience in conducting fauna assessments in the Goldfields, have published research articles on biodiversity, fauna assemblages, conservation significant species, trapping techniques and temporal variations in trapped fauna assemblages based on Goldfields surveys and are therefore appropriately trained and experienced for the task of preparing this assessment. Both Scott and Graham have undertaken multiple assessments in the goldfields including near the project area and are familiar with the habitat and fauna assemblage in the region.

3.4 TAXONOMY AND NOMENCLATURE

Taxonomy and nomenclature for fauna species used in this report are generally based on the WA Museum species list. Terrestrial Ecosystems has presumed that the identifications referred to in the appendices or in reports used to provide local and regional comparative data were correct and we have only corrected obvious records where the nomenclature was known to be incorrect.

3.5 LIMITATIONS

This vertebrate fauna risk assessment is a site assessment and is based on information contained in the Commonwealth Government database and other published and unpublished fauna survey data for the bioregion and personal experience over the past 20 years of undertaking fauna surveys and assessment in the goldfields. It is acknowledged that multiple surveys conducted in different seasons, repeated over several years are necessary to fully appreciate the fauna assemblage in a project area.

The EPA (2020) Technical Guidance Terrestrial Fauna Surveys suggested that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 2.

Table 2. Fauna survey limitations and constraints

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comment
Availability of data and information	Yes, moderate	There is a paucity of vertebrate fauna survey data available for similar habitats near the project area. However, data from the reports used for contextual information are adequate to provide an appreciation of the vertebrate fauna in the project area.
Competency/experience of the survey team, including experience in the bioregion surveyed	No	The authors of this report have appropriate post-graduate qualifications, undertaken multiple surveys and assessments in the Goldfields, have published a book and multiple refereed journal articles based on fauna surveys in the region and are familiar with the vertebrate fauna in this bioregion.
Scope of the survey, e.g. where faunal groups were excluded from the survey	N/A	
Timing, weather and season	No	Weather was suitable for the site visit.
Disturbance that may have affected results, e.g. fire, flood	No	Disturbances in the project area have been factored into this assessment.
The proportion of fauna identified, recorded or collected	N/A	
Adequacy of the survey intensity and proportion of survey achieved, e.g. the extent to which the area was surveyed	No	Basic fauna assessment requirements were met.
Access problems	No	The site was accessible
Problems with data and analysis, including sampling biases	N/A	

N/A = not applicable, Significant = major impact on outcome of the report, Moderate = impacted parts of the report, Negligible = almost no impact on the report.

4. RESULTS

4.1 FAUNA HABITAT

The following three broad fauna habitats are present in the project area (Figure 2):

- Clay pan;
- Scattered Mulga and Casuarina over mixed shrubs and chenopods over a rocky substrate; and
- Scattered Mulga over mixed shrubs and chenopods over sand and clay.

There was also evidence of recent exploration activity and historical disturbance associated with exploration and pastoral activity. Seventeen habitat assessments were undertaken during the field assessment. Undisturbed areas are generally in good condition, but disturbed areas have most had the vegetation removed and are highly degraded. The results of the habitat assessment and associated photographs are provided in Appendix D.

Plates 1 – 8 provide an indication of the variation fauna habitat in the project area.



Plate 1. Fauna habitat



Plate 2. Fauna habitat



Plate 3. Fauna habitat



Plate 4. Fauna habitat



Plate 5. Disturbed area



Plate 6. Disturbed area



Plate 7. Disturbed area



Plate 8. Disturbed area

4.2 BIOREGIONAL VERTEBRATE FAUNA ASSEMBLAGE

Appendix B provides a summary of the fauna survey data that are available near the project area. There are appreciable differences in the recorded fauna assemblages within and among fauna surveys shown in Appendix B. These differences are partially due to the variable survey effort deployed among surveys and they also reflect variations in soils and vegetation as well as temporal variations in the fauna assemblages.

Tables 3-5 provide a list of vertebrate species potentially found near the project area that have been compiled based on the fauna survey report results shown in Appendix B.

Table 3. Birds potentially found near the project area

Family	Species	Common Name
Casuariidae	*Dromaius novaehollandiae*	Emu
Anatidae	*Cygnus atratus*	Black Swan
	Tadorna tadornoides	Australian Shelduck
	Chenonetta jubata	Australian Wood Duck
	Anas superciliosa	Pacific Black Duck
	Anas gracilis	Grey Teal
	Aythya australis	Hardhead

Family	Species	Common Name
Megapodiidae	*Leipoa ocellata*	Malleefowl
Phasianidae	*Coturnix pectoralis*	Stubble Quail
Podicipedidae	*Poliocephalus poliocephalus*	Hoary-headed Grebe
Columbidae	*Phaps chalcoptera*	Common Bronzewing
	Ocyphaps lophotes	Crested Pigeon
	Geopelia cuneata	Diamond Dove
Cuculidae	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo
	Chrysococcyx osculans	Black-eared Cuckoo
	Chrysococcyx lucidus	Shining Bronze-Cuckoo
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar
Podargidae	*Podargus strigoides*	Tawny Frogmouth
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar
Apodidae	*Apus pacificus*	Pacific Swift
Rallidae	*Tribonyx ventralis*	Black-tailed Nativehen
Recurvirostridae	*Himantopus leucocephalus*	Pied Stilt
	Cladorhynchus leucocephalus	Banded Stilt
	Recurvirostra novaehollandiae	Red-necked Avocet
Charadriidae	*Vanellus tricolor*	Banded Lapwing
	Charadrius ruficapillus	Red-capped Plover
	Erythrogonys cinctus	Red-kneed Dotterel
	Elseyornis melanops	Black-fronted Dotterel
Scolopacidae	*Tringa nebularia*	Common Greenshank
	Tringa glareola	Wood Sandpiper
Turnicidae	*Turnix velox*	Little Buttonquail
Laridae	*Chroicocephalus novaehollandiae*	Silver Gull
Otididae	*Ardeotis australis*	Australian Bustard
Ardeidae	*Ardea pacifica*	White-necked Heron
	Egretta novaehollandiae	White-faced Heron
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill

Family	Species	Common Name
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant
Ardeidae	*Ardea alba*	Great Egret
Accipitridae	*Elanus axillaris*	Black-shouldered Kite
	Lophoictinia isura	Square-tailed Kite
	Hieraaetus morphnoides	Little Eagle
	Aquila audax	Wedge-tailed Eagle
	Circus assimilis	Spotted Harrier
	Accipiter fasciatus	Brown Goshawk
	Accipiter cirrocephalus	Collared Sparrowhawk
	Haliastur sphenurus	Whistling Kite
Cuculidae	*Heteroscenes pallidus*	Pallid Cuckoo
Strigidae	*Ninox boobook*	Southern Boobook
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra
	Todiramphus pyrrhopygius	Red-backed Kingfisher
Meropidae	*Merops ornatus*	Rainbow Bee-eater
Falconidae	*Falco cenchroides*	Nankeen Kestrel
	Falco longipennis	Australian Hobby
	Falco berigora	Brown Falcon
	Falco peregrinus	Peregrine Falcon
Timaliidae	*Zosterops lateralis*	Silvereye
Cacatuidae	*Eolophus roseicapilla*	Galah
	Nymphicus hollandicus	Cockatiel
Psittaculidae	*Polytelis anthopeplus*	Regent Parrot
	Neopsephotus bourkii	Bourke's Parrot
	Neophema splendida	Scarlet-chested Parrot
	Barnardius zonarius	Australian Ringneck
	Psephotus varius	Mulga Parrot
	Melopsittacus undulatus	Budgerigar
	Glossopsitta porphyrocephala	Purple-crowned Lorikeet
Ptilonorhynchidae	*Chlamydera guttata*	Western Bowerbird
	Ptilonorhynchus maculata	Spotted Bowerbird

Family	Species	Common Name
Climacteridae	*Climacteris affinis*	White-browed Treecreeper
	Climacteris rufus	Rufous Treecreeper
Maluridae	*Malurus pulcherrimus*	Blue-breasted Fairywren
	Malurus lamberti	Variegated Fairywren
	Malurus splendens	Splendid Fairywren
	Malurus leucopterus	White-winged Fairywren
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater
	Purnella albifrons	White-fronted Honeyeater
	Lichenostomus cratitius	Purple-gaped Honeyeater
	Manorina flavigula	Yellow-throated Miner
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater
	Anthochaera carunculata	Red Wattlebird
	Gavicalis virescens	Singing Honeyeater
	Gavicalis virescens	Singing Honeyeater
	Ptilotula ornata	Yellow-plumed Honeyeater
	Ptilotula keartlandi	Grey-headed Honeyeater
	Conopophila whitei	Grey Honeyeater
	Epthianura tricolor	Crimson Chat
	Epthianura aurifrons	Orange Chat
	Epthianura albifrons	White-fronted Chat
	Sugomel nigrum	Black Honeyeater
	Lichmera indistincta	Brown Honeyeater
	Lichmera indistincta	Brown Honeyeater
	Phylidonyris niger	White-cheeked Honeyeater
	Nesoptilotis leucotis	White-eared Honeyeater
	Nesoptilotis flavicollis	Yellow-throated Honeyeater
	Melithreptus chloropsis	Gilbert's Honeyeater
	Melithreptus brevirostris	Brown-headed Honeyeater

Family	Species	Common Name
	Melithreptus brevirostris	Brown-headed Honeyeater
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote
	Pardalotus rubricatus	Red-browed Pardalote
	Pardalotus striatus	Striated Pardalote
Acanthizidae	*Pyrrholaemus brunneus*	Redthroat
	Acanthiza iredalei	Slender-billed Thornbill
	Acanthiza apicalis	Inland Thornbill
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill
	Acanthiza uropygialis	Chestnut-rumped Thornbill
	Acanthiza robustirostris	Slaty-backed Thornbill
	Smicrornis brevirostris	Weebill
	Gerygone fusca	Western Gerygone
	Aphelocephala leucopsis	Southern Whiteface
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler
Cinclosomatidae	*Cinclosoma castanotum*	Chestnut Quail-thrush
	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush
Campephagidae	*Coracina maxima*	Ground Cuckooshrike
	Coracina novaehollandiae	Black-faced Cuckooshrike
	Lalage tricolor	White-winged Triller
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella
Oreoicidae	*Oreoica gutturalis*	Crested Bellbird
Pachycephalidae	*Colluricincla harmonica*	Grey Shrikethrush
	Pachycephala inornata	Gilbert's Whistler
	Pachycephala pectoralis	Golden Whistler
	Pachycephala rufiventris	Rufous Whistler
Artamidae	*Artamus personatus*	Masked Woodswallow
	Artamus superciliosus	White-browed Woodswallow
	Artamus cinereus	Black-faced Woodswallow
	Artamus cyanopterus	Dusky Woodswallow

Family	Species	Common Name
	Cracticus torquatus	Grey Butcherbird
	Cracticus nigrogularis	Pied Butcherbird
	Gymnorhina tibicen	Australian Magpie
	Strepera versicolor	Grey Currawong
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail
	Rhipidura albiscapa	Grey Fantail
Monarchidae	*Grallina cyanoleuca*	Magpie-lark
Corvidae	*Corvus orru*	Torresian Crow
	Corvus bennetti	Little Crow
	Corvus coronoides	Australian Raven
Petroicidae	*Microeca fascinans*	Jacky Winter
	Petroica goodenovii	Red-capped Robin
	Melanodryas cucullata	Hooded Robin
Locustellidae	*Cincloramphus cruralis*	Brown Songlark
	Cincloramphus mathewsi	Rufous Songlark
Hirundinidae	*Hirundo neoxena*	Welcome Swallow
	Petrochelidon ariel	Fairy Martin
	Petrochelidon nigricans	Tree Martin
	Cheramoeca leucosterna	White-backed Swallow
Zosteropidae	*Zosterops lateralis*	Silvereye (Western)
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird
Estrildidae	*Taeniopygia guttata*	Zebra Finch
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit

Table 4. Amphibians potentially found near the project area

Family	Species	Common Name
Limnodynastidae	*Neobatrachus kunapalari*	Wheatbelt Frog
	Neobatrachus sudelli	Sudell's Frog
	Neobatrachus sutor	Shoemaker Frog
	Neobatrachus wilsmorei	Plonking Frog
	Platyplectrum spenceri	Spencer's Burrowing Frog
Myobatrachidae	*Crinia georgiana*	Quacking Frog
	Pseudophryne occidentalis	Western Toadlet
Pelodryadidae	*Cyclorana maini*	Main's Frog
	Cyclorana occidentalis	Western Water-holding Frog
	Litoria moorei	Motorbike Frog

Table 5. Mammals potentially found near the project area

Family	Species	Common Name
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna
Bovidae	*Bos taurus*	Cow
	Capra hircus	Goat
	Ovis aries	Sheep
Camelidae	*Camelus dromedarius*	Dromedary
	Canis lupus	Dingo
	Vulpes vulpes	Red Fox
Felidae	*Felis catus*	Cat
Molossidae	*Austronomus australis*	White-striped Freetail Bat
	Mormopterus planiceps	Southern Free-tail Bat
	Mormopterus sp. 4	South-western Free-tail Bat
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat
	Chalinolobus morio	Chocolate Wattled Bat
	Nyctophilus geoffroyi	Lesser Long-eared Bat
	Nyctophilus holtorum	Holt's Long-eared Bat
	Nyctophilus major	Greater Long-eared Bat
	Scotorepens balstoni	Inland Broad-nosed Bat
	Vespadelus baverstocki	Inland Forest Bat
	Vespadelus regulus	Southern Forest Bat
Dasyuridae	*Antechinomys laniger*	Kultarr
	Ningaui ridei	Wongai Ningaui
	Ningaui yvonneae	Mallee Ningaui
	Pseudantechinus woolleyae	Woolley's False Antechinus
	Sminthopsis crassicaudata	Fat-tailed Dunnart
	Sminthopsis dolichura	Little Long-tailed Dunnart
	Sminthopsis gilberti	Gilbert's Dunnart
	Sminthopsis hirtipes	Hairy-footed Dunnart
	Sminthopsis murina	Slender-tailed Dunnart
	Sminthopsis ooldea	Ooldea Dunnart
Burramyidae	*Cercartetus concinnus*	Southwestern Pygmy Possum
Macropodidae	*Macropus fuliginosus*	Western Grey Kangaroo
	Osphranter robustus	Euro
	Osphranter rufus	Red Kangaroo
Leporidae	*Oryctolagus cuniculus*	Rabbit
Muridae	*Mus musculus*	House Mouse
	Notomys alexis	Spinifex Hopping Mouse
	Notomys mitchellii	Mitchell's Hopping Mouse
	Pseudomys bolami	Bolam's Mouse
	Pseudomys hermannsburgensis	Sandy Inland Mouse

Table 6. Reptiles potentially found near the project area

Family	Species	Common Name
Agamidae	*Ctenophorus caudicinctus*	Ring-tailed Dragon
	Ctenophorus cristatus	Crested Dragon
	Ctenophorus fordi	Mallee Dragon
	Ctenophorus inermis	Military Dragon
	Ctenophorus infans	Ring-tailed Dragon
	Ctenophorus isolepis	Central Military Dragon
	Ctenophorus nuchalis	Central Netted Dragon
	Ctenophorus ornatus	Ornate Crevice Dragon
	Ctenophorus reticulatus	Western Netted Dragon
	Ctenophorus salinarum	Saltpan Dragon
	Ctenophorus scutulatus	Lozenge-marked Dragon
	Diporiphora amphiboluroides	Mulga Dragon
	Moloch horridus	Thorny Devil
	Pogona minor	Western Bearded Dragon
	Tympanocryptis cephalus	Pebble Dragon
Carphodactylidae	*Nephrurus laevissimus*	Smooth Knob-tail

Family	Species	Common Name
	Nephrurus vertebralis	Midline Knob-tail
	Nephrurus wheeleri	Banded Knob-tail
	Underwoodisaurus milii	Barking Gecko
Diplodactylidae	*Amalosia reticulata*	Reticulated Velvet Gecko
	Diplodactylus conspicillatus	Fat-tailed Gecko
	Diplodactylus granariensis	Wheatbelt Stone Gecko
	Diplodactylus pulcher	Beautiful Gecko
	Hesperoedura reticulata	Reticulated Velvet Gecko
	Lucasium damaeum	Beaded Gecko
	Lucasium maini	Main's Ground Gecko
	Lucasium squarrosum	Mottled Ground Gecko
	Rhynchoedura ornata	Beaked Gecko
	Strophurus assimilis	Goldfields Spiny-tailed Gecko
	Strophurus ciliaris	Spiny-tailed Gecko
	Strophurus elderi	Jewelled Gecko
	Strophurus intermedius	Southern Spiny-tailed Gecko
	Strophurus strophurus	Western Spiny-tailed Gecko
	Strophurus wellingtonae	Western Shield Spiny-tailed Gecko
Elapidae	*Acanthophis pyrrhus*	Desert Death Adder
	Brachyurophis fasciolatus	Narrow-banded Burrowing Snake
	Brachyurophis semifasciata	Half-girdled Snake
	Demansia psammophis	Yellow-faced Whipsnake
	Elapognathus coronatus	Crowned Snake
	Furina ornata	Orange-naped Snake
	Neelaps bimaculatus	Black-naped Burrowing Snake
	Suta gouldii	Gould's Snake
	Suta monachus	Hooded Snake
	Pseudechis australis	Mulga Snake
	Pseudechis butleri	Spotted Mulga Snake

Family	Species	Common Name
	Pseudonaja mengdeni	Western Brown Snake
	Pseudonaja modesta	Ringed Brown Snake
	Simoselaps bertholdi	Jan's Banded Snake
	Suta fasciata	Rosen's Snake
	Suta suta	Curl Snake
Gekkonidae	*Christinus marmoratus*	Marbled Gecko
	Gehyra punctata	Spotted Dtella
	Gehyra purpurascens	Purplish Dtella
	Gehyra variegata	Variegated Gehyra
	Hemidactylus frenatus	Asian House Gecko
	Heteronotia binoei	Bynoe's Gecko
Pygopodidae	*Aprasia repens*	Southwest Sandplain Worm Lizard
	Delma australis	Marble-faced Delma
	Delma butleri	Unbanded Delma
	Delma fraseri	Fraser's Delma
	Delma nasuta	Sharp-snouted Delma
	Lialis burtonis	Burton's Legless Lizard
	Pygopus lepidopodus	Common Scaly-foot
	Pygopus nigriceps	Western Hooded Scaly-foot
Pythonidae	*Antaresia stimsoni*	Stimson's Python
	Morelia spilota	Carpet Python
Scincidae	*Cryptoblepharus buchananii*	Buchanan's Snake-eyed Skink
	Ctenotus atlas	Southern Mallee Ctenotus
	Ctenotus brooksi	Wedge-snout Ctenotus
	Ctenotus calurus	Blue-tailed Fine-snout Ctenotus
	Ctenotus greeri	Spotted-necked Ctenotus
	Ctenotus helenae	Clay-soil Ctenotus
	Ctenotus leae	Orange-tailed Fines-nout Ctenotus
	Ctenotus leonhardii	Leonhardi's Ctenotus
	Ctenotus pantherinus	Leopard Ctenotus

Family	Species	Common Name
	Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus
	Ctenotus schomburgkii	Barred Wedge-snout Ctenotus
	Ctenotus severus	Stern Ctenotus
	Ctenotus uber	Spotted Ctenotus
	Ctenotus xenopleura	Wide-striped Ctenotus
	Cyclodomorphus branchialis	Common Slender Bluetongue
	Cyclodomorphus melanops	Spinifex Slender Blue-tongue
	Egernia depressa	Southern Pygmy Spiny-tailed Skink
	Egernia formosa	Goldfields Crevice Skink
	Egernia napoleonis	Southwestern Crevice Skink
	Egernia richardi	Bright Crevice-skink
	Eremiascincus richardsonii	Broad-banded Sand-swimmer
	Hemiergis gracilipes	South-western Mulch-skink
	Hemiergis initialis	South-western Earless Skink
	Hemiergis peronii	Lowlands Earless Skink
	Lampropholis guichenoti	Pale-flecked Garden Skink
	Lerista bipes	North-western Sandslider
	Lerista desertorum	Central Desert Robust Slider
	Lerista kingi	King's Slider
	Lerista lineopunctulata	Dotted-line Robust Slider
	Lerista macropisthopus	Unpatterned Robust Slider
	Lerista muelleri	Wood Mulch-slider
	Lerista picturata	Southern Robust Slider
	Lerista timida	Timid Slider
	Liopholis inornata	Desert Skink
	Liopholis striata	Nocturnal Desert Skink
	Menetia greyii	Common Dwarf Skink
	Morethia adelaidensis	Saltbush Morethia Skink
	Morethia butleri	Woodland Morethia Skink
	Morethia obscura	Shrubland Pale-flecked Morethia
	Saiphos equalis	Three-toed Skink
	Tiliqua occipitalis	Western Blue-tongued Lizard
	Tiliqua rugosa	Bobtail
Typhlopidae	*Anilios australis*	Austral Blind Snake
	Anilios bicolor	Dark-spined Blind Snake
	Anilios bituberculatus	Prong-snouted Blind Snake
	Anilios hamatus	Pale-headed Blind Snake
	Anilios waitii	Waite's Blind Snake
Varanidae	*Varanus caudolineatus*	Stripe-tailed Monitor
	Varanus giganteus	Perentie
	Varanus gouldii	Gould's Goanna
	Varanus panoptes	Yellow-spotted Monitor
	Varanus tristis	Black-headed Monitor
Chelidae	*Chelodina oblonga*	Oblong Turtle

4.3 CONSERVATION SIGNIFICANT FAUNA

Conservation significant fauna are protected by the Commonwealth *EPBC Act 1999*, and this list includes species covered by international treaties such as the Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) and the *Biodiversity Conservation Act 2016* (*BC Act 2016*). The *BC Act 2016* provides for the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* that lists species under multiple categories. In addition, the DBCA maintains a list of fauna that require monitoring under four priorities based on the current knowledge of their distribution, abundance and threatening processes. The *EPBC Act 1999* and *BC Act 2016* imply legislative requirements for the management of anthropogenic impacts to minimise the effects of disturbances on species and their habitats. Priority species have no statutory protection, other than the DBCA wishes to monitor potential impacts on these species. Environmental consultants and proponents of developments are encouraged to avoid and minimise impacts on these species. Definitions of the significant fauna under the *BC Act 2016* are provided in Appendix C.

Wetland and wetland migratory bird species have been excluded from the following list and assessments as there is no suitable habitat for these species in the project area. One threatened species of fauna and one migratory/marine species of birds identified under the *EPBC Act 1999* potentially occur in the project area, the same two species plus an additional bird also are listed under the *BC Act 2016*. The following is an assessment of the likelihood of each of the species listed in Table 7 being found in the project area.

Table 7. Assessment of the potential presence of a conservation significant fauna species in the project area

Species	DBCA Schedule / Priority	Status under Commonwealth EPBC Act	Comment on the potential presence of a species
Night Parrot *Pezoporus occidentalis*	Critically Endangered	Endangered	Highly unlikely to be in the project area, due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.
Sandhill Dunnart *Sminthopsis psammophila*	Endangered	Endangered	Highly unlikely to be in the project area, due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.
Malleefowl *Leipoa ocellata*	Vulnerable	Vulnerable	Highly unlikely to be in the project area due to a lack of suitable habitat and prevalence of feral and pest fauna. The potential for impacting on this species is therefore very low.
Grey Falcon *Falco hypoleucos*	Vulnerable	Vulnerable	Highly unlikely to be in the project area due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.
Great Desert Skink *Liopholis kintorei*	Vulnerable	Vulnerable	Highly unlikely to be in the project area due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.
Chuditch *Dasyurus geoffroii*	Vulnerable	Vulnerable	Highly unlikely to occur in the project area. The potential for impacting on this species is therefore very low.
Princess Parrot *Polytelis alexandrae*	Priority 4	Vulnerable	May infrequently be seen in the region, however, clearing vegetation is unlikely to impact on this species.
Mulgara *Dasycercus blythi*	Priority 4		Highly unlikely to be in the project area due to a lack of suitable habitat. The potential for impacting on this species is therefore very low.
Fork-tailed Swift *Apus pacificus*	Migratory	Migratory	May very infrequently be seen in the region, however, clearing vegetation is unlikely to impact on this aerial species.
Grey Wagtail *Motacilla cinereal*	Migratory	Migratory	Highly unlikely to be present in the project area. The potential for impacting on this species is therefore low.
Peregrine Falcon *Falco peregrinus*	OS		May very infrequently be seen in the region, however, clearing vegetation is unlikely to impact on this aerial species.

OS – Other Specially protected fauna

Night Parrot (*Pezoporus occidentalis*) - Critically Endangered under the *BC Act 2016* and Endangered under the *EPBC Act 1999*

The Night Parrot is a small, arid-adapted, nocturnal, ground-feeding parrot (Johnstone and Storr 1998, Threatened Species Scientific Committee 2016). Its length is 22-25cm with a body mass of approximately 104g (Threatened Species Scientific Committee 2016), although it was suggested that they were semi-nomadic, the Night Parrots in south-western Queensland appear to be sedentary (Murphy 2015).

The Night Parrot was probably originally distributed over much of semi-arid and arid Australia (Garnett et al. 1993, Threatened Species Scientific Committee 2016). Records in north-west and western Queensland in the early 1990-2000s were in a broad cross section of the habitats available (Garnett et al. 1993, Cupitt and Cupitt 2008, Boles et al. 2016). There have been recent sightings in the Pilbara in 1980, 2005 and 2017, central WA in 1979, north-eastern South Australia in 1979, western Queensland (including Pullen-Pullen-Mt Windsor-Diamantina population) in 1980, 1990, 1993, 2006 and 2013-17 (Davis and Metcalf 2008, Garnett et al. 2011, Charalambous 2016, Pickrell 2016, AG staff 2017, Palaszxzuk and Miles 2017, Rykers 2017, AG staff 2018), Pilbara in 2017 (Jones 2017) and the northern Goldfields (Jackett et al. 2017). Garnett et al. (2011) suggested that there were between 50-250 mature individuals in less than 5% of its previous range.

Wilson's (1937) summary of observations provided information on the early records of Night Parrots' preferred habitat and breeding sites. Recent information indicates its preferred habitat appears to be in Triodia grasslands, chenopod shrublands, shrubby samphire and floristically diverse habitats dominated by large-seeded species (Threatened Species Scientific Committee 2016, McCarthy 2017, Murphy et al. 2017b). At Pullen Pullen Reserve it nests in large, more or less ring-shaped Triodia, and the nest consists of a tunnel (25-30^{o} and 0^{o} to the ground; 20-33cm long) through an apron of dead spinifex leaves that leads to a chamber under a live hummock, with a shallow depression (3-4cm) excavated into the gravelly/sandy soil (Murphy et al. 2017a). In the northern Goldfields the nest was again in a spinifex hummock, it was circular, with an excavated depression (~1.5-2.0cm) in sandy substrate (Hamilton et al. 2017, Jackett et al. 2017). The entrance tunnel was 62cm long, and was downward sloping (27^{o}) with the entrance 28cm above the ground (Hamilton et al. 2017). It has clutches of two to four sub-elliptical, white eggs with a lustrous appearance (Murphy et al. 2017a). Breeding followed significant rains in March for the observations in Pullen-Pullen Reserve and in April in the northern Goldfields (Hamilton et al. 2017, Murphy et al. 2017a), but it is thought that breeding generally occurs between April and October (Murphy et al. 2017a).

Murphy et al. (2017b) placed a GPS tag on Night Parrots and reported that the two birds called at dusk from their diurnal roosts among spinifex hummocks and then flew to more floristically diverse habitats dominated by large-seeded, prolifically seeding species to feed.

There are no mature spinifex hummocks in the project area and a prevalence of feral and pest fauna. As the preferred roosting and nesting sites for Night Parrots are not present in the project area and there is a significant threatening process for the species in the area (i.e. feral cats), it is Terrestrial Ecosystems' assessment that Night Parrots are not present in the project area and will therefore not be impacted by any proposed development.

Sandhill Dunnart (***Sminthopsis psammophila***) - *Endangered* under the *BC Act 2016* and *EPBC Act 1999*

The Sandhill Dunnart is a small, dasyurid with a body length of approximately 8-12 cm, and a tail length approximately 10-12 cm (Threatened Species Scientific Committee 2015). It has been recorded from numerous widely dispersed localities in the Great Victoria Desert and the Eyre Peninsula (Woinarski et al. 2014).

The Sandhill Dunnart occupies sandy semi-arid and arid areas dominated by mature spinifex. They live in burrows dug under large spinifex hummocks as well as hollow logs and Hopping Mice burrows (Woinarski et al. 2014).

The project area is outside its existing known extant geographic range, and the habitat that it has recently been recorded in is not present in the project area, so it is highly improbable that it is present in the project area.

Malleefowl (*Leipoa ocellata*) - Vulnerable under the *BC Act 2016* and *EPBC Act 1999*

Malleefowl are large, ground-dwelling birds that rarely fly unless alarmed or are perching for the night. Historically, Malleefowl have been found in mallee regions of southern Australia from approximately the 26th parallel of latitude southwards. Prior to vegetation clearing for agriculture, Malleefowl were abundant in the WA Wheatbelt. Vegetation clearing for agriculture also opened adjacent bushland to predators, and in the south-west of WA, Malleefowl often only persist in isolated remnant patches of native vegetation. Sheep and other herbivores (e.g. goats, kangaroos) grazing in remnant vegetation removes or thins the undergrowth, and they also compete with Malleefowl for herbaceous foods and can cause changes to the structure and floristic diversity of foraging habitats (Benshemesh 2007).

Malleefowl and their eggs are vulnerable to predation by foxes, and newly hatched chicks are vulnerable to foxes, cats and raptors (Priddel and Wheeler 1990, Benshemesh and Burton 1999, Benshemesh 2007, Lewis and Hines 2014). Their abundance in the Goldfields is low and they are sparsely distributed, favouring those areas that are more densely vegetated. Malleefowl build distinctive nests that comprise a large mound of soil/pebbles covering a central core of leaf litter. These nest mounds range in diameter but can span more than five metres and may be up to one metre high. Malleefowl are generally monogamous and once breeding commences, they pair for life. The presence of nest mounds provides an indication of the presence of Malleefowl in the area.

Malleefowl have been observed in the bioregion, however, there are no recent records of active breeding mounds in the vicinity of the project area. No mounds were recorded, and the open fauna habitat and presence of feral and pest species significantly reduce the probability of Malleefowl utilising the project area. Therefore, Terrestrial Ecosystems' assessment is that vegetation clearing in the project area is unlikely to have any significant impact on this species.

Grey Falcon (*Falco hypoleucos*) - Vulnerable species under the *EPBC Act 1999* and *BC Act 2016*

The Grey Falcon is a moderately large raptor that is found mostly in the northern half of Western Australia, in lightly wooded, coastal or riverine areas.

There are multiple records of the Grey Falcon in the Pilbara, but very few in the Goldfields. Therefore, it is highly unlikely that the Grey Falcon is in the project area, and if it was present then it would move to adjacent areas if disturbed.

Great Desert Skink (*Liopholis kintorei*) – Vulnerable under the *BC Act 2016* and *EPBC Act 1999*

The Great Desert Skink is a communal living skink that lives in a burrow complex in the sandy deserts vegetated with spinifex (Pearson et al. 2001). The site visit indicated that there was no suitable habitat for this species in the project area.

Chuditch (*Dasyurus geoffroii*) – Vulnerable under the *BC Act 2016* and *EPBC Act 1999*

The Chuditch is the largest extant carnivorous marsupial in WA. It is usually active from dusk to dawn. Formally known from over 70% of Australia, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west WA and other isolated areas. Chuditch are solitary animals for most of their life and den in hollow logs, burrows, culverts, etc. and have also been recorded in tree hollows and rock cavities. Chuditch are opportunistic feeders, and forage primarily on the ground at night. Their diet can include other mammals, birds, lizards, bird and reptile eggs but the majority is a mixture of large invertebrates (e.g. spiders, scorpions and crickets).

How et al. (1988) reported Chuditch being found near the Norseman-Lake King Road and near Mount Holland. DBCA records show that one specimen was recorded in 1974 in Kambalda East. There are multiple records south of Southern Cross and Marvel Loch and there have been other reported sightings east of Kambalda and near Norseman, but Terrestrial Ecosystems can find none north or east of Kalgoorlie.

As the project area is a significantly long way north-east of the species known distribution it is highly unlikely that the Chuditch would be found in the project area and the habitat is not suitable. As a consequence, Terrestrial Ecosystems' assessment is that any development is unlikely to have a significant impact on this species.

Princess Parrot (*Polytelis alexandrae*) - Vulnerable species under the *EPBC Act 1999* and a Priority 4 species with DBCA

The species is found mostly in the inland arid areas of Australia, and in Western Australia in the Gibson, Little Sandy and Great Victoria Deserts (Johnstone and Storr 1998, Pavey et al. 2014). However, they occasionally occurred in lightly wooded areas adjacent to the sandy deserts (Moriarty 1972).

The project area is a long way south and west of its known geographic distribution, so it is Terrestrial Ecosystems' assessment it is highly unlikely to be seen in the project area, unless it is an aviary escapee.

Very little is known about the Princess Parrot; even the exact extent of its geographical distribution. It is thought to be nomadic within the central desert regions of Australia, occupying arid shrub lands, particularly those dominated by Mulga, Desert Oak and spinifex. Due to the paucity of information on the species, accurate estimates of its conservation significance are difficult to make, however, this species is probably threatened by habitat loss to agricultural practices and changes in fire regimes.

It is possible that the Princess Parrot maybe an infrequent visitor to this area when resources are suitable. However, if it was present any proposed development is unlikely to significantly impact on this species as it will move away to other areas if it is disturbed.

Brush-tailed Mulgara (*Dasycercus blythi*) - Priority 4 with the DBCA

Woolley (2005) recognises two species of 'Mulgara'; *Dasycercus blythi* and *D. cristicauda*. *Dasycercus blythi* has a non-crested tail, two upper premolars and six nipples; *D. cristicauda* has a crested tail, three upper premolars and eight nipples. Both species potentially have overlapping distributions in arid Australia, but it is thought that *D. cristicauda* does not currently exist in Western Australia, although there are old records indicating its presence. Woolley (2005) suggested the common names for these two species be Brush-tailed Mulgara for *D. blythi* and Crest-tailed Mulgara for *D. cristicauda*. These two species can be sympatric in places, but probably utilise different parts of the habitat on a local scale when they are recorded in the same area. Currently, there are insufficient data to separate the spatial ecology, burrows and reproductive biology of these two species. Information that follows is based on what is known for 'Mulgara' without distinguishing between the species.

The reported distribution of Mulgara includes much of the inland spinifex covered sandy desert and spinifex vegetated areas in the Pilbara and northern goldfields. Within these areas their distribution is patchy and it is most frequently confined to mature spinifex dominated habitat (Gibson and Cole 1992, Masters 1998, Masters et al. 2003, Thompson and Thompson 2008). In some areas, their relative abundance is positively associated with rainfall in the previous 12 to 24 months (Gibson and Cole 1992, Masters 1998, Dickman et al. 2001, Letnic and Dickman 2005) and recent burning of the spinifex does not seem to be sufficient to shift Mulgara out of an area (Thompson and Thompson 2007). Mulgara are generally sedentary in contrast with some other small dasyurids and have high site fidelity and a low propensity for dispersal once a home range has been established (Masters 1998, Dickman et al. 2001).

Fauna habitat in the project area is not suitable for Mulgara. It is therefore Terrestrial Ecosystems' view that they are unlikely of be found in the project area.

Fork-tailed Swift (*Apus pacificus*) - Migratory species under the *EPBC Act 1999* and *BC Act 2016*

This species breeds in the northeast and mid-east Asia and winters in Australia and southern New Guinea. It is a visitor to most parts of Western Australia, beginning to arrive in the Kimberley in late September, in the Pilbara in November and in the southwest land division in mid-December, and leaving by late April. The Fork-tailed swift is an almost exclusively an aerial species, foraging and sleeping on the wing. It rarely comes to earth, usually only for breeding. It is common in the Kimberley, uncommon to moderately common near northwest, west and southeast coasts and rare to scarce elsewhere. It is rarely seen in the Goldfields (Plate 9), so it is unlikely to be impacted by the proposed development.

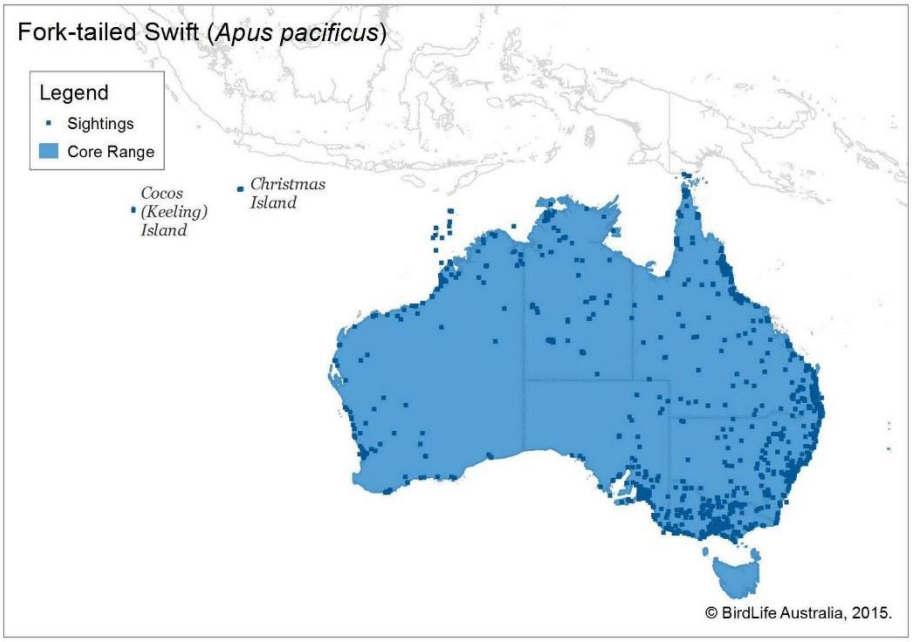


Plate 9. Range and actual reported sightings of the Fork-tailed Swift

(taken from http://www.environment.gov.au/biodiversity/threatened/publications/epbc-act-referral-guidelines-migratory-birds)

Grey Wagtail (*Motacilla cinerea*) - Migratory under the *EPBC Act 1999* and *BC Act 2016*

The Grey Wagtail is a small yellow breasted bird with a grey back and head. Johnstone and Storr (2004) reported this migratory species as breeding in Palearctic from western Europe and north-west Africa to eastern Asia and wintering in Africa, south-east Asia, Indonesia, the Philippines, New Guinea and Australia. Its preferred habitat in Australia is banks and rocks in fast-running fresh water including rivers, streams and creeks where it feeds on insects.

The Atlas of Living Australia records two sightings on the south-coast of Western Australia and none around the project area. It is highly unlikely to be seen in the project area due to a lack of records and suitable habitat (Plate 10) so it is unlikely to be impacted by the proposed development.

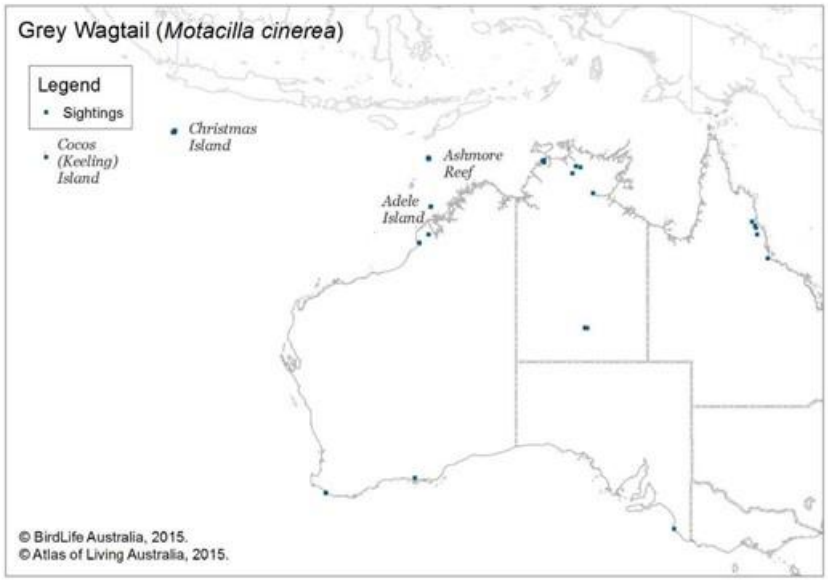


Plate 10. Reported sightings of the Grey Wagtail

(taken from http://www.environment.gov.au/biodiversity/threatened/publications/epbc-act-referral-guidelines-migratory-birds)

Peregrine Falcon (*Falco peregrinus*) - Otherwise specially protected under the *BC Act 2016*

The Peregrine Falcon is uncommon, although widespread throughout much of Australia excluding the extremely dry areas and has a wide and patchy distribution. It shows habitat preference for areas near cliffs along coastlines, rivers and ranges and within woodlands along watercourses and around lakes. Nesting sites include ledges along cliffs, granite outcrops and quarries, hollow trees near wetlands and old nests of other large bird species. There is no evidence to suggest any change in status in the last 50 years.

Terrestrial Ecosystems' assessment is that the Peregrine Falcon may infrequently be seen in the project area, however, development is unlikely to have a significant impact on this species as it will readily move away from disturbance and there are abundant areas of similar habitat in the region.

5. DISCUSSION

5.1 ADEQUACY OF THE FAUNA SURVEY DATA FOR FAUNA HABITATS REPRESENTED IN THE PROJECT AREA

The EPA's (2020) Technical Guidance on terrestrial fauna surveys indicated that the type of survey should be determined based on:

- level of existing regional knowledge;
- type and comprehensiveness of recent local surveys;
- degree of existing disturbance or fragmentation at the regional scale;
- extent, distribution and significance of habitats;
- significance of species likely to be present;
- sensitivity of the environment to the proposed activities; and
- scale and nature of impact.

The project area is 188.5ha in an area where there is limited vertebrate fauna survey information in the nearby fauna habitats. However, we have provided a substantial quantity of vertebrate fauna survey data for other sites with similar habitat albeit some are over 120km from the project area. It is unlikely that further survey effort or a detailed/targeted vertebrate fauna survey in the project area will provide new species not previously identified for this area, identify conservation significant fauna or provide additional information that would alter the assessment of potential impacts.

5.1.1 Amphibians

Frogs are normally only detected immediately after rainfall or around semi-permanent pools. It is likely that *Neobatrachus sutor*, *Pseudophryne occidentalis*, *Neobatrachus kunapalari* and *Neobatrachus wilsmorei* could also be found in the general area. Development of the project area is likely to result in a loss of individuals within the disturbed area, however, is unlikely to have a significant impact on these species when assessed in a regional context.

5.1.2 Reptiles

Typically, between 25 and 35 species of reptiles are caught in open mulga woodland (McKenzie and Hall 1992, Terrestrial Ecosystems 2010, 2012b, a). None of the species likely to be in the project area are of conservation significance. There were no characteristics of the reptile assemblage anticipated to be in the project area that indicated that there are reptiles of conservation significance or different to that in the neighbouring areas and given that there were large expanses of similar habitat in adjacent areas, development of the project area is unlikely to have significant impact on reptiles when assessed in a regional context.

Terrestrial Ecosystems' view is that the development of the project area is unlikely to significantly impact on the reptile fauna of the bioregion.

5.1.3 Birds

The number of birds and bird species in the northern Goldfields fluctuates based on seasons and recent rainfall (Craig and Chapman 2003). Semi-arid and arid areas of inland Australia support a diverse range of transient and nomadic species that move through large areas in search of available resources. Heavy rain that is followed by flowering and seeding of many plant species is often sufficient to draw many of these nomadic species to the general area. These species move on to other areas once the resource is depleted or better resources are available in adjacent areas.

The project area is likely to support a similar assemblage to that present in the adjacent areas (Dell et al. 1988, McKenzie and Hall 1992, Bell et al. 2007). There are no bird species of conservation significance likely to reside in the project area, however, some may infrequently be observed in the region (i.e. Peregrine Falcon and Princess Parrot). The Princess Parrot is nomadic and moves around the arid interior often in search of water and resources and the Peregrine Falcon will normally have a very large home range. Development of the project area, particularly when similar habitat exists in the adjacent areas, is unlikely to significantly impact on any conservation significant species of bird. All birds will readily shift to other areas when there is a disturbance.

Terrestrial Ecosystems' view is that the proposed development is unlikely to significantly impact on the avian fauna of the bioregion.

5.1.4 Mammals

The diversity of small terrestrial mammals potentially caught in the project area would be low due the sparsely vegetated and degraded habitat and presence of feral and pest fauna.

Terrestrial Ecosystems' view is that the development of the project area is unlikely to significantly impact on the mammal fauna of the bioregion.

5.2 BIODIVERSITY VALUE

An ecological assessment of a site should consider its biodiversity value at the genetic, species and ecosystem levels, and its ecological functional value at the ecosystem level. There are inadequate data to assess the ecological value at the genetic level.

Fauna habitat represented in the project area is abundant and in similar condition in adjacent areas. Therefore, the fauna assemblage that is present in the project area will also be present and abundant in the adjacent areas. The available fauna survey data (Appendix B) provides a good indication of the vertebrate fauna that are potentially in the project area.

5.2.1 Ecological functional value at the ecosystem level

A small quantity of the project area has been disturbed by exploration activity, with the consequence that the area will have a depleted vertebrate fauna assemblage. The most significant impact on vertebrate fauna in the project area and surrounds will have been feral cats and wild dogs.

This site doesn't support conservation significant fauna or a conservation significant ecosystem.

5.2.2 Maintenance of threatened ecological communities

No threatened ecological fauna communities were identified in the project area.

5.2.3 Condition of fauna habitat

Multiple sections of the project area have been disturbed by exploration activity. The uncleared fauna habitat present in the project area is like many square kilometres of adjacent habitat. The proposed development is therefore unlikely to have a significant impact on the vertebrate fauna when considered in a bioregional context.

5.2.4 Ecological linkages

The project area does not provide an important ecological linkage or fauna movement corridor.

5.2.5 Size and scale of the proposed disturbance

The project area is a small proportion of similar fauna habitat found in the adjacent area and region. Given the available fauna survey data for these habitat types, no additional surveys are warranted.

5.2.6 Abundance and distribution of similar habitat in the adjacent areas

Fauna habitats present in the project area are abundant in adjacent areas. It is therefore likely that the fauna assemblage in the project area is like many square kilometres of similar habitat in adjacent areas and the bioregion.

5.2.7 Potential impacts on ecosystem function

Clearing native vegetation is likely to result in the loss of small vertebrate fauna on-site that are unable to move away during the clearing process. The few larger animals, such as kangaroos and large goannas, and most of the birds will move into adjacent areas once clearing commences. Shifting animals into adjacent areas will increase the pressure on resources in those areas and it is likely that there will be some disruption to the ecosystems in these areas for a short period until a balance is restored.

The sparseness of the vegetation and limited ground cover mean there is a very low abundance of terrestrial vertebrate fauna in most of the project area.

Impacts associated with clearing vegetation and development in the project area in a landscape or bioregional context on the vertebrate fauna are likely to be low as the proposed disturbance area is very small relative to the quantity of similar habitat in the bioregion.

The impact of feral and pest fauna which are present in the project area will be doing more environmental damage than the combined impacts of proposed development and vegetation clearing of open mulga in the project area.

6. POTENTIAL ENVIRONMENTAL IMPACTS

Development of the area will potentially affect vertebrate fauna in numerous ways, including death/injury of fauna during vegetation clearing, impacts with vehicles and the loss of habitat.

Although there are anticipated short term impacts on fauna, they are not likely to result in significant impacts on fauna habitat and fauna assemblages in the long term. The overall impact on fauna species and species of conservation significance will be minimal provided the recommended management procedures are implemented and adhered to.

6.1 DIRECT IMPACTS

6.1.1 Animal deaths during the clearing process and displacement of fauna

Clearing vegetation and activities associated with the development will result in the loss of some small fauna that retreat to burrows, such as reptiles and mammals. Nocturnal species are unlikely to be active when most of the land clearing and construction work is taking place which may result in these individuals being adversely impacted when they attempt to escape. This loss of vegetation is unlikely to have a significant impact when considered in a bioregional context. Larger terrestrial animals and avian species will most often move to adjacent areas. These species will be required to establish new activity areas and home ranges, and this could result in the temporary displacement of resident species.

6.1.2 Reduction or loss of activity areas and closure of burrows

Clearing vegetation and associated development activities are likely to destroy reptile and mammal burrows or foraging habitat that are currently in use or could be used again. Clearing vegetation that forms part of the activity area of individuals has the potential to force these animals into adjacent areas. These areas may offer fewer resources placing individuals under survival pressure. It could also cause individuals to move into the territories of other individuals increasing competition for resources. Forced relocations could increase the possibility of predation.

6.2 INDIRECT IMPACTS

In addition to the obvious impact of vegetation clearing there can be an equally significant or greater impact in the adjacent areas because of 'edge effects'. Edge effects can lead to the disruption of ecological processes such as predation and dispersal, animal movements and can change assemblage structure. The consequence is that the impact area will always be much larger than the cleared area. Goldingay and Whelan (1997) and Clarke and Oldland (2007) reported that edge effects can extend up to 150-200m from the edge for some species, meaning the impact area on vertebrate fauna is likely to be larger than the cleared footprint.

Small mammals can respond both positively and negatively to edges depending on their ecological traits (Laurance 1991, 1994, Goosem and Marsh 1997, Goosem 2000). Edge and disturbance effects can lead to altered and most often higher levels of predation, restricting or increasing fauna movements and altering assemblage structure (Oxley et al. 1974, Paton 1994, Baker et al. 1998, Temple 1998, Luck et al. 1999, Goosem et al. 2001).

For this project area, the sparseness of vegetation and ground cover mean there will be few 'edge effects' as a consequence of vegetation clearing. Vehicle tracks also have the propensity to develop weed infestations which can impact on natural fauna habitats. Cleared corridors can also provide improved predator access to areas, enhance the invasion of pest species into areas and may act as inhibitors or disrupt fauna migration and movement patterns.

6.2.1 Habitat fragmentation

In addition to direct impacts of vegetation clearing, infrastructure including tracks, has the potential to fragment habitat. Cleared linear tracks of land are 'unnatural' in much of the habitat. These linear structures that partition existing activity areas, isolate sections of established communities and may alter long and medium-term patterns of movement around established home ranges particularly for small mammals and reptiles. A reduction in the population because of this development would be difficult to detect given our current knowledge of the spatial ecology for most of the small mammals known to be in the area.

6.2.2 Introduced fauna and weeds

Increased habitat fragmentation and human activity often results in an increase in the abundance of introduced species such as the house mice (*Mus musculus*), feral cats (*Felis catus*) and wild dogs (*Canis lupus*). This increase may be due to a decline in habitat health, increased road kills, poor disposal of waste and easier access to areas via tracks.

House mice, cats and wild dogs are known to be established in the area. In many situations they have become a 'naturalised' species in the Australian bush. Increases in dog or cat numbers can have a detrimental impact on native fauna because they predate on and compete with native species, severely disrupting the natural balance. The feral cat is a particularly damaging predator on native fauna and any increase in their numbers could have a detrimental effect on local native fauna (Kinnear 1993, Bamford 1995, Woinarski et al. 2017, Woinarski et al. 2018, Murphy et al. 2019), hence it is important to ensure that populations of the feral predators, such as cats are under control.

Infrastructure known to support feral species, such as rubbish disposal sites and bins, and permanent water should be managed to minimise increases in these populations.

Introduced plant species can successfully and rapidly invade areas of cleared native vegetation or otherwise disturbed by humans. Introduced plant species may replace native species that provide shelter or foraging areas for native fauna. Major changes to the structure of vegetation will alter the fauna habitat and consequently may influence fauna species composition. Preparing and implementing a weed management plan will largely reduce their threat to native fauna species.

6.2.3 Road fauna deaths

An increase in road fauna deaths is likely to occur where new roads/tracks are constructed or upgraded, in particular, affecting kangaroos, nocturnal birds and ground dwelling large carnivorous predators. Species such as goannas and raptors are attracted to carrion on road verges and therefore, there is an increased propensity for these species to be killed by vehicles. Given the small size of the project area and that there is limited fauna habitat present, the impacts of road fauna deaths is likely to be low.

6.2.4 Fire

Increased human activity is often associated with an altered fire regime which leads to a degradation of natural ecosystems. Fire has been identified as one of the threatening processes for some conservation significant species as numerous small mammal and bird species rely on long unburnt vegetation.

Large and widespread fires are unlikely to be a significant threat to native fauna species in and adjacent to the project area due to the sparseness of the vegetation.

6.2.5 Anthropogenic activity

Unnatural noises, vibrations, artificial light sources, and vehicle and human movement in an area may be sufficient to force individuals or fauna species to move from adjacent areas or alter their activity periods. This form of disturbance is likely to occur during the initial vegetation clearing and when development activity commences. The overall impact is likely to be confined to a relatively small area and is unlikely to be a significant impact.

6.2.6 Dust

Dust generated from shifting topsoil and increased vehicle traffic can potentially degrade surrounding vegetation, reducing its ability to absorb sunlight and influencing photosynthetic rates. Degradation of these areas may potentially render habitat unsuitable for fauna. Dust suppression and management programs are an essential component of minimising impacts on fauna in areas adjacent to the mine. An effective dust management and monitoring program is required.

6.2.7 Risk assessment

Fauna surveys to support Environmental Impact Assessments (EIA) are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on the biodiversity on a particular area and region. Potential impacts on fauna from the proposed development are identified and briefly described above. Tables 8, 9 and 10 provide a summary of the risk assessment associated with this project.

Any risk assessment is a product of the likelihood of an impact occurring and the consequences of that impact. Likelihood and consequences are categorised and described below. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 10.

Table 8. Fauna impact risk assessment descriptors

Likelihood		
Level	Description	Criteria
A	Rare	The environmental event may occur, or one or more conservation significant species may be present in exceptional circumstances.
B	Unlikely	The environmental event could occur, or one or more conservation significant species could be present at some time.
C	Moderate	The environmental event should occur, or one or more conservation significant species should be present at some time.
D	Likely	The environmental event will probably occur, or one or more conservation significant species will be present in most circumstances.
E	Almost certain	The environmental event is expected to occur, or one or more conservation significant species is expected be present in most circumstances.
Consequences		
Level	Description	Criteria
1	Insignificant	Insignificant impact on fauna of conservation significance or regional biodiversity, and the loss of individuals will be insignificant in the context of the availability of similar fauna or fauna assemblages in the area.
2	Minor	Impact on fauna localised and no significant impact on species of conservation significance in the project area. Loss of species at the local scale.
3	Moderate	An appreciable loss of fauna in a regional context or a limited impact on species of conservation significance in the project area.
4	Major	Significant impact on conservation significant fauna or their habitat in the project area and/or regional biodiversity and/or a significant loss in the biodiversity at the landscape scale.
5	Catastrophic	Loss of species at the regional scale and/or a significant loss of species categorised as 'vulnerable' or 'endangered' under the EPBC Act (1999) at a regional scale.
Acceptability of Risk		
Level of risk	Management Action Required	
Low	No action required.	
Moderate	Avoid if possible, routine management with internal audit and review of monitoring results annually.	
High	Externally approved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually. May a referral to the Commonwealth under the EPBC Act 1999.	
Extreme	Unacceptable, project should be redesigned or not proceed.	

Table 9. Levels of acceptable risk

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequence	Insignificant (1)	Low	Low	Low	Low	Low
	Minor (2)	Low	Low	Low	Moderate	Moderate
	Moderate (3)	Low	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

Table 10. A risk assessment of the impact of ground disturbance activity on fauna

			Before management				With management		
	Potential impacts		Inherent risk			Risk controls	Residual risk		
Factor			Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Fauna survey data	Inadequate survey data to adequately assess the risks	Unknown loss of fauna, fauna of conservation significance, and fauna assemblages, and an incomplete fauna assessment.	B	2	Low				
	Inadequacy of comparative data	Limits on the availability of comparative data reduced the capacity to assess the uniqueness of the fauna assemblages in the project area.	B	2	Low				
Clearing vegetation	Loss of fauna habitat – local scale	Loss of terrestrial fauna in the project area.	E	2	Mod.				
	Loss of fauna habitat – landscape scale	Loss of some fauna during vegetation clearing.	B	1	Low				
	Loss of fauna habitat – regional scale	Small loss of some fauna from the region.	B	1	Low				
	Loss of a threatened ecological fauna community	Loss of an undetected threatened ecological fauna community.	A	3	Low				
	Habitat fragmentation	Fauna movement restricted resulting in the death of fauna and a loss of biodiversity.	A	2	Low				
Death or loss of conservation significant fauna	Loss of a unique terrestrial fauna ecosystem	Loss of an ecosystem containing fauna with high species richness, high abundance and numerous top of the food chain predators.	A	2	Low				
	Arid Bronze Azure	Loss of a Arid Bronze Azure or small population of Arid Bronze Azure	A	3	Low				
	Night Parrot	Loss of a Night Parrot or small population of Night Parrots	A	3	Low				
	Great Desert Skink	Loss of a Great Desert Skink or small population of Great Desert Skink	A	3	Low				
	Malleefowl	Loss of a Malleefowl or small population of Malleefowl	A	2	Low				

			Before management				With management		
	Chuditch	Loss of a Chuditch or small population of Chuditch	A	2	Low				
	Princess Parrot	Loss of a Princess Parrot or small population of Princess Parrot	A	2	Low				
	Mulgara	Loss of a Mulgara or small population of Mulgara	A	2	Low				
	Fork-tailed Swift	Loss of a Fork-tailed Swift or small population of Fork-tailed Swift	A	2	Low				
	Sandhill Dunnart	Loss of a Sandhill Dunnart or small population of Sandhill Dunnart	A	3	Low				
	Grey Wagtail	Loss of a Grey Wagtail or small population of Grey Wagtail	A	2	Low				
	Peregrine Falcon	Loss of a Peregrine Falcon or small population of Peregrine Falcon	A	2	Low				
Human impacts	Increase or spread of weeds	Changed vegetation and a resulting loss of fauna habitat	E	2	Mod.	Implementation of a weed management plan.	D	2	Low
	Road kills	Animals being killed by vehicles as they cross roads	E	1	Low	Limiting speeds	E	1	Low
	Increase in feral mammals, specifically the dog and cat	Increased predation on the native fauna	C	2	Low				

6.3 NATIVE VEGETATION CLEARING PRINCIPLES AS THEY PERTAIN TO VERTEBRATE FAUNA

The *Environmental Protection Act (1986)* outlines 10 principles that are to be used in the assessment of native vegetation clearing permit applications which are also applicable for other assessments and approvals (Table 11). Where possible, native vegetation should not be cleared if any of the following principles are comprised.

Table 11. Assessment of impact using the native vegetation clearing principles

Principle	Response
It comprises a high level of biological diversity.	Clearing vegetation will not comprise a high level of biodiversity.
It comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Clearing the vegetation will not result in the loss of significant habitat for indigenous fauna.
It includes, or is necessary for the continued existence or, rare flora.	N/A
It comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	The area does not contain a threatened ecological fauna community.
It is significant as a remnant of native vegetation in an area that has been extensively cleared.	The area is not a remnant.
It is growing in, or in association with, an environment associated with a watercourses or wetland.	The area does not contain a natural wetland.
The clearing of the vegetation is likely to cause appreciable land degradation.	N/A
The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Clearing of vegetation is unlikely to impact on the environmental values of the bioregion.
The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	N/A
The clearing of the vegetation is likely to cause, or exacerbate the incidence of flooding.	N/A

6.4 REFERRAL UNDER THE EPBC ACT

The proposed project is unlikely to significantly impact on a conservation significant vertebrate fauna species, so a referral under the *EPBC Act 1999* is not required.

7. SUMMARY

The total assessed area is 188.5ha but the development area is likely to be substantially less. There are three broad fauna habitats in the project area: clay pan; scattered Mulga and Casuarina over mixed shrubs and chenopods over a rocky substrate; and scattered Mulga over mixed shrubs and chenopods over sand and clay. There was evidence of recent exploration activity and pre-existing disturbance areas.

Clearing native vegetation in the project area is likely to result in the loss of small vertebrate fauna on-site that are unable to move away during the clearing process, however, this loss is not likely to be significant when viewed in a bioregional context. The few larger animals, such as kangaroos, large goannas and snakes, and most of the birds will move into adjacent areas once vegetation clearing commences, so potential impacts will be low. There may be an on-going loss of small native fauna to vehicle strikes on access tracks, but overall, this impact will be very low. Forced fauna migrants as a result of vegetation clearing will increase competition for resources, which may result in the subsequent loss of migrants or local individuals. Individuals shifted out of their established activity areas are also vulnerable to predation until they have become established in their new areas.

Impacts on vertebrate fauna associated with clearing vegetation in the project area in a landscape or bioregional context are likely to be low as there are vast tracts of similar fauna habitat in adjacent areas, and the sparseness of the vegetation and ground cover mean the abundance of terrestrial vertebrate in the project area will be low.

Feral predators such as cats are likely in a landscape context to have a much larger impact on the vertebrate fauna than clearing the vegetation and developing and operating a mine in this location.

The proposed project is unlikely to significantly impact on a conservation significant species, so a referral under the *EPBC Act 1999* is not required.

8. MANAGEMENT STRATEGIES

The purpose of this section is to identify generic management and mitigation strategies to address the potential impacts of development in the project area. Specific management and mitigation strategies to address potential impacts should be addressed in the recommended Vertebrate Fauna Management Plan and Construction Environmental Management Plan.

8.1 INDUCTION AND AWARENESS

All contractors and staff involved in vegetation clearing, development and ongoing operations in the project area should be made aware of the possible presence and issues associated with terrestrial fauna in the area through the induction process.

> **Recommendation 1:** An induction program that includes a component on managing fauna is a mandatory for staff working in the project area.

8.2 DUST

Dust generated from the vegetation clearing and development could potentially degrade surrounding vegetation, reducing its ability to absorb sunlight and influencing photosynthetic rates. Degradation of these areas will potentially render habitat unsuitable for fauna. Dust suppression and management programs are an essential component of minimising mining impacts on fauna during the construction program.

> **Recommendation 2:** The impact of dust on adjacent vegetation and fauna habitat is managed and monitored against appropriate KPIs and in accordance with the clients' Construction Environmental Management Plan.

8.3 MINIMISING SECONDARY IMPACTS TO FAUNA AND FAUNA HABITAT

Pets and feral animals have the potential to impact on fauna. Pets should not be permitted on site and feral and pest fauna numbers monitored and controlled. All rubbish likely to attract animals should be suitably contained and disposed of so as not to encourage the feeding of fauna around the site.

Based on feral cat tracks and scats recorded in the region it is highly probable that the project area currently supports a population of feral cats. Reducing the impacts of feral cats will reduce the stress on fauna and fauna assemblages in the area. Increased activity will result in increased traffic and a consequential increase in the fauna deaths on tracks. Limiting vehicle speed on mine roads can reduce collisions with fauna, particularly larger animals such as kangaroos and emus. Dead animals on the road also have the propensity to attract raptors, goannas and even cattle, which are then likely to be killed.

Management of secondary impacts to habitat and fauna should be addressed in a Vertebrate Fauna Management Plan. The Vertebrate Fauna Management Plan should include:

- Control and reduction methods for feral and pest fauna;
- Management of pets on-site;
- Habitat fragmentation and barriers to fauna movement;
- Vegetation clearing and development protocols;
- Vehicle impacts on vertebrate fauna (short and long term);
- Vehicle speed limits on site; and
- Anthropogenic activity.

Recommendation 3: Prepare and implement a Vertebrate Fauna Management Plan.

9. REFERENCES

AG staff. 2017. Night parrot feather discovered in South Australia gives hope to ecologists. Australian Geographic **September**.

AG staff. 2018. Critically endangered night parrot fledging photographed on Queensland reserve. Australian Geographic **February**.

Baker, J., R. L. Goldingay, and R. J. Whelan. 1998. Powerline easement through forests: a case study of impacts on avifauna. Pacific Conservation Biology **4**:79-89.

Bamford, M. J. 1995. Predation by feral cats upon lizards. The Western Australian Naturalist **20**:191-196.

Bell, D., R. Bell, and W. Loneragan. 2016. Winter avifauna of Wanjarri Nature Reserve and Lake Mason Conservation Park of the Eastern Goldfields, Western Australia. Australian Field Ornithology **33**:198-205.

Bell, D. T., R. C. Bell, and W. A. Loneragan. 2007. Winter bird assemblages across an arid gradient in south-west Western Australia. Winter bird assemblages across an arid gradient in south-west Western Australia **90**:219-227.

Benshemesh, J. 2007. National Recovery Plan for Malleefowl. South Australia.

Benshemesh, J., and P. Burton. 1999. Fox predation on Malleefowl three years after the spread of RCD in Victoria. Unpublished report for Parks Victoria and Department of Natural Resources and Environment, Mildura.

Boles, W. E., N. W. Longmore, and M. C. Thompson. 2016. A Recent Specimen of the Night Parrot *Geopsittacus occidentalis*. Emu **94**:37-40.

Charalambous, S. 2016. First night parrot fledgling spotted in 100 years spotted in western Queensland. Australian Geographic **November**.

Clarke, M. F., and J. M. Oldland. 2007. Penetration of remnant edges by noisy miners (*Manorina melanocphala*) and implications for habitat restoration. Wildlife Research **34**:253-261.

Cowan, M. 2001. Murchison 1 (MUR1 - East Murchison subregion). Pages 466-479 *in* N. L. McKenzie, J. E. May, and S. McKenna, editors. A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Perth.

Cowan, M. A., and R. A. How. 2004. Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. Records of the Western Australian Museum **22**:91-100.

Craig, M. D., and A. Chapman. 2003. Effects of short-term drought on the avifauna of Wanjarri Nature Reserve: What do they tell us about drought refugia? Journal of the Royal Society of Western Australia **86**:133-137.

Cupitt, R., and S. Cupitt. 2008. Another recent specimen of the Night Parrot *Pezoporus occidentalis* from Western Queensland. Australian Field Ornithology **25**:69-75.

Davis, R. A., and B. M. Metcalf. 2008. The Night Parrot (*Pezoporus occidentalis*) in northern Western Australia: a recent sighting from the Pilbara region. Emu **108**:233-236.

Dell, J., R. A. How, A. V. Milewski, and G. J. Keighery. 1988. The biological survey of the eastern goldfields of Western Australia Part 5: Edjudina - Menzies Study Area. Records of the Western Australian Museum **Supplement No. 31**:38-69.

Dickman, C. R., A. S. Haythornthwaite, G. H. McNaught, P. S. Mahon, B. Tamayo, and M. Letnic. 2001. Population dynamics of three species of dasyurid marsupials in arid central Australia: a 10 year study. Wildlife Research **28**:493-506.

Environmental Protection Authority. 2020. Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment. Western Australia.

Garnett, S., G. Crowley, R. Duncan, N. Baker, and P. Doherty. 1993. Notes on live Night Parrot sightings in north-western Queensland. Emu **93**:292-296.

Garnett, S. T., J. K. Szabo, and G. Dutson. 2011. The Action Plan for Australian Birds 2010. CSIRO, Collingwood, Melbourne.

Gibson, D. F., and J. R. Cole. 1992. Aspects of the ecology of the Mulgara, *Dasycercus cristicauda*, (Marsupialia: Dasyuridae) in the Northern Territory. Australian Mammalogy **15**:105-112.

Goldingay, R. L., and R. J. Whelan. 1997. Powerline easements: do they promote edge effects in eucalypt forest for small mammals? Wildlife Research **24**:737-744.

Goosem, M. 2000. Effects of tropical rainforest roads on small mammals: Edge changes in community composition. Wildlife Research **27**:151-163.

Goosem, M., Y. Izumi, and S. Turton. 2001. Efforts to restore habitat connectivity for an upland tropical rainforest fauna: A trial of underpasses below roads. Ecological Management and Restoration **2**:196-202.

Goosem, M. W., and H. Marsh. 1997. Fragmentation of small mammal community by a powerline corridor through tropical rainforest. Wildlife Research **24**:613-629.

Hamilton, N., A. Burbidge, T. Douglas, and L. Gilbert. 2017. Piecing the puzzle together: the fate of the Night Parrot nest found in Western Australia by Jackett et al. (2017). Australian Field Ornithology **34**:151-154.

Hart Simpson and Associates. 2000. Anaconda Nickel Ltd, Cawse Expansion Project, Fauna Survey. Perth.

How, R. A., J. Dell, and B. G. Muir. 1988. Vertebrate Fauna. Pages 44-94 *in* R. A. How, K. R. Newbey, J. Dell, B. G. Muir, and R. J. Hnatiuk, editors. The Biological Survey of the Eastern Goldfields of Western Australia; Part 4, Lake Johnston - Hyden Study Area. Records of the Western Australian Museum.

Jackett, N., B. Greatwich, G. Swann, and A. Boyle. 2017. A nesting record and vocalisations of the Night Parrot Pezoporus occidentalis from the East Murchison, Western Australia. Australian Field Ornithology **34**:144-150.

Johnstone, R. E., and G. M. Storr. 1998. Handbook of Western Australian Birds. Volume I - Non-Passerines (Emu to Dollarbird). Western Australian Museum, Perth.

Johnstone, R. E., and G. M. Storr. 2004. Handbook of Western Australian birds, Volume II passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.

Jones, A. 2017. Night parrot sighting in Western Australia shocks birdwatching world. ABC News.

Kinnear, J. 1993. Masterly marauders: The cat and the fox. Landscope **8**:20-28.

Laurance, W. F. 1991. Edge effects in tropical forest fragments: application of a model for design of nature reserves. Biological Conservation **57**:205-219.

Laurance, W. F. 1994. Rainforest fragmentation and the structure of small mammal communities in tropical Queensland. Biological Conservation **69**:23-32.

Letnic, M., and C. R. Dickman. 2005. The responses of small mammals to patches regenerating after fire and rainfall in the Simpson Desert, central Australia. Austral Ecology **30**:24-39.

Lewis, M., and M. Hines. 2014. Malleefowl activity at nesting sites increase fox and other feral animal visitation rates. Pages 242-247 Proceedings of the 5th National Malleefowl Forum 2014.

Luck, G. W., H. P. Possingham, and D. C. Paton. 1999. Bird responses at inherent and induced edges in the Murray Mallee, South Australia. 1. Differences in abundance and diversity. Emu **99**:157-169.

Masters, P. 1998. The Mulgara *Dasycercus cristicauda* (Marsupialia: Dasyuridae) at Uluru National Park, Northern Territory. Australian Mammalogy **20**:403-407.

Masters, P., C. R. Dickman, and M. Crowther. 2003. Effects of cover reduction on Mulgara *Dasycercus cristicauda* (Marsupialia: Dasyuridae), rodent and invertebrate populations in central Australia: Implications for land management. Austral Ecology **28**:658-665.

McCarthy, M. 2017. Night parrot feather discovery proves Australia's most elusive bird is alive in South Australia. ABC News.

McKenzie, N. L., and N. J. Hall. 1992. The Biological Survey of the Eastern Goldfields of Western Australia. Part 8. Kurnalpi-Kalgoorlie Study Area. Records of the Western Australian Museum **Supplement No. 41**.

Moriarty, T. K. 1972. Birds of Wanjarri, W.A. (27°25'S, 120°40'E). Emu **72**:1-7.

Murphy, B. P., L.-A. Woolley, H. M. Geyle, S. M. Legge, R. Palmer, C. R. Dickman, J. Augusteyn, S. C. Brown, S. Comer, T. S. Doherty, C. Eager, G. Edwards, D. A. Fordham, D. Harley, P. J. McDonald, H. McGregor, K. E. Moseby, C. Myers, J. Read, J. Riley, D. Stokeld, G. J. Trewella, J. M. Turpin, and J. C. Z. Woinarski. 2019. Introduced cats (*Felis catus*) eating a continental fauna: The number of mammals killed in Australia. Biological Conservation **237**:28-40.

Murphy, S. 2015. Shining a light: The research unlocking the secrets of the mysterious Night Parrot. Australian Birdlife **4**:30-35.

Murphy, S. A., J. J. Austin, R. K. Murphy, J. Silcock, L. Joseph, S. T. Garnett, N. P. Leseberg, J. E. M. Watson, and A. H. Burbidge. 2017a. Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. Emu **117**:107-113.

Murphy, S. A., J. Silcock, R. Murphy, J. Reid, and J. J. Austin. 2017b. Movements and habitat use of the night parrot *Pezoporus occidentalis* in south-western Queensland. Austral Ecology.

Oxley, D. J., M. B. Fenton, and G. R. Carmody. 1974. The effects of roads on populations of small mammals. Journal of Applied Ecology **11**:51-59.

Palaszxzuk, A., and S. Miles. 2017. New night parrot community discovered in central west Queensland.

Paton, P. W. C. 1994. The effect of edge on avian nest success: How strong is the evidence? Conservation Biology **8**:17-26.

Pavey, C. R., C. E. M. Nano, J. R. Cole, P. J. McDonald, P. Nunn, A. Silcocks, and R. H. Clarke. 2014. The breeding and foraging ecology and abundance of the Princess Parrot (*Polytelis alexandrae*) during a population irruption. Emu:NULL.

Pearson, D., P. M. Davies, N. Carnegie, and J. Ward. 2001. The great desert skink (*Egernia kintorei*) in Western Australia: Distribution, reproduction and ethno-zoological observations. Herpetofauna **31**:64-68.

Pickrell, J. 2016. The night parrot's secret sanctuary. Australian Geographic **August**.

Priddel, D., and R. Wheeler. 1990. Survival of Malleefowl *Leipoa ocellata* chicks in the absence of ground-dwelling predators. Emu **90**:81-87.

Rykers, E. 2017. Night parrot call recordings released online for first time. Australian Geographic **February**.

Storr, G. M., and R. E. Johnstone. 1983. Part VI Amphibians and Reptiles. Pages 70-74 *in* N. L. McKenzie, editor. Wildlife of the Dampier Peninsula, south-west Kimberley, Western Australia. Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife, Perth.

Storr, G. M., L. A. Smith, and R. E. Johnstone. 1990. Lizards of Western Australia. III: Geckos and Pygopods. Western Australian Museum, Perth.

Storr, G. M., L. A. Smith, and R. E. Johnstone. 1999. Lizards of Western Australia. I: Skinks. Western Australian Museum, Perth.

Storr, G. M., L. A. Smith, and R. E. Johnstone. 2002. Snakes of Western Australia. Western Australian Museum, Perth.

Temple, S. A. 1998. The edge of the cut: implications for wildlife populations. Journal of Forestry **96**:22-26.

Terrestrial Ecosystems. 2010. Fauna Assessment for the Majestic Gold Project. Perth.

Terrestrial Ecosystems. 2012a. Fauna Assessment for the Santa Area. Perth.

Terrestrial Ecosystems. 2012b. Level 2 Fauna Assessment for the Aldiss Area. Perth.

Thompson, G. G., and S. A. Thompson. 2007. Shape and spatial distribution of Mulgara (*Dasycercus cristicauda*) burrows, with comments on their presence in a burnt habitat and a translocation protocol. Journal of the Royal Society of Western Australia **90**:195-202.

Thompson, G. G., and S. A. Thompson. 2008. Abundance and spatial distribution of five small mammals at a local scale. Australian Mammalogy **30**:65-70.

Thompson, S. A. 2004. Mine site rehabilitation index using reptile assemblage as a bio-indicator. PhD. Edith Cowan University, Perth.

Thompson, S. A., and G. G. Thompson. 2006. Reptiles of the Western Australian Goldfields. Goldfields Environmental Management Group, Kalgoorlie, WA.

Threatened Species Scientific Committee. 2015. Conservation Advice *Sminthopsis psammophila* sandhill dunnart. Canberra.

Threatened Species Scientific Committee. 2016. Conservation Advice *Pezoporus occidentalis* Night Parrot. Canberra.

Tyler, M. J., L. A. Smith, and R. E. Johnstone. 2000. Frogs of Western Australia. Western Australian Museum, Perth.

Van Dyck, S., and R. Strahan. 2008. The Mammals of Australia. Reed New Holland, Sydney.

Wilson, H. 1937. Notes on the Night Parrot, with references to recent occurrences. Emu **37**:79-87.

Woinarski, J. C. Z., A. A. Burbidge, and P. L. Harrison. 2014. The Action Plan for Australian Mammals 2012. CSRIO Publishing, Melbourne.

Woinarski, J. C. Z., B. P. Murphy, S. M. Legge, S. T. Garnett, M. J. Lawes, S. Comer, C. R. Dickman, T. S. Doherty, G. Edwards, A. Nankivell, D. Paton, R. Palmer, and L. A. Woolley. 2017. How many birds are killed by cats in Australia? Biological Conservation **214**:76-87.

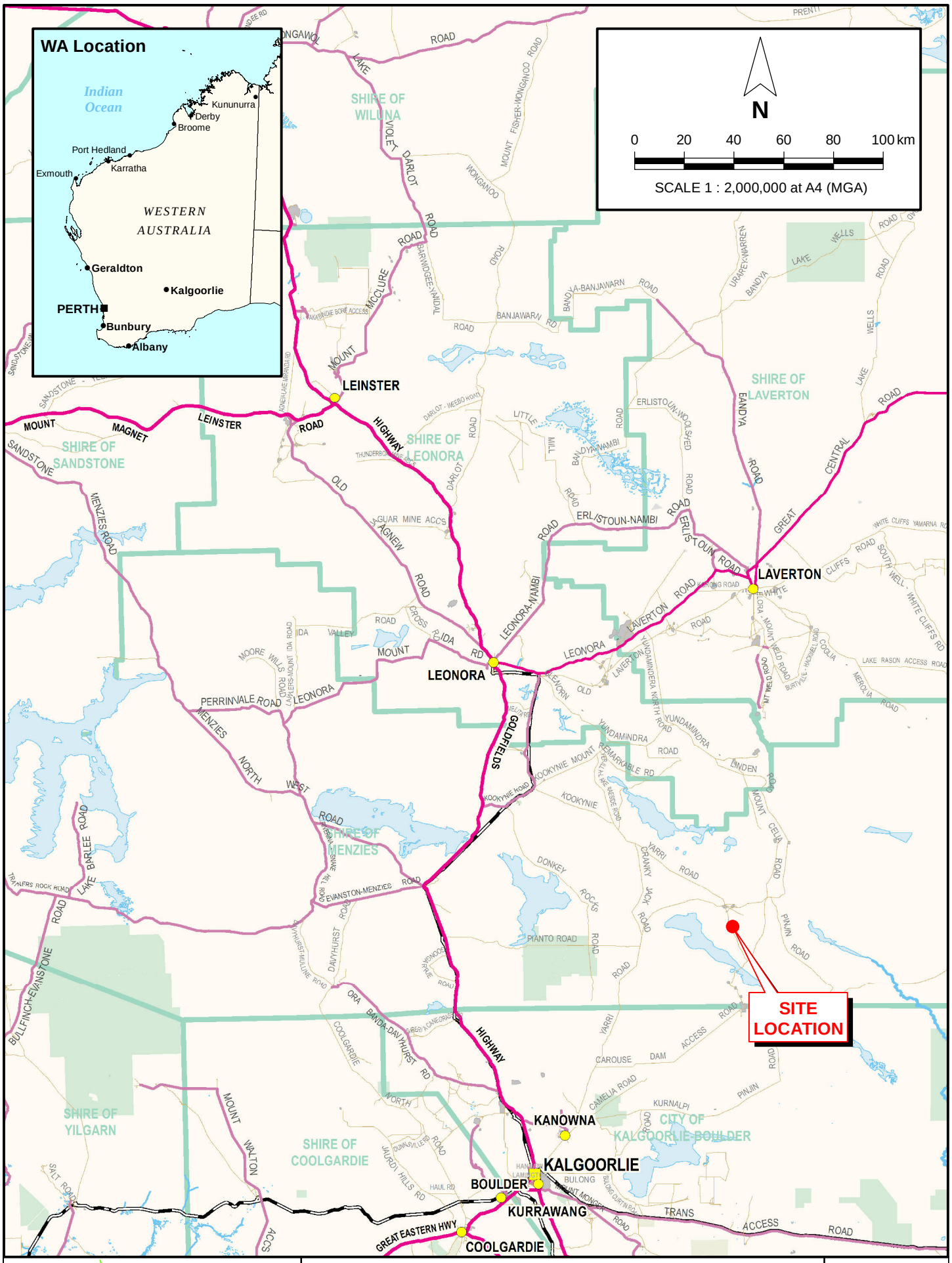
Woinarski, J. C. Z., B. P. Murphy, R. Palmer, S. M. Legge, C. R. Dickman, T. S. Doherty, G. Edwards, A. Nankivell, J. L. Read, and D. Stokeld. 2018. How many reptiles are killed by cats in Australia? Wildlife Research **45**:247-266.

Woolley, P. A. 2005. The species of *Dasycercus* Peters, 1875 (Marsupialia: Dasyuridae). Memoirs of Museum Victoria **62**:213-221.

Figures

Vertebrate fauna reconnaissance survey and risk assessment
Edjudina Project Area





PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-0013-f01.mxd

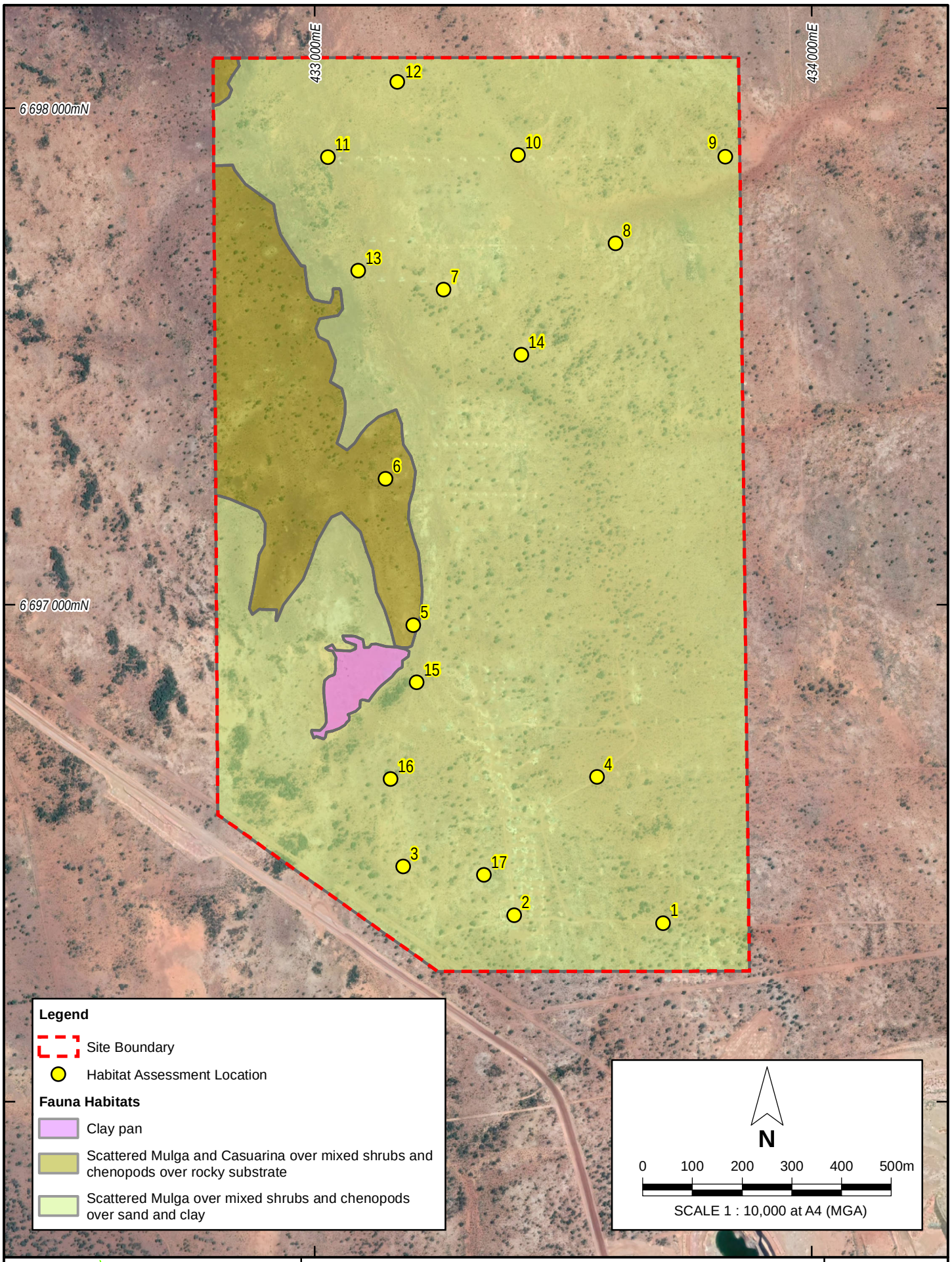
TERRESTRIAL ECOSYSTEMS

Nexus Minerals Ltd
VERTEBRATE FAUNA RECONNAISSANCE SURVEY AND RISK ASSESSMENT
EDJUDINA PROJECT AREA

Figure 1

REGIONAL LOCATION

Drawn: S. Thompson | Date: 4 Jul 2022 | Job: 2022-0013



2022-0013-f02.mxd

PINPOINT CARTOGRAPHICS (08) 9562 7136

TERRESTRIAL ECOSYSTEMS

Nexus Minerals Ltd
VERTEBRATE FAUNA RECONNAISSANCE SURVEY AND RISK ASSESSMENT
EDJUDINA PROJECT AREA

Figure 2

FAUNA HABITAT TYPES

Drawn: S. Thompson

Date: 4 Jul 2022

Job: 2022-0013

Appendix A.

Results of the *EPBC Act* Protected Matters Search

Vertebrate fauna reconnaissance survey and risk assessment
Edjudina Project Area



Appendix B.

Vertebrate Fauna Recorded in Biological Surveys in the Region

Vertebrate fauna reconnaissance survey and risk assessment
Edjudina Project Area



B.1 VERTEBRATE FAUNA ASSESSMENTS

			A	B										C											D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
Amphibians																																
Limnodynastidae	*Neobatrachus kunapalari*	Wheatbelt Frog	X											1																		
	Neobatrachus sudelli	Sudell's Frog	X																													
	Neobatrachus sutor	Shoemaker Frog	X											9	3	10	30	19	25	22	12	9			1	1	8	1				
	Neobatrachus wilsmorei	Plonking Frog	X		3	2																				1						
	Platyplectrum spenceri	Spencer's Burrowing Frog	X																													
Myobatrachidae	*Crinia georgiana*	Quacking Frog	X																													
	Pseudophryne occidentalis	Western Toadlet	X												1	1	84	1	95		4	2					2					
Pelodryadidae	*Cyclorana maini*	Main's Frog	X																													
	Cyclorana occidentalis	Western Water-holding Frog	X																													
	Litoria moorei	Motorbike Frog	X																													
Reptiles																																
Agamidae	*Ctenophorus caudicinctus*	Ring-tailed Dragon																														
	Ctenophorus caudicinctus	Ring-tailed Dragon	X																													
	Ctenophorus cristatus	Crested Dragon	X				5	1	1					1	1	3	5	1	10	1	1	4							3	4			
	Ctenophorus fordi	Mallee Dragon	X	22	42	2	15	2	2	6	9														1	4		1		4	4		
	Ctenophorus inermis	Military Dragon																														
	Ctenophorus infans	Ring-tailed Dragon	X																													
	Ctenophorus isolepis	Central Military Dragon	X																													
	Ctenophorus nuchalis	Central Netted Dragon	X																													
	Ctenophorus ornatus	Ornate Crevice Dragon	X																													
	Ctenophorus pictus	Painted Dragon	X																													
	Ctenophorus reticulatus	Western Netted Dragon	X									1	2		3	4	13	19		30	6	18	3		7	3		4	5	8			
	Ctenophorus salinarum	Saltpan Dragon	X																													
	Ctenophorus scutulatus	Lozenge-marked Dragon	X		3	7	3		8			3	1			2	2	3	2	5		2	13			8				9			
	Diporiphora amphiboluroides	Mulga Dragon	X																	7										1	1	
	Moloch horridus	Thorny Devil	X		1				1	1	2		1			5							17			1		2		2	3	
	Pogona minor	Western Bearded Dragon		1	1	1	1		3	1	1		3	13	2	11	3	14	3	14	21	2	24	2	1			2		2	1	1
	Tympanocryptis cephalus	Pebble Dragon	X														7						1									
Carphodactylidae	*Nephrurus laevissimus*	Smooth Knob-tail	X	18	18		2	1	1	12	9																					
	Nephrurus vertebralis	Midline Knob-tail	X																							1						
	Nephrurus wheeleri	Banded Knob-tail	X																													
	Underwoodisaurus milii	Barking Gecko	X									9		11	31	16	18	22	22		2	10	28	10						5		2
Diplodactylidae	*Amalosia reticulata*	Reticulated Velvet Gecko	X													1						4							1			

			A	B										C											D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
	Diplodactylus conspicillatus	Fat-tailed Gecko	X																													
	Diplodactylus granariensis	Wheatbelt Stone Gecko	X			2	1	5	8	4	8	4		77	18	74	71	13	62	8	29	68	76	1			1		2			4
	Diplodactylus pulcher	Beautiful Gecko	X						1			2	1	53	8	86	21	78	88	123	80	100	46	12		1			2	2		
	Hesperoedura reticulata	Reticulated Velvet Gecko	X																													
	Lucasium damaeum	Beaded Gecko	X																													
	Lucasium maini	Main's Ground Gecko	X			1	2	2						9	346	9	60	6	39	1	9	69	1	1					3			5
	Lucasium squarrosum	Mottled Ground Gecko	X																													
	Rhynchoedura ornata	Beaked Gecko	X		2	1	2	2	3	1				4	3	5		23	20		41	106	9			1						
	Strophurus assimilis	Goldfields Spiny-tailed Gecko	X							3				44	1	1	7	19	1				112									
	Strophurus ciliaris	Spiny-tailed Gecko																														
	Strophurus elderi	Jewelled Gecko	X																						3							
	Strophurus intermedius	Southern Spiny-tailed Gecko																														
	Strophurus strophurus	Western Spiny-tailed Gecko	X																													
	Strophurus wellingtonae	Western Shield Spiny-tailed Gecko	X																													
Elapidae	*Acanthophis pyrrhus*	Desert Death Adder	X																													
	Brachyurophis fasciolatus	Narrow-banded Burrowing Snake	X								1																					
	Brachyurophis semifasciata	Half-girdled Snake	X							1		1		9	7	6	6	5	2	1												
	Demansia psammophis	Yellow-faced Whipsnake	X				2							1	1	1	4		2	1			3									
	Echiopsis curta	Bardick	X																													
	Elapognathus coronatus	Crowned Snake	X																													
	Furina ornata	Orange-naped Snake	X																													
	Neelaps bimaculatus	Black-naped Burrowing Snake	X																													
	Notechis scutatus	Tiger Snake	X																													
	Suta gouldii	Gould's Snake	X																							1						
	Suta monachus	Hooded Snake	X				1							2	7	9	4	3	11	4	2	3	6				1			1		
	Pseudechis australis	Mulga Snake	X												1	2		1		1		1										
	Pseudechis butleri	Spotted Mulga Snake	X																													
	Pseudonaja mengdeni	Western Brown Snake	X											1									1									1
	Pseudonaja modesta	Ringed Brown Snake	X		1		3							1		1		2				2	1					1	2	1		
	Simoselaps bertholdi	Jan's Banded Snake	X						1						4	8	2		2		1	1	2			1						
	Suta fasciata	Rosen's Snake	X												2		3			1												
	Suta suta	Curl Snake	X																													
Gekkonidae	*Christinus marmoratus*	Marbled Gecko	X																													
	Gehyra punctata	Spotted Dtella	X																													
	Gehyra purpurascens	Purplish Dtella	X				2							1	1	1	1	1	9		6	6										
	Gehyra variegata	Variegated Gehyra	X	1	1		3	4	6		2	3	1	23	14	38	37	28	45	39	6	37	12	2	3	1			3	6	1	2
	Hemidactylus frenatus	Asian House Gecko	X																													
	Heteronotia binoei	Bynoe's Gecko	X										2	24	10	16	9	12	28	25	1	13	8		3	1	2		6			6

			A	B										C											D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
Pygopodidae	*Aprasia repens*	Southwest Sandplain Worm Lizard	X																													
	Delma australis	Marble-faced Delma	X											8		4	3	2	9			2	6									1
	Delma butleri	Unbanded Delma	X	1			1							4							2		2									
	Delma fraseri	Fraser's Delma												1							1											
	Delma nasuta	Sharp-snouted Delma																										1				
	Lialis burtonis	Burton's Legless Lizard	X											5									3			2			1			
	Pygopus lepidopodus	Common Scaly-foot	X											2	3	2	2						1									
	Pygopus nigriceps	Western Hooded Scaly-foot	X			1																										
Pythonidae	*Antaresia stimsoni*	Stimson's Python	X																													
	Morelia spilota	Carpet Python	X																													
Scincidae	*Cryptoblepharus australis*	Inland Snake-eyed Skink	X																													
	Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink	X			1	3				1		3		3	10	12	1	5	3		7										
	Ctenotus atlas	Southern Mallee Ctenotus	X	4	3	1	4	3	2	2	3			16					1	1			104			6			2	6		
	Ctenotus brooksi	Wedgsnout Ctenotus	X	17						3																						
	Ctenotus calurus	Blue-tailed Finesnout Ctenotus	X																													
	Ctenotus greeri	Spotted-necked Ctenotus	X																													
	Ctenotus helenae	Clay-soil Ctenotus	X																													
	Ctenotus leae	Orange-tailed Finesnout Ctenotus	X																													
	Ctenotus leonhardii	Leonhardi's Ctenotus	X																						1							
	Ctenotus pantherinus	Leopard Ctenotus	X																													
	Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus	X																													
	Ctenotus schomburgkii	Barred Wedgesnout Ctenotus	X	4	9	3	5	5	1		1			2									2			1			6	1		
	Ctenotus severus	Stern Ctenotus	X																													
	Ctenotus uber	Spotted Ctenotus	X			1						1	6	46	6	29	13	48	5	44	27	3	25		2				7			
	Ctenotus xenopleura	Wide-striped Ctenotus	X																													
	Cyclodomorphus branchialis	Common Slender Bluetongue																														
	Cyclodomorphus melanops	Spinifex Slender Blue-tongue	X			10	2		2			2		24		1	2	6	2				24									
	Egernia depressa	Southern Pygmy Spiny-tailed Skink	X											15		57	68	2	3	27		3			1	1		1		4		
	Egernia formosa	Goldfields Crevice Skink	X										5	1	4	8			2	8	1	14			1				1	3		
	Egernia napoleonis	Southwestern Crevice Skink	X																													
	Egernia richardi	Bright Crevice-skink	X																													
	Egernia stokesii	Western Spiny-tailed Skink	X																													
	Eremiascincus richardsonii	Broad-banded Sand-swimmer	X											3	6	5	4	4		6	2		1									
	Hemiergis gracilipes	South-western Mulch-skink																														
	Hemiergis initialis	South-western Earless Skink	X											12	1	4	5															
	Hemiergis peronii	Lowlands Earless Skink	X																													
	Lampropholis guichenoti	Pale-flecked Garden Skink	X																													
	Lerista bipes	North-western Sandslider	X																													

			A	B									C										D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
	Lerista desertorum	Central Desert Robust Slider	X																												
	Lerista kingi	King's Slider	X																												
	Lerista lineopunctulata	Dotted-line Robust Slider																													
	Lerista macropisthopus	Unpatterned Robust Slider	X				1			2																					
	Lerista muelleri	Wood Mulch-slider	X																												
	Lerista picturata	Southern Robust Slider	X											14	20	18	18	17	5		1	5	20						2			1
	Lerista timida	Timid Slider	X																												
	Liopholis inornata	Desert Skink	X	3	2	1		2		2	4				4				8	2		71	2			1	1		1	1		
	Liopholis striata	Nocturnal Desert Skink	X												2					9			1									
	Menetia greyii	Common Dwarf Skink	X	1	2	1	1	1	1		1		1	6	3	19	3	6	23	17	4	18	1									1
	Morethia adelaidensis	Saltbush Morethia Skink	X																										1			
	Morethia butleri	Woodland Morethia Skink	X										2	4	7	14	1		6	4		17						1		1		2
	Morethia obscura	Shrubland Pale-flecked Morethia	X																													
	Saiphos equalis	Three-toed Skink	X																													
	Tiliqua occipitalis	Western Blue-tongued Lizard	X		1						1			5		1		2		3			4					3				
	Tiliqua rugosa	Bobtail	X											2		3	1			2	1	2	1	1		3		2	2	5		7
Typhlopidae	*Anilios australis*	Austral Blind Snake	X						2	1				14	7	8	14		7		7	2	6									
	Anilios bicolor	Dark-spined Blind Snake												1			1						1									
	Anilios bituberculatus	Prong-snouted Blind Snake	X					1						1		2	2	2	2	1		1										
	Anilios hamatus	Pale-headed Blind Snake							1					9	10	10	24	18	7	2	13	6	9									
	Anilios waitii	Waite's Blind Snake																														
Varanidae	*Varanus caudolineatus*	Stripe-tailed Monitor	X											1	11	11	15	1		17	9	1	9		3	1				4		
	Varanus giganteus	Perentie	X																													
	Varanus gouldii	Gould's Goanna	X			2		1						6	8	10	9	9	3	2	2	7		1		1		1	2	1	1	
	Varanus panoptes	Yellow-spotted Monitor	X																													
	Varanus tristis	Black-headed Monitor	X									1		3	3	5	1															
Chelidae	*Chelodina oblonga*	Oblong Turtle	X																													
Birds																																
Casuariidae	*Dromaius novaehollandiae*	Emu																								14		23	11			
Anatidae	*Anas gracilis*	Grey Teal																											10			
Megapodiidae	*Leipoa ocellata*	Malleefowl																										1			1	
Columbidae	*Phaps chalcoptera*	Common Bronzewing																							1			1	4	2		3
	Ocyphaps lophotes	Crested Pigeon																											2			
Cuculidae	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo																							3	1		5	2	4	1	1
	Chrysococcyx osculans	Black-eared Cuckoo																												2		
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar																												1		
Podargidae	*Podargus strigoides*	Tawny Frogmouth																							3	1						
Accipitridae	*Aquila audax*	Wedge-tailed Eagle																														2

			A	B									C											D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
	Circus assimilis	Spotted Harrier																										1		
	Haliastur sphenurus	Whistling Kite																						2							
Cuculidae	*Heteroscenes pallidus*	Pallid Cuckoo																						1	1			4			1
Strigidae	*Ninox boobook*	Southern Boobook																													1
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher																													2
Meropidae	*Merops ornatus*	Rainbow Bee-eater																									6	19	6	12	10
Falconidae	*Falco cenchroides*	Nankeen Kestrel																						1							
	Falco berigora	Brown Falcon																						1				1	2	1	
Cacatuidae	*Eolophus roseicapilla*	Galah																						24				10	1	1	
	Nymphicus hollandicus	Cockatiel																						1				15			
Psittaculidae	*Barnardius zonarius*	Australian Ringneck																						6	11		3	63	7		16
	Psephotus varius	Mulga Parrot																						16	7		4	1		4	
	Melopsittacus undulatus	Budgerigar																									4			2	
	Glossopsitta porphyrocephala	Purple-crowned Lorikeet																						7				3	7		6
Climacteridae	*Climacteris affinis*	White-browed Treecreeper	X																										1		
	Climacteris rufus	Rufous Treecreeper	X																									4			
Maluridae	*Malurus lamberti*	Variegated Fairywren																						45			20			1	
	Malurus splendens	Splendid Fairywren	X																												
	Malurus leucopterus	White-winged Fairywren	X																									10			
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater	X																												
	Purnella albifrons	White-fronted Honeyeater	X																					4	17			11	15	15	19
	Lichenostomus cratitius	Purple-gaped Honeyeater	X																												
	Manorina flavigula	Yellow-throated Miner	X																						52		1	86	2	1	36
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	X																					21	20		22	10	13	12	14
	Anthochaera carunculata	Red Wattlebird	X																									31			
	Gavicalis virescens	Singing Honeyeater	X																					10	9					1	15
	Ptilotula ornata	Yellow-plumed Honeyeater	X																								1	30			8
	Ptilotula plumula	Grey-fronted Honeyeater																												2	
	Epthianura tricolor	Crimson Chat	X																												
	Epthianura aurifrons	Orange Chat	X																												
	Epthianura albifrons	White-fronted Chat	X																												
	Sugomel nigrum	Black Honeyeater	X																												
	Lichmera indistincta	Brown Honeyeater	X																					2			2				30
	Phylidonyris niger	White-cheeked Honeyeater	X																										7		
	Nesoptilotis leucotis	White-eared Honeyeater	X																								1	3	7	1	
	Melithreptus brevirostris	Brown-headed Honeyeater																											17		5
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote	X																												
	Pardalotus striatus	Striated Pardalote	X																					1				56	5	7	9

			A	B									C											D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
Pardalotidae	*Pardalotus striatus*	Striated Pardalote	X																												
Acanthizidae	*Pyrrholaemus brunneus*	Redthroat	X																					14	2		7		6		1
	Acanthiza iredalei	Slender-billed Thornbill																													
	Acanthiza apicalis	Inland Thornbill	X																					22			14		14	4	14
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	X																					47							4
	Acanthiza uropygialis	Chestnut-rumped Thornbill	X																					67	33		12	2	42	3	25
	Acanthiza robustirostris	Slaty-backed Thornbill	X																					2							
	Smicrornis brevirostris	Weebill	X																					15	12		40	155	137	55	77
	Gerygone fusca	Western Gerygone	X																												
	Aphelocephala leucopsis	Southern Whiteface	X																					18			2				
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler	X																					23	1		18	5		3	28
Cinclosomatidae	*Cinclosoma castanotum*	Chestnut Quail-thrush	X																												
	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush	X																												
Campephagidae	*Coracina maxima*	Ground Cuckooshrike	X																									4			
	Coracina novaehollandiae	Black-faced Cuckooshrike	X																					5	6			13	2	1	9
	Lalage tricolor	White-winged Triller	X																					1	2						
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	X																									15			
Oreoicidae	*Oreoica gutturalis*	Crested Bellbird	X																					6	5		2	5	5	2	
Pachycephalidae	*Colluricincla harmonica*	Grey Shrikethrush	X																					9			2	1	7		1
	Pachycephala inornata	Gilbert's Whistler	X																												
	Pachycephala pectoralis	Golden Whistler	X																												
	Pachycephala rufiventris	Rufous Whistler	X																					7			8		10	5	
Artamidae	*Artamus personatus*	Masked Woodswallow	X																												
	Artamus cinereus	Black-faced Woodswallow	X																									1			7
	Artamus cyanopterus	Dusky Woodswallow	X																					2				3			
	Cracticus torquatus	Grey Butcherbird	X																					2	5		1	3	7	1	
	Cracticus nigrogularis	Pied Butcherbird	X																					2				9	1		2
	Gymnorhina tibicen	Australian Magpie	X																									30	14		4
	Strepera versicolor	Grey Currawong	X																					1	2			7	2	1	7
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	X																									1			2
	Rhipidura albiscapa	Grey Fantail	X																					1							
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	X																					9				6			
Corvidae	*Corvus orru*	Torresian Crow	X																												
	Corvus bennetti	Little Crow	X																												
	Corvus coronoides	Australian Raven	X																												
Petroicidae	*Microeca fascinans*	Jacky Winter	X																						1			11	8		6
	Petroica goodenovii	Red-capped Robin	X																					187	5		7	5	14	5	6
	Melanodryas cucullata	Hooded Robin	X																									1			

			A	B										C											D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
Locustellidae	*Cincloramphus mathewsi*	Rufous Songlark	X																													
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	X																						4							
	Petrochelidon ariel	Fairy Martin	X																													
	Petrochelidon nigricans	Tree Martin	X																									4				
	Cheramoeca leucosterna	White-backed Swallow	X																													
Zosteropidae	*Zosterops lateralis*	Silvereye (Western)	X																													
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	X																					2					4			
Estrildidae	*Taeniopygia guttata*	Zebra Finch	X																					9								
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit	X											1									4					1				
Mammals																																
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna																											1			
Camelidae	*Camelus dromedarius*	Dromedary	X																													
Canidae	*Canis lupus*	Dingo	X																													
	Vulpes vulpes	Red Fox																											1			1
Felidae	*Felis catus*	Cat	X																													
Molossidae	*Austronomus australis*	White-striped Freetail Bat	X																							5	3	17	6	2	1	
	Mormopterus planiceps	Southern Free-tail Bat	X																							11		8				
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	X																													
	Chalinolobus morio	Chocolate Wattled Bat	X																							1		3	3			
	Nyctophilus geoffroyi	Lesser Long-eared Bat	X																							1		2	1			
	Nyctophilus holtorum	Holt's Long-eared Bat																								10		42	4			
	Nyctophilus major	Greater Long-eared Bat	X												1																	
	Scotorepens balstoni	Inland Broad-nosed Bat	X																							2		11				
	Vespadelus baverstocki	Inland Forest Bat	X																													
	Vespadelus regulus	Southern Forest Bat	X																							1		5				
Dasyuridae	*Ningaui* sp.	Ningaui sp.												35	2	2		22				4	17									
	Antechinomys laniger	Kultarr	X												1																	
	Ningaui ridei	Wongai Ningaui	X	1				4	3	5				1									2						1			
	Ningaui yvonneae	Mallee Ningaui	X											1																		
	Pseudantechinus woolleyae	Woolley's False Antechinus	X																				1									
	Sminthopsis crassicaudata	Fat-tailed Dunnart	X	1					1					2	5		2	15	12	4	26	28	24	108	1	1	2	1	5	2		1	
	Sminthopsis dolichura	Little Long-tailed Dunnart	X	1	1	1	1		1	2	2	12		63	34	47	15	25	36	46	11	28	32	2	4	7	1	6	3	8	1	4
	Sminthopsis gilberti	Gilbert's Dunnart	X																													
	Sminthopsis hirtipes	Hairy-footed Dunnart	X																													
	Sminthopsis murina	Slender-tailed Dunnart	X																													
	Sminthopsis ooldea	Ooldea Dunnart	X																													
Burramyidae	*Cercartetus concinnus*	Southwestern Pygmy Possum	X											23	15	37	62	32	20	8	17	22	16			2			8			1
Macropodidae	*Macropus fuliginosus*	Western Grey Kangaroo	X																					1	8			2	7			6

			A	B									C										D							
Family	Species	Common name		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Spinifex	Salmon Gums	Davyhurst	Gimlet South	Golden	Palace Undist	Security	Crossroads	Rose Undist	Wendy Gully	Floodplains	KK53	KK4	KK1	KK54	KK2	KK51	KK55	KK11
	Osphranter robustus	Euro	X																					4							2
	Osphranter rufus	Red Kangaroo	X																							1		15	3		8
Leporidae	*Oryctolagus cuniculus*	Rabbit	X														1			1											
Thylacomyidae	*Macrotis lagotis*	Bilby	X																												
Muridae	*Mus musculus*	House Mouse	X					1		2	4			26	6	19	25	2	24	10	18	22	13	31	8	1			13	11	4	4
	Notomys alexis	Spinifex Hopping Mouse	X	9	3	1	1		2																							
	Notomys mitchellii	Mitchell's Hopping Mouse	X	1												1														2	7	
	Pseudomys albocinereus	Ash-grey Mouse	X																													
	Pseudomys bolami	Bolam's Mouse	X											9	30	49	13	3	13	1	8	24	5	4		9	2					
	Pseudomys hermannsburgensis	Sandy Inland Mouse	X		2				4	1				8	9	9	5	3	4		2	14	5	2	1			2		2	2	
	Pseudomys nanus	Western Chestnut Mouse	X																													

A Atlas of Living Australia

B Cowan, M.A. and How, R.A. (2004) Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. Records of the Western Australian Museum, 22, 91-100.

C Thompson's (2004)PHD and other data

D McKenzie, N.L., Rolfe, J.K. and Youngson, W.K. (1992) Vertebrate fauna. In: The Biological Survey of the Eastern Goldfields of Western Australia; Part 8; Kurnalpi - Kalgoorlie Study Area. Records of the Western Australian Museum Supplement No 41, 37-65.

			A																								B								C
Family	Species	Common name	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 14a	Site 5a	Site 1a	Site 22	Site 17a	Site 14	Site 15	Site 20a	Site 21a	Site 11	Site 11a	Site 8	Site 19	Freshwater	Salt Lake	Site 14b	Site 12a	Site 10	Site 3	Site 5	Site 9	Site 4	Site 6	Site 8	Opportunitic	Goongarrie
Amphibians																																		
Limnodynastidae	*Neobatrachus sutor*	Shoemaker Frog	3	1	5	10																												
	Neobatrachus wilsmorei	Plonking Frog	1		11		2	2																										
	Platyplectrum spenceri	Spencer's Burrowing Frog							8																									
Myobatrachidae	*Crinia georgiana*	Quacking Frog																																
	Pseudophryne occidentalis	Western Toadlet								2																								
Reptiles																																		
Agamidae	*Ctenophorus caudicinctus*	Ring-tailed Dragon									12																							
	Ctenophorus cristatus	Crested Dragon										5														1								
	Ctenophorus fordi	Mallee Dragon	43	26				2				16															7	11						
	Ctenophorus inermis	Military Dragon											1																					
	Ctenophorus reticulatus	Western Netted Dragon			2	1			1	13			2	2	4	4	4												1					
	Ctenophorus salinarum	Saltpan Dragon								1								5	1	2														
	Ctenophorus vadnappa	Red-barred Dragon	3		2	1		7				3			1	1	2																	
	Moloch horridus	Thorny Devil	1			1	2			1					1												1							
	Pogona minor	Western Bearded Dragon	1	1	2		4	2				1		1	3		1	2	1	2	2								2		6			
	Tympanocryptis cephalus	Pebble Dragon																	1															
Carphodactylidae	*Nephrurus laevissimus*	Smooth Knob-tail	18	18			1					2																28						
	Nephrurus vertebralis	Midline Knob-tail																1		2														
	Underwoodisaurus milii	Barking Gecko								2			9																			1		
Diplodactylidae	*Amalosia reticulata*	Reticulated Velvet Gecko																									1			2				
	Diplodactylus granariensis	Wheatbelt Stone Gecko					1	2				1					1									14	1	1	3	5		1		
	Diplodactylus granariensis	Wheatbelt Stone Gecko																																
	Diplodactylus pulcher	Beautiful Gecko							4	3			3		1						1								2		4			
	Lucasium maini	Main's Ground Gecko					3	1				2															6			6				
	Lucasium squarrosum	Mottled Ground Gecko							1				3			2		1	3															
	Rhynchoedura ornata	Beaked Gecko	2		1		7	1				2								2														
	Strophurus assimilis	Goldfields Spiny-tailed Gecko																									5							
	Strophurus ciliaris	Spiny-tailed Gecko							2	2			1			1																		
	Strophurus intermedius	Southern Spiny-tailed Gecko					2																											
	Strophurus strophurus	Western Spiny-tailed Gecko																		7														
Elapidae	*Brachyurophis fasciolatus*	Narrow-banded Burrowing Snake														1																		
	Brachyurophis semifasciata	Half-girdled Snake																										1		1				
	Demansia psammophis	Yellow-faced Whipsnake																									1				1	1		
	Demansia psammophis	Yellow-faced Whipsnake										2																						
	Suta monachus	Hooded Snake							1			1	3																					
	Pseudonaja mengdeni	Western Brown Snake					1																							1				
	Pseudonaja modesta	Ringed Brown Snake	1									3																						

			A																								B								C
Family	Species	Common name	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 14a	Site 5a	Site 1a	Site 22	Site 17a	Site 14	Site 15	Site 20a	Site 21a	Site 11	Site 11a	Site 8	Site 19	Freshwater	Salt Lake	Site 14b	Site 12a	Site 10	Site 3	Site 5	Site 9	Site 4	Site 6	Site 8	Opportunitic	Goongarrie
	Simoselaps bertholdi	Jan's Banded Snake																			1								1			1			
	Suta fasciata	Rosen's Snake								2																									
Gekkonidae	*Gehyra purpurascens*	Purplish Dtella										2																				2			
	Gehyra variegata	Variegated Gehyra	1	1			2			15	1	4	15		1	1	2			1	1														
	Hemidactylus frenatus	Asian House Gecko																																	
	Heteronotia binoei	Bynoe's Gecko								7			34		2		2									2									
Pygopodidae	*Delma australis*	Marble-faced Delma																								1						1			
	Delma nasuta	Sharp-snouted Delma		1								1																							
	Lialis burtonis	Burton's Legless Lizard					1																			1									
	Pygopus nigriceps	Western Hooded Scaly-foot					1	1					1			1																			
Scincidae	*Cryptoblepharus buchananii*	Buchanan's Snake-eyed Skink						1	1			3			4		1									2						1			
	Ctenotus atlas	Southern Mallee Ctenotus	3	4								1			4												7							
	Ctenotus brooksi	Wedgsnout Ctenotus		24																								11							
	Ctenotus calurus	Blue-tailed Finesnout Ctenotus																			1														
	Ctenotus greeri	Spotted-necked Ctenotus																			12														
	Ctenotus helenae	Clay-soil Ctenotus																			1														
	Ctenotus leonhardii	Leonhardi's Ctenotus			5	9												5	4	2											1			
	Ctenotus pantherinus	Leopard Ctenotus																			4														
	Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus																			11														
	Ctenotus schomburgkii	Barred Wedgesnout Ctenotus	9	4	1			3				5				2		3		15	11						1		7	1				
	Ctenotus severus	Stern Ctenotus									1		6																						
	Ctenotus uber	Spotted Ctenotus						1	3				2		6	6	1												1						
	Cyclodomorphus branchialis	Common Slender Bluetongue					1					2																							
	Egernia depressa	Southern Pygmy Spiny-tailed Skink						2				1			10	4										1			1						
	Egernia formosa	Goldfields Crevice Skink								3					5											1									
	Eremiascincus richardsonii	Broad-banded Sand-swimmer							1				1																			1			
	Lerista desertorum	Central Desert Robust Slider											6			2					6														
	Lerista macropisthopus	Unpatterned Robust Slider								2		1																							
	Lerista picturata	Southern Robust Slider								2																									
	Liopholis inornata	Desert Skink	1	3			1	1							1		1										1	1	1			1			
	Liopholis striata	Nocturnal Desert Skink														2																			
	Menetia greyii	Common Dwarf Skink	2	1	1			1		4		2			1															1					
	Morethia butleri	Woodland Morethia Skink								4			6	2	2		2									1									
	Tiliqua occipitalis	Western Blue-tongued Lizard	1				1																							4					
	Tiliqua rugosa	Bobtail																											3	3		1			
Typhlopidae	*Anilios hamatus*	Pale-headed Blind Snake							1											1															
	Anilios waitii	Waite's Blind Snake							2											1															
Varanidae	*Varanus caudolineatus*	Stripe-tailed Monitor			1				1	2						6																1			

			A																								B								C
Family	Species	Common name	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 14a	Site 5a	Site 1a	Site 22	Site 17a	Site 14	Site 15	Site 20a	Site 21a	Site 11	Site 11a	Site 8	Site 19	Freshwater	Salt Lake	Site 14b	Site 12a	Site 10	Site 3	Site 5	Site 9	Site 4	Site 6	Site 8	Opportunitic	Goongarrie
	Varanus giganteus	Perentie								1																								
	Varanus gouldii	Gould's Goanna			1	1		2		1			1				2										1		1					
	Varanus panoptes	Yellow-spotted Monitor							2							1		1																
	Varanus tristis	Black-headed Monitor							1								3																	
Birds																																		
Casuariidae	*Dromaius novaehollandiae*	Emu	8	2	1				1	2		3			4		1		2		2	1	1	5									1	
Anatidae	*Tadorna tadornoides*	Australian Shelduck																				1											1	
	Chenonetta jubata	Australian Wood Duck																				1											1	
	Anas superciliosa	Pacific Black Duck																				1											1	
	Anas gracilis	Grey Teal																				1											1	
Phasianidae	*Coturnix pectoralis*	Stubble Quail																						1										
Columbidae	*Phaps chalcoptera*	Common Bronzewing										2					1			1		1	1		1								1	
	Ocyphaps lophotes	Crested Pigeon		2	6				5	6			11	1		7				9		1	1	2									1	
	Geopelia cuneata	Diamond Dove			1																													
Cuculidae	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo	6		1							2			3		2		3	1	3		1										1	
	Chrysococcyx osculans	Black-eared Cuckoo	3	4								6			2	2					1													
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar							3			3		3						1				2									1	
Podargidae	*Podargus strigoides*	Tawny Frogmouth										1				1																	1	
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar								2	2												1											
Rallidae	*Tribonyx ventralis*	Black-tailed Nativehen																				1												
Recurvirostridae	*Himantopus leucocephalus*	Pied Stilt																															1	
	Cladorhynchus leucocephalus	Banded Stilt																					1										1	
	Recurvirostra novaehollandiae	Red-necked Avocet																				1											1	
Charadriidae	*Vanellus tricolor*	Banded Lapwing								1			4					9						4										
	Charadrius ruficapillus	Red-capped Plover																				1												
	Erythrogonys cinctus	Red-kneed Dotterel																															1	
	Elseyornis melanops	Black-fronted Dotterel																				1												
Scolopacidae	*Tringa nebularia*	Common Greenshank																															1	
Turnicidae	*Turnix velox*	Little Buttonquail	13	3												2								5										
Laridae	*Chroicocephalus novaehollandiae*	Silver Gull																															1	
Otididae	*Ardeotis australis*	Australian Bustard							4										1															
Ardeidae	*Ardea pacifica*	White-necked Heron																				1											1	
	Egretta novaehollandiae	White-faced Heron																				1											1	
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill																															1	
Ardeidae	*Ardea alba*	Great Egret																															1	
Accipitridae	*Elanus axillaris*	Black-shouldered Kite																															1	
	Lophoictinia isura	Square-tailed Kite																															1	
	Hieraaetus morphnoides	Little Eagle		1								2				1					3												1	

			A																								B								C
Family	Species	Common name	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 14a	Site 5a	Site 1a	Site 22	Site 17a	Site 14	Site 15	Site 20a	Site 21a	Site 11	Site 11a	Site 8	Site 19	Freshwater	Salt Lake	Site 14b	Site 12a	Site 10	Site 3	Site 5	Site 9	Site 4	Site 6	Site 8	Opportunitic	Goongarrie
	Aquila audax	Wedge-tailed Eagle							2				2	6						3													1	
	Circus assimilis	Spotted Harrier						1																1										
	Accipiter fasciatus	Brown Goshawk													1						3		1										1	
	Accipiter cirrocephalus	Collared Sparrowhawk																					1										1	
Cuculidae	*Heteroscenes pallidus*	Pallid Cuckoo						4						2		1				1	1													
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra																																1
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher											6			1						1		1									1	
Meropidae	*Merops ornatus*	Rainbow Bee-eater	3	1								5				3					3												1	
Falconidae	*Falco cenchroides*	Nankeen Kestrel							5	4			2							2	3												1	
	Falco longipennis	Australian Hobby										1								1													1	
	Falco berigora	Brown Falcon		2					3			2	2		2	3				3	5			1									1	
	Falco peregrinus	Peregrine Falcon																															1	
Timaliidae	*Zosterops lateralis*	Silvereye																															1	
Cacatuidae	*Eolophus roseicapilla*	Galah							908	7		4	2	44	5	7	62		1	4	5	1	1	8									1	
	Nymphicus hollandicus	Cockatiel							2			11					4		6	35	3	1	1	4										
Psittaculidae	*Neopsephotus bourkii*	Bourke's Parrot														4					1	1												
	Neophema splendida	Scarlet-chested Parrot													2																			
	Barnardius zonarius	Australian Ringneck			10			3	31	1				25	8	3				9	16	1		36									1	1
	Psephotus varius	Mulga Parrot	4	4	3			2							4	14					2			11									1	
	Melopsittacus undulatus	Budgerigar	1	6				38	9			27	2	11	1	17			20	170	29	1	1	15										
Climacteridae	*Climacteris affinis*	White-browed Treecreeper						1								4	1																	
Maluridae	*Malurus pulcherrimus*	Blue-breasted Fairywren	15	9																													1	
	Malurus splendens	Splendid Fairywren	24												34																		1	1
	Malurus leucopterus	White-winged Fairywren			17				1									3	76	40		1	1	2									1	
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater	2											2	3				2				1										
	Purnella albifrons	White-fronted Honeyeater	69	125	16			7				144		3	12		6		1	2	4		1	1	4								1	
	Manorina flavigula	Yellow-throated Miner			109			3	15			74	1	10		41				21	13			98									1	1
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	18	23	7			6	2	2		52	5	11	30	10	4			9	8	1	1	2									1	1
	Anthochaera carunculata	Red Wattlebird			1							5				3					2												1	1
	Gavicalis virescens	Singing Honeyeater	2		4					1		1	2	11	2	3			3	8	2	1	1	3									1	1
	Ptilotula ornata	Yellow-plumed Honeyeater										230																					1	
	Ptilotula plumula	Grey-fronted Honeyeater										12		56		2					3		1											
	Conopophila whitei	Grey Honeyeater	2		1												17						1	18										
	Epthianura tricolor	Crimson Chat							24				6	154		29			18	75														
	Epthianura aurifrons	Orange Chat																	5															
	Epthianura albifrons	White-fronted Chat																				1											1	
	Sugomel nigrum	Black Honeyeater	7	4											3																			
	Lichmera indistincta	Brown Honeyeater																															1	

			A																								B								C	
Family	Species	Common name	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 14a	Site 5a	Site 1a	Site 22	Site 17a	Site 14	Site 15	Site 20a	Site 21a	Site 11	Site 11a	Site 8	Site 19	Freshwater	Salt Lake	Site 14b	Site 12a	Site 10	Site 3	Site 5	Site 9	Site 4	Site 6	Site 8	Opportunitic	Goongarrie
	Nesoptilotis leucotis	White-eared Honeyeater	4																														1	1
	Melithreptus brevirostris	Brown-headed Honeyeater										6																					1	1
Pardalotidae	*Pardalotus striatus*	Striated Pardalote		1								2									2			1									1	1
Acanthizidae	*Pyrrholaemus brunneus*	Redthroat	16	8				2							4		1			2				2									1	1
	Acanthiza iredalei	Slender-billed Thornbill																																1
	Acanthiza apicalis	Inland Thornbill	32	38				1				15			18	2	2				3				2								1	1
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	2		4							1			48	8				9	4												1	
	Acanthiza uropygialis	Chestnut-rumped Thornbill	23	3	27				3	3		46			86	126	10			53	88		1	5	2								1	1
	Acanthiza robustirostris	Slaty-backed Thornbill														6					3													
	Smicrornis brevirostris	Weebill	50	36				2				269				7	2				98												1	
	Aphelocephala leucopsis	Southern Whiteface													153	52	12			4	5			8									1	
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler	1							2					4		3							3									1	1
Cinclosomatidae	*Cinclosoma castanotum*	Chestnut Quail-thrush										3			1																			
	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush														3			2															1
Campephagidae	*Coracina maxima*	Ground Cuckooshrike							31			6	3						4					2										
	Coracina novaehollandiae	Black-faced Cuckooshrike		11	3				5			12	1	4	15	10				7	9			6									1	1
	Lalage tricolor	White-winged Triller	2		2				3			14			3	34	6			39			1	9										
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	2																		6			2										1
Oreoicidae	*Oreoica gutturalis*	Crested Bellbird	11	6	2				5		2	15		14	18	10	2		3	6	15			1	1								1	1
	Oreoica gutturalis	Crested Bellbird																																
Pachycephalidae	*Colluricincla harmonica*	Grey Shrikethrush	6	16								17			5		1				5												1	1
	Pachycephala rufiventris	Rufous Whistler		2								32			13		1				8		1										1	1
Artamidae	*Artamus personatus*	Masked Woodswallow	1	1								18		2		72			2		2		1	31										
	Artamus superciliosus	White-browed Woodswallow														3																		
	Artamus cinereus	Black-faced Woodswallow							25				11	55		1	1		7	12			1	6									1	
	Cracticus torquatus	Grey Butcherbird	2	2	1				4			8		2		8				4	8		1	7									1	1
	Cracticus nigrogularis	Pied Butcherbird	3	2	14				23	4	1	5		6	1		2			13	4			1									1	1
	Gymnorhina tibicen	Australian Magpie			5				3			2	9			1																	1	
	Strepera versicolor	Grey Currawong			4				2			1			1		1				2			3									1	1
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail			1				2			5	1							12		1	1	2									1	1
	Rhipidura albiscapa	Grey Fantail										13																					1	1
Monarchidae	*Grallina cyanoleuca*	Magpie-lark							12				2							3		1		7									1	
Corvidae	*Corvus orru*	Torresian Crow										2							2					2									1	
	Corvus bennetti	Little Crow			149				50	7		7	12	29	10	6			11	36	24	1		21									1	1
	Corvus coronoides	Australian Raven																															1	
Petroicidae	*Microeca fascinans*	Jacky Winter							1			28				1					22		1										1	
	Petroica goodenovii	Red-capped Robin	8		4				5	3	3	20	1	1	106	47	4			3	29		1	3									1	1
	Melanodryas cucullata	Hooded Robin		2					1			32		2	13	1	1		1	2			1										1	

			A																												B								C
Family	Species	Common name	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 14a	Site 5a	Site 1a	Site 22	Site 17a	Site 14	Site 15	Site 20a	Site 21a	Site 11	Site 11a	Site 8	Site 19	Freshwater	Salt Lake	Site 14b	Site 12a	Site 10	Site 3	Site 5	Site 9	Site 4	Site 6	Site 8	Opportunitic	Goongarrie
Locustellidae	*Cincloramphus cruralis*	Brown Songlark							7				8	3		1		7	7															
	Cincloramphus mathewsi	Rufous Songlark															2							3									1	
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	2	1																		1	1										1	
	Petrochelidon ariel	Fairy Martin		5																													1	
	Petrochelidon nigricans	Tree Martin		7																		1											1	
	Cheramoeca leucosterna	White-backed Swallow											2									1											1	
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	3	1	4			1				5								5				4									1	1
Estrildidae	*Taeniopygia guttata*	Zebra Finch (Australian)		4								2		12	2				9	36	5	1		4									1	
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit			2				16			4	36					7	18			1	1	1									1	
Mammals																																		
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna													1													1						
Bovidae	*Capra hircus*	Goat							1	1				1							1													
	Ovis aries	Sheep			1	1		1	1							1					1													
Camelidae	*Camelus dromedarius*	Dromedary										1						1																
Canidae	*Canis lupus*	Dingo	1									1						1																
	Vulpes vulpes	Red Fox	1	1						1					1	1	1				1													
Felidae	*Felis catus*	Cat		1														1																
Molossidae	*Austronomus australis*	White-striped Freetail Bat								1		1																						
	Mormopterus planiceps	Southern Free-tail Bat								1																								
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat							1	3																								
	Nyctophilus geoffroyi	Lesser Long-eared Bat							4	3			9																					
	Scotorepens balstoni	Inland Broad-nosed Bat							6	1																								
Dasyuridae	*Ningaui ridei*	Wongai Ningaui	1	3																	5						2							
	Sminthopsis crassicaudata	Fat-tailed Dunnart		1		1				1						7		5													1	1		
	Sminthopsis dolichura	Little Long-tailed Dunnart	3					1	2	1		1				1		1		2	1							2		2		2		
Burramyidae	*Cercartetus concinnus*	Southwestern Pygmy Possum																								1			3			1		
Macropodidae	*Macropus fuliginosus*	Western Grey Kangaroo								1										1														
	Osphranter robustus	Euro						1		1			1			1				1	1													
	Osphranter rufus	Red Kangaroo							1	1			1	1		1		1	1	1														
Leporidae	*Oryctolagus cuniculus*	Rabbit		1						2			1					1		1														
Muridae	*Mus musculus*	House Mouse	4	2						2			1					2			3													
	Notomys alexis	Spinifex Hopping Mouse	2	9				2				1			1					1														
	Notomys mitchellii	Mitchell's Hopping Mouse		3				1																										
	Pseudomys bolami	Bolam's Mouse															3									1	1	3						
	Pseudomys hermannsburgensis	Sandy Inland Mouse	2	1					1							2		1		1	7						1							

A Dell, J and How, R.A. (1988) Vertebrate fauna. In: The biological Survey of the Eastern Goldfields of Western Australia, Part 5, Edjudina - Menzies Study Area. Records of the Western Australian Museum, Supplement No 31., pp. 38-77.

B Hart, Simpson and Associates (2000) Anaconda Nickel Ltd, Cawse Expansion Project, Fauna Survey. Unpublished report for Anaconda Nickel Ltd, Perth.

C Bell, D.T., Bell, R.C. and Loneragan, W.A. (2016) Winter bird assemblages across an arid gradient in south-west Western Australia. Journal of the Royal Society of Western Australia 90, 219-227.

Appendix C.

Definitions of Significant Fauna under the WA *Biodiversity Conservation Act 2016* and Priority Species

Vertebrate fauna reconnaissance survey and risk assessment
Edjudina Project Area



ATTACHMENT C
DEFINITIONS OF SIGNIFICANT FAUNA UNDER THE WA BIODIVERSITY CONSERVATION ACT 2016

Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such. The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*. Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened Species

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

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

CR Critically endangered species

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

[1] The definition of flora includes algae, fungi and lichens

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

EN Endangered species

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct Species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the pwild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially Protected Species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory birds protected under an international agreement

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependant fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

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

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

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

P1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

P2 Priority 2: Poorly-known species

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

P3 Priority 3: Poorly-known species

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

P4 Priority 4: Rare, Near Threatened and other species in need of monitoring

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

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

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

Appendix D.
Fauna habitat assessment results

Vertebrate fauna reconnaissance survey and risk assessment
Edjudina Project Area



ENVIRONMENTAL ASSESSMENT:

PROPOSED WALLBROOK MINE SITES AND SURROUNDS



Alexander Holm & Associates
Natural Resource Management Services

July 2009

Contents

Summary 1
Scope of works 2
Site overview 2
Wallbrook 2
Climate 2
Topography and drainage 3
Hydrogeology 4
Vegetation and soils 4
Assessment methodology 5
Assessment personnel, timing and seasonal conditions 5
Declared flora 5
Threatened ecological communities 5
Land systems land units and vegetation associations 6
Field survey 6
Environmental analysis 7
Landforms and vegetation 7
Conservation estate 7
Land systems 7
Land units and vegetation types 9
Vegetation and soil condition 22
Threatened ecosystems and wetlands. 22
Threatened ecological communities and significant wetlands 22
Ecosystems at risk 22
Flora 23
Fauna 26
Fauna general 26
Priority fauna 27
Fauna habitat 28
Hydrological summary 29
Crusader Eleven Bells and Redbrook clearing proposal 30
Site 30
Land units and vegetation 30
Drainage and groundwater 30
Habitat 30
Assessment against clearing principles 33
Discussion and recommendations 36
References 37
Attachments 39

Tables

Table 1: Land systems within the Wallbrook survey area..... 9
Table 2: Land unit descriptions, vulnerability to erosion and associated vegetation communities..... 10
Table 3: Vegetation communities and associated land units..... 21
Table 4: Area of each land unit within Wallbrook survey area..... 21
Table 5: Vegetation and soil surface condition..... 22
Table 6: List of species found in the Wallbrook area on each land unit during field survey in November 2006 and March 2009..... 23
Table 7: Declared rare flora and priority flora found in general area..... 26
Table 8: Threatened species that may occur in the general area listed under EPBC act 1999 and/or afforded protection under Wildlife Conservation Act WA (1950)..... 27
Table 9: List of species occurring in the general area in Department of Conservation and Land Management Threatened and Priority Fauna database..... 28

Figures

Figure 1: Wallbrook location and outline of survey area (pink) and traverse during field survey (blue)..... 3
Figure 2: Land systems of the Wallbrook area (Pringle, Van Vreeswyk & Gilliagan 1994) 8
Figure 3: Land units within the clearing envelope for the proposed Eleven Bells and Redbrook mines in the Wallbrook area..... 31

Attachments

Attachment 1: Australian Government Department of Environment Heritage and Arts Protected matters search tool output.

Maps

Map of land units overlain on satellite imagery.

SUMMARY

This report for Saracen Gold Mines Pty Ltd covers environmental assessments of 1) a 3.5km by 10 km envelope surrounding the Wallbrook area within Edjudina pastoral lease in the North Eastern Goldfields and 2) clearing for Crusader, Eleven Bells and Redbrook mines, which are within the Wallbrook survey area.

The survey area was traversed, mainly by vehicle supported by on-foot traverse of inaccessible areas, from March 13 to 17, 2009. Complimentary data on species distributions were obtained from a survey in November 2006 along a proposed haul road passing through the survey area from Porphyry mine to Carosue Dam processing plant.

Gundockerta land system, which occupies over 80% of the survey area, is characterised by extensive gently undulating plains on weathered greenstones with stony mantles and lower alluvial tracts.

Eleven land units were identified:
1a Low hills on basalt.
1b Low hills and rises on granitic rocks
2a Low rises and gently sloping plains on volcanic rocks
2b Low gravelly rises, minor breakaways and gently sloping plains
3a Stony weakly saline plains
3b Gravelly plains
3c Plains on granitic rocks
4 Hardpan plains
5 Alluvial plains
6 Drainage lines
7 Groves and drainage foci

Land units were mostly associated with bluebush shrublands (BLSS, CPBS, PSAS and PXHS) and sandy granitic shrublands (SGRS). Vegetation was in good (score 2) to fair (score 3) condition. Soil erosion was noted along drainage tracts and associated plains.

No rare or priority species were found among the one hundred and thirty five flora species identified from field surveys. There are no identified threatened ecological communities (TECs) in the biogeographic subregion (MUR1) covering the survey area.

Drainage is via overland flow to minor drainage tracts which discharge into Lake Rebecca a large playa lake to the west and there is potential for increased sediment discharge with increased mining activity.

It is recommended that, in mining and exploration activity within this area, the proponent:

1. **Minimises disturbance to fauna habitat within breakaways, granite outcrops and hilltops in the south east, drainage tracts and drainage foci.**

2. **Minimises disturbance to erodible landscapes along drainage tracts and associated alluvial and saline plains otherwise installs erosion control where necessary.**

SCOPE OF WORKS

Alexander Holm & Associates were contracted by Saracen Gold Mines Pty Ltd (Saracen) to:

1. Conduct an environmental assessment of the Wallbrook area within a 3.5km by 10 km envelope to include:
   - Review available information on likelihood of a) presence of rare or priority plant species and b) threatened plant communities, in the general search area.
   - Conduct a flora and vegetation survey.
   - Assess landscape stability and condition.
   - Provide descriptions of land units and relate information on flora, vegetation associations and landscape stability to these units.
   - Provide a map of land units and associated vegetation.
   - Provide a report on findings including an assessment against clearing principles.

2. Assess the proposed clearing for Crusader, Eleven Bells and Redbrook mines, which are within the Wallbrook survey area, in relation to the Department of Mines and Petroleum clearing principles.

SITE OVERVIEW

Wallbrook

Wallbrook is within the Edjudina pastoral lease about 7 km south west of Edjudina homestead and 160 km north east of Kalgoorlie Boulder (Figure 1). Saracen proposes to develop several minor gold resources within the Wallbrook area and there is potential to develop other resources within the general area.

Climate

The climate is arid to semi-arid with an average annual rainfall of 230 mm with rain likely throughout the year.

Rainfall in the region is unreliable and inconsistent. Winter rainfall consists of light showers from April to October. Significant summer rainfall events originating from the north-west as tropical cyclones are most likely between January and March. The highest recorded daily rainfall is 177.8mm (February) at Kalgoorlie and 92.6mm (January) at Laverton. For Kalgoorlie, a one in one hundred years 1 hour and 72 hours rainfall event is estimated to result in 43 and 173mm respectively. Rain falls on an average of 42 days a year at Laverton (Data from www.bom.gov.au).

The average annual potential pan evaporation rate at Carosue Dam is approximately 2800mm http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/evaporation.cgi.

Winds are mostly light easterlies.

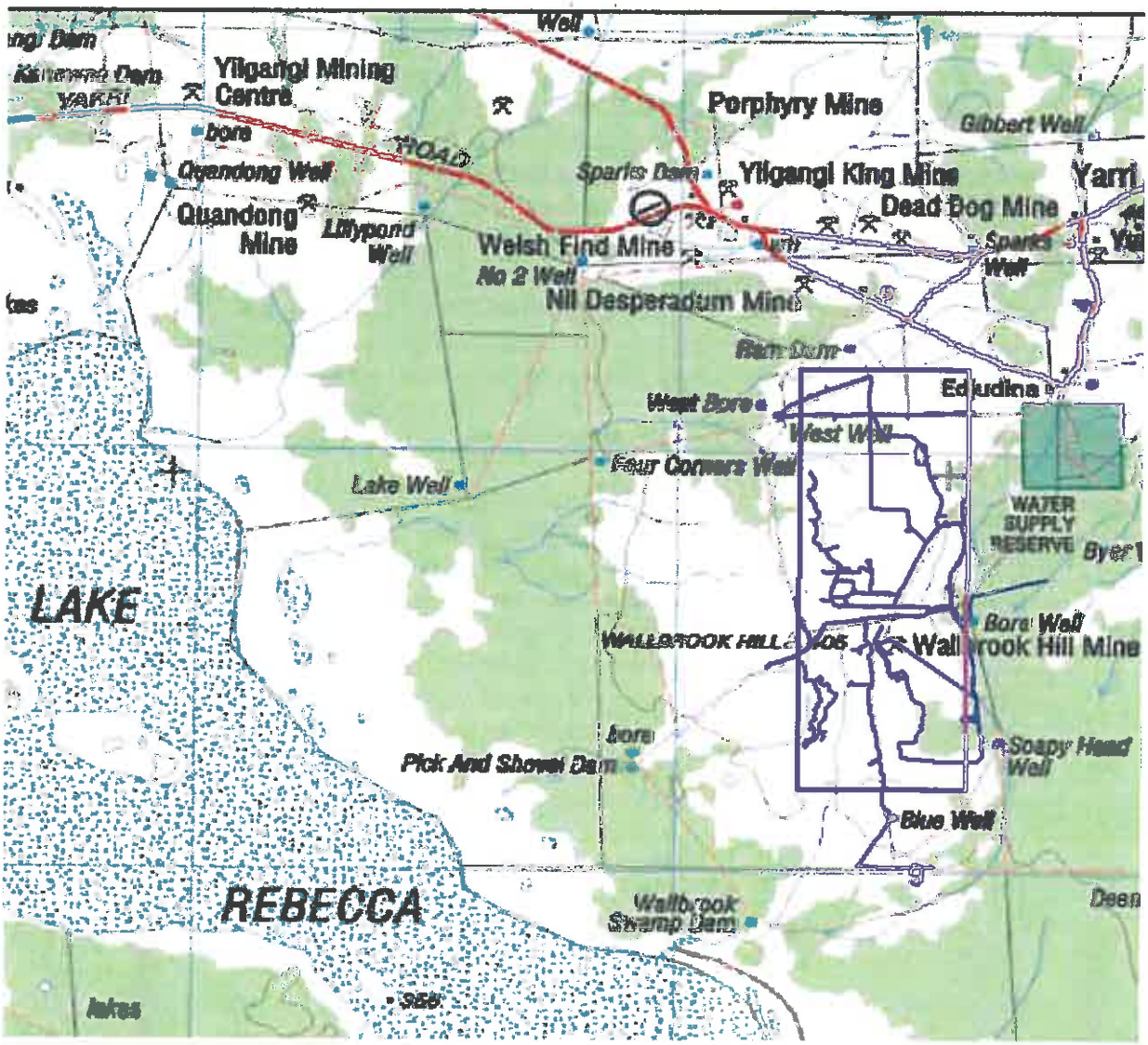


Figure 1: Wallbrook location and outline of survey area (pink) and traverse during field survey (blue).

Topography and drainage

Landform patterns comprise extensive sand plain, sub-parallel greenstone belts and breakaways with often extensive lower pediments which give way to level to very gently inclined sheet flood plains. Relief is subdued. There are no major river systems. South-east trending, broad, saline, palaeo-drainage systems traverse the region and are defining features of the Yilgarn block of south-western Australia (Gentilli, 1979). These drainage systems have very low gradients and contain playa lakes including Lake Rebecca, Carey and Raeside. Lakes form local depo-centres with poorly developed radial drainage

systems. During occasional intense rainfall events lakes may fill, and in very rare events some may overflow, link-up and discharge to the Nullarbor Plain through Ponton Creek (Pringle et al., 1994).

Hydrogeology

Groundwater occurs throughout the region within sparse fractures in basement rocks, within the weathering profile, and in alluvial sediments. Regional water table elevations vary from around 350 m above sea level around Lake Raeside to 400 – 450 m above sea level around Lake Carey and are generally 30 to 100 m below surface. Groundwater recharge occurs from major, but infrequent, rainfall events, mainly on drainage divides, and locally at site specific intake areas such as drainage lines or sandplains and dune fields. Groundwater is in hydraulic continuity and flows from drainage divides towards paleo-drainages and then south-easterly toward the Nullarbor Plain. Groundwater beneath catchment divides occurs as lenses of less than 5000 mg/l TDS which are superimposed on a regional field of saline groundwater with linear bodies of hypersaline groundwater along paleo-drainages, and local brine pools associated with salt lakes (Allen, 1994).

Vegetation and soils

The region lies within the Eremaean botanical province mainly in the Austin botanical district with the eastern edge approaching the Helms botanical district (Beard, 1990). Lake Ballard/Lake Rebecca forms a major vegetation divide with characteristic *Acacia aneura* (mulga) low woodlands associated with red loams over siliceous hard pan to the north and low woodlands of mixed mulga and *Casuarina cristata* (black oak) and *Eucalyptus* sp on alkaline and calcareous soils to the south. Spinifex hummock grassland with eucalypt overstory on sand plain is common. Halophytic vegetation occurs throughout the region on paleo-drainage systems, breakaways and on some stony and alluvial plains. Highly saline soils support Atriplex (saltbush), Maireana (bluebush) and Tecticornia (samphire) shrublands, while less saline soils support mulga with saltbush or bluebush understoreys.

ASSESSMENT METHODOLOGY

Assessment personnel, timing and seasonal conditions

The work was conducted by a) Dr Alexander Holm, ecologist with extensive experience in arid environments and Goldfield regions and an accredited environmental consultant with the Environmental Consultants Association of Western Australia, and b) Alan Payne, land resource specialist and author or co-author of land resource surveys throughout Western Australia including those of nearby Murchison region (Curry *et al.*, 1994) and Kambalda area (Payne, Mitchell & Hennig, 1998). Mr Ray Cranfield (assisting botanist to rangeland surveys in the goldfields) assisted with plant identification. *Eremophila* and *Acacia* species were identified by botanists at the Western Australian herbarium.

The Wallbrook area was surveyed from March 13 to 17 2009. Complimentary data on species distributions were obtained from a survey in November 2006 along the proposed haul road route which passes through the survey area from the Porphyry mine to the Carosue Dam processing plant (Anon 2007).

Rainfall patterns in the eastern Goldfields have over the past decade been dominated by summer rainfall. The March 2009 survey followed summer rains resulting in germination of numerous grasses and other annual or biennial species favoured by summer rains.

Declared flora

Likelihood of presence of declared rare or priority flora was inferred from flora collections held by Department of Environment and Conservation and from the "Threatened Flora Database" from Species and Communities Branch summarised in Holm (2006).

Declared flora listed on Commonwealth Department of Environment and Heritage database of threatened species were identified for the above search area using the protected matters search tool http://www.environment.gov.au/erin/ert/epbc/index.html. (Attachment 1).

Threatened ecological communities

The likelihood of presence of threatened ecological communities within the above area was assessed by searches of Department of Environment and Conservation's database of threatened ecological communities (Holm 2006). Commonwealth Department of Environment and Heritage's database of threatened ecological communities and wetlands of national significance was assessed using the protected matters search tool http://www.environment.gov.au/erin/ert/epbc/index.html. (Attachment 1).

Other threatened ecosystems in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion identified during "A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002", are listed in Cowan (2001).

Land systems land units and vegetation associations

Land systems and vegetation associations were derived from a land resource survey of north eastern Goldfields (Pringle, Van Vreeswyk & Gilligan, 1994). Land units were identified on 1:20,000 scale aerial photographs, checked in the field, and captured digitally.

Field survey

Flora survey and reporting were according to guidance and position statements published by the Western Australian Environmental Protection Authority (EPA, 2002).

Declared rare and priority and other significant flora, likely to occur in the region, were identified along with their habitat preference during the desk top study. These species were specifically targeted during survey.

The survey area was traversed for 112 km mostly by vehicle to cover as much of the area using existing tracks as far as possible. Twenty eight full inventory sites were selected to cover each land unit. An additional 12 flora census sites were selected to encompass slight variations in pattern within each land unit. Additional sites were recorded within the proposed clearing envelopes for the mine sites.

At each inventory site:

- Digital photographs with automatic GPS location were taken.
- All flora species within 40 – 50 m of central location were inventoried and specimens collected where identity was uncertain or unknown.
- Canopy cover, vegetation condition and soil erosion were visually estimated using standard rating scales as used for rangeland surveys and described by Pringle *et al.* (2004).
- Landform, vegetation, soil surface and surface water flow characteristics were described.

Species encountered during traverse, other than those noted at inventory sites, were recorded within relevant land units.

Additional data on species composition was included from 16 inventory sites sampled in November 2006.

ENVIRONMENTAL ANALYSIS

Landforms and vegetation

The survey area consists mostly of erosional and depositional landforms with low hills on greenstones (Payne, Mitchell & Hennig, 1998).

About 90% of the area is occupied by Beard Vegetation Association 400 – Succulent steppe with open low woodland and the remainder on the margins by Association 18 - Low woodland; mulga (*Acacia aneura*).

Conservation estate

Less than 1% of the region is set aside for nature conservation. The closest conservation area is Goongarrie National Park, approximately 60 km west.

There are no listed sites of international or national significance or wetlands of International, National or sub-regional significance within the project area (Appendix 1).

There are no registered sites on State or National heritage registers.

An Aboriginal heritage survey of Saracen Gold Mines Pty Ltd's proposed Porphyry Haul Road through the Wallbrook area and of the proposed Wallbrook mine area was undertaken between 18 and 22 June 2007 by Wayne Glenndenning of Western Heritage Resouces accompanied by representatives of the Wongatha people and the Maduwongga people. No sites were found in the mine area while a quartz quarry was identified along the route of the proposed haul road.

Lake Rebecca, located 10 km west is a registered mythological site.

Land systems

The survey area falls mostly, and the proposed mines sites fall entirely, within the Gundockerta land system characterised by extensive gently undulating plains on weathered greenstones with stony mantles and lower alluvial tracts (Pringle, Van Vreeswyk & Gilligan, 1994)(Figure 2). Areas and description of each land system within the survey envelope are shown in Table 1.

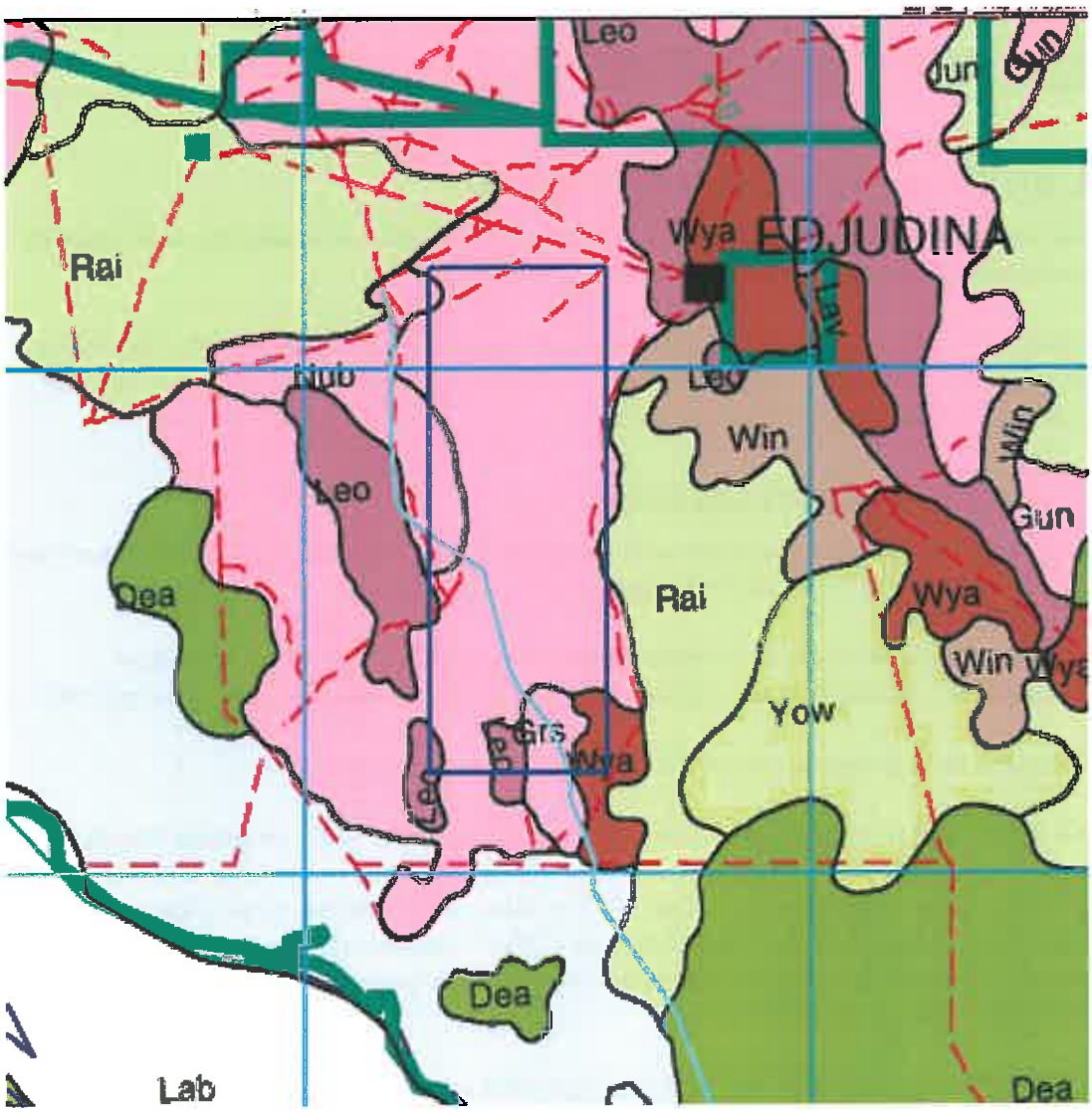


Figure 2: Land systems of the Wallbrook area (Pringle, Van Vreeswyk & Gilliagan 1994)

Gun: Gunodockerta
Grs: Gransal
Leo: Leonora
Nub: Nubev
Rai: Rainbow
Way: Wyarri

Table 1: Land systems within the Wallbrook survey area

Land system	Description	Area	
		ha	%
Gunodockerta	Extensive gently undulating plains on weathered greenstones with stony mantles and lower alluvial tracts supporting bluebush shrublands.	2930	83.8
Nubev	Gently undulating stony plains, minor low rises and drainage floors supporting mulga and halophytic shrublands.	184	5.3
Gransal	Stony plains and low rises on granite supporting mainly halophytic shrublands.	177	5.0
Leonora	Low greenstone hills and stony plains supporting mixed stony chenopod shrublands.	103	2.9
Wyarri	Hills domes and tor fields on granite with occasional quartz dykes	94	2.7
Rainbow	Rainbow (Rai) is characterised by cemented quaternary alluvium (hardpan) plains supporting mulga shrublands.	12	0.3
Total		3500	100

Land units and vegetation types

Eleven land units were identified and associated vegetation types described (Table 2).

Vegetation types associated with each land unit are listed in Table 3.

A map of land units is overlain on satellite imagery (Map 1).

Table 2: Land unit descriptions, vulnerability to erosion and associated vegetation communities.

Land unit	Landform and soil	Vegetation community
1a. Low hills on basalt		
	Rounded hills with relief up to 20m and footslopes 5 – 10% with very abundant (>90%) surface mantles of basalt pebbles and cobbles; stony soils and shallow calcareous loams. Run-off areas with low vulnerability to erosion. (1 inventory site)	Very scattered (PFC mostly <5%) low shrublands dominated by *Ptilotus obovatus* and *Enneapogon caerulescens*, other isolated shrubs such as *Solanum lasiophyllum*,*Senna artemisioides*, *Maireana sedifolia*, *Acacia tetragonophylla*, and *A.burkittii* .

Land unit	Landform and soil	Vegetation community
1b. Low hills and rises on granitic rocks		
	Hills with relief up to about 30m, rough uneven crests with granitic tors and bare domes and stony lower slopes 5 – 12%; much outcrop of parent material and abundant mantles (80 - >90%) of granite and quartz rocks, pebbles and grit. Shallow stony sand soils. Run-off areas with low vulnerability to erosion. (2 inventory sites)	Very scattered (PFC 5 – 7.5%) tall (>2m) or mixed height shrublands dominated by *Acacia quadrimarginea* , *Eremophila compacta* ssp. *compacta* and *Ptilotus obovatus;* other common shrubs include *Acacia aneura, A. tetragonophylla, Solanum lasiophyllum, Leiocarpa websteri,* and *Senna artemisioides* and grasses *Cymbopogon ambiguus* and *Tripogon loliiformis.* (SGRS).

Land unit	Landform and soil	Vegetation community
2a. Low rises and gently sloping plains on volcanic rocks		
	Rounded rises with up to 10m relief and side slopes 2 – 3% and broad near level to gently sloping plains (slopes 1 – 2%); surface mantles vary from few to very abundant (5 - >90%) pebbles and rocks predominantly quartz but also metamorphic and calcareous nodules. Calcareous loamy earth soils. Generally low vulnerability to erosion. (3 inventory and 6 flora census sites)	Very scattered to scattered (PFC 5 – 20%) low (<1m) or mixed height shrublands dominated by *Maireana sedifolia* often with prominent low tree or tall (>2m) shrub layers of *Casuarina pauper, Acacia quadrimarginea* or *A. aneura.* Other common shrubs are *Ptilotus obovatus, Hakea preissii, Maireana pyramidata, M. georgei, M. triptera, Atriplex vesicaria, Solanum lasiophyllum, Dodonea lobulata, Eremophila* spp. *Scaevola spinescens* and the grass *Enneapogon caerulescens.* (CPBS).

Land unit	Landform and soil	Vegetation community
2b. Low gravelly rises, minor breakaways and gently sloping plains		
	Rises and occasional low breakaways with relief up to 8m and side slopes 6 – 8% and gently sloping (2 – 3%) lower plains; abundant to very abundant (80 - >90%) surface mantles of lateritic gravels and angular and platy metamorphic pebbles and cobbles. Stony soils and shallow loamy earths. Run-off areas with low vulnerability to erosion. (3 inventory sites)	Very scattered to scattered (PFC 5 – 15%) low (<1m) or mixed height shrublands dominated by *Maireana sedifolia* with numerous other shrubs including *Acacia quadrimarginea, A. tetragonophylla, Casuarina pauper, Ptilotus obovatus, Dodonea lobulata, Maireana triptera* and *Enchylaena tomentosa.* (CPBS).

Land unit	Landform and soil	Vegetation community
3a. Stony weakly saline plains		
	Level to gently inclined (slopes 0.5 – 1.5%) weakly saline plains with patchy mantles of few to very abundant (10 - >90%) of quartz and occasionally metamorphic pebbles and cobbles. Shallow loamy earth and loamy duplex soils. Low to moderate vulnerability to water erosion. (7 inventory and one flora census sites)	Isolated to scattered (PFC <2.5 – 20%) low (<1m) halophytic shrublands dominated by *Atriplex vesicaria* or *Maireana pyramidata* (occasionally *Maireana sedifolia*) with numerous other shrubs commonly *Maireana georgei, M. glomerifolia, Hakea preissii, Ptilotus obovatus, Tecticornia halocnemoides, Frankenia* sp., *Scaevola spinescens* and *Enchylaena tomentosa.* (BLSS, PSAS, occasionally CPBS or PXHS).

Land unit	Landform and soil	Vegetation community
3b. Gravelly plains		
	Level to very gently sloping (slopes 0.5 – 1.5%) plains with abundant to very abundant (70->90%) mantles of ironstone and lateritic gravels, pebbles and rocks; stony loamy earth soils. Low vulnerability to erosion. (3 inventory sites)	Very scattered to scattered (PFC <5 – 20%) tall (>2m) or low (<1m) shrublands dominated by *Acacia aneura* or *Maireana sedifolia* with numerous other shrubs commonly *Acacia burkittii, A. tetragonophylla, Ptilotus obovatus, Maireana triptera, M. georgei, Dodonea lobulata, Eremophila oldfieldii* and *Solanum lasiophyllum.* (HMCS, CPBS).

Land unit	Landform and soil	Vegetation community
3c. Plains on granitic rocks		
	Gently sloping (slopes 1 – 3%) plains and occasional low rises on granite with variable density surface mantles of granite and quartz pebbles, occasional granite and quartz outcrop; shallow sandy soils. Low vulnerability to erosion. (1 inventory and 1 flora census site)	Very scattered (PFC ≤ 5 – 10% tall shrublands of *Acacia quadrimarginea* (occasionally with *A.aneura*) and diverse low shrubs dominated by *Eremophila compacta, Ptilotus obovatus* and *Chrysocephalum puteale*, also annual grasses. (SGRS).

Land unit	Landform and soil	Vegetation community
4. Hardpan plains		
	Near level (slopes <1%) plains over hardpan or parent rock, usually without surface mantles, but occasionally with mantles of quartz and other pebbles and rocks; shallow sandy loam and loam soils. Low vulnerability to erosion. (2 inventory sites)	Scattered (PFC 10 – 20%) tall (>2m) shrublands, sometimes weakly groved or clumped, of *Acacia aneura* with *Acacia tetragonophylla, Ptilotus obovatus, Solanum lasiophyllum, Eremophila compacta* ssp. *compacta, Maireana triptera, M. georgei, Rhagodia* sp., *Spartothamnella teucriiflora* and, on sites with more sandy soils, grasses such as *Eragrostis eriopoda* and *Monachatha paradoxus.* (HPMS, MUWA).

Land unit	Landform and soil	Vegetation community
5. Alluvial plains 	Near level (slopes <1%) weakly saline alluvial plains with sparse mantles (<10 – 15%) quartz pebbles and calcareous nodules; calcareous loamy earth soils. Low vulnerability to erosion (1 inventory and 1 flora census site)	Patchy, very scattered to scattered (PFC 2.5 – 15%) low (<1m) shrublands dominated by *Atriplex vesicaria* with other shrubs commonly *Cratystylis subspinescens, Atriplex bunburyana, Solanum lasiophyllum* and grasses *Enneapogon caerulescens* and *Enteropogon acicularis*. (BLSS).

Land unit	Landform and soil	Vegetation community
6. Drainage lines		
	Active drainage tracts 50 – 200m wide with shallow central channels and gutters usually <10m wide, sometimes with sharp incision and active erosion; loamy earth or loamy duplex soils without mantles or few (<10%) mantles of quartz pebbles, channel bedloads of sand and gravels. Moderate to high vulnerability to water erosion. (2 inventory and 2 flora census sites)	Very scattered to scattered (PFC 5 – 20%) low (<1m) shrublands dominated by halophytic shrubs *Atriplex vesicaria* or *Maireana pyramidata* with *Maireana georgei, Eremophila decipiens, Hakea preissii, Casuarina pauper, Atriplex bunburyana* and *Dodonea lobulata.* (BLSS, PSAS).

Land unit	Landform and soil	Vegetation community
7. Groves and drainage foci		
	Level areas roughly circular up to 50m in diameter or more elongated and diffuse up to 100m in extent, usually no rock surface mantles but abundant cover of plant litter; soils are loamy earths or clays. Run-on sink (accumulation) areas. Low vulnerability to erosion. (2 inventory and 3 flora census sites)	Highly variable and diverse closed (PFC >50%) woodlands or tall shrublands; dominant trees and tall shrubs may be *Acacia aneura, A. quadrimarginea, A. oswaldii, Hakea preissii, Dodonea lobulata* or *Myoporum platycarpum* with many other shrubs such as *Acacia tetragonophylla, Ptilotus obovatus, Rhagodia* spp., *Eremophila oldfieldii, E. decipiens, Enchylaena tomentosa, Maireana pyramidata, Cratystylis subspinescens, Exocarpus aphylla, Scaevola spinescens* and *Senna artemisioides ssp. filifolia* (DRXT).

* (DRXT etc) vegetation types see Table 3.

The most common vegetation community is Calcyphytic pearl bluebush shrublands (CPBS)(Table 3) which is the dominant community on the two widespread land units: 2a and 3a (Table 2).

Table 3: Vegetation communities and associated land units

Vegetation community*	Description	Land unit
BLSS*	Bladder saltbush low shrublands	3a, 5, 6
CPBS	Calcyphytic pearl bluebush shrublands	2a, 2b, 3a, 3b
DRXT	Drainage mixed thicket	7
HPMS	Hardpan plain mulga shrublands	4
HMCS	Mulga shrublands with scattered chenopod low shrubs	3b
LHMS	'Lateritic' hardpan plain mulga shrublands	3b
MUWA	Mulga wanderrie grassy shrublands	4
PSAS	Sago bush low shrublands	3a, 6
PXHS	Plain mixed halophyte low shrublands	3a
SGRS	Sandy granitic acacia shrublands	1b, 3c

* (Pringle, Van Vreeswyk & Gilligan, 1994) (Payne et al 1998).

Low rises and gently sloping plains on volcanic rocks (Land unit 2a) and Stony weakly saline plains (Land unit 3a) together occupy over three quarters of the survey area. Drainage lines (Land unit 6) and drainage foci (Land unit 7) together occupy about 5% of the survey area (Table 4).

Table 4: Area of each land unit within Wallbrook survey area.

Land unit	Description	Area	
		(hectares)	%
1a	Low hills on basalt	22.9	0.7
1b	Low hills and rises on granitic rocks	31.6	0.9
2a	Low rises and gently sloping plains on volcanic rocks	1618.0	47.0
2b	Low gravelly rises, minor breakaways and gently sloping plains	112.8	3.3
3a	Stony weakly saline plains	1056.0	30.6
3b	Gravelly plains	83.2	2.4
3c	Plains on granitic rocks	66.8	1.9
4	Hardpan plains	259.2	7.5
5	Alluvial plains	65.0	1.9
6	Drainage lines	117.7	3.4
7	Groves and drainage foci	12.8	0.4
Total		3446	100

Vegetation and soil condition

The survey area is within Edjudina pastoral lease and previously has been extensively grazed.

Vegetation was in mostly in good (score 2) to fair (score 3) condition (Table 5). Soil erosion, noted in land units 2a was mostly minor sheeting. More severe erosion was noted in stony weakly saline plains (land unit 3a) and along drainage lines (land unit 6) (Table 5).

Table 5: Vegetation and soil surface condition

Land unit	Perennial cover (%)	Vegetation condition @	Erosion score*	Erosion type**	Slope (%)
1a	<5	2	0		8
1b	5 (7.5)	2	0		5-12
2a	10-15 (5,20)	2-4	0 (1)	M	2 (1)
2b	5-10	2-3	0		2-8
3a	5-20 (<2.5)	2-4 (1)	0-2	M,P,R,S	0.5 – 1.5
3b	10-20 (<5)	3-5	0		0.5 – 1.5 (3)
3c	<5	3	0		2-3
4	10-20	2-3	0		0.5
5	2,5-15	2	0		0.5
6	5-20	2	2-3	M,P,R,S	0.5
7	50-100	1-2	0		0

@ 1: Excellent – 5 totally degraded
* 0 nil – 5 severe
** m: microterracing/sheeting., p: pedastalling; r rilling; s: scalding and capping; g: guttering/gullying

Threatened ecosystems and wetlands.

Threatened ecological communities and significant wetlands

There are no identified threatened ecological communities (TECs) on Saracen tenements or in the entire MUR1 biogeographic subregion (Cowan, 2001).

While there are no nationally significant wetlands in the area (Appendix 1), Lake Rebecca, to the west, is a major wet land in the area, with local significance and is a declared mythological site.

Ecosystems at risk

Cowan (2001) lists the following three vegetation communities, occurring within the Wallbrook area, as 'ecosystems at risk' primarily from overgrazing and feral animals:

CPBS: Calcyphytic pearl bluebush shrublands
HMCS Mulga shrublands with scattered chenopod low shrubs

PXHS: Plain mixed halophyte low shrublands

Flora

One hundred and thirty five flora species were found during field surveys of which nine were only identified to genera level (Table 6).

Table 6: List of species found in the Wallbrook area on each land unit during field survey in November 2006 and March 2009.

	Land unit										
Species	**1a**	**1b**	**2a**	**2b**	**3a**	**3b**	**3c**	**4**	**5**	**6**	**7**
Abutilon cryptopetalum	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Abutilon otocarpum					Yes						
Abutilon sp.											Yes
Acacia aneura		Yes	Yes		Yes	Yes	Yes	Yes		Yes	Yes
Acacia aneura aff. var. *tenuis*						Yes					
Acacia burkittii	Yes		Yes			Yes	Yes	Yes		Yes	
Acacia craspedocarpa										Yes	
Acacia duriuscula			Yes		Yes						
Acacia kalgoorliensis									Yes		
Acacia oswaldii						Yes					Yes
Acacia quadrimarginea		Yes	Yes	Yes		Yes	Yes				Yes
Acacia ramulosa var. *linophylla*		Yes									
Acacia ramulosa var. *ramulosa*			Yes	Yes			Yes	Yes		Yes	Yes
Acacia sclerosperma			Yes								
Acacia tetragonophylla	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Alyxia buxifolia											Yes
Aristida contorta		Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	
Atriplex bunburyana			Yes		Yes			Yes	Yes	Yes	
Atriplex nummularia			Yes								
Atriplex stipitata			Yes								
Atriplex vesicaria			Yes	Yes	Yes				Yes	Yes	Yes
Austrostipa elegantissima			Yes	Yes	Yes					Yes	Yes
Austrostipa sp.			Yes								
Boerhavia coccinea			Yes							Yes	Yes
Brachychiton gregorii		Yes									
Brachyscome ciliocarpa					Yes					Yes	
Calandrinia polyandra										Yes	
Casuarina pauper			Yes	Yes	Yes					Yes	Yes
Cheilanthes lasiophylla		Yes						Yes			Yes
Cheilanthes sieberi		Yes					Yes				
Chenopodium gaudichaudianum					Yes						Yes
Chloris truncata					Yes					Yes	
Chrysocephalum pterochaetum							Yes				
Chrysocephalum puteale		Yes	Yes				Yes				
Citrullus lanatus			Yes		Yes					Yes	Yes
Convolvulus angustissimus										Yes	Yes
Cratystylis subspinescens			Yes	Yes	Yes				Yes	Yes	Yes
Cymbopogon ambiguus	Yes	Yes									
Dactyloctenium radulans										Yes	
Dodonea lobulata	Yes		Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes

	Land unit										
Species	**1a**	**1b**	**2a**	**2b**	**3a**	**3b**	**3c**	**4**	**5**	**6**	**7**
Dodonea rigida							Yes		Yes		
Enchylaena tomentosa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Enneapogon avenaceus					Yes			Yes		Yes	
Enneapogon caerulescens	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Enneapogon polyphyllus			Yes	Yes	Yes	Yes		Yes	Yes	Yes	
Enteropogon ramosus			Yes	Yes	Yes	Yes			Yes	Yes	Yes
Eragrostis dielsii							Yes			Yes	
Eragrostis eriopoda							Yes	Yes			
Eremophila alternifolia			Yes	Yes							Yes
Eremophila clarkei								Yes			
Eremophila compacta		Yes					Yes	Yes		Yes	
Eremophila decipiens			Yes	Yes	Yes	Yes			Yes	Yes	Yes
Eremophila georgii		Yes								Yes	
Eremophila glabra			Yes								
Eremophila glandulifera								Yes			
Eremophila granitica			Yes					Yes		Yes	Yes
Eremophila latrobei ssp. *latrobei*			Yes	Yes		Yes				Yes	Yes
Eremophila longifolia			Yes	Yes	Yes			Yes			Yes
Eremophila oldfieldii			Yes	Yes	Yes	Yes				Yes	Yes
Eremophila oppositifolia ssp. *angustifolia*			Yes		Yes						
Eremophila scorparia			Yes	Yes	Yes				Yes	Yes	Yes
Eremophila serrulata							Yes				
Eremophila sp.										Yes	
Eriochriton sclerolaenoides				Yes							
Erodium cygnorum		Yes									
Eucalyptus oleosa ssp. *oleosa*								Yes			
Euphorbia drummondii			Yes		Yes	Yes		Yes		Yes	
Exocarpos aphyllus					Yes					Yes	Yes
Fimbristylis dichotoma							Yes				
Frankenia pauciflora var. *?pauciflora*			Yes							Yes	
Frankenia sp.			Yes	Yes	Yes					Yes	Yes
Hakea lorea spp. *lorea*	Yes	Yes									
Hakea preissii		Yes	Yes		Yes		Yes	Yes	Yes	Yes	Yes
Hibiscus sturtii var *grandiflorus*		Yes									
Indigofera sp.		Yes									
Leiocarpa websteri		Yes									
Maireana convexa			Yes							Yes	
Maireana georgei			Yes	Yes	Yes	Yes		Yes		Yes	Yes
Maireana glomerifolia					Yes						
Maireana integra					Yes					Yes	
Maireana planifolia							Yes				
Maireana pyramidata			Yes		Yes	Yes		Yes	Yes	Yes	Yes
Maireana sedifolia	Yes		Yes	Yes	Yes	Yes			Yes	Yes	Yes
Maireana tomentosa					Yes					Yes	
Maireana trichoptera									Yes		
Maireana triptera			Yes	Yes		Yes		Yes		Yes	
Maireana villosa								Yes			
Malvastrum americanum		Yes			Yes		Yes			Yes	
Marsdenia australis		Yes	Yes	Yes	Yes	Yes		Yes			Yes
Monachather paradoxus						Yes	Yes	Yes		Yes	
Muelleranthus trifoliolatus		Yes									

	Land unit										
Species	**1a**	**1b**	**2a**	**2b**	**3a**	**3b**	**3c**	**4**	**5**	**6**	**7**
Myoporum platycarpum ssp. *platycarpum*										Yes	Yes
Olearia pimeleoides				Yes							
Oxalis perennans					Yes						Yes
Paspalidium basicladum			Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Pimelea microcephala					Yes						
Pittosporum angustifolium	Yes				Yes					Yes	Yes
Prostanthera wilkieana				Yes							
Psydrax latifolia				Yes							
Ptilotus obovatus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ptilotus polystachyus										Yes	
Ptolotus exaltatus			Yes								
Rhagodia drummondii	Yes	Yes	Yes			Yes	Yes	Yes			Yes
Rhagodia eremaea				Yes				Yes			Yes
Rhagodia sp.			Yes								
Salsola tragus			Yes								
Salvia verbenaca					Yes				Yes		
Santalum spicatum			Yes			Yes				Yes	Yes
Scaevola spinescens	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sclerolaena cuneata			Yes	Yes	Yes				Yes	Yes	Yes
Sclerolaena densiflora		Yes									
Sclerolaena diacantha			Yes	Yes	Yes						
Sclerolaena eriacantha		Yes									
Sclerolaena eurotioides									Yes		
Sclerolaena patenticuspis			Yes		Yes	Yes	Yes		Yes	Yes	Yes
Sclerolaena sp.			Yes		Yes					Yes	
Senna artemisioides	Yes	Yes	Yes				Yes			Yes	Yes
Senna artemisioides ssp. x *artemisioides*											Yes
Senna artemisioides ssp. x *sturtii*			Yes				Yes		Yes		
Senna artemisioides ssp. *filifolia*			Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Sida calyxhymenia			Yes	Yes	Yes	Yes	Yes	Yes			Yes
Sida intricate		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sida sp.			Yes		Yes		Yes				
Sida sp. (S. van Leeuwen 226)			Yes	Yes		Yes			Yes		
Solanum coactiliferum								Yes			
Solanum hoplopetalum									Yes		
Solanum nummularium		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Solunum lasiophyllum	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Solunum orbiculatum ssp. *orbiculatum*					Yes				Yes	Yes	
Spartothamnella teucriflora							Yes	Yes			Yes
Sporobolus actinocladus					Yes						
Tecticornia halocnemoides				Yes	Yes						Yes
Tecticornia sp.			Yes							Yes	
Themda triandra		Yes									
Tripogon loliiformis	Yes	Yes	Yes		Yes		Yes				
Total	16	34	67	42	59	34	37	39	31	64	54

There are four declared species of rare flora (WA Wildlife Conservation Act 1950 – Wildlife Conservation (Rare Flora) Notice 2005) within Murchison and Great Victoria Desert biogeographical regions. Of these, three species (*Conospermum toddii* -Victoria

Desert Smokebush; *Eucalyptus articulata* – Ponton Creek Mallee and *Thryptomene wittweri*) occur in the general vicinity.

No rare species were found during field survey.

None of the species listed in the Commonwealth Department of Environment and Heritage's database of Threatened Species and Threatened Ecological Communities, are known to occur in this area.

Over 150 priority species (species with varying conservation status) have been recorded within the Murchison and Great Victoria Desert IBRAs and 20 of these species have been collected in the general vicinity (Table 7).

Table 7: Declared rare flora and priority flora found in general area.

R Declared Rare Flora – Extant Taxa (= Threatened flora = Endangered + Vulnerable)	
Conospermum toddii (Victoria desert smokebush)	
P1 Priority 1 – Poorly known taxa from one or two populations under threat.	
Eremophila annosocaule	*Tecticornia flabelliformis*
Eremophila eversa	*Tecticornia mellaria*
Grevillea phillipsiana	*Ptilotus tetrandrus*
P2 Priority 2 – Poorly known taxa from one or two populations not all currently under threat	
Micromyrtus serrulata	*Thryptomene eremaea*
Olearia mucronata	
P3 Priority 3 – Poorly known taxa from several populations at least some of which are not under threat	
Acacia eremophila numerous-nerved variant (A.S. George 11924)	*Gunniopsis propinqua*
Calytrix praecipua	*Hybanthus floribundus* subsp. *chloroxanthus*
Eucalyptus pimpiniana	
P4 Priority 4 – Rare taxa not currently under threat	
Eucalyptus kruseana (Bookleaf mallee)	*Hemigenia exilis*
Eucalyptus nigrifunda (Desert wandoo)	*Lepidobolus deserti*
Eucalyptus x brachyphylla	

No priority species were found during field survey.

Fauna

Fauna general

In an assessment of the vertebrate fauna of the nearby Carosue Dam – Safari Bore area, Metcalf and Bamford (2002) concluded that the vertebrate fauna is likely to be typical of the eastern Goldfields. The project area was expected to be moderately rich in reptiles and birds because of the range of landform and vegetation types, but mammalian fauna is likely to be depauperate with an estimated 10 locally extinct species of an original native mammal fauna of about 30 species.

Priority fauna

There are nine species of birds, four mammals and one reptile listed as Threatened Species under the EPBC 1999 act or protected under Western Australian legislation that are likely to occur in the area (Table 8).

Table 8: Threatened species that may occur in the general area listed under EPBC act 1999 and/or afforded protection under Wildlife Conservation Act WA (1950).

Genus	Species	Common name	Status	Schedule	Division	Source	EPBC Act Protection	State protection
Birds								
Falco	*peregrinus*	Peregrin Falcon	SP	4	2	Cowan	No	Yes
Acanthiza	*iredalei iredalei*	Slender-billed thornbill	V	1	2	EPBC	No	Yes
Polytelis	*alexandrae*	Alexandra's parrot	V	1	2	EPBC	No	No
Leipoa	*ocellata*	Malleefowl	V	1	2	EPBC	No	Yes
Merops	*ornatus*	Rainbow Bee-eater	V			EPBC	Yes	No
Ardea	*ibis*	Cattle Egret	M			EPBC	Yes	No
Ardea	*alba*	Great Egret	M			EPBC	Yes	No
Apus	*pacificus*	Fork-tailed Swift	M			EPBC	Yes	No
Charadrius	*veredus*	Oriental plover	M			EPBC	Yes	No
Mammals								
Dasycercus	*cristicauda*	Mulgari	V	1	1	EPBC	No	Yes
Notoryctes	*typhiops*	Southern marsupial mole	E	1	1	EPBC	No	Yes
Macrotis	*lagotis*	Greter bilby	V	1	1	Cowan	No	Yes
Sminthopsis	*psammophila*	Sandhill Dunnart	E			EPBC	No	No
Reptiles								
Egernia	*kintorei*	Great desert skink	V	1	3	EPBC	No	Yes

Status SP: Special protection; V: Vulnerable; E: Endangered; M: Migratory

Four bird species and one crustacean were identified within the Department of Conservation and Land Management Threatened Fauna database as having been collected in the general area over the past 100 years (Table 9).

There have been a few recent sightings of *Falco peregrinus* (peregrine falcon), schedule 4 protected fauna and *Charadrius rubricollis* (hooded plover), priority 1 fauna in the south Laverton area. There have also been recent sightings of *Leipoa ocellata* (mallee fowl) on nearby pastoral leases. Habitat within the Wallbrook survey envelope mostly appears un-suitable for mallee fowl and no nesting sites were found.

Table 9: List of species occurring in the general area in Department of Conservation and Land Management Threatened and Priority Fauna database.

Schedule 1 - Fauna that is rare or is likely to become extinct

Leipoa ocellata Malleefowl *1 record*

This species was once widely distributed across southern Australia. It prefers woodland or shrubland with an abundant litter layer that provides essential material for the construction of its nest mound.

Date	*Certainty*	*Seen*	*Location Name*	*Method*
1908	1	2	Kalgoorlie	Day sighting

Schedule 4 - Other specially protected fauna

Falco peregrinus Peregrine Falcon *4 records*

This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.

1983	1	1	Cardunia Rocks Nature Reserve	Day sighting
1998	1	1	Anaconda	
2004	1	1	Laverton	Day sighting
2004	1	1	Laverton	Day sighting

Priority One: Taxa with few, poorly known populations on threatened lands

Branchinella apophysata Crustacean *1 record*

This species of crustacean is known only from a single location near Mt Margaret. Nothing is known of its habits or ecological requirements.

1937	1		Mount Margaret	Caught or trapped

Priority Four: Taxa in need of monitoring

Charadrius rubricollis Hooded Plover *1 Record*

This species frequents the margins and shallows of salt lakes, also along coastal beaches, where it forages for invertebrates along the water's edge.

2001	1	2	Lake Yindargooda	Day sighting

Amytornis textilis textilis Thick-billed Grass-wren (western ssp) *1 record*

This species inhabits shrubland, preferring the denser vegetation along drainage depressions.

1908	2	1	Kalgoorlie	Day sighting

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Fauna habitat

Fauna refugia in the region include breakaways, rock outcrops, rocky hilltops, drainage lines, dampland areas north of Lake Raeside and salt lakes after heavy rainfall. The Wallbrook survey envelope contains one small breakaway (Land unit 2b) in the north west, extensive granite outcrops and hilltops in the south east (Land unit 1b), extensive

drainage tracts (Land unit 6) and drainage foci (Land unit 7), all of which provide fauna refuge and habitat.

Hydrological summary

This landscape drains internally to isolated groves and drainage foci (land unit 7); to ill-defined flood out areas and some 8km to Lake Rebecca via drainage lines to the south.

Groves and drainage foci are oval or irregular run-on areas, up to 100m, in extent that receive sheet or channelled water flow from adjacent slightly higher surfaces.

CRUSADER ELEVEN BELLS AND REDBROOK CLEARING PROPOSAL

Site

The proposed gold mines at Crusader (Wallbrook 1 and 2), Redflag (Wallbrook 3), Eleven Bells (Wallbrook 4) and Redbrook (Wallbrook 5, 6 and 7) are located centrally in the survey area, approximately 10.5 km south of Porphyry and 1.5 km east of Wallbrook Hill (Map 1). Saracen proposes to develop these mines to provide additional ore for the Carouse Dam treatment plant 35km to the south. Ore will be transported along a purpose-built haul road from Porphyry which passes just east of the proposed mines (Figure 3).

Saracen proposes to clear approximately 82ha for mine pits, waste rock landforms, isolation bunds, ore pads, access roads, site office and machinery hard-stand.

Land units and vegetation

Over 80% of the clearing envelope area, and the majority of the area to be cleared, is Land unit 2a (Low rises and gently sloping plains on volcanic rocks) which supports Calcyphytic pearl bluebush shrublands (CPBS). The remainder of the area to be cleared is within Land unit 3c (Plains on granitic rocks) which supports Sandy granitic acacia shrublands (SGRS).

Drainage and groundwater

The area to be cleared is slightly elevated and mostly drains west towards a significant drainage tract (Land unit 6). This drainage tract eventually discharges to Lake Rebecca.

Ground water table at Eleven Bells is approximately 30-35mbgl and water salinity is approximately 15,000 ppm TDS (Aquaterra preliminary bore hole testing June 2009).

Habitat

Drainage tracts (Land unit 6) and drainage foci (Land unit 7) are significant refugia within the clearing envelope.

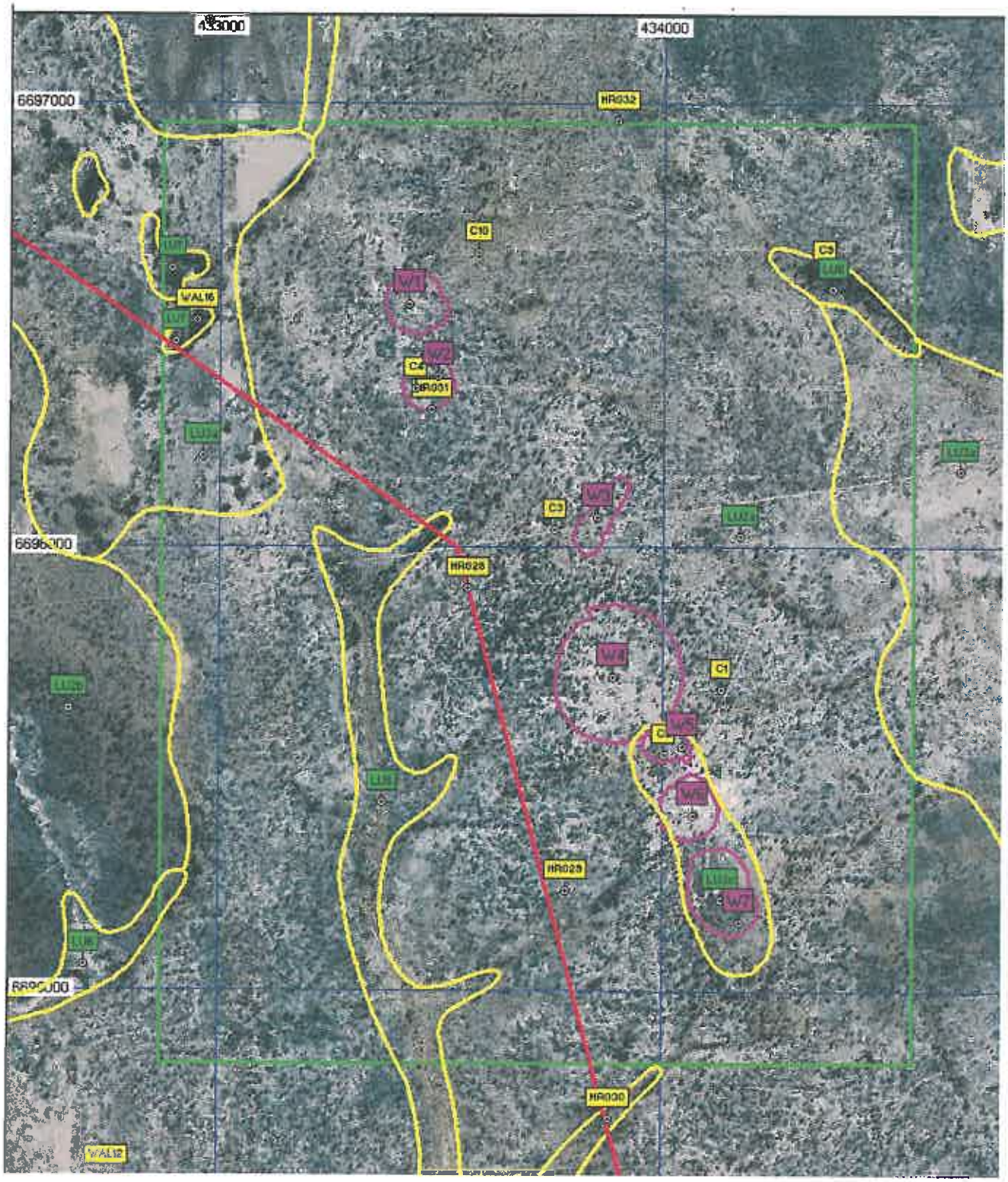


Figure 3: Land units within the clearing envelope for the proposed Eleven Bells and Redbrook mines in the Wallbrook area.

(Note legend on next page.)

Legend for figure 3:

Land units

LU2a:	Low rises and gently sloping plains on volcanic rocks
LU2b:	Low gravelly rises, minor breakaways and gently sloping plains
LU3a:	Stony weakly saline plains
LU3c:	Plains on granitic rocks
LU6:	Drainage lines
LU7:	Groves and drainage foci

Recording sites

WAL02:	Inventory sites
C1:	Vegetation census sites (2009)
HR029:	Vegetation census sites (2006)

Proposed mines:

W1:	Crusader
W2:	Crusader 2
W3:	Redflag
W4:	Eleven Bells (2009-10)
W5:	Redbrook 1 (2009-10)
W6:	Redbrook 2 (2009-10)
W7:	Redbrook 3 (2009-10)

Red line: proposed haul road from Porphyry
Green line: clearing envelope
Yellow line: land unit boundary

ASSESSMENT AGAINST CLEARING PRINCIPLES

Results of this survey are used to assess the area to be cleared against ten clearing principles from the Department of Mines and Petroleum.

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

The survey area is in the north-eastern Goldfields region and in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion, adjacent to Great Victoria Desert bio-geographic region.

Vegetation within the application area is consistent with bluebush and acacia shrublands found throughout the North Eastern Goldfields subregion and is not unusually diverse.

Proposal is not at variance to this principle

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

The Wallbrook survey envelope contains one small breakaway in the north west, extensive granite outcrops and hilltops in the south east, extensive drainage tracts and drainage foci all of which provide fauna refuge and habitat. Two drainage foci and a significant drainage tract occur within the clearing envelope and within 300m of the area to be cleared.

Proposal is potentially at variance to this principle

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

No species of rare or priority flora were found during survey.

The proposal is unlikely to be at variance to this principle.

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

There are no Threatened Ecological Communities (TECs) within the North Eastern Goldfields subregion (Cowan, 2001).

The proposal is not at variance to this principle.

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

About 90% of the area is occupied by Beard Vegetation Association 400 – Succulent steppe with open low woodland and the remainder on the margins by Association 18 - Low woodland; mulga (*Acacia aneura*).

Vegetation Associations 18 and 400 are extensive (1,268,000 km^2 and 192,000 km^2 respectively) within the North Eastern Goldfields region. While these vegetation types have been extensively grazed in the region, most remain uncleared and intact.

Proposal is not at variance to this principle.

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

This landscape drains internally to isolated groves and drainage foci (land unit 7); to ill-defined flood out areas and some 8km to Lake Rebecca via drainage lines to the south.

Groves and drainage foci are oval or irregular run-on areas, up to 100m, in extent that receive sheet or channelled water flow from adjacent slightly higher surfaces.

Proposal is potentially at variance with this principle.

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

The survey area is part of a pastoral lease and has been grazed over many years and vegetation is mostly in good to fair condition. Soil erosion, noted in land unit 2a was mostly minor sheeting. More severe erosion was noted in stony weakly saline plains (land unit 3a) and along drainage lines (land unit 6). These units are mostly within Gundockerta land system which is vulnerable to soil erosion particularly when soil surfaces are disturbed (Pringle, Van Vreeswyk & Gilligan, 1994).

Water table within the clearing envelope is saline (c 15,000 ppm) and at 30 -35 mbgl is well below the rooting depth of vegetation growing on this site. Clearing of vegetation will have minimal, if any, effect on water tables and associated risk of secondary salinity.

Proposal is potentially at variance with this principle in respect of soil erosion .

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

The closest conservation area is Goongarrie National Park, about 60 km north west of the project area.

Proposal is not at variance with this principle.

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

This landscape drains internally to isolated groves and drainage foci; to ill-defined flood out areas and some 8km to Lake Rebecca via drainage tracts to the south. Disturbance to drainage tracts and associated alluvial and saline plains may increase the sediment load to Lake Rebecca.

The climate is arid to semi-arid with 230 mm of annual rainfall and annual evaporation rates are about 2800 mm. Recharge to groundwater is limited to years of extreme rainfall.

The proposal is unlikely to impact groundwater or reduce quality of surface water.

Proposal maybe at variance with this principle.

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

The climate is arid to semi-arid with about 230 mm of annual rainfall. Rain falls on an average of 43 days a year.

Most rainfall events will cause little runoff, however extreme rainfall events such as those recorded in summers of 1984 and 1967 will result in significant runoff.

Drainage is via overland flow to minor drainage tracts which discharge into Lake Rebecca a large playa lake of 268 km^2 with a catchment of 2,488 km^2 (Aquaterra 2007). Saline lakes in the northern Goldfields are likely to flood to a depth of 2-5cm every year, to a depth of 10 cm roughly every 5 years and to a 'biologically significant' depth of 20 cm once every 10 years (actis 2008)..

Clearing in this proposal will have negligible effect on the volume of discharge to Lake Rebecca.

Proposal is unlikely to be at variance with this principle.

DISCUSSION AND RECOMMENDATIONS

The Wallbrook survey area is located within the north-eastern Goldfields region and in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion, adjacent to Great Victoria Desert bio-geographic region.

Vegetation within the application area is consistent with bluebush and acacia shrublands found throughout the North Eastern Goldfields subregion and is not unusually diverse.

There are no known threatened ecological communities or wetlands of national significance or sub-regional significance in the area.

One hundred and thirty five flora species were found during field surveys in November 2006 and March 2009. No rare or priority species were found.

The Wallbrook survey area contains one small breakaway in the north west, extensive granite outcrops and hilltops in the south east, extensive drainage tracts and drainage foci, all of which provide fauna refuge and habitat.

Wallbrook is part of a pastoral lease and has been grazed over many years. Vegetation is mostly in fair to good condition.

Gundockerta land system, which occurs on over 80% of the survey area, is vulnerable to soil erosion which is evident on Stony weakly saline plains (Land unit 3a) and Drainage tracts (Land unit 6).

Drainage is via overland flow to drainage tracts which discharge into Lake Rebecca, a large playa lake to the west.

It is recommended that, in mining and exploration activity within this area, the proponent:

1. **Minimises disturbance to fauna habitat within breakaways, granite outcrops and hilltops in the south east, drainage tracts and drainage foci.**

2. **Minimises disturbance to erodible landscapes along drainage tracts and associated alluvial and saline plains otherwise installs erosion control where necessary.**

REFERENCES

Actis Environmental Services (2008). Discharge from the Porphyry Mine to Lake Rebecca: Modelled impact to Lake Rebecca. Report for Saracen Gold Mines

Allen, A.D. (1994). Hydrogeology. In An inventory and condition survey of rangelands in the north-eastern Goldfields, Western Australia (eds K.M.W. Howes), pp. 36-58. Department of Agriculture, Perth Western Australia.

Alexander Holm & Associates. (2006) Environmental Impact Assessment and Environmental Management Commitments and Procedures. Report for Saracen Gold Mines Pty Ltd, Perth, Western Australia.

Anon (2007) Supporting information for clearing permit applications associated with re-opening of the Porphyry mine site: Saracen Gold Mines June 2007

Aquaterra Consulting Pty Ltd. (2007) Porphyry Pit Development: Surface Water Management. Prepared for Saracen Gold Mines Pty Ltd, Perth, Western Australia.

Beard, J. S. 1990. Plant Life of Western Australia. Kangaroo Press, Kenthurst, NSW.

Cowan, M. (2001). Murchison 1 (MUR1 - East Murchison subregion). In A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002 (eds N.L. McKenzie & J.E. May), pp. 466-479. The Department of Conservation and Land Management, Perth.

Curry, P.J., Payne, A.L., Leighton, K.A., Hennig, P. & Blood, D.A. (1994) *An Inventory and Condition Survey of the Murchison River Catchment, Western Australia.* Department of Agriculture. Technical Bulletin 84. pp 430.

EPA. (2002) *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3.* Environmental Protection Authority.

Gentilli, J. (1979) Western Landscapes University of Western Australia Press, Perth Western Australia.

Metcalf, B. & Bamford, M. (2002) Vertebrate fauna of the proposed Carosue Dam - Safari haul road. Report for Sons of Gwalia Ltd. M.J. and A.R. Bamford Consulting Ecologists Payne, Mitchell & Hennig, 1998.

Payne, A. L., A. A. Mitchell, and P. Hennig. 1998. *Land systems of the Kambalda area and surrounds. A report prepared for Western Mining Corporation Resources Ltd.* Agriculture Western Australia, Perth.

Pringle, H.J.R., Van Vreeswyk, A.M.E. & Gilligan, S.A. (1994) *An Inventory and Condition Survey of Rangelands in the North-eastern Goldfields, Western Australia.* Department of Agriculture. Technical Bulletin 87. pp 323.

Disclaimer

While Alexander Holm & Associates has carried out some enquiries concerning data, assumptions and information supplied to it, those enquiries were limited and Alexander Holm & Associates does not accept responsibility for their accuracy. Accordingly, Alexander Holm & Associates does not accept any legal responsibility to any person, organisation or company for any loss or damage suffered by them resulting from their use of the report however caused, and whether by breach of contract, negligence or otherwise

Within the limitation imposed by the scope of review, the data assessment and preparation of the report have been undertaken in a professional manner and in accordance with generally accepted practices using a degree of care ordinarily exercised by professional environmental consultants. No other warranty, expressed or implied, is made.

ATTACHMENTS

Attachment 1: Australian Government Department of Environment Heritage and Arts Protected matters search tool output

Australian Government
Department of the Environment, Water, Heritage and the Arts



Protected Matters Search Tool

You are here: Environment Home > EPBC Act > Search

29 April 2009 14:05

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html



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

Search Type: Point

Buffer: 50 km

Coordinates: -29.86944,122.3166



Report Contents:

Summary
Details
- Matters of NES
- Other matters protected by the EPBC Act
- Extra Information

Caveat
Acknowledgments

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	4
Migratory Species:	5

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.
Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Places on the RNE:	None
Listed Marine Species:	3
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Acanthiza iredalei iredalei Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Plants		
Gastrolobium graniticum Granite Poison	Endangered	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Leipoa ocellata Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus	Migratory	Species or species habitat may

Rainbow Bee-eater		occur within area

Migratory Wetland Species

Birds

Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a

referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

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

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia

- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

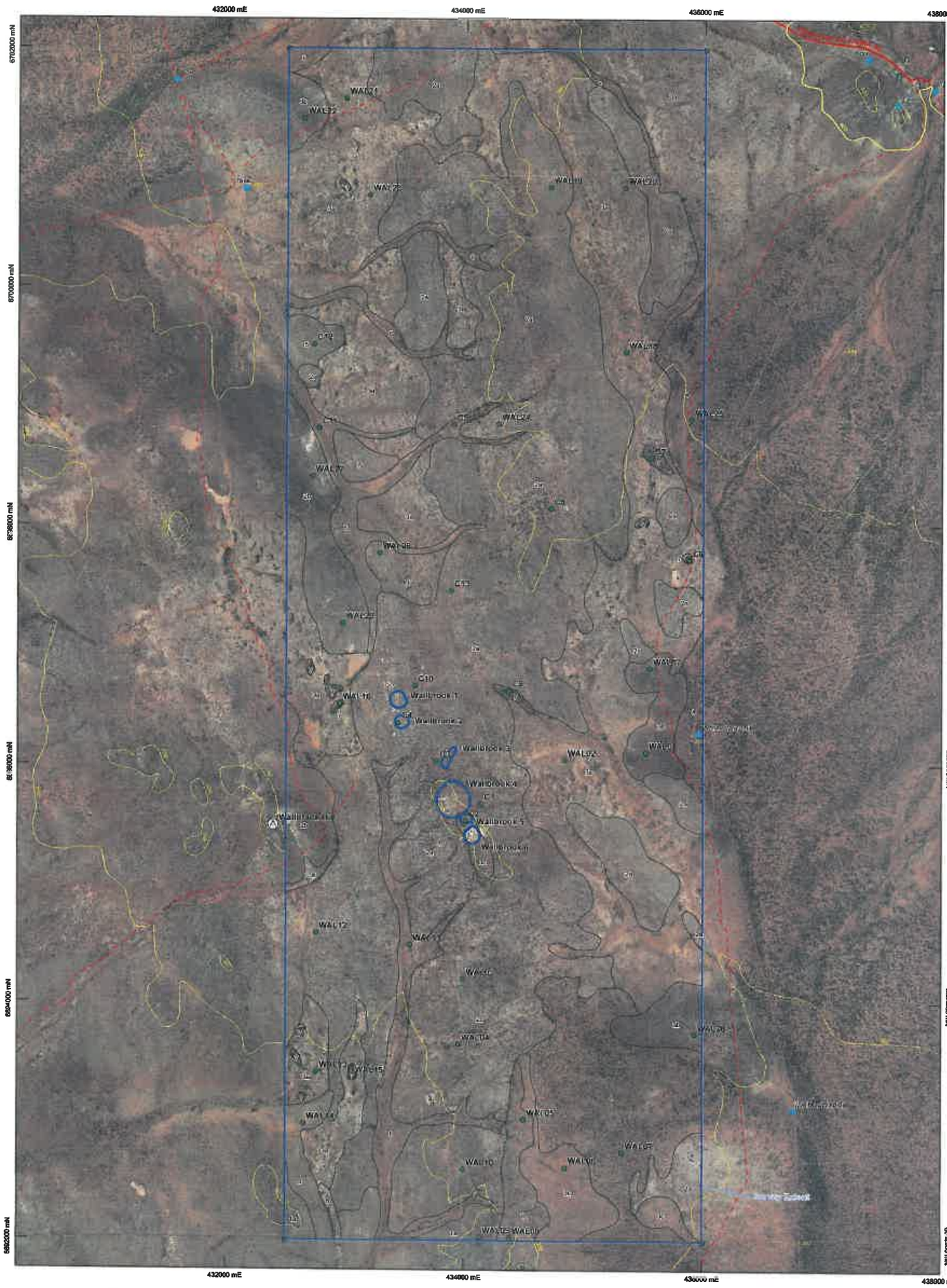
ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Accessibility | Disclaimer | Privacy | © Commonwealth of Australia 2004

Last updated: Thursday, 20-Nov-2008 14:17:56 EST

Department of the Environment, Water, Heritage and the Arts
GPO Box 787 Canberra ACT 2601 Australia
Telephone: +61 (0)2 6274 1111

© Commonwealth of Australia 2004



Location Map



Legend

Unit 1a	Low hills on basalt
Unit 1b	Low hills and rises on granitic rocks
Unit 2a	Low rises and gently sloping plains on volcanic rocks
Unit 2b	Low gravelly rises, minor breakaways and gently sloping plains
Unit 3a	Stony, weakly saline plains
Unit 3b	Gravelly plains
Unit 3c	Plains on granitic rocks
Unit 4	Hardpan plains
Unit 5	Alluvial plains
Unit 6	Drainage lines
Unit 7	Groves and drainage foci
⊙ **WAL27**	Inventory site
⊙ **C13**	Vegetation audit site

PROJECT:	**WALLBROOK HILL PROJECT**
PROSPECT:	W.A.

Wallbrook Hill Area
Showing
Land units

1 : 20,000

0 200 400 800 1200 1600 metres

Projection: GDA94 zone 51	
Compiled by: Alec Holm & Alan Payne	Date: June 2009
Scale: 1:20,000 Drawn: Ellis Drafting & Graphics	Date: 17 June 2009
	Plan No: