



# **Northern Star Resources Limited**

## **Carouse Dam TSF Cell 4 Project**

### **Referral Documentation**

EPBC Act Referral: 2021/9026

26 August 2021

Contact:  
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Environmental Superintendent  
Northern Star Resources Limited  
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# EPBC Act referral



Australian Government

Department of Agriculture, Water and the Environment

Note: PDF may contain fields not relevant to your application. These fields will appear blank or unticked. Please disregard these fields.

<b>Title of proposal</b>	<b>2021/9026 - Northern Star Resources - Carosue Dam TSF Cell 4</b>
<b>Section 1</b>	
<b>Summary of your proposed action</b>	
<b>1.1 Project industry type</b>	Mining
<b>1.2 Provide a detailed description of the proposed action, including all proposed activities</b>	
<p>Northern Star (Carosue Dam) Pty Ltd (Northern Star) proposes to expand the Tailings Storage Facility (TSF) at the Carosue Dam Operations with the construction of TSF Cell 4 and associated infrastructure. The Carosue Dam Project is located approximately 110km north-east of Kalgoorlie in the Pinjin region of the Eastern Goldfields. Carosue Dam was previously owned by Saracen Gold Mines Pty Ltd; however, in February 2021, a merger of equals between Northern Star Resources and Saracen Mineral Holdings was completed. Northern Star (Carosue Dam) Pty Ltd is a wholly owned subsidiary of ASX listed company Northern Star Resources Limited. In order to continue processing operations into the future, Northern Star is working on a 10-year TSF permitting design, which includes the construction of an additional cell adjacent to the existing TSF. The project occurs on existing mining tenure (M28/269 &amp; M31/295) and will involve 241ha of vegetation clearing of which 90ha is considered suitable Malleefowl habitat.</p> <p>The project has been referred under the EPBC Act 1999 as the development will involve the removal of Malleefowl (<i>Leipoa ocellata</i>) mounds within the disturbance footprint. Northern Star engaged a fauna consultant to critically assess the impacts of the proposed development on Malleefowl within and adjacent to the clearing envelope. This report has been attached as a supporting document. The survey determined that of the 10 mounds that were likely to be cleared due to the development, only three were classified as recently active but unoccupied. All other mounds were considered abandoned or failed. All mounds surveyed are not currently active, including additional mounds that were located outside the the proposed development area. The specialist report assessed the proposed development against the EPBC's significant impact criteria for the Malleefowl and determine that this activity and the removal of unoccupied mounds within the disturbance footprint, would not have a significant impact on the species. Northern Star is committed to conducting clearing of mounds outside of nesting season to ensure mounds remain unoccupied at the time, preventing any potential impacts to individuals of this species.</p>	
<b>1.3 What is the extent and location of your proposed action?</b>	
See Appendix B	
<b>1.5 Provide a brief physical description of the property on which the proposed action will take place and the location of the proposed action (e.g. proximity to major towns, or for off-shore actions, shortest distance to mainland)</b>	
<p>The proposed TSF expansion and associated infrastructure is located adjacent to the existing tailings storage facility and will abut the western side of the existing wall on mining lease M28/269 &amp; M31/295. The development is located 2.8km north west of the Carosue Dam processing plant. Carosue Dam is located approximately 110km north east of Kalgoorlie-Boulder in the Goldfields region of Western Australia. The nearest residents to Carosue Dam are located at Pinjin Station, approximately 40km east of the project site. The underlying tenure is mainly pastoral lease (Pinjin Station) and a small area of Vacant Crown Land (VCL).</p>	
<b>1.6 What is the size of the proposed action area development footprint (or work area) including disturbance footprint and avoidance footprint (if relevant)?</b>	
<p>The action area development footprint is 273.4ha. Within this boundary, 241ha of native vegetation clearing will be required for the development of TSF Cell 4 and associated infrastructure including roads, topsoil stockpiles, diversions, construction laydown and access.</p>	
<b>1.7 Proposed action location</b>	
Lot - The location of the proposed action is at the Carosue Dam Gold Mine on mining tenements M28/269 & M	
<b>1.8 Primary jurisdiction</b>	Western Australia
<b>1.9 Has the person proposing to take the action received any Australian Government grant funding to undertake this project?</b>	
<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	



Note: PDF may contain fields not relevant to your application. These fields will appear blank or unticked. Please disregard these fields.

**1.10 Is the proposed action subject to local government planning approval?**

☐ Yes ☒ No

**1.11 Provide an estimated start and estimated end date for the proposed action**

Start Date 17/07/2022  
End Date 31/07/2022

**1.12 Provide details of the context, planning framework and state and/or local Government requirements**

The development of the TSF expansion and associated infrastructure will require approval under state legislation, including amendment of the existing Native Vegetation Clearing Permit (NVCP) under section 51E of the Environmental Protection Act 1986, a Works Approval and licence amendment under Part V of the Environmental Protection Act 1986, as well as development approval under the Mining Act 1978. Northern Star has referred the proposal under the EPBC Act due to the presence of Malleefowl in the area (listed as Vulnerable under the EPBC Act (1999) and Vulnerable under the Biodiversity Conservation Act (2016)). With regards to the NVCP, a clearing permit exists over the area with a condition that prevents direct impacts to the malleefowl nests. An amendment to this clearing permit is being sought to remove this condition.

**1.13 Describe any public consultation that has been, is being or will be undertaken, including with Indigenous stakeholders**

Northern Star consults with relevant stakeholders including the underlying pastoral holders, relevant traditional owner groups, as well as State and local government departments. Northern Star keeps a stakeholder consultation register (Att 2-Stakeholder register\_Confidential).

Relevant applications will be submitted to WA Department of Mines, Industry Regulation and Safety, and WA Department of Water and Environmental Regulation for project approval under State legislation.

**1.14 Describe any environmental impact assessments that have been or will be carried out under Commonwealth, State or Territory legislation including relevant impacts of the project**

In order to support proposed development in the area, there have been a number of flora and fauna surveys conducted over the proposed disturbance footprint and in adjacent surrounding areas. Due to the presence of Malleefowl in the area, Northern Star commissioned targeted surveys of the proposed development area to critically assess the potential impacts to the species. This assessment determined that the proposal would not have a significant impact on a species of conservation significance. Supporting documentation is attached to this referral (Att 3-Malleefowl Impact Assessment\_2021, pp8-9).

Comprehensive archaeological and ethnographic heritage surveys have been conducted with relevant traditional owner groups for the proposed development of TSF Cell 4 and associated infrastructure. Previous surveys have also been conducted in the wider mining area. Surveys are submitted to Department of Planning Lands & Heritage.

**1.15 Is this action part of a staged development (or a component of a larger project)?**

☐ Yes ☒ No

**1.16 Is the proposed action related to other actions or proposals in the region?**

☒ Yes ☐ No

**1.16.1 Identify the nature/scope and location of the related action (Including under the relevant legislation)**

This proposal is related to the current mining and processing operations at Carosue Dam Gold Mine.



Note: PDF may contain fields not relevant to your application. These fields will appear blank or unticked. Please disregard these fields.

## Section 2

### Matters of national environmental significance

2.1 Is the proposed action likely to have any direct or indirect impact on the values of any World Heritage properties?

☐ Yes ☒ No

2.2 Is the proposed action likely to have any direct or indirect impact on the values of any National Heritage places?

☐ Yes ☒ No

2.3 Is the proposed action likely to have any direct or indirect impact on the ecological character of a Ramsar wetland?

☐ Yes ☒ No

2.4 Is the proposed action likely to have any direct or indirect impact on the members of any listed species or any threatened ecological community, or their habitat?

☒ Yes ☐ No

### Species or threatened ecological community

Malleefowl (*Leipoa ocellata*)

### Impact

A survey of the disturbance footprint was conducted in 2021 to identify and assess impacts of clearing native vegetation in the area (Att 3-TSF Environmental Assessment\_2021, pp 15-18). The clearing 90ha of preferred Malleefowl habitat including the removal of several unoccupied mounds within the development footprint. Specialist fauna consultants assessed the potential impact of the project against the significance criteria for vulnerable species and determined this proposal would not have a significant impact on the species. This was due to the extensive range of suitable habitat in the surrounding areas and through the region, as well as the determination that no mounds were currently active (Att 4-Malleefowl Impact Assessment\_2021, pp 1-9). Any clearing impacting mounds within the development footprint will be undertaken outside of nesting season to prevent any impacts to individuals of the species.

2.4.2 Do you consider this impact to be significant?

☐ Yes ☒ No

2.5 Is the proposed action likely to have any direct or indirect impact on the members of any listed migratory species or their habitat?

☐ Yes ☒ No

2.6 Is the proposed action to be undertaken in a marine environment (outside Commonwealth marine areas)?

☐ Yes ☒ No

2.7 Is the proposed action likely to be taken on or near Commonwealth land?

☐ Yes ☒ No

2.8 Is the proposed action taking place in the Great Barrier Reef Marine Park?

☐ Yes ☒ No

2.9 Is the proposed action likely to have any direct or indirect impact on a water resource from coal seam gas or large coal mining development?

☐ Yes ☒ No

2.10 Is the proposed action a nuclear action?

☐ Yes ☒ No

2.11 Is the proposed action to be taken by a Commonwealth agency?

☐ Yes ☒ No





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**2.12 Is the proposed action to be undertaken in a Commonwealth Heritage place overseas?**

☐ Yes ☒ No

**2.13 Is the proposed action likely to have any direct or indirect impact on any part of the environment in the Commonwealth marine area?**

☐ Yes ☒ No



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## Section 3

### Description of the project area

#### 3.1 Describe the flora and fauna relevant to the project area

The region lies within the Eremaean botanical province near the southern boundary of the Austin botanical district (Beard, 1990). The Eremaean Botanical Province is typified by plants from the families Fabaceae (*Acacia* spp., *Senna* spp.), Scrophulariaceae (*Eremophila* spp.), Chenopodiaceae (Samphires, Bluebushes, Saltbushes), Asteraceae (Daisies) and Poaceae (grasses). The Austin Botanical District is essentially the Mulga (*Acacia aneura*) region of Western Australia. *Acacia aneura* is a dominant or a significant component in most plant communities in this District. The region is often rich in ephemerals, which reduce to scrub on hills. The Austin Botanical District is also characterised by hummock grasslands, saltbush shrublands and *Tecticornia* shrublands (Beard, 1990; Cowan 2001).

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 pauper* (black oak) and *Eucalyptus* species 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 palaeodrainage 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 understories.

Vegetation of the Carosue Dam area consists of low open *Eucalyptus* woodland over *Acacia* and other mixed shrubs to *Casuarina* and *Acacia* woodland. Toward Lake Rebecca, the vegetation becomes more halophytic and the overstory disappears, leaving low halophytic shrubs with occasional sandy banks and drainage zones, which support a wide range of species. A number of flora and vegetation surveys have been undertaken throughout the Carosue Dam Project area.

There are no identified threatened ecological communities (TECs) in the entire MUR1 biogeographic subregion (Cowan, 2001). There are no listed priority ecological communities (PECs) in the area.

One hundred and thirty six flora taxa representing 25 families were found during field survey in 2012. Chenopodiaceae accounted for 23 taxa, Fabaceae and Myrtaceae 19 taxa each and Scrophulariaceae 15 taxa (Att 5-TSF Flora Study\_2012, pp. 25).

Flora composition and vegetation associations within the survey envelope are typical of the region and not unusually diverse. No threatened (rare) or endangered flora taxa were found during reconnaissance or targeted surveys. *Eremophila arachnoides* subsp. *tenera* (P3) is widespread in the survey area. No plants were found outside the distribution boundary established in the 2019 survey (Att 6-Seismic Environmental Assessment\_2019, pp. 45 & Att 3-TSF Environmental Assessment\_2021, pp 1).

Major fauna habitats and other notable landscape features were identified throughout the Carosue Dam region. These consisted of undulating plains, low rocky hills and breakaways, broad drainage systems, often supporting *Eucalypts*, sandy soils supporting Mallee over Spinifex, a range of shrublands often dominated by *Acacia* species and the Lake Rebecca salt lake system.

While malleefowl are known to have been active in the survey area there was little evidence of current activity possibly due to the prevailing drought. There were no sightings of birds, tracks or significant litter disturbance. Nineteen malleefowl mounds were found during this survey plus two relocated from the 2012 survey (Att 5-TSF Flora Study\_2012, pp. 31, Att 6-Seismic Environmental Assessment\_2019, pp. 39-40 & Att 3-TSF Environmental Assessment\_2021, pp 1).

Numerous surveys have been conducted in the wider Carosue Dam Region. Malleefowl have been sighted and/or nesting mounds located throughout most of the tenements associated with Carosue Dam operations from around Deep South 70km north of the TSF (Att 7-DeepSouth Survey\_2011, pp 28), 10km to the east (Att 8-Relief Hill Survey\_2020, pp 2) and 6km SW (Att 9-Airstrip Malleefowl Survey\_2017, pp 3-4).

#### 3.2 Describe the hydrology relevant to the project area (including water flows)

The terrain of the north-eastern Goldfields is generally flat to gently undulating, relatively low lying and covered mainly by thin superficial soils and occasionally by low hills of bedrock. It is traversed in an east-south-easterly direction by broad saline palaeodrainages of which the closest to the Carosue Dam Project area is Lake Rebecca, lies approximately 10km north-east of the proposed development. The lake receives surface drainage from the surrounding country and very occasionally fills.

There are no nationally significant wetlands in the area. Lake Rebecca is a major wetland with local and regional significance. There are no defined drainage channels, playas or other wetlands in the survey area and no riparian vegetation is at risk.



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**3.3 Describe the soil and vegetation characteristics relevant to the project area**

Approximately 60% of the TSF survey area is occupied by either alluvial plains supporting halophytic low shrubland or plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Sand plains and sandy rises occupy 22% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or metamorphic rocks occupy the remainder (Att 5-TSF Flora Study\_2012, pp22). 'Sandplain spinifex hummock grassland' (SASP) occupies most of the elevated southwestern portion of the survey area. Other elevated land units on basalt, metamorphic rocks and laterite are mostly occupied by 'Calcareous casuarina acacia shrubland or woodland' (CCAS) except when bluebush (*Maireana* species) occurs where the landscape is in better condition, in which case the vegetation type is 'calcyphytic pearl bluebush shrublands' (CPBS). CCAS vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands either with casuarina and eucalypt woodlands (PECW) or without (PXHS) (Att 5-TSF Flora Study\_2012, pp22).

**3.4 Describe any outstanding natural features and/or any other important or unique values relevant to the project area**

There are no outstanding natural features and/or any other important or unique values relevant to the project area.

**3.5 Describe the status of native vegetation relevant to the project area**

The survey area has been disturbed by recent and historic mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks, cut lines and pastoral fences cross the area. Large tracts of the vegetation are degraded, some totally degraded. Spinifex communities (SASP) on sandplains and sandy rises are not suitable for grazing and are in pristine condition. Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands and this land unit is rated moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerability to soil erosion and small areas on these units are slightly eroded.

**3.6 Describe the gradient (or depth range if action is to be taken in a marine area) relevant to the project area**

The Carosue Dam Project lies in a valley bounded by Lake Rebecca to the northeast and small hills and ranges of the Mulgabbie area to the east. The valley transitions into Lake Rebecca to the south. Breakaways and hills of underlying bedrock occur to the west and give way to extensive sand plains overlying granites further to the west.

**3.7 Describe the current condition of the environment relevant to the project area**

Please see section 3.5 for the vegetation and soil condition. There have been sightings of wild dogs and goats in the vicinity of the area. Weed species are minimal, however there is a known population of Tobacco Weed (*Nicotiana glauca*) located south of the Carosue Dam Tailings Storage Facility (TSF). Northern Star have procedures that include the management of weed species and feral animals on site. All sightings are reported to the Carosue Dam HSEC Department and recorded.

**3.8 Describe any Commonwealth Heritage places or other places recognised as having heritage values relevant to the project**

There are no Commonwealth Heritage places or other places recognised as having heritage values relevant to the project area.

**3.9 Describe any Indigenous heritage values relevant to the project area**

A search of Department of Planning Lands and Heritage Aboriginal Heritage Inquiry System determined there are no registered Aboriginal Heritage Sites or other sites of significance on M28/269 & M31/295. Numerous archaeological and ethnographic surveys have been completed throughout the Carosue Dam area. In August 2021, heritage surveys were conducted over the project area with relevant traditional owner groups. If any heritage sites are identified by this survey, appropriate approvals under relevant legislation will be sought in consultation with the traditional owners.

**3.10 Describe the tenure of the action area (e.g. freehold, leasehold) relevant to the project area**

The TSF Cell 4 and associated infrastructure will be located on M28/269 & M31/295. The underlying tenure is mainly pastoral lease (Pinjin Pastoral Station) and a small area of Vacant Crown Land (VCL).

**3.11 Describe any existing or any proposed uses relevant to the project area**

The current use of the project area is for activities relating to mining and processing.



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## Section 4

### Measures to avoid or reduce impacts

#### 4.1 Describe the measures you will undertake to avoid or reduce impact from your proposed action

Clearing will be limited to only that necessary for the construction of TSF Cell 4 and associated infrastructure relating to the project and will occur outside of the malleefowl breeding season. Necessary approvals for the project will be gained under state legislation which will highlight all environmental risks and mitigation measures associated with the project, as well as environmental objectives and performance criteria. Clearing will be conducted in accordance with the Carosue Dam Clearing Management Safe Work Procedure (Att 10-Clearing Management).

Earthworks will be planned and managed closely to minimise erosion.

To ensure that vegetation clearing will be controlled and monitored, no clearing will occur without a site clearing activity permit authorised by the site environmental representative and department manager.

The area to be cleared will be surveyed and pegged prior to commencement of clearing to ensure only the approved area is cleared.

#### 4.2 For matters protected by the EPBC Act that may be affected by the proposed action, describe the proposed environmental outcomes to be achieved

The malleefowl mounds that will be impacted by clearing activities for the development of the project are currently unoccupied or abandoned. Malleefowl nesting season runs between September and February, therefore clearing for the project will not take place during these months to ensure there is no risk of adversely impacting any individuals.

Assessment of the proposed development by external fauna consultants determined impacts to Malleefowl are not considered to be significant. Immediately prior to clearing, the area will be inspected to ensure no malleefowl are present.



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## Section 5

### Conclusion on the likelihood of significant impacts

#### 5.1 You indicated the below ticked items to be of significant impact and therefore you consider the action to be a controlled action

- ☐ World Heritage properties
- ☐ National Heritage places
- ☐ Wetlands of international importance (declared Ramsar wetlands)
- ☐ Listed threatened species or any threatened ecological community
- ☐ Listed migratory species
- ☐ Marine environment outside Commonwealth marine areas
- ☐ Protection of the environment from actions involving Commonwealth land
- ☐ Great Barrier Reef Marine Park
- ☐ A water resource, in relation to coal seam gas development and large coal mining development
- ☐ Protection of the environment from nuclear actions
- ☐ Protection of the environment from Commonwealth actions
- ☐ Commonwealth Heritage places overseas
- ☐ Commonwealth marine areas

#### 5.2 If no significant matters are identified, provide the key reasons why you think the proposed action is not likely to have a significant impact on a matter protected under the EPBC Act and therefore not a controlled action

Malleefowl are part of a widely-dispersed population of unknown extent. Malleefowl have been sighted and/or nesting mounds located throughout most of the tenements associated with Carosue Dam operations from around Deep South 70km north of the TSF (Att 7-DeepSouth Survey\_2011, pp 28), 10km to the east (Att 8-Relief Hill Survey\_2020, pp 2) and 6km SW (Att 9-Airstrip Malleefowl Survey\_2017, pp 3-4). Records of malleefowl extend in all directions beyond these locations as recorded by Department of Biodiversity, Conservation & Attractions (DBCA). Destruction of three currently unoccupied nesting mounds through expansion of the TSF will have minimal impact on the size of the malleefowl population in this region as there is extensive habitat in adjacent areas for malleefowl use in subsequent breeding seasons.

Of the 12 nesting mounds affected by the proposed development, destruction of eight abandoned and failed mounds will have no negative impacts on malleefowl. The remaining four nesting mounds have been used in recent years but are currently unoccupied and there is no evidence of malleefowl in the development area. Three of these unoccupied nesting mounds will be destroyed through clearing and one other is within 55m of the proposed haul road.

Destruction of three unoccupied malleefowl nesting mounds is unlikely to have a significant effect on a matter of national environmental significance, being populations of "vulnerable" malleefowl, due to the extensive habitat available in areas adjacent to the proposed development, and therefore does not warrant referral to the Australian Government Department of the Environment. Similarly, the proposed clearing is not considered to be "taking or disturbing" threatened fauna and therefore does not trigger the requirement for authorisation from the Western Australian Minister for Environment.

A detailed assessment of the potential impacts to malleefowl, utilising the Significant Impact Guidelines 1.1, was undertaken by a fauna specialist and is provided with this referral. Based on the guidelines, it was concluded the project would not have a significant impact on the species (Att 4-Malleefowl Impact Assessment\_2021, pp. 5-9).



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## Section 6

### Environmental record of the person proposing to take the action

#### 6.1 Does the person taking the action have a satisfactory record of responsible environmental management? Explain in further detail

Northern Star (Carosue Dam) Pty Ltd, previously Saracen Gold Mines Pty Ltd, have had a satisfactory record of responsible environmental management. Since commencement of operation at Carosue Dam in 2006 the company has maintained high environmental standards in line with current best practice guidelines and have maintained compliance with local, state and federal legislation. Audits by the State Departments have not revealed any major environmental issues and all minor issues raised have been rectified in a timely fashion. Northern Star has stringent policies, procedures and management plans to ensure that matters of environmental significance are safeguarded and managed professionally.

#### 6.2 Provide details of any past or present proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against either (a) the person proposing to take the action or, (b) if a permit has been applied for in relation to the action – the person making the application

There are not any past or present proceedings against either the person proposing the action or the person making the application.

#### 6.3 If it is a corporation undertaking the action will the action be taken in accordance with the corporation's environmental policy and framework?

☒ Yes ☐ No

#### 6.3.1 If the person taking the action is a corporation, provide details of the corporation's environmental policy and planning framework

Please see attached Clearing Management Safe Work Procedure (Att 10-Clearing Management) and Northern Star's Environmental Policy (Att 11- Environmental Policy).

#### 6.4 Has the person taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?

☒ Yes ☐ No

#### 6.4.1 EPBC Act No and/or Name of Proposal

A referral was made by Saracen Gold Mines Pty Ltd, to the clear native vegetation for the Carosue Dam Aerodrome Project in 2017, due to the impacts to two malleefowl mounds in the development area. The referral decision determined that the proposal was 'Not a controlled action' (EPBC Act referral 2017/7925).



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<b>Section 7</b>
<b>Information sources</b>
<b>Reference source</b>
Beard, J. S. (1990). Plant Life of Western Australia. Kangaroo Press, Kenthurst, NSW.
<b>Reliability</b>
Excellent
<b>Uncertainties</b>
None
<b>Reference source</b>
Cowan, M. (2001). Murchison 1 (MUR1 - East Murchison subregion). Pp 466-479 in N. L. McKenzie and J. E. May, (ed.) A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002. Department of Conservation and Land Management, Perth, Western Australia.
<b>Reliability</b>
Excellent
<b>Uncertainties</b>
None



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## Section 8

### Proposed alternatives

Do you have any feasible alternatives to taking the proposed action?

Yes



No





Note: PDF may contain fields not relevant to your application. These fields will appear blank or unticked. Please disregard these fields.

## Section 9

### Person proposing the action

9.1.1 Is the person proposing the action an organisation or business?

☒ Yes ☐ No

#### Organisation

Organisation name (as registered for ABN/ACN) NORTHERN STAR (CAROSUE DAM) PTY LTD

Business name

ABN 14116649122

ACN

Business address 388 Hay St, Subiaco, 6008, WA, Australia

Postal address

Main Phone number (08) 6188 2100

Fax

Primary email address CDOEnviro@nsrltd.com

Secondary email address

9.1.2 I qualify for exemption from fees under Regulation 5.23(1)(ii) of the EPBC Regulations because I am:

☐ Small business  
☒ Not applicable

9.1.2.2 I would like to apply for a waiver of full or partial fees under Regulation 5.21A of the EPBC Regulations

☐ Yes ☒ No

9.1.3 Contact (for an organisation - the contact details of the person authorised to sign on behalf of the organisation)

First name Robert  
Last name Williamson  
Job title General Manager - Carosue Dam Operations  
Phone (08) 6229 9500  
Mobile  
Fax  
Email CDOEnviro@nsrltd.com  
Primary address 388 Hay St, Subiaco, 6008, WA, Australia  
Address

Declaration: Person proposing the action (To be signed by the person at 9.1.3)

I, Rob Williamson, declare that to the best of my knowledge the information I have given on, or attached to the EPBC Act Referral is complete, current and correct. I understand that giving false or misleading information is a serious offence. I declare that I am not taking the action on behalf or for the benefit of any other person or entity.

Signature: R. Williamson Date: 26/08/2021

I, \_\_\_\_\_, the person proposing the action, consent to the designation of \_\_\_\_\_ as the proponent for the purposes of the action described in this EPBC Act Referral.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_



Note: PDF may contain fields not relevant to your application. These fields will appear blank or unticked. Please disregard these fields.

## Proposed designated proponent

### 9.2.1 Is the proposed designated proponent an organisation or business?

☒ Yes ☐ No

#### Organisation

Organisation name (as registered for ABN/ACN)	NORTHERN STAR (CAROSUE DAM) PTY LTD
Business name	
ABN	14116649122
ACN	
Business address	388 Hay St, Subiaco, 6008, WA, Australia
Postal address	
Main Phone number	(08) 6188 2100
Fax	
Primary email address	CDOEnviro@nsrltd.com
Secondary email address	

### 9.2.2 Contact (for an organisation - the contact details of the person authorised to sign on behalf of the organisation)

First name	Robert
Last name	Williamson
Job title	General Manager - Carosue Dam Operations
Phone	(08) 6229 9500
Mobile	
Fax	
Email	CDOEnviro@nsrltd.com
Primary address	388 Hay St, Subiaco, 6008, WA, Australia
Address	

#### Declaration: Proposed Designated Proponent

I, Rob Williamson, the  
proposed designated proponent, consent to the designation of  
myself as the proponent for the purposes of the action described in this EPBC Act Referral.

Signature: R. Williamson Date: 26/08/2021



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### Referring party (person preparing the information)

#### 9.3.1 Is the referring party an organisation or a business?

☒ Yes ☐ No

#### Organisation


Organisation name (as registered for ABN/ACN)	NORTHERN STAR (CAROSUE DAM) PTY LTD
Business name	
ABN	14116649122
ACN	
Business address	388 Hay St, Subiaco, 6008, WA, Australia
Postal address	
Main Phone number	(08) 6188 2100
Fax	
Primary email address	CDOEnviro@nsrltd.com
Secondary email address	

#### 9.3.2 Contact (for an organisation - the contact details of the person authorised to sign on behalf of the organisation)

First name	Kiera
Last name	Mews
Job title	Environmental specialist
Phone	(08) 6229 9052
Mobile	
Fax	
Email	CDOEnviro@nsrltd.com
Primary address	388 Hay St, Subiaco, 6008, WA, Australia
Address	

#### Declaration: Referring party (person preparing the information)

I, KIERA JANE MEWS, declare that to the best of my knowledge the information I have given on, or attached to this EPBC Act Referral is complete, current and correct. I understand that giving false or misleading information is a serious offence.

Signature:  Date: 26/08/2021



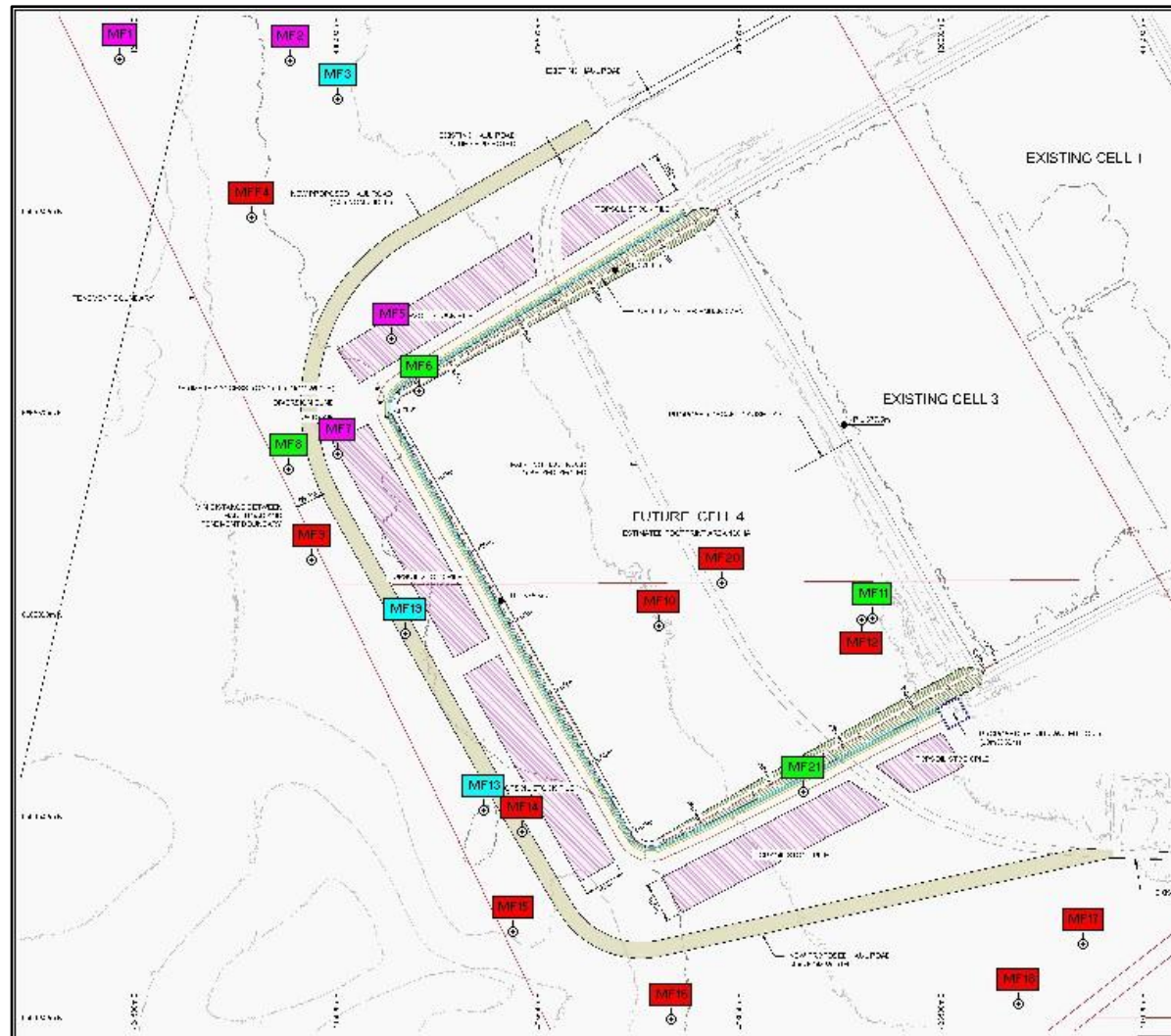
Note: PDF may contain fields not relevant to your application. These fields will appear blank or unticked. Please disregard these fields.

Appendix A	
Attachment	
Document Type	File Name
action_area_images	TSF Cell 4 Proposed activity location and recorded mounds.pdf
action_area_images	Att 1-TSF Cell 4 location.pdf
public_consultation_reports	Att 2-Stakeholder register_Confidential.pdf
supporting_tech_reports	Att 3- TSF Environmental Assessment_2021.pdf
supporting_tech_reports	Att 4-Malleefowl Impact Assessment_2021.pdf
flora_fauna_investigation	CDO_REP_TSF3 Flora Study_Holm 2012.pdf
flora_fauna_investigation	CDO-REP Malleefowl Survey Saracen Airstrip Aug2017.pdf
flora_fauna_investigation	Siesmic Environmental Assessment feb 21 2019.pdf
flora_fauna_investigation	Environmental Assessment TSF July 19 2021.pdf
flora_fauna_investigation	NSR TSF CELL4 Mallee fowl memo August 42021.pdf
flora_fauna_investigation	Att 5-TSF3 Flora Study_2012.pdf
flora_fauna_investigation	Att 6-Seismic Environmental Assessment_2019.pdf
flora_fauna_investigation	Att 7-DeepSouth Survey_2011.pdf
flora_fauna_investigation	Att 8-Relief Hill Survey_2020.pdf
flora_fauna_investigation	Att 9-Airstrip Malleefowl Survey_2017.pdf
corp_env_policy_docs	NSR-COR-003-POL - Environmental Policy.pdf
corp_env_policy_docs	CDO-ENV-023-SWP - Clearing Management.pdf
corp_env_policy_docs	Att 10-Clearing Management.pdf
corp_env_policy_docs	Att 11-Environmental Policy.pdf

Appendix B
Coordinates
Area 1
-30.132094956406,122.331896888925
-30.150669826909,122.34524320466
-30.153044005573,122.33262309456
-30.15289328379,122.33136920569
-30.152326900965,122.33037649082
-30.141288559888,122.32327309479
-30.139811423476,122.3229510381
-30.138096487449,122.32316571377
-30.136753638292,122.32400519235
-30.135797289378,122.32515568874
-30.132094956406,122.331896888925

**Figure 1: Location of mallee fowl nesting mounds and proposed land disturbance associated with cell 4 expansion of Carosue TSF.**

Red tags: Long abandoned  
 Purple tags: Recent failed.  
 Blue tags: Recent abandoned.  
 Green tags: Recent potentially active.



# **ENVIRONMENTAL ASSESSMENT:**

## **PROPOSED EXPANSION OF CAROSUE DAM TAILINGS STORAGE FACILITY**

### **NORTHERN STAR RESOURCES LIMITED**



**Alexander Holm & Associates**  
Natural Resource Management Services

**July 19, 2021**



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# Attachments

Attachment 1: 'NatureMap' report

Attachment 2: 'Protected matters' search tool output

# SUMMARY

This report for Northern Star Resources Ltd covers environmental assessments and a malleefowl survey to support clearing applications to accommodate expansion of the Tailings Storage Facility (TSF) and associated infrastructure at Carosue Dam 115km northeast of Kalgoorlie.

The 842ha survey area associated with expansion of the TSF has had previous environmental assessments. In 2019 it was part of a reconnaissance vegetation, flora and fauna study of a 4300ha area which included an intensive targeted survey for *Eremophila arachnoides* subsp. *tenera*. (Alexander Holm & Associates 2019b). In 2012, 680ha of the present survey area were covered by an environmental assessment and intensive malleefowl survey (Alexander Holm & Associates 2012). This report summarises and updates material within these reports and includes information from a new malleefowl survey from June 11 to 16, 2021.

Rainfall during 2019 (91mm) and 2020 (141mm) was well below average resulting in widespread loss of shrubs and trees. Rainfall to mid-June 2021 was 107mm with some reasonable falls, however drought conditions remain.

While malleefowl have been active in the survey area, there was little evidence of current activity possibly due to the prevailing drought. There were no sightings of birds, tracks or significant litter disturbance. Several nesting mounds were located which are likely to be re-used when conditions for egg-laying improve. Malleefowl have shown a habitat preference for low basalt hills and acacia woodlands which are common in the general Carosue Dam area (Alexander Holm & Associates 2019). Alternative nesting sites are therefore available thereby minimising the impact of clearing of approximately 90ha of preferred habitat during expansion of the TSF.

Flora composition and vegetation associations within the survey envelope are typical of the region and not unusually diverse. There are no Threatened Ecological Communities and no Priority Ecological Communities within or adjacent to the survey area.

No listed species of rare or critically endangered flora were found and no records of Declared Rare Flora (DRF) found in or nearby the survey area. *Eremophila arachnoides* subsp. *tenera*, a Priority 3 listed taxa (P3) is prevalent within the survey envelope. *E. arachnoides* subsp. *tenera* has been found to be widespread in the general area (Alexander Holm & Associates 2019a) and was recently downgraded from a P1 listing and further searches are likely to expand its known range. It is unlikely that this sub-species is seriously endangered.

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands. Disturbance to alluvial plains has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca. Nevertheless potential risk of clearing to the quality of water discharging to Lake Rebecca is low.

Water tables are below the rooting depth of vegetation growing in these areas and hypersaline. Artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes and affect vegetation.

It is recommended that, in planning and implementing clearing operations within the survey area, the proponent:

- 1. Where possible avoids disturbance to *Eremophila arachnoides* subsp. *tenera*.**
- 2. Monitors malleefowl use of mound-nests and avoids disturbance during nesting and incubation.**
- 3. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially alluvial plains.**
- 4. Monitors local water tables and vegetation surrounding the proposed TSF and prepares contingency plans to counter potentially deleterious impacts of rising water tables.**

# SCOPE OF WORKS

Alexander Holm & Associates were contracted by Northern Star Resources Ltd (NSR) to conduct the following work in the Carosue Dam area 115 km Northeast of Kalgoorlie.

NSR operates the Carosue Gold Mine and plans to expand the Tailings Storage Facility (TSF) requiring vegetation clearing within an 842ha area to accommodate the expanded TSF and associated infrastructure.

**1:** A systematic on-ground survey to locate, record and map evidence of Malleefowl (*Leipoa ocellata*).

**2:** Revision of previous environmental assessments in the area to include:

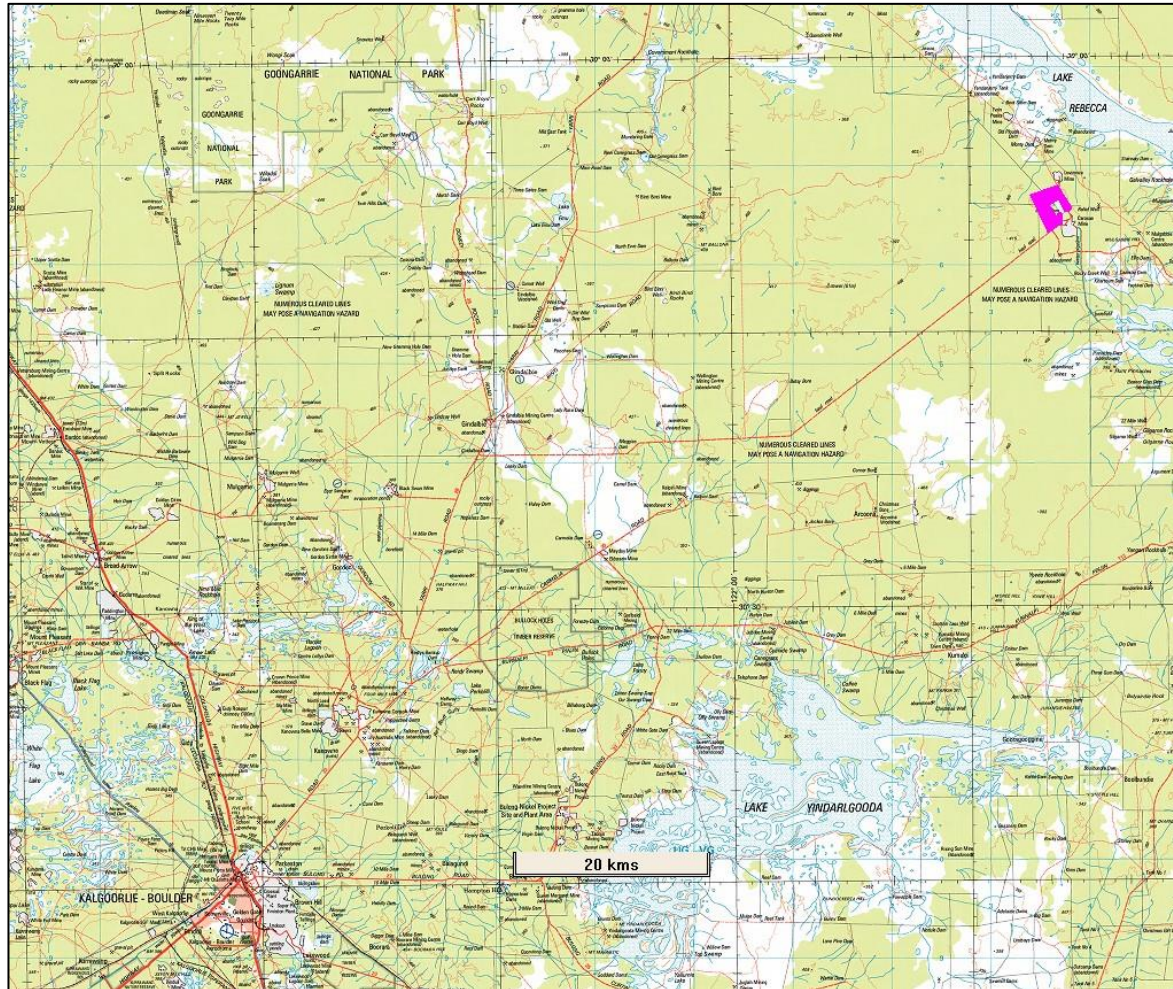
- An update of available information on likelihood of a) presence of threatened (rare) or priority plant species and b) threatened plant communities in the general search area.
- An assessment of the proposal in relation to impacts on land stability, vegetation and fauna.
- An assessment of the proposal against clearing principles.

The report summarises and updates material within the reports by Alexander Holm & Associates (2019b): 'Environmental assessment- proposed seismic survey area. Saracen Gold Mines' and Alexander Holm & Associates (2012): 'Environmental assessment – proposed expansion of Tailings Storage Facility. Saracen Gold Mines'.

# REGIONAL SETTING

## Location

Carosue Dam TSF is approximately 115 km northeast of Kalgoorlie Boulder, and south of Lake Rebecca (Figure 1).



**Figure 1: Survey area (in pink) in relation to Lake Rebecca and Kalgoorlie Boulder in the southwest.**

## Declared flora and fauna.

The Department of Parks and Wildlife and the Western Australian Museum's 'NatureMap'<sup>1</sup> was interrogated for records of all recorded conservation taxon within a 40 km radius of the study area (Attachment 1). The list was augmented by other recent searches from nearby survey areas (Alexander Holm & Associates 2012, 2019b)

*Thryptomene eremaea*, a Priority 2 taxon, is recorded in NatureMap as being located within 40km of the study area. It is an erect open shrub, 0.5 to 1.5m high, producing pink or white flowers from July to September and grows on red or yellow sands on sandplains

<sup>1</sup><https://naturemap.dpaw.wa.gov.au/default.aspx>

and shallow sandy soils over granite. *Th. eremaea* was recorded by Alexander Holm & Associates (2019b) growing on low basalt hills in an adjacent survey during 2019.

*Eremophila arachnoides* subsp. *tenera*, a Priority 3 taxon, was recorded by Alexander Holm and Associates (2012, 2019b) and is prevalent on alluvial soils in the survey area. This taxa is not listed in the NatureMap search area.

Malleefowl, declared rare or likely to become extinct, are present in the area.

Declared flora and fauna listed on Commonwealth Department of Environment and Energy database of threatened species were identified within a 50km radius of the study area using the protected matters search tool<sup>2</sup> (Attachment 2). There are no declared flora listed.

Significant conservation fauna which may be present in the survey area include several birds and one mammal. The majority of the birds are waterbirds that are either vagrants or irregular visitors and would not utilise the actual project area due to the lack of wetlands. Most other significant birds are expected only as vagrants but three species may use the site regularly: Malleefowl, Peregrine Falcon and Rainbow Bee-eater (Alexander Holm & Associates 2019b). The Chuditch or Western Quoll is listed as Vulnerable under the EPBC Act, inhabited a wide range of habitats including the Goldfields, but is now restricted to the forests and woodlands of the southwest.

## Threatened and priority ecological communities.

The likelihood of presence of threatened ecological communities within the general survey area was assessed using the protected matters search tool (Attachment 2).

Other threatened ecosystems in the south-east of Eastern Murchison (MUR 1) biogeographic subregion, identified during ‘A Biodiversity Audit of Western Australia’s 53 Biogeographical Subregions in 2002’, are listed in Cowan (2001).

Priority ecological communities in the area were assessed from Department of Parks and Wildlife listing (Version 27, June 2017). Sandstone, Yalgoo Paynes Find (Payne et al., 1998) and Kambalda north (Payne, Mitchell & Hennig, 1998).

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<sup>2</sup> <http://www.environment.gov.au/erin/ert/epbc/>

# ASSESSMENT METHODOLOGY

## Assessment personnel

The malleefowl survey was conducted by Dr Holm and Mr Eliot. The report was prepared by Dr Alexander Holm (Alexander Holm & Associates).

Dr Holm is an ecologist with over 35 years experience in arid environments and Goldfield regions and an accredited environmental consultant with the Environmental Consultants Association of Western Australia.

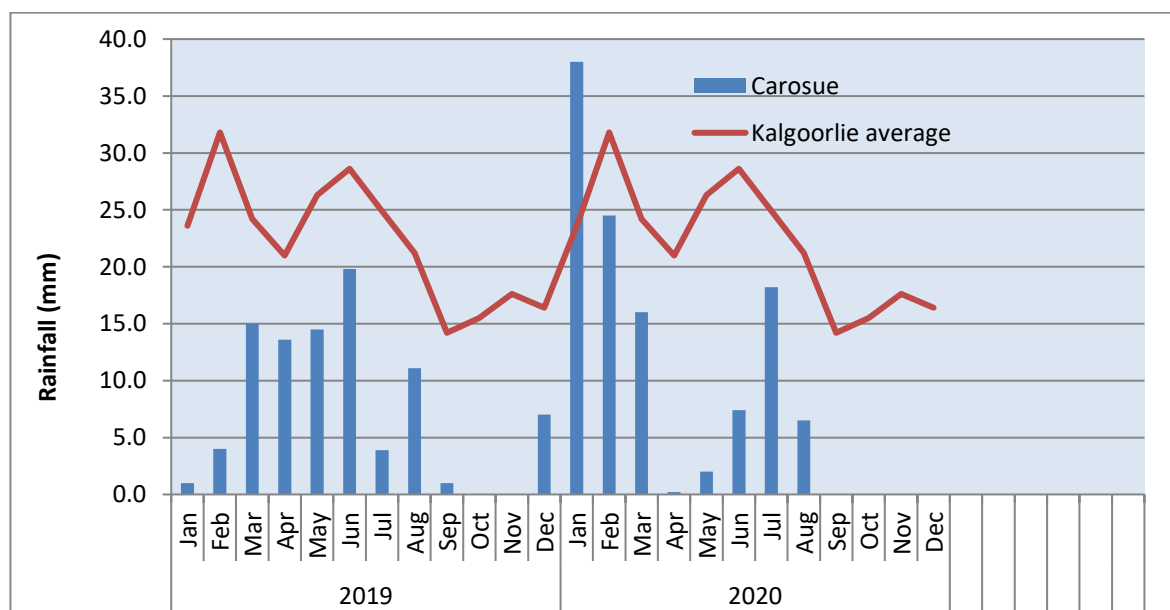
Mr Geoffrey Eliot was soil and landscape technician for the Western Australian Department of Agriculture's rangeland surveys and has over 20 years experience in Western Australian arid regions.

Field work, land unit mapping and botanical identification for the 2012 survey, on which results of this report are based was conducted by Mr Andrew Mitchell. Mr Mitchell was assisting botanist to Western Australian Department of Agriculture's rangeland surveys, senior author of 'Arid Shrubland Plants of Western Australia' (Mitchell and Wilcox 1994) and recently retired botanist with AQIS (Australian Quarantine and Inspection Service).

## Timing of survey and seasonal conditions

Malleefowl survey from June 11 to 16, 2021.

Rainfall during 2019 (91mm) and 2020 (141mm) was well below average (Figure 2) resulting in widespread loss of shrubs and trees. Rainfall to mid-June 2021 was 107mm with some reasonable falls, however drought conditions remain.

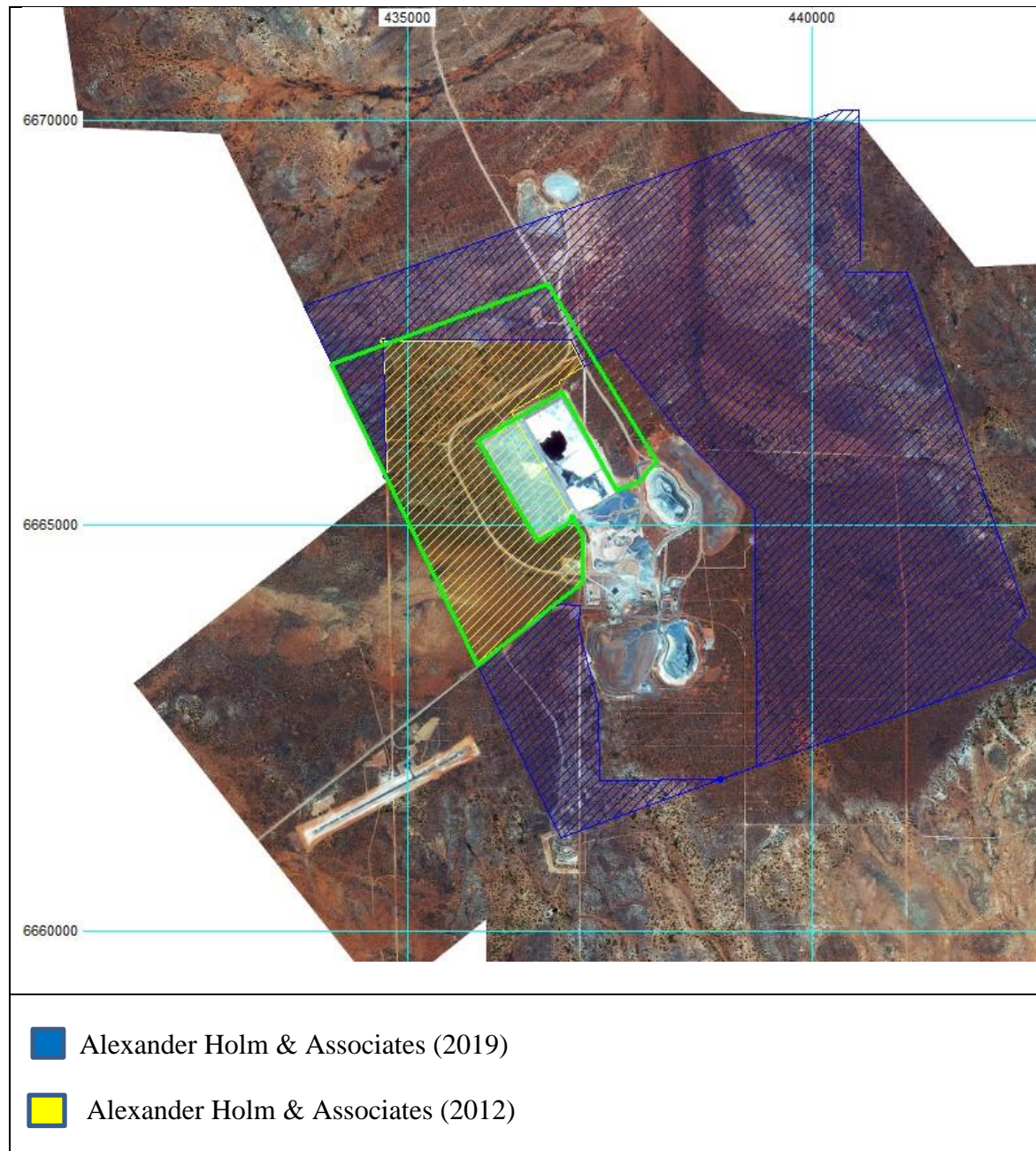


**Figure 2: Monthly rainfall (mm) at Carosue Dam in comparison to averages at Kalgoorlie airport.**



## Survey area

The 842ha survey area associated with the Cell 4 expansion of the TSF has had previous environmental assessments (Figure 3). In 2019 it was part of a reconnaissance vegetation, flora and fauna study of a 4300ha area which included an intensive targeted survey for *Eremophila arachnoides* subsp. *tenera*. (Alexander Holm & Associates 2019b). In 2012, 680ha of the present survey area were covered by an environmental assessment and intensive malleefowl survey (Alexander Holm & Associates 2012).



**Figure 3: Survey area (green) and locations of previous surveys.**



## **Malleefowl survey**

Operators searched along gridlines 40m apart using GPS devices to maintain position. Evidence of malleefowl activity, active and dormant nests were noted and coordinates recorded. A total of 246km was traversed (Figure 5).

It is estimated that the search procedures were sufficient to locate 90 to 100% of active nests in less densely vegetated areas and 60 - 80% of active nests in more densely vegetated areas. Nests previously located where not known to search operators and used as a test of search efficiency.

# ENVIRONMENTAL ANALYSIS

## Conservation estate

There are no conservation reserves within 50 km of the survey area (Appendix 1). The closest conservation area is Bullock Holes Reserve, approximately 60 km southwest. 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) although Lake Rebecca is considered an ecologically significant component of inter-regional palaeo-channels.

There are no registered sites on State or National heritage registers.

Lake Rebecca is a registered mythological site.

## Land systems and landforms

Approximately 50% of the survey area consists of low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys of Moriarty land system (Pringle et al. 1994). Plains with eucalypt woodlands with non-halophytic undershrubs of Deadman land system occupy 36% and most of the remainder is sandplain of Kirgella land system.

## Land units, soil types and vegetation communities

Approximately 60% of the TSF survey area is occupied by either alluvial plains supporting halophytic low shrubland or plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Sand plains and sandy rises occupy 22% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or metamorphic rocks occupy the remainder (Alexander Holm & Associates 2012).

‘Sandplain spinifex hummock grassland’ (SASP) occupies most of the elevated southwestern portion of the survey area. Other elevated land units on basalt, metamorphic rocks and laterite are mostly occupied by ‘Calcareous casuarina acacia shrubland or woodland’ (CCAS) except when bluebush (*Maireana* species) occurs where the landscape is in better condition, in which case the vegetation type is ‘calcyphytic pearl bluebush shrublands’ (CPBS). CCAS vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands either with casuarina and eucalypt woodlands (PECW) or without (PXHS) (Alexander Holm & Associates 2012).

## Vegetation and soil condition

The survey area has been disturbed by recent and historic mining activity and is mostly within a pastoral lease and has been grazed. Vehicle tracks, cut lines and pastoral fences cross the area.

Large tracts of the vegetation are degraded, some totally degraded. Spinifex communities (SASP) on sandplains and sandy rises are not suitable for grazing and are in pristine condition.

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands and this land unit is rated moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerability to soil erosion and small areas on these units are slightly eroded.

## **Threatened ecosystems and wetlands.**

There are no identified threatened ecological communities (TECs) in the entire MUR1 biogeographic subregion (Cowan, 2001).

There are no listed priority ecological communities (PECs) in the area.

There are no nationally significant wetlands in the area (Appendix 1). Lake Rebecca is a major wetland with local and regional significance.

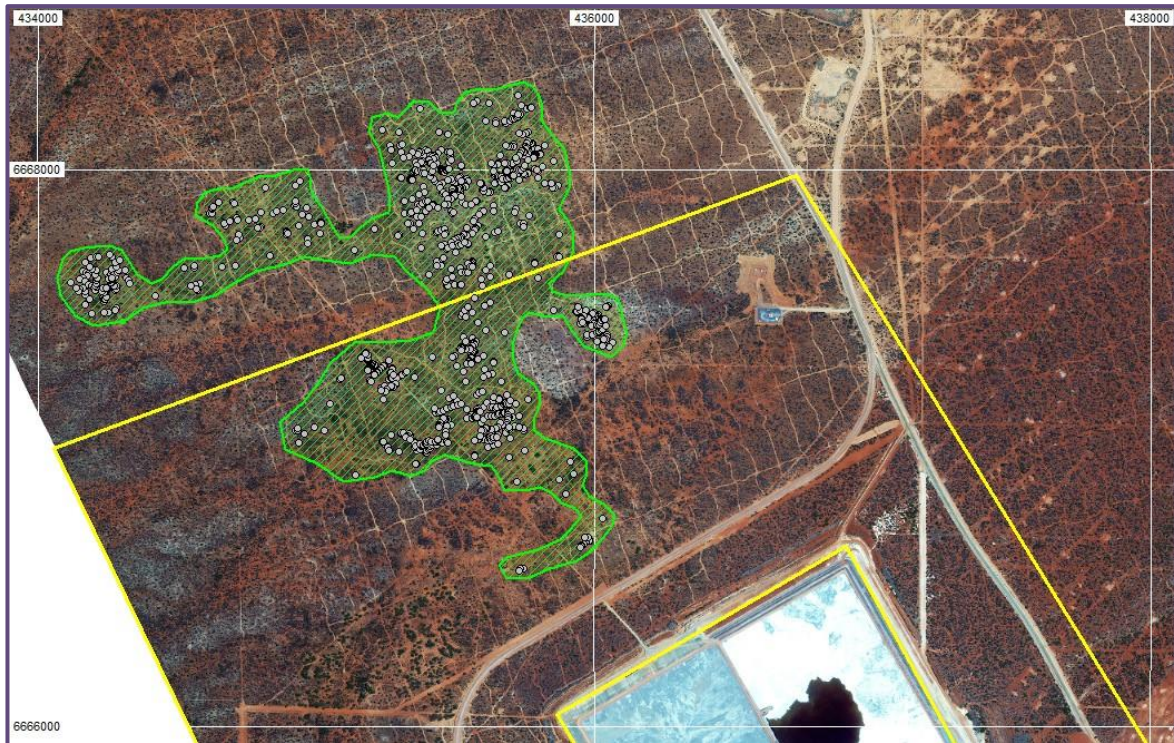
There are no defined drainage channels, playas or other wetlands in the survey area and no riparian vegetation is at risk.

## **Flora**

One hundred and thirty six flora taxa representing 25 families were found during field survey in 2012 (Alexander Holm & Associates 2012). Chenopodiaceae accounted for 23 taxa, Fabaceae and Myrtaceae 19 taxa each and Scrophulariaceae 15 taxa.

No threatened (rare) or endangered flora taxa were found during reconnaissance or targeted surveys.

*Eremophila arachnoides* subsp. *tenera* (P3) is widespread in the survey area as shown in Figure 4. No plants were found outside the distribution boundary established in the 2019 survey (Alexander Holm & Associates 2019b).



**Figure 4: Location of *Eremophila arachnoides* subsp. *tenera* (Alexander Holm & Associates 2019b)**

## Fauna

While malleefowl are known to have been active in the survey area (Alexander Holm & Associates 2012, 2019b) there was little evidence of current activity possibly due to the prevailing drought. There were no sightings of birds, tracks or significant litter disturbance. Nineteen malleefowl mounds were found during this survey plus two relocated from the 2012 survey (Table 1).

Ten mounds were long-abandoned (e.g. MF17).





Three mounds were very small, little more than tentative small pits (recent failed).  
(e.g. MF5)



Four mounds appeared to have been used and were now abandoned (recent ?abandoned).  
(e.g. MF19)



Four mounds had been used but were not currently active (recent ?active).  
(e.g. MF 8)



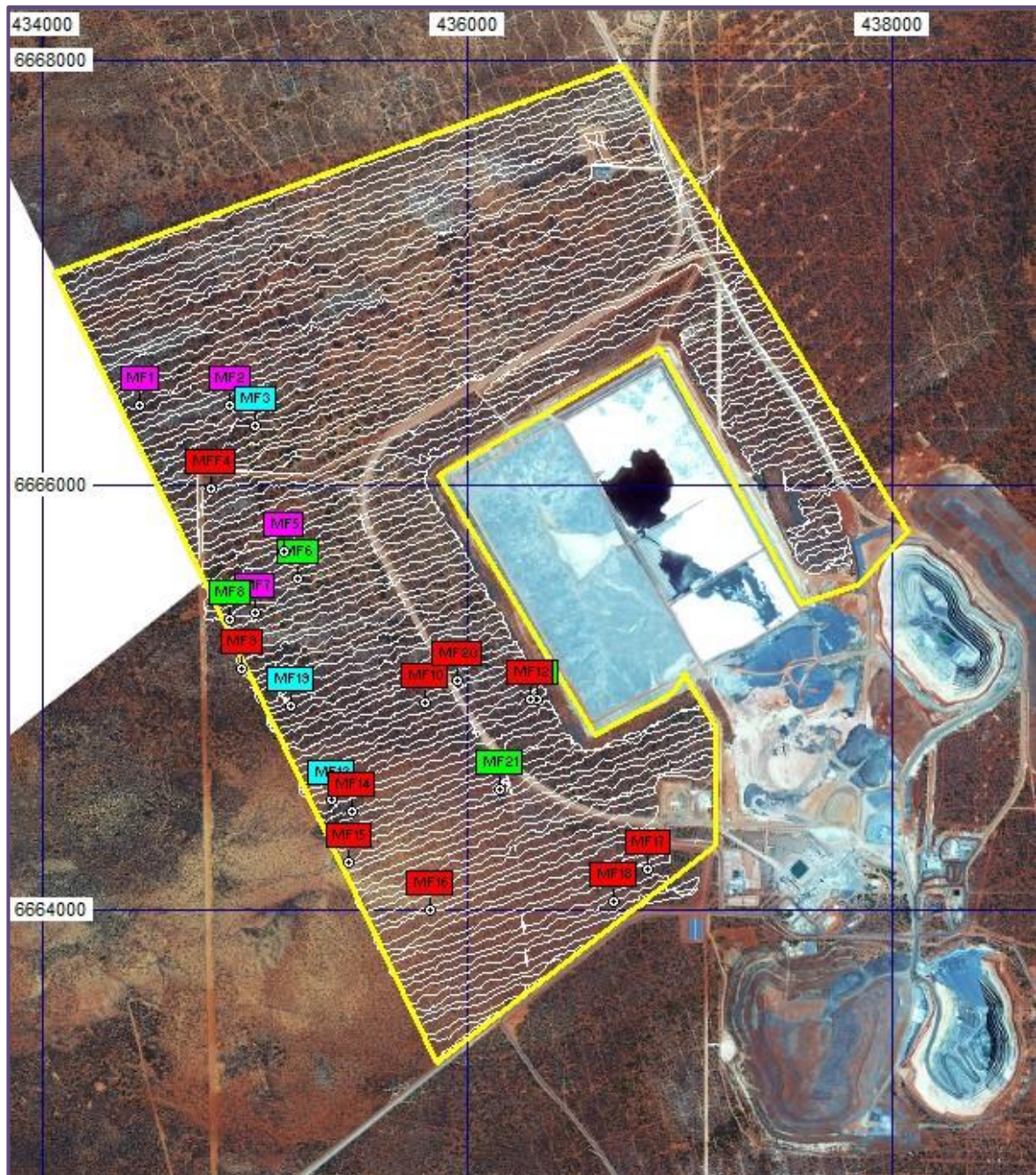
**Table 1: Location and activity status of malleefowl mounds**

<b>MF mound</b>	<b>Location</b>				<b>Status</b>
MF1	UTM	51J	434460	6666377	Recent ?abandoned
MF2	UTM	51J	434882	6666373	Recent failed
MF3	UTM	51J	435002	6666280	Recent ?abandoned
MF4	UTM	51J	434789	6665985	Long abandoned
MF5*	UTM	51J	435134	6665687	Recent failed
MF6	UTM	51J	435202	6665555	Recent ?active
MF7	UTM	51J	435002	6665398	Recent failed
MF8	UTM	51J	434879	6665363	Recent ?active
MF9	UTM	51J	434936	6665138	Long abandoned
MF10	UTM	51J	435798	6664973	Long abandoned
MF11	UTM	51J	436328	6664994	Recent ?active
MF12	UTM	51J	436300	6664988	Long abandoned
MF13	UTM	51J	435364	6664519	Recent ?abandoned
MF14	UTM	51J	435460	6664464	Long abandoned
MF15	UTM	51J	435438	6664219	Long abandoned
MF16	UTM	51J	435828	6663999	Long abandoned
MF17	UTM	51J	436850	6664186	Long abandoned
MF18	UTM	51J	436693	6664037	Long abandoned
MF19	UTM	51J	435169	6664955	Recent ?abandoned
MF20	UTM	51J	435955	6665080	Long abandoned
MF21	UTM	51J	436156	6664563	Recent ?active

\* (position doubtful)

Malleefowl mounds were more abundant in rocky basalt hill foot-slopes and plains supporting acacia shrublands.





**Figure 5: Location and status of malleefowl mounds (green: recent probably active; aqua: recent probably abandoned; fuchsia: recent failed; red: long abandoned) and foot traverse (white).**

# ASSESSMENT IN RELATION TO CLEARING PRINCIPLES

Results of previous surveys (Alexander Holm & Associates 2012, 2019b) and updated information from this survey are used to assess clearing within the survey area in relation to ten clearing principles prescribed in Schedule 5 under amendments in 2004 to the Environmental Protection Act (1986):

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

The survey area is in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions. Lake Ballard/Lake Rebecca form 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 (black oak) and *Eucalyptus* species on alkaline and calcareous soils to the south. The survey area straddles this vegetation divide.

Sandplain spinifex hummock grassland occupies most of the elevated southwestern portion of the survey area. Other elevated land units, on basalt, metamorphic rocks and laterite, are mostly occupied by acacia or casuarina over bluebush (*Maireana* species) or non-chenopodiaceous shrubs. This vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands often with casuarina or eucalypt overstories.

Vegetation associations and species composition are typical of the area and are 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.**

Malleefowl are or have been recently active in the survey area. Four mounds in the area had been recently used but not currently active and another four had been used and may have been abandoned. Malleefowl have shown a habitat preference for low basalt hills (land unit 2b) and acacia woodlands (land unit 4a), both of which are common in the general Carosue Dam area (Alexander Holm & Associates 2019). Alternative nesting sites are therefore available thereby minimising the impact of clearing of approximately 90ha of these land units during expansion of the TSF.

**Proposal is 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.**



No listed species of rare or endangered flora were found during this survey.

*Eremophila arachnoides* subsp. *tenera*, a Priority 3 listed taxa (P3) is prevalent within the survey envelope. *E. arachnoides* subsp. *tenera* has been found to be widespread in the general area (Alexander Holm & Associates 2019a) and was recently downgraded from a P1 listing.

**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 northeast Goldfields subregion (Cowan, 2001). There are no Priority Ecological Communities within or adjacent to the survey area.

**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.**

The TSF survey area falls mostly on Vegetation Association 20 (Low woodland; mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) and the remainder on Vegetation Association 24 (Plains with eucalypt woodlands with non-halophytic undershrubs).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation.

Neither vegetation community has been extensively cleared and clearing within this survey area will have minimal effect on extent of these vegetation communities.

**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.**

The TSF landscape drains north-easterly via overland flow to off-site drainage tracts which flow into Lake Rebecca 7 km to the north east. There are no defined water courses or wetlands within the survey area.

**Proposal is not 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 has been disturbed by recent mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Land units supporting chenopod vegetation, preferentially grazed by livestock, are mostly degraded and few areas are in good condition. Spinifex communities on sandplains and sandy rises are not suitable for grazing and are in excellent condition.

Minor to moderate soil erosion is evident on alluvial plains and these land units are rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slightly vulnerable to soil erosion and small areas on these units are slightly eroded. Spinifex sandplain and rises are susceptible to wind erosion following fire.

Water tables are a) below the rooting depth of vegetation growing in these areas and b) hypersaline. Extensive clearing of vegetation at catchment-scale or artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes.

Clearing of vegetation at local scales will have minimal, if any, effect on water tables and associated risk of secondary salinity. Tailings disposal has the potential to raise water tables.

**Proposal is 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 are nearby.

**Proposal is 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.**

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands. Disturbance to alluvial plains has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca. Nevertheless, potential risk to quality of water discharging to Lake Rebecca is considered low.

**Proposal is unlikely to be 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 runoff.

Clearing in this proposal will have negligible effect on the volume of runoff discharged.

**Proposal is unlikely to be at variance with this principle.**

# DISCUSSION AND RECOMMENDATIONS

NSR operates the Carosue Gold Mine and plans to expand the Tailings Storage Facility (TSF) requiring vegetation clearing to accommodate the expanded TSF and associated infrastructure.

Flora composition and vegetation associations within the survey envelope are typical of the region and not unusually diverse. There are no Threatened Ecological Communities (TECs) and no Priority Ecological Communities within or adjacent to the survey area.

No listed species of rare or critically endangered flora were found and no records of Declared Rare Flora (DRF) found in or nearby the survey area. *Eremophila arachnoides* subsp. *tenera*, a Priority 3 listed taxa (P3) is prevalent within the survey envelope. *E. arachnoides* subsp. *tenera* has been found to be widespread in the general area (Alexander Holm & Associates 2019a) and was recently downgraded from a P1 listing and further searches are likely to expand its known range. It is unlikely that this sub-species is seriously endangered.

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands. Disturbance to alluvial plains has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca. Nevertheless potential risk of clearing to quality of water discharging to Lake Rebecca is considered low.

While malleefowl have been active in the survey area, there was little evidence of current activity possibly due to the prevailing drought. There were no sightings of birds, tracks or significant litter disturbance.. Several nesting mounds were located which are likely to be re-used when conditions for egg-laying improve. Malleefowl have shown a habitat preference for low basalt hills and acacia woodlands which are common in the general Carosue Dam area (Alexander Holm & Associates 2019).

It is recommended that, in planning and implementing clearing operations within the survey area, the proponent:

- 1. Where possible avoids disturbance to *Eremophila arachnoides* subsp. *tenera*.**
- 2. Monitors malleefowl use of mound-nests and avoids disturbance during nesting and incubation.**
- 3. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially alluvial plains.**
- 4. Monitors local water tables and vegetation surrounding the proposed TSF and prepares contingency plans to counter potentially deleterious impacts of rising water tables.**



# REFERENCES

- Alexander Holm & Associates (2012). Environmental assessment: Tailings storage facility expansion (p. 81)
- Alexander Holm & Associates (2019a). Case for revision of priority listing for *Eremophila arachnoides* subsp. *tenera* (p. 9)
- Alexander Holm & Associates (2019b). Environmental assessment: Proposed Seismic Survey (p. 136)
- Mitchell, A.A., & Wilcox, D.G. (1994). *Arid Shrubland Plants of Western Australia*. (2 ed.). Perth: University of Western Australia Press
- 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 (p. 323)

## Disclaimer

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: ‘NatureMap’ report**





# NatureMap Species Report

Created By Guest user on 08/06/2021

**Conservation Status** Conservation Taxon (T, X, IA, S, P1-P5)

**Current Names Only** Yes

**Core Datasets Only** Yes

**Method** 'By Circle'

**Centre** 122° 20' 17" E, 30° 07' 54" S

**Buffer** 40km

**Group By** Kingdom

Kingdom	Species	Records
Animalia	1	54
Plantae	1	4
<b>TOTAL</b>	<b>2</b>	<b>58</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Animalia</b>				
1.	24557 <i>Leipoa ocellata</i> (Malleefowl)		T	
<b>Plantae</b>				
2.	19695 <i>Thryptomene eremaea</i>		P2	

#### Conservation Codes

T - Rare or likely to become extinct  
X - Presumed extinct  
IA - Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

## **Attachment 2: ‘Protected matters’ search tool output**





# 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: 08/06/21 18:39:05

## [Summary](#)

## [Details](#)

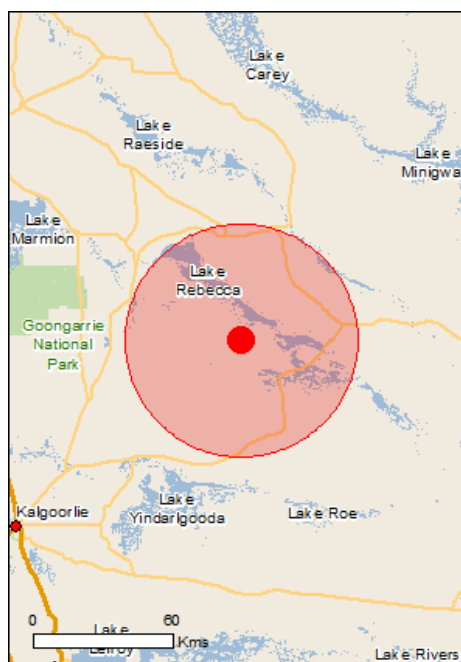
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

## [Caveat](#)

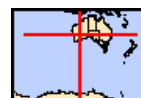
## [Acknowledgements](#)



This map may contain data which are  
©Commonwealth of Australia  
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[Coordinates](#)

[Buffer: 50.0Km](#)



# 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](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	None
<a href="#">Listed Threatened Species:</a>	6
<a href="#">Listed Migratory Species:</a>	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.

<a href="#">Commonwealth Land:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	9
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None

## Extra Information

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

<a href="#">State and Territory Reserves:</a>	None
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	14
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None

# Details

## Matters of National Environmental Significance

### Listed Threatened Species [\[ Resource Information \]](#)

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Falco hypoleucos</a> Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pezoporus occidentalis</a> Night Parrot [59350]	Endangered	Species or species habitat may occur within area
<a href="#">Polytelis alexandrae</a> Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area

### Mammals

<a href="#">Dasyurus geoffroi</a> Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
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### 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
<b>Migratory Marine Birds</b>		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area

### Migratory Terrestrial Species

<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
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### Migratory Wetlands Species

<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Calidris melanotos</a> 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		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Chrysococcyx osculans</a> Black-eared Cuckoo [705]		Species or species habitat known to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Thinornis rubricollis</a> Hooded Plover [59510]		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
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
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
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		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

Name	Status	Type of Presence
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

-30.13109 122.33917

# 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.

# Impacts on malleefowl of land clearing associated with expansion of Carosue Dam TSF.

An assessment for Northern Star Resources Limited

Alexander Holm & Associates  
Natural Resource Management Services

August 4, 2021

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## Background:

Northern Star Resources Ltd (Northern Star) operates the Carosue Gold Mine and plans to expand the Tailings Storage Facility (TSF) requiring vegetation clearing within an 842ha area to accommodate the expanded TSF and associated infrastructure.

Alexander Holm & Associates were commissioned by Northern Star in June 2021 to revise and update previous environmental assessments in the area and conduct a systematic on-ground survey to locate, record and map evidence of malleefowl (*Leipoa ocellata*). This work was reported in Alexander Holm & Associates (2021). In light of findings from this survey Northern Star have now requested Alexander Holm & Associates to critically assess the likely impacts of the proposed development on malleefowl within and adjacent to the clearing envelope.

Malleefowl are regarded as a nationally threatened species and are listed as "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) whereby approval may be required for a proposed activity that significantly adversely affects their wellbeing.

Malleefowl are "Threatened" species under Western Australian legislation and listed as "Vulnerable" under the *Biodiversity Conservation Act (2016)*. Taking or disturbing threatened fauna requires authorisation from the Minister for Environment.

A "National Recovery Plan for Malleefowl *Leipoa ocellata*", published in 2007, sets out actions necessary to stop the decline of, and support the recovery of, malleefowl (Benshemesh 2007).

## Evidence of malleefowl

The June 2021 malleefowl survey involved two operators searching along gridlines 40m apart covering the entire 842ha area whereby a total of 246km was traversed (Alexander Holm & Associates 2021). There were no sightings of birds or their tracks and minimal, isolated, non-species specific, litter disturbance. Twenty one malleefowl nesting mounds were found of which, ten mounds with shrubs and/or trees and likely to have been unused for more than 20 years, were classed "long-abandoned", three were little more than tentative scratchings ("recent failed"), four appeared to have been used within the past five to 10 years but were now abandoned ("recent abandoned") and four had been used within the past five years but were not currently occupied ("recent potentially active").

In February 2019, two operators searched along gridlines 25m apart for presence of the priority listed species *Eremophila arachanoides* subsp. *tenura* during which presence of malleefowl were noted (Alexander Holm & Associates 2019). Approximately 170ha were searched within the 842ha area of interest during which one "recent abandoned" nesting mound was found (MF3). There were no bird sightings.

In November 2012, operators searched along gridlines 50m apart for evidence of malleefowl within a 640ha area entirely within the 842ha area of current interest (Alexander Holm &

Associates 2012). Two adult birds were sighted, three "recent active" nesting mounds (MF11;MF13;MF21), and three "long abandoned" mounds located, two of which have been destroyed and one remains (MF20). Saracen Gold installed a continuous camera recorder at MF13 shortly after its discovery. No nesting activity was observed and the nest was subsequently abandoned.

## Malleefowl preferred habitat

Malleefowl nesting mounds in the proposed development area were more abundant in foot-slopes of rocky basalt hills (land unit 2b) and plains supporting acacia shrublands (land unit 4a and 4b) (Alexander Holm & Associates 2019). Fire-prone sandplains were not preferred habitat and saline alluvial plains were avoided. Similar habitat preferences have been noted for the adjacent Great Victoria Desert (Department of Parks and Wildlife 2016).

## Impact of proposed development on malleefowl

Locations of malleefowl nesting mounds in relation to the proposed TSF development are shown in Figure 1 and impact of this development on these mounds is assessed in Table 1.

Ten nesting mounds will be destroyed. Of these, four are "long abandoned", two are "recent failed", one "recent abandoned" and three (MF6; MF11; MF21) "recent potentially active". Two other nesting mounds are within 60m of the new haul road, one (MF8) is "recent potentially active" and the other "recent abandoned".

Of the 12 nesting mounds affected by the proposed development, destruction of eight abandoned and failed mounds will have no negative impacts on malleefowl. Of the remaining four nesting mounds, MF11 and MF21 were found to be active and occupied during the November 2012 survey, but not occupied in June 2021 and no evidence (fresh litter, egg shell) of activity over the past few years. MF6 and MF8 had not been found prior to the 2021 survey and neither were occupied in June 2021. There was no evidence of activity during the past few years at MF6. Litter material in MF8 appeared more recent than in any of the other "recent potentially active" nesting mounds.

**Table 1: Malleefowl nesting mounds in the vicinity and impact of proposed development**

MF mound	Status	Impact
MF1	Recent abandoned	None
MF2	Recent failed	None
MF3	Recent abandoned	None
MF4	Long abandoned	None
MF5	Recent failed	Destroyed
MF6	Recent potentially active	Destroyed
MF7	Recent failed	Destroyed
MF8	Recent potentially active	55m west of new haul road
MF9	Long abandoned	None
MF10	Long abandoned	Destroyed

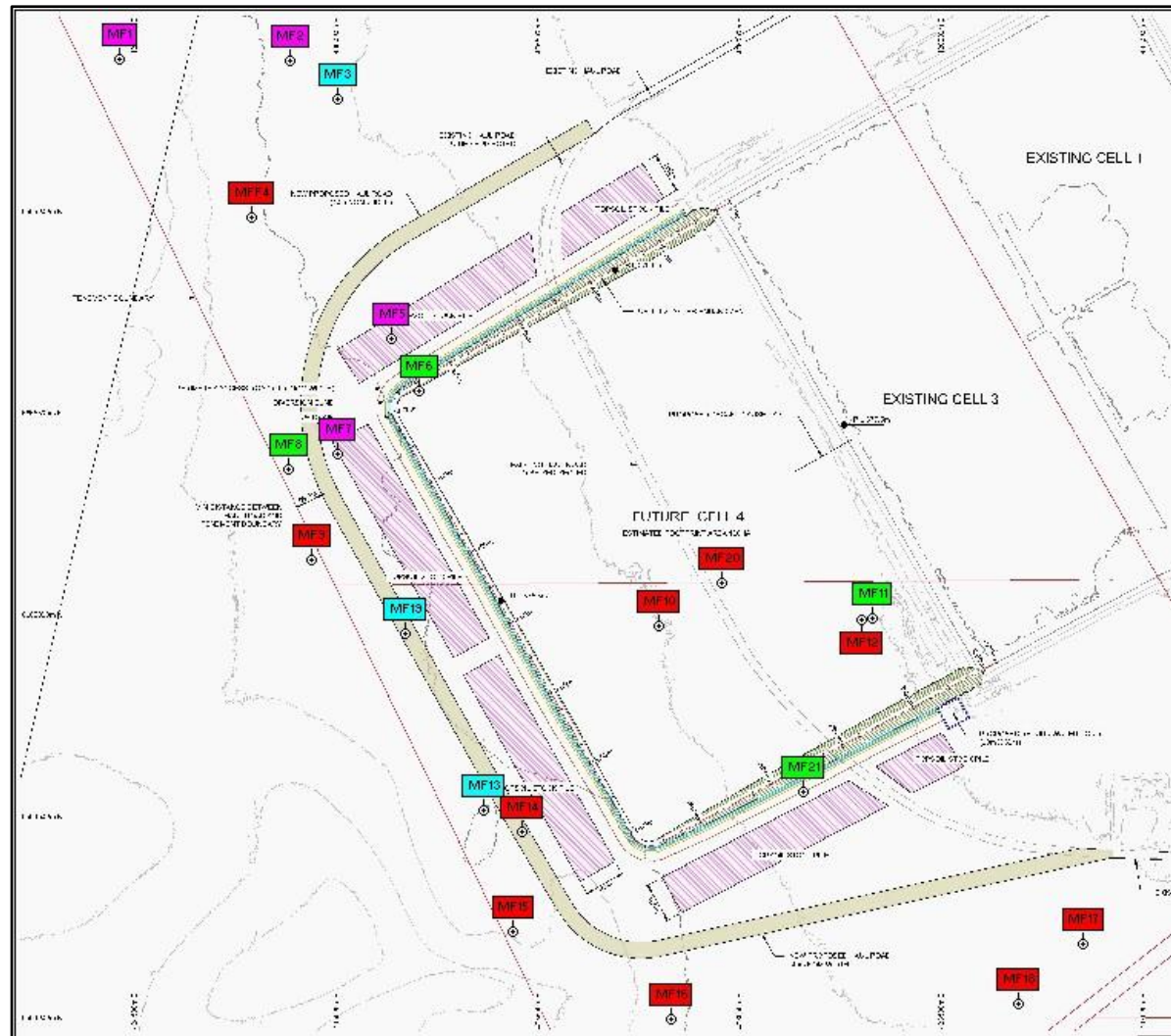
MF mound	Status	Impact
MF11	Recent potentially active	Destroyed
MF12	Long abandoned	Destroyed
MF13	Recent abandoned	37m west of new haul road
MF14	Long abandoned	Destroyed
MF15	Long abandoned	None
MF16	Long abandoned	None
MF17	Long abandoned	None
MF18	Long abandoned	None
MF19	Recent abandoned	Destroyed
MF20	Long abandoned	Destroyed
MF21	Recent potentially active	Destroyed

Approximately 90ha of preferred malleefowl habitat will be cleared during the proposed development consisting of roughly equal proportions of basalt hill foot-slopes and plains supporting acacia shrubland. Suitable Malleefowl habitat available in areas adjacent to the proposed disturbance is in excess of 2000ha (Alexander Holm & Associates 2019).



**Figure 1: Location of mallee fowl nesting mounds and proposed land disturbance associated with cell 4 expansion of Carosue TSF.**

Red tags: Long abandoned  
 Purple tags: Recent failed.  
 Blue tags: Recent abandoned.  
 Green tags: Recent potentially active.



## Referral under the EPBC Act

Malleefowl, classified as "vulnerable" and listed as a matter of national environmental significance under the EPBC Act, are known to be present in the general area of the proposed development. An action will require approval if the action has, will have, or is likely to have a significant impact on an "important population" of a vulnerable species (Department of The Environment 2013). An "important population" is a population necessary for the long term survival and recovery of the species where a "population of a species" is defined under the EPBC act as an occurrence of the species in a particular area including but not limited to a geographically distinct regional population, or collection of local populations, or a population or collection of local populations occurring within a particular bioregion.

In assessing if the proposed development of the TSF Cell 4 will have a significant impact on malleefowl, the following criteria are considered as to whether there is a possibility that the development will:

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

Malleefowl, which may be impacted by the proposed development, are part of a sparse, widely-dispersed population of unknown extent. Malleefowl have been sighted and/or nesting mounds located throughout most of the tenements associated with Carosue Dam operations from around Deep South 70km north of the TSF (Alexander Holm & Associates 2011), 10km to the east (Alexander Holm & Associates 2020) and 6km SW (Alexander Holm & Associates 2017). Records of malleefowl extend in all directions beyond these locations (Department of Parks and Wildlife 2016). While this sparse, widely-dispersed population of malleefowl throughout the Western Australian arid zone can be considered an "important population" necessary for the long-term survival of the species in the region, Benshemesh (2007) states that no particular population or general area can be described as of greater importance for the long-term survival of malleefowl.

Factors affecting the long-term survival of malleefowl in the arid-zone include livestock grazing, broad-scale fire, drought and fox-predation (Benshemesh 2007). Localized impacts from mining, such as habitat destruction through clearing, are likely to be of lesser importance. Expansion of the TSF will have negligible impact on the widely dispersed malleefowl population in this region as there is extensive habitat in adjacent areas for malleefowl use in subsequent breeding seasons.

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

While malleefowl have been previously sighted within the development envelope and active-occupied nests located in past surveys, there is no evidence that malleefowl are currently present. It is known that malleefowl in arid areas are verging on nomadic, having irregular or unpredictable home range (Department of Parks and Wildlife 2016). Nesting mounds, which appear to be un-occupied during poor seasons, occur mostly on foot slopes of basalt hills and in acacia shrubland on extensive plains (Alexander Holm & Associates 2021). Plains supporting acacia shrubland are widespread in the vicinity of the proposed development and occupy 36% or 1800ha while basalt hills occupy a more restricted area of 380ha (Alexander Holm & Associates 2019). Approximately 90ha of preferred habitat will be cleared during

expansion of the TSF which will have minimal impact on the area of occupancy of malleefowl due to the broad range of suitable habitat within the region.

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

Malleefowl in this arid environment are part of a widely-dispersed, semi-nomadic population. The proposed clearing will not fragment an existing population.

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

Malleefowl in the vicinity of the TSF prefer plains supporting acacia shrubland and foot slopes of basalt hills for nesting sites. Similar habitat preferences are noted for the adjacent Great Victoria Desert (Department of Parks and Wildlife 2016) and are extensive throughout the region (e.g. Pringle, Van Vreeswyk et al. 1994). Clearing of 90ha of preferred habitat for the development of the TSF is not considered to be critical for survival of the species due to the availability of similar habitat nearby and throughout the region.

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

Malleefowl appear to occupy nesting sites only during favourable seasons and the four recently-active nesting mounds affected by this development are not currently occupied. Northern Star will ensure clearing is completed outside of the breeding season while nesting mounds are un-occupied. Malleefowl breeding cycle will not be disrupted while these nesting mounds are un-occupied.

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

Malleefowl nesting mounds in the proposed development area are more abundant in foot-slopes of rocky basalt hills and plains supporting acacia shrublands which are common in the vicinity of the TSF (Alexander Holm & Associates 2019) and extensive throughout the region (e.g. Pringle, Van Vreeswyk et al. 1994). The malleefowl population is unlikely to decline through impacts of this development due to the wide availability of preferred habitat throughout the region.

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

Mining activity has potential to increase feral predators of malleefowl especially fox and cat and to introduce weed species that may invade malleefowl habitat. Effective putrescible rubbish management and weed control hygiene is essential to minimise adverse effects. Northern Star have procedures in place to address and mitigate risks associated with invasive species, therefore it is unlikely that invasive species will significantly impact malleefowl populations or habitat due to the proposed development.

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

Transmission of disease to malleefowl is unknown, however risk of transmission will be minimised through practices that minimise presence of feral predators or other non-native fauna. Northern Star have procedures and practices in place to control feral animals as

required throughout the project area through trapping and baiting programs, therefore the risk of introducing disease to malleefowl populations due to the proposed development is considered low.

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

Malleefowl survival is threatened by vegetation clearing, predation by fox and cat, increased fire frequency, road mortality and competition with sheep, rabbit, cattle and goat (Department of Parks and Wildlife Fauna facts). Mining activity, such as the proposed expansion of the TSF, has cumulative effects on malleefowl survival particularly with clearing and road mortality. While the proposed development will not interfere substantially with the recovery or ongoing survival of malleefowl in the north eastern Goldfields it is difficult to assess the cumulative effect especially when other land users are also implicated.

In making a decision as to whether or not to refer an action to the Minister, the following are considered:

- 1. Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?*

Adult malleefowl were sighted in the development area in November 2012 when two active and occupied nesting mounds were found (Alexander Holm & Associates 2012). A recent intensive survey located three recently active, but not currently occupied, nesting mounds within the development area and another nearby. There were no sightings of birds or their tracks and minimal, isolated, non-species specific, litter disturbance (Alexander Holm & Associates 2021).

- 2. Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?*

The proposed development will destroy three recently active, but not currently occupied, nesting mounds. There is no evidence of current malleefowl activity in the development area which is experiencing extended drought conditions. The proposed development will not directly affect the malleefowl population. It is likely that some of these recently active nesting mounds could be re-used when seasonal conditions improve. In this event, alternative nesting sites will be required following destruction of these three nesting mounds. There is extensive preferred habitat (more than 2000ha) in adjacent areas which would provide suitable locations for the development of alternative nesting sites.

- 3. Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?*

Malleefowl have shown a habitat preference for low basalt hills and acacia shrubland which cover more than 2000ha in adjacent areas (Alexander Holm & Associates 2019). Alternative

nesting sites are therefore available thereby minimising the impact of destruction of three nesting mounds. One other recently active, but not currently occupied, nesting mound is approximately 55m from the proposed haul road. Disturbance in the vicinity of this mound will be avoided.

4. *Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?*

The proposed development and destruction of three un-occupied nesting mounds will not have a significant impact on populations of malleefowl in the Carosue Dam area. Northern Star will ensure clearing is completed outside of the breeding season while nesting mounds are un-occupied.

## **Action under the *Western Australian Biodiversity Conservation Act 2016***

Taking or disturbing threatened fauna requires authorisation from the Minister for Environment.

No malleefowl will be "taken" during the proposed clearing.

Development activity will destroy three recently active, but not currently occupied, nesting mounds and may impact one other nearby mound. There is no evidence of current malleefowl activity in the development area which is experiencing extended drought conditions. The proposed development is unlikely to directly disturb malleefowl while nesting mounds remain un-occupied.

## **Conclusions**

Malleefowl, which may be impacted by the proposed development, are part of a sparse, widely-dispersed population of unknown extent throughout the Western Australian arid zone.

Of the 12 nesting mounds affected by the proposed development, destruction of eight abandoned and failed mounds will have no negative impacts on malleefowl. The remaining four nesting mounds have been used in recent years but are currently un-occupied and there is no evidence of malleefowl in the development area. Three of these un-occupied nesting mounds will be destroyed through clearing and one other is within 55m of the proposed haul road.

Nesting mounds, which appear to be un-occupied during poor seasons, occur mostly on foot slopes of basalt hills and in acacia shrubland on extensive plains. Approximately 90ha of preferred habitat will be cleared during the proposed development. Plains supporting acacia shrubland and basalt hills occupy more than 2000ha in areas adjacent to the proposed development and cover extensive areas further out.

Northern Star have undertaken to monitor malleefowl activity in the vicinity of the four affected nesting mounds and ensure clearing is outside malleefowl breeding cycles while nesting mounds are un-occupied.

Destruction of three un-occupied malleefowl nesting mounds and 90ha of preferred habitat is unlikely to have a significant effect on a matter of national environmental significance, being populations of "vulnerable" malleefowl, due to the extensive habitat available in areas adjacent to the proposed development, and therefore does not warrant referral to the Australian Government Department of the Environment. Similarly, the proposed clearing is not considered to be "taking or disturbing" threatened fauna and therefore does not trigger the requirement for authorisation from the Western Australian Minister for Environment.

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**ENVIRONMENTAL ASSESSMENT:**

**TAILINGS STORAGE FACILITY  
EXPANSION**

**SARACEN GOLD MINES**



**Alexander Holm & Associates**  
Natural Resource Management Services

**December 2012**

Cover photograph: *Grevillea nematophylla* subsp. *nematophylla*



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Attachment 1: Results of database searches by Department of Environment and Conservation for rare and priority species
Attachment 2: Australian Government Department of Sustainability, Environment, Water, Population and Communities' Protected matters search tool output
Attachment 3: List of species found at each inventory site during field survey in November 2012
Attachment 4: Locations of inventory sites and site information.
Attachment 5: Example recording sheet.

# SUMMARY

This report for Saracen Gold Mines Pty Ltd covers environmental assessments and malleefowl survey to support clearing applications within a 680 ha survey area associated with expansion of a tailings storage facility in the Carosue dam area.

The TSF area was surveyed from November 17 - 21, 2012. The winter season preceding the survey was dry and very few annual species were recorded.

Twenty six inventory sites were assessed which provided systematic coverage of the area and encompassed slight variations in pattern within each land unit. Inventory data was supplemented by plant collections and observations during intensive walking traverses through the survey area.

Six land units were identified and associated vegetation communities and soil types described. Approximately 60% of the TSF survey area is occupied by either alluvial plains supporting halophytic low shrubland or plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Sand plains and sandy rises occupy 22% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or metamorphic rocks occupy the remainder.

‘Sandplain spinifex hummock grassland’ (SASP) occupies most of the elevated south western portion of the survey area. Other elevated land units on basalt, metamorphic rocks and laterite are mostly occupied by ‘Calcareous casuarina acacia shrubland or woodland’ (CCAS) except when bluebush (*Maireana* species) occurs where the landscape is in better condition in which case the vegetation type is ‘calcyphytic pearl bluebush shrublands’ (CPBS). CCAS vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands either with casuarina and eucalypt woodlands (PECW) or without (PXHS).

There are no known threatened ecological communities, priority ecosystem communities or wetlands of national significance or sub-regional significance in the area although nearby Lake Rebecca is an ecologically significant component of regional palaeo-channels.

Large tracts of the vegetation are degraded, some totally degraded, on the other hand spinifex communities (SASP) on sandplains and sandy rises are in pristine condition. PXHS and PECW vegetation communities are mostly in poor condition, occur on land units that are moderately vulnerable to erosion, and are thus rated as vulnerable to disturbance.

One hundred and thirty six flora taxa representing 25 families were found during field survey. Chenopodiaceae accounted for 23 taxa, Fabaceae and Myrtaceae 19 taxa each and Scrophulariaceae 15 taxa. There were no unidentified specimens. Species composition

and vegetation communities are typical of the area and not considered to be unusually diverse.

The collection of the following species at this location indicates a significant extension of their known distribution range:

- *Daviesia benthamii* subsp. *acanthoclona*
- *Eucalyptus flocktoniae* subsp. *flocktoniae*
- *Eucalyptus oleosa* subsp. *cylindroidea* (to be confirmed)
- *Marianthus bicolor*
- *Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155-109)
- *Thryptomene kochii*

No taxa are considered to be locally endemic.

No alien to Western Australia (weed) species were located during survey.

No listed threatened (rare) or endangered flora species were found.

A single plant of *Spartothamnella* sp. Helena & Aurora Range, a priority 3 species and a single population of at least 100 plants of *Eremophila arachnoides* subsp. *tenera*, a priority 1 species, were located during survey within the alluvial plain (land unit 5).

While few annual species were recorded, there have been several recent surveys in this general area and some have followed excellent winter seasons with abundant annuals during which only one priority annual species has been recorded: *Gunniopsis rubra* a priority 3 species. This species prefers damp habitats adjacent to saltlakes and it is considered unlikely that this or other priority annual species will occur within the survey area.

Malleefowl are active in the survey area. Three active and three moribund nests were located, tracks observed and two birds sighted during the survey. No clear habitat preference emerged from these observations with activity noted on most land units and vegetation types, although malleefowl appear to avoid areas with dense spinifex.

The survey area has been disturbed by recent mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands (land unit 5) and this land unit is rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerability to soil erosion and small areas on these units are slightly eroded.

The TSF landscape drains north-easterly from the south and west via overland flow through land units 4a and 5 to off-site drainage tracts which flow into Lake Rebecca 7 km to the north east. Disturbance to land unit 5 in particular, has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca.

Water tables are a) below the rooting depth of vegetation growing in these areas and b) hypersaline. Artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes and affect vegetation.

It is recommended that, in planning and implementing mining operations within the TSF survey area, the proponent:

- 1. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially alluvial plains (land unit 5).**
- 2. Avoids disturbance to the known locations of *Spartothamnella* sp. Helena & Aurora Range, and *Eremophila arachnoides* subsp. *tenera*.**
- 3. Monitors local water tables and vegetation surrounding the proposed TSF and prepares contingency plans to counter potentially deleterious impacts of rising water tables.**
- 4. Avoids disturbance within 100m of active malleefowl nests during nesting and incubation.**



# SCOPE OF WORKS

Alexander Holm & Associates were contracted by Saracen Gold Mines Pty Ltd (Saracen) to conduct the following surveys within a 680ha survey envelope associated with expansion of the Carosue Dam tailings storage facility (TSF):

- 1) An environmental assessment to include:
  - A review of available information on likelihood of a) presence of threatened (rare) or priority plant species and b) threatened plant communities in the general search area.
  - A flora and vegetation survey.
  - An assessment of landscape stability and condition.
  - A description of land units and relate information on flora, vegetation communities and landscape stability to these units.
  - A map of land units and associated vegetation.
  - A report on findings within a local and regional context
  - An assessment of the proposal against clearing principles.

The scope of works is to comply with EPA objectives for protection of the environment specifically to “ensure that flora and vegetation surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered” and to “enable an assessment of impacts on the conservation values and status of the site in a regional and local context” (Environmental Protection Authority, 2004).

- 2) A systematic search for evidence of malleefowl (*Leipoa ocellata*).

# REGIONAL OVERVIEW

## Regional setting

Carosue Dam TSF is approximately 115 km north east of Kalgoorlie Boulder, and south east of Lake Rebecca (Figure 1). It is within the north-eastern Goldfields region, Kalgoorlie-Boulder local government area, and partly within unallocated crown land (UCL), Gindalbie and Pinjin pastoral leases. It is located in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions (Desmond, Cowan & Chant, 2003).

The most extensive land use in the region is pastoralism and over 80% of this region is pastoral leasehold. Most of the remainder is unallocated crown land and less than 1% is set aside for nature conservation.



Figure 1: TSF extension survey area (in green) in relation to Lake Rebecca.



## Climate

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 at Kalgoorlie is 177.8 mm (in February) and 92.6 mm (in 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 173 mm respectively. (Data from [www.bom.gov.au](http://www.bom.gov.au)).

The average potential pan evaporation rate at Carosue Dam is approximately 2800 mm per annum<sup>1</sup>.

Winds are mostly light easterlies.

## Topography and drainage

Landform patterns in the general area 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 (Gentili, 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, Van Vreeswyk & Gilligan, 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 palaeo-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 palaeo-drainages, and local brine pools associated with salt lakes.

## 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, 1976). Lake Ballard/Lake Rebecca form a major vegetation divide with characteristic *Acacia aneura* (mulga) low woodlands associated with red loams over siliceous hardpan to the north and low woodlands of mixed mulga and *Casuarina obesa* (black oak) and *Eucalyptus* species on alkaline and calcareous soils to the south. Spinifex hummock

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<sup>1</sup> [http://www.bom.gov.au/cgi-bin/climate/cgi\\_bin\\_scripts/evaporation.cgi](http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/evaporation.cgi).

grassland with eucalypt overstory on sand plain is common. Halophytic vegetation occurs throughout the region on palaeo-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 eucalypt or mulga with saltbush or bluebush understoreys.

The most common vegetation associations in the survey area include Beard Vegetation Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.), 110 (Hummock grassland, shrub steppe and red mallee over spinifex) and 389 (Succulent steppe with open low woodland; mulga over saltbush) (Table 1).

**Table 1: Vegetation associations (Beard, 1976) in project area in comparison with South Laverton area (SLA), total area in WA and area within conservation reserves**

Veg Assn	Description	SLA Area km <sup>2</sup>	Reserve priority	Western Australia		
				Area km <sup>2</sup>	Within reserve km <sup>2</sup>	%
20	Low woodland; mulga mixed with <i>Casuarina obesa</i> and <i>Eucalyptus</i> spp.	7892	L	13045	2173	16.7
24	Low woodland; <i>Casuarina obesa</i>	15.2	L	265.6	2.4	0.9
110	Hummock grassland; shrub steppe and red mallee over spinifex	356	M	4746	1201	25.3
389	Succulent steppe with open low woodland; mulga over salt bush	2344	M	6465	230	3.6

L\*: Low; M: Medium; H: High priority for reservation

# ASSESSMENT METHODOLOGY

## Assessment personnel

The work was managed by Dr Alexander Holm (Alexander Holm & Associates) with botanical assistance from Mr Andrew Mitchell. Alec Holm is an ecologist with extensive experience in arid environments and Goldfield regions and an accredited environmental consultant with the Environmental Consultants Association of Western Australia.

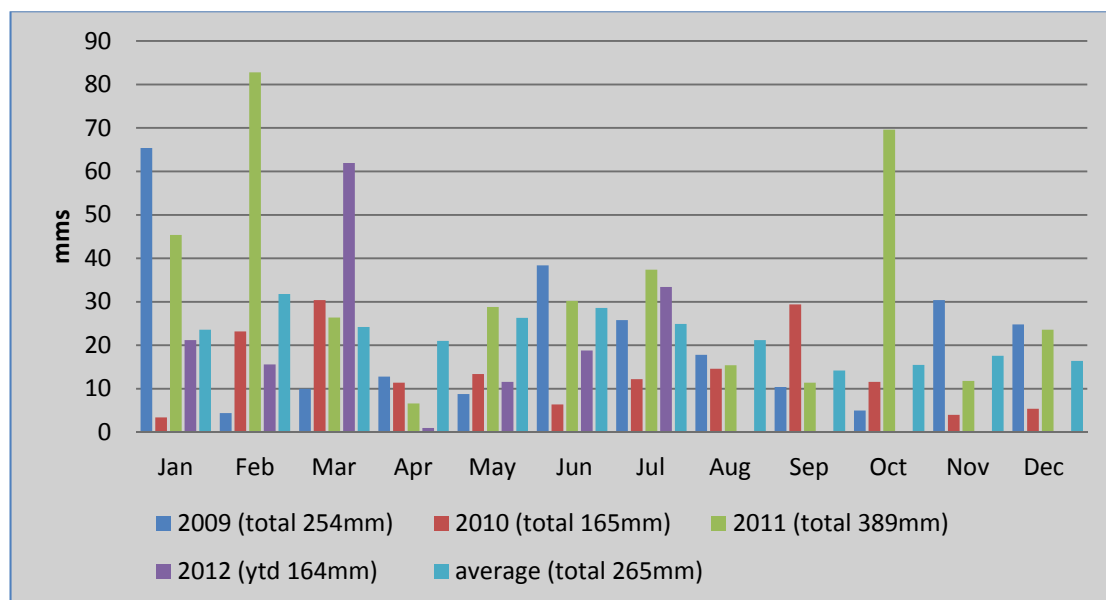
Mr Andrew Mitchell was assisting botanist to Western Australian Department of Agriculture's rangeland surveys, senior author of "Arid Shrubland Plants of Western Australia" (Mitchell & Wilcox, 1994) and recently retired botanist with AQIS (Australian Quarantine and Inspection Service).

Field work for the survey was conducted by Mr Mitchell and Dr Holm.

## Timing of survey and seasonal conditions

The TSF area was surveyed from November 17 - 21, 2012.

Rainfall during the summer of 2011-2012 was well above average and winter rains during 2012 below average (Figure 2). Some biannual herbs and grasses persisted from preceding seasons and were readily identified at the time of survey. On the other hand, there were very few annual species.



**Figure 2: Monthly rainfall (mm) at Kalgoorlie airport**

## Declared flora and fauna

Likelihood of presence of declared threatened or priority flora was inferred from Department of Environment and Conservations' Threatened and Priority Flora Database (TPFL), the WA Herbarium database (WAHerb) and the Threatened and Priority Flora Species List within a 70 km radial buffer area around 30 deg 04 min S; 122 deg 18 min E. (DEC data base searches dated July 10, 2012; Attachment 1).

The Department of Environment and Conservation's "NatureMap"<sup>2</sup> was also interrogated for records of all collected flora within a 40 km radius of the study area and the list was augmented by other recent searches from nearby survey areas (Alexander Holm & Associates, 2011).

Declared flora and fauna listed on Commonwealth Department of Sustainability, Environment, Water, Population and Communities' database of threatened species were identified for the study area using the protected matters search tool<sup>3</sup> (Attachment 2).

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<sup>2</sup><http://naturemap.dec.wa.gov.au/default.aspx>

<sup>3</sup><http://www.environment.gov.au/erin/ert/epbc/>

**Table 2: Declared threatened and priority flora under the WA Conservation Act and threatened species under the Commonwealth EPBC Act found in the general area.**

Taxa	Priority rating	Form	Habitat
<b>Aizoaceae</b>			
<i>Gunniopsis propinqua</i>	P3	Prostrate annual or perennial, herb, Fl. white/pink	Stony sandy loam. Lateritic outcrops, winter-wet sites.
<b>Amaranthaceae</b>			
<i>Ptilotus rigidus</i>	P1	?	?
<i>Ptilotus tetrandrus</i>	P1	Annual herb	Loamy sand
<b>Asteraceae</b>			
<i>Cratystylis centralis</i>	P3	Much-branched brittle, greyish low shrub	Red sandy loam with ironstone gravel. Flat plains, breakaway country.
<i>Olearia mucronata</i>	P3	Densely branched, unpleasantly aromatic mid high shrub. Fl. white & yellow	Schistose hills, along drainage channels
<i>Vittadinia cervicularis</i> var. <i>oldfieldii</i>	P1	Annual herb	Alluvium
<b>Chenopodiaceae</b>			
<i>Tecticornia flabelliformis</i>	P1	Erect low shrub	Clay. Saline flats
<i>Tecticornia mellaria</i>	P1	Erect low shrub	Well-drained red gypseous sand, clay. Gypseous dunes, margins of playa lakes, on clay pans.
<i>Tecticornia</i> sp. Lake Way (P. Armstrong 05/961) (NatureMap)	P1	?	?
<b>Cyperaceae</b>			
<i>Eleocharis papillosa</i>	P3/Vu	Annual	Red clay over granite, open clay flats. Claypans
<b>Fabaceae</b>			
<i>Acacia eremophila</i> numerous-nerved variant (A.S. George 11924)	P3	Dense spreading shrub	Sandy soils and flats
<i>Gastrolobium graniticum</i>	T/E	Erect open shrub	Sand, sandy loam, granite. Margins of rock outcrops, along drainage lines
<i>Mirbelia stipitata</i>	P3	Spiny low shrub	Red sandy loam

Taxa	Priority rating	Form	Habitat
<i>Phyllanthus baeckeoides</i>		Low to mid-height shrub. Fl. White-yellow/green yellow	Red lateritic & sandy clay soils. Granite outcrops.
<b>Goodeniaceae</b>			
<i>Dampiera eriantha</i>	P1	Erect perennial herb	?
<i>Goodenia lyrata</i>	P3	Prostrate herb with lyrate leaves	Red sandy loam. Near claypan
<i>Lechenaultia aphylla</i>	P1	Small, tangled low shrub, apparently leafless	Red sand. Slopes, drainage areas.
<b>Lamiaceae</b>			
<i>Hemigenia exilis</i>	P4	Erect, multi-stemmed mid-high shrub. Fl. blue-purple/white	Laterite. Breakaways, slopes.
<b>Myrtaceae</b>			
<i>Calytrix praecipua</i>	P3	Low shrub	Skeletal sandy soils over granite or laterite. Breakaways, outcrops.
<i>Eucalyptus articulata</i>	T	Straggly mallee, to 3m high.	Red sand, sandy loam. Arkose rubble. Sand dunes.
<i>Eucalyptus jutsonii</i> subsp. <i>jutsonii</i>	P4	Mallee, 4-7 m high, bark rough over most stems, grey to light grey-brown	Red to pale orange deep sands. Undulating areas and on dunes.
<i>Eucalyptus kruseana</i> (Bookleaf mallee)	P4	Straggly mallee, 2-3.5 m high, bark smooth.	Sandy loam. Granite outcrops & hills.
<i>Eucalyptus nigrifunda</i> (Desert wandoo)	P4	Tree, 5-7 m high, bark rough & black on trunk	Sandy clay. Breakaways of decomposing granite.
<i>Eucalyptus pimpiniana</i>	P3	Straggly shrubby mallee to 2m	Red sand. Sand dunes and plains.
<i>Eucalyptus x brachyphylla</i>	P3	Mallee or tree, to 4 m high, bark rough, flaky. White flowers	Sandy loam. Granite outcrops.
<i>Homalocalyx grandiflorus</i>	P3	Spreading shrub	Yellow sand, sandplains.
<i>Micromyrtus serrulata</i>	P3	Erect or somewhat spreading low to mid-height shrub. . Fl. white	Brownish sandy and clayey soils over granite.
<i>Micromyrtus serrulata</i>	P2	Erect open shrub	Red or yellow sand. Sandplains
<i>Thryptomene wittweri</i>	T	Spreading or rounded shrub	Skeletal red stony soils. Breakaways, stony creek beds.
<b>Phyllanthaceae</b>			
<i>Sauropus ramosissimus</i>	P3	Slender, much branched low shrub	?

Taxa	Priority rating	Form	Habitat
<b>Proteaceae</b>			
<i>Conospermum toddii</i> (Victoria desert smokebush)	P4	Spreading mid-height shrub. Fl. White/white yellow	Yellow sand. Sand dunes
<i>Grevillea phillipsiana</i>	P1	Prickly mid-height shrub	Red sand, stony loam. Granite hills.
<i>Hakea rigida</i>	P2	Mid to tall shrub	Sandy soils, yellow sand
<i>Persoonia leucopogon</i>	P1	Erect or decumbent low shrub	Sand or sandy clay
<b>Rutaceae</b>			
<i>Phebalium appressum</i>	P1	Mid-height rounded shrub	Yellow sandplain.
<i>Philotheca tubiflora</i>	P1	Compact, much branched low shrub	Rocky rises & hills, outcrops.
<b>Scrophulariaceae</b>			
<i>Eremophila annosocaulis</i>	P3	Low compact shrub.	Stony soils.
<i>Eremophila arachnoides subsp. tenera</i>	P1	Broom-like tall shrub, branches with tubercules	?
<i>Eremophila eversa</i>	P1	Shrub	?
<i>Eremophila mirabilis</i>	P2	Low to mid-height warty shrub	Clay sand, stony clayey loam. Granite country.
<i>Eremophila praecox</i>	P1	Mid shrub	Red/brown sandy loam. Undulating plains
<i>Eremophila simulans subsp. megacalyx</i>	P3	Erect mid-height shrub	?

- T - Declared rare flora – extant taxa either rare, in danger of extinction, or otherwise in need of special protection
- P1 Priority 1 – Poorly known taxa from one or two populations under threat.
- P2 Priority 2 – Poorly known taxa from one or two populations not all currently under threat
- P3 Priority 3 – Poorly known taxa from several populations at least some of which are not under threat
- P4 Priority 4 – Rare taxa not currently under threat
- E Endangered – Taxa facing a very high risk of extinction in the wild in the near future; Vu: Vulnerable (EPBC Act)

## **Threatened and priority ecological communities**

The likelihood of presence of threatened ecological communities within the general survey area was assessed by searches of Department of Environment and Conservation's database of threatened ecological communities. Commonwealth Department of Sustainability, Environment, Water, Population and Communities' database of threatened ecological communities and wetlands of national significance was assessed using the protected matters search tool (Attachment 2).

Other threatened ecosystems in the south-east of Eastern Murchison (MUR 1) biogeographic subregion, identified during "A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002", are listed in Cowan (2001).

Priority ecological communities in the area were assessed from Department of Environment and Conservation's provisional listing (Version 15, December 2010).



## Land systems land units and vegetation communities

Land systems and land units were derived from a land resource survey of north eastern Goldfields (Pringle, Van Vreeswyk & Gilligan, 1994). Land systems for the region south of the north eastern Goldfield survey have been tentatively identified by desk-top photographic interpretation and extrapolation (Department of Agriculture and Food WA).

Vegetation communities were established firstly with reference to those listed in Pringle *et al.* (1994) where they are listed as 'site types', and secondly, where no comparable community could be found, with reference to those listed in adjacent surveys of Sandstone, Yalgoo Paynes Find (Payne *et al.*, 1998) and Kambalda north (Payne, Mitchell & Hennig, 1998).

Tentative land units were identified by examination of high resolution aerial photography. Boundaries were checked in the field, transferred to geo-referenced ortho-photo maps and captured digitally. Vegetation communities were visually associated with each land unit.

## Field survey

### *Vegetation and flora survey*

Flora survey was according to guidance and position statements published by the Western Australian Environmental Protection Authority and is rated as an enhanced level 1 survey (Environmental Protection Authority, 2004).

Declared threatened and priority and other significant flora, likely to occur in the region, were identified along with their habitat preference and where necessary, the lead botanist inspected specimens of these species in the WA herbarium prior to survey. These species were specifically targeted during survey.

Twenty six inventory sites were selected to 1) sample each land unit within the survey area, 2) provide systematic coverage of the survey area, and 3) to encompass variations in pattern within each land unit. Each inventory site was located by GPS and the following information recorded:

- Digital photographs of a north, south, east and west aspect and of the soil surface. Representative photographs of the landscape and soil surface of each land unit are shown in Table 4.
- All flora species within approximately 50 m of a central location and in the same land unit were inventoried and voucher specimens collected of all taxa which were also compiled within a reference field herbarium.
- Vegetation condition and soil erosion were visually estimated using rating scales of Keighery (Keighery, 1994) and compared with standard rating scales used for rangeland surveys and described by Pringle *et al.* (2004).
- Vegetation community and land unit descriptions using terminology from Payne *et al.* (1998).

- Vegetation cover, landform, slope, elevation, surface coarse fragment characteristics and surface water flow characteristics (Anon, 2009).

These data were augmented by walking traverses by two surveyors throughout the entire survey area of approximately 60km as part of the survey for malleefowl. The survey aimed to:

- Locate priority or threatened flora.
- Locate species not previously recorded at inventory sites.

Details of inventory site locations and recorded information are presented in Appendix 4. An example recording sheet is attached (Appendix 5). All recording sheets have been scanned and are available for inspection if required.

### ***Malleefowl survey***

Malleefowl habitat considered most at risk from mining operations and adjoining areas encompassing approximately 90% of the survey area was searched for evidence of malleefowl. Operators searched along gridlines 50m apart using GPS devices to maintain position. Malleefowl tracks, active and dormant nests and malleefowl sightings were noted and coordinates recorded.

It is estimated that the search procedures were sufficient to locate 90 to 100% of active nests in less densely vegetated areas and 60 - 80% of active nests in more densely vegetated areas.

# ENVIRONMENTAL ANALYSIS

## Conservation estate

The TSF survey area falls mostly on Vegetation Association 20 (Low woodland; mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) and the remainder on Vegetation Association 24 (Plains with eucalypt woodlands with non-halophytic undershrubs) (Beard, 1976).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation (Table 1).

There are no conservation reserves within 50 km of the survey area (Appendix 1). The closest conservation area is Bullock Holes Reserve, approximately 60 km south 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) although Lake Rebecca is considered an ecologically significant component of inter-regional palaeo-channels.

There are no registered sites on State or National heritage registers.

Lake Rebecca is a registered mythological site.

## Land systems and landforms

Approximately 50% of the survey area consists of low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys of Moriarty land system. Plains with eucalypt woodlands with non-halophytic undershrubs of Deadman land system occupy 36% and most of the remainder is sandplain of Kirgella land system (Table 3).

**Table 3: Descriptions of land systems within the survey area (Pringle, Van Vreeswyk & Gilligan, 1994 and Department of Agriculture and Food, WA).**

Land type	Land system	Description	Soil and land management
Plains with eucalypt woodlands with non-halophytic undershrubs	Deadman	Level to gently undulating plains with casuarina-acacia shrublands.	Generally not susceptible to soil erosion
Sandplain spinifex hummock grasslands	Kirgella	Extensive sandplain with spinifex hummock grasslands and mulga and mallee shrublands	Prone to wildfires which temporarily render sands unstable.
Low hills with eucalypt or acacia woodlands with halophyte undershrubs	Lawrence	Low greenstone hills with ironstone ridges, supporting pearl bluebush shrublands with mixed eucalypt overstoreys.	Narrow drainage tracts are susceptible to water erosion.
Stony plains with acacia shrublands and halophytic shrubs	Moriarty	Low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys.	Slopes of low rises (land unit 2b), alluvial plains (land unit 5) and narrow drainage tracts (NA) are moderately susceptible to soil erosion.



## Land units, soil types and vegetation communities



### *Land unit descriptions and mapping*

Six land units were identified and associated vegetation communities and soil types described (Table 4).



A map of land units is overlain on an orthophoto map derived from aerial photography (insert).

**Table 4: Land unit descriptions, their soil type, vulnerability to erosion and associated vegetation communities.**

Land unit	Land form and soil type	Vegetation community
<b>2a. Low lateritic rises</b>		
	<p>Gentle low rises with slopes to 2%, relief up to 2 – 3 m, very abundant (&gt;90%) surface mantles of ironstone fine and medium gravel with occasional calcrete accumulations. Lithosols or red earthy soils.</p> <p>Run-off source zones, very low vulnerability to erosion.</p>	<p>Very sparse woodland (to 10 m) of <i>Casuarina obesa</i> with very sparse mid-height shrub layers (PFC* 10 %) dominated by <i>Eremophila scoparia</i>, <i>Scaevola spinescens</i>, <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>Acacia colletioides</i>. (CCAS)**.</p>
<b>2b. Low rises on basaltic or metamorphic rocks</b>		
	<p>Gently rounded hills, rises and gentle slopes to 7%, relief to 5 m, many to very abundant mantles (10 – &gt;90%) of fine to coarse gravels of dolerite, ironstone, shale, quartz and calcrete. Often with abundant cryptogams. Calcareous red earths.</p> <p>Run –off source zones water to lower parts of the landscape occasionally via shallow incised drainage channels. Very low to slight vulnerability to erosion.</p>	<p>Very sparse to mid-dense (PFC 10 – 35%) mixed height degraded chenopod shrublands (&lt;4 m) dominated by <i>Dodonaea lobulata</i>, <i>Senna artemisioides</i> subsp. <i>filifolia</i>, <i>Acacia burkittii</i> <i>Ptilotus obovatus</i> with isolated to very sparse tree layer (6 -15m) of <i>Casuarina obesa</i> and occasionally <i>Acacia incurvaneura</i>, <i>Grevillea nematophylla</i> subsp. <i>nematophylla</i> and/or <i>Alectryon oleifolius</i> (PFC &lt;1 – 3%). (CCAS).</p> <p>Less frequently shrublands dominated by <i>Maireana sedifolia</i> (CPBS)</p>

Land unit	Land form and soil type	Vegetation community
<b>2c. Sandy rises</b> 	<p>Broad sandy rise to 10m and slopes to 3%.</p> <p>Deep sandy soils.</p> <p>Slight vulnerability to erosion particularly following fire.</p>	<p>Sparse woodlands (PFC 5 -10%) dominated by <i>Acacia incurvaneura</i> and low mallees (4 - 10m) including <i>Eucalyptus eremicola</i>, <i>E.ceratocorys</i> and <i>E. oldfieldii</i> over a diverse sparse (PFC 20 -30%) shrubland (&lt;1.5 m) with spinifex (<i>Triodia irritans</i>) often dominated by myrtaceous shrubs. Shrubs include <i>Eremophila forrestii</i> subsp. <i>forrestii</i>, <i>Thryptomene kochii</i>, <i>Verticordia pritzelii</i>, <i>Prostanthera althoferi</i> subsp. <i>althoferi</i> and <i>Acacia effusifolia</i> (SASP)</p>
<b>4a. Plains supporting eucalypt or acacia shrublands</b> 	<p>Very gently inclined to level plains (slopes &lt;1.5%); mostly common to abundant (10 - 90%), but sometimes fewer (&lt;10%), mantles of ironstone fine gravel, calcrete nodules and quartz fragments, often abundant cryptogams. Deep calcareous red earthy soils.</p> <p>Broad transfer zones receiving water from upper units and shedding onto lower parts of landscape with occasional sheet and rill erosion. Slightly vulnerable to erosion.</p>	<p>Very sparse (PFC 1 -5%) tall acacia shrublands (4-6 m) dominated by <i>Acacia incurvaneura</i>, <i>Acacia aptaneura</i> or sparse (PFC 5 -25%) mid height (&lt;4m) acacia shrublands dominated by <i>Acacia burkittii</i> with overstoreys of isolated <i>Casuarina obesa</i> (CCAS) or <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i> (CEAS) and lower shrubs including <i>Dodonaea lobulata</i>, <i>Senna artemisioides</i> subsp. <i>filifolia</i>, and <i>Ptilotus obovatus</i>.</p>



Land unit	Land form and soil type	Vegetation community
<b>4b. Sand plains supporting sparse eucalypt woodlands .</b>		
	<p>Extensive gently sloping sand plain (slopes 2 -2.5%) with sandy or slightly crusted soil surfaces and abundant patchy litter. Deep sandy soils.</p> <p>Not vulnerable to soil erosion.</p>	<p>Very sparse (PFC 5%) eucalypt woodland (6 - 10m) of <i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>, <i>E. yilgarnensis</i> and <i>E. oleosa</i> subsp. <i>oleosa</i> over mixed height (0.5 – 3m), very sparse (PFC 5 -10%) shrubs including <i>Eremophila caperata</i>, <i>Acacia colletioides</i> and <i>Westringia rigida</i> and mid-dense (PFC 30-40%) <i>Triodia irritans</i>. (SASP)</p>
<b>5. Alluvial plains supporting chenopod shrublands .</b>		
	<p>Near level (slopes &lt;1 %) plains with very few to common surface mantles (&lt;2 – 20%) of fine and medium gravels of quartz, ironstone and calcrete nodules. Common to abundant cryptogams. Calcareous loamy red earths.</p> <p>Subject to occasional shallow sheet flow, occasionally more concentrated. Stripped soils surfaces common. Moderate vulnerability to erosion.</p>	<p>Very sparse to sparse (PFC 10 – 30%) mixed height chenopod shrublands (&lt;4 m) dominated by <i>Maireana sedifolia</i> <i>M. georgei</i>, <i>M. pyramidata</i>, <i>Atriplex vesicaria</i>, <i>Ptilotus obovatus</i> and others or in poor condition dominated by <i>Senna artemisioides</i> subsp. <i>filifolia</i>, <i>Eremophila scorparia</i>, <i>Dodonaea lobulata</i> and <i>Acacia burkittii</i> overtopped with isolated and clumped (PFC &lt;1 – 40% in clumps) tree layer (6 -15m) of <i>Casuarina obesa</i>, <i>Eucalyptus brachycorys</i> and <i>E. lesouefii</i> (PECW, PXHS).</p>

\* (PFC): Projected foliar cover

\*\* (CCAS etc.) vegetation types see Table 6.

### ***Land units within the TSF survey area***

Approximately 60% of the TSF survey area is occupied by either alluvial plains supporting halophytic low shrubland or plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Sand plains and sandy rises occupy 22% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or metamorphic rocks occupy the remainder (Table 5).

**Table 5: Area of each land unit within TSF extension survey area**

<b>Land unit</b>	<b>Description</b>	<b>Hectares</b>	<b>%</b>
2a.	Low lateritic rises	11.37	1.7
2b	Low rises on basaltic or metamorphic rocks	101.71	14.9
2c	Sandy rises	12.00	1.8
4a	Plains supporting eucalypt or acacia shrublands	218.51	32.1
4b	Sand plains supporting sparse eucalypt woodlands	138.73	20.3
5	Alluvial plains supporting chenopod shrublands	198.68	29.2
Total		681.00	100

### ***Vegetation communities within the TSF survey area***

‘Sandplain spinifex hummock grassland’ (SASP) occupies most of the elevated south western portion of the survey area (Table 6). Other elevated land units on basalt, metamorphic rocks and laterite are mostly occupied by ‘Calcareous casuarina acacia shrubland or woodland’ (CCAS) except when bluebush (*Maireana* species) occurs where the landscape is in better condition, in which case the vegetation type is ‘calcyphytic pearl bluebush shrublands’ (CPBS). CCAS vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands either with casuarina and eucalypt woodlands (PECW) or without (PXHS).



**Table 6: Vegetation communities, associated land units and vulnerability to disturbance.**

<b>Vegetation community*</b>	<b>Description</b>	<b>Land unit</b>	<b>Vulnerable</b>
CCAS	Calcareous casuarina acacia shrubland or woodland (P)	2a, 2b, 4a	
CEAS	Calcareous plain eucalypt mallee/acacia woodlands/shrublands (P)	4a	
CPBS	Calcyphytic peal bluebush shrublands (P)	2b	
PECW	Plain eucalypt chenopod woodland (P)	5	Yes
PXHS	Plain mixed halophyte low shrublands (P)	5	Yes (C)
SASP	Sandplain spinifex hummock grassland (P)	2c, 4b	

\*(P)(Pringle, Van Vreeswyk & Gilligan, 1994); (C) (Cowan, 2001)

## Vegetation and soil condition

The survey area has been disturbed by recent mining activity and is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Large tracts of the vegetation are degraded (score 4-5), some totally degraded (score 6) (Table 7). Spinifex communities (SASP) on sandplains and sandy rises are not suitable for grazing and are in pristine condition (score 1). PXHS and PECW vegetation communities are mostly in poor condition, occur on land units that are moderately vulnerable to erosion and are thus rated as vulnerable to disturbance (Table 6).

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands (land unit 5) and this land unit is rated moderately vulnerable to erosion (Table 7). Other land units are mostly rated nil or slight vulnerability to soil erosion and small areas on these units are slightly eroded (Table 7).

**Table 7: Vegetation and soil surface condition ratings for each land unit with outliers in parenthesis**

Land unit	Perennial cover (%)	Vegetation condition @	Vulnerability to erosion	Erosion	Slope (%)
2a. Low lateritic rises.	10	5	Nil	Nil	2
2b. Low rises on basaltic or metamorphic rocks.	10–35	3 (4–5)	Nil to slight	Nil (minor)	(1–4) 7
2c. Sandy rises.	40	1	Nil	Nil	3
4a. Plains supporting eucalypt or acacia shrublands .	10–25	4 (5–6)	Slight	Nil to minor	0–1 (1.5)
4b. Sand plains supporting sparse eucalypt woodlands .	30–40	1	Nil	Nil	2–2.5
5. Alluvial plains supporting chenopod shrublands	10 – 30 (50)	3 (4–5) 6	Moderate	Nil (minor to moderate)	0–1

@ 1: Pristine – 6 totally degraded

## Threatened ecosystems and wetlands.

### *Threatened and priority ecological communities*

There are no identified threatened ecological communities (TECs) on Saracen tenements or in the entire MUR1 biogeographic subregion (Cowan, 2001).

There are no listed priority ecological communities (PECs) in the area.

### *Ecosystems at risk*

Cowan, (2001) lists PXHS vegetation community (Plain mixed halophyte low shrublands) as an ecosystem at risk to disturbance. This current survey also identifies PECW (Plain eucalypt chenopod woodland) as an ecosystem at risk. PXHS and PECW occur on land unit 5 which is moderately vulnerable to erosion (Table 6).

### *Significant wetlands*

There are no nationally significant wetlands in the area (Appendix 1). Lake Rebecca is a major wetland with local and regional significance.

### *Riparian vegetation*

There are no defined drainage channels, playas or other wet lands in the survey area and no riparian vegetation is at risk.

# Flora

## **General**

One hundred and thirty six flora taxa representing 25 families were found during field survey (Table 8). Chenopodiaceae accounted for 23 taxa, Fabaceae and Myrtaceae 19 taxa each and Scrophulariaceae 15 taxa. There were no unidentified specimens.

A list of species within each family found at each inventory site and during traverse is presented in Attachment 3. Species typifying the survey area include: *Acacia tetragonophylla* and *Scaevola spinescens* (present on 24 of the 26 sites); *Ptilotus obovatus* (23 sites) *Acacia burkittii*, *Casuarina obesa* and *Senna artemisioides* subsp. *filifolia* (20 sites).

## **Local endemics**

No taxa are considered to be locally endemic.

## **Extension of distribution range**

The collection of the following species at this location indicates a significant extension of their known distribution range:

- *Daviesia benthamii* subsp. *acanthoclona*
- *Eucalyptus flocktoniae* subsp. *flocktoniae*
- *Eucalyptus oleosa* subsp. *cylindroidea* (to be confirmed)
- *Marianthus bicolor*
- *Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155-109)
- *Thryptomene kochii*

## **Declared species**

No alien to Western Australia (weed) species were located during survey.

**Table 8: List of species found within the TSF survey area on each land unit during field survey in November 2012.**

Family	Taxa	Priority	Range Extn	Land unit					
				2a	2b	2c	4a	4b	5
Amaranthaceae	<i>Ptilotus nobilis</i>							Y	
Amaranthaceae	<i>Ptilotus obovatus</i>			Y	Y		Y		Y
Apocynaceae	<i>Marsdenia australis</i>			Y	Y		Y		Y
Apocynaceae	<i>Alyxia buxifolia</i>			Y	Y		Y	Y	
Asteraceae	<i>Olearia subspicata</i>							Y	
Asteraceae	<i>Cratystylis subspinescens</i>								Y
Asteraceae	<i>Olearia exiguifolia</i>							Y	
Asteraceae	<i>Olearia muelleri</i>			Y	Y		Y		Y
Boraginaceae	<i>Halgania cyanea</i> var. <i>Charleville</i> (R.W. Purdie +111)						Y		
Boraginaceae	<i>Halgania erecta</i>					Y			
Casuarinaceae	<i>Casuarina obesa</i>			Y	Y		Y		Y
Casuarinaceae	<i>Allocasuarina helmsii</i>							Y	
Chenopodiaceae	<i>Maireana georgei</i>			Y	Y		Y		Y
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>				Y				Y
Chenopodiaceae	<i>Maireana triptera</i>				Y		Y		Y
Chenopodiaceae	<i>Maireana trichoptera</i>				Y				Y
Chenopodiaceae	<i>Maireana tomentosa</i>								Y
Chenopodiaceae	<i>Maireana villosa</i>								Y
Chenopodiaceae	<i>Maireana sedifolia</i>			Y	Y		Y		Y
Chenopodiaceae	<i>Maireana pyramidata</i>								Y
Chenopodiaceae	<i>Maireana pentatropis</i>				Y				Y
Chenopodiaceae	<i>Maireana integra</i>								Y
Chenopodiaceae	<i>Rhagodia drummondii</i>							Y	
Chenopodiaceae	<i>Tecticornia disarticulata</i>								Y
Chenopodiaceae	<i>Salsola australis</i>				Y		Y		Y
Chenopodiaceae	<i>Maireana carnosae</i>								Y
Chenopodiaceae	<i>Enchylaena lanata</i>								Y
Chenopodiaceae	<i>Rhagodia eremaea</i>			Y	Y		Y		Y
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>				Y				Y

Family	Taxa	Priority	Range Extn	Land unit					
				2a	2b	2c	4a	4b	5
Chenopodiaceae	<i>Atriplex bunburyana</i>								Y
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>				Y		Y		Y
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>				Y				Y
Chenopodiaceae	<i>Sclerolaena drummondii</i>			Y	Y				Y
Chenopodiaceae	<i>Sclerolaena diacantha</i>				Y				Y
Chenopodiaceae	<i>Atriplex vesicaria</i>								Y
Convolvulaceae	<i>Duperreya commixta</i>					Y			
Convolvulaceae	<i>Convolvulus clementii</i>								Y
Euphorbiaceae	<i>Bertya dimerostigma</i>					Y		Y	
Fabaceae	<i>Acacia effusifolia</i>					Y			
Fabaceae	<i>Acacia ramulosa</i>						Y		Y
Fabaceae	<i>Acacia hemiteles</i>				Y		Y	Y	Y
Fabaceae	<i>Acacia colletioides</i>			Y	Y		Y	Y	Y
Fabaceae	<i>Acacia burkittii</i>				Y		Y	Y	Y
Fabaceae	<i>Acacia aptaneura</i>				Y		Y		
Fabaceae	<i>Acacia oswaldii</i>				Y				Y
Fabaceae	<i>Acacia jennerae</i>							Y	
Fabaceae	<i>Acacia kempeana</i>				Y		Y		
Fabaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>				Y		Y		Y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>petiolaris</i>				Y				
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>			Y	Y		Y		Y
Fabaceae	<i>Acacia ligulata</i>				Y		Y	Y	
Fabaceae	<i>Templetonia incrassata</i>			Y	Y		Y		
Fabaceae	<i>Acacia incurvaneura</i>				Y	Y	Y	Y	Y
Fabaceae	<i>Acacia resinimarginea</i>							Y	
Fabaceae	<i>Acacia tetragonophylla</i>			Y	Y	Y	Y	Y	Y
Fabaceae	<i>Acacia erinacea</i>				Y				Y
Fabaceae	<i>Daviesia benthamii</i> subsp. <i>acanthoclona</i>		Y					Y	
Frankeniaceae	<i>Frankenia interioris</i>								Y
Goodeniaceae	<i>Cooperhooia strophilata</i>							Y	
Goodeniaceae	<i>Scaevola spinescens</i>			Y	Y		Y	Y	Y
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>					Y	Y	Y	

Family	Taxa	Priority	Range Extn	Land unit					
				2a	2b	2c	4a	4b	5
Lamiaceae	<i>Westringia rigida</i>					Y		Y	
Lamiaceae	<i>Teucrium racemosum</i>								Y
Lamiaceae	<i>Physopsis viscida</i>						Y		
Lamiaceae	<i>Westringia cephalantha</i>							Y	
Lamiaceae	<i>Spartothamnella teucriiflora</i>				Y				
Lamiaceae	<i>Spartothamnella</i> sp. Helena & Aurora Range (P.G. Armstrong 155-109)	P3	Y						Y
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>						Y		
Loranthaceae	<i>Amyema miquelii</i>						Y	Y	
Malvaceae	<i>Brachychiton gregorii</i>								Y
Malvaceae	<i>Sida ectogama</i>								Y
Malvaceae	<i>Sida</i> sp. dark green fruits (S. van Leeuwen 2260)							Y	
Myrtaceae	<i>Aluta aspera</i> subsp. <i>aspera</i>					Y			
Myrtaceae	<i>Eucalyptus brachycorys</i>						Y	Y	Y
Myrtaceae	<i>Eucalyptus salmonophloia</i>								Y
Myrtaceae	<i>Enekbatus cryptandroides</i>					Y			
Myrtaceae	<i>Leptospermum fastigiatum</i>							Y	
Myrtaceae	<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>		Y					Y	
Myrtaceae	<i>Eucalyptus leptopoda</i> subsp. <i>leptopoda</i>							Y	
Myrtaceae	<i>Eucalyptus lesouefii</i>								Y
Myrtaceae	<i>Eucalyptus oldfieldii</i>					Y			
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>				Y		Y	Y	Y
Myrtaceae	<i>Eucalyptus ceratocorys</i>					Y			
Myrtaceae	<i>Eucalyptus eremicola</i>			Y		Y		Y	
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>cylindroidea</i>		Y			Y			
Myrtaceae	<i>Eucalyptus yilgarnensis</i>				Y				
Myrtaceae	<i>Melaleuca eleuterostachya</i>							Y	
Myrtaceae	<i>Melaleuca interioris</i>							Y	
Myrtaceae	<i>Thryptomene kochii</i>		Y			Y			
Myrtaceae	<i>Verticordia pritzelii</i>					Y			
Myrtaceae	<i>Eucalyptus concinna</i>				Y				
Pittosporaceae	<i>Marianthus bicolor</i>		Y			Y			

Family	Taxa	Priority	Range Extn	Land unit					
				2a	2b	2c	4a	4b	5
Pittosporaceae	<i>Pittosporum angustifolium</i>				Y				Y
Pittosporaceae	<i>Bursaria occidentalis</i>					Y		Y	Y
Poaceae	<i>Enneapogon caerulescens</i>				Y				
Poaceae	<i>Eragrostis dielsii</i>								Y
Poaceae	<i>Paspalidium constrictum</i>								Y
Poaceae	<i>Eragrostis eriopoda</i>						Y		Y
Poaceae	<i>Enneapogon avenaceus</i>								Y
Poaceae	<i>Austrostipa elegantissima</i>			Y	Y		Y		
Poaceae	<i>Austrostipa plumigera</i>			Y					
Poaceae	<i>Triodia irritans</i>					Y	Y	Y	
Poaceae	<i>Aristida contorta</i>				Y				
Proteaceae	<i>Grevillea juncifolia</i> subsp. <i>juncifolia</i>					Y			
Proteaceae	<i>Hakea francisiana</i>							Y	
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>sarissa</i>							Y	
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>				Y	Y			
Rubiaceae	<i>Psyrax suaveolens</i>				Y	Y			
Rutaceae	<i>Phebalium canaliculatum</i>					Y			
Santalaceae	<i>Santalum acuminatum</i>			Y			Y	Y	
Santalaceae	<i>Exocarpos aphyllus</i>								Y
Santalaceae	<i>Santalum spicatum</i>				Y		Y	Y	Y
Sapindaceae	<i>Dodonaea amblyophylla</i>					Y			
Sapindaceae	<i>Dodonaea lobulata</i>			Y	Y		Y		Y
Sapindaceae	<i>Dodonaea rigida</i>						Y		
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>				Y		Y		Y
Sapindaceae	<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>								Y
Scrophulariaceae	<i>Eremophila platythamnus</i> subsp. <i>platythamnus</i>							Y	
Scrophulariaceae	<i>Eremophila scoparia</i>			Y	Y		Y		Y
Scrophulariaceae	<i>Eremophila arachnoides</i> subsp. <i>tenera</i>	P1							Y
Scrophulariaceae	<i>Eremophila caperata</i>							Y	
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>			Y	Y				
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>			Y	Y		Y		Y
Scrophulariaceae	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>						Y		Y

Family	Taxa	Priority	Range Extn	Land unit					
				2a	2b	2c	4a	4b	5
Scrophulariaceae	<i>Eremophila granitica</i>				Y	Y	Y		Y
Scrophulariaceae	<i>Eremophila glabra</i> subsp. <i>glabra</i>				Y		Y		
Scrophulariaceae	<i>Eremophila georgei</i>								Y
Scrophulariaceae	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>					Y			
Scrophulariaceae	<i>Eremophila eriocalyx</i>						Y		
Scrophulariaceae	<i>Eremophila clarkei</i>								Y
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>			Y	Y	Y	Y		Y
Scrophulariaceae	<i>Eremophila alternifolia</i>						Y		Y
Solanaceae	<i>Solanum lasiophyllum</i>								Y
Solanaceae	<i>Solanum plicatile</i>						Y		
Solanaceae	<i>Lycium australe</i>								Y
Zygophyllaceae	<i>Zygophyllum glaucum</i>							Y	

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## Threatened and priority flora

There are three declared species of threatened flora (WA Wildlife Conservation Act 1950 – Wildlife Conservation (Rare Flora) Notice 2010(2)) likely to occur in the general area: *Thryptomene wittweri*, *Eucalyptus articulata* and *Gastrolobium graniticum* which is also an endangered species under the Commonwealth EPBC Act (Table 2).

No threatened (rare) or endangered species were found during field survey.

Two priority species were found during field survey: one plant of *Spartothamnella* sp. Helena & Aurora Range (P3) and over 100 plants of *Eremophila arachnoides* subsp. *tenera* (P1)(Figure 3).

## Fauna

### Habitat

Fauna refugia in the region include breakaways, rock outcrops, rocky hilltops, drainage lines, dampland areas adjacent to salt lakes and salt lakes after heavy rainfall.

The TSF survey area contains none of these features.

### Malleefowl

Malleefowl were active in the survey area. Three active and three moribund nests were located, tracks observed and two birds sighted during the survey (Table 9). No clear habitat preference emerged from these observations with activity noted on most land units and vegetation types, although malleefowl appear to avoid areas with dense spinifex.

**Table 9: Locations and habitat associated with malleefowl observations**

Observation	Easting	Northing	Land unit	Vegetation type
<b>Zone 51</b>				
Active nest	435355	6664526	2c	SASP
Active nest	436137	6664564	4b	SASP
Active nest	436328	6664992	4a	CEAS
Moribund nest	436958	6664353	4a	CEAS
Moribund nest	435953	6665082	2b	CEAS
Moribund nest	436958	6664353	4a	CCAS
Tracks	435391	6666265	5	PECW
Adult bird	436511	6665082	4a	CEAS
Adult bird	434723	6666650	5	PECW



*Spartothamnella* sp. Helena & Aurora  
Range P3

Location: Zone 51 436219E  
6666827N

Land unit: 5

Vegetation type: PXHS

Number of plants: 1



*Eremophila arachnoides* subsp.  
*tenera* P1

Location: Zone 51 435560E  
6667100N

Land unit 5

Vegetation type PXHS

Number of plants: >100

**Figure 3: Priority species within survey area and their location, habitat and abundance**

## Hydrological summary

The TSF landscape drains north-easterly from the south and west via overland flow through land units 4a and 5 to off-site drainage tracts which flow into Lake Rebecca 7 km to the north east.

Groundwater within the in the vicinity of the existing tailings facility is hypersaline (30,000 to 120,000 mg/l TDS) and between 15 and 60m below ground level (Saracen annual ground water report). Groundwater beneath the sandplain and sandy rise to the southwest of the survey area is likely to be less saline however no data exists for this aquifer.

# ASSESSMENT OF TSF EXTENSION IN RELATION TO CLEARING PRINCIPLES

Results of this survey are used to assess clearing within the TSF extension survey area in relation to ten clearing principles prescribed in Schedule 5 under amendments in 2004 to the Environmental Protection Act (1986):

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

The survey area is in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions. Lake Ballard/Lake Rebecca form 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 (black oak) and *Eucalyptus* species on alkaline and calcareous soils to the south. The survey area straddles this vegetation divide.

‘Sandplain spinifex hummock grassland’ (SASP) occupies most of the elevated south western portion of the survey area. Other elevated land units on basalt, metamorphic rocks and laterite are mostly occupied by ‘Calcareous casuarina acacia shrubland or woodland’ (CCAS) except when bluebush (*Maireana* species) occurs where the landscape is in better condition in which case the vegetation type is ‘calcyphytic pearl bluebush shrublands’ (CPBS). CCAS vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands either with casuarina and eucalypt woodlands (PECW) or without (PECW). Large tracts of the vegetation, except for spinifex communities (SASP), are degraded, some totally degraded.

Vegetation associations and species composition are typical of the area, most are in poor condition and are not considered to be unusually diverse.

One hundred and thirty six flora taxa representing 25 families were found during field survey. A single plant of *Spartothamnella* sp. Helena & Aurora Range, a priority 3 species and a single population of at least 100 plants of *Eremophila arachnoides* subsp. *tenera*, a priority 1 species, were located during survey.

**Proposal may 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.**

Malleefowl are active in the survey area. Three active and three moribund nests were located, tracks observed and two birds sighted during the survey. No clear habitat

preference emerged from these observations with activity noted on most land units and vegetation types, although mallefowl appear to avoid areas with dense spinifex.

**Proposal is 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 listed species of rare or critically endangered flora were found during this survey.

A search of the Department of Environment and Conservation's Rare and Priority Flora Database revealed no records of Declared Rare Flora (DRF) in or nearby the survey area.

**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 east Goldfields subregion (Cowan, 2001).

There are no Priority Ecological Communities within or adjacent to the survey area.

**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.**

The TSF survey area falls mostly on Vegetation Association 20 (Low woodland; mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) and the remainder on Vegetation Association 24 (Plains with eucalypt woodlands with non-halophytic undershrubs).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation.

Neither vegetation community has been extensively cleared and clearing within this survey area will have minimal effect on extent of these vegetation communities.

**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.**

The TSF landscape drains north-easterly from the south and west via overland flow through land units 4a and 5 to off-site drainage tracts which flow into Lake Rebecca 7 km to the north east. There are no defined water courses or wetlands within the survey area.

**Proposal is not 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 has been disturbed by recent mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Large tracts of the vegetation are degraded, some totally degraded on the other hand spinifex communities (SASP), on sandplains and sandy rises, are in pristine condition. PXHS and PECW vegetation communities are mostly in poor condition, occur on land units that are moderately vulnerable to erosion and are thus rated as vulnerable to disturbance.

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands (land unit 5) and this land unit is rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerability to soil erosion and small areas on these units are slightly eroded.

Water tables are a) below the rooting depth of vegetation growing in these areas and b) hypersaline. Extensive clearing of vegetation at catchment-scale or artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes.

Clearing of vegetation at local scales will have minimal, if any, effect on water tables and associated risk of secondary salinity. Tailings disposal has the potential to raise water tables.

**Proposal is potentially 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 are nearby.

**Proposal is 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.**

Approximately 60% of the TSF survey area is occupied by either alluvial plains supporting halophytic low shrubland or plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Sand plains and sandy rises occupy 22% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or metamorphic rocks occupy the remainder

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands (land unit 5) and this land unit is rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerability to soil erosion and only small areas on these units are slightly eroded.

Disturbance to land unit 5 has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca.

The climate is arid to semi-arid with 230 mm of annual rainfall and annual evaporation rates are about 3200 mm. Natural recharge to groundwater is limited to years of extreme rainfall, on the other hand, the proposed tailings discharge may result in artificial recharge of water tables.

**Proposal is potentially 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 1967 and 1984, will result in runoff.

The TSF landscape drains north-easterly from the south and west via overland flow through land units 4a and 5 to off-site drainage tracts which flow into Lake Rebecca 7 km to the north east.

Clearing in this proposal will have negligible effect on the volume of runoff discharged.

**Proposal is unlikely to be at variance with this principle.**

# DISCUSSION AND RECOMMENDATIONS

The TSF survey area in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions.

Six land units were identified and associated vegetation communities and soil types described. Approximately 60% of the TSF survey area is occupied by either alluvial plains supporting halophytic low shrubland or plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Sand plains and sandy rises occupy 22% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or metamorphic rocks occupy the remainder.

‘Sandplain spinifex hummock grassland’ (SASP) occupies most of the elevated south western portion of the survey area. Other elevated land units on basalt, metamorphic rocks and laterite are mostly occupied by ‘Calcareous casuarina acacia shrubland or woodland’ (CCAS) except when bluebush (*Maireana* species) occurs where the landscape is in better condition, in which case the vegetation type is ‘calcyphytic pearl bluebush shrublands’ (CPBS). CCAS vegetation also occurs on lower plains while the lowest parts of the landscape are alluvial plains with halophytic shrublands either with casuarina and eucalypt woodlands (PECW) or without (PXHS).

There are no known threatened ecological communities, priority ecosystem communities or wetlands of national significance or sub-regional significance in the area although nearby Lake Rebecca is an ecologically significant component of regional palaeo-channels.

Large tracts of the vegetation are degraded, some totally degraded, on the other hand spinifex communities (SASP) on sandplains and sandy rises are in pristine condition. PXHS and PECW vegetation communities are mostly in poor condition, occur on land units that are moderately vulnerable to erosion and are thus rated as vulnerable to disturbance

One hundred and thirty six flora taxa representing 25 families were found during field survey. Chenopodiaceae accounted for 23 taxa, Fabaceae and Myrtaceae 19 taxa each and Scrophulariaceae 15 taxa. The winter season preceding the survey was dry and very few annual species were recorded. There have been several recent surveys in this general area and some have followed excellent winter seasons with abundant annuals (Alexander Holm & Associates, 2011, 2012). During these surveys only one priority annual species has been recorded: *Gunniiopsis rubra* a priority 3 species. . This species prefers damp habitats adjacent to saltlakes and it is considered unlikely that this or other priority annual species will occur within the survey area.



Species composition and vegetation associations are typical of the region; most associations are degraded and not considered to be unusually diverse.

No alien to Western Australia (weed) species were located during survey.

A single plant of *Spartothamnella* sp. Helena & Aurora Range, a priority 3 species and a single population of at least 100 plants of *Eremophila arachnoides* subsp. *tenera*, a priority 1 species, were located during survey.

Malleefowl are active in the survey area. Three active and three moribund nests were located, tracks observed and two birds sighted during the survey. No clear habitat preference emerged from these observations with activity noted on most land units and vegetation types, although malleefowl appear to avoid areas with dense spinifex.

The survey area has been disturbed by recent mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Minor to moderate soil erosion is evident on alluvial plains supporting chenopod shrublands (land unit 5) and this land unit is rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerability to soil erosion and small areas on these units are slightly eroded.

The TSF landscape drains north-easterly from the south and west via overland flow through land units 4a and 5 to off-site drainage tracts which flow into Lake Rebecca 7 km to the north east. Disturbance to land unit 5 has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca.

Water tables are a) below the rooting depth of vegetation growing in these areas and b) hypersaline. Artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes.

It is recommended that, in planning and implementing mining operations within the TSF survey area, the proponent:

- 1. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially alluvial plains (land unit 5).**
- 2. Avoids disturbance to the known locations of *Spartothamnella* sp. Helena & Aurora Range, and *Eremophila arachnoides* subsp. *tenera*.**
- 3. Monitors local water tables and vegetation surrounding the proposed TSF and prepares contingency plans to counter potentially deleterious impacts of rising water tables.**
- 4. Avoids disturbance within 100m of active malleefowl nests during nesting and incubation.**



# REFERENCES

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## **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: Results of database searches by  
Department of Environment and Conservation for  
threatened and priority species**







Department of  
**Environment and Conservation**

*Our environment, our future*



Your Ref:

Our Ref: **40-0712FL**

Enquiries: Jessica Donaldson

Phone: (08) 9334 0123

Fax: (08) 9334 0278

Email: [jessica.donaldson@dec.wa.gov.au](mailto:jessica.donaldson@dec.wa.gov.au)

**Alexander Holm & Associates**

PO Box 1835  
FREMANTLE WA 6959

Attention: Alec Holm

Dear Alec Holm,

**REQUEST FOR THREATENED AND PRIORITY FLORA INFORMATION**

I refer to your request of 17 July 2012 for Threatened (Declared Rare) and Priority Flora information in the Lake Rebecca area. The search was conducted within a 70km radial area from the central coordinate you submitted.

A search was undertaken for this area of **(1)** the Department's *Threatened (Declared Rare) and Priority Flora* database (for results, *if any*, see "TPFL" – coordinates are GDA94), **(2)** the *Western Australian Herbarium Specimen* database for priority species opportunistically collected in the area of interest (for results, *if any*, see "WAHERB" – coordinates are GDA94 – see condition number 9 in the attached 'Conditions in Respect of Supply' and **(3)**, the Department's *Threatened and Priority Flora List* [this list is searched using 'place names'. This list, which may also be used as a species target list, contains species that are declared rare (Conservation Code R or X for those presumed to be extinct), poorly known (Conservation Codes 1, 2 or 3), or require monitoring (Conservation Code 4) – for results, *if any*, see "TP List"]. The results are attached electronically to this email.

Attached also are the conditions under which this information has been supplied. Your attention is specifically drawn to the seventh point, which refers to the requirement to undertake field investigations for the accurate determination of Threatened and Priority flora occurrence at a site. *The information supplied should be regarded as an indication only of the Threatened and Priority flora that may be present and may be used as a target list in any surveys undertaken.*

The information provided does not preclude you from obtaining and complying with, where necessary, land clearing approvals from other agencies.

An invoice for \$300 (plus GST) to supply this information will be forwarded.

It would be appreciated if any populations of Threatened and Priority flora you encounter in the area could be reported to this Department to ensure their ongoing management.

If you require any further details, or wish to discuss Threatened and Priority flora management, please contact Dr Ken Atkins, Manager, Species and Communities Branch, on (08) 9334 0455.

Yours faithfully

Jessica Donaldson

.....  
for Keiran McNamara  
DIRECTOR GENERAL

20 July 2012

**Species and Communities Branch**

17 Dick Perry Ave, Technology Park, Kensington

Phone: (08) 9334 0455 Fax: (08) 9334 0278

Locked Bag 104, Bentley Delivery Centre, Bentley, Western Australia 6983

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**DEPARTMENT OF ENVIRONMENT AND CONSERVATION**  
**THREATENED (DECLARED RARE) AND PRIORITY FLORA INFORMATION**  
**CONDITIONS IN RESPECT OF SUPPLY OF INFORMATION**

1. All requests for data to be made in writing to the Director General, Department of Environment and Conservation, Attention: Threatened Flora Database Officer, Species and Communities Branch.
2. The data supplied may not be supplied to other organisations, nor be used for any purpose other than for the project for which they have been provided, without the prior written consent of the Director General, Department of Environment and Conservation.
3. Specific locality information for Threatened and Priority Flora is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information may not be used in public reports without the written permission of the Director General, Department of Environment and Conservation. Publicly available reports may only show generalised locations or, where necessary, show specific locations without identifying species. Species and Communities Branch is to be contacted for guidance on the presentation of Threatened and Priority Flora information.
4. Note that the Department of Environment and Conservation respects the privacy of private landowners who may have Threatened and Priority Flora on their property. Threatened and Priority Flora locations identified in the data as being on private property should be treated in confidence, and contact with property owners made through the Department of Environment and Conservation.
5. Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data provided, they may be present. The Department of Environment and Conservation accepts no responsibility for this.
6. Receiving organisations must also recognise that the database is subject to continual updating and amendment, and such considerations should be taken into account by the user.
7. **It should be noted that the supplied data do not necessarily represent a comprehensive listing of the Threatened and Priority Flora of the area in question. Its comprehensiveness is dependant on the amount of survey carried out within the specified area. The receiving organisation should employ a botanist, if required, to undertake a survey of the area under consideration.**
8. Acknowledgment of the Department of Environment and Conservation as source of the data is to be made in any published material. The unique reference number that is given upon the request for information should be quoted when referencing the data. Copies of all such publications are to be forwarded to the Department of Environment and Conservation, Attention: The Manager, Species and Communities Branch.
9. The development of the PERTH Herbarium database was not originally intended for electronic mapping (eg. GIS ArcView). The latitude and longitude coordinates for each entry are not verified prior to being databased. It is only in recent times that collections have been submitted with GPS coordinates. Therefore, be aware when using this data in ArcView that some records may not plot to the locality description given with each collection.

**Species and Communities Branch**

17 Dick Perry Ave, Technology Park, Kensington

Phone: (08) 9334 0455 Fax: (08) 9334 0278

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# DECLARED RARE AND PRIORITY FLORA LIST

## CONSERVATION CODES

for Western Australian taxa

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**T:**        **Threatened Flora** (Declared Rare Flora - Extant )  
Schedule 1 under the *Wildlife Conservation Act 1950* Rare Flora Notice

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

**X:**        **Presumed Extinct Flora** (Declared Rare Flora – Extinct)  
Schedule 2 under the *Wildlife Conservation Act 1950* Rare Flora Notice

Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.

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Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:

**CR:**        **Critically Endangered** - considered to be facing an extremely high risk of extinction in the wild.

**EN:**        **Endangered** –considered to be facing a very high risk of extinction in the wild.

**VU:**        **Vulnerable** - considered to be facing a high risk of extinction in the wild.

A list of the current rankings can be downloaded from DEC's [Listing of species and ecological communities](http://www.dec.wa.gov.au/content/view/full/852/2010/) webpage at  
<http://www.dec.wa.gov.au/content/view/full/852/2010/>

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**Attachment 2: Australian Government  
Department of Sustainability, Environment,  
Water, Population and Communities' Protected  
matters search tool output**



# 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 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>

Report created: 17/07/12 18:20:38

## Summary

## Details

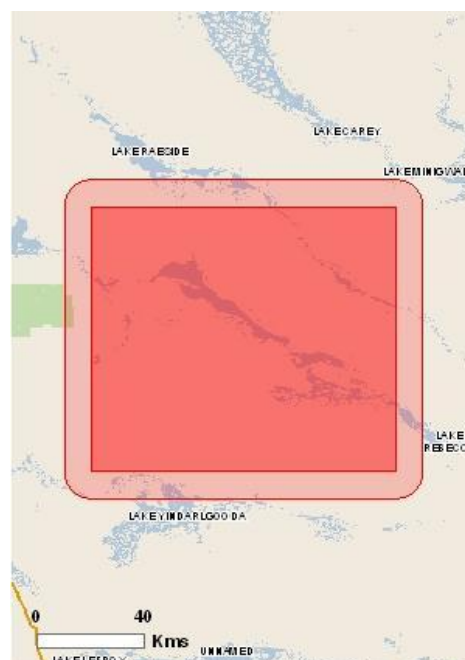
## Matters of NES

## Other Matters Protected by the EPBC Act

### Extra Information

## Caveat

## Acknowledgements



This map may contain data which are  
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(Geoscience Australia). ©PSMA 2010

## Coordinates

Buffer: 10.0Km



## Summary

## Matters of National Environment 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>

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Areas:</a>	None
<a href="#">Threatened Ecological Communities:</a>	None
<a href="#">Threatened Species:</a>	4
<a href="#">Migratory Species:</a>	8

## 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>

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.

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>.

<a href="#">Commonwealth Lands:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	5
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves:</a>	None

## Extra Information

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

<a href="#">Place on the RNE:</a>	2
<a href="#">State and Territory Reserves:</a>	2
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	6
<a href="#">Nationally Important Wetlands:</a>	None

## Details

### Matters of National Environmental Significance

Threatened Species		[ Resource Information ]
Name	Status	Type of Presence
<b>BIRDS</b>		
<a href="#">Acanthiza iredalei iredalei</a>		
Slender-billed Thornbill (western) [25967]	Vulnerable	Species or species habitat likely to occur within area



Name	Status	Type of Presence
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat may occur within area

#### MAMMALS

<a href="#">Dasycercus cristicauda</a> Mulgara [328]	Vulnerable	Species or species habitat likely to occur within area
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#### PLANTS

<a href="#">Gastrolobium graniticum</a> Granite Poison [14872]	Endangered	Species or species habitat likely to occur within area
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#### Migratory Species [\[ Resource Information \]](#)

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

Name	Threatened	Type of Presence
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#### Migratory Marine Birds

<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat may occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat may occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area

#### Migratory Terrestrial Species

<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area

#### Migratory Wetlands Species

<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat may occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		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

<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat may occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat may occur within

Name	Threatened	Type of Presence area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area

## Extra Information

### Places on the RNE [\[ Resource Information \]](#)

Note that not all Indigenous sites may be listed.

Name	State	Status
<b>Natural</b>		
<a href="#">Lake Marmion</a>	WA	Indicative Place
<a href="#">Goongarrie Area</a>	WA	Registered

### State and Territory Reserves [\[ Resource Information \]](#)

Name	State
Bullock Holes Timber Reserve	WA
Goongarrie	WA

### 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 Resources Audit,

Name	Status	Type of Presence
<b>Mammals</b>		
<a href="#">Capra hircus</a> Goat [2]		Species or species habitat likely to occur within area
<a href="#">Felis catus</a> Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
<a href="#">Oryctolagus cuniculus</a> Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
<a href="#">Vulpes vulpes</a> Red Fox, Fox [18]		Species or species habitat likely to occur within area
<b>Plants</b>		
<a href="#">Carrichtera annua</a> Ward's Weed [9511]		Species or species habitat likely to occur within area
<a href="#">Cenchrus ciliaris</a> Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area

# Coordinates

-29.61667 121.8,-29.61667 122.83333,-30.51667 122.83333,-30.51667 121.8,-29.61667 121.8

## 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

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

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 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.

## 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:

- [Department of Environment, Climate Change and Water, New South Wales](#)
- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment and Natural Resources, South Australia](#)
- [Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [Environmental and Resource Management, Queensland](#)
- [Department of Environment and Conservation, Western Australia](#)
- [Department of the Environment, Climate Change, Energy and Water](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [SA 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, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [State Forests of NSW](#)
- 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.

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Please feel free to provide feedback via the [Contact Us](#) page.

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**Attachment 3: List of species found at each  
inventory site during field survey in November  
2012**



[illegible]

Family	Taxa	Priority	Range Ex	1	2	3	4	5	6	7	8	9	10	11	12	13
Chenopodiaceae	<i>Rhagodia drummondii</i>			Y		Y										
Chenopodiaceae	<i>Rhagodia eremaea</i>								Y		Y	Y	Y		Y	
Chenopodiaceae	<i>Salsola australis</i>														Y	Y
Chenopodiaceae	<i>Sclerolaena diacantha</i>												Y	Y	Y	
Chenopodiaceae	<i>Sclerolaena drummondii</i>											Y		Y		
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>														Y	
Chenopodiaceae	<i>Tecticornia disarticulata</i>															
Convolvulaceae	<i>Convolvulus clementii</i>															
Convolvulaceae	<i>Duperreya commixta</i>					Y										
Euphorbiaceae	<i>Bertya dimerostigma</i>															
Fabaceae	<i>Acacia aptaneura</i>						Y	Y	Y		Y					
Fabaceae	<i>Acacia burkittii</i>			Y			Y	Y	Y	Y	Y		Y	Y		Y
Fabaceae	<i>Acacia colletioides</i>			Y		Y	Y		Y			Y		Y	Y	Y
Fabaceae	<i>Acacia effusifolia</i>					Y										
Fabaceae	<i>Acacia erinacea</i>															
Fabaceae	<i>Acacia hemiteles</i>			Y				Y							Y	
Fabaceae	<i>Acacia incurvaneura</i>				Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y
Fabaceae	<i>Acacia jennerae</i>					Y										
Fabaceae	<i>Acacia kempeana</i>									Y				Y		
Fabaceae	<i>Acacia ligulata</i>			Y		Y	Y	Y	Y					Y		Y
Fabaceae	<i>Acacia oswaldii</i>								Y							
Fabaceae	<i>Acacia ramulosa</i>						Y						Y			
Fabaceae	<i>Acacia resinimarginea</i>			Y												
Fabaceae	<i>Acacia tetragonophylla</i>				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fabaceae	<i>Daviesia benthamii</i> subsp. <i>acanthoclona</i>		yes			Y										
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>						Y	Y		Y	Y	Y		Y	Y	Y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>petiolaris</i>								Y							
Fabaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>								Y							
Fabaceae	<i>Templetonia incrassata</i>										Y	Y			Y	Y



Family	Taxa	Priority	Range Ex	1	2	3	4	5	6	7	8	9	10	11	12	13
Frankeniaceae	<i>Frankenia interioris</i>															
Goodeniaceae	<i>Cooperhooikia stropholata</i>			Y												
Goodeniaceae	<i>Scaevola spinescens</i>			Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lamiaceae	<i>Physopsis viscida</i>															
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>				Y	Y		Y			Y					
Lamiaceae	<i>Spartothamnella</i> sp. Helena & Aurora Range (P.G. Armstrong 155-109)	P3	yes													
Lamiaceae	<i>Spartothamnella teucriflora</i>								Y							
Lamiaceae	<i>Teucrium racemosum</i>															
Lamiaceae	<i>Westringia cephalantha</i>			Y												
Lamiaceae	<i>Westringia rigida</i>			Y	Y	Y										
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>									Y						
Loranthaceae	<i>Amyema miquelii</i>					Y		Y								
Malvaceae	<i>Brachychiton gregorii</i>												Y			
Malvaceae	<i>Sida ectogama</i>															
Malvaceae	<i>Sida</i> sp. dark green fruits (S. van Leeuwen 2260)															
				Y												
Myrtaceae	<i>Aluta aspera</i> subsp. <i>aspera</i>															
Myrtaceae	<i>Enekbatus cryptandroides</i>															
Myrtaceae	<i>Eucalyptus brachycorys</i>			Y									Y			
Myrtaceae	<i>Eucalyptus ceratocorys</i>															
Myrtaceae	<i>Eucalyptus concinna</i>															
Myrtaceae	<i>Eucalyptus eremicola</i>			Y	Y							Y				
Myrtaceae	<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>		yes	Y		Y										
Myrtaceae	<i>Eucalyptus leptopoda</i> subsp. <i>leptopoda</i>															
Myrtaceae	<i>Eucalyptus lesouefii</i>															
Myrtaceae	<i>Eucalyptus oldfieldii</i>				Y											
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>cylindroidea</i>		yes		Y											
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>			Y		Y	Y	Y	Y	Y						

Family	Taxa	Priority	Range Ex	1	2	3	4	5	6	7	8	9	10	11	12	13
Myrtaceae	<i>Eucalyptus salmonophloia</i>															
Myrtaceae	<i>Eucalyptus yilgarnensis</i>															
Myrtaceae	<i>Leptospermum fastigiatum</i>			Y												
Myrtaceae	<i>Melaleuca eleuterostachya</i>					Y										
Myrtaceae	<i>Melaleuca interioris</i>															
Myrtaceae	<i>Thryptomene kochii</i>		yes													
Myrtaceae	<i>Verticordia pritzelii</i>															
Pittosporaceae	<i>Bursaria occidentalis</i>			Y	Y	Y										
Pittosporaceae	<i>Marianthus bicolor</i>		yes													
Pittosporaceae	<i>Pittosporum angustifolium</i>															
Poaceae	<i>Aristida contorta</i>								Y							
Poaceae	<i>Austrostipa elegantissima</i>								Y			Y		Y	Y	
Poaceae	<i>Austrostipa plumigera</i>											Y				
Poaceae	<i>Enneapogon avenaceus</i>															
Poaceae	<i>Enneapogon caerulescens</i>															
Poaceae	<i>Eragrostis dielsii</i>															
Poaceae	<i>Eragrostis eriopoda</i>									Y						
Poaceae	<i>Paspalidium constrictum</i>															
Poaceae	<i>Triodia irritans</i>			Y	Y	Y				Y						
Proteaceae	<i>Grevillea juncifolia</i> subsp. <i>juncifolia</i>															
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>				Y		Y			Y						
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>sarissa</i>			Y		Y										
Proteaceae	<i>Hakea francisiana</i>															
Rubiaceae	<i>Psyrax suaveolens</i>				Y											
Rutaceae	<i>Phebalium canaliculatum</i>															
Santalaceae	<i>Exocarpos aphyllus</i>															
Santalaceae	<i>Santalum acuminatum</i>			Y			Y					Y				
Santalaceae	<i>Santalum spicatum</i>			Y		Y	Y									
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>								Y					Y		Y

[illegible]

[illegible]

[illegible]

Family	Taxa	Priority	Range Ex	14	15	16	17	18	19	20	21	22	23	24	25	26	Off*	Count
Frankeniaceae	<i>Frankenia interioris</i>															Y		1
Goodeniaceae	<i>Cooperhookia strophiolata</i>																	1
Goodeniaceae	<i>Scaevola spinescens</i>			Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		24
Lamiaceae	<i>Physopsis viscida</i>																y	0
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>										Y							5
Lamiaceae	<i>Spartothamnella</i> sp. Helena & Aurora Range (P.G. Armstrong 155-109)	P3	yes														y	0
Lamiaceae	<i>Spartothamnella teucriflora</i>																	1
Lamiaceae	<i>Teucrium racemosum</i>								Y				Y					2
Lamiaceae	<i>Westringia cephalantha</i>																	1
Lamiaceae	<i>Westringia rigida</i>																	3
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>																	1
Loranthaceae	<i>Amyema miquelii</i>																	2
Malvaceae	<i>Brachychiton gregorii</i>								Y									2
Malvaceae	<i>Sida ectogama</i>												Y					1
Malvaceae	<i>Sida</i> sp. dark green fruits (S. van Leeuwen 2260)																	1
Myrtaceae	<i>Aluta aspera</i> subsp. <i>aspera</i>																y	0
Myrtaceae	<i>Enekbatus cryptandroides</i>																y	0
Myrtaceae	<i>Eucalyptus brachycorys</i>					Y							Y					4
Myrtaceae	<i>Eucalyptus ceratocorys</i>																y	0
Myrtaceae	<i>Eucalyptus concinna</i>									Y								1
Myrtaceae	<i>Eucalyptus eremicola</i>																	3
Myrtaceae	<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>		yes															2
Myrtaceae	<i>Eucalyptus leptopoda</i> subsp. <i>leptopoda</i>																y	0
Myrtaceae	<i>Eucalyptus lesouefii</i>			Y	Y	Y												3
Myrtaceae	<i>Eucalyptus oldfieldii</i>																	1
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>cylindroidea</i>		yes															1
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>												Y			Y		8

Family	Taxa	Priority	Range Ex	14	15	16	17	18	19	20	21	22	23	24	25	26	Off*	Count
Myrtaceae	<i>Eucalyptus salmonophloia</i>																y	0
Myrtaceae	<i>Eucalyptus yilgarnensis</i>														Y			1
Myrtaceae	<i>Leptospermum fastigiatum</i>																	1
Myrtaceae	<i>Melaleuca eleuterostachya</i>																	1
Myrtaceae	<i>Melaleuca interioris</i>																y	0
Myrtaceae	<i>Thryptomene kochii</i>		yes														y	0
Myrtaceae	<i>Verticordia pritzelii</i>																y	0
Pittosporaceae	<i>Bursaria occidentalis</i>								Y									4
Pittosporaceae	<i>Marianthus bicolor</i>		yes														y	0
Pittosporaceae	<i>Pittosporum angustifolium</i>									Y			Y					2
Poaceae	<i>Aristida contorta</i>																	1
Poaceae	<i>Austrostipa elegantissima</i>										Y	Y						6
Poaceae	<i>Austrostipa plumigera</i>																	1
Poaceae	<i>Enneapogon avenaceus</i>															Y		1
Poaceae	<i>Enneapogon caeruleus</i>													Y				1
Poaceae	<i>Eragrostis dielsii</i>															Y		1
Poaceae	<i>Eragrostis eriopoda</i>												Y					2
Poaceae	<i>Paspalidium constrictum</i>					Y										Y		2
Poaceae	<i>Triodia irritans</i>																	4
Proteaceae	<i>Grevillea juncifolia</i> subsp. <i>juncifolia</i>																y	0
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>							Y										4
Proteaceae	<i>Grevillea sarissa</i> subsp. <i>sarissa</i>																	2
Proteaceae	<i>Hakea francisiana</i>																y	0
Rubiaceae	<i>Psyrax suaveolens</i>						Y											2
Rutaceae	<i>Phebalium canaliculatum</i>																y	0
Santalaceae	<i>Exocarpos aphyllus</i>												Y					1
Santalaceae	<i>Santalum acuminatum</i>																	3
Santalaceae	<i>Santalum spicatum</i>								Y			Y	Y		Y			7
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>			Y			Y			Y				Y	Y	Y		9

Family	Taxa	Priority	Range Ex	14	15	16	17	18	19	20	21	22	23	24	25	26	Off*	Count
Sapindaceae	<i>Dodonaea amblyophylla</i>																y	0
Sapindaceae	<i>Dodonaea lobulata</i>			Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		19
Sapindaceae	<i>Dodonaea rigida</i>										Y							5
Sapindaceae	<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>															Y		1
Scrophulariaceae	<i>Eremophila alternifolia</i>								Y							Y		5
Scrophulariaceae	<i>Eremophila arachnoides</i> subsp. <i>tenera</i>	P1														Y		1
Scrophulariaceae	<i>Eremophila caperata</i>																	2
Scrophulariaceae	<i>Eremophila clarkei</i>																	1
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>			Y				Y				Y	Y			Y		13
Scrophulariaceae	<i>Eremophila eriocalyx</i>																y	0
Scrophulariaceae	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>																	1
Scrophulariaceae	<i>Eremophila georgei</i>																y	0
Scrophulariaceae	<i>Eremophila glabra</i> subsp. <i>glabra</i>																	2
Scrophulariaceae	<i>Eremophila granitica</i>								Y	Y	Y					Y		10
Scrophulariaceae	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>															Y		3
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>				Y		Y	Y		Y					Y			8
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>																	2
Scrophulariaceae	<i>Eremophila platythamnos</i> subsp. <i>platythamnos</i>																y	0
Scrophulariaceae	<i>Eremophila scoparia</i>			Y	Y	Y				Y			Y	Y				10
Solanaceae	<i>Lycium australe</i>																y	0
Solanaceae	<i>Solanum lasiophyllum</i>					Y			Y				Y			Y		4
Solanaceae	<i>Solanum plicatile</i>																y	0
Zygophyllaceae	<i>Zygophyllum glaucum</i>																y	0

\* found during traverse



## **Attachment 4: Locations of inventory sites and site information.**



WP	UTM	Site ID	Zone	Easting	Northing	Land unit	Veg type	Slope	Relief
WP	UTM	TSF01	51J	436040	6663595	4B	SASP	2.5	-
WP	UTM	TSF02	51J	435420	6664390	2C	SASP	3%	10m
WP	UTM	TSF03	51J	435963	6664338	4B	SASP	2%	-
WP	UTM	TSF04	51J	437010	6664754	4A	CEAS	<1%	-
WP	UTM	TSF05	51J	436541	6665145	4A	CEAS	<1%	-
WP	UTM	TSF06	51J	435926	6665228	2B	CCAS	1.5%	-
WP	UTM	TSF07	51J	436507	6664886	4A	CEAS	1.5%	-
WP	UTM	TSF08	51J	436416	6665908	4A	CEAS	1%	-
WP	UTM	TSF09	51J	436103	6665853	2A	CCAS	2%	-
WP	UTM	TSF10	51J	434835	6665570	5	PECW	1%	-
WP	UTM	TSF11	51J	435498	6665133	2B	CPBS	2%	-
WP	UTM	TSF12	51J	435158	6665316	2B	CPBS	1%	-
WP	UTM	TSF13	51J	436234	6666269	4A	CCAS	0%	
WP	UTM	TSF14	51J	435792	6665862	5	CCAS	1%	-
WP	UTM	TSF15	51J	435389	6665932	5	PECW	0%	
WP	UTM	TSF16	51J	435103	6666183	5	PECW	<1%	-
WP	UTM	TSF17	51J	434764	6666403	2B	CPBS	4%	-
WP	UTM	TSF18	51J	434811	6665840	2B	CPBS	2%	-
WP	UTM	TSF19	51J	436603	6667252	5	PXHS	0.5%	-
WP	UTM	TSF20	51J	435816	6667250	2B	CPBS	4%	5m
WP	UTM	TSF21	51J	436897	6666931	4A	CEAS	0.5%	-
WP	UTM	TSF22	51J	436531	6666838	4A	CCAS	0.5%	-
WP	UTM	TSF23	51J	435776	6666690	5	PXHS	0.5%	-
WP	UTM	TSF24	51J	435467	6666867	2B	CPBS	7%	4m
WP	UTM	TSF25	51J	434807	6667070	2B	CPBS	2%	-
WP	UTM	TSF26	51J	435558	6667102	5	PXHS	1%	-

## **Attachment 5: Example recording sheet.**







# **ENVIRONMENTAL ASSESSMENT:**

## **PROPOSED SEISMIC SURVEY AREA**

### **SARACEN GOLD MINES**



**Alexander Holm & Associates**  
Natural Resource Management Services

**February 2019**





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# SUMMARY

This report for Saracen Gold Mines Pty Ltd covers environmental assessments to support clearing applications within a 4300ha area associated with a seismic survey in the Carosue dam area approximately 115km north east of Kalgoorlie.

The environmental assessment had three components:

- A reconnaissance vegetation and flora survey from January 7 -12, 2019.
- A reconnaissance fauna survey from January 14-17, 2019.
- A targeted flora survey for *Eremophila arachnoides* subsp. *tenera* from February 4- 13, 2019.

Rainfall during winter in 2017 and 2018 was well below average (Figure 2). There were late winter rains in 2018 and as a result, some biannual herbs and grasses persisted from preceding seasons and were readily identified at the time of survey. There were few annual species.

Seventy-two inventory sites were assessed during the reconnaissance vegetation and flora survey which provided systematic coverage of the area and encompassed variations in photo-pattern. A systematic assessment of land-type, geology, relief, soil type and vegetation at each site enabled the area to be mapped into readily-identifiable land units.

Thirteen land units were identified, and eleven associated vegetation communities described. Approximately 40% of the survey area is occupied by plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina. Chenopod shrublands occur on approximately 25% of the area either on calcareous plains or alluvial plains. Sand plains and sandy rises occupy 4% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or felsic rocks occupy the remainder.

One hundred and twenty-nine flora taxa representing 26 families were found during the reconnaissance survey. Chenopodiaceae accounted for 24 taxa, Fabaceae 19 taxa and Scrophulariaceae 17 taxa. There were four sterile specimens which were identified to genera level. Flora species composition and vegetation communities are typical of the area and not considered to be unusually diverse.

No listed species of rare or critically endangered flora were found during this survey and no records of Declared Rare Flora (DRF) in or nearby the survey area. Three populations consisting of over 2500 plants of *Eremophila arachnoides* subsp. *tenera*, a Priority 1 listed taxa (P1), were located within the survey envelope during the follow-up targeted flora survey. Priority flora are under consideration for listing as threatened species and as such require protection until their status is decided.

The collection of the following species at this location indicates a significant extension of their known distribution range:

- *Eucalyptus oleosa* subsp. *cylindroidea*

- *Thryptomene kochii*
- *Sclerolaena glabra*

No taxa are considered to be locally endemic.

No alien to Western Australia (weed) species were located during survey although *Carthamus lanatus* (saffron thistle) was noted growing along road verges.

Approximately 17% of the survey area is occupied by alluvial plains where moderate soil erosion is evident and are rated as moderately vulnerable to erosion. These alluvial systems support “Plain mixed halophyte low shrublands” and “Plain eucalypt chenopod woodland” vegetation communities which are degraded through overgrazing. While, disturbance to alluvial plains has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca, the proposed strip clearing is unlikely to result in significant increases in sediment discharge.

The survey landscape mainly drains via overland flow to a main drainage which flows into Lake Rebecca 5 km to the north. Southern areas drain southerly through various drainage systems again to Lake Rebecca. Lake Rebecca is a major wetland with local and regional significance. Survey lines will intercept these watercourses.

Malleefowl are active in the survey area. There were three sightings of birds during this survey and active mounds have been found in previous studies. Malleefowl is probably more abundant to the west where there are extensive sandy soils associated with land unit 1d and 4d occupying about 4.5% of the survey area. They may also be more abundant in rocky hills and low rises collectively occupying 17% of the survey area. Malleefowl mounds are of importance for the birds, whether or not they are active or recently-used.

Large Eucalypt trees, common in land unit 5b, may support nesting by the Peregrine Falcon (and other birds).

There are no Threatened Ecological Communities (TECs) within the north east Goldfields subregion and no Priority Ecological Communities within or adjacent to the survey area. No conservation areas are nearby.

It is recommended that, in planning and implementing seismic operations within the survey area, the proponent:

1. **Avoids disturbance to *Eremophila arachnoides* subsp. *tenera*.**
2. **Undertakes a Malleefowl survey especially within land units 1a, 1b, 1c, 1d, 2a and 2b and avoids disturbance within 50m of active Malleefowl nests during nesting and incubation.**
3. **Installs signage on access roads to the exploration area if Malleefowl are seen or suspected.**
4. **Avoids destruction of mature Eucalyptus trees with nesting hollows.**
5. **Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially alluvial plains (land unit 5a and 5b).**
6. **Avoids disturbance to the main drainage channel (land unit 6).**

# SCOPE OF WORKS

Alexander Holm & Associates were contracted by Saracen Gold Mines Pty Ltd (Saracen) to conduct the following surveys in the Carosue Dam area. Bamford Consulting Ecologists (BCE), were sub-contracted by Alexander Holm & Associates to undertake and report on the fauna component of the assessment.

Saracen operates the Carosue Gold Mine and is proposing intensive exploration around its existing mine. A seismic survey is proposed over a 4300ha area requiring clearing of 3m wide access-lines at 90m spacing. Parts of this area have been covered by earlier environmental assessments. The current assessment envelope covers the balance of 3136ha.

**Part A:** An environmental assessment to include:

- A review of available information on likelihood of a) presence of threatened (rare) or priority plant species and b) threatened plant communities in the general search area.
- A reconnaissance level fauna, flora and vegetation survey.
- An assessment of landscape stability and condition.
- A description of land units and relate information on fauna, flora, vegetation communities and landscape stability to these units.
- A map of land units and associated vegetation communities.
- A report on findings within a local and regional context
- An assessment of the proposal in relation to impacts on fauna.
- An assessment of the proposal against clearing principles.

The scope of works is to comply with Western Australian Environmental Protection Authority (EPA) objectives for protection of the environment specifically to “ensure that flora and vegetation surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered” and to “enable an assessment of impacts on the conservation values and status of the site in a regional and local context” (Environmental Protection Authority, 2004).

The work takes into account the following surveys that are either within or adjoin the proposed project envelope and will produce a unified landunit/ vegetation association map to cover these surveys:

- Matiske Consulting Pty Ltd (2010) Flora and vegetation survey of the proposed airstrip.
- Matiske Consulting Pty Ltd (2010) Flora and vegetation survey of the Karari pit extension.
- Alexander Holm & Associates (2010) Environmental assessment-proposed expansion of Whirling Dervish mine.
- Alexander Holm & Associates (2012b) Environmental assessment – proposed expansion of Tailings Storage Facility.

In addition, information on fauna was available from a number of previous studies in the area. These include:

- Alexander Holm and Assoc. (2017). Malleefowl survey of proposed airstrip. Saracen Gold Mines.
- Coffey environments (2010). Level 1 vertebrate fauna survey for the Carosue Dam Project, Saracen Gold.
- Biologic. (2010). Level 1 survey for a proposed pipeline from GGT to Carosue Dam and powerline from Black Swan to Carosue Dam. Tropicana JV and Saracen Gold Mine Pty Ltd.
- Henry-Hall *et al.* (1990). Report on survey of Goongarrie Nature Reserve.
- ABRS (2013). Bush Blitz; Biological survey of Credo Station Reserve WA.

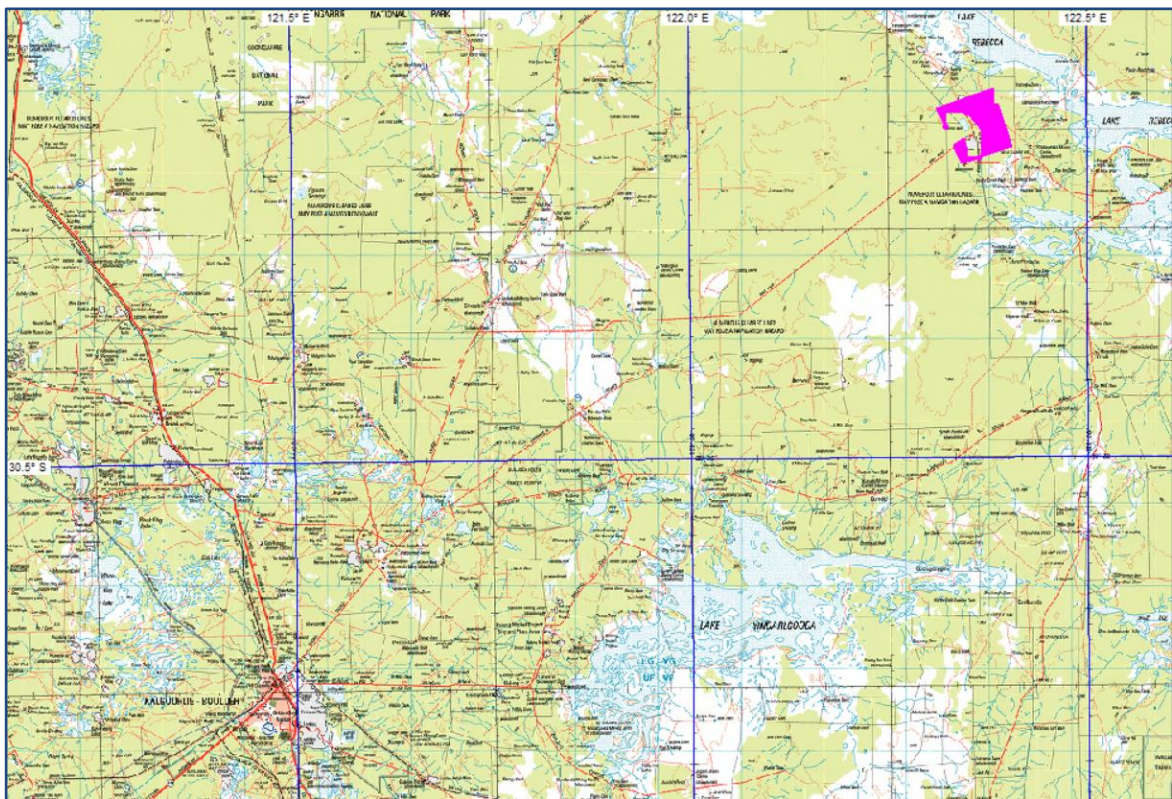
**Part B:** A targeted survey to locate, record and map the extent of populations of *Eremophila arachanoides* subsp. *tenera*, a Priority 1 taxon, within and adjacent to habitats identified during the reconnaissance survey.

# REGIONAL OVERVIEW

## Regional setting

Carosue Dam TSF is approximately 115 km north east of Kalgoorlie Boulder, and south east of Lake Rebecca (Figure 1). It is within the north-eastern Goldfields region, Kalgoorlie-Boulder local government area, and partly within unallocated crown land (UCL), Gindalbie and Pinjin pastoral leases. It is located in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions (Cowan 2001, Desmond, Cowan and Chant 2003).

The most extensive land use in the region is pastoralism and over 80% of this region is pastoral leasehold. Most of the remainder is unallocated crown land and less than 1% is set aside for nature conservation.



**Figure 1: Survey area (in pink) in relation to Lake Rebecca and Kalgoorlie Boulder in the south west.**



## Climate

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 at Kalgoorlie is 177.8 mm (in February) and 92.6 mm (in January) at Laverton. For Kalgoorlie, one in one hundred years rainfall events of 1 hour and 72 hours are estimated to result in 43 and 173 mm of rain respectively. (Data from [www.bom.gov.au](http://www.bom.gov.au)).

The average potential pan evaporation rate at Carosue Dam is approximately 2800 mm per annum<sup>1</sup>.

Winds are mostly light easterlies.

## Topography and drainage

Landform patterns in the general area 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 (Gentili, 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, Van Vreeswyk & Gilligan, 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 palaeo-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 palaeo-drainages, and local brine pools associated with salt lakes.

## 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, 1976). Lake Ballard/Lake Rebecca form a major vegetation divide with characteristic *Acacia aneura* (mulga) low woodlands associated with red loams over siliceous hardpan to the north and low woodlands of mixed mulga and *Casuarina obesa* (black oak) and

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<sup>1</sup> [http://www.bom.gov.au/cgi-bin/climate/cgi\\_bin\\_scripts/evaporation.cgi](http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/evaporation.cgi).

*Eucalyptus* species 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 palaeo-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 eucalypt or mulga with saltbush or bluebush understoreys.

The most common vegetation associations in the region include Beard Vegetation Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.), 110 (Hummock grassland, shrub steppe and red mallee over spinifex) and 389 (Succulent steppe with open low woodland; mulga over saltbush) (Table 1).

**Table 1: Vegetation associations (Beard, 1976) in project area in comparison with South Laverton area (SLA), total area in WA and area within conservation reserves**

Veg Assn	Description	SLA Area km <sup>2</sup>	Reserve priority	Western Australia		
				Area km <sup>2</sup>	Within reserve km <sup>2</sup>	%
20	Low woodland; mulga mixed with <i>Casuarina obesa</i> and <i>Eucalyptus</i> spp.	7892	L	13045	2173	16.7
24	Low woodland; <i>Casuarina obesa</i>	15.2	L	265.6	2.4	0.9
110	Hummock grassland; shrub steppe and red mallee over spinifex	356	M	4746	1201	25.3
389	Succulent steppe with open low woodland; mulga over salt bush	2344	M	6465	230	3.6
529	Succulent steppe with open low woodland; mulga and sheoak over salt bush	46.6	H	102.8	0.1	0.1

L\*: Low; M: Medium; H: High priority for reservation

# ASSESSMENT METHODOLOGY

## Assessment personnel

The work was managed and conducted by Dr Alexander Holm (Alexander Holm & Associates). Dr Holm is an ecologist with over 35 years experience in arid environments and Goldfield regions and an accredited environmental consultant with the Environmental Consultants Association of Western Australia.

Mr Andrew Mitchell was assisting botanist to Western Australian Department of Agriculture's rangeland surveys, senior author of "Arid Shrubland Plants of Western Australia" (Mitchell and Wilcox 1994) and recently retired botanist with AQIS (Australian Quarantine and Inspection Service). Mr Mitchell provided off-site assistance in expert identification of flora specimens collected in the field and preliminary land unit mapping.

Mr Geoffrey Eliot was soil and landscape technician for the Western Australian Department of Agriculture's rangeland surveys and has over 20 years experience in Western Australian arid regions.

Field work for the vegetation and flora surveys was conducted by Mr Eliot and Dr Holm.

The identity of priority flora taxa *Eremophila arachanoides* subsp. *tenera* was confirmed by Mr Andrew Brown, recently retired botanist at the Western Australian Herbarium and author of "A field guide to the Eremophilas of Western Australia" (Brown and Buirchell 2011)

Dr Mike Bamford is a wildlife biologist, scientific illustrator and science communicator and with his wife Mandy, he has operated Bamford Consulting Ecologists since the mid 1980s. The business specialises in fauna investigations for Environmental Impact Assessment and to meet conditions of approval, such as monitoring of impacts and monitoring of rehabilitation. Some work is also done on environmental education and interpretation. Mike has extensive experience in the south-west of Western Australia, Western Australia's Goldfields, Pilbara, Kimberley, the Western Deserts, the Northern Territory, Christmas Island and far north Queensland.

**Dr Barry Shepherd** is an ecologist with more than 20 years working as an environmental consultant. Barry's core skills are around environmental and ecological impact assessment, and environmental approvals. Around this experience, he has conducted a large number of environmental baseline survey for birds, bats, small mammals and herpetofauna, and specialises in marine mammals and bats. He is also experienced in line transect population studies (Distance). Barry has undertaken extensive analysis of bat echolocation and calls and is competent on most ultra-sonic detection systems. Barry has written a large number of baseline survey reports, impact assessments and environmental approval documentation.

Field work for the fauna survey was conducted by Drs Bamford and Shepherd.

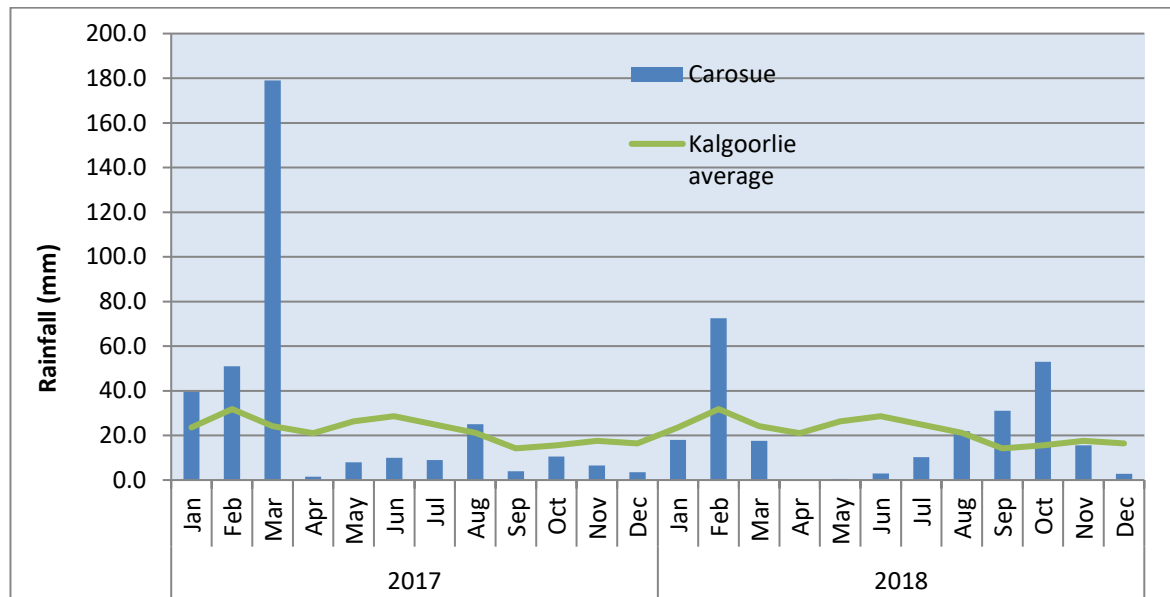
## Timing of survey and seasonal conditions

Vegetation and flora reconnaissance survey from January 7 -12, 2019.

Fauna reconnaissance survey from January 14-17, 2019.

Flora targeted survey from February 4- 13, 2019.

Rainfall during winter in 2017 and 2018 was well below average (Figure 2). There were late winter rains in 2018 and as a result, some biannual herbs and grasses persisted from preceding seasons and were readily identified at the time of survey. On the other hand, there were very few annual species.



**Figure 2: Monthly rainfall (mm) at Carosue Dam in comparison to averages at Kalgoorlie airport**

## Declared flora and fauna

The Department of Parks and Wildlife and the Western Australian Museum's "NatureMap"<sup>2</sup> was interrogated for records of all collected flora within a 40 km radius of the study area (Attachment 1). The list was augmented by other recent searches from nearby survey areas (Alexander Holm & Associates 2012a, Alexander Holm & Associates 2012b, Alexander Holm & Associates 2012c, Alexander Holm & Associates 2012d).

*Thryptomene eremaea*, a Priority 2 taxon, is recorded in NatureMap as being located within 40km of the study area. It is an erect open shrub, 0.5 to 1.5m high, producing pink or white flowers from July to September and grows on red or yellow sands on sandplains and shallow sandy soils over granite.

*Eremophila arachnoides* subsp. *tenera*, a Priority 1 taxon, was recorded by Alexander Holm and Associates (2012d) in an adjacent survey during 2012.

Declared flora and fauna listed on Commonwealth Department of Environment and Energy database of threatened species were identified within a 100km radius of the study area using the protected matters search tool<sup>3</sup> (Attachment 2).

*Gastrolobium graniticum* is classed as Endangered under the EPBC Act 1999 and as a Declared Rare taxa under the Wildlife Conservation Act 1950 [WA]. This member of the Fabaceae is an erect shrub 0.9 to 1.2 m high with purple branches, and ovate leaves 2.5 to 6 cm long. The distribution of this species is restricted to the Kalgoorlie ad Coolgardie districts where it is found in sandy or sandy loam soils near granite rocks.

Records of bird observations in Australia, 1998-2019 from BirdLife Australia Atlas Database (Birdlife Australia) within a 40km radius of the study area.

Records of biodiversity data from multiple sources across Australia from Atlas of Living Australia and within a 40km radius of the study area.

Significant conservation fauna which may be present in the survey area, include one reptile, 19 birds and two mammals. The single reptile is a Priority 2 skink that may occur under leaf-litter around trees and mallee. The majority (9) of the birds are waterbirds that are either vagrants or irregular visitors and would not utilise the actual project area due to the lack of wetlands. Most other significant birds are expected only as vagrants but three species may use the site regularly: Malleefowl, Peregrine Falcon and Rainbow Bee-eater. Only two significant mammals are expected, with the Central Long-eared Bat potentially roosting in large trees, and the Brush-tailed Mulgara probably being locally extinct or possibly being a vagrant.

## Threatened and priority ecological communities

The likelihood of presence of threatened ecological communities within the general survey area was assessed using the protected matters search tool (Attachment 2).

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<sup>2</sup><https://naturemap.dpaw.wa.gov.au/default.aspx>

<sup>3</sup><http://www.environment.gov.au/erin/ert/epbc/>

Other threatened ecosystems in the south-east of Eastern Murchison (MUR 1) biogeographic subregion, identified during “A Biodiversity Audit of Western Australia’s 53 Biogeographical Subregions in 2002”, are listed in Cowan (2001).

Priority ecological communities in the area were assessed from Department of Parks and Wildlife listing (Version 27, June 2017).

## **Land systems land units and vegetation communities**

Land systems and land units were derived from a land resource survey of north eastern Goldfields (Pringle, Van Vreeswyk & Gilligan, 1994). Land systems for the region south of the north eastern Goldfield survey have been tentatively identified by desk-top photographic interpretation and extrapolation (Department of Agriculture and Food WA).

Vegetation communities were established firstly with reference to those listed in Pringle et al. (1994) where they are listed as ‘site types’, and secondly, where no comparable community could be found, with reference to those listed in adjacent surveys of Sandstone, Yalgoo Paynes Find (Payne et al., 1998) and Kambalda north (Payne, Mitchell & Hennig, 1998).

Tentative land units were identified by examination of high-resolution aerial photography. Boundaries were checked in the field, transferred to geo-referenced ortho-photo maps and captured digitally. Vegetation communities were visually associated with each land unit.

## **Field survey**

### ***Reconnaissance vegetation and flora survey***

The survey and reporting were conducted to comply with the EPA’s “Technical Guidance – flora and vegetation surveys for environmental impact assessment” (Environmental Protection Authority 2016). A reconnaissance level survey was considered appropriate in the first instance in view of results of several vegetation and flora surveys in or adjacent to the study area (Figure 3).

Seventy two inventory sites (relevés) were selected to 1) sample each land unit within the survey area, 2) provide systematic coverage of the survey area, and 3) to encompass variations in pattern within each land unit. Each inventory site was located by GPS and the following information recorded:

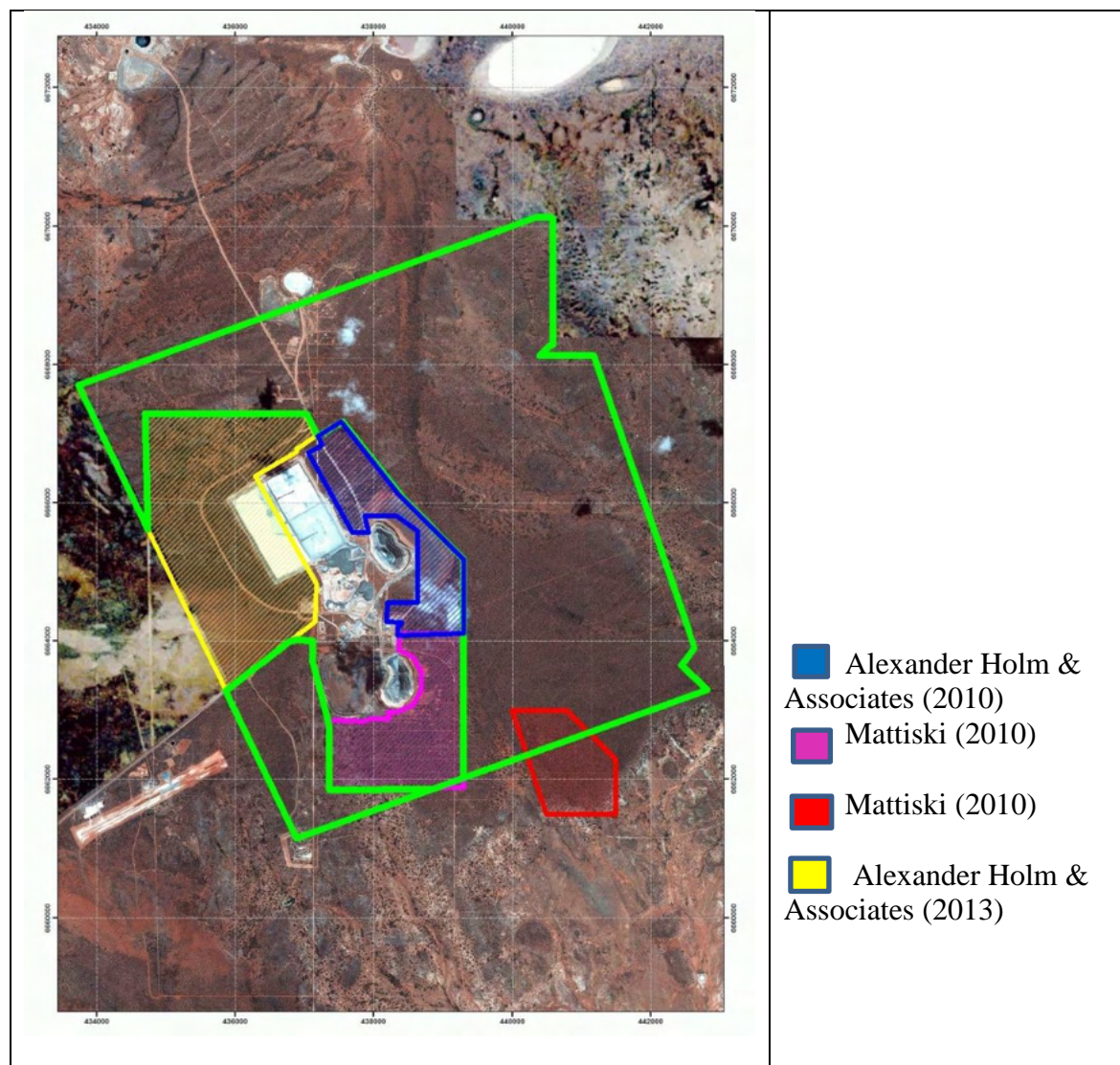
- Digital photographs.
- All flora species within approximately 50 m of a central location and in the same land unit were inventoried and voucher specimens collected of all taxa which were also compiled within a reference field herbarium.
- Vegetation condition were visually estimated using rating scales of Environmental Protection Authority (2016) and soil erosion compared with standard rating scales used for rangeland surveys and described by Pringle *et al.* (2004).
- Vegetation community and land unit descriptions using terminology from Payne et al. (1998).

- Vegetation cover, landform, slope, relief, surface coarse fragment characteristics and surface water flow characteristics (Anon, 2009).
- Soil characteristics (texture, reaction to acid and fragment characteristics) of A horizon to maximum of 30cm (Anon, 2009).

These data were augmented by walking traverses by two surveyors along selected routes. The survey aimed to:

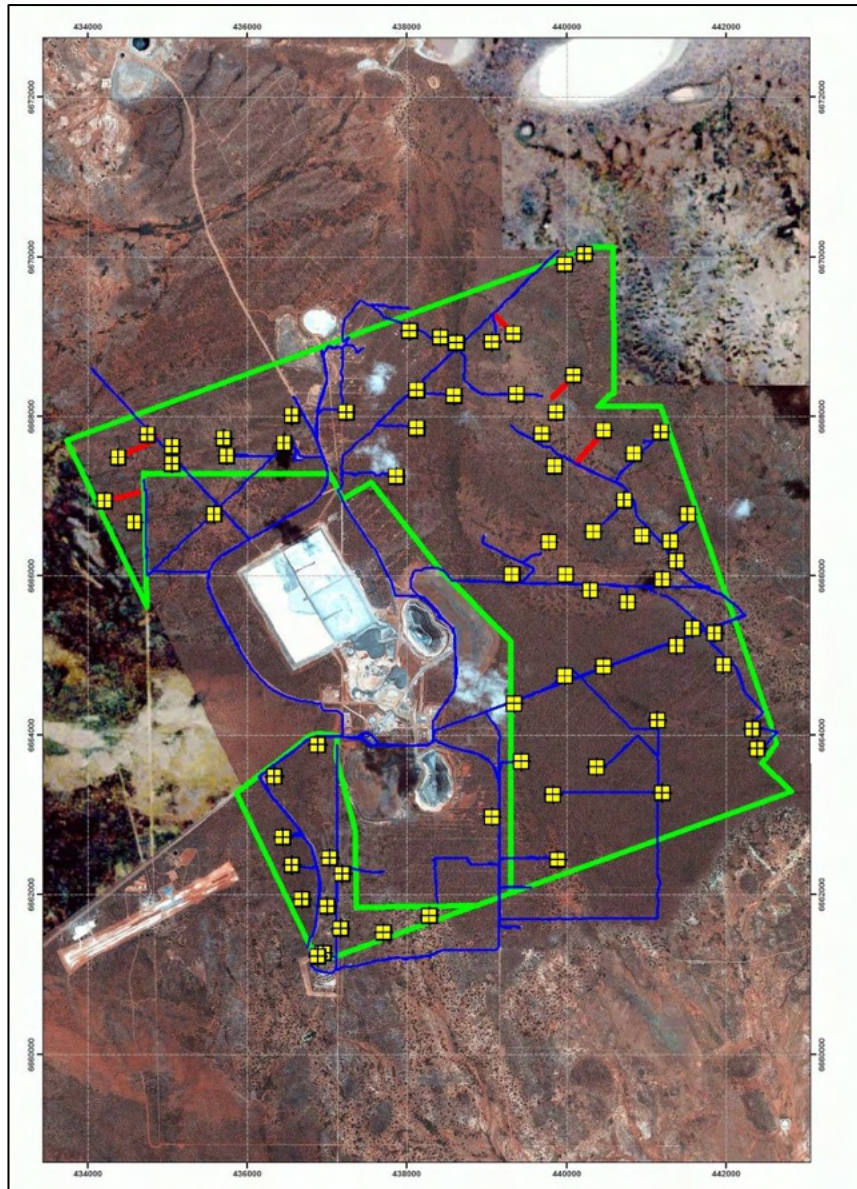
- Locate priority or threatened flora.
- Locate species not previously recorded at inventory sites.

Locations of inventory sites, vehicle traverse (150km) and walking traverses (2.5km) are shown in Figure 4.



**Figure 3: Proposed survey area (green) and locations of existing flora and vegetation surveys.**





**Figure 4: Location of inventory sites (yellow) vehicle traverse (blue) and walking traverses (red) during initial flora survey.**

### ***Targeted flora survey***

Three main search areas were defined by locations of *Eremophila arachanoides* subsp. *tenura* found during the reconnaissance survey and earlier adjoining surveys: a northern area of about 600ha and southern areas of about 50ha and 40ha. Each area was searched by two operators along previously defined transects approximately 25m apart using GPS guidance to ensure a systematic coverage. Additional opportunistic traverses were done to cover possible habitat outside the pre-defined search area. Total foot-traverse distance was 209km.

Operators concentrated on defining population boundaries. About 40-50% of found plants in the northern area were tagged with tape and located by GPS including all outliers. All found plants in the southern areas were tagged and located by GPS.



Additional areas outside the two main search areas, which were considered as possibilities for occurrence of the target species, were also inspected.

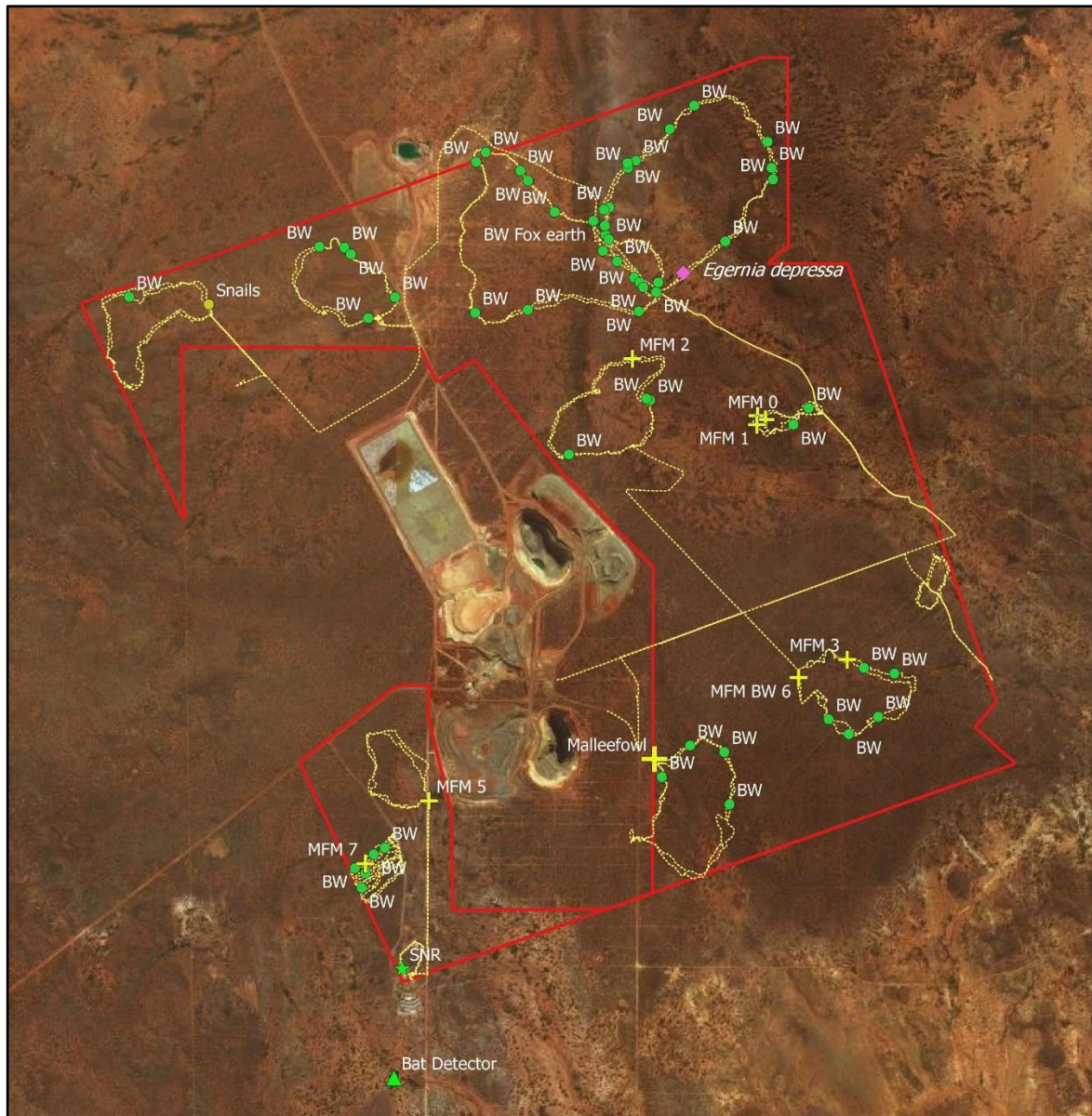
### ***Reconnaissance fauna survey***

The site visit involved looking around as much of the project area as possible in daylight; as shown in Figure 5. This enabled environmental descriptions to be prepared and allowed opportunistic observations on fauna. Familiarity with the environment enables interpretation of species lists from databases. Targeted searching was undertaken for two significant species known from the general area: the Malleefowl (searching for nest mounds, foraging signs, tracks and direct observations); and the Brush-tailed Mulgara (searching for burrows, tracks and scats). In general, walks were unstructured and two personnel travelled 20-40m apart, with the track determined by areas of interest and intended to cover as much ground as possible. An exception to this was just north of the accommodation village where systematic transects were walked across a small area to search for Malleefowl mounds. Signs of all species observed, and other notable features of interest were recorded.

On the evening of 14th January, between c.19:30 and 21:10, the surveyors conducted a torch-light search of a rocky breakaway just north of the mine camp for nocturnal fauna. Both surveyors carried head torches and recorded species observed or heard.

Throughout the torch-light survey, bat echolocations and calls were recorded on a hand-held bat detector (Echo Meter Touch 2 Pro (EMT2)(Ser No: E2A00773). The EMT2 was run from a Samsung Galaxy S7 with Echo Meter software version 2.6.5. A Wildlife Acoustics Song Meter 4 BAT Full Spectrum (SM4BAT) was deployed next to three settling ponds that form part of the Mine Camp's sewerage treatment plant on the afternoon of 14th January and retrieved on the morning of 17th January 2019. The settling ponds were located approximately 1km due south of the Survey Area boundary and 0.75km south of the Mine Camp. Recordings from the EMT2 and SM4BAT were viewed in Kaleidoscope Viewer v4.5.4 from Wildlife Acoustics. More than 4,000 audio records were obtained over the three nights of sampling indicating very high levels of bat activity. Only a small sample was assessed to provide a preliminary list of bat fauna supporting the Level 1 survey.

The complete fauna memo report is attached



**Figure 5: Vehicle traverse and walking traverses (yellow) during fauna survey. Locations of fauna observations are indicated: BW = Boodie warrens, MFM = Malleefowl mound**

# ENVIRONMENTAL ANALYSIS

## Conservation estate

Beard Vegetation Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) is the most common vegetation association in the survey area occupying 83%. Vegetation Association 529 (Succulent steppe with open low woodland; mulga and sheoak over salt bush) occupies 12% and the remaining 5% is Vegetation Association 24 (Low woodland; *Casuarina obesa*) (Beard 1976).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation (Table 1). Vegetation Association 529 is very poorly conserved and has a high priority for conservation.

There are no conservation reserves within 50 km of the survey area (Appendix 1). The closest conservation area is Bullock Holes Reserve, approximately 60 km south 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) although Lake Rebecca is considered an ecologically significant component of inter-regional palaeo-channels.

There are no registered sites on State or National heritage registers.

Lake Rebecca is a registered mythological site.

## Land systems and landforms

Approximately 55% of the survey area is occupied by plains with eucalypt woodlands with non-halophytic undershrubs of Deadman land system; 14% consists of low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys of Moriarty land system; 4% is sandplain of Kirgella land system and the remainder by Leonora, Lawrence, Campsite and Gundockerta (Table 2).

**Table 2: Descriptions of land systems within the survey area (Pringle, Van Vreeswyk & Gilligan, 1994 and Department of Agriculture and Food, WA).**

<b>Land type</b>	<b>Land system</b>	<b>Description</b>	<b>Soil and land management</b>
Hills and ridges	Lawrence	Low greenstone hills with ironstone ridges, supporting pearl bluebush shrublands with mixed eucalypt overstoreys.	Narrow drainage tracts are susceptible to water erosion.
Erosional surfaces of low relief	Gundockerta	Extensive gently undulating plains on weathered greenstone with stony mantles and lower alluvial tracts	Saline plains and adjacent alluvial tracts are susceptible to water erosion.
Depositional plains with calcareous red earths	Deadman	Level to gently undulating plains with casuarina-acacia shrublands.	Generally not susceptible to soil erosion
	Moriarty	Low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys.	Slopes of low rises, alluvial plains and narrow drainage tracts are moderately susceptible to soil erosion.
Sandplain spinifex hummock grasslands	Kirgella	Extensive sandplain with spinifex hummock grasslands and mulga and mallee shrublands	Prone to wildfires which temporarily render sands unstable.
Plains with saline alluvium	Campsite	Alluvial plains and minor gently undulating stony upper plains with groved eucalypt woodlands.	Moderately susceptible to erosion

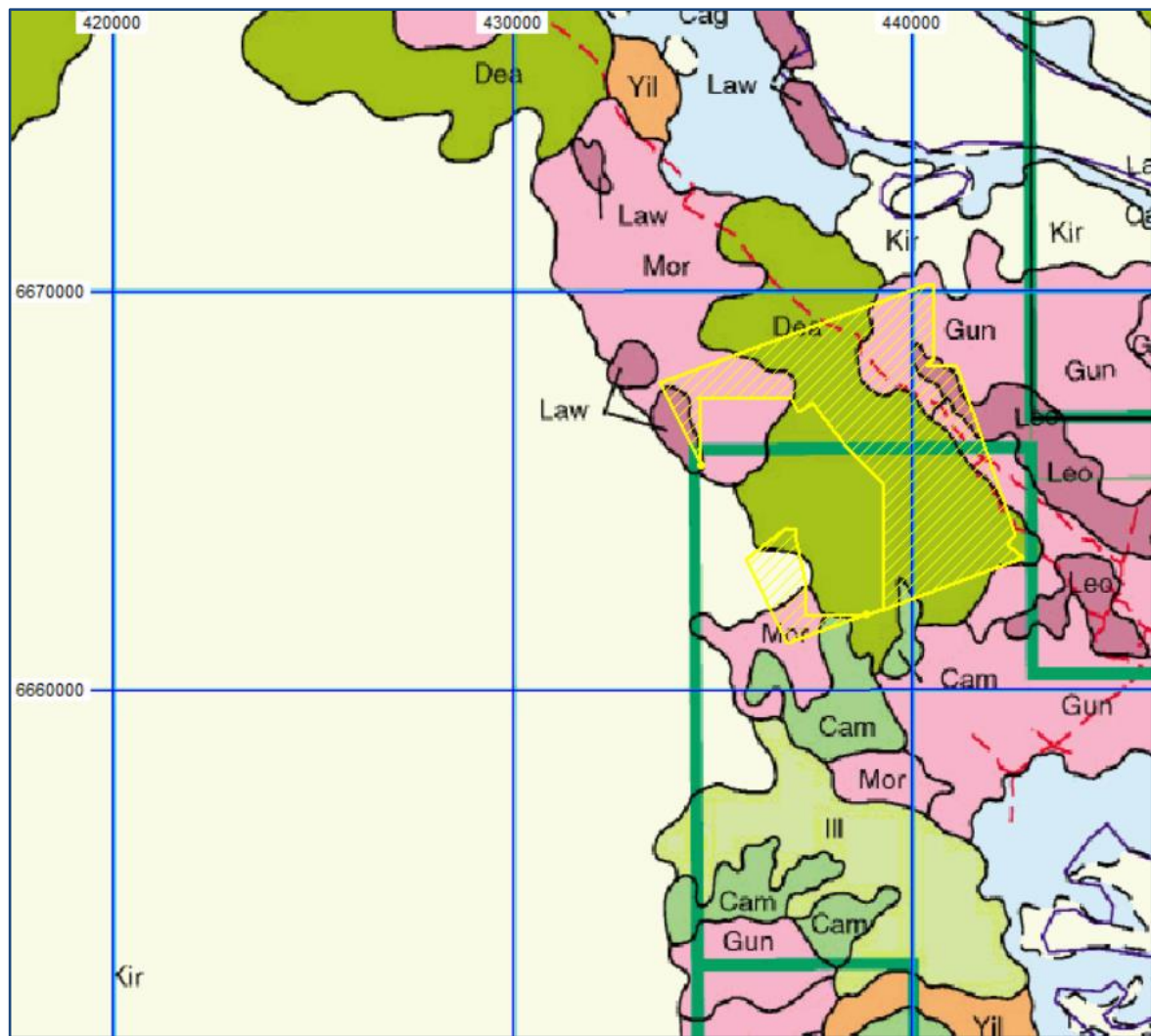


Figure 6: Land systems within the survey area (in yellow)

## Land units, soil types and vegetation communities



### *Land unit descriptions and mapping*



Thirteen land units and associated vegetation communities and soil types are described (Table 4).

A map of land units is overlain on an aerial photograph (Figure 7).





**Table 3: Land unit descriptions, their soil type, vulnerability to erosion and associated vegetation communities.**



Land unit	Land form and soil type	Vegetation community
<b>1a. Lateritic hills</b>		
	<p>Lateritic hills with relief to 20m with slopes up to 8%, very abundant (&gt;90%) surface mantles of ironstone coarse and medium gravel and occasional quartz.</p> <p>Shallow sandy loams or sandy clay loams over calcrete or parent laterite.</p> <p>Run-off source zones, nil vulnerability to erosion.</p>	<p>Open mixed shrubland (PFC 6-15%) dominated by <i>Acacia stowardii</i>, <i>Dodoniaea lobulata</i> and <i>Ptilotus obovatus</i> with very sparse overstorey of <i>Casuarina pauper</i>, <i>Eucalyptus</i> spp and occasional <i>Acacia incurvaneura</i>.</p> <p>“Stony ironstone acacia shrubland” (SIAS vegetation community)</p>
<b>1b. Basalt hills</b>		
	<p>Basalt hills with relief to 30m, slopes from 3-10%, abundant (50-90%) surface mantles of coarse gravel and cobbles of basalt and occasional quartz or calcrete.</p> <p>Sandy loams less than 30cm in depth often highly calcareous.</p> <p>Run-off source zones, nil vulnerability to erosion.</p>	<p>Open mixed height shrubland (PFC 25-30%) dominated by <i>Acacia quadrimarginea</i>, <i>A. burkittii</i>, and <i>Dodoniaea lobulata</i> with very sparse overstorey of <i>Casuarina pauper</i>.</p> <p>“Greenstone hill acacia shrubland” (GHAS vegetation community)</p>



Land unit	Land form and soil type	Vegetation community
<b>1c. Felsic hills breakaways and footslopes</b>		
	Breakaways with relief of 25m and scarp slopes of 20%, low hills to 12m with slopes of 5% and footslopes with slopes of 2%, Common to very abundant (20->90% surface mantles of medium to coarse gravel and cobbles of felsic rocks and occasional quartz.	Open low or mixed height shrubland (PFC 10-30%) dominated by <i>Scaevola spinescens</i> , <i>Acacia erinacea</i> , <i>Eremophila scoparia</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> with very sparse overstorey of <i>Casuarina pauper</i> or <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i> and occasionally open woodlands of <i>Eucalyptus lesouefii</i> .
	Skeletal sandy loams less than 15cm. Non-calcareous.	“Breakaway mixed shrubland” (BRXS vegetation community)
	Run-off source zones, nil vulnerability to erosion.	.
<b>1d. Sandy rises</b>		
	Broad sandy rise to 10m and slopes to 3%.	Sparse woodlands (PFC 5 -10%) dominated by <i>Acacia incurvaneura</i> and low mallees (4 -10m) including <i>Eucalyptus eremicola</i> , <i>E.ceratocorys</i> and <i>E. oldfieldii</i> over a diverse sparse (PFC 20 -30%) shrubland (<1.5 m) with spinifex ( <i>Triodia irritans</i> ) often dominated by myrtaceous shrubs. Shrubs include <i>Eremophila forrestii</i> subsp. <i>forrestii</i> , <i>Thryptomene kochii</i> , <i>Verticordia pritzelii</i> , <i>Prostanthera althoferi</i> subsp. <i>althoferi</i> and <i>Acacia effusifolia</i>
	Deep sandy soils.  Most rain water infiltrates and in high intensity rainfall sheds water to lower parts of the landscape. Slight vulnerability to erosion.	“Sandplain mallee spinifex woodland” (SAMA vegetation community).





Land unit	Land form and soil type	Vegetation community
<b>2a. Low lateritic rises</b> 	<p>Gentle low rises with slopes to 2%, relief up to 2 – 3 m, common to very abundant (20 - &gt;90%) surface mantles of fine and medium gravel of laterite with occasional calcrete and quartz.</p> <p>Sandy loams to 30cm occasionally highly calcareous at surface and overlaying calcrete.</p> <p>Run-off source zones, nil to slight vulnerability to erosion.</p>	<p>Very sparse to open mid-height shrubland (PFC 10-25%) dominated by <i>Eremophila forrestii</i>, <i>E. scoparia</i>, <i>Dodonaea lobulata</i>, <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>Acacia colletioides</i> with sparse overstorey of <i>Acacia incurvaneura</i> or isolated <i>Casuarina pauper</i></p> <p>“Calcareous casuarina acacia shrubland” (CCAS vegetation community).</p>
<b>2b. Low rises on basalt</b> 	<p>Gently rounded hills, rises and gentle slopes to 7%, relief to 5 m, many to abundant mantles (20 –90%) fine to coarse gravels of dolerite, ironstone, shale, quartz and calcrete. Often with abundant cryptogams.</p> <p>Shallow calcareous sandy loams over calcrete.</p> <p>Run –off source zones to lower parts of the landscape occasionally via shallow incised drainage channels. Nil to slight vulnerability to erosion.</p>	<p>Very sparse to open (PFC 10 – 20%) mixed height shrublands dominated by <i>Dodonaea lobulata</i>, <i>Senna artemisioides</i> subsp. <i>filifolia</i>, <i>Acacia burkittii</i>, <i>Ptilotus obovatus</i> or less frequently, <i>Maireana sedifolia</i> and <i>Atriplex nummularia</i> subsp. <i>spathulata</i> with isolated to very sparse overstorey of <i>Casuarina pauper</i> and occasionally <i>Acacia incurvaneura</i>, <i>Grevillea nematophylla</i> subsp. <i>nematophylla</i> and/or <i>Alectryon oleifolius</i></p> <p>“Greenstone hill mixed shrubland” (GHMW vegetation community).</p>




Land unit	Land form and soil type	Vegetation community
<b>4a. Plains supporting acacia shrublands</b> 	<p>Very gently inclined to level plains (slopes &lt;1.5%); mostly few to common (2-20%) mantles of ironstone fine gravel, calcrete nodules and quartz fragments, often abundant cryptogams.</p> <p>Deep sandy loam to sandy clay loams mostly non-calcareous.</p> <p>Broad transfer zones receiving water from upper units and shedding onto lower parts of landscape with occasional sheet and rill erosion. Nil to slight vulnerability to erosion.</p>	<p>Open tall acacia shrublands (PFC 10 - 30%) dominated by <i>Acacia incurvaneura</i>, <i>A. ayersiana</i>, <i>A. burkittii</i>, <i>A. hemiteles</i>, <i>A. tetragonophylla</i> and very sparse lower shrubs including <i>Dodonaea lobulata</i>, <i>Senna artemisioides</i> subsp. <i>filifolia</i>, and <i>Ptilotus obovatus</i> with overstoreys of isolated <i>Casuarina pauper</i> or <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>.</p> <p>Plain acacia eucalypt shrubland (PAES)</p>
<b>4b. Plains supporting acacia shrublands on hardpan.</b> 	<p>Gently inclined plains (slopes &lt;1.5%); mostly few to common (2-20%) mantles of ironstone fine to coarse gravel, calcrete nodules and quartz fragments, often abundant cryptogams.</p> <p>Non-calcareous sandy loams over ferruginous hardpan at &gt;30cms.</p> <p>Broad transfer zones receiving water from upper units and shedding onto lower parts of landscape. Not vulnerable to erosion.</p>	<p>Open tall acacia shrublands (PFC 15 - 30%) dominated by <i>Acacia incurvaneura</i>, <i>A. ayersiana</i>, <i>A. burkittii</i>, <i>A. ramulosa</i> and very sparse lower shrubs including <i>Dodonaea rigida</i>, <i>D. lobulata</i> and <i>Ptilotus obovatus</i> with overstoreys of isolated <i>Casuarina pauper</i> or <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>.</p> <p>“Hardpan plain mulga shrubland” (HPMS vegetation community)</p>

Land unit	Land form and soil type	Vegetation community
<b>4c. Calcareous plains supporting chenopod shrublands</b>		
	<p>Gently inclined plains (slopes 1%); mostly very few to few (&lt;2-10%) mantles of fine to medium ironstone gravel, calcrete nodules and quartz fragments.</p> <p>Calcareous sandy clay loams greater than 30cms.</p> <p>Broad transfer zones receiving water from upper units and shedding onto lower parts of landscape. Nil to slightly vulnerable to erosion with very minor soil surface deflation.</p>	<p>Open, mostly degraded <i>Maireana sedifolia</i> shrubland (PFC 10-25%) with colonizing shrubs including <i>Senna artemisioides</i> subsp. <i>filifolia</i>, <i>Eremophila scoparia</i> and <i>Acacia burkittii</i> and with very sparse overstorey of <i>Acacia incurvaneura</i> or <i>Casuarina pauper</i>.</p> <p>“Plain mixed halophyte shrubland” (PXHS vegetation community).</p>
<b>4d. Spinifex sandplain</b>		
	<p>Extensive level to gently sloping sand plain (slopes 0 -2%) with sandy or slightly crusted soil surfaces and abundant patchy litter.</p> <p>Deep sandy loam.</p> <p>Moderate vulnerability to wind erosion if cover removed.</p> <p>Fire susceptible.</p>	<p>Fire-climax community. Very sparse (PFC 5%) eucalypt woodland (6 -10m) of <i>Eucalyptus yilgarnensis</i> and <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i> over mixed height (0.5 – 4m), very sparse (PFC 5 -15%) shrubs including, <i>Acacia colletioides</i>, <i>A. ramulosa</i>, <i>A. burkittii</i>, <i>Eremophila caperata</i> and <i>Westringia rigida</i> and variable density (PFC 5-50%) <i>Triodia irritans</i>.</p> <p>“Sandplain mallee spinifex woodland” (SAMA vegetation community).</p>



Land unit	Land form and soil type	Vegetation community
<b>5a. Alluvial plains supporting chenopod shrublands.</b>		
	<p>Near level to gently sloping (slopes &lt;1 -1%) plains with very few to common surface mantles (&lt;2 – 20%) of fine and medium gravels of quartz, ironstone and calcrete nodules. Common to abundant cryptogams.</p> <p>Sandy clay loam often calcareous especially at depth.</p> <p>Subject to occasional shallow sheet flow, occasionally more concentrated. Stripped soils surfaces common. Moderate vulnerability to erosion.</p>	<p>Very sparse to open, often degraded (PFC 5 – 30%) chenopod shrublands dominated by <i>Maireana sedifolia</i> <i>M. georgei</i>, <i>M. pyramidata</i>, <i>Atriplex vesicaria</i>, <i>Ptilotus obovatus</i> and others or in poor condition dominated by <i>Senna artemisioides</i> subsp. <i>filifolia</i>, <i>Eremophila scorparia</i>, <i>Dodonaea lobulata</i>, <i>Acacia burkittii</i> and <i>A. hemiteles</i> with isolated, occasionally clumped overstorey of <i>Acacia incurvaneura</i>, <i>Casuarina pauper</i>, <i>Eucalyptus brachycorys</i> or <i>E. lesouefii</i></p> <p>“Plain mixed halophyte shrubland” (PXHS vegetation community).</p>
<b>5b. Alluvial plains supporting chenopod shrublands and salmon gums</b>		
	<p>Gently sloping plains (slopes 1-2%) with very few to few mantles (&lt;2-10%) of fine to medium gravels of ironstone, basalt and quartz fragments.</p> <p>Sandy clay loam, occasionally light clay, often saline.</p> <p>Subject to shallow sheet flow, occasionally more concentrated. Stripped soil surfaces common. Moderate vulnerability to erosion.</p>	<p>Open, often degraded, chenopod shrublands dominated by either <i>Maireana sedifolia</i>, <i>Atriplex vesicaria</i>, <i>A. nummularia</i>, or <i>Tecticornia disarticulata</i> and in poor condition dominated by <i>Senna artemisioides</i> subsp. <i>filifolia</i>, <i>Eremophila scorparia</i>, <i>Acacia hemiteles</i>, with sparse overstorey, and groves of <i>Eucalyptus salmonophlioia</i> and <i>E. salubris</i>.</p> <p>“Plain eucalypt chenopod shrubland” (PECW vegetation community).</p>

Land unit	Land form and soil type	Vegetation community
<b>6. Drainage tracts</b>		
	<p>Gently sloping (1%) drainage tracts 50 – 200m wide with occasional minor channels, mostly without surface mantles, and abundant litter trains.</p> <p>Sandy clay loam to sandy clay greater than 30cms.</p> <p>Slight to moderate vulnerability to water erosion.</p>	<p>Open to mid-close (PFC: 20 – 60%), tall acacia shrubland and occasional thickets dominated by <i>Acacia incurvaneura</i>, <i>A. ayersiana</i> and <i>A. burkittii</i> with isolated <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>, <i>Brachychiton gregorii</i> or <i>Casuarina pauper</i> or less commonly <i>Bursaria occidentalis</i>, <i>Senna artemisioides</i> ssp. <i>filifolia</i>, <i>Grevillea nematophylla</i> subsp. <i>nematophylla</i> and <i>Teucrium teucriiflorum</i>.</p> <p>“Drainage tract acacia shrubland” (DRAS vegetation community)</p>

\* (PFC): Projected foliar cover

\*\* (CCAS etc.) vegetation types see Table 6.



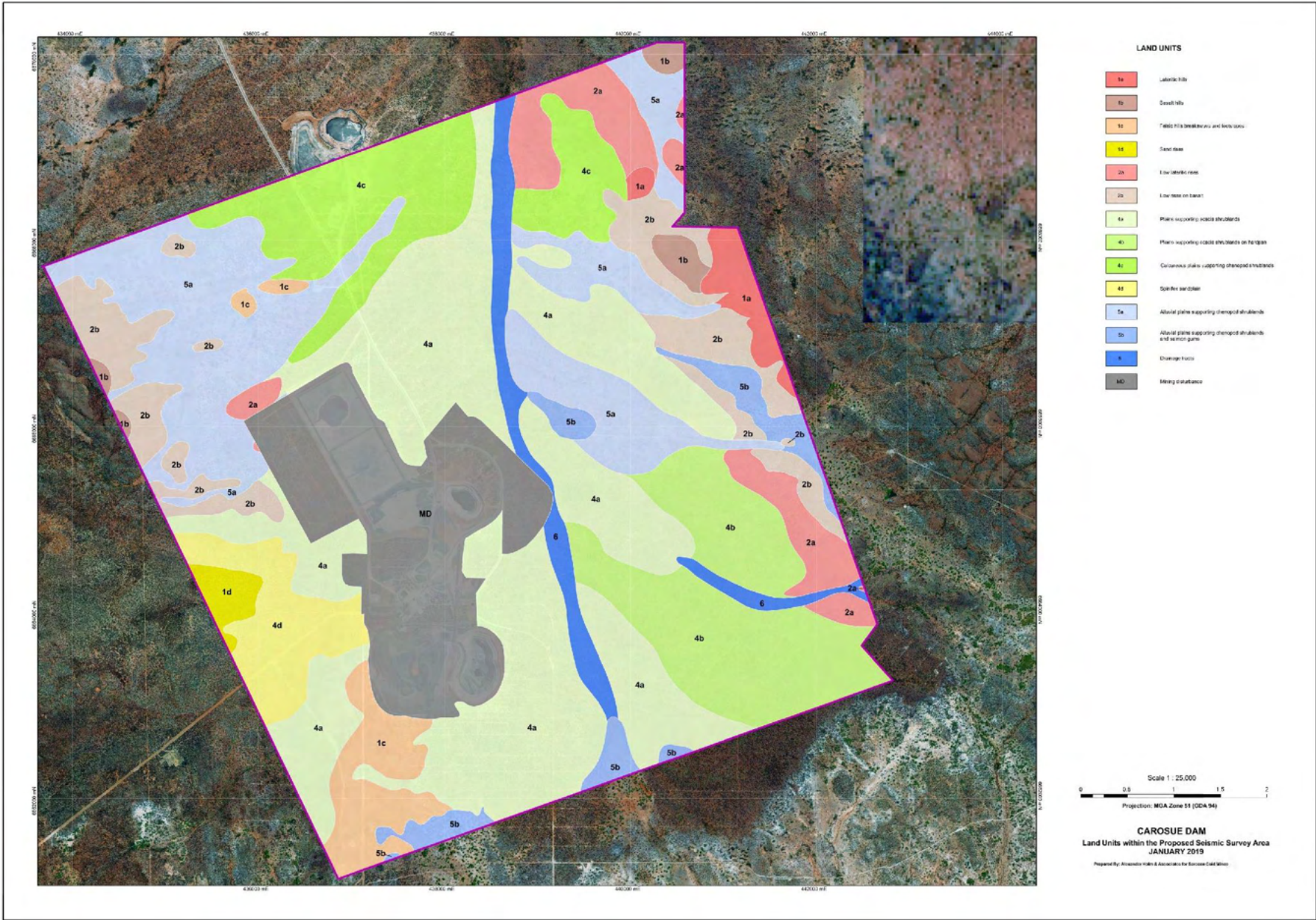


Figure 7: Map of land units

## ***Land unit areas***

Approximately 40% of the survey area is occupied by plains supporting acacia shrublands with sparse overstoreys of eucalypts and casuarina (land units 4a and 4b). Chenopod shrublands occur on approximately 25% of the area either on calcareous plains (land unit 4c) or alluvial plains (land units 5a and 5b). Sand plains and sandy rises occupy 4% of the area and typically support spinifex tussock grasslands with sparse eucalypt overstoreys. Low hills and rises on laterite, basalt or felsic rocks occupy the remainder (Table 5).

**Table 4: Area of each land unit within the extended survey area**

<b>Land unit</b>	<b>Description</b>	<b>Hectares</b>	<b>%</b>
1a.	Lateritic hills	70.08	1.43
1b.	Basalt hills	43.92	0.90
1c.	Felsic hills breakaways and footslopes	166.45	3.40
1d.	Sandy rises	37.85	0.77
2a.	Low lateritic rises	233.41	4.77
2b.	Low rises on basalt	335.56	6.85
4a.	Plains supporting acacia shrublands	1327.78	27.12
4b.	Plains supporting acacia shrublands on hardpan	476.59	9.73
4c.	Calcareous plains supporting chenopod shrublands	411.70	8.41
4d.	Spinifex sandplain	175.69	3.57
5a.	Alluvial plains supporting chenopod shrublands	716.20	14.63
5b.	Alluvial plains supporting chenopod shrublands and salmon gums	127.16	2.60
6.	Drainage tracts	154.11	3.15
MD	Mining disturbance	619.44	12.65
<b>Total</b>		<b>4895.93</b>	<b>100.00</b>

## ***Vegetation communities***

Fire-susceptible ‘Sandplain mallee spinifex grassland’ (SAMA) occupies central western areas (Table 5). Elevated land units on laterite are mostly occupied by ‘Stony ironstone acacia shrubland’ (SIAS) while lower lateritic slopes are occupied by ‘Calcareous casuarina acacia shrubland’ (CCAS). Elevated land unit on basalt are occupied by ‘Greenstone hill shrubland’ (GHAS and GHMW) while those on felsic geology, mostly in the south west, are ‘Breakaway mixed shrubland’ (BRXS).

‘Plain acacia eucalypt shrubland’ (PAES) and ‘Hardpan plain mulga shrubland’ (HPMS) occupy extensive plains throughout the central areas through which pass a significant drainage tract occupied by ‘Drainage tract acacia shrubland’ (DRAS).

‘Plain mixed halophyte low shrublands’ (PXHS) occur on plains in northern areas and on adjacent alluvial plains which are often degraded. The lowest parts of the landscape, discharging overland flows to Lake Rebecca in the south, are occupied with ‘Plain eucalypt chenopod woodland’ (PECW).

**Table 5: Vegetation communities, associated land units and vulnerability to disturbance.**

Vegetation community	Description	Land unit	Vulnerable
BRXS	Breakaway mixed shrubland (N)	1c	
CCAS	Calcareous casuarina acacia shrubland or woodland (N)	2a	Yes (C)
DRAS	Drainage tract acacia shrubland (S)	6	
GHAS	Greenstone hill acacia shrubland (N)	1b	
GHMW	Greenstone hill mixed shrubland (N)	2b	
HPMS	Hardpan plain mulga shrubland (N)	4b	
PAES	Plain acacia eucalypt shrubland (new)	4a	
PECW	Plain eucalypt chenopod woodland (N)	5b	Yes
PXHS	Plain mixed halophyte low shrublands (N)	4c 5a	Yes (C)
SAMA	Sandplain mallee spinifex woodland (N)	1d 4d	
SIAS	Stony ironstone acacia shrubland (N)	1a	

\*(N)(Pringle, Van Vreeswyk & Gilligan, 1994); (S) (Payne, Van Vreeswyk, Pringle, Leighton and Hennig 1998) (C) (Cowan, 2001)

## Vegetation and soil condition

The survey area has been disturbed by recent and historic mining activity and is mostly within a pastoral lease and has been grazed. Vehicle tracks, cut lines and pastoral fences cross the area.

Land units supporting chenopod vegetation, preferentially grazed by livestock, are mostly degraded and few areas are in good condition (Table 6). Spinifex communities (SASP) on sandplains and sandy rises are not suitable for grazing and are in excellent condition. Hills on laterite, basalt and felsic geology are mostly in excellent condition. (Table 5) while lower slopes on laterite and basalt are often in poorer condition.

Minor to moderate soil erosion is evident on alluvial plains (land unit 5a and 5b) and these land units are rated as moderately vulnerable to erosion (Table 6). Other land units are mostly rated nil or slight vulnerable to soil erosion and only small areas on these units are

slightly eroded (Table 7). Spinifex sand plain and rises are susceptible to wind erosion following fire.

**Table 6: Vegetation and soil surface condition ratings for each land unit**

Land unit	Vulnerability to erosion	Erosion status	Vegetation condition
1a. Lateritic hills	Nil	100% nil	100% excellent
1b. Basalt hills	Nil	100% nil	100% excellent/v.good
1c. Felsic hills breakaways and footslopes	Nil	100% nil	100% excellent/good
1d. Sandy rises	Slight	100% nil	100% excellent
2a. Low lateritic rises	Nil -slight	100% nil to minor	80% excellent/good 20% poor
2b. Low rises on basalt	Nil -slight	93% nil to minor 7% moderate	50% excellent/good 50% poor
4a. Plains supporting acacia shrublands	Nil -slight	94% nil to minor 6% moderate	75% excellent/good 25% poor
4b. Plains supporting acacia shrublands on hardpan	Nil	100% nil to minor	100% excellent/good
4c. Calcareous plains supporting chenopod shrublands	Nil -slight	83% nil to minor 17% moderate	17% good 17% poor 66% degraded
4d. Spinifex sandplain	Moderate	100% nil to minor	100% excellent/ v.good
5a. Alluvial plains supporting chenopod shrublands	Moderate	71% nil to minor 29% moderate	14% good 29% poor 57% degraded/ completely degraded
5b. Alluvial plains supporting chenopod shrublands and salmon gums	Moderate	67% nil to minor 33% moderate	33% good 29% poor 28% degraded
6. Drainage tracts	Slight to moderate	60% nil 40% minor	60% excellent/good 20% poor 20% degraded



## Threatened ecosystems and wetlands.

### ***Threatened and priority ecological communities***

There are no identified threatened ecological communities (TECs) on Saracen tenements or in the entire MUR1 biogeographic subregion (Cowan, 2001).

There are no listed priority ecological communities (PECs) in the area.

### ***Ecosystems at risk***

Cowan, (2001) lists PXHS vegetation community (Plain mixed halophyte low shrublands) as an ecosystem at risk to disturbance (Table 5). PXHS vegetation community is associated with land unit 5a, 57% of which was degraded through over grazing. This current survey also identifies PECW (Plain eucalypt chenopod woodland) as an ecosystem at risk in that over 50% is in poor or degraded condition. PXHS and PECW occur on land unit 5a and 5b which are moderately vulnerable to erosion and erosion is evident (Table 6).

### ***Significant wetlands***

There are no nationally significant wetlands in the area (Appendix 1). Lake Rebecca is a major wetland with local and regional significance.

### ***Riparian vegetation***

The survey landscape mainly drains via overland flow to a main drainage tract (land unit 6a) which flows into Lake Rebecca 5 km to the north. Southern areas drain southerly through various drainage systems also to Lake Rebecca.

## Flora

### ***General***

One hundred and twenty-nine flora taxa representing 26 families were found during the reconnaissance survey (Table 7). Chenopodiaceae accounted for 24 taxa, Fabaceae 19 taxa and Scrophulariaceae 17 taxa. There were four sterile specimens which were identified to genera level.

An additional 14 taxa were found on the sandy rises of land unit 1D during the November 2013 survey (Table 7).

A list of species within each family found at each inventory site is presented in Attachment 3. Species typifying the survey area include: *Acacia tetragonophylla*, *Scaevola spinescens*; *Ptilotus obovatus*, *Acacia burkittii*, *Casuarina pauper*, *Dodonaea lobulata* and *Senna artemisioides* subsp. *filifolia*, all present on at least 70% of sites.

### ***Local endemics***

No taxa are considered to be locally endemic.

### ***Range extension***

The collection of the following species at this location indicates a significant extension of their known distribution range:

- *Eucalyptus oleosa* subsp. *cylindroidea*
- *Sclerolaena glabra*
- *Thryptomene kochii*

### ***Declared weed species***

No alien to Western Australia (weed) species were located during survey although *Carthamus lanatus* (saffron thistle) was noted growing along road verges.

**Table 7: List of flora taxa found during field survey in January 2019 and on land unit 1D during field survey in November 2012.**

Family	Taxa	Land units											
		1A	1B	1C	1D	2A	2B	4A	4B	4C	5A	5B	6
Amaranthaceae	<i>Ptilotus obovatus</i>	y	y	y		y	y	y	y	y	y	y	y
Apocynaceae	<i>Alyxia buxifolia</i>			y			y	y			y	y	
Apocynaceae	<i>Marsdenia australis</i>	y	y			y	y	y	y	y	y	y	y
Asteraceae	<i>Brachyscome ciliaris</i>		y					y			y		y
Asteraceae	<i>Brachyscome trachycarpa</i>										y		
Asteraceae	<i>Cratystylis subspinescens</i>					y				y	y	y	
Asteraceae	<i>Minuria cunninghamii</i>									y	y		
Asteraceae	<i>Olearia exiguiifolia</i>							y					y
Asteraceae	<i>Olearia muelleri</i>	y		y		y	y	y	y	y	y	y	
Asteraceae	<i>Vittadinia eremaea</i>									y	y		
Boraginaceae	<i>Halgania cyanea</i>							y					y
Boraginaceae	<i>Halgania erecta*</i>				Y								
Casuarinaceae	<i>Allocasuarina helmsii</i>												
Casuarinaceae	<i>Casuarina pauper</i>	y	y	y		y	y	y	y	y	y	y	
Chenopodiaceae	<i>Atriplex bunburyana</i>						y	y	y	y	y	y	
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>	y	y	y		y	y	y	y	y	y	y	
Chenopodiaceae	<i>Atriplex vesicaria</i>			y			y			y	y	y	
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>		y				y	y		y	y	y	
Chenopodiaceae	<i>Enchylaena lanata</i>			y			y	y			y	y	y
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	y		y			y	y			y	y	y
Chenopodiaceae	<i>Enchyleana x Maireana</i> hybrid							y		y	y		y
Chenopodiaceae	<i>Eriochiton sclerolaenoides</i>	y											
Chenopodiaceae	<i>Maireana georgei</i>	y	y	y			y	y		y	y	y	y
Chenopodiaceae	<i>Maireana pentatropis</i>	y	y	y		y	y				y	y	
Chenopodiaceae	<i>Maireana planifolia</i>										y	y	
Chenopodiaceae	<i>Maireana pyramidata</i>							y		y	y	y	
Chenopodiaceae	<i>Maireana sedifolia</i>	y	y	y		y	y	y		y	y	y	
Chenopodiaceae	<i>Maireana tomentosa</i>			y							y	y	
Chenopodiaceae	<i>Maireana triptera</i>	y		y			y	y		y	y	y	y
Chenopodiaceae	<i>Rhagodia drummondii</i>	y	y				y	y		y	y	y	
Chenopodiaceae	<i>Rhagodia eremaea</i>	y	y	y		y	y	y			y	y	y
Chenopodiaceae	<i>Salsola australis</i>									y		y	
Chenopodiaceae	<i>Sclerolaena cuneata</i>											y	

Family	Taxa	Land units											
		1A	1B	1C	1D	2A	2B	4A	4B	4C	5A	5B	6
Chenopodiaceae	<i>Sclerolaena diacantha</i>	y	y	y		y	y	y		y	y	y	
Chenopodiaceae	<i>Sclerolaena gardneri</i>									y	y	y	
Chenopodiaceae	<i>Sclerolaena glabra</i>	y										y	
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>										y	y	
Chenopodiaceae	<i>Tecticornia disarticulata</i>			y								y	
Convolvulaceae	<i>Convolvulus clementii</i>									y			y
Convolvulaceae	<i>Duperreya commixta*</i>				Y								
Euphorbiaceae	<i>Bertya dimerostigma*</i>				Y								
Fabaceae	<i>Acacia aptaneura</i>			y					y	y	y	y	
Fabaceae	<i>Acacia ayersiana</i>	y	y	y		y		y	y				y
Fabaceae	<i>Acacia burkittii</i>	y	y	y		y	y	y	y	y	y	y	y
Fabaceae	<i>Acacia caesaneura</i>					y		y	y				
Fabaceae	<i>Acacia effusifolia*</i>				Y								
Fabaceae	<i>Acacia erinacea</i>	y		y									
Fabaceae	<i>Acacia hemiteles</i>	y	y				y	y	y	y	y	y	y
Fabaceae	<i>Acacia incurvaneura</i>	y	y	y	Y	y	y	y	y	y	y		y
Fabaceae	<i>Acacia kempeana</i>					y	y		y		y		
Fabaceae	<i>Acacia ligulata</i>			y			y	y		y			
Fabaceae	<i>Acacia nyssophylla</i>	y	y	y		y	y	y		y	y	y	
Fabaceae	<i>Acacia oswaldii</i>		y	y		y	y	y	y	y	y	y	
Fabaceae	<i>Acacia quadrimarginea</i>		y										
Fabaceae	<i>Acacia ramulosa</i> var. <i>linophylla</i>		y	y		y	y	y	y				
Fabaceae	<i>Acacia sibirica</i>	y	y			y	y	y	y			y	
Fabaceae	<i>Acacia tetragonophylla</i>	y	y	y	Y	y	y	y	y	y	y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>	y	y	y		y	y	y	y	y	y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>		y				y	y	y		y	y	y
Fabaceae	<i>Senna cardiosperma</i>	y	y										
Fabaceae	<i>Templetonia incrassata</i>			y		y		y	y		y		
Frankeniaceae	<i>Frankenia interioris</i>			y						y	y	y	
Goodeniaceae	<i>Scaevola spinescens</i>	y	y	y		y	y	y	y	y	y	y	y
Lamiaceae	<i>Physopsis viscida</i>												
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>		y		Y	y		y	y		y		y
Lamiaceae	<i>Teucrium disjunctum</i>										y		
Lamiaceae	<i>Teucrium teucriiflorum</i>					y		y	y		y		y
Lamiaceae	<i>Westringia rigida</i>				Y					y			

Family	Taxa	Land units											
		1A	1B	1C	1D	2A	2B	4A	4B	4C	5A	5B	6
Loranthaceae	<i>Amyema fitzgeraldii</i>							y		y	y		y
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>							y	y				y
Loranthaceae	<i>Amyema preissii</i>						y						
Loranthaceae	<i>Lysiana casuarinae</i>							y		y	y		
Malvaceae	<i>Abutilon cryptopetalum</i>									y			
Malvaceae	<i>Abutilon otocarpum</i>										y		
Malvaceae	<i>Brachychiton gregorii</i>		y			y		y	y		y		y
Malvaceae	<i>Sida calyxhymenia</i>			y				y	y				
Malvaceae	<i>Sida intricata</i>						y	y			y		
Malvaceae	<i>Sida</i> sp. <i>Excedentifolia</i> (J.L. Egan 1925)					y							
Malvaceae	<i>Sida spodochroma</i>									y	y	y	y
Myrtaceae	<i>Aluta aspera</i> subsp. <i>aspera</i> *				Y								
Myrtaceae	<i>Calytrix</i> sp.			y									
Myrtaceae	<i>Enekbatus cryptandroides</i> *				Y								
Myrtaceae	<i>Eucalyptus ewartiniana</i>					y							
Myrtaceae	<i>Eucalyptus ceratocorys</i> *				Y								
Myrtaceae	<i>Eucalyptus concinna</i>	y						y	y				
Myrtaceae	<i>Eucalyptus eremicola</i> *				Y								
Myrtaceae	<i>Eucalyptus eremicola</i> subsp. <i>peeneri</i>			y									
Myrtaceae	<i>Eucalyptus lesouefii</i>			y			y					y	
Myrtaceae	<i>Eucalyptus oldfieldii</i> *				Y								
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>cylindroidea</i> *				Y								
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>			y				y	y		y		y
Myrtaceae	<i>Eucalyptus salmonophloia</i>			y								y	
Myrtaceae	<i>Eucalyptus salubris</i>						y					y	
Myrtaceae	<i>Eucalyptus yilgarnensis</i>	y											
Myrtaceae	<i>Melaleuca hamata</i>					y							
Myrtaceae	<i>Thryptomene kochii</i> *				Y								
Myrtaceae	<i>Verticordia pritzelii</i> *				Y								
Pittosporaceae	<i>Bursaria occidentalis</i>				Y			y			y		y
Pittosporaceae	<i>Marianthus bicolor</i> *				Y								
Pittosporaceae	<i>Pittosporum angustifolium</i>										y		
Poaceae	<i>Aristida contorta</i>		y							y			
Poaceae	<i>Astrostipa</i> sp.	y	y			y	y			y	y		
Poaceae	<i>Austrostipa elegantissima</i>	y		y		y	y			y	y	y	

Family	Taxa	Land units											
		1A	1B	1C	1D	2A	2B	4A	4B	4C	5A	5B	6
Poaceae	<i>Austrostipa eremophila</i>							y					
Poaceae	<i>Enneapogon avenaceus</i>						y				y	y	
Poaceae	<i>Enneapogon caerulescens</i>									y	y		
Poaceae	<i>Enneapogon polyphyllus</i>										y		
Poaceae	<i>Eragrostis eriopoda</i>					y		y	y				
Poaceae	<i>Monachather paradoxus</i>					y		y					
Poaceae	<i>Paspalidium constrictum</i>						y			y	y	y	y
Poaceae	<i>Thyridolepis</i> sp								y				
Poaceae	<i>Triodia irritans</i>				Y					y			
Proteaceae	<i>Grevillea juncifolia</i> subsp. <i>juncifolia</i> *				Y								
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>				Y								
Proteaceae	<i>Hakea preissii</i>			y							y		
Pteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>		y			y							
Rubiaceae	<i>Psyrdrax suaveolens</i>			y	Y	y							
Rutaceae	<i>Phebalium canaliculatum</i>	y	y		Y					y	y	y	y
Santalaceae	<i>Exocarpos aphyllus</i>			y							y	y	
Santalaceae	<i>Santalum acuminatum</i>											y	
Santalaceae	<i>Santalum spicatum</i>	y	y	y		y	y	y	y	y	y		y
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>	y	y	y		y	y	y		y	y	y	
Sapindaceae	<i>Dodonaea amblyophylla</i> *				Y								
Sapindaceae	<i>Dodonaea lobulata</i>	y	y	y		y	y	y	y	y	y	y	y
Sapindaceae	<i>Dodonaea rigida</i>			y		y		y	y		y		y
Scrophulariaceae	<i>Eremophila alternifolia</i>			y				y		y	y		
Scrophulariaceae	<i>Eremophila arachnoides</i> subsp. <i>tenera</i>										y	y	
Scrophulariaceae	<i>Eremophila caperata</i>												
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	y		y	Y	y	y	y	y	y	y	y	y
Scrophulariaceae	<i>Eremophila eriocalyx</i>	y	y			y	y	y	y		y		y
Scrophulariaceae	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>				Y	y		y	y				
Scrophulariaceae	<i>Eremophila georgei</i>	y	y	y			y	y	y		y		
Scrophulariaceae	<i>Eremophila glabra</i> subsp. <i>glabra</i>		y			y	y	y	y	y	y		y
Scrophulariaceae	<i>Eremophila granitica</i>				Y			y	y				y
Scrophulariaceae	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	y	y	y		y	y	y	y				
Scrophulariaceae	<i>Eremophila longifolia</i>						y	y	y		y	y	y
Scrophulariaceae	<i>Eremophila maculata</i>											y	
Scrophulariaceae	<i>Eremophila metallicorum</i>					y		y		y	y		y

Family	Taxa	Land units											
		1A	1B	1C	1D	2A	2B	4A	4B	4C	5A	5B	6
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>	y	y	y		y	y	y	y	y	y		y
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>	y		y			y	y				y	y
Scrophulariaceae	<i>Eremophila scoparia</i>	y	y	y		y	y			y	y	y	
Scrophulariaceae	<i>Eremophila</i> sp									y	y		
Solanaceae	<i>Lycium australe</i>										y		
Solanaceae	<i>Solanum nummularium</i>					y		y			y		
Solanaceae	<i>Solanum lasiophyllum</i>		y				y	y	y	y	y	y	y
Violaceae	<i>Hybanthus floribundus</i> subsp. <i>curvifolius</i>	y											
Zygophyllaceae	<i>Roepera aurantiaca</i> subsp. <i>aurantiaca</i>										y		

\* 2013 survey

## ***Threatened and priority flora***

There are three threatened flora taxa (WA Wildlife Conservation Act 1950 – Wildlife Conservation (Rare Flora) Notice 2010(2) likely to occur in the general area: *Thryptomene wittweri*, *Eucalyptus articulata* and *Gastrolobium graniticum* which is also an endangered species under the Commonwealth EPBC Act (Table 2).

No threatened (rare) or endangered flora taxa were found during reconnaissance or targetted surveys.

*Eremophila arachnoides* subsp. *tenera* (P1) was located at:

- Northern area of approximately 125ha containing about 2500, mostly adult, plants (Figure 8). The vast majority of these are located on land unit 5a: Alluvial plains supporting chenopod shrublands.
- A southern area of approximately 3.4ha containing 28 adult plants.
- A southern area of approximately 3.4ha containing 13 adult plants.
- A southern area of approximately 1.2ha containing 5 adult plants
- Two singletons in the southern area.

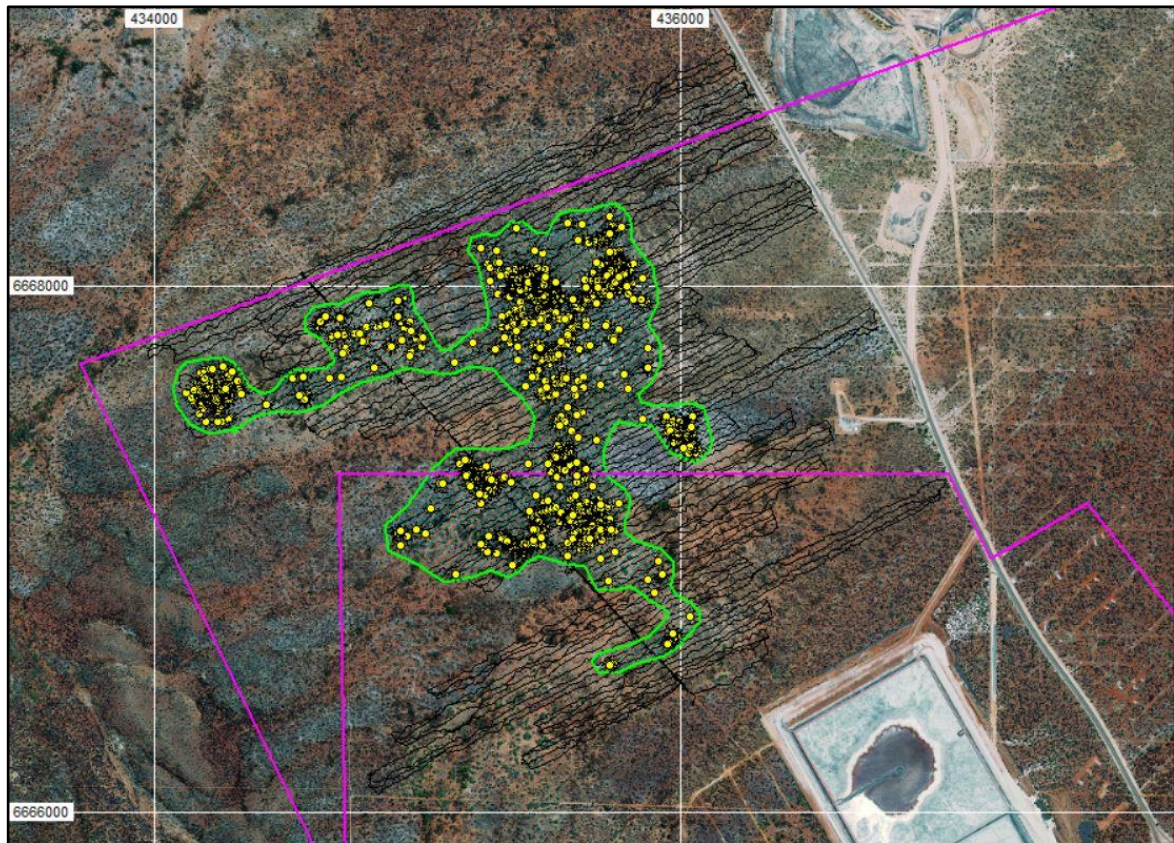
Southern areas shown in Figure 9 and all occurring on land unit 5b: Alluvial plains supporting chenopod shrublands and salmon gums.

It is likely that other populations exist in similar land units to the south of the survey area.

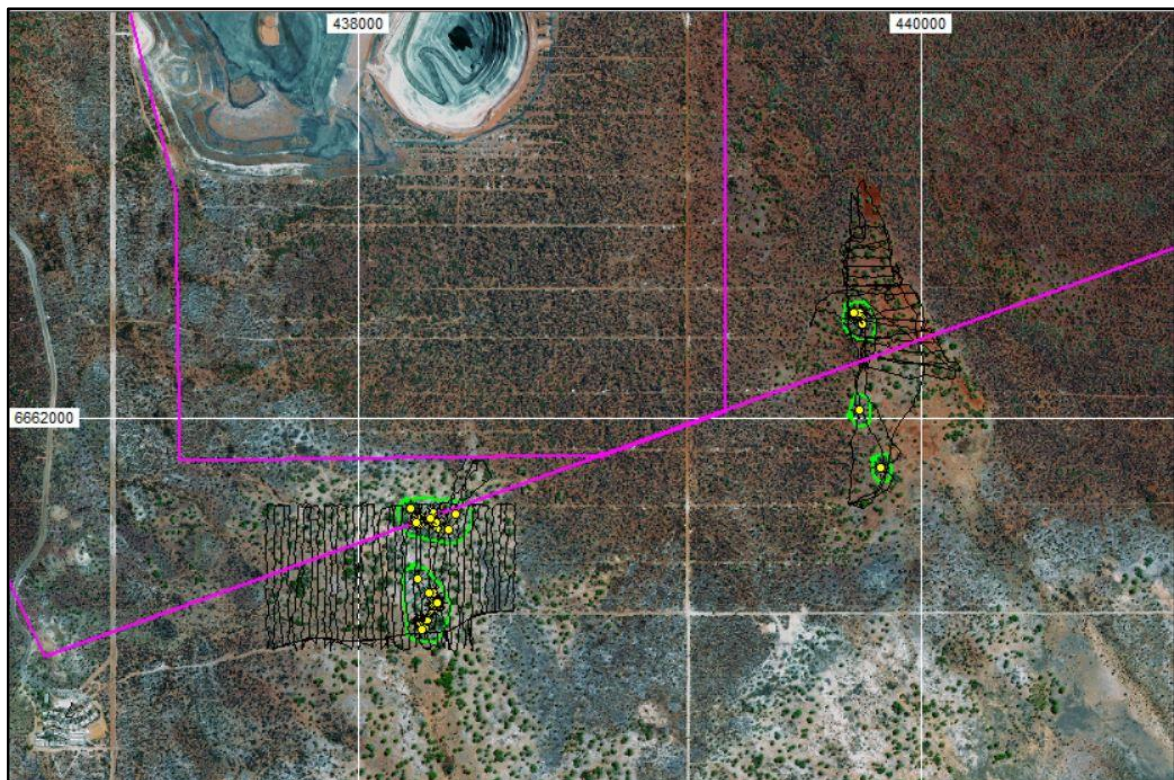


*Eremophila arachnoides* subsp. *tenera*  
P1





**Figure 8:** Location of *Eremophila arachnoides subsp. tenera* (yellow dots) and search traverses (black lines) in the northern area.



**Figure 9:** Location of *Eremophila arachnoides subsp. tenera* (yellow dots) and search traverses (black lines) in the southern area.



# Fauna

## ***Conservation significant fauna***

### *Malleefowl*

Malleefowl are active in the survey area. There were three sightings of birds during field work for this survey and active mounds have been found in previous studies (Coffey Environment 2010, Alexander Holm and Associates 2012d), and in the airport area just to the west. Several Malleefowl mounds were found during this survey but most were long-inactive (Figure 5). The species is therefore clearly resident, but density of mounds is low. Furthermore, several mounds were very small, little more than small pits with a slightly raised edge of excavated soil, and it is unlikely they had ever been used for breeding; possibly they were dug by young males. These tended to be in heavy loamy-clay soils which are not usually the preferred substrate, with sands and gravels generally favoured. Malleefowl is probably more abundant to the west where there are extensive sandy soils associated with land unit 1d and 4d together occupying about 4.5% of the survey area. They may also be more abundant in rocky hills and low rises (land unit 1a, 1b, 1c 2a and 2b) collectively occupying 17% of the survey area.

### *Peregrine Falcon*

Peregrine Falcon were not observed but are a widespread species and considered likely to be a regular visitor if not resident. It could also breed in tall eucalypts in the area, probably by utilising old nests of the Australian Raven.

### *Rainbow Bee-eater.*

This species is only considered of local significance but was formerly listed as Migratory under legislation. It is still considered locally significant as it is a true migrant and breeds in burrows in the area, making it vulnerable to disturbance and predation. It will also often nest along tracks, increasing its vulnerability.

## ***Habitat***

The sandy soils supporting spinifex and mallee in the south-west (land units 1d and 4d) are likely to be rich in reptiles as the soils allow for burrowing and the spinifex provides abundant cover. Such areas are also likely to be rich in shrubland-dependent birds and some small mammals. During the site inspection, it was noted that the transition between eucalypt woodland and acacia shrublands appeared to be rich in birds; south of the current operations this is where species such as the Red-capped Robin, White-eared and Brown-headed Honeyeaters and White-browed Babblers were observed. It was also where a Malleefowl was seen. Tall shrublands of acacia with little understorey, found across large areas of loamy-clay soils (land unit 4a and 4b), are probably less rich in species. The low rocky hills (land units 1a, 1b, 1c) have potential for short range endemic invertebrates and appeared to be floristically rich, so may be seasonally important for nectar-dependent birds and invertebrates.

## ***Impacting processes on fauna***

### *Habitat loss leading to population decline.*

Habitat loss from clearing 3m wide drill-lines at 90m intervals will affect about 3% of the landscape, and there will inevitably be some mortality during this clearing. Note that the habitat loss will be temporary except where lines are maintained as access tracks, and

therefore populations should recover from this loss eventually. The effect of habitat loss can be reduced by avoiding sensitive environmental features such as Malleefowl mounds.

*Habitat loss leading to population fragmentation.*

This is unlikely to be a concern with the proposal as the clearing is in narrow lines through otherwise more or less continuous vegetation.

*Ongoing mortality from operations.*

Main sources of ongoing mortality will be from vehicle strike and entrapment in drilling sumps. There are standard procedures for minimising these risks.

*Species interactions including feral and overabundant native species.*

Feral predators are present and affect fauna assemblage. Creation of multiple tracks will improve their access into areas where currently tracks are few. The presence of personnel in these areas can also lead to an increase in activity of feral species.

*Hydrological change.*

There may be some disruption of surface flow especially on the lower slopes of hills. Wastewater from drilling is usually contained in lined sumps so should have no impact.

*Altered fire regimes.*

Drilling activities and the presence of personnel will increase the risk of unplanned bushfire.

*Disturbance (dust, light, noise).*

Some level of disturbance during drilling is inevitable but temporary. If drilling occurs at night, lighting may be a source of mortality for insects. While only a temporary effect there are means by which this sort of mortality can be reduced. It is not known if the specially protected jewel beetles known from the general area are present, or how they might be affected by light.

## Hydrological summary

The survey landscape mainly drains via overland flow to a main drainage tract (land unit 6) which flows into Lake Rebecca 5 km to the north. Southern areas drain southerly through various drainage systems again to Lake Rebecca.

Groundwater within the vicinity of the existing tailings facility is hypersaline (30,000 to 120,000 mg/l TDS) and between 15 and 60m below ground level (Saracen annual ground water report). Groundwater beneath the sandplain and sandy rise to the west of the survey area is likely to be less saline however no data exists for this aquifer.

# ASSESSMENT IN RELATION TO CLEARING PRINCIPLES

Results of this survey are used to assess clearing within the survey area in relation to ten clearing principles prescribed in Schedule 5 under amendments in 2004 to the Environmental Protection Act (1986):

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

The survey area is in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions. Lake Ballard/Lake Rebecca form 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 (black oak) and *Eucalyptus* species on alkaline and calcareous soils to the south. The survey area straddles this vegetation divide.

Beard Vegetation Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) is the most common vegetation association in the survey area occupying 83%. Vegetation Association 529 (Succulent steppe with open low woodland; mulga and sheoak over salt bush) occupies 12% and the remaining 5% is Vegetation Association 24 (Low woodland; *Casuarina obesa*) (Beard 1976).

One hundred and twenty nine flora taxa representing 26 families were found during the reconnaissance survey. An additional 14 taxa were found on the sandy rises of land unit 1D during the November 2013 survey.

Vegetation associations and species composition are typical of the area and most are 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.**

Malleefowl are active in the survey area. Malleefowl mounds are of importance for the birds, whether or not they are active or recently-used, while active mounds (containing eggs) are of special value. Even very old mounds have been found to be re-used, possibly after an interval of several decades (M. Bamford pers. obs; Mt Jackson area). Malleefowl is probably more abundant to the west where there are extensive sandy soils associated with land unit 1d and 4d together occupying about 4.5% of the survey area. They may

also be more abundant in rocky hills and low rises (land unit 1a, 1b, 1c 2a and 2b) collectively occupying 17% of the survey area.

Large Eucalypt trees, common in land unit 5b, may support nesting by the Peregrine Falcon (and other birds).

**Proposal is 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 listed species of rare or critically endangered flora were found during this survey.

A search of the Department of Environment and Conservation's Rare and Priority Flora Database revealed no records of Declared Rare Flora (DRF) in or nearby the survey area.

Three populations consisting of over 2500 plants of *Eremophila arachnoides* subsp. *tenera*, a Priority 1 listed taxa (P1) were located within the survey envelope. Priority flora are under consideration for listing as threatened species and as such require protection until their status is decided.

**The proposal is 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 Threatened Ecological Communities (TECs) within the north east Goldfields subregion (Cowan, 2001).

There are no Priority Ecological Communities within or adjacent to the survey area.

**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.**

Beard Vegetation Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) is the most common vegetation association in the survey area occupying 83%. Vegetation Association 529 (Succulent steppe with open low woodland; mulga and sheoak over salt bush) occupies 12% and the remaining 5% is Vegetation Association 24 (Low woodland; *Casuarina obesa*) (Beard 1976).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation (Table 1). Vegetation Association 529 is very poorly conserved and has a high priority for conservation.

Vegetation Association 529 has not been extensively cleared and clearing within this survey area will have minimal effect on extent of this vegetation community.

**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.**

The survey landscape mainly drains via overland flow to a main drainage tract (land unit 6) which flows into Lake Rebecca 5 km to the north. Southern areas drain southerly through various drainage systems again to Lake Rebecca. Lake Rebecca is a major wetland with local and regional significance.

Survey lines will intercept these watercourses.

**Proposal is 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 has been disturbed by recent mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Land units supporting chenopod vegetation, preferentially grazed by livestock, are mostly degraded and few areas are in good condition. Spinifex communities (SASP) on sandplains and sandy rises are not suitable for grazing and are in excellent condition. Hills on laterite, basalt and felsic geology are mostly in excellent condition while lower slopes on laterite and basalt are often in poorer condition.

Minor to moderate soil erosion is evident on alluvial plains (land unit 5a and 5b) and these land units are rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slight vulnerable to soil erosion and only small areas on these units are slightly eroded. Spinifex sand plain and rises are susceptible to wind erosion following fire.

Extensive clearing within alluvial land units 5a and 5b are likely to lead to further soil erosion. Limited strip clearing, as proposed, is unlikely to cause extensive land degradation.

Water tables are a) below the rooting depth of vegetation growing in these areas and b) hypersaline. Extensive clearing of vegetation at catchment-scale or artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes.

Clearing of vegetation at local scales will have minimal, if any, effect on water tables and associated risk of secondary salinity.

**Proposal is 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 are nearby.

**Proposal is 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.**

Approximately 17% of the survey area is occupied by alluvial plains supporting halophytic low shrubland with sparse overstoreys of eucalypts and casuarina (land units 5a and 5b). Minor to moderate soil erosion is evident on alluvial plains and these land units are rated as moderately vulnerable to erosion. Other land units are mostly rated nil or slightly vulnerable to soil erosion.

While, disturbance to land units 5a and 5b has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca, the proposed strip clearing is unlikely to result in significant increases in sediment discharge.

**Proposal is unlikely to be 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 runoff.

Clearing in this proposal will have negligible effect on the volume of runoff discharged.

**Proposal is unlikely to be at variance with this principle.**

# DISCUSSION AND RECOMMENDATIONS

Saracen operates the Carosue Gold Mine and is proposing intensive exploration around its existing mine. A seismic survey is proposed over a 4300ha area requiring clearing of 3m wide access-lines at 90m spacing. Parts of this area have been covered by earlier environmental assessments. The current environmental assessment envelope covers the balance of 3136ha.

Flora composition and vegetation associations are typical of the region and not considered unusually diverse. There are no Threatened Ecological Communities (TECs) and no Priority Ecological Communities within or adjacent to the survey area.

No listed species of rare or critically endangered flora were found during this survey and no records of Declared Rare Flora (DRF) found in or nearby the survey area. Three populations consisting of over 2500 plants of *Eremophila arachnoides* subsp. *tenera*, a Priority 1 listed taxa (P1), were located within the survey envelope. Priority flora are under consideration for listing as threatened species and as such require protection until their status is decided.

No alien to Western Australia (weed) species were located during survey although *Carthamus lanatus* (saffron thistle) was noted growing along road verges.

Approximately 17% of the survey area is occupied by alluvial plains (land units 5a and 5b) where moderate soil erosion is evident, and these land units are rated as moderately vulnerable to erosion. These alluvial systems support PXHS vegetation community (Plain mixed halophyte low shrublands) and PECW (Plain eucalypt chenopod woodland) which are degraded through over grazing. While, disturbance to land units 5a and 5b has the potential to increase sediment discharge to drainage tracts down-slope and ultimately, and through extreme events, to Lake Rebecca, the proposed strip clearing is unlikely to result in significant increases in sediment discharge.

The survey landscape mainly drains via overland flow to a main drainage tract (land unit 6) which flows into Lake Rebecca 5 km to the north. Southern areas drain southerly through various drainage systems again to Lake Rebecca. Lake Rebecca is a major wetland with local and regional significance. Survey lines will intercept these watercourses.

Malleefowl are active in the survey area. There were three sightings of birds during field work for this survey and active mounds have been found in previous studies. Malleefowl is probably more abundant to the west where there are extensive sandy soils associated with land unit 1d and 4d together occupying about 4.5% of the survey area. They may also be more abundant in rocky hills and low rises (land unit 1a, 1b, 1c 2a and 2b) collectively occupying 17% of the survey area. Malleefowl mounds are of importance for the birds, whether or not they are active or recently-used. Malleefowl mounds are active from about May to December and depending on rainfall into January. Active mounds containing eggs are of special value.



Large Eucalypt trees, common in land unit 5b, may support nesting by the Peregrine Falcon (and other birds).

It is recommended that, in planning and implementing seismic operations within the survey area, the proponent:

- 1. Avoids disturbance to *Eremophila arachnoides* subsp. *tenera*.**
- 2. Undertakes a Malleefowl survey especially within land units 1a, 1b, 1c, 1d, 2a and 2b and avoids disturbance within 50m of active Malleefowl nests during nesting and incubation.**
- 3. Installs signage on access roads to the exploration area if Malleefowl are seen or suspected.**
- 4. Avoids destruction of mature Eucalyptus trees with nesting hollows.**
- 5. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially alluvial plains (land unit 5a and 5b).**
- 6. Avoids disturbance to watercourses within land unit 6.**

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**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: ‘NatureMap’ report**



# NatureMap Species Report

Created By Alexander Holm on 18/01/2019

**Conservation Status** Conservation Taxon (T, X, IA, S, P1-P5)

**Current Names Only** Yes

**Core Datasets Only** Yes

**Method** 'By Circle'

**Centre** 122° 21' 56" E, 30° 08' 16" S

**Buffer** 40km

**Group By** Kingdom

Kingdom	Species	Records
Animalia	1	54
Plantae	1	4
<b>TOTAL</b>	<b>2</b>	<b>58</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Animalia</b>				
1.	24557 <i>Leipoa ocellata</i> (Malleefowl)		T	
<b>Plantae</b>				
2.	19695 <i>Thryptomene eremaea</i>		P2	

**Conservation Codes**  
T - Rare or likely to become extinct  
X - Presumed extinct  
IA - Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.



## **Attachment 2: ‘Protected matters’ search tool output**





# 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: 18/01/19 21:08:05

[Summary](#)

[Details](#)

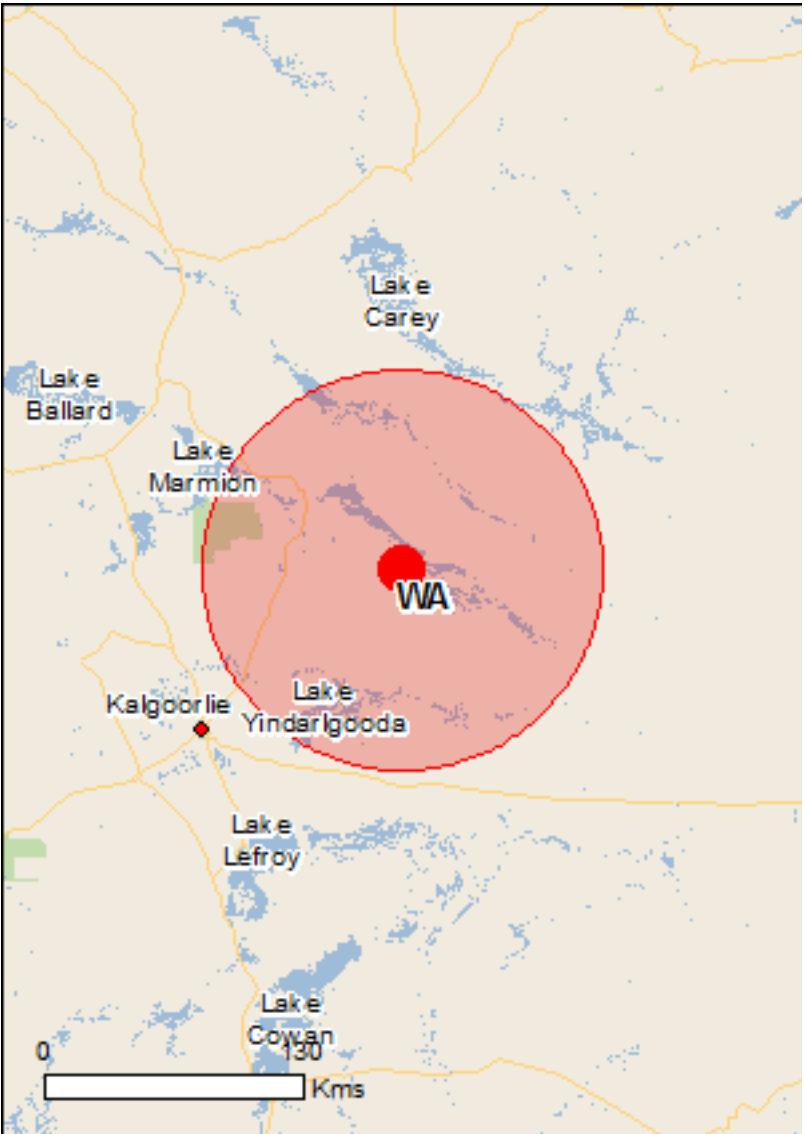
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are  
©Commonwealth of Australia  
(Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 100.0Km



# 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](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	None
<a href="#">Listed Threatened Species:</a>	10
<a href="#">Listed Migratory Species:</a>	9

## 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.

<a href="#">Commonwealth Land:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	14
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None

## Extra Information

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

<a href="#">State and Territory Reserves:</a>	6
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	15
<a href="#">Nationally Important Wetlands:</a>	1
<a href="#">Key Ecological Features (Marine)</a>	None

# Details

## Matters of National Environmental Significance

Listed Threatened Species		[ Resource Information ]
Name	Status	Type of Presence
Birds		
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pezoporus occidentalis</a> Night Parrot [59350]	Endangered	Species or species habitat may occur within area
<a href="#">Polytelis alexandrae</a> Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Mammals		
<a href="#">Dasyurus geoffroii</a> Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
<a href="#">Sminthopsis psammophila</a> Sandhill Dunnart [291]	Endangered	Species or species habitat likely to occur within area
Plants		
<a href="#">Eucalyptus articulata</a> Ponton Creek Mallee [56772]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Gastrolobium graniticum</a> Granite Poison [14872]	Endangered	Species or species habitat likely to occur within area
<a href="#">Hibbertia crispula</a> Ooldea Guinea-flower [15222]	Vulnerable	Species or species habitat may occur within area
<a href="#">Tecticornia flabelliformis</a> Bead Glasswort [82664]	Vulnerable	Species or species habitat known to 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		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species

Name	Threatened	Type of Presence
habitat likely to occur within area		
Migratory Terrestrial Species		
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[ <a href="#">Resource Information</a> ]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
<a href="#">Actitis hypoleucos</a> Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a> Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
<a href="#">Chrysococcyx osculans</a> Black-eared Cuckoo [705]		Species or species habitat known to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<a href="#">Thinornis rubricollis</a> Hooded Plover [59510]		Species or species habitat known to occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves	[ Resource Information ]
Name	State
Bullock Holes Timber Reserve	WA
Cardunia Rocks	WA
Coonana Timber Reserve	WA
Goongarrie	WA
Queen Victoria Spring	WA
Wallaby Rocks Timber Reserve	WA

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
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area



Name	Status	Type of Presence
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
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
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		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 likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nationally Important Wetlands		[ Resource Information ]
Name		State
<a href="#">Lake Marmion</a>		WA



# 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

-30.13825 122.36587

# 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.

## **Attachment 3: List of flora taxa found at each inventory site**



Family	Taxa	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Amaranthaceae	<i>Ptilotus obovatus</i>	y		y	y	y	y		y	y	y	y		y		y
Apocynaceae	<i>Alyxia buxifolia</i>															
Apocynaceae	<i>Marsdenia australis</i>	y				y	y	y	y		y	y	y	y	y	y
Asteraceae	<i>Brachyscome ciliaris</i>						y									
Asteraceae	<i>Brachyscome trachycarpa</i>															
Asteraceae	<i>Cratystylis subspinescens</i>		y													
Asteraceae	<i>Minuria cunninghammii</i>															
Asteraceae	<i>Olearia exiguifolia</i>										y	y				
Asteraceae	<i>Olearia muelleri</i>				y	y					y			y		y
Asteraceae	<i>Vittadinia eremaea</i>															
Boraginaceae	<i>Halgania cyanea</i>															
Casuarinaceae	<i>Allocauarina helmsii</i>															
Casuarinaceae	<i>Casuarina pauper</i>				y			y		y	y			y		y
Chenopodiaceae	<i>Atriplex bunburyana</i>		y											y		
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>		y		y									y		
Chenopodiaceae	<i>Atriplex vesicaria</i>		y											y		
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>															
Chenopodiaceae	<i>Enchylaena lanata</i>									y				y		
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>													y		
Chenopodiaceae	<i>Enchyleana x Maireana</i> hybrid															
Chenopodiaceae	<i>Eriochiton sclerolaenoides</i>															
Chenopodiaceae	<i>Maireana georgei</i>				y					y	y			y		
Chenopodiaceae	<i>Maireana pentatropis</i>															y
Chenopodiaceae	<i>Maireana planifolia</i>															
Chenopodiaceae	<i>Maireana pyramidata</i>															
Chenopodiaceae	<i>Maireana sedifolia</i>		y		y											
Chenopodiaceae	<i>Maireana tomentosa</i>															
Chenopodiaceae	<i>Maireana triptera</i>		y		y									y		
Chenopodiaceae	<i>Rhagodia drummondii</i>															
Chenopodiaceae	<i>Rhagodia eremaea</i>		y				y	y			y	y		y		y
Chenopodiaceae	<i>Salsola australis</i>															
Chenopodiaceae	<i>Sclerolaena cuneata</i>															
Chenopodiaceae	<i>Sclerolaena diacantha</i>		y											y		y
Chenopodiaceae	<i>Sclerolaena gardneri</i>															
Chenopodiaceae	<i>Sclerolaena glabra</i>															
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>															
Chenopodiaceae	<i>Tecticornia disarticulata</i>															
Convolvulaceae	<i>Convolvulus clementii</i>															
Fabaceae	<i>Acacia aptaneura</i>															
Fabaceae	<i>Acacia ayersiana</i>	y		y		y			y		y	y				
Fabaceae	<i>Acacia burkittii</i>	y		y	y	y	y	y	y	y	y	y				y
Fabaceae	<i>Acacia caesaneura</i>												y		y	
Fabaceae	<i>Acacia erinacea</i>															

[illegible]

Family	Taxa	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Pittosporaceae	<i>Pittosporum angustifolium</i>															
Poaceae	<i>Aristida contorta</i>															
Poaceae	<i>Astrostipa</i> sp.												y			
Poaceae	<i>Austrostipa elegantissima</i>													y		
Poaceae	<i>Austrostipa eremophila</i>							y								
Poaceae	<i>Enneapogon avenaceus</i>															
Poaceae	<i>Enneapogon caeruleus</i>															
Poaceae	<i>Enneapogon polyphyllus</i>															
Poaceae	<i>Eragrostis eriopoda</i>			y									y		y	
Poaceae	<i>Monachather paradoxus</i>												y		y	
Poaceae	<i>Paspalidium constrictum</i>															
Poaceae	<i>Thyridolepis</i> sp.															
Poaceae	<i>Triodia irritans</i>															
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>															
Proteaceae	<i>Hakea preissii</i>															
Pteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>														y	
Rubiaceae	<i>Psydax suaveolens</i>														y	
Rutaceae	<i>Phebalium canaliculatum</i>											y				
Santalaceae	<i>Exocarpos aphyllus</i>															
Santalaceae	<i>Santalum acuminatum</i>															
Santalaceae	<i>Santalum spicatum</i>						y		y		y	y		y		y
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>canescens</i>		y		y						y			y		y
Sapindaceae	<i>Dodonaea lobulata</i>	y		y		y	y		y	y	y	y		y		y
Sapindaceae	<i>Dodonaea rigida</i>			y		y	y	y	y	y	y		y		y	
Scrophulariaceae	<i>Eremophila alternifolia</i>															
Scrophulariaceae	<i>Eremophila arachnoides</i> subsp. <i>tenera</i>															
Scrophulariaceae	<i>Eremophila caperata</i>															
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>		y					y				y		y		
Scrophulariaceae	<i>Eremophila eriocalyx</i>	y		y	y	y			y	y	y		y	y		
Scrophulariaceae	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>								y				y		y	
Scrophulariaceae	<i>Eremophila georgei</i>			y					y					y		
Scrophulariaceae	<i>Eremophila glabra</i> subsp. <i>glabra</i>															
Scrophulariaceae	<i>Eremophila granitica</i>	y			y	y	y	y		y						
Scrophulariaceae	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>								y				y	y	y	
Scrophulariaceae	<i>Eremophila longifolia</i>		y				y							y		
Scrophulariaceae	<i>Eremophila maculata</i>		y													
Scrophulariaceae	<i>Eremophila metallicorum</i>											y				
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>						y		y		y			y		y
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>						y				y			y		
Scrophulariaceae	<i>Eremophila scoparia</i>		y													
Scrophulariaceae	<i>Eremophila</i> sp.															
Solanaceae	<i>Lycium australe</i>															
Solanaceae	<i>Solanum nummularium</i>										y		y			

[illegible]



[illegible]

Family	Taxa	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Fabaceae	<i>Acacia hemiteles</i>		y	y	y	y	y	y	y	y		y				y
Fabaceae	<i>Acacia incurvaneura</i>	y			y	y	y	y						y		y
Fabaceae	<i>Acacia kempeana</i>	y					y	y								
Fabaceae	<i>Acacia ligulata</i>															
Fabaceae	<i>Acacia nyssophylla</i>								y			y			y	
Fabaceae	<i>Acacia oswaldii</i>			y		y						y				
Fabaceae	<i>Acacia quadrimarginea</i>															
Fabaceae	<i>Acacia ramulosa</i> var. <i>linophylla</i>	y					y									
Fabaceae	<i>Acacia sibirica</i>									y	y	y	y		y	y
Fabaceae	<i>Acacia tetragonophylla</i>	y	y	y	y			y	y			y	y		y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>		y	y	y	y	y	y	y	y		y	y			y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>									y			y	y		
Fabaceae	<i>Senna cardiosperma</i>										y					
Fabaceae	<i>Templetonia incrassata</i>			y		y										
Frankeniaceae	<i>Frankenia interioris</i>															
Goodeniaceae	<i>Scaevola spinescens</i>	y		y		y	y		y	y	y	y		y	y	y
Lamiaceae	<i>Physopsis viscida</i>															
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>	y														
Lamiaceae	<i>Teucrium disjunctum</i>															
Lamiaceae	<i>Teucrium teucriiflorum</i>	y												y		
Lamiaceae	<i>Westringia rigida</i>															
Loranthaceae	<i>Amyema fitzgeraldii</i>				y			y								
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>															
Loranthaceae	<i>Amyema preissii</i>															
Loranthaceae	<i>Lysiana casuarinae</i>			y												
Malvaceae	<i>Abutilon cryptopetalum</i>															
Malvaceae	<i>Abutilon otocarpum</i>				y											
Malvaceae	<i>Brachychiton gregorii</i>	y												y		
Malvaceae	<i>Sida calyxthymenia</i>	y														
Malvaceae	<i>Sida intricata</i>											y	y	y		
Malvaceae	<i>Sida</i> sp. <i>Excedentifolia</i> (J.L. Egan 1925)															
Malvaceae	<i>Sida spodochroma</i>							y	y							
Myrtaceae	<i>Calytrix</i> sp.															
Myrtaceae	<i>Eucalyptus ewartianiana</i>															
Myrtaceae	<i>Eucalyptus concinna</i>	y									y			y		
Myrtaceae	<i>Eucalyptus eremicola</i> subsp. <i>peeneri</i>															
Myrtaceae	<i>Eucalyptus lesouefii</i>															
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>				y			y								
Myrtaceae	<i>Eucalyptus salmonophloia</i>		y						y	y		y				
Myrtaceae	<i>Eucalyptus salubris</i>								y							
Myrtaceae	<i>Eucalyptus yilgarnensis</i>														y	
Myrtaceae	<i>Melaleuca hamata</i>															
Pittosporaceae	<i>Bursaria occidentalis</i>							y								

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[illegible]

Family	Taxa	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Amaranthaceae	<i>Ptilotus obovatus</i>	y	y	y	y	y	y	y	y	y		y	y	y	y	y
Apocynaceae	<i>Alyxia buxifolia</i>															
Apocynaceae	<i>Marsdenia australis</i>		y			y		y	y	y			y	y	y	
Asteraceae	<i>Brachyscome ciliaris</i>				y		y								y	
Asteraceae	<i>Brachyscome trachycarpa</i>															
Asteraceae	<i>Cratystylis subspinescens</i>										y	y				
Asteraceae	<i>Minuria cunninghamii</i>															y
Asteraceae	<i>Olearia exiguifolia</i>															
Asteraceae	<i>Olearia muelleri</i>		y			y	y			y		y			y	
Asteraceae	<i>Vittadinia eremaea</i>					y										y
Boraginaceae	<i>Halgania cyanea</i>						y							y		
Casuarinaceae	<i>Allocasuarina helmsii</i>															
Casuarinaceae	<i>Casuarina pauper</i>	y	y		y	y	y		y	y	y	y				
Chenopodiaceae	<i>Atriplex bunburyana</i>		y	y			y			y						y
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>		y	y					y	y		y				y
Chenopodiaceae	<i>Atriplex vesicaria</i>		y	y							y					y
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>								y		y					y
Chenopodiaceae	<i>Enchylaena lanata</i>			y				y		y						
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>							y						y		
Chenopodiaceae	<i>Enchyleana x Maireana</i> hybrid									y				y		y
Chenopodiaceae	<i>Eriochiton sclerolaenoides</i>															
Chenopodiaceae	<i>Maireana georgei</i>		y	y			y		y	y			y	y		
Chenopodiaceae	<i>Maireana pentatropis</i>								y							
Chenopodiaceae	<i>Maireana planifolia</i>															
Chenopodiaceae	<i>Maireana pyramidata</i>										y					
Chenopodiaceae	<i>Maireana sedifolia</i>	y	y	y	y	y	y		y		y	y			y	y
Chenopodiaceae	<i>Maireana tomentosa</i>															
Chenopodiaceae	<i>Maireana triptera</i>						y			y			y	y	y	y
Chenopodiaceae	<i>Rhagodia drummondii</i>								y	y					y	y
Chenopodiaceae	<i>Rhagodia eremaea</i>				y			y						y		
Chenopodiaceae	<i>Salsola australis</i>					y							y			
Chenopodiaceae	<i>Sclerolaena cuneata</i>															
Chenopodiaceae	<i>Sclerolaena diacantha</i>			y			y		y				y			y
Chenopodiaceae	<i>Sclerolaena gardneri</i>															y
Chenopodiaceae	<i>Sclerolaena glabra</i>															
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>															
Chenopodiaceae	<i>Tecticornia disarticulata</i>															
Convolvulaceae	<i>Convolvulus clementii</i>					y		y					y			y
Fabaceae	<i>Acacia aptaneura</i>			y		y				y			y			y
Fabaceae	<i>Acacia ayersiana</i>	y			y		y					y			y	
Fabaceae	<i>Acacia burkittii</i>	y	y	y	y	y	y	y	y	y		y		y	y	y
Fabaceae	<i>Acacia caesaneura</i>	y														
Fabaceae	<i>Acacia erinacea</i>															

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[illegible]

Fabaceae	<i>Acacia hemiteles</i>						y				y					y
Fabaceae	<i>Acacia incurvaneura</i>	y	y	y	y	y		y	y							
Fabaceae	<i>Acacia kempeana</i>															
Fabaceae	<i>Acacia ligulata</i>				y									y		
Fabaceae	<i>Acacia nyssophylla</i>										y	y		y		
Fabaceae	<i>Acacia oswaldii</i>					y						y		y	y	
Fabaceae	<i>Acacia quadrimarginea</i>											y		y		y
Fabaceae	<i>Acacia ramulosa</i> var. <i>linophylla</i>															
Fabaceae	<i>Acacia sibirica</i>	y														y
Fabaceae	<i>Acacia tetragonophylla</i>	y	y	y	y		y		y	y	y	y	y	y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>	y	y	y	y	y	y	y		y		y	y	y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>							y	y							
Fabaceae	<i>Senna cardiosperma</i>															
Fabaceae	<i>Templetonia incrassata</i>										y	y				
Frankeniaceae	<i>Frankenia interioris</i>							y								y
Goodeniaceae	<i>Scaevola spinescens</i>	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Lamiaceae	<i>Physopsis viscida</i>															
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>		y	y												
Lamiaceae	<i>Teucrium disjunctum</i>						y					y				
Lamiaceae	<i>Teucrium teucriiflorum</i>		y	y					y							
Lamiaceae	<i>Westringia rigida</i>															
Loranthaceae	<i>Amyema fitzgeraldii</i>									y						
Loranthaceae	<i>Amyema gibberula</i> var. <i>gibberula</i>															
Loranthaceae	<i>Amyema preissii</i>												y			
Loranthaceae	<i>Lysiana casuarinae</i>			y					y	y						
Malvaceae	<i>Abutilon cryptopetalum</i>															
Malvaceae	<i>Abutilon otocarpum</i>															
Malvaceae	<i>Brachychiton gregorii</i>								y	y						
Malvaceae	<i>Sida calyxhymenia</i>															
Malvaceae	<i>Sida intricata</i>						y			y	y					
Malvaceae	<i>Sida</i> sp. <i>Excedentifolia</i> (J.L. Egan 1925)															
Malvaceae	<i>Sida spodochroma</i>				y											
Myrtaceae	<i>Calytrix</i> sp.															
Myrtaceae	<i>Eucalyptus ewartiniana</i>															
Myrtaceae	<i>Eucalyptus concinna</i>															
Myrtaceae	<i>Eucalyptus eremicola</i> subsp <i>peeneri</i>															
Myrtaceae	<i>Eucalyptus lesouefii</i>															y
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>		y						y							
Myrtaceae	<i>Eucalyptus salmonophloia</i>															y
Myrtaceae	<i>Eucalyptus salubris</i>															y
Myrtaceae	<i>Eucalyptus yilgarnensis</i>															
Myrtaceae	<i>Melaleuca hamata</i>															
Pittosporaceae	<i>Bursaria occidentalis</i>															
Pittosporaceae	<i>Pittosporum angustifolium</i>															

[illegible]

Zygophyllaceae    *Roepera aurantiaca* subsp. *aurantiaca*

y

Family	Taxa	61	62	63	64	65	66	67	68	69	70	71	72	Counts
Amaranthaceae	<i>Ptilotus obovatus</i>	y		y	y	y	y	y	y	y	y	y	y	64
Apocynaceae	<i>Alyxia buxifolia</i>	y						y	y	y	y	y	y	11
Apocynaceae	<i>Marsdenia australis</i>										y			37
Asteraceae	<i>Brachyscome ciliaris</i>													8
Asteraceae	<i>Brachyscome trachycarpa</i>													1
Asteraceae	<i>Cratystylis subspinescens</i>	y												5
Asteraceae	<i>Minuria cunninghamii</i>													3
Asteraceae	<i>Olearia exiguiifolia</i>													2
Asteraceae	<i>Olearia muelleri</i>	y						y		y		y		29
Asteraceae	<i>Vittadinia eremaea</i>													3
Boraginaceae	<i>Halgania cyanea</i>													2
Casuarinaceae	<i>Allocasuarina helmsii</i>			y										1
Casuarinaceae	<i>Casuarina pauper</i>	y					y	y	y	y	y	y		47
Chenopodiaceae	<i>Atriplex bunburyana</i>	y									y			14
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>	y						y	y				y	29
Chenopodiaceae	<i>Atriplex vesicaria</i>	y						y						15
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>	y									y			11
Chenopodiaceae	<i>Enchylaena lanata</i>										y		y	13
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	y						y			y		y	16
Chenopodiaceae	<i>Enchyleana x Maireana</i> hybrid										y			7
Chenopodiaceae	<i>Eriochiton sclerolaenoides</i>													1
Chenopodiaceae	<i>Maireana georgei</i>							y			y			25
Chenopodiaceae	<i>Maireana pentatropis</i>							y						8
Chenopodiaceae	<i>Maireana planifolia</i>													2
Chenopodiaceae	<i>Maireana pyramidata</i>										y			7
Chenopodiaceae	<i>Maireana sedifolia</i>	y						y		y	y	y		39
Chenopodiaceae	<i>Maireana tomentosa</i>							y						4
Chenopodiaceae	<i>Maireana triptera</i>							y		y	y		y	24
Chenopodiaceae	<i>Rhagodia drummondii</i>	y									y			12
Chenopodiaceae	<i>Rhagodia eremaea</i>												y	15
Chenopodiaceae	<i>Salsola australis</i>													6
Chenopodiaceae	<i>Sclerolaena cuneata</i>													1
Chenopodiaceae	<i>Sclerolaena diacantha</i>	y			y	y	y				y			24
Chenopodiaceae	<i>Sclerolaena gardneri</i>	y												5
Chenopodiaceae	<i>Sclerolaena glabra</i>													2
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>													4
Chenopodiaceae	<i>Tecticornia disarticulata</i>	y						y					y	4
Convolvulaceae	<i>Convolvulus clementii</i>													4
Fabaceae	<i>Acacia aptaneura</i>												y	15
Fabaceae	<i>Acacia ayersiana</i>		y		y	y	y			y				19
Fabaceae	<i>Acacia burkittii</i>		y	y	y	y	y		y		y		y	55
Fabaceae	<i>Acacia caesaneura</i>													5
Fabaceae	<i>Acacia erinacea</i>								y					2

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## **Attachment 4: Inventory site data on landform, soil type and erosion.**



Site	LU code	Land system	Geology	Land unit	Slope %	Relief	Landform	Soil texture	Erosion score	Vulnerability to erosion
SE01	6	Deadman	CZc	PLO	0%	0m	Flat	Sandy clay loam	nil	slightly
SE02	5b	Campsite	CZc	PLA	0%	0m	Flat	Light clay	nil	moderately
SE03	4b	Deadman	Sit	PLO	1%	1m	Flat	Sandy loam	nil	nil
SE04	4a	Deadman	CZc	PLO	1%	1m	Flat	sandy loam	nil	nil
SE05	4b	Deadman	CZc	PLO	0%	0m	Flat	Sandy loam	nil	nil
SE06	6	Deadman	CZc	CHM	1%	1m	Flat	Sandy loam	nil	slightly
SE07	4a	Deadman	CZc	PLO	0%	0m	Flat	Sandy loam	nil	nil
SE08	4b	Deadman	CZI	PLC	3%	3m	Upper slope	Sandy loam	nil	nil
SE09	4a	Deadman	CZc	PLO	1%	1m	Flat	Sandy loam	nil	nil
SE10	4a	Deadman	CZc	PLC	1%	1m	Flat	Sandy loam	nil	nil
SE11	6	Deadman	CZc	CHM	1%	1m	Flowline	Sandy clay loam	nil	nil
SE12	2a	Deadman	CZI	RIL	2%	10m	Crest	Sandy loam	nil	nil
SE13	2b	Moriarty	CZc	PLC	2%	3m	Lower slope	Sandy loam	nil	nil
SE14	2a	Deadman	CZc	RIL	1%	1m	Upper slope	Sandy loam	nil	nil
SE15	2a	Deadman	CZI	RIL	2%	1m	Lower slope	Sandy loam	nil	nil
SE16	4b	Deadman	CZI	PLO	1%	0m	Flat	Sandy loam	nil	nil
SE17	5b	Deadman	CZc	CHM	2%	1m	Broad wash	Sandy clay loam	minor	moderately
SE18	5a	Deadman	CZc	PLC	1%	0m	Flat	Sandy clay loam	minor	slightly
SE19	5a	Deadman	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE20	4b	Deadman	CZc	PLC	1%	0m	Flat	Sandy clay loam	minor	slightly
SE21	2b	Deadman	CZc	HIL	3%	2 -3m	Upper slope	Sandy loam	nil	nil
SE22	5a	Deadman	CZc	PLS	2%	0m	Flat	Sandy clay loam	moderate	moderately
SE23	5b	Moriarty	CZc	PLS	2%	0m	Flat	Sandy clay loam	moderate	moderately
SE24	5b	Moriarty	CZc	PLC	1%	1m	Flat	Sandy clay loam	nil	nil
SE25	1a	Leonora	Czu	HIL	5%	6m	Upper slope	Sandy loam	nil	nil
SE26	5b	Moriarty	CZc	PLO	1%	0m	Flat	Sandy clay loam	nil	slightly
SE27	2b	Moriarty	CZc	HIL	5%	5m	Upper slope	Sandy loam	nil	nil
SE28	4a	Deadman	CZc	PLO	0%	0m	Flat	loamy sand	nil	nil
SE29	1a	Leonora	Ab	HIL	8%	10m	Upper slope	Sandy clay loam	nil	nil
SE30	1a	Leonora	CZc	PLC	1%	1m	Flat	Sandy loam	nil	nil
SE31	4a	Deadman	CZc	PLO	0%	om	Flat	Sandy loam	nil	nil
SE32	2b	Moriarty	CZc	PLC	1%	1m	Low rise	Sandy loam	nil	nil
SE33	5a	Moriarty	CZc	PLA	1%	1m	Flat	Sandy clay	minor	moderately
SE34	1b	Leonora	Ab	HIL	10%	17m	Lower slope	Sandy loam	nil	nil
SE35	4c	Deadman	CZc	PLC	1%	0m	Flat	Sandy clay loam	nil	nil
SE36	4a	Deadman	CZc	PLO	1%	1m	Flat	Sandy clay loam	nil	nil
SE37	6	Deadman	CZc	CHM	1%	1m	Flat	sandy clay	minor	slightly
SE38	1b	Gunadocketa	CZc	HIL	3%	3 - 4m	Lower slope	Sandy loam	nil	nil

Site	LU code	Land system	Geology	Land unit	Slope %	Relief	Landform	Soil texture	Erosion score	Vulnerability to erosion
SE39	5a	Gunadocketa	CZc	PLO	1%	1m	Flat	Sandy clay loam	minor	slightly
SE40	4c	Gunadocketa	CZc	PLC	1%	1m	Broad flowline	Sandy clay loam	moderate	moderately
SE41	2a	Gunadocketa	CZc	HIL	2%	2m	Low rise	Sandy loam	minor	slightly
SE42	4c	Deadman	CZc	PLC	1%	1m	Flat	Sandy clay loam	nil	nil
SE43	6	Deadman	CZc	PLO	1%	1m	Flat	Sandy clay loam	minor	slightly
SE44	4a	Deadman	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE45	4c	Gunadocketa	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE46	1a	Leonora	Ab	HIL	8%	17 - 20m	Crest	Sandy loam	nil	nil
SE47	4a	Deadman	CZc	PLC	1%	1m	Flat	Sandy clay loam	nil	nil
SE48	5a	Deadman	CZc	PLO	1%	1m	Flat	Sandy clay loam	minor	slightly
SE49	4c	Deadman	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE50	4c	Moriarty	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE51	5a	Moriarty	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE52	5a	Moriarty	CZc	PLC	2%	2m	Flat	Sandy clay loam	moderate	moderately
SE53	5a	Moriarty	CZc	PLH	1%	1m,	Flat	Sandy loam	moderate	moderately
SE54	5a	Moriarty	CZc	PLH	1%	1m	Flat	Sandy clay loam	moderate	moderately
SE55	5a	Moriarty	CZc	PLC	1%	1m	Flat	Sandy clay loam	minor	slightly
SE56	5a	Moriarty	CZc	PLC	2%	2m	Flat	Sandy clay loam	moderate	moderately
SE57	2b	Moriarty	CZc	PLC	2%	2m	Lower slope	Sandy loam	moderate	moderate
SE58	2b	Moriarty	CZc	PLC	3%	3m	Lower slope	Sandy loam	nil	nil
SE59	1b	Lawrance	Ab	HIL	8%	30m	Upper slope	Sandy loam	nil	nil
SE60	5b	Campsite	CZc	PLA	2%	2m	Flat	Sandy clay loam	moderate	moderately
SE61	5b	Campsite	CZc	PLA	1%	1m	Flat	Sandy clay loam	moderate	moderately
SE62	4d	Deadman	CZc	SSH/PLO	0%	0m	Flat	Sandy loam	minor	slightly
SE63	4d	Deadman	CZc	SSH/PLO	0%	0m	Flat	Sandy loam	minor	slightly
SE64	4a	Kirgella	CZc	PLO	0%	0	Flat	Sandy loam	nil	nil
SE65	4a	Kirgella	CZc	PLC	0%	0m	Flat	Sandy loam	minor	slightly
SE66	4a	Moriarty	CZc	PLO	0%	0m	Flat	Sandy loam	nil	nil
SE67	1c	Moriarty	CZc	HIL	6%	25m	Upper slope	Sandy loam	nil	nil
SE68	1c	Moriarty	CZc	HIL	5%	12m	Upper slope	Sandy loam	nil	nil
SE69	1c	Kirgella	CZc	HIL	2%	6m	Mid slope	Sandy loam	nil	nil
SE70	4a	Moriarty	CZc	PLC	2%	2m	Broad drainage plain	Sandy loam	moderate	moderately
SE71	1c	Moriarty	CZc	PLO	2%	2m	Mid slope	Sandy clay loam	nil	nil
SE72	1c	Moriarty	CZc	PTX	20%	25m	Crest	Durey crust	nil	nil

## **Attachment 5: Inventory site data on dominant flora vegetation cover and condition.**

Site	Upper storey		Mid storey		Lower storey		Total cover	Veg condition
	US % cover	US Dominant	MS cover	MS Dominant	LS Cover	LS Dominant		
SE01	20%	acaaye <sup>4</sup>	5%	acabur	0%		20%	2
SE02	10%	eucsalmon	0%		2%	eremac	10%	3
SE03	5%	eucole	10%	acaaye	2%	scvspi	15%	2
SE04	5%	eucole	5%	acabur	0%		10%	3
SE05	10%	eucole	10%	acabur	0%		20%	3
SE06	10%	acainc	15%	acabur	0%		25%	3
SE07	2%	eucole	25%	acainc	5%	dodrig	30%	2
SE08	2%	eucole	15%	acalin	0%		15%	3
SE09	5%	eucole	20%	acainc	0%		20%	2
SE10	2%	caspau	10%	acainc	2%	ptiobo	10%	2
SE11	20%	eucole	40%	acainc	1%	ptiobo	60%	2
SE12	5%	acainc	20%	erefor	0%		25%	2
SE13	2%	caspau	5%	ereold	3%	ptiobo	10%	2
SE14	5%	acainc	15%	erefor	0%		20%	3
SE15	2%	caspau	10%	acainc	3%	ptiobo	15%	3
SE16	10%	acainc	4%	acalin	1%	ptiobo	15%	3
SE17	10%	eucsalmon	20%	acahem	0%		25%	5
SE18	1%	caspau	10%	acahem	0%		10%	6
SE19	2%	eucole	5%	acabur	0%		5%	6
SE20	5%	caspau	10%	snnfil	5%	ptiobo	15%	3
SE21	1%	caspau	20%	dodlob	2%	ptiobo	20%	4
SE22	1%	acainc	5%	acahem	1%	ptiobo	5%	6
SE23	5%	eucsalmon	5%	atrnum	10%	atrves	20%	3
SE24	1%	caspau	15%	eresco	1%	ptiobo	15%	4
SE25	2%	caspau	15%	acasib	1%	ptiobo	15%	2
SE26	2%	eucsalmon	15%	atrnum	10%	atrves	25%	4
SE27	5%	caspau	4%	dodlob	1%	ptiobo	10%	4
SE28	30%	acainc	1%	erefor	0%		30%	3
SE29	4%	euccon	4%	eresco	2%	ptiobo	10%	2
SE30	2%	caspau	10%	acasib	3%	ptiobo	15%	2
SE31	8%	acainc	2%	scvspi	0%		10%	2
SE32	2%	caspau	3%	acabur	15%	maigeo	20%	3
SE33	2%	acainc	5%	maised	0%		7%	5
SE34	1%	acainc	30%	acaqua	0%		30%	2
SE35	2%	acainc	3%	acabur	5%	maised	10%	3
SE36	1%	acainc	15%	acabur	5%	eremet	20%	4

<sup>4</sup> Field codes see following table for taxa

Site	Upper storey		Mid storey		Lower storey		Total cover	Veg condition
	US % cover	US Dominant	MS cover	MS Dominant	LS Cover	LS Dominant		
SE37	1%	eucole	60%	acabur	1%	snnart	60%	4
SE38	3%	caspau	20%	acabur	2%	ptiobo	25%	3
SE39	1%	caspau	25%	acabur	0%		25%	4
SE40	1%	caspau	25%	maised	0%		25%	5
SE41	3%	caspau	5%	eresco	5%	ptiobo	10%	4
SE42	4%	acainc	5%	snnfil	2%	maised	10%	5
SE43	5%	acainc	10%	acabur	1%	ptiobo	15%	5
SE44	1%	acainc	20%	acabur	0%		20%	5
SE45	1%	acainc	10%	snnfil	15%	maised	25%	4
SE46	2%	acainc	6%	acasib	2%	scvspi	10%	2
SE47	2%	eucole	5%	acabur	3%	olemue	10%	4
SE48	4%	acainc	5%	snnfil	2%	maised	10%	4
SE49	1%	acaapt	15%	snnfil	1%	maised	15%	5
SE50	5%	caspau	5%	snnfil	1%	ptiobo	10%	5
SE51	2%	caspau	4%	snnfil	15%	maised	20%	3
SE52	1%	caspau	4%	snnfil	10%	maised	15%	4
SE53	1%	acainc	10%	acabur	2%	maised	10%	5
SE54	1%	caspau	15%	acabur	1%	maised	15%	5
SE55	1%	caspau	4%	acabur	15%	maised	20%	3
SE56	5%	caspau	20%	snnfil	5%	maised	30%	4
SE57	1%	caspau	10%	snnfil	5%	maised	15%	4
SE58	2%	caspau	15%	dodlob	2%	ptiobo	15%	3
SE59	2%	caspau	25%	acaqua	0%		25%	2
SE60	5%	eucsalmon	5%	eresco	10%	maised	20%	3
SE61	2%	eucsalmon	0%		15%	maised	15%	4
SE62	5%	eucole	15%	acabur	5%	spinifex	25%	2
SE63	18%	eucole	12%	acahem	20%	wesrig	50%	2
SE64	4%	eucole	30%	acabur	0%		35%	2
SE65	4%	eucole	10%	acabur	0%		15%	3
SE66	2%	eucole	30%	acabur	3%	scvspi	35%	2
SE67	4%	eucole	1%	eresco	10%	scvspi	15%	3
SE68	20%	eucles	2%	eresco	5%	acaeri	25%	1
SE69	4%	caspau	30%	acacol	5%	scvspi	35%	1
SE70	1%	caspau	40%	dodlob	2%	ptiobo	40%	3
SE71	5%	caspau	2%	dodlob	3%	scvspi	10%	2
SE72	1%	caspau	2%	acajen	2%	sidcal	5%	3

Fieldcode	Taxa
acaapt	<i>Acacia aptaneura</i>
acaaye	<i>Acacia ayersiana</i>
acaaye	<i>Acacia ayersiana</i>
acabur	<i>Acacia burkittii</i>
acacol	<i>Acacia nyssophylla</i>
acaeri	<i>Acacia erinacea</i>
acahem	<i>Acacia hemiteles</i>
acainc	<i>Acacia incurvaneura</i>
acainc	<i>Acacia incurvaneura</i>
acajen	<i>Acacia ligulata</i>
acalin	<i>Acacia ramulosa</i> var. <i>linophylla</i>
acaqua	<i>Acacia quadrimarginea</i>
acasib	<i>Acacia sibirica</i>
atrnum	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>
atrves	<i>Atriplex vesicaria</i>
caspau	<i>Casuarina pauper</i>
dodlob	<i>Dodonaea lobulata</i>
dodrig	<i>Dodonaea rigida</i>
erefor	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>
eremac	<i>Eremophila maculata</i>
eremet	<i>Eremophila metallicorum</i>
ereold	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>
eresco	<i>Eremophila scoparia</i>
eucon	<i>Eucalyptus concinna</i>
eucles	<i>Eucalyptus lesouefii</i>
eucole	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>
eucsalmon	<i>Eucalyptus salmonophloia</i>
maigeo	<i>Maireana georgei</i>
maised	<i>Maireana sedifolia</i>
maised	<i>Maireana sedifolia</i>
olemue	<i>Olearia muelleri</i>
ptiobo	<i>Ptilotus obovatus</i>
scvspi	<i>Scaevola spinescens</i>
scvspi	<i>Scaevola spinescens</i>
sidcal	<i>Sida calyxhymenia</i>
snnart	<i>Senna artemisioides</i> subsp. x <i>artemisioides</i>
snnfil	<i>Senna artemisioides</i> subsp. <i>filifolia</i>
spinifex	<i>Triodia irritans</i>
wesrig	<i>Westringia rigida</i>



## **Attachment 6: Location of inventory sites**

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Site		Zone		Easting	Northing
SE01	UTM	GDA94	51J	439437	6663669
SE02	UTM	GDA94	51J	439895	6662441
SE03	UTM	GDA94	51J	441203	6663268
SE04	UTM	GDA94	51J	439847	6663259
SE05	UTM	GDA94	51J	440379	6663600
SE06	UTM	GDA94	51J	441148	6664178
SE07	UTM	GDA94	51J	440474	6664857
SE08	UTM	GDA94	51J	441383	6665118
SE09	UTM	GDA94	51J	439979	6664741
SE10	UTM	GDA94	51J	439072	6662978
SE11	UTM	GDA94	51J	439349	6664400
SE12	UTM	GDA94	51J	441592	6665331
SE13	UTM	GDA94	51J	441870	6665276
SE14	UTM	GDA94	51J	441973	6664879
SE15	UTM	GDA94	51J	442345	6664079
SE16	UTM	GDA94	51J	442396	6663827
SE17	UTM	GDA94	51J	439324	6666014
SE18	UTM	GDA94	51J	439997	6666014
SE19	UTM	GDA94	51J	440303	6665814
SE20	UTM	GDA94	51J	440763	6665669
SE21	UTM	GDA94	51J	441206	6665957
SE22	UTM	GDA94	51J	439781	6666421
SE23	UTM	GDA94	51J	441383	6666174
SE24	UTM	GDA94	51J	441311	6666433
SE25	UTM	GDA94	51J	441518	6666766
SE26	UTM	GDA94	51J	440951	6666503
SE27	UTM	GDA94	51J	440727	6666945
SE28	UTM	GDA94	51J	440335	6666555
SE29	UTM	GDA94	51J	440838	6667523
SE30	UTM	GDA94	51J	441184	6667793
SE31	UTM	GDA94	51J	439852	6667376
SE32	UTM	GDA94	51J	439875	6668046
SE33	UTM	GDA94	51J	439689	6667781
SE34	UTM	GDA94	51J	440466	6667821
SE35	UTM	GDA94	51J	438025	6669069
SE36	UTM	GDA94	51J	438417	6668982
SE37	UTM	GDA94	51J	438607	6668926
SE38	UTM	GDA94	51J	440221	6670024
SE39	UTM	GDA94	51J	439973	6669890
SE40	UTM	GDA94	51J	439322	6669020
SE41	UTM	GDA94	51J	439061	6668928
SE42	UTM	GDA94	51J	438122	6668327
SE43	UTM	GDA94	51J	438585	6668258
SE44	UTM	GDA94	51J	438125	6667846
SE45	UTM	GDA94	51J	439373	6668271
SE46	UTM	GDA94	51J	440081	6668511
SE47	UTM	GDA94	51J	437857	6667239
SE48	UTM	GDA94	51J	437236	6668045
SE49	UTM	GDA94	51J	436547	6668009

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Site		Zone		Easting	Northing
SE50	UTM	GDA94	51J	436454	6667663
SE51	UTM	GDA94	51J	435737	6667504
SE52	UTM	GDA94	51J	435701	6667722
SE53	UTM	GDA94	51J	435584	6666770
SE54	UTM	GDA94	51J	435056	6667408
SE55	UTM	GDA94	51J	435051	6667626
SE56	UTM	GDA94	51J	434747	6667777
SE57	UTM	GDA94	51J	434371	6667489
SE58	UTM	GDA94	51J	434570	6666681
SE59	UTM	GDA94	51J	434206	6666935
SE60	UTM	GDA94	51J	437709	6661531
SE61	UTM	GDA94	51J	438287	6661738
SE62	UTM	GDA94	51J	436884	6663887
SE63	UTM	GDA94	51J	436344	6663481
SE64	UTM	GDA94	51J	436447	6662715
SE65	UTM	GDA94	51J	436552	6662378
SE66	UTM	GDA94	51J	436693	6661952
SE67	UTM	GDA94	51J	436958	6661272
SE68	UTM	GDA94	51J	437001	6661861
SE69	UTM	GDA94	51J	437035	6662469
SE70	UTM	GDA94	51J	437188	6662265
SE71	UTM	GDA94	51J	437176	6661585
SE72	UTM	GDA94	51J	436884	6661238

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## **Attachment 7: Fauna memo report**



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4<sup>th</sup> February 2019

**Saracen Carosue Project**  
**Fauna assessment of proposed exploration drilling program**  
M. Bamford, B. Shepherd and K. Chuk

**Background**

Saracen operates the Carosue Gold Mine and is proposing intensive exploration around its existing mine, with a spread of 3m cleared drill-lines at 90m spacing. Environmental Impact Assessment for this proposal is being prepared by Alexander Holm and Assoc. (AHA), and Bamford Consulting Ecologists (BCE) has been asked to provide information on the fauna component of this assessment.

BCE uses a 'values and impacts' assessment process with the following components:

- The identification of fauna values:
  - Assemblage characteristics: uniqueness, completeness and richness;
  - Species of conservation significance;
  - Recognition of ecotypes or vegetation/substrate associations (VSAs) that provide habitat for fauna, particularly those that are rare, unusual and/or support significant fauna;
  - Patterns of biodiversity across the landscape;
  - Ecological processes upon which the fauna depend.
- The review of impacting processes such as:
  - Habitat loss leading to population decline;
  - Habitat loss leading to population fragmentation;
  - Degradation of habitat due to weed invasion leading to population decline;
  - Ongoing mortality from operations;
  - Species interactions including feral and overabundant native species;
  - Hydrological change;
  - Altered fire regimes; and
  - Disturbance (dust, light, noise).

The following memo provides information on the approach to the assessment, the fauna values and reviews impacting processes in relation to these values and the proposed exploration program.

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## Methods

### Desktop Assessment

#### Sources of information

Information on the fauna assemblage of the survey area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA) and the EPBC Protected Matters Search Tool of the Department of Energy and the Environment (DEE) (Table ). Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

Frogs: Tyler *et al.* (2009) and Anstis (2013);

Reptiles: Storr *et al.* (1983, 1990, 1999 and 2002) and Wilson and Swan (2017);

Birds: Johnstone and Storr (1998, 2005) and Barrett *et al.* (2003); and

Mammals: Menkhorst & Knight (2004); Armstrong (2011); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia.	Records of biodiversity data from multiple sources across Australia.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.
NatureMap (DBCA)	Records in the WAM and DBCA databases. Includes historical data and records on Threatened and Priority species in WA.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.
BirdLife Australia Atlas Database (Birdlife Australia)	Records of bird observations in Australia, 1998-2019.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.
EPBC Protected Matters (DEE)	Records on matters of national environmental significance protected under the EPBC Act.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.

In addition, information on fauna was available from a number of previous studies in the area. These included:

- Alexander Holm and Assoc. (2017). Malleefowl survey of proposed airstrip. Saracen Gold Mines.
- Coffey environments (2010). Level 1 vertebrate fauna survey for the Carosue Dam Project, Saracen Gold.

- Biologic. (2010). Level 1 survey for a proposed pipeline from GGT to Carosue Dam and powerline from Black Swan to Carosue Dam. Tropicana JV and Saracen Gold Mine Pty Ltd.
- Henry-Hall *et al.* (1990). Report on survey of Goongarrie Nature Reserve.
- ABRS (2013). Bush Blitz; Biological survey of Credo Station Reserve WA.

#### Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2016. The authorities used for each vertebrate group were: amphibians (Doughty *et al.* 2016a), reptiles (Doughty *et al.* 2016b), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). This includes the use of capital letters in English names. English names of species where available are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

#### Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the project area is of no importance. Similarly, waterbirds were generally excluded even though they could over-fly the site, since the site provides little habitat for them. The only exceptions were species that might use the water treatment wetlands near the village. Species returned from databases but excluded from species lists due to lack of suitable habitat (and some database errors) are not presented.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:

**Resident:** species with a population permanently present in the survey area;

**Migrant or regular visitor:** species that occur within the project area regularly in at least moderate numbers, such as part of annual cycle;

**Irregular Visitor:** species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time;

**Vagrant:** species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project area is unlikely to be of importance for the species; and

**Locally extinct:** species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the project area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation context, and species which use the site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times, or may have been previously confirmed as present. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence that the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals. It must be stressed that these status categories are predictions only and that often very intensive sampling would be required to confirm a species' status.

#### **Field Investigation and Personnel**

The project area was visited between 14<sup>th</sup> and 17<sup>th</sup> January 2019 by Drs Mike Bamford (B.Sc. Hons. Ph.D. Biol.) and Barry Shepherd (B.Sc. Hons. Env. Biol., Ph.D. Ecol.). The site visit involved looking around as much of the project area as possible in daylight; tracks and effort of this search are shown in Figure 1. This enabled environmental descriptions to be prepared and some opportunistic observations on fauna to be made. Familiarity with the environment enables interpretation of species lists from databases. Targeted searching was undertaken for two significant species known from the general area: the Malleefowl (searching for nest mounds, foraging signs, tracks and direct observations); and the Brush-tailed Mulgara (searching for burrows, tracks and scats). In general, walks were unstructured and two personnel travelled 20-40m apart, with the track determined by areas of interest and intended to cover as much ground as possible. An exception to this was just north of the accommodation village where systematic transects were walked across a small area to search for Malleefowl mounds. Signs of all species observed, and other notable features of interest were recorded.

On the evening of 14<sup>th</sup> January, between c.19:30 and 21:10, the surveyors conducted a torch-light search of a rocky breakaway just north of the mine camp for nocturnal fauna. Both surveyors carried head torches and recorded species observed or heard.

Throughout the torch-light survey, bat echolocations and calls were recorded on a hand-held bat detector (Echo Meter Touch 2 Pro (EMT2)(Ser No: E2A00773). The EMT2 was run from a Samsung Galaxy S7 with Echo Meter software version 2.6.5. A Wildlife Acoustics Song Meter 4 BAT Full Spectrum (SM4BAT) was deployed next to three settling ponds that form part of the Mine Camp's sewerage treatment plant on the afternoon of 14<sup>th</sup> January and retrieved on the morning of 17<sup>th</sup> January 2019. The settling ponds were located approximately 1 km due south of the Survey Area boundary and 0.75 km south of the Mine Camp. Recordings from the EMT2 and SM4BAT were viewed in Kaleidoscope Viewer v4.5.4 from Wildlife Acoustics. More than 4,000 audio records were obtained over the three nights of sampling indicating very high levels of bat activity. Only a small sample was assessed to provide a preliminary list of bat fauna supporting the Level 1 survey.

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**Vegetation and Substrate Associations**

Vegetation and Substrate Associations (VSAs) in the project area were assessed during the desktop review and as part of the field investigations. Within the project area, all major VSAs were visited to develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area. VSAs correspond to the Land Units described by AHA.

**Survey Limitations**

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE investigation of the survey area in Table 2.

Table 2. Survey limitations as outlined by EPA.

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study and site inspection). Survey intensity was deemed adequate for the various habitat types viewable from aerial photograph, scale of the project and the amount of data records available in the region. The entire area was not searched for Malleefowl mounds and though the survey results are deemed representative for the Project Area as a whole, only a small percentage of the habitats inside the Project Area boundary was surveyed.
Competency/experience of the consultant(s) carrying out the survey.	The ecologists have had extensive experience in conducting fauna surveys and have conducted several fauna studies in the region (over three decades).
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The survey focussed on vertebrate fauna and fauna values.
Proportion of fauna identified, recorded and/or collected.	All vertebrate fauna observed were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Abundant information from databases and previous studies.
The proportion of the task achieved and further work which might be needed.	The survey was completed and the report provides fauna values for the project area.
Timing/weather/season/cycle.	Timing is not of great importance for level 1 investigations.

EPA Limitation	BCE Comment
Disturbances (e.g. fire, flood, accidental human intervention etc.) that affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	The survey area is approximately 3135 ha and was traversed by vehicle and on foot and thus was adequately comprehensive to assess fauna and fauna values.
Completeness (e.g. was relevant area fully surveyed).	Site was fully surveyed to the level appropriate for a level 1 assessment. Fauna database searches covered a 10 to 20 km radius beyond the survey area boundary.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna and habitat in the region.
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. bio-geographic) information on the region.	Extensive regional information was available and was consulted.

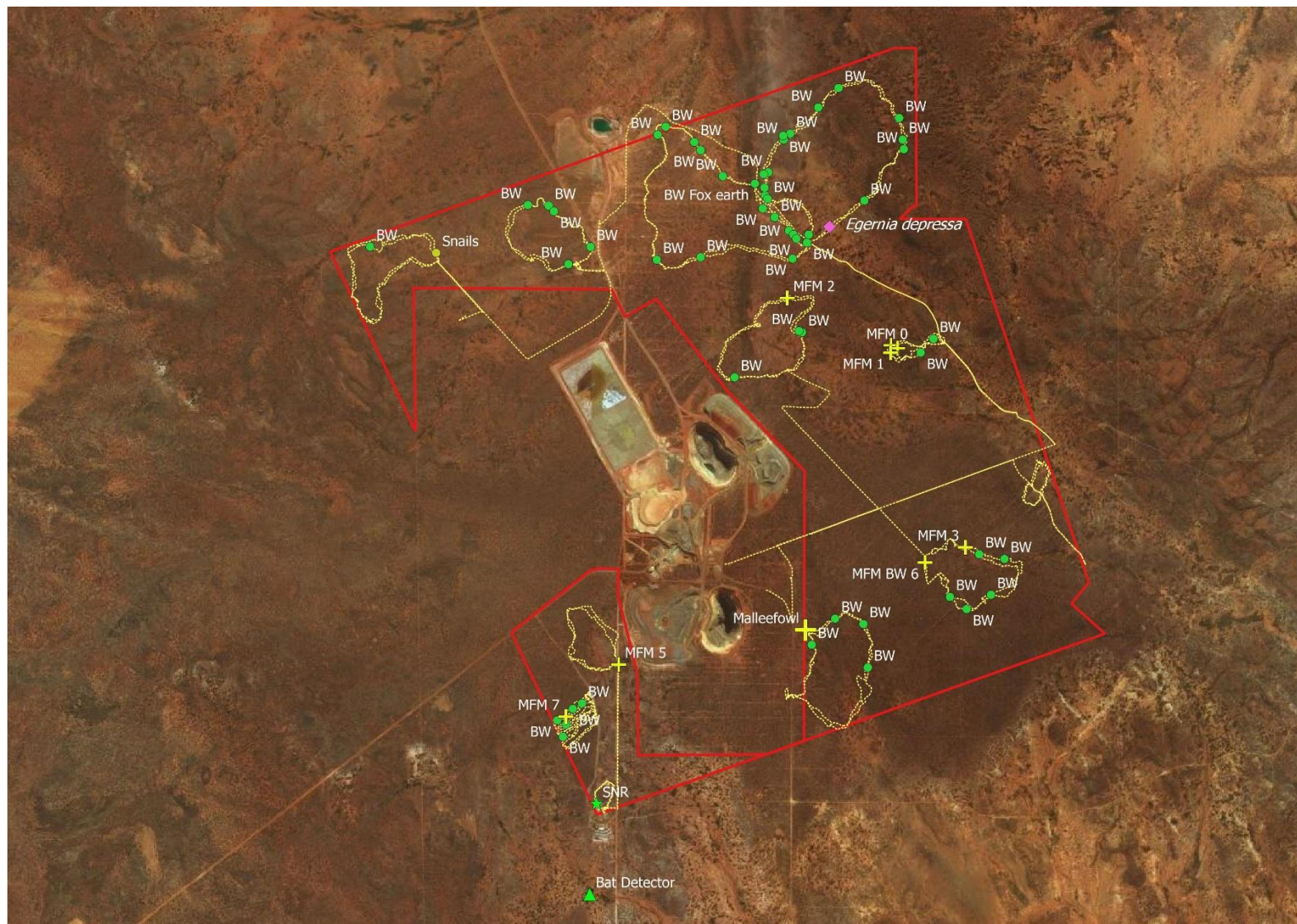


Figure 1. Areas of the project area visited by vehicle and on foot, indicating tracks taken. Locations of fauna observations are indicated: BW = Boodie warrens, MFW = Malleefowl mound.

## **Fauna assemblage**

The vertebrate fauna assemblage potentially includes 285 species, with a further six species considered locally extinct (Table 3). A complete list of all species appears in Appendix 1, indicating those of conservation significance and assigning each species a status category in the area. Appendix 1 includes a list of jewel beetles known from the general area but no other information on invertebrates is available. Appendix 2 provides notes on fauna observations made during the January 2019 site inspection.

- Assemblage characteristics. A rich assemblage which reflects the fairly complex environment ranging from low rocky hills to shrublands on gravelly loams and open woodland on clayey-loams. Broadly typical of the eastern goldfields with some southern elements present. The extinct species are those that have disappeared from vast areas of Australia, due largely to predation by feral species. The Boodie was clearly abundant in the region (see Figure 1).
  - Species of conservation significance. Numbers of conservation significant species are summarised in Table 4. The 11 invertebrates are all jewel beetles that have special protection, primarily to prevent over-collection by entomologists. The remaining significant species include one reptile, 19 birds and two mammals. The single reptile is a Priority 2 skink that may occur under leaf-litter around trees and mallee. The majority (9) of the birds are waterbirds that are either vagrants or irregular visitors, and would not utilise the actual project area due to the lack of wetlands. Most other significant birds are expected only as vagrants but three species may use the site regularly: Malleefowl (CS1), Peregrine Falcon (CS1) and Rainbow Bee-eater (CS3). These are discussed below. Only two significant mammals are expected, with the Central Long-eared Bat (CS2) potentially roosting in large trees in the area, and the Brush-tailed Mulgara (CS2) probably being locally extinct or possibly being a vagrant, as much of the project area lacked suitable habitat (sandy soil with spinifex), and there was no evidence of the species.
  - Vegetation and Substrate Associations (VSAs). These provide habitat for fauna and are represented by the land units described by AHA. Notable features of the landscape are low rocky hills in the north-west, north-east and south-east, a broad area of loam-clay soils that are part of a broad drainage system through the centre of the area, and sandy soils in the far west. The drainage system soils support tall eucalypts and the sandy soils support mallee over spinifex. Other areas support a range of shrublands largely dominated by acacia. These have some significance to patterns of biodiversity.
  - Patterns of biodiversity across the landscape. Massive sample efforts are required to determine patterns of biodiversity, but some can be surmised from the landscape and VSAs. The sandy soils supporting spinifex and mallee in the south-west are likely to be rich in reptiles as the soils allow for burrowing and the spinifex provides abundant cover. Such areas are also likely to be rich in shrubland-dependent birds and some small mammals. During the site inspection, it was noted that the transition between eucalypt woodland and acacia shrublands appeared to be rich in birds; south of the current operations this is where species such as the Red-capped Robin, White-eared and Brown-headed Honeyeaters and White-browed Babblers were observed. It was also where a Malleefowl was seen. Tall shrublands of acacia with little understorey,
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found across large areas of loamy-clay soils, are probably less rich in species. The low rocky hills have potential for short range endemic invertebrates and appeared to be floristically rich, so may be seasonally important for nectar-dependent birds and invertebrates.

- Ecological processes upon which the fauna depend. A range of ecological processes can be important for fauna, but a major feature of the project area is surface hydrology/drainage. There is extensive drainage via small ephemeral watercourses from the low rocky hills, as well as broad drainage through the centre of the area. These patterns of drainage affect productivity for both flora and fauna. Introduced species (in particular the European Fox and Feral Cat) have probably led to local extinction of several species, and may be suppressing the populations of some species that are still present. Some of the vegetation, notably mallee over spinifex and shrublands on low rocky hills, are likely to be fire-prone and this can have both negative and positive effects on fauna.

#### Malleefowl

Several Malleefowl mounds were found (Figure 1) but all were long-inactive. Mounds have been found in previous studies (Coffey Environment 2010, Alexander Holm and Assoc. 2017), and in the airport area just to the west some of these were active or recently active. There was also one sighting of a bird in January 2019. Malleefowl mounds are active from about May to December, even into January depending on rainfall.

The species is clearly resident but from past experience the density of mounds is low. Furthermore, several of the mounds were very small, little more than small pits with a slightly raised edge of excavated soil, and it is unlikely they had ever been used for breeding; possibly they were dug by young males. These tended to be in heavy loamy-clay soils which are not usually the preferred substrate, with sands and gravels generally favoured. The Malleefowl is probably more abundant to the west where there are extensive sandy soils.

#### Peregrine Falcon

Not observed but a widespread species and considered likely to be a regular visitor if not resident. It could also breed in tall eucalypts in the area, probably by utilising old nests of the Australian Raven.

#### Rainbow Bee-eater.

This species is only considered of local significance but was formerly listed as Migratory under legislation. It is still considered locally significant as it is a true migrant and breeds in burrows in the area, making it vulnerable to disturbance and predation. It will also often nest along tracks, increasing its vulnerability.

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Table 3. Composition of the vertebrate fauna of the project area.

Taxon	Number of species expected	Number of species in each status category				
		Resident	Regular visitor or migrant	Irregular visitor	Vagrant	Locally extinct
frogs	5	4	-	1	-	-
reptiles	74	67	5	1	1	-
birds	165	64	43	36	22	-
mammals	41	28	3	2	2	6
<b>Total</b>	<b>285</b> (including 9 int.)	<b>163</b>	<b>51</b>	<b>40</b>	<b>25</b>	<b>6</b>

Table 4. Numbers of species of conservation significance in each major taxon (excluding locally extinct species).

Taxon	Conservation Significant (CS) fauna		
	CS1	CS2	CS3
Invertebrates	11	-	-
Frogs	-	-	-
Reptiles	-	1	-
Birds	15	3	1
Mammals	-	2	-

CS1 = listed under legislation

CS2 = listed as priority by DBCA

CS3 = locally significant

## Impacts

Impacts are a result of the interaction of the proposed development and the fauna values, and can be interpreted from the nature of both. For example, the assessment of fauna values identifies minor drainage lines, Malleefowl mounds and large trees as notable features for biodiversity. Impacting processes are discussed below.

- Habitat loss leading to population decline. Habitat loss from clearing 3m wide drill-lines at 90m intervals will affect about 3% of the landscape, and there will inevitably be some mortality during this clearing. Note that the habitat loss will be temporary except where lines are maintained as access tracks, and therefore populations should recover from this loss eventually. The effect of habitat loss can be reduced by avoiding sensitive environmental features (such as Malleefowl mounds; see recommendations below).
- Habitat loss leading to population fragmentation. This is unlikely to be a concern with the proposal as the clearing is in narrow lines through otherwise more or less continuous vegetation.

- Degradation of habitat due to weed invasion leading to population decline. The native vegetation in the area appears to have very low levels of weed invasion currently. There are standard procedures for minimising the risk of introducing weeds (discussed in recommendations below).
- Ongoing mortality from operations. Main sources of ongoing mortality will be from vehicle strike and entrapment in drilling sumps. There are standard procedures for minimising these risks (discussed in recommendations below).
- Species interactions including feral and overabundant native species. Feral predators are already present and affecting the fauna assemblage, but the creation of multiple tracks will improve their access into areas where currently tracks are few. The presence of personnel in these areas can also lead to an increase in activity of feral species. Recommendations to limit these affects are discussed below.
- Hydrological change. There may be some disruption of surface flow especially on the lower slopes of hills. Wastewater from drilling is usually contained in lined sumps so should have no impact.
- Altered fire regimes. Drilling activities and the presence of personnel will increase the risk of unplanned bushfire.
- Disturbance (dust, light, noise). Some level of disturbance during drilling is inevitable but temporary. If drilling occurs at night, lighting may be a source of mortality for insects. While only a temporary effect there are means by which this sort of mortality can be reduced. It is not known if the specially protected jewel beetles known from the general area are actually present, or how they might be affected by light.

## **Recommendations**

Impacts outlined above clearly indicate a range of recommendations to ensure that adverse effects are minimised.

- Habitat loss leading to population decline.
    - Malleefowl mounds are of importance for the birds, whether or not they are active or recently-used, while active mounds (containing eggs) are of special value. Even very old mounds have been found to be re-used, possibly after an interval of several decades (M. Bamford pers. obs; Mt Jackson area). Therefore, no mounds should be damaged or otherwise disturbed if this is possible. If this is not possible, then it should be ensured that mounds are not active or disturbance should be delayed until breeding is complete. This requires a mound survey along all areas to be cleared, but given the apparent low density of mounds it is suggested that this could be carried out by exploration personnel with guidance from an experienced zoologist. For example, exploration personnel could be shown known mounds and could take photographs of suspected mounds for confirmation and interpretation by a zoologist. The protocol for searching for mounds needs to be discussed with government agencies, but in similar projects searching involves walking the alignment and ensuring that mounds can be avoided, while in areas of dense vegetation with poor visibility, searching needs to extend 50m from the centreline. This is to avoid clearing activity within c. 50m of an active mound.
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This sort of detailed searching involves a small team of 3-4 people, but would only be needed in areas most likely to have mounds such as in the sandy soils in the west, and amongst the low rocky hills, particularly of the north-west and north-east.

- Large trees may support nesting by the Peregrine Falcon (and other birds) but it is assumed that clearing for exploration lines will go around trees wherever possible. Clearing should also avoid, if possible, mallee and tall shrubs with extensive beds of leaf-litter as these are important for some fauna.
  - In general, the clearing footprint should be minimised and vegetation retained where possible. Even tall shrubs and small trees can harbour colonies of lizards and bats that can survive if the vegetation is pushed over slowly and is not roughly wind-rowed. Clearing from mid winter to mid spring runs the risk of destroying nests of small birds. While this may be unavoidable, retaining shrubs will reduce the risk. Consideration could be given to having a 'spotter' present during clearing, especially in areas of dense vegetation.
  - To encourage regeneration, drill-lines should be ripped. Large branches and logs can be moved back over the drill-line, but there is a risk of killing fauna that may have colonised pushed-over vegetation.
  - Degradation of habitat due to weed invasion leading to population decline. There are standard equipment hygiene practices to minimise the risk of introducing weeds, and these should be practiced.
  - Ongoing mortality from operations.
    - Vehicle strike. There are existing speed limits and signage where Malleefowl have been seen near roads. These need to be installed on access roads to the exploration area if birds are seen or suspected.
    - Entrapment in drilling sumps. It is standard practice to create a ramp in drilling sumps, but plastic linings (required to prevent drill wastewater from soaking into the ground) can render such ramps more or less useless. Rope ladders, heavy rope mesh and even branches can be placed into sumps to assist egress by small animals. Drilling sumps should be filled as soon as they are no longer required. Capping drill-holes is standard practice but should be reiterated in inductions.
  - Species interactions including feral and overabundant native species. Personnel should be encouraged not to feed feral fauna and to report Foxes and Cats. Rapid rehabilitation of drill-lines will reduce their attractiveness to these feral species.
  - Hydrological change. Where drill lines cross minor drainage lines, soil should not cause damming of the drainage line, and should not form an alternative route for water flow.
  - Altered fire regimes. Personnel should be educated on the need to avoid bushfire. Spinifex areas in particular can readily be set alight so special care may be needed.
  - Disturbance (dust, light, noise). Dust and noise should be suppressed where possible. Lighting should not be left on overnight unless needed.
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Appendix 1. Vertebrate fauna assemblage of the project area, based upon database and literature searches and the January 2019 site inspection. Sources of information are:

- ALA = Atlas of Living Australia, searched January 2019;
- N = Naturemap Database, searched January 2019;
- EPBC = EPBC Protected Matters, searched January 2019;
- BA = Birdlife Australia's Birddata database, searched January 2019;
- GNP 1990 = fauna survey of Goongarrie nature reserve (Henry-Hall *et al.* 1990);
- BB 2011 = fauna survey of Credo Station (ABRS 2013).
- BCE 2018 = species observed in the project area in January 2019;

Conservation significance (CS) codes:

- CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 4 for full explanation.
- EPBC Act listings: Cr = Critically Endangered, E = Endangered, V = Vulnerable, Mig = Migratory (see Appendix 3).
- Biodiversity Conservation Act listings: for all CS1 species S1 to 7 = Schedules 1 to 7 respectively, (see Appendix 3).
- DBCA Priority species: P1 to P4 = Priority 1 to 4 (see Appendix 4).

Expected status as outlined in Methods.

FROGS	CS	ALA	N	GNP 1990	BB 2011	BCE 2018	Expected status in area
<b>HYLIDAE</b>							
Water-holding Frog <i>Cyclorana platycephala</i>		X	X				Resident
Desert Tree Frog <i>Litoria rubella</i>							Irregular visitor
<b>LIMNODYNASTIDAE</b>							
Kunapalari Frog <i>Neobatrachus kunapalari</i>		X	X		X		Resident
Shoemaker Frog <i>Neobatrachus sutor</i>		X	X				Resident
<b>MYOBATRACHIDAE</b>							
Western Toadlet <i>Pseudophryne occidentalis</i>					X		Resident

REPTILES	CS	ALA	N	GNP 1990	BB 2011	BCE 2018	Expected status in area
<b>AGAMIDAE</b>							
Bicycle Dragon <i>Ctenophorus cristatus</i>		X	X	X	X	X	Resident
Mallee Sand Dragon <i>Ctenophorus fordi</i>		X	X				Resident
Military Dragon <i>Ctenophorus isolepis</i>					X		Resident
Central Netted Dragon <i>Ctenophorus nuchalis</i>							Resident
Western Netted Dragon <i>Ctenophorus reticulatus</i>		X	X	X	X	X	Resident
Lozenge-marked Dragon <i>Ctenophorus scutulatus</i>		X	X	X	X	X	Resident
Mulga Dragon <i>Diporiphora amphiboluroides</i>		X					Resident
Thorny Devil <i>Moloch horridus</i>		X	X				Resident

REPTILES		CS	ALA	N	GNP 1990	BB 2011	BCE 2018	Expected status in area
Western Bearded Dragon	<i>Pogona minor</i>		X	X	X			Resident
<b>DIPLODACTYLIDAE</b>								
Fat-tailed Gecko	<i>Diplodactylus conspicillatus</i>						X	Resident
Goldfields Stone Gecko	<i>Diplodactylus granariensis</i>					X		Resident
Western Saddled Ground Gecko	<i>Diplodactylus pulcher</i>		X	X	X	X		Resident
Reticulated Velvet Gecko	<i>Hesperoedura reticulata</i>					X		Resident
Main's Ground Gecko	<i>Lucasium maini</i>				X			Resident
Beaked Gecko	<i>Rhynchoedura ornata</i>		X	X	X	X		Resident
Thorn-tailed Gecko	<i>Strophurus assimilis</i>							Resident
Jewelled Gecko	<i>Strophurus elderi</i>							Resident
Western Ring-tailed Gecko	<i>Strophurus strophurus</i>				X			Resident
Western Shield Spiny-tailed Gecko	<i>Strophurus wellingtonae</i>					X		Resident
<b>CARPHODACTYLIDAE</b>								
<b>Knob-tailed Gecko</b>	<i>Nephurus vertebralis</i>							Resident
Barking Gecko	<i>Underwoodisaurus milii</i>		X	X		X		Resident
<b>GEKKONIDAE</b>								
Purple Arid Dtella	<i>Gehyra purpurascens</i>		X	X	X	X		Resident
Variegated Dtella	<i>Gehyra variegata</i>		X	X	X	X		Resident
Bynoe's Gecko	<i>Heteronotia binoei</i>		X	X	X	X		Resident
<b>PYGOPODIDAE</b>								
Marble-faced Delma	<i>Delma australis</i>					X		Resident
Unbanded Delma	<i>Delma butleri</i>		X	X				Resident
Burton's Legless Lizard	<i>Lialis burtonis</i>		X	X		X		Resident
Western Hooded Scaly-foot	<i>Pygopus nigriceps</i>		X					Resident
<b>SCINCIDAE</b>								
	<i>Cryptoblepharus australis</i>		X	X				Resident
Buchanan's Snake-eyed Skink	<i>Cryptoblepharus buechananii</i>					X		Resident
Peron's Fence Skink	<i>Cryptoblepharus plagiocephalus</i>				X			Resident
	<i>Ctenotus atlas</i>		X	X	X			Resident
Leonhardi's Ctenotus	<i>Ctenotus leonhardii</i>		X	X	X	X	X	Resident
	<i>Ctenotus mimetes</i>						X	Resident
Leopard Skink	<i>Ctenotus pantherinus</i>							Resident
Barred Wedge-snout Ctenotus	<i>Ctenotus schomburgkii</i>		X	X	X	X		Resident
Spotted Ctenotus	<i>Ctenotus uber</i>		X	X	X	X		Resident
Wide-striped Ctenotus	<i>Ctenotus xenopleura</i>					X		Resident
Slender Blue-tongue	<i>Cyclodomorphus melanops</i>		X	X				Resident

REPTILES		CS	ALA	N	GNP 1990	BB 2011	BCE 2018	Expected status in area
Pygmy Spiny-tailed Skink	<i>Egernia depressa</i>		X	X		X	X	Resident
Goldfields Crevice Skink	<i>Egernia formosa</i>		X	X		X		Resident
South-Western Crevice-Skink	<i>Egernia napolensis</i>		X					Resident
Broad-banded Sand-swimmer	<i>Eremiascincus richardsonii</i>					X	X	Resident
	<i>Lerista desertorum</i>							Resident
	<i>Lerista kingi</i>		X	X				Resident
Unpatterned Robust Slider	<i>Lerista macropisthopus</i>	P2				X		Resident
Southern Robust Slider	<i>Lerista picturata</i>					X		Resident
Timid Slider	<i>Lerista timida</i>		X	X		X		Resident
Desert Skink	<i>Liopholis inornata</i>		X	X		X	X	Resident
Common Dwarf Skink	<i>Menetia greyii</i>		X	X	X	X	X	Resident
Saltbush Morethia Skink	<i>Morethia adelaidensis</i>					X	X	Resident
Woodland Dark-flecked Morethia	<i>Morethia butleri</i>		X	X	X	X		Resident
Western Blue-tongue	<i>Tiliqua occipitalis</i>		X	X		X		Resident
Bobtail	<i>Tiliqua rugosa</i>		X	X		X		Resident
<b>VARANIDAE</b>								
Stripe-tailed Monitor	<i>Varanus caudolineatus</i>		X	X	X	X		Resident
Perentie	<i>Varanus giganteus</i>					X		Resident
Sand Goanna	<i>Varanus gouldii</i>		X	X		X	X	Resident
Black-headed Monitor	<i>Varanus tristis</i>			X				Resident
<b>TYPHLOPIDAE</b>								
Southern Blind Snake	<i>Anilius australis</i>					X		Resident
Dark-spined blind snake	<i>Anilius bicolor</i>							Resident
Prong-snouted Blind Snake	<i>Anilius bituberculatus</i>					X		Resident
Northern Hook-snouted Blind Snake	<i>Anilius hamatus</i>						X	Resident
Beaked Blind Snake	<i>Anilius waitii</i>							Resident
<b>ELAPIDAE</b>								
Desert Death Adder	<i>Acanthophis pyrrhus</i>		X	X				Resident
Southern Shovel-nosed Snake	<i>Brachyuropsis semifasciata</i>							Resident
Yellow-faced Whipsnake	<i>Demansia psammophis</i>							Resident
Moon Snake	<i>Furina ornata</i>					X		Resident
Monk Snake	<i>Parasuta monachus</i>		X	X		X		Resident
Mulga Snake	<i>Pseudechis australis</i>		X	X		X		Resident
Ringed Brown Snake	<i>Pseudonaja modesta</i>		X	X	X			Resident
Gwardar	<i>Pseudonaja mengdeni</i>							Resident
Jan's Banded Snake	<i>Simoselaps bertholdi</i>		X	X		X	X	Resident
Rosen's Snake	<i>Suta fasciata</i>							Resident



BIRDS		CS	ALA	N	EPBC	BA	GNP 1990	BB 2011	BCE 2018	Expected status in area
Crested Pigeon	<i>Ocyphaps lophotes</i>		X	X		X		X	X	Resident
Common Bronzewing	<i>Phaps chalcoptera</i>		X	X		X		X		Resident
<b>CUCULIDAE</b>										
Fan-tailed Cuckoo	<i>Cacomantis flabelliformi</i>							X		Irregular visitor
Horsfield's Bronze-Cuckoo	<i>Chalcites basalys</i>		X	X		X		X		Regular migrant
Black-eared Cuckoo	<i>Chalcites osculans</i>		X	X	X	X		X		Regular migrant
Pallid Cuckoo	<i>Cuculus pallidus</i>		X			X		X		Regular migrant
<b>APODIDAE</b>										
Fork-tailed Swift	<i>Apus pacificus</i>	M S5			X			X		Regular migrant
<b>RALLIDAE</b>										
Eurasian Coot	<i>Fulica atra</i>					X		X	X	Regular visitor
Australian Spotted Crake	<i>Porzana fluminea</i>							X		Irregular visitor
Black-tailed Native-hen	<i>Gallinula ventralis</i>							X		Irregular visitor
<b>RECURVIROSTRIDAE</b>										
Banded Stilt	<i>Cladorhynchus leucocephalus</i>							X		Vagrant
Black-winged Stilt	<i>Himantopus himantopus</i>					X		X		Irregular visitor
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>					X		X		Vagrant
<b>CHARADRIIDAE</b>										
Inland Dotterel	<i>Charadrius australis</i>									Irregular visitor
Black-fronted Dotterel	<i>Charadrius melanops</i>							X		Irregular visitor
Red-capped Plover	<i>Charadrius ruficapillus</i>							X		Irregular visitor
Red-kneed Dotterel	<i>Erythronyx cinctus</i>							X		Regular visitor
Hooded Plover	<i>Thinornis rubricollis</i>	P4			X					Vagrant
Banded Lapwing	<i>Vanellus tricolor</i>			X				X		Regular visitor
<b>SCOLOPACIDAE</b>										
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	M S5			X					Irregular visitor
Curlew Sandpiper	<i>Calidris ferruginea</i>	Cr M S1 S5			X					Vagrant
Pectoral Sandpiper	<i>Calidris melanotos</i>	M S5			X					Vagrant

BIRDS		CS	ALA	N	EPBC	BA	GNP 1990	BB 2011	BCE 2018	Expected status in area
Red-necked Stint	<i>Calidris ruficollis</i>	M S5						X		Irregular visitor
Wood Sandpiper	<i>Tringa glareola</i>	M S5								Vagrant
Common Sandpiper	<i>Tringa hypoleucos</i>	M S5			X					Irregular visitor
Common Greenshank	<i>Tringa nebularia</i>	M S5								Irregular visitor
Marsh Sandpiper	<i>Tringa stagnatalis</i>	M S5								Irregular visitor
<b>ARDEIDAE</b>										
White-faced Heron	<i>Egretta novaehollandiae</i>					X		X		Irregular visitor
White-necked Heron	<i>Ardea pacifica</i>					X		X		Irregular visitor
Eastern Great Egret	<i>Ardea modesta</i>				X					Vagrant
Nankeen Night Heron	<i>Nycticorax caledonicus</i>									Vagrant
<b>THRESKIORNITHIDAE</b>										
Yellow-billed Spoonbill	<i>Platalea flavipes</i>							X		Vagrant
Glossy Ibis	<i>Plegadis falcinellus</i>	M S5						X		Vagrant
Australian White Ibis	<i>Threskiornis molucca</i>							X		Vagrant
Straw-necked Ibis	<i>Threskiornis spinicollis</i>							X		Vagrant
<b>PHALACROCORACIDAE</b>										
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>					X		X		Irregular visitor
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>									Vagrant
<b>ACCIPITRIDAE</b>										
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>									Resident
Brown Goshawk	<i>Accipiter fasciatus</i>		X			X		X		Regular visitor
Wedge-tailed Eagle	<i>Aquila audax</i>		X	X		X		X		Resident
Spotted Harrier	<i>Circus assimilis</i>		X					X		Regular visitor
Black-shouldered Kite	<i>Elanus axillaris</i>									Regular visitor
Letter-winged Kite	<i>Elanus scriptus</i>	P4								Irregular visitor
Whistling Kite	<i>Haliastur spheurnus</i>		X			X		X		Regular visitor
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>					X				Regular visitor
Little Eagle	<i>Hieraaetus morphnoides</i>					X		X		Regular visitor
Square-tailed Kite	<i>Lophoictinia isura</i>							X		Irregular visitor



BIRDS		CS	ALA	N	EPBC	BA	GNP 1990	BB 2011	BCE 2018	Expected status in area
Black Kite	<i>Milvus migrans</i>									Irregular visitor
<b>FALCONIDAE</b>										
Brown Falcon	<i>Falco berigora</i>		X	X		X		X		Regular visitor
Nankeen Kestrel	<i>Falco cenchroides</i>		X	X		X		X	X	Regular visitor
Grey Falcon	<i>Falco hypoleucos</i>	S3								Vagrant
Australian Hobby	<i>Falco longipennis</i>		X			X		X	X	Regular visitor
Peregrine Falcon	<i>Falco peregrinus</i>	S7						X		Regular visitor
Black Falcon	<i>Falco subniger</i>									Irregular visitor
<b>STRIGIDAE</b>										
Southern Boobook	<i>Ninox novaeseelandiae</i>		X			X		X		Resident
<b>TYTONIDAE</b>										
Barn Owl	<i>Tyto alba</i>			X				X		Resident
<b>PODARGIDAE</b>										
Tawny Frogmouth	<i>Podargus strigoides</i>			X		X		X		Resident
<b>CAPRIMULGIDAE</b>										
Spotted Nightjar	<i>Eurostopodus argus</i>			X		X				Regular visitor
<b>AEGOTHELIDAE</b>										
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>		X	X		X				Resident
<b>MEROPIIDAE</b>										
Rainbow Bee-eater	<i>Merops ornatus</i>	CS3	X	X	X	X		X	X	Regular migrant
<b>ALCEDINIDAE</b>										
Red-backed Kingfisher	<i>Todiramphus pyrrhopygia</i>		X					X		Resident
Sacred Kingfisher	<i>Todiramphus sanctus</i>							X		Regular visitor
<b>CACATUIDAE</b>										
Major Mitchell's Cockatoo	<i>Cacatua leadbeateri</i>									Irregular visitor
Little Corella	<i>Cacatua sanguinea</i>									Vagrant
Galah	<i>Eolophus roseicapilla</i>		X	X		X		X		Regular visitor
Cockatiel	<i>Nymphicus hollandicus</i>		X					X		Regular visitor
<b>PSITTACIDAE</b>										
Australian Ringneck	<i>Barnardius zonarius</i>		X	X		X		X	X	Resident
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>		X			X		X		Regular visitor

BIRDS		CS	ALA	N	EPBC	BA	GNP 1990	BB 2011	BCE 2018	Expected status in area
Budgerigar	<i>Melopsittacus undulatus</i>							X		Regular visitor
Scarlet-chested Parrot	<i>Neophema splendida</i>					X				Irregular visitor
Night Parrot	<i>Pezoporus occidentalis</i>	E S1			X					Vagrant
Princess Parrot	<i>Polytelis alexandrae</i>	V P4			X					Vagrant
Regent Parrot	<i>Polytelis anthopeplus</i>		X					X		Regular visitor
Mulga Parrot	<i>Psephotus varius</i>		X	X		X		X	X	Resident
<b>CLIMACTERIDAE</b>										
White-browed Treecreeper	<i>Climacteris affinis</i>		X	X				X		Resident
Rufous Treecreeper	<i>Climacteris rufa</i>							X		Resident
<b>PTILONORHYNCHIDAE</b>										
Western Bowerbird	<i>Ptilonorhynchus guttatus</i>			X		X				Resident
<b>MALURIDAE</b>										
White-winged Fairy-wren	<i>Malurus leucopterus</i>		X	X		X	X	X		Resident
Splendid Fairy-wren	<i>Malurus splendens</i>		X	X		X	X	X	X	Resident
<b>MELIPHAGIDAE</b>										
Spiny-cheeked Honeyeater	<i>Acanthagenys rufogularis</i>		X	X		X		X	X	Resident
Red Wattlebird	<i>Anthochaera carunculata</i>		X	X		X		X		Regular visitor
Pied Honeyeater	<i>Certhionyx variegatus</i>									Regular visitor
White-fronted Chat	<i>Epthianura albifrons</i>		X	X				X		Regular visitor
Orange Chat	<i>Epthianura aurifrons</i>		X							Irregular visitor
Crimson Chat	<i>Epthianura tricolor</i>		X	X		X		X		Regular visitor
Grey-fronted Honeyeater	<i>Lichenostomus plumulus</i>		X							Irregular visitor
Singing Honeyeater	<i>Lichenostomus virescens</i>		X			X		X	X	Resident
Brown Honeyeater	<i>Lichmera indistincta</i>		X	X		X		X		Resident
Yellow-throated Miner	<i>Manorina flavigula</i>		X	X		X		X	X	Resident
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>		X	X		X		X	X	Resident
White-eared Honeyeater	<i>Nesoptilotis leucotis</i>		X	X		X		X	X	Resident
White-fronted Honeyeater	<i>Phylidonyris albifrons</i>		X	X		X		X		Regular visitor
Yellow-plumed Honeyeater	<i>Ptilotula ornata</i>		X			X		X		Regular visitor

BIRDS		CS	ALA	N	EPBC	BA	GNP 1990	BB 2011	BCE 2018	Expected status in area
Black Honeyeater	<i>Sugomel niger</i>							X		Irregular visitor
<b>PARDALOTIDAE</b>										
Striated Pardalote	<i>Pardalotus striatus</i>		X	X		X		X		Resident
<b>ACANTHIZIDAE</b>										
Inland Thornbill	<i>Acanthiza apicalis</i>		X	X		X		X	X	Resident
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>		X	X		X		X	X	Resident
Slender-billed Thornbill	<i>Acanthiza iredalei</i>									Vagrant
Slaty-backed Thornbill	<i>Acanthiza robustirostris</i>		X	X		X				Resident
Chestnut-rumped Thornbill	<i>Acanthiza uropygialis</i>		X	X		X		X	X	Resident
Southern Whiteface	<i>Aphelocephala leucopsis</i>		X	X		X		X		Resident
Rufous Fieldwren	<i>Calamanthus campestris</i>									Regular visitor
Western Gerygone	<i>Gerygone fusca</i>							X		Resident
Redthroat	<i>Pyrrholaemus brunneus</i>		X	X		X		X	X	Resident
Weebill	<i>Smicrornis brevirostris</i>		X	X		X		X	X	Resident
<b>NEOSITTIDAE</b>										
Varied Sittella	<i>Daphoenositta chrysoptera</i>		X			X		X		Resident
<b>POMATOSTOMIDAE</b>										
White-browed Babbler	<i>Pomatostomus superciliosus</i>		X	X		X		X	X	Resident
<b>CINCLOSOMATIDAE</b>										
Chestnut Quail-thrush	<i>Cinclosoma castanotum</i>		X			X		X		Regular visitor
Copper-backed Quail-thrush	<i>Cinclosoma castaneothorax</i>									Irregular visitor
Chiming Wedgebill	<i>Psophodes occidentalis</i>									Vagrant
<b>CAMPEPHAGIDAE</b>										
Ground Cuckoo-shrike	<i>Coracina maxima</i>		X	X		X		X		Resident
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>		X	X		X		X		Resident
White-winged Triller	<i>Lalage tricolor</i>		X	X		X		X		Resident
<b>PACHYCEPHALIDAE</b>										
Grey Shrike-thrush	<i>Colluricincla harmonica</i>		X	X		X	X	X	X	Resident
Crested Bellbird	<i>Oreoica gutturalis</i>		X	X		X	X	X	X	Resident
Gilbert's Whistler	<i>Pachycephala inornata</i>							X		Irregular visitor



BIRDS		CS	ALA	N	EPBC	BA	GNP 1990	BB 2011	BCE 2018	Expected status in area
Brown Songlark	<i>Cinclorhamphus cruralis</i>		X					X		Resident
Rufous Songlark	<i>Cinclorhamphus mathewsi</i>							X		Resident
<b>HIRUNDINIDAE</b>										
White-backed Swallow	<i>Cheramoeca leucosternum</i>		X			X		X	X	Resident
Welcome Swallow	<i>Hirundo neoxena</i>		X	X		X		X	X	Resident
Fairy Martin	<i>Petrochelidon ariel</i>									Irregular visitor
Tree Martin	<i>Petrochelidon nigricans</i>		X	X		X		X		Resident

MAMMALS		CS	ALA	N	EPBC	GNP 1990	BB 2011	BCE 2018	Expected status in area
<b>TACHYGLOSSIDAE</b>									
Echidna	<i>Tachyglossus aculeatus</i>			X			X	X	Resident
<b>DASYURIDAE</b>									
Kultarr	<i>Antechinomys laniger</i>								Resident
Brush-tailed Mulgara	<i>Dasycercus blythi</i>	P4							Vagrant
Chuditch	<i>Dasyurus geoffroii</i>	V S3			X				Locally extinct
Wongai Ningau	<i>Ningau ridei</i>		X	X					Resident
Southern Ningau	<i>Ningau yvonneae</i>						X		Resident
Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>						X		Resident
Fat-tailed Dunnart	<i>Sminthopsis crassicaudata</i>		X	X			X		Resident
Little Long-tailed Dunnart	<i>Sminthopsis dolichura</i>		X	X			X		Resident
Hairy-footed Dunnart	<i>Sminthopsis hirtipes</i>								Resident
Ooldea Dunnart	<i>Sminthopsis ooldea</i>						X		Resident
<b>THYLACOMYIDAE</b>									
Greater Bilby	<i>Macrotis lagotis</i>	V S3							Locally extinct
<b>BURRAMYIDAE</b>									
Western Pygmy Possum	<i>Cercartetus concinnus</i>						X		Resident
<b>POTOROIDAE</b>									
Boodie	<i>Bettongia lesueur</i>	Ex S4						*	Locally extinct
<b>PERAMELIDAE</b>									

MAMMALS		CS	ALA	N	EPBC	GNP 1990	BB 2011	BCE 2018	Expected status in area
Pig-footed Bandicoot	<i>Chaeropus ecaudatus</i>	Ex S4							Extinct
Golden Bandicoot	<i>Isoodon auratus</i>	V S3							Locally extinct
Western Barred Bandicoot	<i>Perameles bougainville</i>	E S3	X						Locally extinct
<b>MACROPODIDAE</b>									
Rufous Hare-Wallaby	<i>Lagorchestes hirsutus</i>	Ex S4							Locally extinct
Western Grey Kangaroo	<i>Macropus fuliginosus</i>		X	X		X	X		Resident
Euro, Biggada	<i>Macropus robustus</i>			X			X	X	Resident
Red Kangaroo, Marlu	<i>Macropus rufus</i>		X	X		X	X		Resident
<b>MOLOSSIDAE</b>									
White-striped Freetail-Bat	<i>Austronomus australis</i>						X	X	Resident
Southern Freetail-Bat	<i>Mormopterus planiceps</i>						X		Resident
<b>VESPERTILIONIDAE</b>									
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>						X	X	Resident
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>						X		Resident
Central Long-eared Bat	<i>Nyctophilus major tor</i>	P3							Resident
Inland Broad-nosed Bat	<i>Scotorepens balstoni</i>								Resident
Inland Forest Bat	<i>Vespadelus baverstocki</i>								Regular visitor
Southern Forest Bat	<i>Vespadelus regulus</i>								Irregular visitor
<b>MURIDAE</b>									
Stick-nest Rat	<i>Leporillus</i> sp	Ex S4						*	Extinct
Spinifex Hopping-Mouse	<i>Notomys alexis</i>								Irregular visitor
Mitchell's Hopping-Mouse	<i>Notomys mitchellii</i>						X	X	Resident
Bolam's Mouse	<i>Pseudomys bolami</i>		X	X			X		Resident
Sandy Inland Mouse	<i>Pseudomys hermannsburgensis</i>		X	X					Resident
<b>INTRODUCED MAMMALS</b>									
European Cattle	<i>Bos taurus</i>	Int.		X				X	Regular visitor
Camel	<i>Camelus dromedarius</i>	Int.			X		X	X	Regular visitor

MAMMALS		CS	ALA	N	EPBC	GNP 1990	BB 2011	BCE 2018	Expected status in area
Dog, Dingo	<i>Canis lupus</i>	Int.	X		X		X	X	Resident
Goat	<i>Capra hircus</i>	Int.		X	X		X	X	Resident
Horse	<i>Equus caballus</i>	Int.			X				Vagrant
Cat	<i>Felis catus</i>	Int.		X	X		X	X	Resident
House Mouse	<i>Mus musculus</i>	Int.	X	X	X		X		Resident
Rabbit	<i>Oryctolagus cuniculus</i>	Int.		X	X		X	X	Resident
Red Fox	<i>Vulpes vulpes</i>	Int.			X		X	X	Resident

<b>CS INVERTEBRATES</b>	<b>CS</b>	<b>BB 2011</b>
<b>BUPRESTIDAE</b>		
jewel beetle <i>Castiarina acuticeps</i>	SP	X
jewel beetle <i>Castiarina aeraticollis</i>	SP	X
jewel beetle <i>Castiarina bakeri</i>	SP	X
jewel beetle <i>Castiarina pallidiventris</i>	SP	X
jewel beetle <i>Castiarina recta</i>	SP	X
jewel beetle <i>Castiarina rufolimbata</i>	SP	X
jewel beetle <i>Castiarina subacuticeps</i>	SP	X
jewel beetle <i>Chalcophorotaenia martinii</i>	SP	X
jewel beetle <i>Diadoxus regius</i>	SP	X
jewel beetle <i>Pseudotaenia gigas</i>	SP	X
jewel beetle <i>Temognatha pascoei</i>	SP	X

SP = special protection under the WA Biodiversity Conservation Act.

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Appendix 2. Annotated species list from site inspection, 16-17 January 2019.

1. *Diplodactylus conspicillatus*. One dead in drill pit in north.
  2. *Strophurus* sp.. Several dead in drill pit in north. Very spiny tail with spines apparently not in clear lines.
  3. *Lucasium* sp.. One dead in drill pit in north.
  4. *Ctenophorus scutulatus*. Seen regularly in mixed shrubland on loam and gravelly loam flats.
  5. *Ctenophorus reticulatus*. One seen in south-east.
  6. *Ctenophorus cristatus*. One seen in woodland in east.
  7. *Varanus gouldii*. Young animal (year 2?) on track in east, and a slightly larger animal seen in south-east. Also one record in north-east.
  8. *Ctenotus mimetes*. One seen in north-west.
  9. *Ctenotus leonhardi*. Hatchling seen in south.
  10. *Eremiascincus richardsonii*. Adult and neonate at base of dead tree; seen head-torching at breakaway near camp. Also one dead animal in pit in south of area.
  11. *Liopholis inornata*. Burrow systems probably this species throughout. Several dead specimens in drill-pits.
  12. *Menetia greyii*. Several seen active.
  13. *Morethia ?adelaidensis*. One seen in shrubland in north-west. Appeared strongly-marked but could be *M. obscura*.
  14. *Anilius hamatus*. One removed from pit near drilling site in south.
  15. *Simoselaps bertholdi*. Two in pit in south; one dead and one rescued.
- 
1. Emu. Dropping near camp wastewater treatment ponds. Droppings also found around Sandalwood in north-west. Fresh tracks across soft ground in south. Old nest (scattered eggshell) in south-west.
  2. Malleefowl. Reported near camp and three fairly old mounds found in east. All are quite small (3, 3.5m and 1.5-2m across) with clear central crater but no plant material in crater. One had possible scratch marks from Malleefowl in clay and raised soil still a bit loose, so maybe only 5-10 years since last used. The very small one also looked like it had been excavated within the last few years and uncertain if it had ever been filled with vegetation. Perhaps an experimental mound started by a young animal? One flushed from eucalypts and scrub in south at about 51J 439316E, 6663325N.
  3. Australasian Grebe. Four adults and a juvenile on treatment ponds.
  4. Grey Teal. Flock of 45 on treatment ponds.
  5. Pink-eared Duck. One on treatment ponds.
  6. Eurasian Coot. One on treatment ponds (17/01; had not been present on 14/01).
  7. Australian Hobby. One seen in north.
  8. Nankeen Kestrel. One over east.
  9. Crested Pigeon. One in camp.
  10. Australian Ringneck. Several around camp regularly and occasionally in woodlands.
  11. Mulga Parrot. Pair in north-west and pair in north-east.
  12. Rainbow Bee-eater. Seen occasionally; group of about five in east might be a pre-migratory gathering. Similar group seen in south.
  13. Splendid Fairy-wren. Parties throughout and coloured males present.
  14. Redthroat. Calling from thickets and few seen throughout.
  15. Inland Thornbill. Few parties throughout.
  16. Chestnut-rumped Thornbill. Few parties throughout.
-

17. Yellow-rumped Thornbill. Party in north-east.
  18. Weebill. Common among eucalypts.
  19. Singing Honeyeater. Small numbers throughout.
  20. Yellow-throated Miner. Parties throughout.
  21. Spiny-cheeked Honeyeater. Seen and heard throughout.
  22. White-eared Honeyeater. Several seen and heard in tall eucalypts in south.
  23. Brown-headed Honeyeater. Party in tall shrubs and eucalypts in south.
  24. Mistletoebird. Several seen and heard in south.
  25. Red-capped Robin. At least two pairs in south.
  26. Rufous Whistler. Occasional birds seen and heard throughout.
  27. Grey Shrike-thrush. Calling in dense thickets and one sheltering from heat in small cave.
  28. Crested Bellbird. Calling throughout.
  29. Quail-thrush. Species not determined. Heard in north-west area.
  30. White-browed Babbler. Parties throughout.
  31. Willie Wagtail. One in north-west and one in south.
  32. White-tailed Fantail. One in south and one in north-east. Pale tail very prominent.
  33. White-backed Swallow. Seen occasionally.
  34. Welcome Swallow. Several over south.
  35. Magpie-lark. One in camp.
  36. Masked Woodswallow. Group of five over east and similar group seen in north-east; included juveniles.
  37. Black-faced Woodswallow. Several on powerlines near offices.
  38. Australian Raven. Small numbers throughout.
  39. Little Crow. Two in north-west area and also small group in north-east.
  40. Grey Currawong. Several in south-west area and one seen in north-west area. Juvenile seen in south-west.
  41. Pied Butcherbird. Adults and a juvenile in south-west. Juvenile also seen in north.
  42. Grey Butcherbird. Several seen and heard in south.
  43. Australian Magpie. Single bird seen in north.
  44. Australian Pipit. Few along roads.
- 
1. Echidna. Diggings throughout and scats in small caves in breakaway.
  2. Boodie. Old warrens widespread (56 recorded) especially in areas where calcrete present. Extinct on the mainland (except for translocated populations).
  3. Stick-nest Rat. Old nests in breakaway overhangs. Coordinates for a large nest in good condition: 51J 436877E, 6661282N. Uncertain if *Leporillus conditor* or *L. apicalis*. Both extinct on the mainland; *L. conditor* survives on one island and some translocated populations.
  4. Euro. Scats in breakaways.
  5. White-striped Bat *Austronomus australis*. Detected near camp and almost constant activity over settling ponds late into evenings.
  6. Gould's Wattled Bat *Chalinolobus gouldii*. Detected near camp and almost constant activity over settling ponds late into evenings.
  7. Chocolate Wattled Bat *Chalinolobus morio*. Occasional records at settling ponds in morning.
  8. Southern Forest Bat *Vespadelus regulus*. Almost constant activity through all nights over settling ponds. Active until 04:43.
-

9. Inland Freetail Bat *Ozimops planiceps*. Occasional records from settling ponds in early morning.
10. Long-eared Bat *Nyctophilus* sp. Probable; could not be identified to species.
11. Mitchell's Hopping-Mouse *Notomys ?mitchelli*. Burrows in old Boodie warrens.
12. Rabbit. Scats and diggings throughout.
13. Goat. Scats in breakaway caves.
14. Cow. Old scats and tracks seen at several locations.
15. Camel. Old scats in north-west.
16. Red Fox. Scats found at a few locations.
17. Feral Cat. Tracks at one location in south.
18. Dingo. Fresh tracks in north.

## Appendix 3. Locations and descriptions of fauna records.

Eastings	Northings	Date_Time	Notes
436804	6660228	17/01/19	Bat detector
439104	6669114	17/01/2019 8:06	Boodie warren
439029	6669044	17/01/2019 8:08	Boodie warren
438849	6668661	17/01/2019 8:19	Boodie warren
438815	6668391	17/01/2019 8:27	Boodie warren
438844	6668352	17/01/2019 8:28	Boodie warren
439328	6667937	17/01/2019 8:46	Boodie warren
439140	6667656	17/01/2019 9:15	Boodie warren
437549	6667634	17/01/2019 10:00	Boodie warren
437644	6669186	17/01/2019 11:15	Boodie warren
437981	6669010	17/01/2019 11:22	Boodie warren
438056	6668915	17/01/2019 11:25	Boodie warren
438317	6668613	17/01/2019 11:32	Boodie warren
438694	6668529	17/01/2019 11:40	Boodie warren and Fox earth
439309	6667842	17/01/2019 12:07	Boodie warren
439979	6668338	17/01/2019 6:40	Boodie warren
440424	6669052	17/01/2019 7:13	Boodie warren
439096	6667982	17/01/2019 11:59	Boodie warren
436411	6662253	16/01/2019 15:49	Boodie warren
439390	6663152	16/01/2019 8:07	Boodie warren
441348	6664218	16/01/2019 10:03	Boodie warren
441644	6664165	16/01/2019 10:11	Boodie warren
441204	6663577	16/01/2019 10:48	Boodie warren
441007	6663719	16/01/2019 10:56	Boodie warren
436700	6662452	16/01/2019 15:36	Boodie warren
436594	6662388	16/01/2019 15:39	Boodie warren
434185	6667767	15/01/2019 7:56	Boodie warren
436511	6667576	15/01/2019 9:09	Boodie warren
439256	6666797	15/01/2019 17:12	Boodie warren
436032	6668264	15/01/2019 9:51	Boodie warren
436276	6668258	15/01/2019 10:08	Boodie warren
436339	6668192	15/01/2019 10:11	Boodie warren
436770	6667779	15/01/2019 10:32	Boodie warren
440649	6666567	15/01/2019 12:19	Boodie warren
440798	6666729	15/01/2019 12:24	Boodie warren
438469	6666267	15/01/2019 15:59	Boodie warren
439220	6666812	15/01/2019 17:11	Boodie warren
440049	6662891	16/01/2019 7:01	Boodie warren
439994	6663397	16/01/2019 7:19	Boodie warren
439662	6663458	16/01/2019 7:28	Boodie warren
441488	6663746	16/01/2019 10:36	Boodie warren
436514	6662206	16/01/2019 15:55	Boodie warren
436480	6662062	16/01/2019 16:27	Boodie warren

Eastings	Northings	Date_Time	Notes
440438	6668940	17/01/2019 7:10	Boodie warren
440382	6669304	17/01/2019 7:19	Boodie warren
438928	6668138	17/01/2019 11:55	Boodie warren
439149	6667936	17/01/2019 12:00	Boodie warren
439184	6667889	17/01/2019 12:02	Boodie warren
439668	6669650	17/01/2019 7:43	Boodie warren
439432	6669422	17/01/2019 7:54	Boodie warren
439022	6669090	17/01/2019 8:07	Boodie warren
438795	6668639	17/01/2019 8:18	Boodie warren
438806	6668482	17/01/2019 8:22	Boodie warren
438062	6667666	17/01/2019 9:43	Boodie warren
437551	6669093	17/01/2019 11:12	Boodie warren
438788	6668239	17/01/2019 11:51	Boodie warren
439571	6668030	17/01/2019 6:22	<i>Egernia depressa</i> colony
440300	6666651	14/01/2019 11:59	Malleefowl mound
437128	6662908	14/01/2019 11:29	Malleefowl mound
439316	6663325	16/01/2019 7:46	Malleefowl
440713	6664119	16/01/2019 11:15	Malleefowl mound and Boodie warren
436512	6662297	16/01/2019 15:43	Malleefowl mound
440377	6666617	15/01/2019 11:50	Malleefowl mound
440296	6666565	15/01/2019 11:57	Malleefowl mound
439080	6667196	15/01/2019 16:47	Malleefowl mound
441185	6664298	16/01/2019 9:55	Malleefowl Mound
436877	6661282	14/01/2019 14:49	old Stick-nest Rat nest in cave
434960	6667699	15/01/2019 8:30	Land snails

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**Appendix 4. Categories used for the assessment of conservation significance.**

IUCN categories (based on review by Mace and Stuart 1994) as used for the Environment Protection and Biodiversity Conservation Act 1999 and the Western Australian Biodiversity Conservation Act 2018.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern.	Taxa that are not Threatened.

**Schedules used in the WA Biodiversity Conservation Act 2018**

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

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WA Department of Biodiversity, Conservation and Attractions Priority species (species not listed under the Biodiversity Conservation Act 2018, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands. Taxa in need of monitoring.
Priority 4. (P4)	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

# **ENVIRONMENTAL ASSESSMENT:**

## **PROPOSED EXPANSION OF SAFARI AND DEEP SOUTH MINES**

### **SARACEN GOLD MINES**



**Alexander Holm & Associates**  
**Natural Resource Management Services**

**January 2011**





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# Attachments

- Attachment 1: Results of database searches by Department of Environment and Conservation for rare and priority species
- Attachment 2: Australian Government Department of Environment Heritage and Arts Protected matters search tool output
- Attachment 3: List of plant species found at each sampling site during field survey in October and November, 2010
- Attachment 4: Locations of inventory sites and site information.

# SUMMARY

This report for Saracen Gold Mines Pty Ltd covers environmental assessments to support clearing applications of three areas associated with expansion of Safari and Deep South mining pits:

Safari pit expansion (Safari)	500.0 ha
Deep South pit expansion (Deep South)	178.9 ha
Camp and administration site (Camp)	93.6 ha

Each survey area was traversed on-foot by three surveyors, during October 25 to November 2, 2010. The survey followed exceptional late winter/spring rainfalls which ensured ideal conditions for plant identification and collection. Thirty one inventory sites were assessed which provided systematic coverage of each area and encompassed slight variations in pattern within each land unit.

Safari clearing envelope falls entirely on Monk land system while Camp and Deep South are partially on Monk and Laverton land systems. Monk land system is characterised by extensive, level to gently inclined plains supporting mulga shrublands. Laverton land system is characterised by hills and ridges with relief up to 60m supporting low to mid height shrublands(Pringle, Van Vreeswyk & Gilligan, 1994).

Seven land units were identified in the survey.

Safari clearing envelope is predominately loamy plains with acacia shrublands with occasional ill-defined drainage tracts trending towards Lake Raeside in the south west.

Loamy plains occupy over 60% of the camp area and a clearly-defined drainage tract passes east-west along the southern boundary. Low basalt or metamorphic hills, rises and footslopes in the north occupy approximately 15% of the area while highly-erodible, sloping sand sheets occupy the remainder.

Loamy plains predominate in Deep South clearing envelope through which pass drainage tracts trending westerly although these are interrupted by previous mining and isolation bunds. Low basalt or metamorphic hills and footslopes occupy approximately 9% in the north east.

One hundred and ninety one flora species representing 41 families were found during field survey including numerous annuals. Six alien (weed) species were located during survey of which *Emex australis* is a declared plant under the Agriculture and Related Resources Protection Act 1976 within some agricultural areas but not within the north eastern Goldfields.

No listed rare or priority flora species were collected. On the other hand, *Arthropodium* sp. Goldfields (H. Pringle 2188), has previously been collected on one occasion and is likely to be considered to be a 'Priority' species. During this survey it was collected at one inventory site and was also collected on three sites in an adjoining survey. This species

has been lodged with the Department of Environment and Conservation for registration as a new species.

Drainage is via overland flow to drainage channels which flow south-westerly towards Lake Raeside, but do not appear to directly discharge to the lake. The existing Deep South mine intersects a drainage channel which has been diverted around the mine by bunds.

It is recommended that, in planning expansion of the mines, the proponent:

- 1. Avoids disturbance to rocky hills (land unit 1) and associated sloping sand sheets (land unit 5).**
- 2. Avoids disturbance to the known location of *Arthropodium* sp. Goldfields (H. Pringle 2188).**
- 3. As far as possible minimises disturbance to drainage tracts (land units 16a and b).**
- 4. Take measures to minimise the spread of weeds.**

# SCOPE OF WORKS

Alexander Holm & Associates were contracted by Saracen Gold Mines Pty Ltd (Saracen) to conduct an environmental assessment of three areas associated with expansion of Safari and Deep South mining pits:

Safari pit expansion (Safari)	500.0 ha
Deep South pit expansion (Deep South)	178.9 ha
Camp and administration site (Camp)	93.6 ha

The assessment is to:

- 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 within a local and regional context
- Provide an assessment of the proposal against clearing principles.

The scope of works is to comply with EPA objectives for protection of the environment specifically to “ensure that flora and vegetation surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered” and to “enable an assessment of impacts on the conservation values and status of the site in a regional and local context.” (Environmental Protection Authority, 2004).



# REGIONAL OVERVIEW

## Clearing envelopes

The proposed expansion of Deep South is within Edjudina pastoral lease while expansion of Safari and the camp area is partly within Edjudina and partly within Mt Weld pastoral leases. The survey areas are adjacent to the Mt Celia road between Lake Carey and Lake Raeside approximately 100 km south of Laverton (Figure 1).

## Climate

The climate is arid to semi-arid with an average annual rainfall of approximately 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 92.6mm (in January) at Laverton. (Data from [www.bom.gov.au](http://www.bom.gov.au)).

The average annual potential pan evaporation rate at Laverton is approximately 3200mm<sup>1</sup>.

Winds are mostly light easterlies.

## 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 (Gentili, 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, 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

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<sup>1</sup> [http://www.bom.gov.au/jsp/ncc/climate\\_averages/evaporation/index.jsp](http://www.bom.gov.au/jsp/ncc/climate_averages/evaporation/index.jsp).



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.

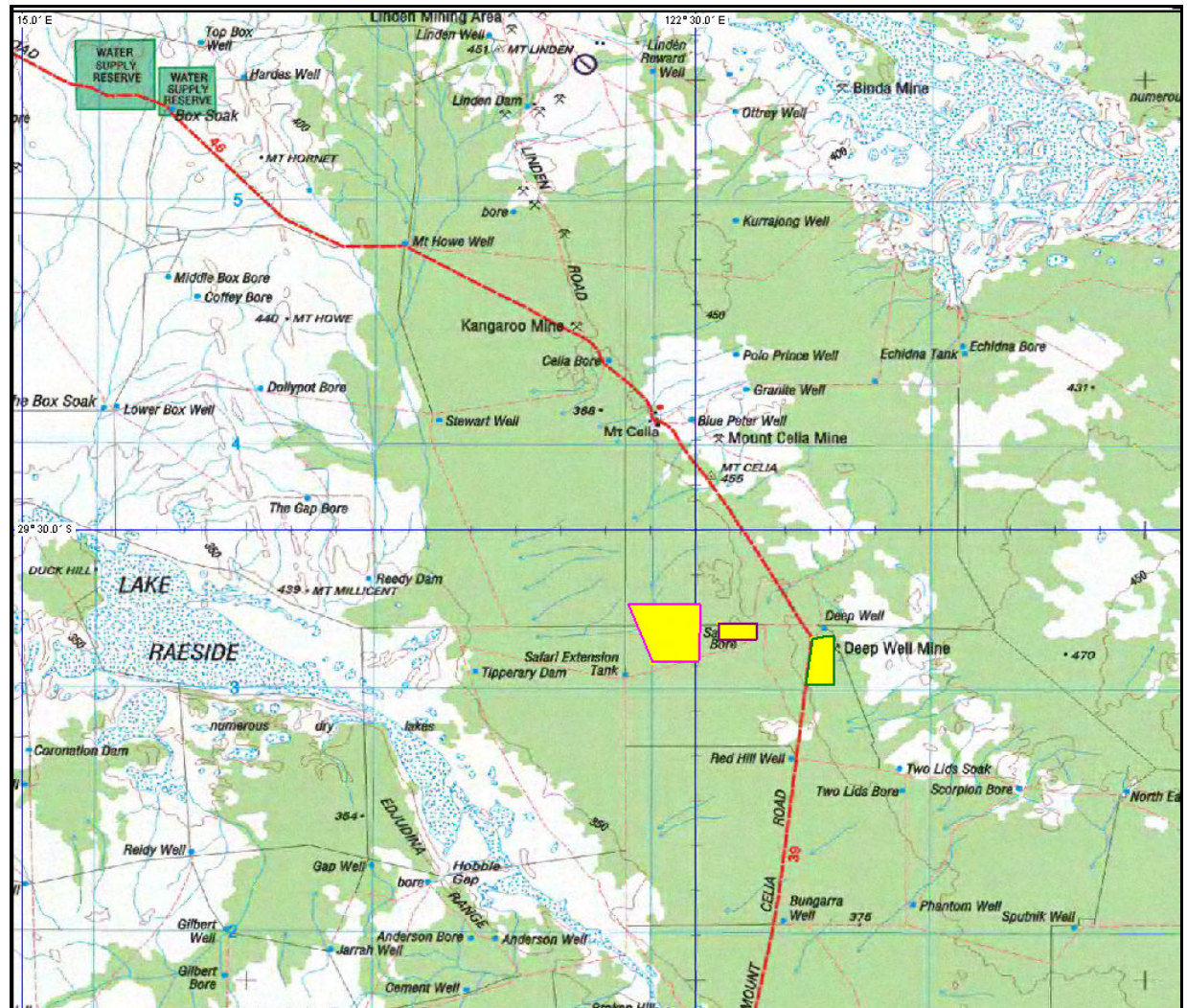


Figure 1: Proposed clearing envelopes (yellow) in relation to nearby salt lakes.

## 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, 1976). 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 pauper* (black oak) and *Eucalyptus* species 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.

Vegetation associations most common in the project area include Beard Vegetation Association 18 (Low woodland: mulga.), 109 (Hummock grassland, shrub steppe) and 400 (Succulent steppe with open low woodland; mulga over bluebush) (Table 1).

**Table 1: Vegetation associations (Beard, 1976) in project area in comparison with South Laverton area (SLA), total area in WA and area within conservation reserves**

Veg Assn	Description	SLA Area km <sup>2</sup>	Reserve priority	Western Australia		
				Area km <sup>2</sup>	Within reserve km <sup>2</sup>	%
18	Low woodland; mulga	12678	M*	199085	10971	5.5
109	Hummock grasslands, shrub steppe; <i>Eucalyptus youngiana</i> over hard spinifex	2396	L	9565	1029	10.8
389	Succulent steppe with open low woodland; mulga over salt bush	2344	M	6465	230	3.6
400	Succulent steppe with open low woodland; mulga over bluebush	1882	H	1924	0	0

L\*: Low; M: Medium; H: High priority for reservation



# ASSESSMENT METHODOLOGY

## Assessment personnel

The work was led by Dr Alexander Holm (Alexander Holm & Associates) who prepared the report and assisted other members on field survey. Alec Holm is an ecologist with extensive experience in arid environments and Goldfield regions and an accredited environmental consultant with the Environmental Consultants Association of Western Australia.

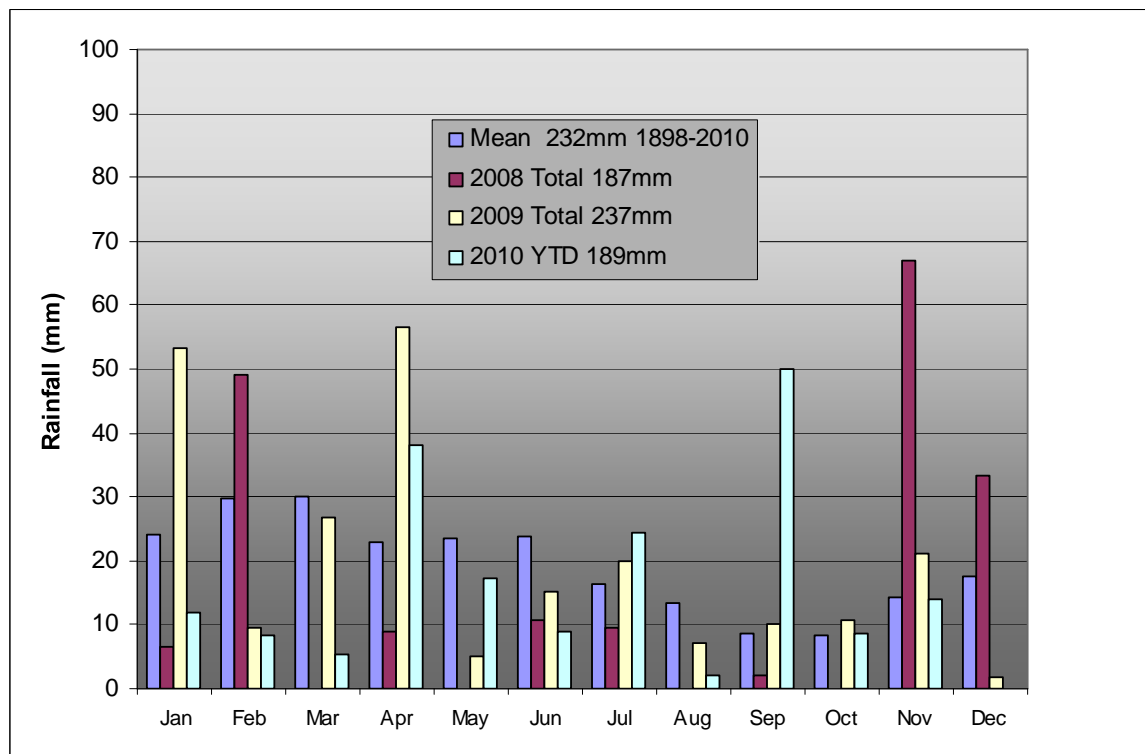
Mr Andrew Mitchell was the lead botanist. Andrew Mitchell was assisting botanist to Western Australian Department of Agriculture's rangeland surveys, author of "Arid Shrubland Plants of Western Australia" (Mitchell & Wilcox, 1994) and recently retired botanist with AQIS (Australian Quarantine and Inspection Service).

Mr Alan Payne defined and mapped land units. Mr Payne is a land resource specialist with over forty years experience in pastoral regions of Western Australia and is author or co-author of land resource surveys throughout pastoral areas of Western Australia (Payne, Curry & Spencer, 1987; Payne, Mitchell & Hennig, 1998; Payne, Mitchell & Holman, 1983; Payne *et al.*, 1998)

## Timing and seasonal conditions

The proposed mine expansion area was surveyed during October 23 to November 2, 2010.

Average to well-above average rains from April 2010 including widespread rain in late August early September (Figure 2) ensured an abundance of annual species and flowering/seeding of perennial species.



**Figure 2: Laverton monthly rainfall 2008 – 2010**

## Declared flora and fauna

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 (DEC data base searches dated September 10 and October 20, 2010; Attachment 1).

The Department of Environment and Conservation’s “NatureMap”<sup>2</sup> was interrogated for records of all collected flora and fauna within a 40 km radius of the study area.

Declared flora and fauna listed on Commonwealth Department of Environment and Heritage database of threatened species were identified for the study area using the protected matters search tool<sup>3</sup> (Attachment 2).

## 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. 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. (Attachment 2).

Other threatened ecosystems in the south-east of Eastern Murchison (MUR 1) biogeographic subregion identified during “A Biodiversity Audit of Western Australia’s 53 Biogeographical Subregions in 2002”, are listed in (Cowan, 2001).

<sup>2</sup><http://naturemap.dec.wa.gov.au/default.aspx>

<sup>3</sup><http://www.environment.gov.au/erin/ert/epbc/>

## Land systems, land units and vegetation associations

Land systems and land units were derived from a land resource survey of north eastern Goldfields (Pringle, Van Vreeswyk & Gilligan, 1994).

Vegetation communities were established with reference to those in Pringle et al. (1994) where they are listed as 'site types'.

Land units were identified by stereoscopic examination of 1:25,000 scale colour photography. Boundaries were checked in the field, transferred to geo-referenced ortho-photo maps provided by Landgate<sup>4</sup> and captured digitally. Vegetation communities were visually associated with each land unit.

## 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. The lead botanist inspected specimens of these species in the WA Herbarium prior to field survey and these species were specifically targeted during survey.

Inventory sites were selected within each clearing envelope, 1) to provide systematic coverage of the area, and 2) to encompass slight variations in pattern within each land unit. Each inventory site was located by GPS and the following information recorded:

- Digital photographs.
- All flora species within 40 – 50 m of central location were inventoried and specimens collected where identity was uncertain or unknown.
- Vegetation condition and soil erosion were visually estimated using standard rating scales as used for rangeland surveys and described by Pringle *et al.* (2004).
- Vegetation community and land unit descriptions using terminology from Pringle *et al.* (2004)
- Vegetation cover, landform, slope, soil surface and surface water flow characteristics (Anon, 2009).

Details of site locations and recorded information are presented in Appendix 3.

Each clearing envelope was traversed on-foot by three operators to:

- Confirm land unit boundaries.
- Locate species not previously recorded at inventory sites.
- Search for evidence of mallee fowl.

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<sup>4</sup> <http://www.landgate.wa.gov.au/corporate.nsf/web/Imagery>



# ENVIRONMENTAL ANALYSIS

## Conservation estate

All three clearing envelopes have been mapped by Beard (1976) as Vegetation Association 18 (Low woodland; mulga.).

Vegetation Association 18 occupies approximately 200,000 km<sup>2</sup> in Western Australia and is extensive in the north east Goldfields. This association is well represented in conservation reserves and therefore has low priority for further reservation (Table 1).

There are no conservation reserves within 50 km of the clearing envelope (Appendix 1).

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.

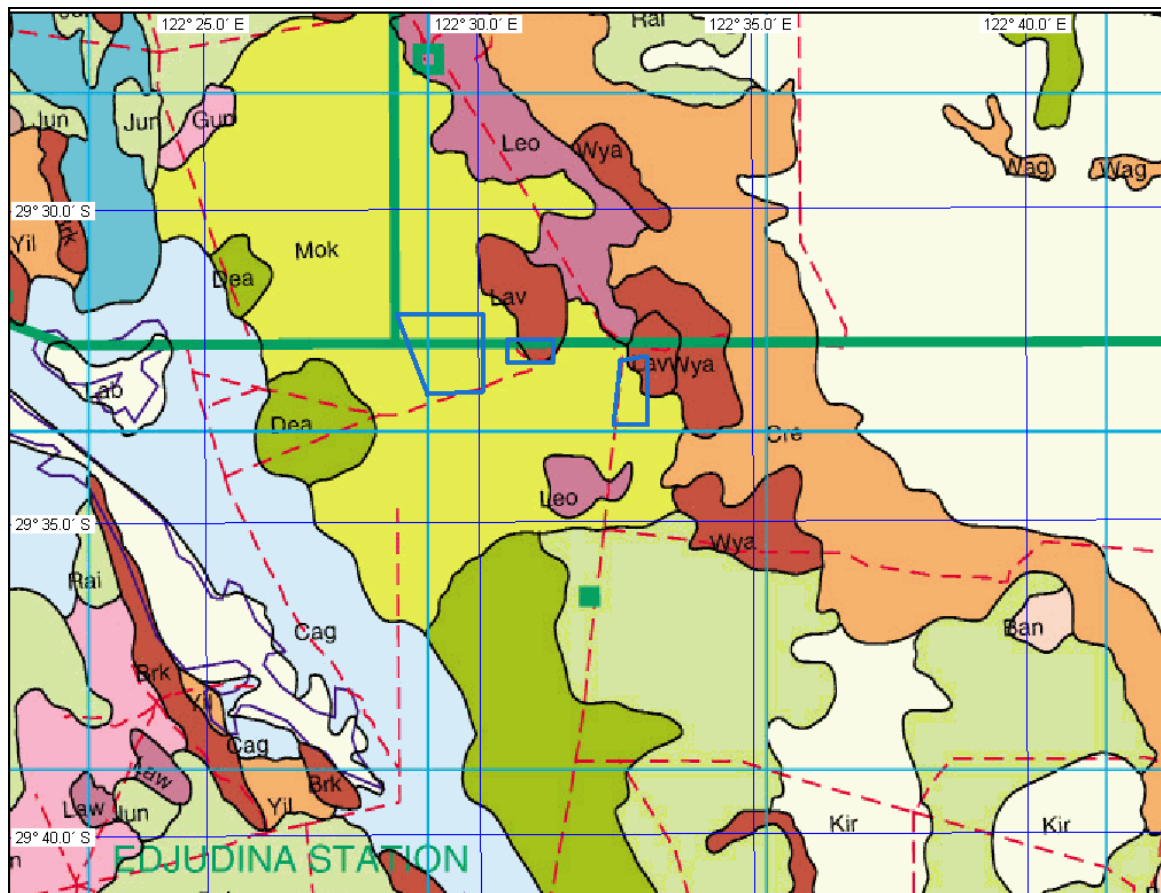
## Land systems and landforms

Safari clearing envelope falls entirely on Monk (Mon) land system while Camp and Deep South are partially on Monk and Laverton (Lav) land systems (Figure 3)

Monk land system is characterised by extensive, level to gently inclined plains subject to sheet flow with generally sparse sub-parallel un-incised drainage zones, sandy tracts and banks in lower areas.

Laverton land system is characterised by greenstone hills and ridges, sparse narrow drainage tracts with shallow channels; relief up to 60m (Pringle, Van Vreeswyk & Gilligan, 1994).





**Figure 3: Land systems in relation to Safari, Camp and Deep South clearing envelopes (in blue from west to east) see text for land system key. Pastoral lease boundaries shown in green.**



## Land units soil and vegetation types



### *Land units*

Seven land units were identified in the survey and associated vegetation and soil types described (Table 2).



Maps of land units are overlain on ortho-photo maps derived from aerial photography (inserted)



**Table 2: Land unit descriptions, soil type, vulnerability to erosion and associated vegetation communities.**

Land unit	Land form and soil type	Vegetation community
<b>1. Low hills on basalt or metamorphic rocks</b> 	<p>Hills with relief up to 30m, rounded crests and moderately inclined (slopes 20 – 30%) upper footslopes; very abundant (&gt;90%) surface mantles of angular basalt pebbles and rocks and rock outcrop; pockets of very shallow loamy soils.</p> <p>Run-off source zones, very low vulnerability to erosion.</p>	<p>Very scattered to scattered (PFC* 5 – 15%) mixed low (&lt;1m) and mid height (1 – 2m) shrublands dominated by <i>Ptilotus obovatus</i>, <i>Senna artemisioides</i> ssp. <i>petiolaris</i> and <i>Maireana georgei</i> or dominated by <i>Ptilotus obovatus</i>, <i>Philotheca brucei</i> ssp. <i>brucei</i>, <i>Eremophila latrobei</i> and <i>Sida calyxhymenia</i>, isolated <i>Acacia</i> spp. (GHAS)**.</p>
<b>2. Lower footslopes on basalt or metamorphic rocks</b> 	<p>Gentle footslopes (slopes about 2 – 5%) below unit 1, common to very abundant (20 - &gt;90%) surface mantles of basalt and metamorphic pebbles and rocks with occasional quartz and calcareous pebbles, shallow calcareous loamy red earth soils.</p> <p>Transfer zones receiving sheet flow from unit 1 and shedding to lower surfaces; very low vulnerability to erosion.</p>	<p>Scattered (PFC 10 - 15%) mixed height (0.3 – 5m) shrublands dominated by <i>Acacia sibirica</i>, <i>A. caesaneura</i>, <i>Ptilotus obovatus</i>, <i>Senna artemisioides</i> ssp. <i>petiolaris</i> and <i>Dodonaea lobulata</i> with numerous other low shrubs and occasional <i>Casuarina pauper</i> trees (GHAS) or dominated by <i>Ptilotus obovatus</i>, <i>Dodonaea lobulata</i>, <i>Maireana georgei</i> and <i>M. triptera</i> (USBS).</p>

Land unit	Land form and soil type	Vegetation community
<p><b>3. Low rises on metamorphic rocks</b></p> 	<p>Rounded rises with gentle side slopes 3 to 5% and relief up to about 8m. Very abundant (&gt;90%) mantles of platy and tabular metamorphic pebbles and stones and some outcrop of parent material; very shallow loamy soils.</p> <p>Run-off areas with very low vulnerability to erosion.</p>	<p>Very scattered to scattered (PFC 5 – 15%) tall shrublands 4 – 6m dominated by <i>Acacia caesaneura</i>, <i>A. quadrimarginea</i>, <i>A. ramulosa</i> with undershrubs <i>Ptilotus obovatus</i>, <i>Eremophila glandulifera</i>, <i>Scaevola spinescens</i> and <i>Maireana</i> spp.(GHAS) or scattered (PFC about 20%) mixed height (0.3 – 3m) generally &gt;20%) mixed height (0.3 – 3m) shrublands dominated by <i>Dodonaea lobulata</i>, <i>Acacia hemi</i> and <i>Ptilotus obovatus</i> with occasional trees of <i>Acacia incurvaneura</i> (SIMS).</p>
<p><b>5. Sloping sand sheets</b></p> 	<p>Sand sheets adjacent to unit 1, sloping 2 - &gt;5%, red sand soils with loose hummocky and mounded surfaces.</p> <p>Currently fairly stable but with high to very high vulnerability to erosion if disturbed or vegetation cover depleted.</p>	<p>Moderately close (PFC 20 – 25%) tall shrublands/woodlands up to about 12m with numerous co-dominants including <i>Acacia caesaneura</i>, <i>Bursaria occidentalis</i>, <i>Dodonaea rigida</i>, <i>Acacia ligulata</i>, <i>Senna artemisioides</i> ssp. <i>petiolaris</i> and <i>Ptilotus obovatus</i>; occasional <i>Eucalyptus youngiana</i>. (SACS).</p>



Land unit	Land form and soil type	Vegetation community
<b>7a. Loamy plains with acacia shrublands</b> 	<p>Near level (slopes mostly &lt;1%) sandy surfaced plains, sandy loam red earth soils.</p> <p>Subject to occasional overland sheet flow, low vulnerability to erosion.</p>	<p>Very scattered to moderately close (PFC 10 – 50%, occasionally more where vegetation is clumped or groved) tall shrublands to about 8m dominated by <i>Acacia caesaneura</i> and/or <i>A. incurvaneura</i> with numerous undershrubs commonly <i>Acacia ligulata</i>, <i>A. tetragonophylla</i>, <i>A. burkittii</i>, <i>Ptilotus obovatus</i>, <i>Senna artemisioides</i> ssp. <i>petiolaris</i>, <i>Rhagodia eremaea</i>, <i>Scaevola spinescens</i>, <i>Solanum lasiophyllum</i>, <i>Eremophila glandulifera</i> and other <i>Eremophila</i> spp.</p> <p>(MUWA, occasionally HPMS).</p>
<b>8. Hardpan plains</b> 	<p>Near level (slopes usually &lt;1%) plains over hardpan with nil or few to very abundant (5 - &gt;90%) surface mantles of quartz, ironstone and other gravels and pebbles; shallow red earth loam soils on hardpan.</p> <p>Subject to occasional sheet water flow, low vulnerability to water erosion.</p>	<p>Very scattered to moderately close (PFC 5 – 25%) tall (4 – 9m) shrublands dominated by <i>Acacia incurvaneura</i> and <i>A. caesaneura</i>, also <i>A. tetragonophylla</i>, <i>A. ramulosa</i> var. <i>ramulosa</i> and <i>A. burkittii</i>; common low shrubs are <i>Ptilotus obovatus</i>, <i>P. schwartzii</i>, <i>Eremophila metallicorum</i>, <i>E. glandulifera</i>, <i>Maireana planifolia</i>, <i>Senna artemisioides</i> ssp. <i>petiolaris</i>, <i>Rhagodia eremaea</i>, <i>Spartothamnella teucrifolia</i> and <i>Solanum lasiophyllum</i></p> <p>(HPMS).</p>

Land unit	Land form and soil type	Vegetation community
<b>16a. Drainage tracts – unchannelled</b> 	<p>Ill defined, unchannelled drainage tracts up to 180m wide but usually much less, subject to occasional more concentrated sheet flow than surrounding plains; shallow red earth soils on hardpan or deep red earth soils.</p> <p>Generally low vulnerability to erosion.</p>	<p>Moderately close to closed (PFC 30 – 80%) tall shrublands or woodlands to 10m dominated by <i>Acacia incurvaneura</i> and/or <i>A. caesaneura</i> with poorly developed or no lower layers; other isolated common shrubs are <i>Grevillea stenobotrya</i>, <i>Acacia tetragonophylla</i>, <i>Eremophila gilesii</i> ssp. <i>variabilis</i>, <i>E. glandulifera</i>, <i>Rhagodia eremaea</i>, <i>Ptilotus obovatus</i> and <i>Maireana planifolia</i> (DRMS). Occasionally less dense acacias (PFC 15 – 20%) (HPMS).</p>
<b>16b. Drainage tracts with creeklines</b> 	<p>Active drainage tracts up to 150m wide with central channels and gutters 5 – 15m wide and up to 1m deep, bedloads of sand and gravel; uneroded or with minor (occasionally moderate) erosion with sharp incision and sheeting, sand and gravel splays and hardpan exposures. Loamy or clayey red earth soils with crusted, generally stable surfaces away from main channels.</p> <p>Currently moderately stable but with moderate to high vulnerability to water erosion if disturbed.</p>	<p>Moderately close to closed (PFC 20 – 80%) tall shrublands (6 – 10m) of <i>Acacia incurvaneura</i>, <i>A. tetragonophylla</i>, <i>A. burkittii</i> with numerous mid and low shrubs <i>Eremophila metallicorum</i>, <i>Senna cardiosperma</i>, <i>Rhagodia eremaea</i> and <i>Enchylaena tomentosa</i> (DRMS)</p> <p>Rarely moderately close (PFC about 30%) mid height shrublands (1 – 2m) dominated by <i>Acacia burkittii</i> with undershrubs such as <i>Ptilotus obovatus</i>, <i>Maireana pyramidata</i>, <i>Rhagodia eremaea</i> and <i>Senna</i> spp.. (DRAS).</p>

\* (PFC): Projected foliar cover

\*\* (SIMS etc) vegetation types (Pringle, Van Vreeswyk & Gilligan, 1994).

Safari clearing envelope is predominately loamy plains with acacia shrublands (land unit 7a) with occasional ill-defined drainage tracts (land unit 16a) trending towards Lake Raeside in the south west (Table 3).

Loamy plains (land unit 7a) occupy over 60% of the camp area and a clearly-defined drainage tract (land unit 16a) passes east-west along the southern boundary. Low basalt or metamorphic hills (land unit 1) rises (land unit 3) and footslopes (land unit 2) in the north occupy approximately 15% of the area while highly-erodible, sloping sand sheets (land unit 5) occupy the remainder (Table 3).

Loamy plains (land unit 7a) predominate in Deep South clearing envelope through which pass drainage tracts trending westerly (land units 16a and 16b) although these are interrupted by previous mining and isolation bunds. Low basalt or metamorphic hills (land unit 1) and footslopes (land unit 2) occupy approximately 9% in the north east (Table 3).

**Table 3: Area of each land unit within three clearing envelopes.**

Land unit	Description	Safari		Camp		Deep South	
		ha	%	ha	%	ha	%
1	Low hills on basalt or metamorphic rocks			8.5	9.1	0.8	0.5
2	Lower footslopes on basalt or metamorphic rocks			4.0	4.3	14.7	8.2
3.	Low rises on metamorphic rocks			0.3	0.4		
5	Sloping sand sheets			16.3	17.4		
7a.	Loamy plains with acacia shrublands	341.4	68.3	57.7	61.7	105.0	58.7
16a.	Drainage tracts – unchannelled	13.5	2.7	4.5	4.8	15.6	8.7
16b	Drainage tracts					2.6	1.4
	Mining disturbance	145.1	29.0	2.2	2.3	40.2	22.5
Total		500.0	100.0	93.5	100.0	178.9	100.0

## ***Vegetation communities***

Vegetation communities are predominately 1) broad expanses of ‘mulga’ shrublands with scattered eucalypts associated with sandy plains and occasional drainage lines (e.g. HPMS and MUWA) and 2) restricted low to mid-height shrublands associated with low hills and rises (e.g. USBS and GHAS) Table 4.

**Table 4: Vegetation communities, associated land units and vulnerability to disturbance**

<b>Vegetation community*</b>	<b>Description</b>	<b>Land unit</b>	<b>Vulnerable</b>
DRAS	Drainage tract acacia shrublands (S)*	16b	
DRMS	Drainage tract mulga shrublands (P)	16a, 16b	
GHAS	Greenstone hill acacia shrublands (P)	1	
HPMS	Hardpan plain mulga shrublands (P)	7a, 8, 16a	
MUWA	Mulga wanderrie grassy shrublands (P)	7a	
SACS	Sandplain acacia shrublands (P)	5	
SIMS	Stony ironstone mulga shrublands (P)	3	Yes (C)
USBS	Upland small bluebush species shrublands (P)	2	Yes (C)

\*(S)(Payne *et al.*, 1998); (P)(Pringle, Van Vreeswyk & Gilligan, 1994); (C)(Cowan, 2001)

## Vegetation and soil condition

The three clearing envelopes are within pastoral leases and have been grazed by livestock and feral animals. Tracks, stock fences and grid lines cross the survey areas.

Vegetation is mostly in excellent (score 1) to fair (score 3) condition (Table 5).

Soil erosion (rilling and micro-terracing) is common in land unit 16b (Drainage tracts with creeklines). Elsewhere there is no erosion or very minor erosion (land unit 16a: Drainage tracts –un-channelled)(Table 5).

**Table 5: Vegetation and soil surface condition ratings for each land unit with outliers in parenthesis**

Land unit	Perennial cover (%)	Vegetation condition @	Erosion score*	Erosion type**	Slope (%)
1	5-15	1-2	0		5-20
2	10-15	2 (3)	0		2.5-4 (1.5)
3	20	2	0		5
5	20-25	1-2	0		3-5
7a	15-50 (10-80)	2-3 (1-4)	0		<0.5- >1 (1.5)
8	15	3	0		<1.0
16a	30-100	2 (3)	0 (1)	m	0 -1
16b	30	2	1	m	1

@ 1: Excellent – 5 totally degraded

\* 0 nil – 5 severe

\*\* m: microterracing/sheeting.

## 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).

There are no nationally significant wetlands in the area (Attachment 2). Lake Raeside, approximately 8 km to the south west, is a major wet land in the area, with local significance.

### ***Ecosystems at risk***

Cowan, (2001) considers SIMS and USBS vegetation associations to be ‘ecosystems at risk’ to disturbance (Table 4).



# Flora

## Species found on site

One hundred and ninety one flora species representing 41 families were found during field survey including numerous annuals (Table 6). Four taxa were only identified to genera level and several taxa have previously been lodged in the Western Australian herbarium but remain undescribed.

A list of species within each family found at each sampling site is presented in Attachment 3. .

## Declared species

Six alien (weed) species were located during survey:

*Acetosa vesicaria*

*Asphodelus fistulosus*

*Emex australis*

*Erodium cicutarium*

*Lysimachia arvensis*

*Sonchus oleraceus*.

Of these, *Emex australis* is a declared plant under the Agriculture and Related Resources Protection Act 1976 within some agricultural areas but not within the north eastern goldfields (Agricultural Protection Authority, 2009).

**Table 6: List of species found in within the three clearing envelopes on each land unit during field survey in October and November 2010.**

Family	Species	Land unit							
		1	2	3	5	7a	8	16a	16b
Aizoaceae	<i>Tetragonia eremaea</i>	y	y			y		y	y
Amaranthaceae	<i>Ptilotus aervoides</i>		y	y		y		y	y
Amaranthaceae	<i>Ptilotus exaltatus</i> var <i>villosus</i>	y	y	y		y			y
Amaranthaceae	<i>Ptilotus gaudichaudii</i> var <i>gaudichaudii</i>		y			y	y	y	
Amaranthaceae	<i>Ptilotus helipteroides</i>		y	y		y			
Amaranthaceae	<i>Ptilotus obovatus</i>	y	y	y	y	y	y	y	y
Amaranthaceae	<i>Ptilotus polystachyus</i>				y	y	y	y	
Apocynaceae	<i>Marsdenia australis</i>	y	y	y	y	y	y	y	y
Apocynaceae	<i>Rhyncharrhena linearis</i>	y	y	y		y	y	y	
Asparagaceae	<i>Arthropodium</i> sp. Goldfields (H. Pringle 2188)							y	
Asphodelaceae	<i>Asphodelus fistulosus</i> (A)							y	y
Asteraceae	<i>Chrysocephalum puteale</i>					y			
Asteraceae	<i>Asteridea athrixoides</i>					y	y	y	y
Asteraceae	<i>Brachyscome cheilocarpa</i>					y	y	y	y
Asteraceae	<i>Calotis hispidula</i>			y		y	y	y	y
Asteraceae	<i>Centipeda thespidioides</i>							y	y
Asteraceae	<i>Cephalopterum drummondii</i>		y			y	y	y	
Asteraceae	<i>Erodiophyllum acanthocephalum</i>					y	y	y	
Asteraceae	<i>Gnephosis arachnoidea</i>					y		y	y
Asteraceae	<i>Helipterum craspedioides</i>	y							
Asteraceae	<i>Olearia muelleri</i>					y			
Asteraceae	<i>Podolepis capillaris</i>					y	y		y

Family	Species	Land unit							
		1	2	3	5	7a	8	16a	16b
Asteraceae	<i>Podolepis gracilis</i>					y			
Asteraceae	<i>Rhodanthe charsleyae</i>							y	y
Asteraceae	<i>Rhodanthe maryonii</i>					y	y	y	y
Asteraceae	<i>Schoenia cassinianna</i>					y		y	
Asteraceae	<i>Sonchus oleraceus</i> (A)							y	y
Asteraceae	<i>Vittadinia eremaea</i>	y				y			y
Asteraceae	<i>Waitzia acuminata</i> var <i>acuminata</i>			y		y	y	y	
Boraginaceae	<i>Trichodesma zeylanicum</i>	y			y				
Brassicaceae	<i>Lepidium oxytrichum</i>		y				y		y
Brassicaceae	<i>Stenopetalum lineare</i>	y		y		y		y	
Campanulaceae	<i>Isotoma petraea</i>	y							
Campanulaceae	<i>Wahlenbergia tumidifructa</i>						y	y	y
Casuarinaceae	<i>Casuarina obesa</i>				y				
Casuarinaceae	<i>Casuarina pauper</i>		y	y					y
Celastraceae	<i>Stackhousia muricata</i>		y			y			
Chenopodiaceae	<i>Atriplex bunburyana</i>					y			y
Chenopodiaceae	<i>Dysphania glomulifera</i> subsp. <i>eremaea</i>						y	y	y
Chenopodiaceae	<i>Dysphania saxatilis</i>	y							
Chenopodiaceae	<i>Enchylaena tomentosa</i>	y	y		y	y	y	y	y
Chenopodiaceae	<i>Eriochiton sclerolaenoides</i>	y	y						
Chenopodiaceae	<i>Maireana georgei</i> (form b)	y	y	y	y	y	y	y	y
Chenopodiaceae	<i>Maireana planifolia</i>		y			y	y	y	y
Chenopodiaceae	<i>Maireana pyramidata</i>					y	y		y
Chenopodiaceae	<i>Maireana scleroptera</i>					y			
Chenopodiaceae	<i>Maireana sedifolia</i>	y	y	y		y			
Chenopodiaceae	<i>Maireana tomentosa</i>								y
Chenopodiaceae	<i>Maireana trichoptera</i>	y	y	y		y			
Chenopodiaceae	<i>Maireana triptera</i>	y	y	y		y	y		y
Chenopodiaceae	<i>Maireana villosa</i>		y	y		y	y		
Chenopodiaceae	<i>Rhagodia eremaea</i>	y	y	y	y	y	y	y	y
Chenopodiaceae	<i>Rhagodia preissii</i>	y	y		y	y			
Chenopodiaceae	<i>Salsola australis</i>		y		y	y			
Chenopodiaceae	<i>Sclerolaena densiflora</i>	y	y			y			
Chenopodiaceae	<i>Sclerolaena diacantha</i>	y	y			y	y		y
Chenopodiaceae	<i>Sclerolaena eriacantha</i>		y	y		y			y
Chenopodiaceae	<i>Sclerolaena gardneri</i>		y			y	y	y	y
Chenopodiaceae	<i>Sclerolaena microcarpa</i>					y			
Chenopodiaceae	<i>Sclerolaena patentiscuspis</i>	y	y			y	y		y
Chenopodiaceae	<i>Sclerolaena</i> sp.								y
Convolvulaceae	<i>Convolvulus clementii</i>								
Convolvulaceae	<i>Cuscuta planiflora</i>			y			y	y	y
Convolvulaceae	<i>Duperreya commixta</i>	y	y		y		y	y	y
Crassulaceae	<i>Crassula colorata</i> var <i>colorata</i>					y		y	
Cucurbitaceae	<i>Citrullus colocynthis</i>				y				
Euphorbiaceae	<i>Euphorbia drummondii</i> subsp. <i>drummondii</i>	y	y		y	y	y	y	y
Euphorbiaceae	<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>	y		y		y		y	
Fabaceae	<i>Acacia aneura</i> (group)					y	y		
Fabaceae	<i>Acacia aptoaneura</i> (ms)					y			
Fabaceae	<i>Acacia burkittii</i>	y	y	y	y	y	y	y	y
Fabaceae	<i>Acacia caesaneura</i>		y	y	y	y	y	y	y
Fabaceae	<i>Acacia hemiteles</i>					y			

Family	Species	Land unit							
		1	2	3	5	7a	8	16a	16b
Fabaceae	<i>Acacia incurvaneura</i> (ms)	y	y	y		y	y	y	y
Fabaceae	<i>Acacia ligulata</i>	y	y	y	y	y	y	y	
Fabaceae	<i>Acacia murrayana</i>				y	y			
Fabaceae	<i>Acacia oswaldii</i>					y			
Fabaceae	<i>Acacia pteroneura</i> (ms)			y		y	y	y	y
Fabaceae	<i>Acacia ramulosa</i> (hybrid)			y		y	y	y	y
Fabaceae	<i>Acacia ramulosa</i> var <i>ramulosa</i>		y	y	y	y	y	y	y
Fabaceae	<i>Acacia sibirica</i>	y	y			y			y
Fabaceae	<i>Acacia</i> sp (mulga group)	y							
Fabaceae	<i>Acacia tetragonophylla</i>	y	y	y	y	y	y	y	y
Fabaceae	<i>Eucalyptus transcontinentalis</i>				y				
Fabaceae	<i>Indigofera brevidens</i>				y	y		y	
Fabaceae	<i>Senna artemisioides</i>	y	y			y	y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>petiolaris</i>	y	y	y	y	y	y	y	y
Fabaceae	<i>Senna cardiosperma</i>	y	y	y		y		y	y
Fabaceae	<i>Senna charlesiana</i>		y	y		y	y	y	y
Fabaceae	<i>Senna manicula</i>		y			y			
Fabaceae	<i>Senna</i> sp. Meekatharra (E. Bailey 1.26)	y	y	y		y			y
Fabaceae	<i>Swainsona formosa</i>							y	
Fabaceae	<i>Swainsona kingii</i>					y	y	y	y
Fabaceae	<i>Swainsona oroboides</i>					y	y		
Fabaceae	<i>Swainsona rostellata</i>								y
Fabaceae	<i>Templetonia egena</i>					y			
Geraniaceae	<i>Erodium cicutarium</i> (A)	y	y					y	
Geraniaceae	<i>Erodium crinitum</i>	y	y	y		y	y	y	y
Goodeniaceae	<i>Brunonia australis</i>			y		y		y	
Goodeniaceae	<i>Goodenia havilandii</i>			y		y	y	y	y
Goodeniaceae	<i>Goodenia pinnatifida</i>		y	y		y	y	y	y
Goodeniaceae	<i>Scaevola spinescens</i>	y	y	y	y	y	y	y	y
Goodeniaceae	<i>Velleia rosea</i>			y		y	y	y	
Haloragaceae	<i>Haloragis gossei</i>	y	y	y		y	y	y	
Hemerocallidaceae	<i>Dianella revoluta</i>	y				y	y	y	
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>					y	y		
Lamiaceae	<i>Salvia verbenaca</i>							y	
Lamiaceae	<i>Spartothamnella teucriflora</i>			y		y	y	y	y
Loranthaceae	<i>Amyema fitzgeraldii</i>					y			
Loranthaceae	<i>Amyena gibberula</i> var <i>gibberula</i>		y	y	y	y	y	y	
Loranthaceae	<i>Lysiana murrayi</i>	y	y			y	y	y	y
Malvaceae	<i>Sida fibulifera</i>		y				y	y	y
Malvaceae	<i>Abutilon cryptopetalum</i>	y	y			y	y	y	y
Malvaceae	<i>Abutilon otocarpum</i>					y	y	y	
Malvaceae	<i>Brachychiton gregorii</i>			y		y	y	y	
Malvaceae	<i>Hibiscus gardneri</i>	y							
Malvaceae	<i>Sida</i> aff. <i>clementii</i>	y	y			y			
Malvaceae	<i>Sida calyxhymenia</i>	y	y	y		y	y	y	y
Malvaceae	<i>Sida</i> sp. dark green fruits (S. vanLeeuwen 2260)			y	y	y	y	y	y
Myrtaceae	<i>Eucalyptus concinna</i>					y			
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>					y			
Myrtaceae	<i>Eucalyptus youngiana</i>				y	y			
Oleaceae	<i>Jasminum didymum</i> subsp. <i>lineare</i>				y				
Phyllanthaceae	<i>Phyllanthus</i> sp.							y	y

Family	Species	Land unit							
		1	2	3	5	7a	8	16a	16b
Pittosporaceae	<i>Bursaria occidentalis</i>				y	y			
Pittosporaceae	<i>Pittosporum angustifolium</i>	y	y	y		y			
Poaceae	<i>Aristida contorta</i>		y	y		y	y	y	
Poaceae	<i>Austrostipa elegantissima</i>					y	y		
Poaceae	<i>Austrostipa nitida</i>	y	y	y	y	y	y	y	y
Poaceae	<i>Austrostipa</i> sp.	y							
Poaceae	<i>Cymbopogon oblectus</i>	y							
Poaceae	<i>Digitaria brownii</i>	y				y	y	y	
Poaceae	<i>Enneapogon avenaceus</i>		y						
Poaceae	<i>Enneapogon caerulescens</i>	y	y	y		y			
Poaceae	<i>Enneapogon cylindricus</i>		y	y		y	y		y
Poaceae	<i>Eragrostis eriopoda</i>				y	y	y		
Poaceae	<i>Eragrostis lacunaria</i>	y							
Poaceae	<i>Eriachne helmsii</i>				y	y			
Poaceae	<i>Monachather paradoxus</i>			y	y	y	y	y	
Poaceae	<i>Paspalidium constrictum</i>	y				y		y	y
Poaceae	<i>Rostraria pumila</i>			y		y		y	
Poaceae	<i>Triodia basedowii</i>				y				
Polygonaceae	<i>Acetosa vesicaria</i> (A)	y							
Polygonaceae	<i>Emex australis</i> (A)							y	y
Portulacaceae	<i>Calandrinia polyandra</i>		y		y	y	y	y	y
Portulacaceae	<i>Calandrinia translucens</i>					y		y	
Primulaceae	<i>Lysimachia arvensis</i> (A)							y	y
Proteaceae	<i>Grevillea acuaria</i>					y			
Proteaceae	<i>Grevillea juncifolia</i>				y				
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>supraplana</i>					y		y	
Proteaceae	<i>Grevillea sarissa</i>				y	y			
Proteaceae	<i>Hakea kippistiana</i>	y							
Proteaceae	<i>Hakea lorea</i>				y			y	
Proteaceae	<i>Hakea preissii</i>	y	y			y	y		y
Pteridaceae	<i>Cheilanthes lasiophylla</i>	y							
Pteridaceae	<i>Cheilanthes sieberi</i>	y		y			y		
Rubiaceae	<i>Psydrax rigidula</i>			y		y	y		
Rubiaceae	<i>Psydrax suaveolens</i>	y				y	y	y	
Rutaceae	<i>Philotheca brucei</i> subsp. <i>brucei</i>	y	y	y					
Santalaceae	<i>Santalum acuminatum</i>				y				y
Santalaceae	<i>Santalum spicatum</i>	y		y	y	y	y	y	y
Sapindaceae	<i>Alectryon oleifolius</i>				y	y			
Sapindaceae	<i>Dodonaea aff rigida</i>		y		y	y			
Sapindaceae	<i>Dodonaea lobulata</i>	y	y	y		y			y
Sapindaceae	<i>Dodonaea rigida</i>	y		y		y		y	
Scrophulariaceae	<i>Eremophila alternifolia</i>		y		y	y			y
Scrophulariaceae	<i>Eremophila clarkei</i>					y		y	
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>				y	y			y
Scrophulariaceae	<i>Eremophila eriocalyx</i>					y	y		
Scrophulariaceae	<i>Eremophila falcata</i>					y			
Scrophulariaceae	<i>Eremophila flabellata</i>							y	y
Scrophulariaceae	<i>Eremophila georgei</i>					y	y	y	y
Scrophulariaceae	<i>Eremophila gilesii</i> subsp. <i>variabilis</i>					y	y	y	
Scrophulariaceae	<i>Eremophila glandulifera</i>			y		y	y	y	y
Scrophulariaceae	<i>Eremophila granitica</i>							y	

Family	Species	Land unit							
		1	2	3	5	7a	8	16a	16b
Scrophulariaceae	<i>Eremophila latrobei</i> subsp. <i>glabra</i>	y		y	y	y	y	y	
Scrophulariaceae	<i>Eremophila longifolia</i>		y		y	y	y	y	y
Scrophulariaceae	<i>Eremophila maculata</i> subsp. <i>brevifolia</i>					y			
Scrophulariaceae	<i>Eremophila metallicorum</i>		y			y	y	y	y
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>	y	y	y	y	y			y
Solanaceae	<i>Duboisia hopwoodii</i>				y				
Solanaceae	<i>Nicotiana cavicola</i>	y							
Solanaceae	<i>Nicotiana rosulata</i>	y	y			y	y	y	y
Solanaceae	<i>Solanum ferocissimum</i>					y	y	y	
Solanaceae	<i>Solanum lasiophyllum</i>		y	y	y	y	y	y	y
Solanaceae	<i>Solanum orbiculatum</i> subsp. <i>orbiculatum</i>	y			y				
Solanaceae	<i>Solanum</i> sp.	y							
Solanaceae	<i>Solanum terraneum</i>	y					y	y	
Thymelaeaceae	<i>Pimelea microcephala</i>	y				y			
Zygophyllaceae	<i>Zygophyllum aurantiacum</i>		y		y	y			y
Zygophyllaceae	<i>Zygophyllum compressum</i>		y	y		y	y	y	y
<b>Totals</b>	<b>191 species</b>	<b>71</b>	<b>73</b>	<b>61</b>	<b>49</b>	<b>138</b>	<b>85</b>	<b>98</b>	<b>84</b>

(A) alien

## Rare and priority flora species

There are two declared species of rare flora (WA Wildlife Conservation Act 1950 – Wildlife Conservation (Rare Flora) Notice 2010(2)) within Murchison and Great Victoria Desert biogeographical regions, of these, *Eucalyptus articulata* occurs in the general vicinity.

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.

*Gastrolobium graniticum* is listed as endangered and likely to occur in the area under the Commonwealth EPBC Act (Attachment 2). This species was not found during field survey.

Over 150 priority species (species with varying conservation status) have been recorded within the Murchison and Great Victoria Desert IBRAs and over 30 of these species have been collected in the general vicinity (Table 7).

No declared priority species were found during field survey.

*Arthropodium* sp. Goldfields (H. Pringle 2188), has previously been collected on one occasion and is likely to be considered to be a 'Priority' species. During this survey it was collected at one inventory site and at three sites from an adjoining survey\* (Alexander Holm & Associates, 2011):

RO35\*: 51J 439735 6751189  
 RO54\*: 51J 435763 6760655  
 RO62\*: 51J 434521 6764770  
 RO71: 51J 453652 6732153

This species has been lodged with the Department of Environment and Conservation for registration as a new species (T. McFarlane and A A Mitchell; 21/12/2010).

**Table 7: Declared rare flora and priority flora found in general area.**

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**R Declared rare flora – extant taxa (= threatened flora = endangered + vulnerable)**

*Eucalyptus articulata* – Ponton Creek Mallee      *Thryptomene wittweri*

**P1 Priority 1 – Poorly known taxa from one or two populations under threat.**

<i>Eremophila arachnoides</i> subsp. <i>tenera</i>	<i>Philotheca tubiflora</i>
<i>Eremophila eversa</i>	<i>Ptilotus tetrandrus</i>
<i>Goodenia lyrata</i>	<i>Tecticornia flabelliformis</i>
<i>Grevillea phillipsiana</i>	<i>Tecticornia mellaria</i>
<i>Lechenaultia aphylla</i>	<i>Tecticornia</i> sp. Lake Way (P. Armstrong 05/961) (NatureMap)
<i>Persoonia leucopogon</i>	<i>Vittadinia cervicularis</i> var. <i>oldfieldii</i>

**P2 Priority 2 – Poorly known taxa from one or two populations not all currently under threat**

*Eremophila mirabilis*      *Thryptomene eremaea*

**P3 Priority 3 – Poorly known taxa from several populations at least some of which are not under threat**

<i>Acacia eremophila</i> numerous-nerved variant (A.S. George 11924)	<i>Gunniopsis propinqua</i>
<i>Calytrix praecipua</i>	<i>Hybanthus floribundus</i> subsp. <i>chloroxanthus</i>
<i>Cratystylis centralis</i>	<i>Micromyrtus serrulat</i>
<i>Eremophila annosocaulis</i>	<i>Mirbelia stipitata</i>
<i>Eremophila simulans</i> subsp. <i>megacalyx</i>	<i>Olearia mucronata</i>
<i>Eucalyptus pimpiniana</i>	<i>Phyllanthus baeckeoides</i>
<i>Frankenia georgei</i>	<i>Sauropus ramosissimus</i>

**P4 Priority 4– Rare taxa not currently under threat**

<i>Conospermum toddii</i> (Victoria desert smokebush)	<i>Eucalyptus x brachyphylla</i>
<i>Eucalyptus kruseana</i> (Bookleaf mallee)	<i>Hemigenia exilis</i>
<i>Eucalyptus nigrifunda</i> (Desert wandoo)	

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## **Fauna habitat**

Fauna refugia in the region include breakaways, rock outcrops, rocky hilltops, drainage lines, dampland areas adjacent to salt lakes and salt lakes after heavy rainfall.

The Camp and Deep South clearing envelopes contain rocky hilltops and all three clearing envelopes contain drainage lines, all of which may act as fauna refugia.

No malleefowl nests (current or moribund) were located during on-foot surveys although one adult bird was sighted nearby at 450640; 6733408 (GDA94).

## **Hydrological summary**

The three clearing envelopes drain by sheet flow into either broad unchannelled (land unit 16a) or channelled drainage tracts (land unit 16b), which drain south-westerly towards to Lake Raeside, however there is no clearly defined discharge route into the lake (Figure 1).

The ground water table in monitoring bores associated with Safari and Deep South mines is between 30 to 60 m below ground level (Saracen unpublished data). Ground water salinity in Safari mine monitoring bores is generally less than 20,000 ppm (TDS) and is less than 2,000 ppm in Deep South monitoring bores (Saracen unpublished data).

# 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 survey area is consistent with mulga shrublands found throughout the north east Goldfields 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 Camp and Deep South clearing envelopes contain rocky hilltops and all three clearing envelopes contain drainage lines, all of which may act as fauna refugia.

No malleefowl nests (current or moribund) were located during on-foot surveys although one adult bird was sighted nearby at 450640; 6733408 (GDA94) in dense mulga woodland.

**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 listed species of rare or priority flora were found during this survey.

*Gastrolobium graniticum* is listed as endangered and likely to occur in the area under the Commonwealth EPBC Act. This species was not found during field survey.

*Arthropodium* sp. Goldfields (H. Pringle 2188), has previously been collected on one occasion and is likely to be considered to be a 'Priority' species. During this survey it was collected at one inventory site:

RO71: 51J 453652 6732153

It was also found on three sites from an adjacent survey:

RO35: 51J 439735 6751189



RO54: 51J 435763 6760655  
RO62: 51J 434521 6764770

**The proposal is potentially 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.**

All three clearing envelopes have been mapped by Beard (1976) as Vegetation Association 18 (Low woodland; mulga.).

Vegetation Association 18 occupies approximately 200,000 km<sup>2</sup> in Western Australia and although less common elsewhere in WA, it is extensive in the north east Goldfields. This association is well represented in conservation reserves and therefore has low priority for further reservation (Table 1).

**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.**

The three clearing envelopes drain by sheet flow into either broad unchannelled (land unit 16a) or channelled drainage tracts (land unit 16b), which drain south-westerly towards to Lake Raeside.

The existing Deep South mine intersects a drainage channel flowing east-west which has been diverted around the mine by bunds.

**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.**

Vegetation is mostly in fair to good condition.

Active soil erosion is common in land unit 16b (channelled drainage tracts) in the Deep South clearing envelope. Land unit 5 (Sloping sand sheets) in the Camp clearing envelope consist of red sand soils with loose hummocky and mounded surfaces which are high to very highly vulnerable to soil erosion if disturbed. Other land units are currently stable and generally not vulnerable to soil erosion.

Water tables are below the rooting depth of vegetation growing on these sites. Clearing of vegetation will have minimal, if any, effect on water tables and associated risk of secondary salinity.

**Proposal is not 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 are nearby.

**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 externally through channelled and un-channelled drainage lines.

The climate is arid to semi-arid with 230 mm of annual rainfall and annual evaporation rates are about 3200 mm. Recharge to groundwater is limited to years of extreme rainfall.

The proposal is unlikely to impact groundwater.

**Proposal is unlikely to be 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 runoff.

Drainage is via overland flow to drainage channels which flow towards Lake Raeside, but do not appear to directly discharge to the lake.

Clearing in this proposal will have negligible effect on the volume of runoff discharged.

**Proposal is unlikely to be at variance with this principle.**



# DISCUSSION AND RECOMMENDATIONS

The proposed three clearing envelopes associated with proposed expansion of Safari and Deep South mines are in the north-eastern Goldfield and in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion, bordering the Great Victoria Desert bio-geographic region

Vegetation communities are predominately 1) broad expanses of ‘mulga’ shrublands with scattered eucalypts associated with sandy or loamy plains and occasional drainage lines (e.g. HPMS and MUWA) and 2) restricted low to mid-height shrublands associated with low hills and rises (e.g. USBS and GHAS). These communities are common throughout the north eastern Goldfields and are not unusually diverse.

There are no known threatened ecological communities or wetlands of national significance or sub-regional significance in the area, although nearby Lake Raeside is considered an ecologically significant component of regional paleo-channels.

One hundred and ninety one flora species representing 41 families were found during field survey including numerous annuals. Six alien (weed) species were located during survey of which *Emex australis* is a declared plant under the Agriculture and Related Resources Protection Act 1976 within some agricultural areas but not within the north eastern goldfields.

No listed rare or priority flora species were collected. On the other hand, *Arthropodium* sp. Goldfields (H. Pringle 2188), has previously been collected on one occasion and is likely to be considered to be a ‘Priority’ species. During this survey it was collected at one inventory site and was also collected on three sites in an adjoining survey. This species has been lodged with the Department of Environment and Conservation for registration as a new species (T. McFarlane and A A Mitchell; 21/12/2010)

The three clearing envelopes contain rocky hills and numerous drainage lines which may act as fauna refugia.

No malleefowl nests (current or moribund) were located during on-foot surveys although one adult bird was sighted nearby at 450640; 6733408 (GDA94).

The survey area is partly on Edjudina and partly on Mt Weld pastoral leases. Vegetation is mostly in fair to excellent condition. Numerous tracks, stock fences and grid lines cross the survey area.

Active soil erosion is common in land unit 16b (channelled drainage tracts) in the Deep South clearing envelope. Land unit 5 (Sloping sand sheets) in the Camp clearing envelope consist of red sand soils with loose hummocky and mounded surfaces which are rated as

having high to very high vulnerability to soil erosion if disturbed. Other land units are currently stable and generally not vulnerable to soil erosion.

Drainage is via overland flow to drainage channels which flow south-westerly towards Lake Raeside, but do not appear to directly discharge to the lake. The existing Deep South mine intersects a drainage channel which has been diverted around the mine by bunds.

It is recommended that, in planning expansion of the mines, the proponent:

- 1. Avoids disturbance to rocky hills (land unit 1) and associated sloping sand sheets (land unit 5).**
- 2. Avoids disturbance to the known location of *Arthropodium* sp. Goldfields (H. Pringle 2188).**
- 3. Minimises disturbance to drainage tracts (land units 16a and b).**
- 4. Take measures to minimise the spread of weeds.**

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# **ENVIRONMENTAL ASSESSMENT:**

## **RELIEF HILL SURVEY AREA**

### **SARACEN GOLD MINES**



**Alexander Holm & Associates**  
Natural Resource Management Services

**February 2020**





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# Attachments

Attachment 1: 'NatureMap' report
Attachment 2: 'Protected matters' search tool output
Attachment 3: List of flora taxa found at each inventory site
Attachment 4: Inventory site data on landform, soil type and erosion.
Attachment 5: Inventory site data on dominant flora vegetation cover and condition.
Attachment 6: Location of inventory sites
Attachment 7: Fauna memo report

# SUMMARY

This report for Saracen Gold Mines Pty Ltd covers environmental assessments within a 2080ha area approximately 6km east of Carosue Dam Operations and 115km north east of Kalgoorlie.

The environmental assessment had two components:

- A reconnaissance vegetation and flora survey from January 7 -12, 2020.
- A reconnaissance fauna survey from January 20 - 23, 2020.

Rainfall during winter in 2017 and 2018 was well below average. There were late winter rains in 2018 and as a result, some biannual herbs and grasses persisted from preceding seasons and were readily identified at the time of survey. There were few annual species.

Sixty-eight inventory sites were assessed during the reconnaissance vegetation and flora survey which provided systematic coverage of the area and encompassed variations in photo-pattern. A systematic assessment of land-type, geology, relief, soil type and vegetation at each site enabled the area to be mapped into readily identifiable land units.

Ten land units were identified, and ten associated vegetation communities described. Over 50% of the survey area is occupied by low hills and rises on basalt supporting very sparse to open mixed height shrublands with very sparse overstoreys of casuarina. Low hills and rises on laterite, commonly supporting acacia-dominated, very sparse to open shrublands with very sparse overstoreys of casuarina or eucalyptus, occupy approximately 20% of the area. Chenopod shrublands occur on approximately 20% of the area either on calcareous plains or alluvial plains. Felsic breakaways, acacia shrublands on hardpan and drainage tracts are minor components of the landscape.

Ninety-nine flora taxa representing 22 families were found during the reconnaissance survey. Chenopodiaceae accounted for 19 taxa, Fabaceae 24 taxa and Scrophulariaceae 16 taxa. There were two sterile specimens which were identified to genera level.

No threatened (rare) or endangered flora taxa were found during this survey.

*Eremophila arachnoides* subsp. *tenera*, a Priority 1 taxa is known to occur on nearby tenements with similar landunits. None were found during this survey.

Several populations, each with scores of individuals, of *Thryptomene eremaea*, a Priority 2 taxa, were found mostly confined to Land Unit 1e (Upland basalt surfaces).

No alien to Western Australia (weed) species were located during survey.

Minor to moderate soil erosion is evident on felsic footslopes, calcareous and alluvial plains and these land units are rated as slightly to moderately vulnerable to erosion. Disturbance to these land units has the potential to increase sediment discharge to drainage tracts and ultimately, and through extreme events, to Lake Rebecca.

The survey landscape mainly drains via overland flow to several broad drainage systems which flow indeterminately into Lake Rebecca 5 km to the north east and south. Lake Rebecca is a major wetland with local and regional significance.

Malleefowl are active in the survey area. Two fresh mounds were found during limited survey suggesting that there are likely to be many more in the survey area.

There are no Threatened Ecological Communities (TECs) within the north east Goldfields subregion and no Priority Ecological Communities within or adjacent to the survey area. No conservation areas are nearby.

It is recommended that, in planning and implementing operations within the survey area, the proponent:

- 1. Avoids disturbance to land unit 1e (Upland basalt surfaces) preferred habitat for *Thryptomene eremaea* a Priority 2 taxa.**
- 2. Undertakes a Malleefowl survey especially within land units 1a, 2a and 4b and avoids disturbance within 50m of active Malleefowl nests during nesting and incubation.**
- 3. Avoids destruction of mature Eucalyptus trees with nesting hollows**
- 4. Old trees, dead trees, fallen logs and termite mounds should be “gently” tipped over and left overnight to allow fauna to disperse**
- 5. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially calcareous plains (land unit 4c) and alluvial plains (land unit 5b).**
- 6. Avoids disturbance to drainage channels (land unit 6).**

# SCOPE OF WORKS

Saracen Gold Mines Pty Ltd (Saracen) is proposing extensive exploration to the east of Safari and Whirling Dervish gold mines. Alexander Holm & Associates were contracted by Saracen to conduct an environmental assessment of a 2080ha area in the Relief Hill area. Bamford Consulting Ecologists (BCE), were sub-contracted by Alexander Holm & Associates to undertake and report on the fauna component of the assessment.

The environmental assessment to include:

- A review of available information on likelihood of a) presence of threatened (rare) or priority plant species and b) threatened plant communities in the general search area.
- A reconnaissance level fauna, flora and vegetation survey.
- An assessment of landscape stability and condition.
- A description of land units and relate information on fauna, flora, vegetation communities and landscape stability to these units.
- A map of land units, associated vegetation communities, soil type and vulnerability to erosion.
- A report on findings within a local and regional context
- An assessment of the proposal in relation to impacts on fauna.
- An assessment of the proposal against clearing principles.

The scope of works is to comply with Western Australian Environmental Protection Authority (EPA) objectives for protection of the environment specifically to “ensure that flora and vegetation surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered” and to “enable an assessment of impacts on the conservation values and status of the site in a regional and local context” (Environmental Protection Authority, 2004).

The work takes into account the following surveys that are either nearby or adjoin the proposed project envelope and will produce a unified landunit/ vegetation association map to cover these surveys:

- Matiske Consulting Pty Ltd (2010) Flora and vegetation survey of the proposed airstrip.
- Matiske Consulting Pty Ltd (2010) Flora and vegetation survey of the Karari pit extension.
- Alexander Holm & Associates (2010) Environmental assessment-proposed expansion of Whirling Dervish mine.
- Alexander Holm & Associates (2012b) Environmental assessment – proposed expansion of Tailings Storage Facility.
- Alexander Holm & Associates (2019). Environmental assessment of proposed seismic survey area.

In addition, information on fauna was available from a number of previous studies in the area. These include:

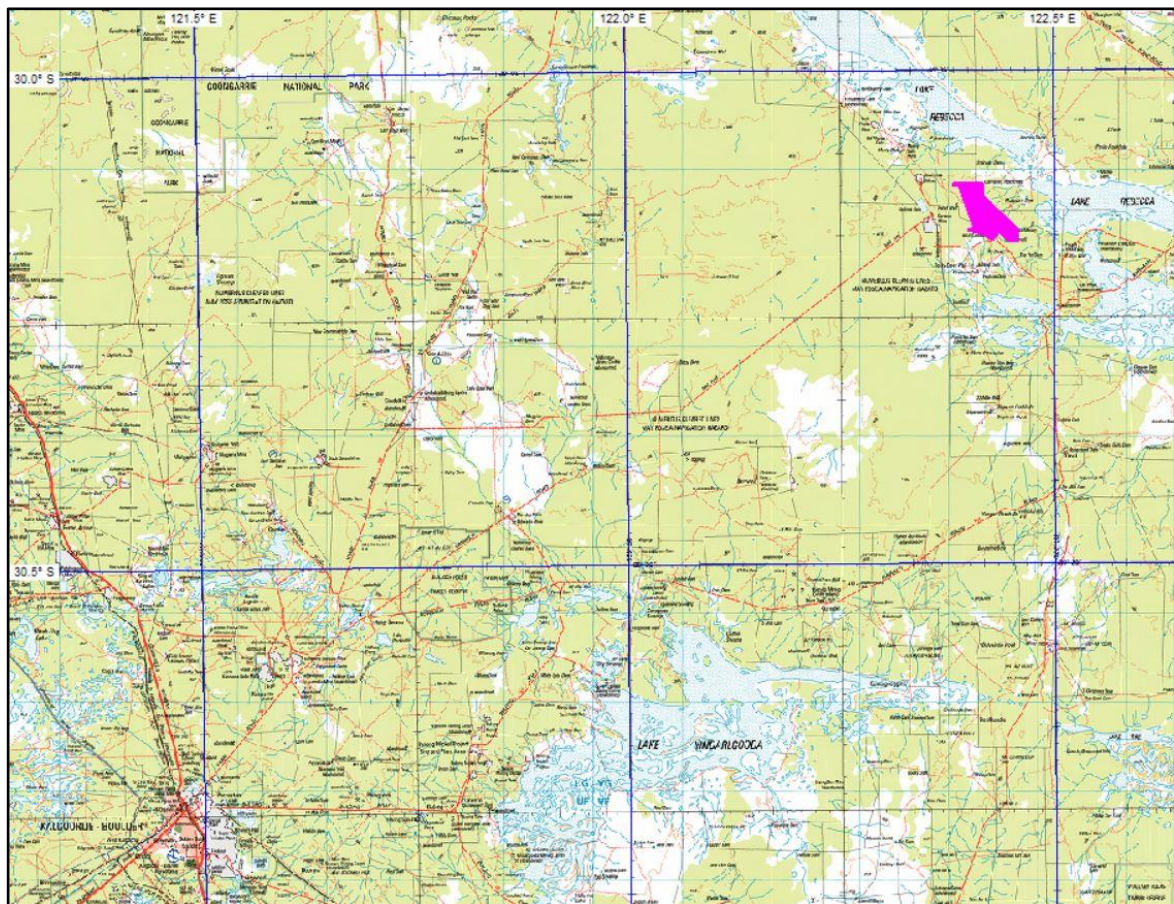
- Alexander Holm and Assoc. (2017). Malleefowl survey of proposed airstrip. Saracen Gold Mines.
- Coffey environments (2010). Level 1 vertebrate fauna survey for the Carosue Dam Project, Saracen Gold.
- Biologic. (2010). Level 1 survey for a proposed pipeline from GGT to Carosue Dam and powerline from Black Swan to Carosue Dam. Tropicana JV and Saracen Gold Mine Pty Ltd.
- Henry-Hall *et al.* (1990). Report on survey of Goongarrie Nature Reserve.
- ABRS (2013). Bush Blitz; Biological survey of Credo Station Reserve WA.

# REGIONAL OVERVIEW

## Regional setting

The survey area is approximately 115 km north east of Kalgoorlie Boulder, and adjacent to Lake Rebecca (Figure 1). It is within Kalgoorlie-Boulder and Menzies local government areas. It falls mainly within Common 17325 and partly within Edjudina, Gindalbie and Pinjin pastoral leases. It is located in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions (Cowan 2001, Desmond, Cowan and Chant 2003).

The most extensive land use in the region is pastoralism and over 80% of this region is pastoral leasehold. Most of the remainder is unallocated crown land and less than 1% is set aside for nature conservation.



**Figure 1: Survey area (in pink) in relation to Lake Rebecca and Kalgoorlie Boulder in the south west.**



## Climate

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 at Kalgoorlie is 177.8 mm (in February) and 92.6 mm (in January) at Laverton. For Kalgoorlie, one in one hundred years rainfall events of 1 hour and 72 hours are estimated to result in 43 and 173 mm of rain respectively. (Data from [www.bom.gov.au](http://www.bom.gov.au)).

The average potential pan evaporation rate at Carosue Dam is approximately 2800 mm per annum<sup>1</sup>.

Winds are mostly light easterlies.

## Topography and drainage

Landform patterns in the general area 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 (Gentili, 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, Van Vreeswyk & Gilligan, 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 palaeo-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 palaeo-drainages, and local brine pools associated with salt lakes.

## 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, 1976). Lake Ballard/Lake Rebecca form a major vegetation divide with characteristic *Acacia aneura* (mulga) low woodlands associated with red loams over siliceous hardpan to the north and low woodlands of mixed mulga and *Casuarina obesa* (black oak) and

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<sup>1</sup> [http://www.bom.gov.au/cgi-bin/climate/cgi\\_bin\\_scripts/evaporation.cgi](http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/evaporation.cgi).

*Eucalyptus* species 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 palaeo-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 eucalypt or mulga with saltbush or bluebush understoreys.

The most common vegetation associations in the region include Beard Vegetation Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.), 110 (Hummock grassland, shrub steppe and red mallee over spinifex) and 389 (Succulent steppe with open low woodland; mulga over saltbush) (Table 1).

**Table 1: Vegetation associations (Beard, 1976) in project area in comparison with South Laverton area (SLA), total area in WA and area within conservation reserves**

Veg Assn	Description	SLA Area km <sup>2</sup>	Reserve priority	Western Australia		
				Area km <sup>2</sup>	Within reserve km <sup>2</sup>	%
20	Low woodland; mulga mixed with <i>Casuarina obesa</i> and <i>Eucalyptus</i> spp.	7892	L	13045	2173	16.7
24	Low woodland; <i>Casuarina obesa</i>	15.2	L	265.6	2.4	0.9
110	Hummock grassland; shrub steppe and red mallee over spinifex	356	M	4746	1201	25.3
389	Succulent steppe with open low woodland; mulga over salt bush	2344	M	6465	230	3.6
529	Succulent steppe with open low woodland; mulga and sheoak over salt bush	46.6	H	102.8	0.1	0.1

L\*: Low; M: Medium; H: High priority for reservation

# ASSESSMENT METHODOLOGY

## Assessment personnel

The work was managed and reported by Dr Alexander Holm (Alexander Holm & Associates). Field work for the vegetation and flora survey was conducted by Mr Eliot and Dr Holm. Mr Mitchell provided off-site assistance in expert identification of flora specimens collected in the field.

Dr Holm is an ecologist with over 35 years experience in arid environments and Goldfield regions and an accredited environmental consultant with the Environmental Consultants Association of Western Australia.

Mr Andrew Mitchell was assisting botanist to Western Australian Department of Agriculture's rangeland surveys, senior author of "Arid Shrubland Plants of Western Australia" (Mitchell and Wilcox 1994) and recently retired botanist with AQIS (Australian Quarantine and Inspection Service).

Mr Geoffrey Eliot was soil and landscape technician for the Western Australian Department of Agriculture's rangeland surveys and has over 20 years experience in Western Australian arid regions.

The fauna survey was conducted and reported by Dr Barry Shepherd and Mr Tim Gamlin.

Dr Barry Shepherd is an ecologist with more than 20 years working as an environmental consultant. Barry's core skills are around environmental and ecological impact assessment, and environmental approvals. Around this experience, he has conducted a large number of environmental baseline survey for birds, bats, small mammals and herpetofauna, and specialises in marine mammals and bats. He is also experienced in line transect population studies. Barry has undertaken extensive analysis of bat echolocation and calls and is competent on most ultra-sonic detection systems. Barry has written a large number of baseline survey reports, impact assessments and environmental approval documentation.

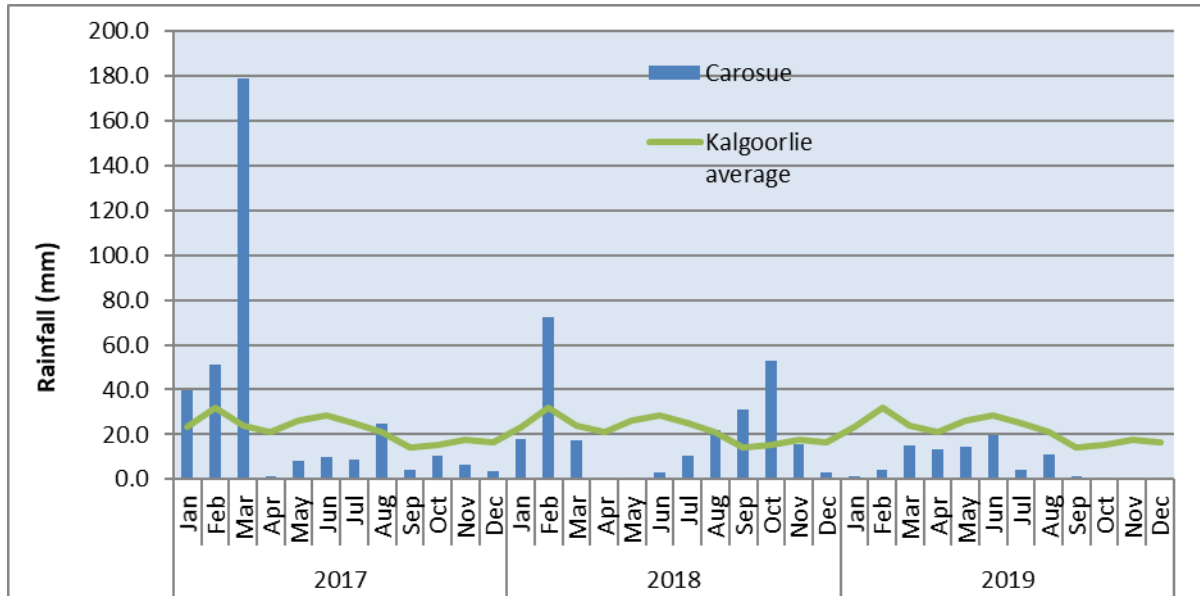
Tim Gamblin is an experienced fauna ecologist working across a range of industry sectors within the WA bioregions. He has technical and practical skills, specialised knowledge of vertebrate fauna ecology, sampling and detection methods, and can communicate results and advice to clients and other stakeholders in the natural resource management, mining and energy sectors. He has over 20 years' experience as a zoologist and has worked within the WA government as well as in the private sector as a fauna consultant. He has a proven ability to provide high quality results whether this be preparing an impact assessment, ecological reporting or working effectively within a fauna survey team. He also enjoys teaching and training students in fauna sampling techniques.

## Timing of survey and seasonal conditions

Vegetation and flora reconnaissance survey from January 7 -12, 2020.

Fauna reconnaissance survey from January 20 – 23, 2020.

Rainfall during winter in 2017 and 2018 was well below average (Figure 2). There were spring rains in 2018, however 2019 has been one of the driest years on record and as a result, very few biannual herbs and grasses have persisted from preceding seasons and there were no annual species.



**Figure 2: Monthly rainfall (mm) at Carosue Dam in comparison to averages at Kalgoorlie airport**

## Declared flora and fauna

The Department of Parks and Wildlife and the Western Australian Museum's "NatureMap"<sup>2</sup> was interrogated for records of all collected flora within a 40 km radius of the study area (Attachment 1). The list was augmented by other recent searches from nearby survey areas (Alexander Holm & Associates 2012a, Alexander Holm & Associates 2012b, Alexander Holm & Associates 2012c, Alexander Holm & Associates 2012d, Alexander Holm & Associates 2019).

*Thryptomene eremaea*, a Priority 2 taxon, is recorded in NatureMap as being located within 40km of the study area. It is an erect open shrub, 0.5 to 1.5m high, producing pink or white flowers from July to September and grows on red or yellow sands on sandplains and shallow sandy soils over granite.

*Eucalyptus pimpiniana*, a Priority 3 taxon, is recorded in Nature Map as being located within 40km of the study area. It is a straggly mallee 0.7-2m high, with smooth bark, producing white flowers from May to October and grows on red sands on sandplains and dunes.

*Eremophila arachnoides* subsp. *tenera*, a Priority 1 taxon, was recorded in adjacent surveys during 2012 and 2019 (Alexander Holm & Associates 2012d, Alexander Holm & Associates 2019).

Declared flora and fauna listed on Commonwealth Department of Environment and Energy database of threatened species were identified within a 100km radius of the study area using the protected matters search tool<sup>3</sup> (Attachment 2).

*Gastrolobium graniticum* is classed as Endangered under the EPBC Act 1999 and as a Declared Rare taxon under the Wildlife Conservation Act 1950 [WA]. This member of the Fabaceae is an erect shrub 0.9 to 1.2 m high with purple branches, and ovate leaves 2.5 to 6 cm long. The distribution of this species is restricted to Kalgoorlie and Coolgardie districts where it is found in sandy or sandy loam soils near granite rocks.

*Eucalyptus articulata* is classed as Vulnerable under the EPBC Act 1999 and as a Declared Rare taxon under the Wildlife Conservation Act 1950 [WA]. It is a low scraggly mallee to 3m high grow in red sand, sandy loam, arkose gravel and sand dunes.

*Hibbertia crispula* is classed as Vulnerable under the EPBC Act 1999 and as a Priority 1 taxon (Priority Flora and Priority Fauna List (Western Australia)). It is a small wiry glabrous shrub growing up to 50 cm high with typical yellow flowers in leaf axils.

*Tecticornia flabelliformis* is classed as Vulnerable under the EPBC Act 1999 and as a Priority 1 taxon (Priority Flora and Priority Fauna List (Western Australia)). It is an erect shrub to 0.2m high growing on clays on saline flats.

Records of bird observations in Australia, 1998-2019 from BirdLife Australia Atlas Database (Birdlife Australia) within a 40km radius of the study area.

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<sup>2</sup><https://naturemap.dpaw.wa.gov.au/default.aspx>

<sup>3</sup> <http://environment.gov.au/epbc/protected-matters-search-tool>

Records of biodiversity data from multiple sources across Australia from Atlas of Living Australia and within a 40km radius of the study area.

Significant conservation fauna which may be present in the survey area, include one reptile, 19 birds and two mammals. The single reptile is a Priority 2 skink that may occur under leaf-litter around trees and mallee. The majority (9) of the birds are waterbirds that are either vagrants or irregular visitors and would not utilise the actual project area due to the lack of wetlands. Most other significant birds are expected only as vagrants but three species may use the site regularly: Malleefowl, Peregrine Falcon and Rainbow Bee-eater. Only two significant mammals are expected, with the Central Long-eared Bat potentially roosting in large trees, and the Brush-tailed Mulgara probably being locally extinct or possibly being a vagrant.

## **Threatened and priority ecological communities**

The likelihood of presence of threatened ecological communities within the general survey area was assessed using the protected matters search tool (Attachment 2).

Other threatened ecosystems in the south-east of Eastern Murchison (MUR 1) biogeographic subregion, identified during “A Biodiversity Audit of Western Australia’s 53 Biogeographical Subregions in 2002”, are listed in Cowan (2001).

Priority ecological communities in the area were assessed from Department of Parks and Wildlife listing (Version 27, June 2017).

## **Land systems land units and vegetation communities**

Land systems and land units were derived from a land resource survey of north eastern Goldfields (Pringle, Van Vreeswyk & Gilligan, 1994). Land systems for the region south of the north eastern Goldfield survey have been tentatively identified by desk-top photographic interpretation and extrapolation (Department of Agriculture and Food WA).

Vegetation communities were established firstly with reference to those listed in Pringle et al. (1994) where they are listed as ‘site types’, and secondly, where no comparable community could be found, with reference to those listed in adjacent surveys of Sandstone, Yalgoo Paynes Find (Payne et al., 1998) and Kambalda north (Payne, Mitchell & Hennig, 1998).

Tentative land units were identified by examination of high-resolution aerial photography and Google imagery. Boundaries were checked in the field, transferred to geo-referenced ortho-photo maps and captured digitally. Vegetation communities were visually associated with each land unit.

## Field survey

### ***Reconnaissance vegetation and flora survey***

The survey and reporting were conducted to comply with the EPA's "Technical Guidance – flora and vegetation surveys for environmental impact assessment" (Environmental Protection Authority 2016). A reconnaissance level survey was considered appropriate in the first instance in view of results of several vegetation and flora surveys nearby or adjacent to the study area (Figure 3).

Sixty eight inventory sites (relevés) were selected to 1) sample each land unit within the survey area, 2) provide systematic coverage of the survey area, and 3) to encompass variations in pattern within each land unit. Each inventory site was located by GPS and the following information recorded:

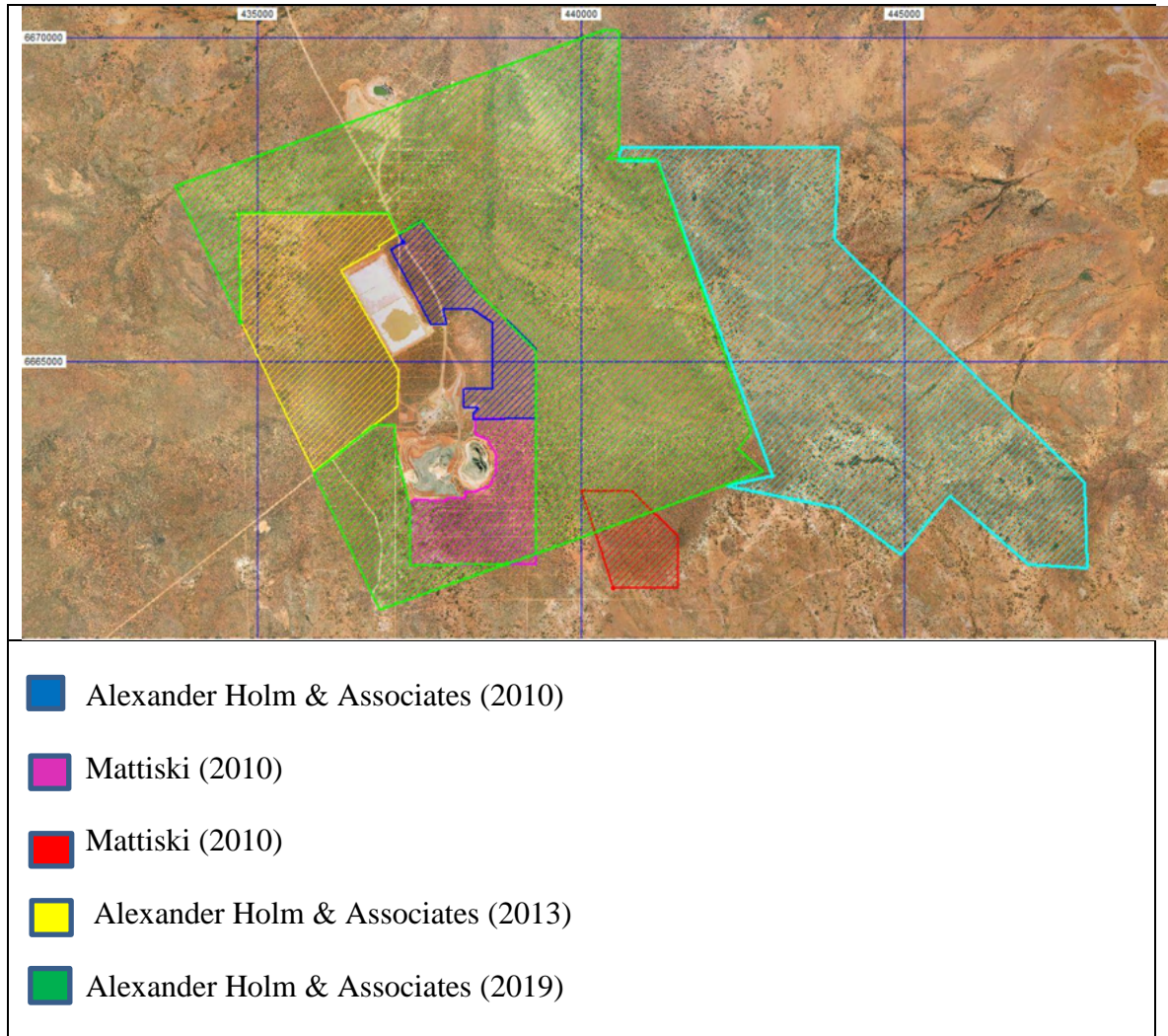
- Digital photographs.
- All flora species within approximately 50 m of a central location and in the same land unit were inventoried and voucher specimens collected of all taxa which were also compiled within a reference field herbarium.
- Vegetation condition were visually estimated using rating scales of Environmental Protection Authority (2016) and soil erosion compared with standard rating scales used for rangeland surveys and described by Pringle *et al.* (2004).
- Vegetation community and land unit descriptions using terminology from Payne *et al.* (1998).
- Vegetation cover, landform, slope, relief, surface coarse fragment characteristics and surface water flow characteristics (Anon, 2009).
- Soil characteristics (texture, reaction to acid and fragment characteristics) of surface horizons to maximum of 30cm (Anon, 2009).

These data were augmented by walking traverses by two surveyors along selected routes. The survey aimed to:

- Locate priority or threatened flora.
- Locate species not previously recorded at inventory sites.

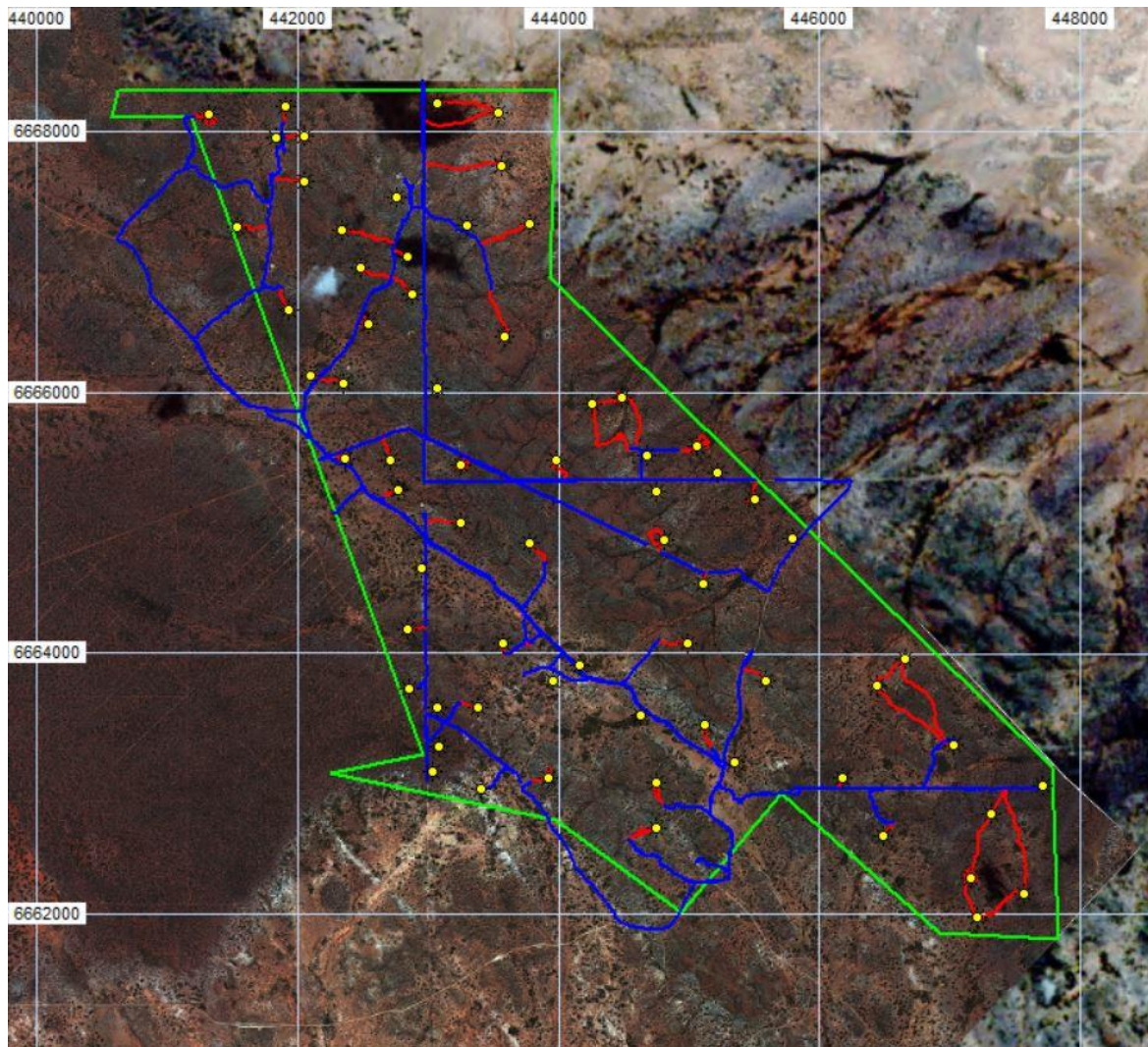
Locations of inventory sites, vehicle traverse (120km) and walking traverses (20km) are shown in Figure 4.





**Figure 3: Proposed survey area (light blue) and locations of existing flora and vegetation surveys.**





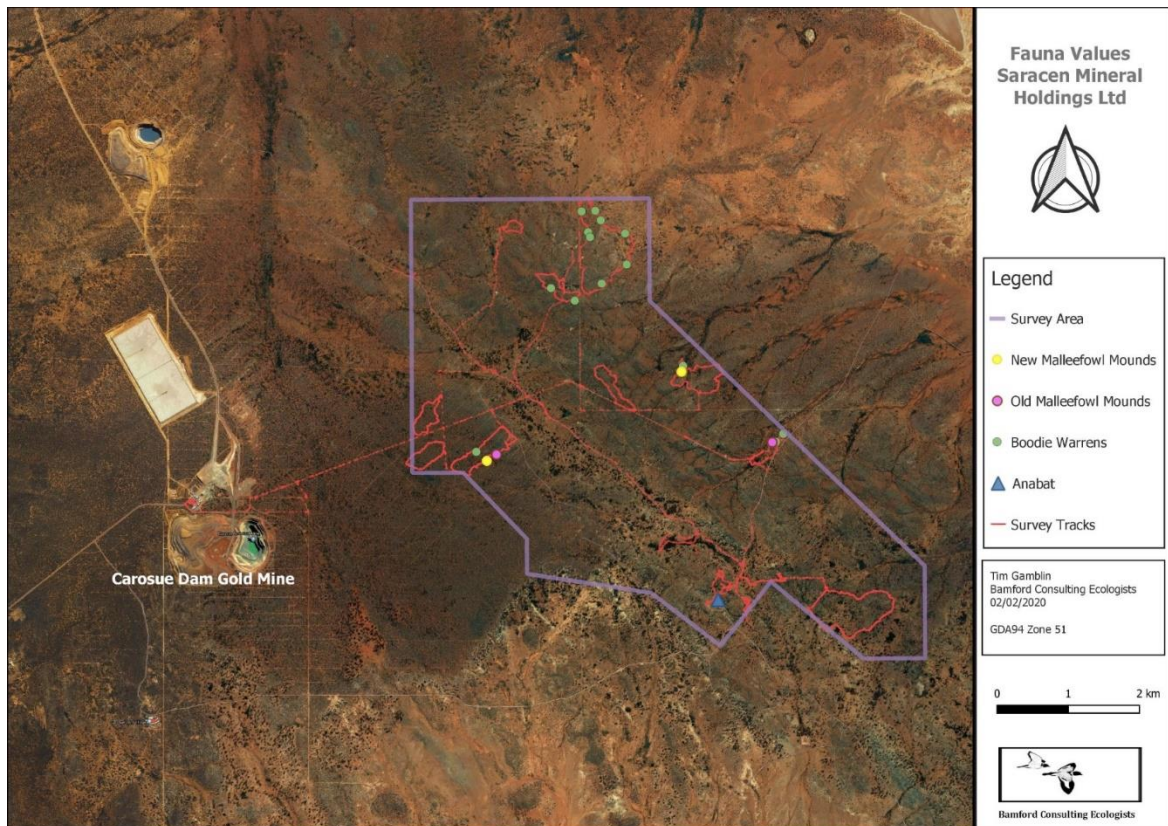
**Figure 4: Location of inventory sites (yellow) vehicle traverse (blue) and walking traverses (red) during flora survey.**

### ***Reconnaissance fauna survey***

The site visit involved looking around as much of the project area as possible in daylight and the tracks and effort of this search are shown in Figure 5. This enabled environmental descriptions to be prepared and some opportunistic observations on fauna to be made. Targeted searching was undertaken for two significant species known from the general area; in particular for nest mounds, foraging signs, tracks and direct observations of Malleefowl (*Leipoa ocellata*). Surveyors were also mindful of the burrows of Brush-tailed Mulgara (*Dasyercus blythi*), although it is likely this species is locally extinct. Signs of all species observed, and other notable features of interest were recorded.

An Anabat Swift full spectrum ultrasonic acoustic detector was placed next to an old mine shaft for two full nights. It was deployed on the afternoon of 21st January and retrieved on the morning of 23rd January 2020. All calls obtained were assessed to provide a list of bat fauna supporting the Level 1 survey.

The complete fauna memo report is attached (Attachment 7).



**Figure 5: Vehicle traverse and walking traverses during fauna survey and locations of significant fauna observations.**

# ENVIRONMENTAL ANALYSIS

## Conservation estate

Beard Vegetation Association 529 (Succulent steppe with open low woodland; mulga and sheoak over salt bush) is the most common vegetation association in the survey area occupying 69%. Vegetation Association 24 (Low woodland; *Casuarina obesa*) occupies 28% and the remaining 3% is Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) (Beard 1976).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation (Table 1). Vegetation Association 529 is very poorly conserved and has a high priority for conservation.

There are no conservation reserves within 50 km of the survey area (Appendix 1). The closest conservation area is Bullock Holes Reserve, approximately 60 km south 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) although Lake Rebecca is considered an ecologically significant component of inter-regional palaeo-channels.

There are no registered sites on State or National heritage registers.

Lake Rebecca is a registered mythological site.

## Land systems and landforms

Approximately 42% of the survey area is occupied by low basalt hills of the Leonora land system with acacia woodlands and halophytic undershrubs; 36% consists of low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys of Moriarty land system; 19% is gently undulating plains on erosional surfaces of Gundockerta land system (Table 2).



**Table 2: Descriptions of land systems within the survey area (Pringle, Van Vreeswyk & Gilligan, 1994 and Department of Agriculture and Food, WA).**

<b>Land type</b>	<b>Land system</b>	<b>Description</b>	<b>Soil and land management</b>
Erosional surfaces of low relief	Gundockerta	Extensive gently undulating plains on weathered greenstone with stony mantles and lower alluvial tracts	Saline plains and adjacent alluvial tracts are susceptible to water erosion.
Depositional plains with calcareous red earths	Deadman	Level to gently undulating plains with casuarina-acacia shrublands.	Generally not susceptible to soil erosion
Low rises to 20m with ferruginous duricrust	Moriarty	Low greenstone hills and stony plains, supporting chenopod shrublands with patchy eucalypt overstoreys.	Slopes of low rises, alluvial plains and narrow drainage tracts are moderately susceptible to soil erosion.
Low, rounded hills to 40m with gently inclined fringing plains	Leonora	Low greenstone hills with eucalypt or acacia woodlands with halophytic undershrubs	Drainage tracts are highly susceptible to soil erosion. Vegetation highly preferred by grazing animals.

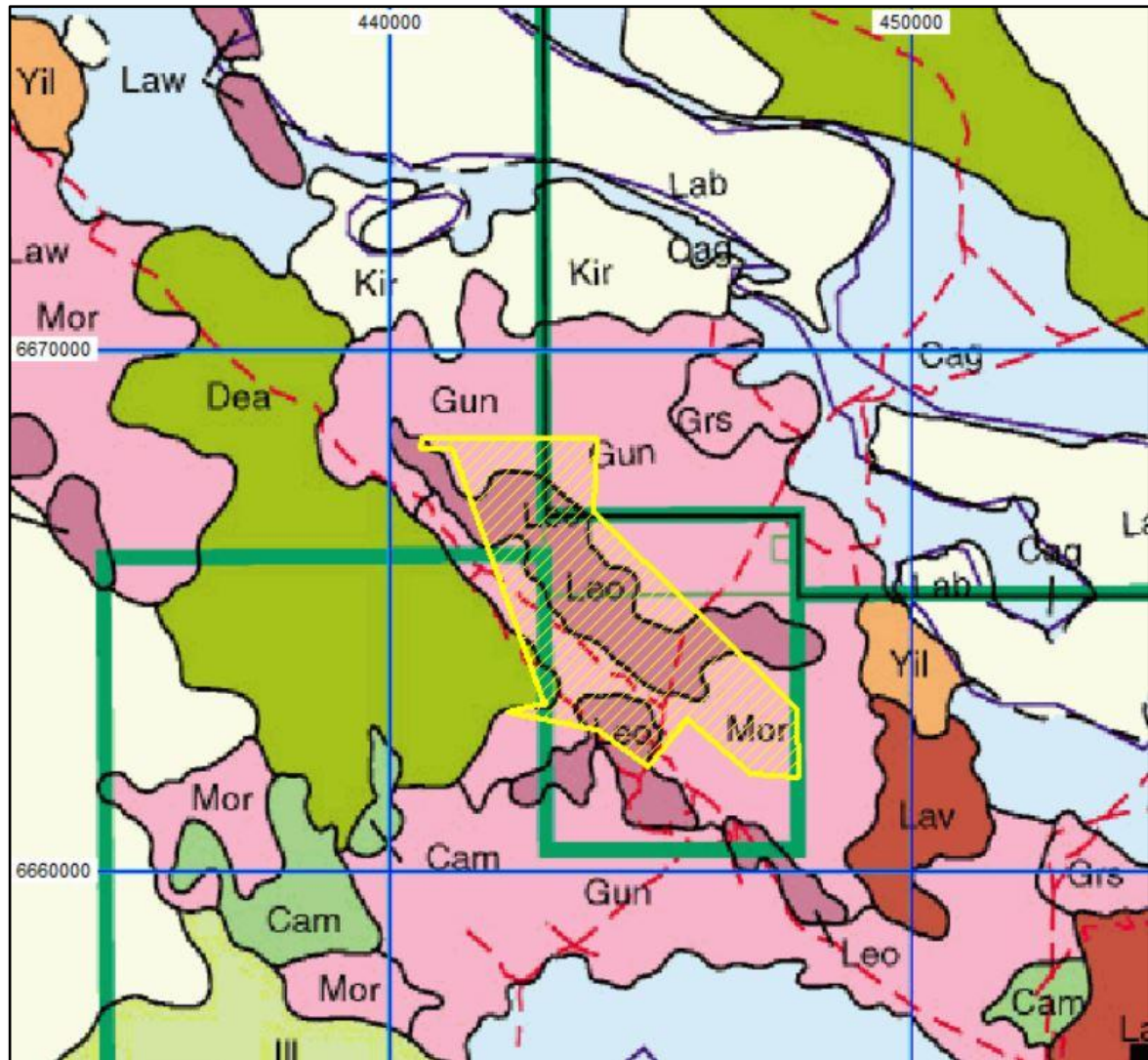


Figure 6: Land systems within the survey area (in yellow)



## Land units, soil types and vegetation communities

### *Land unit descriptions and mapping*



Ten land units and associated vegetation communities and soil types are described (Table 4).



A map of land units is overlain on an aerial photograph (Figure 7).

**Table 3: Land unit descriptions, their soil type, vulnerability to erosion and associated vegetation communities.**



Land unit	Land form and soil type	Vegetation community
<b>1a. Lateritic hills</b> 	<p>Lateritic hills with relief to 20m with slopes up to 8%, very abundant (&gt;90%) surface mantles of ironstone medium to coarse gravel and cobbles with and occasional quartz fragments and calcrete nodules.</p> <p>Shallow sandy loams or sandy clay loams over calcrete or parent laterite.</p> <p>Run-off source zones, nil vulnerability to erosion.</p>	<p>Very sparse to open mixed shrubland (PFC 5-25%) dominated by <i>Acacia</i> sp., <i>A. stowardii</i>, <i>Dodonaea lobulata</i>, <i>Eremophila scoparia</i> and <i>Scaevola spinescens</i> with very sparse overstorey of <i>Casuarina pauper</i> or <i>Eucalyptus lesouefii</i>.</p> <p>“Stony ironstone acacia shrubland” (SIAS vegetation community) or “Breakaway mixed shrubland” (BRXS vegetation community)</p>
<b>1b. Basalt hills</b> 	<p>Basalt hills with relief to 50m, slopes from 3-10%, abundant (50-90%) surface mantles of coarse gravel and cobbles of basalt and occasional quartz or calcrete.</p> <p>Sandy loams or sandy clay loams less than 30cm in depth often highly calcareous.</p> <p>Run-off source zones, nil vulnerability to erosion.</p>	<p>Open to very sparse mixed height shrubland (PFC 10-30%) dominated by <i>Acacia quadrimarginea</i>, <i>Acacia</i> sp., <i>Dodonaea lobulata</i> and <i>Eremophila scoparia</i> with very sparse overstorey of <i>Casuarina pauper</i>.</p> <p>Mid-dense <i>A. quadrimarginea</i> and <i>Acacia</i> sp shrublands (PFC 40-50%) are common on mid slopes.</p> <p>“Greenstone hill acacia shrubland” (GHAS vegetation community)</p>






Land unit	Land form and soil type	Vegetation community
<b>1b. Basalt hills continued</b> 		<p>Occasional pockets of very sparse <i>Eucalyptus lesouefii</i> woodlands with minimal understory.</p> <p>“Greenstone hill non-halophytic woodlands” (GNEW vegetation community)</p>
<b>1c. Felsic hills breakaways and footslopes</b> 	<p>Breakaways and low hills with relief of 10m and footslopes with slopes of 2-4%, Common to many (20-50%) surface mantles of medium to coarse gravel and cobbles of felsic rocks and quartz fragments.</p> <p>Deep sandy loam gradational to light clay. Non-calcareous.</p> <p>Run-off source zones, slight to moderate vulnerability to erosion.</p>	<p>Very sparse woodland of <i>Eucalyptus salubris</i>, <i>E. griffithsii</i> and <i>E. oleosa</i> subsp. <i>oleosa</i> (PFC 10-15%) over very sparse chenopod shrubland of <i>Atriplex</i> spp. with <i>Eremophila scoparia</i>.</p> <p>“Breakaway footslope eucalypt woodland with chenopod understory” (BECW vegetation community).</p>

Land unit	Land form and soil type	Vegetation community
<b>1e. Upland basalt surfaces</b> 	<p>Upper slopes of basalt hills with slopes to 5%, very abundant (&gt;90%) surface mantles of medium to coarse gravel and cobbles of basalt.</p> <p>Skeletal sandy loam to sandy clay loams less than 15cm. Non-calcareous.</p> <p>Run-off source zones, nil vulnerability to erosion.</p>	<p>Very sparse (PFC 10%) low shrubland dominated by <i>Thryptomene eremaea</i> with very sparse <i>Acacia quadrimarginea</i> overstorey and emergent <i>Casuarina pauper</i>.</p> <p>“Greenstone hill mixed shrubland” (GHMS vegetation community)</p>
<b>2a. Low lateritic rises</b> 	<p>Low hillocks and gentle low rises with slopes to 3%, relief up to 5m, abundant (90%) surface mantles of fine to coarse gravel of laterite with occasional calcrete and quartz.</p> <p>Mostly shallow sandy loams or sandy clay loams often gradational to calcareous light clay and overlaying calcrete.</p> <p>Run-off source zones, nil to slight vulnerability to erosion.</p>	<p>Very sparse to open mixed-height shrubland (PFC 10-25%) dominated by <i>Acacia hemiteles</i>, <i>Acacia</i> sp, <i>Dodonaea lobulata</i>, <i>Scaevola spinescens</i> and <i>Ptilotus obovatus</i> with sparse overstorey of <i>Casuarina pauper</i>, <i>A. stowardii</i> and/or <i>Eucalyptus lesouefii</i>.</p> <p>“Stony ironstone acacia shrubland” (SIAS vegetation community)</p>



Land unit	Land form and soil type	Vegetation community
<b>2b. Low rises on basalt</b> 	<p>Low hills and rises with slopes to 2%, relief to 5 m and common to abundant mantles (10–90%) fine to coarse gravels of basalt, quartz and calcrete.</p> <p>Mostly, shallow highly calcareous sandy loams to sandy clay loams over calcrete.</p> <p>Run –off source zones to lower parts of the landscape occasionally via shallow incised drainage channels. Slight to moderate vulnerability to erosion.</p>	<p>Very sparse to open (PFC 10 – 20%) mixed height shrublands dominated by <i>Senna artemisioides</i> subsp. <i>petiolaris</i>, <i>Dodonaea lobulata</i>, <i>Acacia burkittii</i>, <i>A. hemiteles</i> and <i>Ptilotus obovatus</i> with isolated to very sparse overstorey of <i>Casuarina pauper</i> and occasionally <i>Acacia incurvaneura</i> or <i>Eucalyptus salmonophloia</i></p> <p>“Greenstone hill acacia shrubland” (GHAS vegetation community)</p>
<b>4b. Plains supporting acacia shrublands on hardpan.</b> 	<p>Gently inclined to level plains (slopes &lt;1%); mostly many to abundant (20-90%) mantles of ironstone fine to medium gravel and quartz fragments.</p> <p>Non-calcareous sandy loam to sandy clay loams over ferruginous hardpan at &gt;30cms.</p> <p>Broad transfer zones receiving water from upper units and shedding onto lower parts of landscape. Not vulnerable to erosion.</p>	<p>Very sparse to open tall acacia shrublands (PFC 10 -30%) dominated by <i>Acacia incurvaneura</i>, <i>A. ramulosa</i> and very sparse lower shrubs commonly <i>Dodonaea rigida</i>, with overstoreys of isolated <i>Casuarina pauper</i> or <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>.</p> <p>“Hardpan plain mulga shrubland” (HPMS vegetation community)</p>

Land unit	Land form and soil type	Vegetation community
<b>4c. Calcareous plains supporting chenopod shrublands</b>		
	Gently inclined to level plains (slopes <1%); with variable mantles of fine to coarse ironstone or basalt gravel, calcrete nodules and quartz fragments.	Very sparse to open, mostly degraded <i>Maireana sedifolia</i> shrubland (PFC 10-25%) with colonizing shrubs including <i>Dodonaea lobulata</i> , <i>Senna artemisioides</i> subsp. <i>petiolaris</i> and <i>Eremophila scoparia</i> with very sparse overstorey of <i>Casuarina pauper</i> .
	Mostly calcareous sandy clay loams gradational to light clays greater than 30cms.	
	Broad transfer zones receiving water from upper units and shedding onto lower parts of landscape. Slightly to moderately vulnerable to erosion with minor to moderate sheet and rill erosion.	“Plain mixed halophyte shrubland” (PXHS vegetation community).
<b>5b. Alluvial plains supporting chenopod shrublands and salmon gums</b>		
	Gently sloping plains (slopes 1%) with very few to few mantles (<2-10%) of fine to coarse gravels of ironstone, basalt and quartz fragments.	Open, often degraded, chenopod shrublands (PFC 20-30%) dominated by <i>Atriplex vesicaria</i> , <i>A. bunburyana</i> , <i>A. nummularia</i> or <i>Maireana pyramidalata</i> , and in poor condition dominated by <i>Senna artemisioides</i> subsp. <i>petiolaris</i> , <i>Eremophila scorparia</i> , <i>Acacia hemiteles</i> with very sparse <i>Eucalyptus salmonophloia</i> , <i>E. salubris</i> overstorey and mid-dense groves of <i>E. salubris</i> .
	Deep sandy clay loam gradational to light clay or deep light clay often calcareous.	
	Subject to shallow sheet flow, occasionally more concentrated. Stripped soil surfaces common. Moderate vulnerability to erosion.	“Plain eucalypt chenopod shrubland” (PECW vegetation community).

Land unit	Land form and soil type	Vegetation community
<b>6. Drainage tracts</b> 	<p>Gently sloping (1%) drainage tracts 50 – 200m wide with occasional minor channels, mostly without surface mantles, and abundant litter trains.</p> <p>Deep, sandy loam to sandy clay.</p> <p>Slight to moderate vulnerability to water erosion.</p>	<p>Open to mid-dense (PFC: 20 – 60%), tall acacia shrubland and occasional thickets dominated by <i>Acacia ramulosa</i> and <i>A. burkittii</i> with very sparse undershrubs including <i>Senna artemisioides</i> ssp. <i>petiolaris</i> and <i>S. cardiosperma</i> with isolated <i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>, or <i>Casuarina pauper</i> overstorey.</p> <p>“Drainage tract acacia shrubland” (DRAS vegetation community)</p>

(PFC): Projected foliar cover

\*\* (SIAS etc.) vegetation types see Table 6.



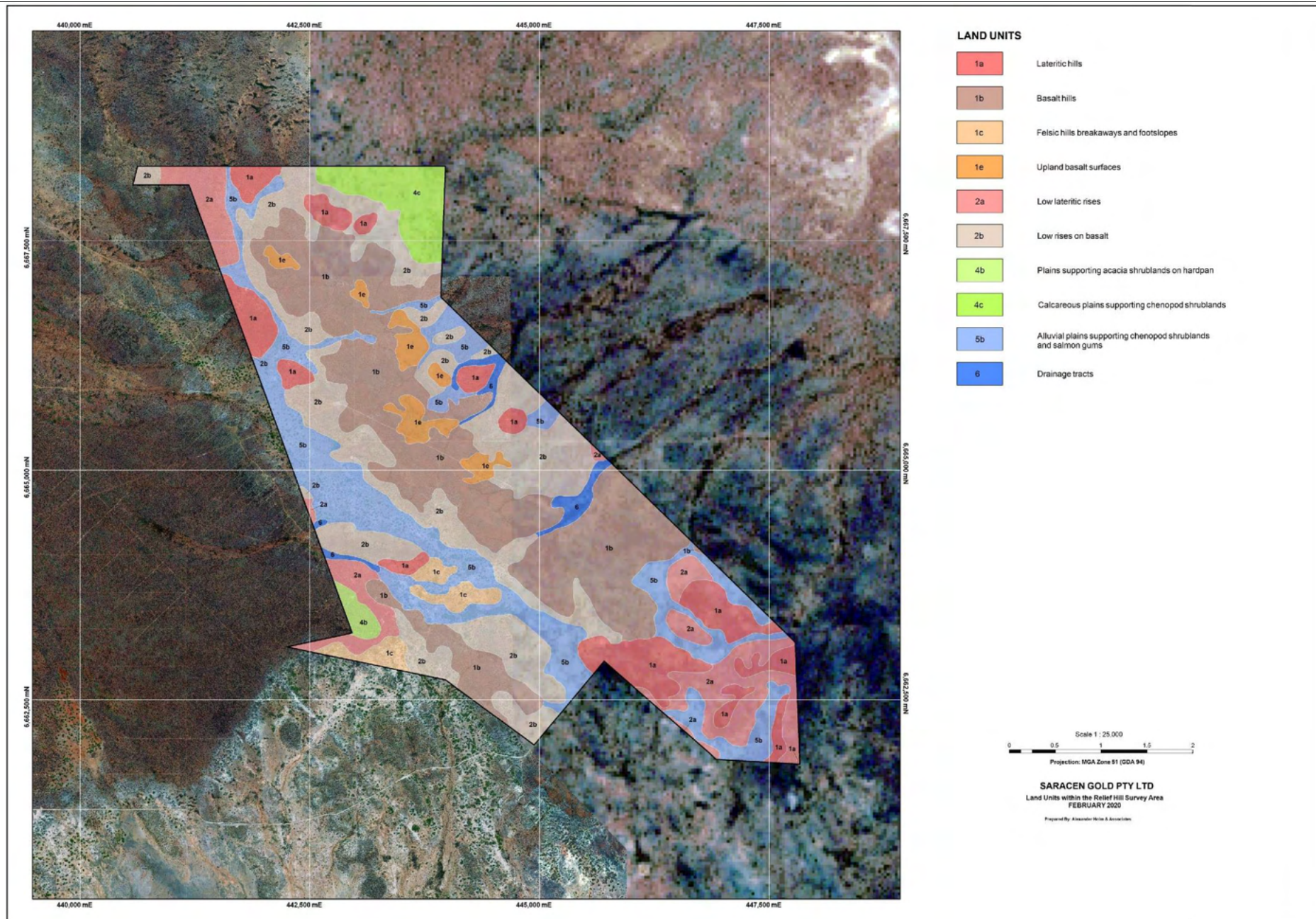


Figure 7: Map of land units

## ***Land unit areas***

Over 50% of the survey area is occupied by low hills and rises on basalt supporting very sparse to open mixed height shrublands with very sparse overstoreys of casuarina (land units 1b, 1e and 2b). Low hills and rises on laterite, commonly supporting acacia-dominated, very sparse to open shrublands with very sparse overstoreys of casuarina or eucalyptus, occupy approximately 20% of the area (land units 1a and 2a). Chenopod shrublands occur on approximately 20% of the area either on calcareous plains (land unit 4c) or alluvial plains (land unit 5b). Felsic breakaways, acacia shrublands on hardpan and drainage tracts are minor components of the landscape (Table 5).

**Table 4: Area of each land unit within the extended survey area**

<b>Land unit</b>	<b>Description</b>	<b>Hectares</b>	<b>%</b>
1a.	Lateritic hills	213.63	10.25
1b.	Basalt hills	596.21	28.60
1c.	Felsic hills breakaways and footslopes	43.98	2.11
1e	Upland basalt surfaces	58.28	2.80
2a.	Low lateritic rises	186.87	8.96
2b.	Low rises on basalt	484.61	23.25
4b.	Plains supporting acacia shrublands on hardpan	15.18	0.73
4c.	Calcareous plains supporting chenopod shrublands	77.99	3.74
5b.	Alluvial plains supporting chenopod shrublands and salmon gums	376.37	18.06
6.	Drainage tracts	31.43	1.51
<b>Total</b>		<b>2084.55</b>	<b>100.00</b>

## ***Vegetation communities***

Land units on laterite are mostly occupied by ‘Stony ironstone acacia shrubland’ (SIAS) or ‘Breakaway mixed shrubland’ (BRXS). (Table 5). Land units on basalt are occupied by ‘Greenstone hill acacia shrubland’ and ‘Greenstone hill mixed shrubland’ (GHAS and GHMS) with pockets of ‘Greenstone hill non-halophytic woodlands’ (GNEW) on lower slopes while those on felsic geology, in the south west, are ‘Breakaway footslope eucalypt woodland with chenopod understory’ (BECW).

‘Hardpan plain mulga shrubland’ (HPMS) occupy extensive plains extending west from the south western margin of the survey area. ‘Plain mixed halophyte low shrublands’ (PXHS) occur on plains in north eastern areas which are often degraded. The lowest parts of the landscape are occupied with ‘Plain eucalypt chenopod woodland’ (PECW) discharging overland flows through ‘Drainage tract acacia shrubland’ (DRAS) to Lake Rebecca.

**Table 5: Vegetation communities, associated land units and vulnerability to disturbance.**

Vegetation community	Description	Land unit	Vulnerable
BECW	Breakaway footslope eucalypt woodland with chenopod understory (S)	1c	
BRXS	Breakaway mixed shrubland (N)	1a	
DRAS	Drainage tract acacia shrubland (S)	6	
GHAS	Greenstone hill acacia shrubland (N)	1b 2b	
GHMW	Greenstone hill mixed shrubland	1e	
GNEW	Greenstone hill non-halophytic woodlands (N)	1b	
HPMS	Hardpan plain mulga shrubland (N)	4b	
PECW	Plain eucalypt chenopod woodland (N)	5b	Yes
PXHS	Plain mixed halophyte low shrublands (N)	4c	Yes (C)
SIAS	Stony ironstone acacia shrubland (N)	1a 2a	

\*(N)(Pringle, Van Vreeswyk & Gilligan, 1994); (S) (Payne, Van Vreeswyk, Pringle, Leighton and Hennig 1998) (C) (Cowan, 2001)

## Vegetation and soil condition

The survey area has been disturbed by recent and historic mining activity and is mostly within a pastoral lease and has been grazed. Vehicle tracks, cut lines and pastoral fences cross the area.

Land units supporting chenopod vegetation, preferentially grazed by livestock, are mostly degraded and few areas are in good condition (Table 6). Hills on laterite and basalt geology are mostly in good to excellent condition while lower slopes on basalt are often in poorer condition.

Minor to moderate soil erosion is evident on felsic footslopes, calcareous and alluvial plains (land units 1c, 4c and 5b) and these land units are rated as slightly to moderately vulnerable to erosion (Table 6). Other land units are mostly rated nil or slightly vulnerable to soil erosion and some areas on these units are slightly eroded.

**Table 6: Vegetation and soil surface condition ratings for each land unit**

<b>Land unit</b>	<b>Vulnerability to erosion</b>	<b>Erosion status</b>	<b>Vegetation condition</b>
1a. Lateritic hills	Nil-slight	70% nil 30% minor	90% excellent/good 10% fair
1b. Basalt hills	Nil-slight	94% nil to minor 6% moderate	94% excellent/good 6% fair
1c. Felsic hills breakaways and footslopes	Slight - moderate	50% slight 50% moderate	100% good
1e. Upland basalt surfaces	Nil	100% nil	100% excellent
2a. Low lateritic rises	Nil -slight	100% nil to minor	100% excellent/good
2b. Low rises on basalt	Nil -slight	100% nil to minor	28% excellent/good 29% fair 43% poor
4b. Plains supporting acacia shrublands on hardpan	Nil -slight	100% nil	100% excellent/good
4c. Calcareous plains supporting chenopod shrublands	Slight to moderate	20% minor 80% moderate	60% fair 40% degraded
5b. Alluvial plains supporting chenopod shrublands and salmon gums	Slight to Moderate	67% nil to minor 33% moderate	33% excellent/good 50% fair 17% degraded
6. Drainage tracts	Slight to moderate	100% minor	50% good 50% fair



## Threatened ecosystems and wetlands.

### ***Threatened and priority ecological communities***

There are no identified threatened ecological communities (TECs) on Saracen tenements or in the entire MUR1 biogeographic subregion (Cowan, 2001).

There are no listed priority ecological communities (PECs) in the area.

### ***Ecosystems at risk***

Cowan, (2001) lists PXHS vegetation community (Plain mixed halophyte low shrublands) as an ecosystem at risk to disturbance (Table 5). PXHS vegetation community is associated with land unit 4c, 40% of which was degraded through over grazing. This current survey also identifies PECW (Plain eucalypt chenopod woodland) as an ecosystem at risk in that over two thirds is in fair or degraded condition. PXHS and PECW occur on land unit 4c and 5b which are moderately vulnerable to erosion and erosion is evident (Table 6).

### ***Significant wetlands***

There are no nationally significant wetlands in the area (Appendix 1). Lake Rebecca is a major wetland with local and regional significance.

### ***Riparian vegetation***

The survey landscape mainly drains via overland flow to drainage tracts (land unit 6) which flows into Lake Rebecca. These drainage tracts carry ephemeral flows for short periods and do not support riparian vegetation.

## Flora

### ***General***

Ninety-nine flora taxa representing 22 families were found during the reconnaissance survey (Table 7). Chenopodiaceae accounted for 19 taxa, Fabaceae 24 taxa and Scrophulariaceae 16 taxa. There were two sterile specimens which were identified to genera level.

A list of species within each family found at each inventory site is presented in Attachment 3. Species typifying the survey area include: *Ptilotus obovatus*, *Dodonaea lobulata*, *Scaevola spinescens*, *Acacia tetragonophylla*, *Casuarina pauper* and *Senna artemisioides* subsp. *petiolaris* all present on at least 70% of sites.

### ***Local endemics***

No taxa are considered to be locally endemic.

### ***Range extension***

No taxa were collected outside of their known distribution range.



### ***Declared weed species***

No alien to Western Australia (weed) species were located during survey.

### ***Threatened and priority flora***

There are two threatened flora taxa (WA Wildlife Conservation Act 1950 – Wildlife Conservation (Rare Flora) Notice 2010(2) likely to occur in the general area: *Eucalyptus articulata* and *Gastrolobium graniticum* which is also an endangered species under the Commonwealth EPBC Act.

No threatened (rare) or endangered flora taxa were found during this survey.

*Eremophila arachnoides* subsp. *tenera*, a Priority 1 taxa is known to occur on nearby tenements with similar landunits. None were found during this survey.

Several populations, each with scores of individuals, of *Thryptomene eremaea*, a Priority 2 taxa, were mostly found confined to Land Unit 1e (Upland basalt surfaces) and occasionally on other basaltic units.

**Table 7: List of flora taxa found during field survey in January 2020.**

Family	Taxa	1a	1b	1c	1e	2a	2b	4b	4c	5b	6
Amaranthaceae	<i>Ptilotus obovatus</i>	y	y			y	y	y	y	y	y
Apocynaceae	<i>Alyxia buxifolia</i>	y	y				y			y	
Apocynaceae	<i>Marsdenia australis</i>		y			y	y		y		y
Apocynaceae	<i>Vincetoxicum lineare</i>		y								
Asteraceae	<i>Cratystylis microphylla</i>	y									
Asteraceae	<i>Olearia muelleri</i>	y	y	y		y	y		y	y	y
Asteraceae	<i>Podolepis capillaris</i>	y	y		y						
Casuarinaceae	<i>Casuarina pauper</i>	y	y		y	y	y	y	y	y	y
Chenopodiaceae	<i>Atriplex codonocarpa</i>									y	
Chenopodiaceae	<i>Atriplex stipitata</i>									y	
Chenopodiaceae	<i>Atriplex bunburyana</i>		y	y		y	y		y	y	
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>		y	y		y	y		y	y	
Chenopodiaceae	<i>Atriplex vesicaria</i>			y		y			y	y	
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>									y	
Chenopodiaceae	<i>Enchylaena lanata</i>									y	
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>		y	y					y	y	
Chenopodiaceae	<i>Maireana georgei</i>		y				y		y	y	
Chenopodiaceae	<i>Maireana integra</i>						y			y	
Chenopodiaceae	<i>Maireana pentatropis</i>	y	y	y			y		y		
Chenopodiaceae	<i>Maireana pyramidata</i>		y			y			y	y	
Chenopodiaceae	<i>Maireana sedifolia</i>	y	y	y		y	y		y	y	y
Chenopodiaceae	<i>Maireana tomentosa</i>			y		y				y	
Chenopodiaceae	<i>Maireana triptera</i>		y	y		y	y		y	y	
Chenopodiaceae	<i>Rhagodia drummondii</i>								y	y	
Chenopodiaceae	<i>Rhagodia eremaea</i>		y							y	
Chenopodiaceae	<i>Sclerolaena cuneata</i>								y	y	
Chenopodiaceae	<i>Sclerolaena diacantha</i>		y	y		y	y		y	y	y
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>						y		y	y	
Chenopodiaceae	<i>Tecticornia disarticulata</i>			y						y	
Fabaceae	<i>Acacia aptaneura</i>	y	y								
Fabaceae	<i>Acacia ayersiana</i>	y	y			y	y	y	y	y	
Fabaceae	<i>Acacia burkittii</i>	y	y	y	y	y	y		y	y	y

Family	Taxa	1a	1b	1c	1e	2a	2b	4b	4c	5b	6
Fabaceae	<i>Acacia erinacea</i>	y	y	y		y	y			y	
Fabaceae	<i>Acacia hemiteles</i>	y	y			y	y	y	y	y	y
Fabaceae	<i>Acacia incurvaneura</i>	y	y		y		y	y	y		
Fabaceae	<i>Acacia kempeana</i>					y					
Fabaceae	<i>Acacia ligulata</i>	y	y			y	y		y	y	y
Fabaceae	<i>Acacia nyssophylla</i>	y	y				y			y	
Fabaceae	<i>Acacia oswaldii</i>	y	y			y	y			y	y
Fabaceae	<i>Acacia quadrimarginea</i>	y	y		y	y	y	y			y
Fabaceae	<i>Acacia ramulosa</i> var. <i>linophylla</i>	y	y			y		y			y
Fabaceae	<i>Acacia sibirica</i>	y	y		y	y	y	y		y	y
Fabaceae	<i>Acacia tetragonophylla</i>	y	y		y	y	y	y	y	y	
Fabaceae	<i>Acacia</i> sp	y	y		y	y	y	y	y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>×sturtii</i>								y		
Fabaceae	<i>Senna artemisioides</i> subsp. <i>filifolia</i>	y	y			y	y			y	
Fabaceae	<i>Senna artemisioides</i> subsp. <i>petiolaris</i>	y	y	y	y	y	y		y	y	y
Fabaceae	<i>Senna artemisioides</i> subsp. <i>x artemisioides</i>		y			y		y		y	y
Fabaceae	<i>Senna cardiosperma</i>		y		y		y				y
Fabaceae	<i>Templetonia incrassata</i>	y					y		y		
Frankeniaceae	<i>Frankenia</i> sp.			y		y				y	
Goodeniaceae	<i>Scaevola spinescens</i>	y	y		y	y	y	y	y	y	
Lamiaceae	<i>Prostanthera althoferi</i> subsp. <i>althoferi</i>		y		y			y			
Lamiaceae	<i>Teucrium disjunctum</i>						y				y
Lamiaceae	<i>Westringia rigida</i>	y									
Malvaceae	<i>Brachychiton gregorii</i>		y		y			y		y	
Malvaceae	<i>Sida calyxhymenia</i>					y		y			
Myrtaceae	<i>Eucalyptus gracilis</i>		y								
Myrtaceae	<i>Eucalyptus lesouefii</i>	y	y			y	y			y	
Myrtaceae	<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>								y		
Myrtaceae	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>	y	y	y		y	y	y	y		y
Myrtaceae	<i>Eucalyptus salmonophloia</i>		y			y	y			y	
Myrtaceae	<i>Eucalyptus salubris</i>	y	y	y		y				y	
Myrtaceae	<i>Eucalyptus concinna</i>								y		
Myrtaceae	<i>Eucalyptus yilgarnensis</i>									y	
Myrtaceae	<i>Thryptomene eremaea</i>				y		y				

Family	Taxa	1a	1b	1c	1e	2a	2b	4b	4c	5b	6
Pittosporaceae	<i>Pittosporum angustifolium</i>								y	y	
Poaceae	<i>Austrostipa elegantissima</i>	y	y		y	y	y		y	y	
Poaceae	<i>Austrostipa scabra</i>								y		
Poaceae	<i>Triodia irritans</i>				y						
Proteaceae	<i>Grevillea acuaria</i>	y				y				y	
Proteaceae	<i>Grevillea nematophylla</i> subsp. <i>nematophylla</i>		y								
Proteaceae	<i>Grevillea stenobotrya</i>	y									
Proteaceae	<i>Hakea preissii</i>		y						y		
Rubiaceae	<i>Psydrax suaveolens</i>	y							y	y	
Rutaceae	<i>Philotheca brucei</i> subsp. <i>brucei</i>	y									
Santalaceae	<i>Exocarpos aphyllus</i>	y		y			y		y	y	
Santalaceae	<i>Santalum acuminatum</i>			y		y				y	
Santalaceae	<i>Santalum spicatum</i>	y	y		y	y	y	y	y	y	
Sapindaceae	<i>Alectryon oleifolius</i>		y			y	y		y	y	
Sapindaceae	<i>Dodonaea lobulata</i>	y	y		y	y	y		y	y	y
Sapindaceae	<i>Dodonaea rigida</i>	y	y		y	y		y			
Sapindaceae	<i>Dodonaea stenozyga</i>	y									
Scrophulariaceae	<i>Eremophila alternifolia</i>						y		y		
Scrophulariaceae	<i>Eremophila caperata</i>			y							
Scrophulariaceae	<i>Eremophila decipiens</i> subsp. <i>decipiens</i>	y	y			y	y		y	y	y
Scrophulariaceae	<i>Eremophila eriocalyx</i>					y					
Scrophulariaceae	<i>Eremophila georgei</i>	y	y		y	y	y	y	y	y	y
Scrophulariaceae	<i>Eremophila glabra</i> subsp. <i>glabra</i>		y								
Scrophulariaceae	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	y	y		y	y	y	y	y		
Scrophulariaceae	<i>Eremophila longifolia</i>					y	y			y	
Scrophulariaceae	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>	y	y	y	y	y	y	y	y	y	y
Scrophulariaceae	<i>Eremophila oppositifolia</i> subsp. <i>angustifolia</i>	y	y			y				y	
Scrophulariaceae	<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>	y	y	y		y					
Scrophulariaceae	<i>Eremophila pustulata</i>	y		y							
Scrophulariaceae	<i>Eremophila scoparia</i>	y	y	y		y	y		y	y	y
Scrophulariaceae	<i>Eremophila</i> sp. Plumridge Lakes (S.G.M. Carr 534)			y				y		y	
Solanaceae	<i>Solanum lasiophyllum</i>	y	y	y	y	y	y	y	y	y	
Violaceae	<i>Hybanthus floribundus</i> subsp. <i>curvifolius</i>				y						



# Fauna

## Survey results

Four reptiles and fifteen mammals were recorded during this survey. Of the mammals six were introduced species. Twenty-six species of bird were recorded (Attachment 7).

## Conservation significant fauna

### *Malleefowl*

Malleefowl have been long-term breeding residents in the Relief Hill area as evidenced by old and new mounds. Vegetation associations with sparse through to dense acacia on loam and gravelly hills were present – providing suitable habitat for this species. Two fresh (i.e. active at the time of the site inspection) mounds found by a limited survey effort (level 1 and few days), suggests the likelihood of many more in the proposed project area.



**Figure 8: Recently active Malleefowl mound at 441659E, 6664603N**

All Malleefowl mounds are of interest; not just active mounds containing eggs. Well-established, recently used and those mounds used over an extended period of time should all be considered important and included in the impact assessment, as loss of such mounds can adversely affect the local Malleefowl population. Similarly, where significant mounds exist, the surrounding habitat must be considered important in terms of impact assessment for the species given their decline over the recent few decades. However, active and closed mounds should be actively protected until the chicks have hatched and dispersed.

### *Peregrine Falcon*

Peregrine Falcon were not observed but are a widespread species and considered likely to be a regular visitor if not resident. It could also breed in tall eucalypts in the area, probably by utilising old nests of the Australian Raven which were observed during this assessment.

*Rainbow Bee-eater.*

This species is only considered of local significance but was formerly listed as Migratory under legislation. It is still considered locally significant as it is a true migrant and breeds in burrows in the area, making it vulnerable to disturbance and predation. It will also often nest along tracks, increasing its vulnerability. No nests were observed however this species is a likely visitor.

## **Hydrological summary**

The survey landscape mainly drains via overland flow to broad drainage tracts (land unit 6) which flow indeterminately into Lake Rebecca.

# ASSESSMENT IN RELATION TO CLEARING PRINCIPLES

Results of this survey are used to assess clearing within the survey area in relation to ten clearing principles prescribed in Schedule 5 under amendments in 2004 to the Environmental Protection Act (1986):

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

The survey area is in the south-east of Eastern Murchison (MUR 1) bio-geographic subregion and adjacent to Shield and Eastern Goldfields bio-geographic sub-regions. Lake Ballard/Lake Rebecca form 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 (black oak) and *Eucalyptus* species on alkaline and calcareous soils to the south. The survey area straddles this vegetation divide.

Beard Vegetation Association 529 (Succulent steppe with open low woodland; mulga and sheoak over salt bush) is the most common vegetation association in the survey area occupying 69%. Vegetation Association 24 (Low woodland; *Casuarina obesa*) occupies 28% and the remaining 3% is Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) (Beard 1976).

Ninety-nine flora taxa representing 22 families were found during the reconnaissance survey (Table 7). Chenopodiaceae accounted for 19 taxa, Fabaceae 24 taxa and Scrophulariaceae 16 taxa.

Vegetation associations and species composition are typical of the area and are 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.**

Malleefowl are active in the survey area. Malleefowl mounds are of importance for the birds, whether or not they are active or recently-used, while active mounds (containing eggs) are of special value.

Large Eucalypt trees, common in land unit 5b, may support nesting by the Peregrine Falcon (and other birds).



**Proposal is 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 listed species of rare or critically endangered flora were found during this survey.

A search of the Department of Environment and Conservation's Rare and Priority Flora Database revealed no records of Declared Rare Flora (DRF) in or nearby the survey area.

**The proposal is not 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 east Goldfields subregion (Cowan, 2001).

There are no Priority Ecological Communities within or adjacent to the survey area.

Several populations, each with scores of individuals, of *Thryptomene eremaea*, a Priority 2 taxa, were found mostly confined to Land Unit 1e (Upland basalt surfaces).

**The proposal is 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.**

Beard Vegetation Association 529 (Succulent steppe with open low woodland; mulga and sheoak over salt bush) is the most common vegetation association in the survey area occupying 69%. Vegetation Association 24 (Low woodland; *Casuarina obesa*) occupies 28% and the remaining 3% is Association 20 (Low woodland: mulga mixed with *Casuarina obesa* and *Eucalyptus* spp.) (Beard 1976).

Vegetation Association 20 occupies approximately 13,000 km<sup>2</sup> in Western Australia of which 16.7% is within conservation reserves and although less than 1% of Vegetation Association 24, which occupies approximately 266 km<sup>2</sup> in Western Australia, is within reserves, both have a low priority for conservation (Table 1). Vegetation Association 529 is very poorly conserved and has a high priority for conservation.

Vegetation Association 529 has not been extensively cleared and clearing within this survey area will have minimal effect on extent of this vegetation community.

**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.**

The survey landscape mainly drains via overland flow through drainage tracts (land unit 6) into Lake Rebecca 5 km to the north. Lake Rebecca is a major wetland with local and regional significance.

**Proposal maybe 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 has been disturbed by recent mining activity, is mostly within a pastoral lease and has been grazed. Vehicle tracks and pastoral fences cross the area.

Land units supporting chenopod vegetation, preferentially grazed by livestock, are mostly degraded and few areas are in good condition. Hills on laterite and basalt geology are mostly in good to excellent condition while lower slopes on basalt are often in poorer condition.

Minor to moderate soil erosion is evident on felsic footslopes, calcareous and alluvial plains (land units 1c, 4c and 5b) and these land units are rated as slightly to moderately vulnerable to erosion. Other land units are mostly rated nil or slightly vulnerable to soil erosion and some areas on these units are slightly eroded.

Extensive clearing within land units 4c and 5b is likely to lead to further soil erosion. Limited strip clearing is unlikely to cause extensive land degradation.

Water tables are a) below the rooting depth of vegetation growing in these areas and b) mostly hypersaline. Extensive clearing of vegetation at catchment-scale or artificial recharge of the water table may raise saline water tables and lead to secondary salinity in surrounding landscapes.

Clearing of vegetation at local scales will have minimal, if any, effect on water tables and associated risk of secondary salinity.

**Proposal is 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 are nearby.

**Proposal is 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.**

Minor to moderate soil erosion is evident on felsic footslopes, calcareous and alluvial plains (land units 1c, 4c and 5b) and these land units are rated as slightly to moderately susceptible to erosion. Disturbance to these land units has the potential to increase

sediment discharge to drainage tracts and ultimately, and through extreme events, to Lake Rebecca.

**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 runoff.

Clearing in this proposal will have negligible effect on the volume of runoff discharged.

**Proposal is unlikely to be at variance with this principle.**

# DISCUSSION AND RECOMMENDATIONS

Saracen operates the Carosue Gold Mine and is proposing extensive exploration around its existing mine. This environmental assessment covers 2080ha approximately 6km east of Carosue Dam Operations in the Relief hill area. Adjoining areas to the west have been covered by earlier environmental assessments.

Flora composition and vegetation associations are typical of the region and not considered unusually diverse. There are no Threatened Ecological Communities (TECs) and no Priority Ecological Communities within or adjacent to the survey area.

No listed species of rare or critically endangered flora were found during this survey and no records of Declared Rare Flora (DRF) found in or nearby the survey area. Several populations, each with scores of individuals, of *Thryptomene eremaea*, a Priority 2 taxa, were found mostly confined to Land Unit 1e (Upland basalt surfaces).

No alien to Western Australia (weed) species were located during survey.

The survey landscape mainly drains via overland flow to drainage tracts (land unit 6) which flow into Lake Rebecca. Lake Rebecca is a major wetland with local and regional significance.

Chenopod shrublands occur on approximately 20% of the area either on calcareous plains (land unit 4c) or alluvial plains (land unit 5b) where soil erosion is evident. These systems support PXHS vegetation community (Plain mixed halophyte low shrublands) and PECW (Plain eucalypt chenopod woodland) which are degraded through over grazing. Disturbance to land units 4c and 5b has the potential to increase sediment discharge to drainage tracts and ultimately, and through extreme events, to Lake Rebecca.

Malleefowl are active in the survey area. Malleefowl mounds are of importance for the birds, whether or not they are active or recently-used. Malleefowl mounds are active from about May to December and depending on rainfall into January. Active mounds containing eggs are of special value.

Large Eucalypt trees, common in land unit 5b, may support nesting by the Peregrine Falcon (and other birds).

It is recommended that, in planning and implementing seismic operations within the survey area, the proponent:

- 1. Avoids disturbance to land unit 1e (Upland basalt surfaces) preferred habitat for *Thryptomene eremaea* a Priority 2 taxa.**
- 2. Undertakes a Malleefowl survey especially within land units 1a, 2a and 4b and avoids disturbance within 50m of active Malleefowl nests during nesting and incubation.**

- 3. Avoids destruction of mature Eucalyptus trees with nesting hollows**
- 4. Old trees, dead trees, fallen logs and termite mounds should be “gently” tipped over and left overnight to allow fauna to disperse**
- 5. Takes measures to minimise erosion through soil disturbance and concentration of overland water flows on vulnerable land units, especially calcareous plains (land unit 4c) and alluvial plains (land unit 5b).**
- 6. Avoids disturbance to drainage channels (land unit 6).**

# REFERENCES

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## **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: ‘NatureMap’ report**



# NatureMap Species Report

Created By Guest user on 16/12/2019

**Conservation Status** Conservation Taxon (T, X, IA, S, P1-P5)  
**Current Names Only** Yes  
**Core Datasets Only** Yes  
**Method** 'By Circle'  
**Centre** 122° 25' 17" E, 30° 08' 47" S  
**Buffer** 40km  
**Group By** Kingdom

Kingdom	Species	Records
Animalia	1	56
Plantae	2	4
<b>TOTAL</b>	<b>3</b>	<b>60</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Animalia</b>				
1.	24557 <i>Leipoa ocellata</i> (Malleefowl)		T	
<b>Plantae</b>				
2.	5746 <i>Eucalyptus pimpleana</i>		P3	
3.	19695 <i>Thryptomene eremaea</i>		P2	

**Conservation Codes**  
T - Rare or likely to become extinct  
X - Presumed extinct  
IA - Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

## **Attachment 2: ‘Protected matters’ search tool output**





# 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: 16/12/19 15:29:50

[Summary](#)

[Details](#)

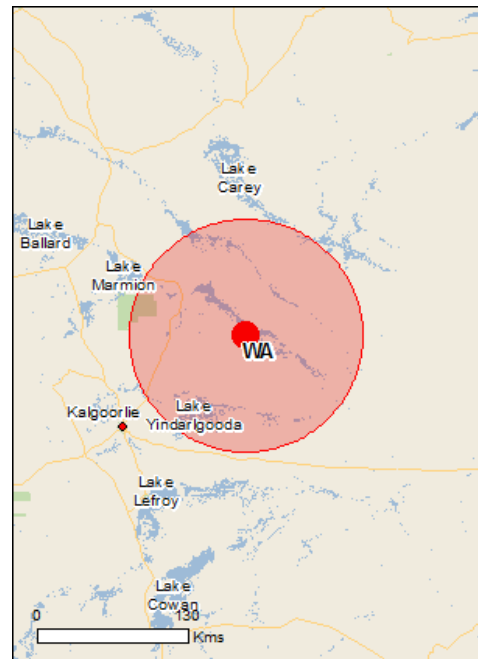
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are  
©Commonwealth of Australia  
(Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 100.0Km



# 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](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	None
<a href="#">Listed Threatened Species:</a>	10
<a href="#">Listed Migratory Species:</a>	9

## 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.

<a href="#">Commonwealth Land:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	14
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Australian Marine Parks:</a>	None

## Extra Information

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

<a href="#">State and Territory Reserves:</a>	6
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	14
<a href="#">Nationally Important Wetlands:</a>	1
<a href="#">Key Ecological Features (Marine)</a>	None



# Details

## Matters of National Environmental Significance

Listed Threatened Species		[ Resource Information ]
Name	Status	Type of Presence
Birds		
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pezoporus occidentalis</a> Night Parrot [59350]	Endangered	Species or species habitat may occur within area
<a href="#">Polytelis alexandrae</a> Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Mammals		
<a href="#">Dasyurus geoffroii</a> Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
<a href="#">Sminthopsis psammophila</a> Sandhill Dunnart [291]	Endangered	Species or species habitat likely to occur within area
Plants		
<a href="#">Eucalyptus articulata</a> Ponton Creek Mallee [56772]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Gastrolobium graniticum</a> Granite Poison [14872]	Endangered	Species or species habitat likely to occur within area
<a href="#">Hibbertia crispula</a> Oldea Guinea-flower [15222]	Vulnerable	Species or species habitat may occur within area
<a href="#">Tecticornia flabelliformis</a> Bead Glasswort [82664]	Vulnerable	Species or species habitat known to 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		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species

Name	Threatened	Type of Presence
habitat likely to occur within area		
<b>Migratory Terrestrial Species</b>		
<a href="#">Motacilla cinerea</a>		
Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a>		
Yellow Wagtail [644]		Species or species habitat may occur within area
<b>Migratory Wetlands Species</b>		
<a href="#">Actitis hypoleucos</a>		
Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a>		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
<a href="#">Calidris ferruginea</a>		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Calidris melanotos</a>		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a>		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
<a href="#">Tringa nebularia</a>		
Common Greenshank, Greenshank [832]		Species or species habitat likely to 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		
<a href="#">Actitis hypoleucos</a>		
Common Sandpiper [59309]		Species or species habitat may occur within area
<a href="#">Apus pacificus</a>		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a>		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a>		
Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Calidris acuminata</a>		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
<a href="#">Calidris ferruginea</a>		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
<a href="#">Calidris melanotos</a> Pectoral Sandpiper [858]		Species or species habitat may occur within area
<a href="#">Charadrius veredus</a> Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
<a href="#">Chrysococcyx osculans</a> Black-eared Cuckoo [705]		Species or species habitat known to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<a href="#">Thinornis rubricollis</a> Hooded Plover [59510]		Species or species habitat known to occur within area
<a href="#">Tringa nebularia</a> Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

## Extra Information

State and Territory Reserves	[ Resource Information ]
Name	State
Bullock Holes Timber Reserve	WA
Cardunia Rocks	WA
Coonana Timber Reserve	WA
Goongarrie	WA
Queen Victoria Spring	WA
Wallaby Rocks Timber Reserve	WA

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 Resources Audit, 2001.	

Name	Status	Type of Presence
<b>Birds</b>		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
<b>Mammals</b>		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
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
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		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 likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]	Species or species habitat may occur within area

Nationally Important Wetlands		[ Resource Information ]
Name		State
<a href="#">Lake Marmion</a>		WA

# 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

-30.14649 122.42139

# 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.

## **Attachment 3: List of flora taxa found at each inventory site**





Family	Taxa	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Amaranthaceae	<i>Ptilotus obovatus</i>	y	y	y	y	y	y		y	y		y	y	y	y	y
Apocynaceae	<i>Alyxia buxifolia</i>															y
Apocynaceae	<i>Marsdenia australis</i>		y				y					y				
Asteraceae	<i>Cratystylis microphylla</i>															
Asteraceae	<i>Olearia muelleri</i>			y	y	y	y		y	y		y	y			y
Asteraceae	<i>Podolepis capillaris</i>			y							y					
Casuarinaceae	<i>Casuarina pauper</i>			y	y	y	y	y	y	y	y	y	y	y	y	y
Chenopodiaceae	<i>Atriplex codonocarpa</i>															
Chenopodiaceae	<i>Atriplex stipitata</i>	y														
Chenopodiaceae	<i>Atriplex bunburyana</i>					y	y	y	y							y
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>	y	y			y	y	y	y	y		y				y
Chenopodiaceae	<i>Atriplex vesicaria</i>															
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>															
Chenopodiaceae	<i>Enchylaena lanata</i>	y														
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>												y			
Chenopodiaceae	<i>Maireana georgei</i>					y		y	y				y			y
Chenopodiaceae	<i>Maireana integra</i>					y										
Chenopodiaceae	<i>Maireana pentatropis</i>					y						y	y			
Chenopodiaceae	<i>Maireana pyramidata</i>	y														
Chenopodiaceae	<i>Maireana sedifolia</i>	y			y	y	y	y	y	y						y
Chenopodiaceae	<i>Maireana tomentosa</i>															
Chenopodiaceae	<i>Maireana triptera</i>	y				y		y				y				
Chenopodiaceae	<i>Rhagodia drummondii</i>															
Chenopodiaceae	<i>Rhagodia eremaea</i>	y							y			y				
Chenopodiaceae	<i>Sclerolaena cuneata</i>	y														
Chenopodiaceae	<i>Sclerolaena diacantha</i>	y				y						y	y			y
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>					y			y							
Chenopodiaceae	<i>Tecticornia disarticulata</i>															
Fabaceae	<i>Acacia aptaneura</i>															
Fabaceae	<i>Acacia ayersiana</i>		y	y			y		y							
Fabaceae	<i>Acacia burkittii</i>	y	y		y		y	y	y		y			y		y
Fabaceae	<i>Acacia erinacea</i>											y	y			
Fabaceae	<i>Acacia hemiteles</i>	y			y	y	y	y	y	y					y	y
Fabaceae	<i>Acacia incurvaneura</i>										y					
Fabaceae	<i>Acacia kempeana</i>									y						
Fabaceae	<i>Acacia ligulata</i>		y			y	y	y	y	y						
Fabaceae	<i>Acacia nyssophylla</i>															
Fabaceae	<i>Acacia oswaldii</i>	y	y	y	y	y		y				y				y

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Family	Taxa	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Amaranthaceae	<i>Ptilotus obovatus</i>		y	y	y	y	y	y	y	y	y	y	y	y	y	y
Apocynaceae	<i>Alyxia buxifolia</i>	y														
Apocynaceae	<i>Marsdenia australis</i>				y											
Asteraceae	<i>Cratystylis microphylla</i>															y
Asteraceae	<i>Olearia muelleri</i>	y	y		y		y	y	y	y	y	y	y	y		y
Asteraceae	<i>Podolepis capillaris</i>															
Casuarinaceae	<i>Casuarina pauper</i>	y	y		y	y	y		y	y	y	y	y	y		
Chenopodiaceae	<i>Atriplex codonocarpa</i>															
Chenopodiaceae	<i>Atriplex stipitata</i>															
Chenopodiaceae	<i>Atriplex bunburyana</i>				y									y	y	
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>										y			y	y	
Chenopodiaceae	<i>Atriplex vesicaria</i>				y						y			y	y	
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>										y					
Chenopodiaceae	<i>Enchylaena lanata</i>															
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>				y						y				y	
Chenopodiaceae	<i>Maireana georgei</i>				y						y				y	
Chenopodiaceae	<i>Maireana integra</i>														y	
Chenopodiaceae	<i>Maireana pentatropis</i>				y											
Chenopodiaceae	<i>Maireana pyramidata</i>				y						y			y	y	
Chenopodiaceae	<i>Maireana sedifolia</i>				y						y			y	y	
Chenopodiaceae	<i>Maireana tomentosa</i>										y			y	y	
Chenopodiaceae	<i>Maireana triptera</i>				y						y			y	y	
Chenopodiaceae	<i>Rhagodia drummondii</i>															
Chenopodiaceae	<i>Rhagodia eremaea</i>															
Chenopodiaceae	<i>Sclerolaena cuneata</i>															
Chenopodiaceae	<i>Sclerolaena diacantha</i>				y	y					y			y	y	
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>				y						y				y	
Chenopodiaceae	<i>Tecticornia disarticulata</i>															
Fabaceae	<i>Acacia aptaneura</i>															
Fabaceae	<i>Acacia ayersiana</i>											y				
Fabaceae	<i>Acacia burkittii</i>	y	y	y	y	y		y						y		
Fabaceae	<i>Acacia erinacea</i>	y				y	y	y			y	y	y	y	y	y
Fabaceae	<i>Acacia hemiteles</i>	y	y		y										y	
Fabaceae	<i>Acacia incurvaneura</i>											y				
Fabaceae	<i>Acacia kempeana</i>															
Fabaceae	<i>Acacia ligulata</i>	y		y				y			y	y	y	y	y	
Fabaceae	<i>Acacia nyssophylla</i>	y						y	y							
Fabaceae	<i>Acacia oswaldii</i>	y					y		y				y			

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Family	Taxa	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Amaranthaceae	<i>Ptilotus obovatus</i>	y		y	y	y	y	y			y		y		y	y
Apocynaceae	<i>Alyxia buxifolia</i>	y			y											
Apocynaceae	<i>Marsdenia australis</i>															
Asteraceae	<i>Cratystylis microphylla</i>															
Asteraceae	<i>Olearia muelleri</i>	y			y			y				y				
Asteraceae	<i>Podolepis capillaris</i>															
Casuarinaceae	<i>Casuarina pauper</i>	y	y	y	y	y	y	y			y	y	y			
Chenopodiaceae	<i>Atriplex codonocarpa</i>															y
Chenopodiaceae	<i>Atriplex stipitata</i>															
Chenopodiaceae	<i>Atriplex bunburyana</i>		y	y										y		y
Chenopodiaceae	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>		y													
Chenopodiaceae	<i>Atriplex vesicaria</i>		y													y
Chenopodiaceae	<i>Chenopodium gaudichaudianum</i>															
Chenopodiaceae	<i>Enchylaena lanata</i>															
Chenopodiaceae	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>		y											y		y
Chenopodiaceae	<i>Maireana georgei</i>		y													
Chenopodiaceae	<i>Maireana integra</i>															
Chenopodiaceae	<i>Maireana pentatropis</i>			y										y		
Chenopodiaceae	<i>Maireana pyramidata</i>		y													
Chenopodiaceae	<i>Maireana sedifolia</i>						y									
Chenopodiaceae	<i>Maireana tomentosa</i>		y											y		y
Chenopodiaceae	<i>Maireana triptera</i>		y											y		y
Chenopodiaceae	<i>Rhagodia drummondii</i>		y													
Chenopodiaceae	<i>Rhagodia eremaea</i>		y													
Chenopodiaceae	<i>Sclerolaena cuneata</i>		y													
Chenopodiaceae	<i>Sclerolaena diacantha</i>		y				y							y		y
Chenopodiaceae	<i>Sclerolaena obliquicuspis</i>															
Chenopodiaceae	<i>Tecticornia disarticulata</i>															
Fabaceae	<i>Acacia aptaneura</i>															
Fabaceae	<i>Acacia ayersiana</i>								y	y	y	y				
Fabaceae	<i>Acacia burkittii</i>		y	y	y	y	y	y				y		y		y
Fabaceae	<i>Acacia erinacea</i>	y		y	y									y	y	
Fabaceae	<i>Acacia hemiteles</i>		y								y					
Fabaceae	<i>Acacia incurvaneura</i>								y	y	y	y				
Fabaceae	<i>Acacia kempeana</i>															
Fabaceae	<i>Acacia ligulata</i>		y	y	y	y									y	
Fabaceae	<i>Acacia nyssophylla</i>				y											
Fabaceae	<i>Acacia oswaldii</i>		y		y	y						y				

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## **Attachment 4: Inventory site data on landform, soil type and erosion.**



Land unit	Site	Landsystem	Geology	Land Code*	Land form	Slope %	Relief m	Soil texture A horizon	Soil texture Subsoil	Acid reaction	Erosion
1a	RH03	Leonora	Czu	HIL	Hillock	3	10	Sandy loam		no	Nil
1a	RH20	Leonora	Ab	HIL	Hillock	3	10	Sandy loam		no	Nil
1a	RH28	Gunadocketa	Czc	HIL	Mid slope	6	15	Sandy loam		no	Nil
1a	RH37	Moriarty	Czl	PGS	Crest	2	15	Sandy clay loam		yes	Nil
1a	RH38	Moriarty	Czc	PGS	Mid slope	4	10	Sandy clay loam		yes	Moderate
1a	RH41	Moriarty	Czl	PGS	Crest	1	18	Sandy loam		yes	Nil
1a	RH42	Moriarty	Czl	HIL	Crest	1	5	Sandy clay loam		no	Nil
1a	RH45	Moriarty	Czu	PGS	Upper slope	2	2	Sandy clay loam	Light clay	yes	Moderate
1a	RH46	Moriarty	Czu	PGS	Mid slope	8	10	Sandy clay loam		yes	Minor
1a	RH63	Moriarty	Czl	HIL	Upper slope	4	4	Sandy loam		no	Nil
1b	RH11	Leonora	Ab	PGS	Mid slope	3	3	Sandy clay loam		yes	Nil
1b	RH12	Leonora	Ab	PGS	Lower slope	12		Sandy loam		yes	Nil
1b	RH13	Leonora	Abp	HIL	Mid slope	9	9	Sandy clay loam		no	Minor
1b	RH14	Leonora	Ab	PGS	Mid slope	5	5	Sandy loam		yes	Nil
1b	RH18	Leonora	Aur	PGS	Mid slope	5	5	Sandy clay loam		yes	Minor
1b	Rh24	Leonora	Ab	PGS	Mid slope	2	4	Sandy clay loam		no	Nil
1b	RH27	Leonora	Ab	PGS	Crest	10	50	Sandy clay loam		no	Nil
1b	RH32	Leonora	Ab	PGS	Upper slope	3	20	Sandy loam		yes	Minor
1b	RH35	Leonora	Ab	PGS	Upper slope	8	18	Sandy clay loam		no	Nil
1b	RH48	Leonora	Aur	FOO	Lower slope	8	10	Sandy clay loam		yes	Moderate
1b	RH49	Leonora	Aur	PGS	Crest	2	20	Sandy loam		yes	Nil
1b	RH50	Leonora	Apq	PGS	Upper slope	9	20	Sandy clay loam		yes	Nil
1b	RH51	Leonora	Aur	PGS	Mid slope	7	8	Sandy loam		yes	Nil
1b	RH56	Moriarty	Czl	HIL	Upper slope	4	8	Sandy loam		no	Nil
1b	RH64	Leonora	Aur	PGS	Crest	3	15	Sandy clay loam		yes	Nil
1b	RH65	Leonora	Ab	HIL	Crest	3	12	Sandy clay loam		no	Nil
1b	RH66	Leonora	Aus	HIL	Upper slope	5	10	Sandy clay loam		no	Nil
1c	RH58	Moriarty	ASF	PGS	Mid slope	4	6	Sandy loam	Light clay	no	Moderate
1c	RH62	Moriarty	ASF	FOO	Lower slope	2	3	Light clay		no	Minor

Land unit	Site	Landsystem	Geology	Land Code*	Land form	Slope %	Relief m	Soil texture A horizon	Soil texture Subsoil	Acid reaction	Erosion
1e	RH10	Leonora	Ab	HIL	Upper slope	4	4	Sandy loam		no	Nil
1e	RH19	Leonora	Ab	HIL	Hillock	15	25	Sandy clay loam		no	Nil
1e	RH26	Leonora	Ab	HIL	Mid slope	8	16	Sandy clay loam		no	Nil
2a	RH04	Gunadocketa	Czl	PGS	Hillock	2	2	Sandy loam		yes	Nil
2a	RH06	Gunadocketa	Czc	PGS	Mid slope	2	2	Sandy loam		yes	Nil
2a	RH09	Gunadocketa	Czc	PLC	Flat	<1		Sandy clay loam		yes	Nil
2a	RH39	Moriarty	CZu	PGS	Mid slope	4	8	Sandy clay loam	Light clay	yes	Nil
2a	RH43	Moriarty	Czc	FOO	Lower slope	3	4	Sandy loam	Light clay	yes	Minor
2a	RH52	Deadman	Czl	PGS	Mid slope	2	3	Sandy clay loam		yes	Minor
2a	RH57	Moriarty	ASF	HIL	Mid slope	2	4	Sandy loam		no	Nil
2b	RH02	Moriarty	Ab	PGS	Lower slope	2	2	Sandy clay loam		yes	Minor
2b	RH05	Leonora	Ab	PGS	Lower slope	2	2	Sandy loam		yes	Minor
2b	RH15	Leonora	Ab	PGS	Lower slope	2	2	Loamy sand		yes	Minor
2b	RH17	Moriarty	Aus	PGS	Lower slope	2	2	Sandy clay loam	Light clay	yes	Minor
2b	RH31	Gunadocketa	Czc	FOO	Lower slope	2	5	Sandy clay loam		yes	Minor
2b	RH33	Gunadocketa	Czc	PLC	Flat	1	1	Light clay		yes	Nil
2b	RH36	Leonora	Ab	PGS	Mid slope	3	10	Sandy clay loam		yes	Nil
2b	RH59	Leonora	AUR	PGS	Upper slope	6	10	Sandy loam		yes	Minor
4b	RH53	Deadman	Czl	PLO	Flat	1	1	Sandy loam		no	Nil
4b	RH54	Deadman	Czl	PLO	Flat	1	1	Sandy loam		no	Nil
4b	RH55	Deadman	Czl	PLO	Flat	1	1	Sandy clay loam		no	Nil
4c	RH21	Gunadocketa	Czc	PLC	Flat	2	4	Sandy clay loam	Light clay	yes	Moderate
4c	RH22	Gunadocketa	CZC	PLO	Flat	10	1	Sandy clay loam	Light clay	no	Moderate
4c	RH23	Gunadocketa	CZC	PLC	Flat	1	1	Light clay		yes	Minor
4c	RH25	Gunadocketa	Czc	PLO?	Flat	<1	1	Sandy loam	Light clay	no	Moderate
4c	RH34	Gunadocketa	Czc	PLC	Flat	2	2	Sandy clay loam	Light clay	yes	Moderate
5b	RH01	Moriarty	Czc	PLA	Alluvial plain	1	1	Sandy clay loam	Light clay	yes	Minor
5b	RH07	Gunadocketa	Czc	PLA	Alluvial plain	1	1	Sandy clay loam		yes	Nil
5b	RH08	Gunadocketa	Czc	PLA	Alluvial plain	1		Sandy loam	Sandy clay loam	No	Moderate
5b	RH16	Moriarty	Czc	PLA	Alluvial plain	1	1	Sandy loam	Light clay	yes	Minor

Land unit	Site	Landsystem	Geology	Land Code*	Land form	Slope %	Relief m	Soil texture A horizon	Soil texture Subsoil	Acid reaction	Erosion
5b?	RH40	Moriarty	Czc	FOO	Lower slope	2	4	Light clay		yes	Minor
5b	RH44	Moriarty	Czc	PLA	Alluvial plain	1	2	Sandy clay loam	Light clay	yes	Minor
5b	RH47	Moriarty	Czc	PLA	Alluvial plain	2	3	Sandy clay loam	Light clay	no	Moderate
5b	RH60	Moriarty	Czc	PLA	Alluvial plain	1	1	Light clay		no	Moderate
5b	RH61	Moriarty	Czc	PLA	Alluvial plain	1	1	Light clay		yes	Nil
5b	RH67	Moriarty	Czc	PLA	Alluvial plain	1	1	Light clay		yes	Moderate
5b	RH68	Moriarty	Czc	PLA	Alluvial plain	0	0	Light clay		no	Nil
6	RH29	Gunadocketa	Qa	DRN	Drainage	1	1	Loamy sand	Sandy loam	no	Minor
6	RH30	Gunadocketa	Qa	DRN	Drainage	1	1	Sandy loam	Sandy clay loam	yes	Minor

\* Land code: DRN: Drainage tracts; FOO: Footslopes; HIL: Hills; PGS: Saline stony slopes; PLA: Saline alluvial plains; PLC: Plains with underlying calcrete; PLO: Loamy plains.

## **Attachment 5: Inventory site data on dominant flora vegetation cover and condition.**

Land unit	Site	Vegetation type	Beard code	Upper stratum		Mid stratum		Lower stratum		Total cover %	Vegetation condition
				Cover %	Dominant	Cover %	Dominant	Cover %	Dominant		
1a	RH03	SIAS	529	5	caspau*	10	dodrig			15	Excellent
1a	RH20	SIAS	529	1	caspau	10	acacia sp	1	ptiobo	10	Excellent
1a	RH28	SIAS	529	2	caspau	15	acacia sp	3	ptiobo	20	Excellent
1a	RH37	SIAS	529	2	eucles	15	acalig	1	ptiobo	15	Good
1a	RH38	SIAS	529	3	eucole	10	acacia sp	1	olemue	15	Good
1a	RH41	SIAS	24	3	eucles	15	acacia sp			20	Excellent
1a	RH42	SIMS	24	3	eucles	15	acasto			20	Fair
1a	RH45	BXSW	24	15	eucles	10	erepus			25	Good
1a	RH46	BXSW	24	5	eucles	5	acacia sp	5	erepav	15	Good
1a	RH63	SIAS	24	1	caspau	3	acacia sp	1	ptiobo	5	Excellent
1b	RH11	GHAS	529	2	caspau	10	eresco	2	ptiobo	15	Excellent
1b	RH12	GNEW	529	10	eucles	2	eresco			10	Excellent
1b	RH13	GHAS	529	1	caspau	40	acaqua			40	Excellent
1b	RH14	GHAS	529	2	caspau	25	acacia sp	3	ptiobo	30	Excellent
1b	RH18	GHMW	529	2	caspau	20	eresco	2	ptiobo	25	Excellent
1b	Rh24	GHAS	529	1	caspau	20	acacia sp	1	ptiobo	20	Good
1b	RH27	GHMW	529	2	caspau	10	eresco	2	ptiobo	15	Excellent
1b	RH32	GHMW	529	1	caspau	20	acacia sp	2	ptiobo	20	Excellent
1b	RH35	GHMW	529	2	caspau	20	dodlob	2	ptiobo	25	Excellent
1b	RH48	GNEW	24	5	eucles	5	eresco	1	erepav	10	Fair
1b	RH49	GHMW	24	2	caspau	20	acalig	1	ptiobo	25	Good
1b	RH50	GHMW	24	1	caspau	25	dodlob	5	ptiobo	30	Excellent
1b	RH51	GHMW	24	1	eucsalub	15	dodlob	1	ptiobo	15	Good
1b	RH56	GHMW	24	2	caspau	15	scvspi	1	ptiobo	20	Excellent
1b	RH64	GHMW	529	2	caspau	15	eresco	2	ptiobo	20	Excellent
1b	RH65	GHAS	529	1	caspau	10	acacia sp	1	podcan	10	Excellent
1b	RH66	GHAS	529	1	acaincur	10	acacia sp	5	podcan	15	Excellent
1c	RH58	BECW	24	5	eucsalub	5	eresco	5	atrbus	15	Good
1c	RH62	BECW	24	2	eucsalub	3	eresco	5	atrves	10	Good

Land unit	Site	Vegetation type	Beard code	Upper stratum		Mid stratum		Lower stratum		Total cover %	Vegetation condition
				Cover %	Dominant	Cover %	Dominant	Cover %	Dominant		
1e	RH10	GHMW	529	1	caspau	4	acaqua	5	thryptere	10	Excellent
1e	RH19	GHMW	529			1	acaqua	10	thryptere	10	Excellent
1e	RH26	GHMW	529			5	acacia sp	5	thryptere	10	Excellent
2a	RH04	SIAS	529	2	caspau	10	snnfil	2	ptiobo	15	Good
2a	RH06	SIAS	529	5	caspau	10	acahem	1	ptiobo	15	Excellent
2a	RH09	CCAS	529	5	caspau	10	dodlob	1	ptiobo	15	Good
2a	RH39	GEHS	24	10	eucles	5	eresco			15	Excellent
2a	RH43	PEXW	529	1	caspau	10	atrum	1	atrabun	10	Fair
2a	RH52	SIAS	20	3	caspau	15	dodlob	1	ptiobo	20	Excellent
2a	RH57	SIAS	24	1	eucles	10	acacia sp			10	Good
2b	RH02	GHAS	529	1	eucsalmon	30	acabur	1	ptiobo	30	Fair
2b	RH05	GHAS	529	3	caspau	20	acahem	2	ptiobo	25	Good
2b	RH15	GHMW	529	2	caspau	10	eresco	1	ptiobo	15	Degraded
2b	RH17	GHAS	529	1	acaincur	25	acabur			25	Degraded
2b	RH31	GHMW	529	2	caspau	20	snnpet			20	Fair
2b	RH33	CCAS	529	5	caspau	15	acalig			20	Good
2b	RH36	GHMW	529	2	caspau	10	snnpet	2	ptiobo	15	Excellent
2b	RH59	GHMW	24	20	eucles	10	acalig			25	Fair
4b	RH53	HCAS	20	1	acaincur	10	acaram			10	Good
4b	RH54	PLMS	20	1	acaincur	25	acaram			25	Excellent
4b	RH55	PLMS	24	2	eucole	20	acaincur			20	Excellent
4c	RH21	PXHS	529	1	caspau	10	dodlob	10	maised	20	Fair
4c	RH22	PXHS	529	2	caspau	10	eresco	15	maised	25	Fair
4c	RH23	PXHS	529	2	caspau	5	dodlob	5	maised	15	Fair
4c	RH25	PXHS	529	1	caspau	10	dodlob	5	maised	15	Degraded
4c	RH34	PXHS	529	2	caspau	20	eresco	1	ptiobo	20	Degraded
5b	RH01	PECW	529	2	eucsalub	15	eresco	2	atrsti	20	Fair
5b	RH07	PXHS	529	5	caspau	15	acalig	1	atrbun	20	Degraded
5b	RH08	PECW	529	4	caspau	15	snnpet	2	ptiobo	20	Degraded



Land unit	Site	Vegetation type	Beard code	Upper stratum		Mid stratum		Lower stratum		Total cover %	Vegetation condition
				Cover %	Dominant	Cover %	Dominant	Cover %	Dominant		
5b	RH16	PESW	529	2	eucsalmon	1	atnum	20	atrves	20	Good
5b	RH40	PEEW	24	3	eucsalmon	10	eresco	1	atrves	15	Fair
5b	RH44	PESW	529	5	eucsalmon	20	atnum	1	atrves	25	Good
5b	RH47	PECW	24	2	eucsalmon	3	eresco	15	maipyr	20	Fair
5b	RH60	PESW	24	5	eucsalub			15	atrves	20	Fair
5b	RH61	PESW	24	5	eucsalub	1	eresco	25	atrves	30	Excellent
5b	RH67	PESW	529	2	eucsalub	2	eresco	15	atrves	20	Fair
5b	RH68	PDFT	529	5	eucsalub	90	acabur			90	Excellent
6	RH29	DRAS	529	2	eucole	40	acabur			40	Good
6	RH30	DRAS	529	5	eucole	10	acacia sp	1	ptiobo	15	Fair

\*see table below for taxa

Field code	Taxa
acaaye	<i>Acacia ayersiana</i>
acabur	<i>Acacia burkittii</i>
acacia sp	<i>Acacia</i> sp
acaeri	<i>Acacia erinacea</i>
acahem	<i>Acacia hemiteles</i>
acaincur	<i>Acacia incurvaneura</i>
acalig	<i>Acacia ligulata</i>
acaosw	<i>Acacia oswaldii</i>
acaqua	<i>Acacia quadrimarginea</i>
acaram	<i>Acacia ramulosa</i> var. <i>linophylla</i>
acasto	<i>Acacia sibirica</i>
atrbun	<i>Atriplex bunburyana</i>
atrnum	<i>Atriplex nummularia</i> subsp. <i>spathulata</i>
atrsti	<i>Atriplex stipitata</i>
atrves	<i>Atriplex vesicaria</i>
caspau	<i>Casuarina pauper</i>
dodlob	<i>Dodonaea lobulata</i>
dodrig	<i>Dodonaea rigida</i>
dodste	<i>Dodonaea stenozyga</i>
dodvis	<i>Dodonaea viscosa</i>
erelat	<i>Eremophila latrobei</i> subsp. <i>latrobei</i>
ereold	<i>Eremophila oldfieldii</i> subsp. <i>angustifolia</i>
erepav	<i>Eremophila parvifolia</i> subsp. <i>auricampa</i>
erepus	<i>Eremophila pustulata</i>
eresco	<i>Eremophila scoparia</i>
eucgra	<i>Eucalyptus gracilis</i>
eucles	<i>Eucalyptus lesouefii</i>
eucole	<i>Eucalyptus oleosa</i> subsp. <i>oleosa</i>
eucsalmon	<i>Eucalyptus salmonophloia</i>
eucsalub	<i>Eucalyptus salubris</i>
frank	<i>Frankenia</i> sp
greacu	<i>Grevillea acuarina</i>
maipyr	<i>Maireana pyramidata</i>
maised	<i>Maireana sedifolia</i>
maised	<i>Maireana sedifolia</i>
maitrip	<i>Maireana triptera</i>
olemue	<i>Olearia muelleri</i>
phibru	<i>Philotheca brucei</i> subsp. <i>brucei</i>
podcap	<i>Podolepis capillaris</i>
ptiobo	<i>Ptilotus obovatus</i>
scvspi	<i>Scaevola spinescens</i>
snnkar	<i>Senna cardiosperma</i>
snnfil	<i>Senna artemisioides</i> subsp. <i>filifolia</i>
snnpet	<i>Senna artemisioides</i> subsp. <i>petiolaris</i>
thryptere	<i>Thryptomene eremaea</i>

## **Attachment 6: Location of inventory sites**

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Site		Zone	Latitude	Longitude
RH01	UTM	51J	442091	6666126
RH02	UTM	51J	442344	6666075
RH03	UTM	51J	441928	6666631
RH04	UTM	51J	441535	6667273
RH05	UTM	51J	442045	6667622
RH06	UTM	51J	441908	6668189
RH07	UTM	51J	441827	6667954
RH08	UTM	51J	442040	6667966
RH09	UTM	51J	441311	6668130
RH10	UTM	51J	442332	6667248
RH11	UTM	51J	442750	6667501
RH12	UTM	51J	442839	6667042
RH13	UTM	51J	442869	6666752
RH14	UTM	51J	442476	6666952
RH15	UTM	51J	442535	6666520
RH16	UTM	51J	442356	6665493
RH17	UTM	51J	442702	6665483
RH18	UTM	51J	443248	6665442
RH19	UTM	51J	443979	6665486
RH20	UTM	51J	444676	6665513
RH21	UTM	51J	443529	6668149
RH22	UTM	51J	443063	6668213
RH23	UTM	51J	443556	6667742
RH24	UTM	51J	443293	6667277
RH25	UTM	51J	443780	6667295
RH26	UTM	51J	443582	6666430
RH27	UTM	51J	443062	6666031
RH28	UTM	51J	444255	6665917
RH29	UTM	51J	444481	6665967
RH30	UTM	51J	445061	6665595
RH31	UTM	51J	445219	6665389
RH32	UTM	51J	444741	6665238
RH33	UTM	51J	445505	6665187
RH34	UTM	51J	445785	6664876
RH35	UTM	51J	445102	6664535
RH36	UTM	51J	444801	6664868
RH37	UTM	51J	447710	6662990
RH38	UTM	51J	447315	6662767
RH39	UTM	51J	447157	6662280
RH40	UTM	51J	447203	6661981
RH41	UTM	51J	447567	6662153
RH42	UTM	51J	447025	6663299
RH43	UTM	51J	446650	6663959
RH44	UTM	51J	446442	6663756
RH45	UTM	51J	446485	6662601
RH46	UTM	51J	446178	6663046
RH47	UTM	51J	445340	6663163
RH48	UTM	51J	445118	6663454
RH49	UTM	51J	445591	6663790

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Site		Zone	Latitude	Longitude
RH50	UTM	51J	444741	6662663
RH51	UTM	51J	444750	6663007
RH52	UTM	51J	442842	6664186
RH53	UTM	51J	442847	6663728
RH54	UTM	51J	443070	6663583
RH55	UTM	51J	443081	6663285
RH56	UTM	51J	443380	6663581
RH57	UTM	51J	443034	6663095
RH58	UTM	51J	443402	6662962
RH59	UTM	51J	443919	6663047
RH60	UTM	51J	444622	6663526
RH61	UTM	51J	444160	6663909
RH62	UTM	51J	443953	6663790
RH63	UTM	51J	443567	6664077
RH64	UTM	51J	443776	6664841
RH65	UTM	51J	444985	6664083
RH66	UTM	51J	443240	6665003
RH67	UTM	51J	442946	6664659
RH68	UTM	51J	442764	6665259

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## **Attachment 7: Fauna memo report**



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**Saracen Relief Hill Project**  
**Fauna assessment**  
M. Bamford, B. Shepherd and T. Gamblin

February 2020

## **Methods**

### **1.1 Desktop Assessment**

#### *1.1.1 Sources of information*

Information on the fauna assemblage of the survey area was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA) and the EPBC Protected Matters Search Tool of the Department of Energy and the Environment (DEE) (Table ). Databases were searched in January 2019 and the search was not repeated for the current project, as the likelihood of new records being added during that period is very low. Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

Frogs: Tyler *et al.* (2009) and Anstis (2013);  
Reptiles: Storr *et al.* (1983, 1990, 1999 and 2002) and Wilson and Swan (2017);  
Birds: Johnstone and Storr (1998, 2005) and Barrett *et al.* (2003); and  
Mammals: Menkhorst & Knight (2004); Armstrong (2011); Churchill (2008); and Van Dyck and Strahan (2008).

Table 1 Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia.	Records of biodiversity data from multiple sources across Australia.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.
NatureMap (DBCA)	Records in the WAM and DBCA databases. Includes historical data	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km

Database	Type of records held on database	Area searched
	and records on Threatened and Priority species in WA.	buffer. Searched: January 2019.
BirdLife Australia Atlas Database (Birdlife Australia)	Records of bird observations in Australia, 1998-2019.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.
EPBC Protected Matters (DEE)	Records on matters of national environmental significance protected under the EPBC Act.	Point search: 30° 10' 05"S, 122° 22' 20"E plus 40 km buffer. Searched: January 2019.

### 1.1.2 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2016. The authorities used for each vertebrate group were: amphibians (Doughty *et al.* 2016a), reptiles (Doughty *et al.* 2016b), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species where available are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

### 1.1.3 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the survey area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the survey area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that might occur as extremely rare vagrants at a terrestrial, inland site, but for which the project area is of no importance. Similarly, waterbirds were generally excluded even though they could over-fly the site, since the site provides little habitat for them. The only exceptions were species that might nest on the site, such as some duck species that nest in tree hollows, and species that might use seasonally inundated paddocks. Species returned from databases but excluded from species lists due to lack of suitable habitat are presented in Appendix 6. Locally extinct species are included in Appendix 6.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the survey area at least occasionally, whether or not they were recorded during field surveys, and whether or not the survey area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the survey area.

The status categories used are:



**Resident:** species with a population permanently present in the survey area;  
**Migrant or regular visitor:** species that occur within the project area regularly in at least moderate numbers, such as part of annual cycle;  
**Irregular Visitor:** species that occur within the survey area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the project area in at least moderate numbers and for some time;  
**Vagrant:** species that occur within the project area unpredictably, in small numbers and/or for very brief periods. Therefore, the project area is unlikely to be of importance for the species; and  
**Locally extinct:** species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present in the project area.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the site is not important in a conservation context, and species which use the site in other ways but for which the site is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times, or may have been previously confirmed as present. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence that the site will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the site might support dispersing individuals. It must be stressed that these status categories are predictions only and that often very intensive sampling would be required to confirm a species' status.

## 1.2 Field Investigation and Personnel

The project area was visited between 20<sup>th</sup> and 23<sup>rd</sup> January 2020 by Dr Barry Shepherd (B.Sc. Hons. Env. Biol., Ph.D. Ecol.) and Tim Gamblin (B.Sc. Zool., Cert Env. Man). The site visit involved looking around as much of the project area as possible in daylight and the tracks and effort of this search are shown in Appendix 1, Figure 1. This enabled environmental descriptions to be prepared and some opportunistic observations on fauna to be made. Targeted searching was undertaken for two significant species known from the general area; in particular for nest mounds, foraging signs, tracks and direct observations of Malleefowl (*Leipoa ocellata*). Surveyors were also mindful of the burrows of Brush-tailed Mulgara (*Dasyurus blythi*), although it is likely this species is locally extinct. Signs of all species observed, and other notable features of interest were recorded.

An Anabat Swift full spectrum ultrasonic acoustic detector was placed next to an old mine shaft for two full nights. It was deployed on the afternoon of 21<sup>st</sup> January and retrieved on the morning of 23<sup>rd</sup> January 2020. All calls obtained were assessed to provide a list of bat fauna supporting the Level 1 survey (Table 3).

## 1.3 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) in the project area were assessed and photographed during the desktop review and as part of the field investigations. Within the project area, all major VSAs were visited to develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area.

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#### **1.4 Survey Limitations**

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. (Table 2)

Table 2 Survey limitations as outlined by EPA.

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study and site inspection). Survey intensity was deemed adequate for the various habitat types viewable from aerial photograph, scale of the project and the amount of data records available in the region. The entire area was not searched for Malleefowl mounds and though the survey results are deemed representative for the Project Area as a whole, only a small percentage of the habitats inside the Project Area boundary was surveyed intensively.
Competency/experience of the consultant(s) carrying out the survey.	The ecologists have had extensive experience in conducting fauna surveys including targeted Malleefowl surveys and have conducted several fauna studies in the region.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The survey focussed on vertebrate fauna and fauna values.
Proportion of fauna identified, recorded and/or collected.	All vertebrate fauna observed were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Abundant information from databases and previous studies.
The proportion of the task achieved and further work which might be needed.	The survey was completed and the report provides fauna values for the project area.
Timing/weather/season/cycle.	Timing is not of great importance for level 1 investigations.
Disturbances (e.g. fire, flood, accidental human intervention etc.) that affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	The survey area is approximately 2649 ha and was traversed by vehicle and on foot and thus was adequately comprehensive to assess fauna and fauna values for a level 1 investigation.
Completeness (e.g. was relevant area fully surveyed).	Site was fully surveyed to the level appropriate for a level 1 assessment. Fauna database searches covered a 10 to 20 km radius beyond the survey area boundary.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna and habitat in the region.
Remoteness and/or access problems.	There were no remoteness/access problems encountered.
Availability of contextual (e.g. bio-geographic) information on the region.	Extensive regional information was available and was consulted.

## 1.5 Species

Four reptiles and fifteen mammals were recorded during this survey. Of the mammals six were introduced species. Twenty-six species of bird were recorded.

### Peregrine Falcon

Not observed but a widespread species and considered likely to be a regular visitor if not resident. It could also breed in tall eucalypts observed in the Relief Hill survey area, probably by utilising old nests of the Australian Raven which were observed in this assessment.

### Rainbow Bee-eater.

This species is only considered of local significance but was formerly listed as Migratory under legislation. It is still considered locally significant as it is a true migrant and breeds in burrows in the area, making it vulnerable to disturbance and predation. It will also often nest along tracks, increasing its vulnerability. No nests were observed however this species is a likely visitor.

## **1.6 Impacts and Recommendations**

1. Malleefowl have been present as breeding residents in the Relief Hill survey polygon for a significant period of time as evidenced by old and new mounds. Vegetation associations with sparse through to dense acacia on loam and gravelly hills were present – providing suitable habitat for this species. Two fresh (i.e. active at the time of the site inspection) mounds found by a limited survey effort (level 1 and few days), suggests the likelihood of many more in the proposed project area.
  2. All Malleefowl mounds are of interest; not just active mounds containing eggs. Well-established, recently used and those mounds used over an extended period of time should all be considered important and included in the impact assessment, as loss of such mounds can adversely affect the local Malleefowl population. Similarly, where significant mounds exist, the surrounding habitat must be considered important in terms of impact assessment for the species given their decline over the recent few decades. However, active and closed mounds should be actively protected until the chicks have hatched and dispersed.
  3. Prior to vegetation clearing, an intensive search for other Malleefowl mounds should be conducted using a team spaced 15-20 m apart depending on density of vegetation in accordance with standard Malleefowl search methods. Ideally, the team should be comprised of trained and experienced ecologists.
  4. All temporary or permanent settling ponds, drainage ditches and other excavations that are present within the survey area and are left open overnight, should be provided with an escape/egress ramp. The egress ramp should allow fauna to crawl out of the excavation but if liners are used, a rope ladder, or other means offering traction should be laid from the bottom of the excavation to the top.
  5. Lighting should not be left on overnight near temporary settlement ponds unless there is a safety need. Lights attracts insects and insects attract bats and birds which can become trapped in water and drown.
  6. Old trees, dead trees, fallen logs and termite mounds should be “gently” tipped over and left overnight to allow fauna inside to disperse .See Appendices.
  7. The plant and operator conducting the clearance works should have a spotter who can usher emerging fauna out of harm’s way.
  8. Personnel conducting the Malleefowl mound search should also advise of active nests of other birds (if found). Active bird nests should be avoided until the young have hatched and fledged.
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**Table 1.** Mammal and Reptile Annotated Species List

<b>Species</b>	<b>Notes</b>
White-striped Freetail Bat <i>Austronomus australis</i>	A few calls.
Gould's Wattled Bat <i>Chalinolobus gouldii</i>	A few calls.
Chocolate Wattled Bat <i>Chalinolobus morio</i>	A few calls.
Southern Forest Bat <i>Vespadelus regulus</i>	Many calls.
Inland Freetail Bat <i>Ozimops planiceps</i>	Many calls. Formerly <i>Mormopterus</i> sp 3. Slight possibility that <i>Ozimops kitcheneri</i> may also be present but is difficult to differentiate and <i>O. planiceps</i> is most likely.
Long-eared bat <i>Nyctophilus</i> spp.	Probable. A few calls. Calls from <i>V. regulus</i> can be variable and can be confused with <i>Nyctophilus</i> species when calls are cluttered. Under-represented and may include the P3 <i>N. major tor</i> .
Inland broad-nosed bat <i>Scotorepens balstoni</i>	A few calls.
Boodie Warrens <i>Bettongia lesueur</i>	14 historic and abandoned Boodie warrens were recorded during the survey. Many showed signs of occupation from other recent fauna including rabbits, fox and varanids (goannas).
Western Grey Kangaroo <i>Macropus fuliginosus</i>	A few individuals seen most days on the red loam flats.
Euro (Common Wallaroo) <i>Macropus robustus</i>	Two individuals seen on the rocky hills in the SE region of the survey area.
Dingo/Dog <i>Canis lupus dingo/Canis lupus</i>	Tracks and scats
Red Fox <i>Vulpes vulpes</i>	Tracks and scats
Cow <i>Bos taurus</i>	Tracks and scats
Goat <i>Capra hircus</i>	Skull
Rabbits <i>Oryctolagus cuniculus</i>	Tracks and scats

Cat <i>Felis catus</i>	Scats
Pygmy Spiny-tailed Skink <i>Egernia depressa</i>	Many suitable habitat trees with latrine scats of suitable size and on one occasion an animal observed at 443103.86E, 6668231.94N.
Western blue-tongued lizard <i>Tiliqua occipitalis</i>	Found beneath cow carcass eating maggots and beetles that were consuming the deceased animal (in the north eastern section).
Crested dragon, Bicycle dragon <i>Ctenophorus cristatus</i>	Seen regularly throughout site.
Goldfields Crevice Skink <i>Egernia formosa</i>	Not seen for 100% confirmation but many scats of suitable size, habitat and consistency.

**Table 2.** Malleefowl *Leipoa ocellata* mounds found in the Relief Hill Polygon 21<sup>st</sup> – 23<sup>rd</sup> Jan 2020.

Age	Easting	Northing	Details
Recent	441659.798	6664603.447	4.2m diameter, 500mm deep, 350mm rim height – nil debris in centre, egg shell/feathers present possibly used late 2019
Recent	444394.987	6665856.113	5.5 m diameter, 1200mm deep, 500 rim height - nil debris, in centre, egg shell/feathers present possibly used late 2019
Old	441795.311	6664693.263	5.2 m diameter, 300 mm deep, 130 mm rim height
Old	445670.728	6664864.485	5.0 m diameter, 350 mm deep, 150 mm rim height



Figure 1. Recently active mound at 441659.798E, 6664603.447N.





Figure 2. Malleefowl evidence (feathers and shell) in and adjacent to both recently active mounds.



Figure 3. Recent mound at 444394.987E, 6665856.113N. (Image: Barry Shepard).



Figure 4. Long furrow of raked leaf-litter extending out from new Malleefowl mound.

## **Annotated Bird List** **Birds**

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1. Malleefowl – two recently active nests, several old disused nests and several possible scats and feathers throughout.
2. Quail (sp. Unknown) – one bird flushed from acacia scrub
3. Common Bronzewing – one pair seen near haul roads and one individual in survey area
4. Brown Goshawk – One bird seen flying at ground level along a track
5. Common Bronzewing – one pair seen near haul roads and one individual in survey area
6. Australian Ringneck – group of three individuals seen flying in centre of site
7. Purple-crowned Lorikeet – One group of eight and two groups of five on last day only in SE section of survey area
8. Splendid Fairy-wren – males and females frequently seen and heard throughout
9. Yellow-throated Miner – a few individuals seen around mine camp
10. Brown Honeyeater – two individuals heard in eastern half
11. Spiny-cheeked Honeyeater – a few seen and heard throughout
12. Singing Honeyeater – a few individuals heard calling throughout
13. Black Honeyeater – Small group seen in agricultural area in north east
14. Weebill – occasional groups heard and seen in Eucalypt woodlands
15. Redthroat – two or three individuals heard in central eastern area of site
16. Inland Thornbill – several heard across the survey area
17. White-browed Babbler – mobs frequently seen and heard throughout
18. Crested Bellbird – individuals frequently seen and heard throughout
19. Rufous Whistler – frequently heard and seen throughout
20. Black-faced Cuckoo-shrike – Several individuals seen across the survey area
21. Pied Butcherbird – One pair seen in centre of survey area
22. Grey Butcherbird – Individual seen in camp area
23. Grey Currawong – One individual seen in centre of survey area
24. Hooded Robin – male and female seen in north-east area
25. Willie Wagtail – one seen in north east.
26. Rufous Songlark – couple seen in NE corner in ranching area

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## Appendices



**Figure 1.** The Pygmy Spiny-tailed skink *Egernia depressa* and associated latrine. Example of a species that commonly lives in dead trees that, if cleared, require “gentle felling” and being left overnight to enhance escape and survival.

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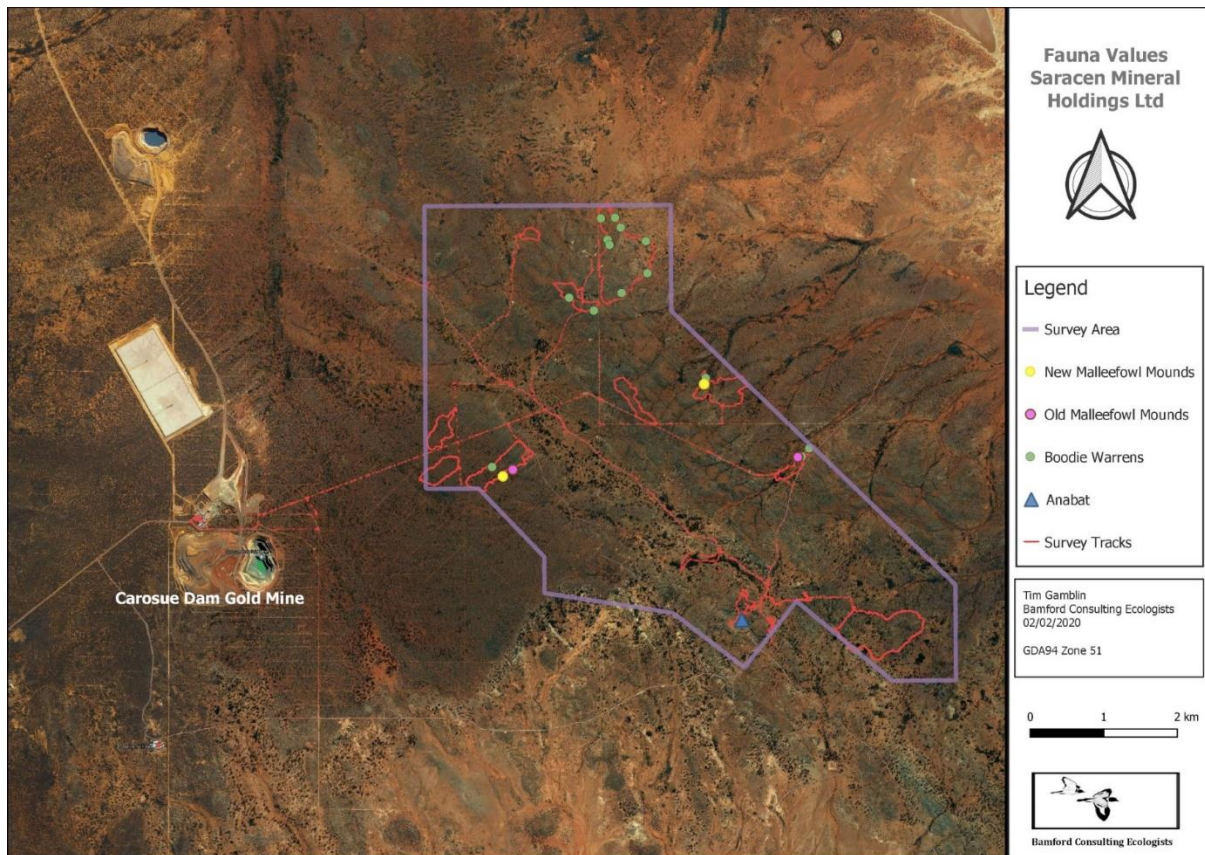


Figure 2. The survey area, indicating tracks followed and locations of significant features.



# Mallee Fowl Survey of proposed Airstrip

## Saracen Gold Mines



**Alexander Holm & Associates**  
**Natural Resource Management Services**

**September 2017**

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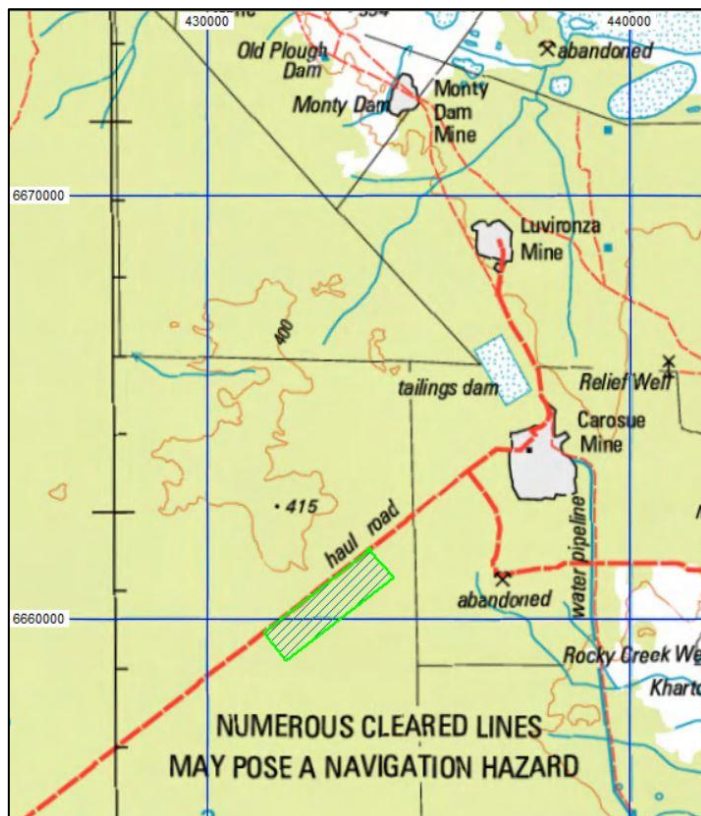
## Purpose

A systematic search for evidence of Malleefowl (*Leipoa ocellata*) within an area proposed for an airstrip

## Site

The site for the proposed airstrip is approximately 115 km north east of Kalgoorlie Boulder, and south east of Lake Rebecca adjacent to the Carosue Dam access road (Figure 1). It is within the north-eastern Goldfields region and Kalgoorlie-Boulder local government area.

The search area is approximately 900m x 3200m encompassing 270ha.



**Figure 1: Location of survey site (in green).**

## Habitat description:

The site falls within the Kirgella land system characterised by extensive sandplain with spinfex hummock grasslands and mulga-mallee shrublands and is prone to wildfires.(Pringle 1994).

There are four main land units on the site, three of which are described in Alexander Holm & Associates (2012):

Land unit 2c: Sandy rises to 10m supporting sparse woodlands dominated by low mallees and mulga over diverse myrtaceous shrubland with spinfex.

Land unit 4a: Plains supporting eucalypt or acacia shrublands and isolated casuarina.

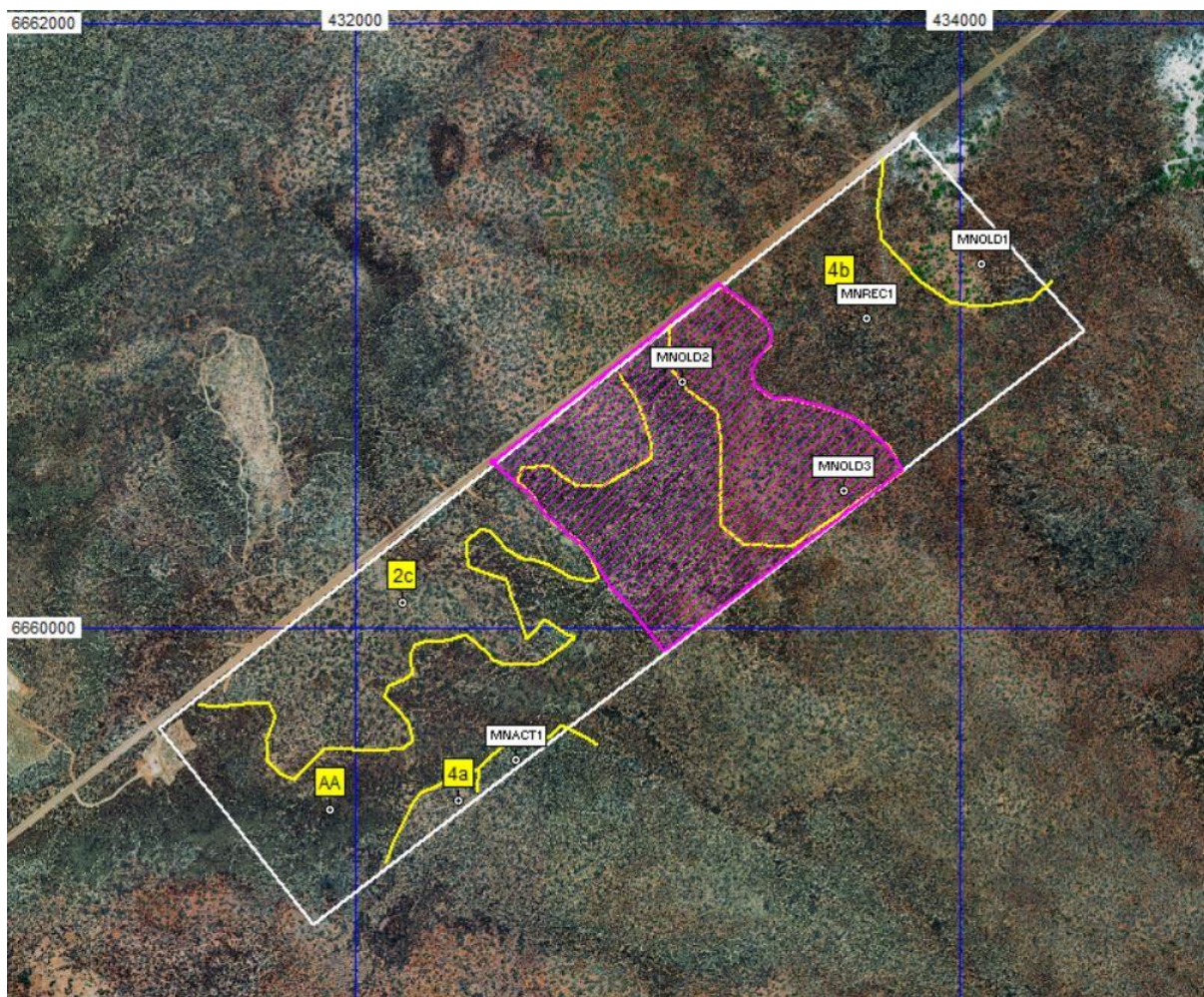


Land unit 4b: Sandplains supporting sparse eucalypt woodlands over sparse shrubs and spinifex

A further unit not described:

Land unit AA: Sandplains supporting dense low acacia -myrtaceous shrubland sometimes with laterite gravel surfaces.

Approximately 80ha of the area had been recently burnt (Figure 2).



**Figure 2: Land units within survey area with burnt area hatched in red and Malleefowl nests in white.**

## Malleefowl survey

Operators searched along gridlines 50m apart using GPS devices to maintain position. A zig-zag search pattern was used when dense vegetation was encountered. Operators looked for Malleefowl tracks, disturbance of litter, active and dormant nests and Malleefowl sightings which if found were noted and coordinates recorded.

It is estimated that the search procedures were sufficient to locate 95 to 100% of active nests in less densely vegetated areas and 80-90% of active nests in more densely vegetated areas.

The search took a total of 40 person hours with an estimated 120km of traverse.








## Results

Malleefowl were active in the survey area. One active, one recently abandoned and three moribund nests were located. No birds were sighted.

Malleefowl appear to avoid areas in dense, fire-prone vegetation (landunit AA) and sand dunes (landunit 2c).

**Table 1: Photographs of each Malleefowl nest.**

<p>Active nest Landunit 4a</p>	
<p>Recent nest Landunit 4b</p>	
<p>Moribund nest Landunit 4a</p>	

Moribund nest Landunit 4b	
Moribund nest Landunit 4b	

**Table 2: Location and habitat associated with Malleefowl observations**

Observation	Easting	Northing	Land unit
	Zone 51		
Active nest	432527	6659565	4a
Recent nest	433689	6661027	4b
Moribund nest	434067	6661207	4a
Moribund nest	433616	6660454	4b
Moribund nest	433076	6660817	4b

## Reference

Alexander Holm & Associates (2012). Environmental assessment: Tailings storage facility expansion. Perth, Western Australia, Unpublished report for Saracen Gold Mines: 81.

Pringle, H. J. R. (1994). Pastoral resources and their management in the north-eastern Goldfields, Western Australia. Perth, Department of Agriculture Western Australia: 135.

## 1. PURPOSE

To ensure that the relevant statutory and regulatory requirements associated with clearing of vegetation for project development are met and to minimise the impact of clearing on the environment in line with Northern Stars's Environmental Policy.

Specific objectives are to:

- Minimise vegetation disturbance where reasonably practicable;
- Prevent disturbance of vegetation adjacent to areas of activity;
- Prevent disturbance of vegetation in areas not approved for clearing under Part V Section 51E;
- Prevent the spread of weeds;
- Ensure clearing is completed in accordance with statutory requirements; and
- Ensure adequate availability and integrity of topsoil for future rehabilitation.

This Work Instruction (WI) applies to all projects requiring clearing, including, but not limited to:

- New projects;
- Expansion of existing projects;
- Near mine Exploration (including grade control and sterilisation drilling); and
- Rehabilitation and closure projects where clearing is required.

Exploration activities carried out away from mining areas (active or on care and maintenance) approved under a POW are exempt.

## 2. SCOPE

## 3. ROLES AND RESPONSIBILITIES

Role	Key Responsibilities
Environmental Manager	<ul style="list-style-type: none"> <li>▪ Ensure approvals are in place in line with the LOMP so clearing can be conducted as required.</li> <li>▪ Ensure Environmental and Management personnel are suitably trained to manage clearing in line with approvals, and Northern Star Policies and Procedures.</li> <li>▪ Notify the DMP of any breach of clearing conditions.</li> </ul>
Environmental Personnel	<ul style="list-style-type: none"> <li>▪ Be aware of approvals and studies (flora, fauna, surface water, Aboriginal Heritage) prior to clearing.</li> <li>▪ Consult with relevant managers and attend daily meetings to determine status of projects that may require clearing.</li> <li>▪ Communicate status of clearing related approvals to the Operations Manager, Managers, Superintendents and Supervisors.</li> <li>▪ Authorise Clearing Activity Permits.</li> <li>▪ Ensure clearing areas are surveyed and suitably marked with flagging tape/pegs, prior to commencement of clearing.</li> <li>▪ Inspect clearing areas before and after clearing and notify environmental personnel of any breaches.</li> <li>▪ Inspect clearing areas before and after clearing.</li> <li>▪ Collect clearing data.</li> <li>▪ Prepare and submit statutory reports with regard to clearing.</li> <li>▪ Assist in the preparation of incident reports in the event of a clearing incident.</li> <li>▪ Communicate this WI to Project Personnel and Contractors.</li> </ul>
Operations Manager	<ul style="list-style-type: none"> <li>▪ To ensure this WI is implemented on site.</li> </ul>

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	<ul style="list-style-type: none"> <li>Review and sign Clearing Activity Permits to ensure they are in line with the LOMP.</li> </ul>
Managers	<ul style="list-style-type: none"> <li>Ensure that construction is in accordance with the relevant approval(s), supporting documentation, standards and guidelines.</li> <li>Awareness of relevant approvals, licences and permits and their conditions and requirements</li> </ul>
Superintendants and Supervisors	<ul style="list-style-type: none"> <li>Awareness of relevant approvals, licences and permits and their conditions and requirements.</li> <li>Ensure clearing areas are surveyed and suitably marked with flagging tape/pegs the area to be cleared, prior to commencement of clearing.</li> <li>Inspect clearing areas before and after clearing and notify environmental personnel of any breeches.</li> <li>Communicate this WI to Project Personnel and Contractors.</li> </ul>
Project Personnel and Contractors	<ul style="list-style-type: none"> <li>Comply with this WI.</li> <li>Minimise the disturbance of vegetation.</li> <li>Follow instructions from Superintendants and Supervisors.</li> </ul>

## 4. PERFORMANCE INDICATORS

For Mining Activities:

- Site Clearing Activity Permits completed and signed for all clearing activities;
- Compliance with clearing approval limits and conditions;
- Minimise vegetation disturbance where reasonably practicable;
- Cleared vegetation and topsoil placed in separate stockpiles (where possible) for rehabilitation and protected from potential contamination; and
- Records of clearing updated monthly (survey).

For exploration activities:

- Clearing is in accordance with PoW or Mining Proposal approval;
- Site Clearing Activity Permits completed and signed for all clearing activities;
- Minimise vegetation disturbance where reasonably practicable;
- Records of clearing updated monthly (survey).

## 5. LEGISLATION, REGULATIONS AND STANDARDS

- Environmental Protection Act, 1986
- Environmental Protection (Clearing of Native Vegetation) Regulations, 2004
- Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, Position Statement No. 51, EPA, 2004

## 6. MANAGEMENT ACTIVITY

### 6.1 Approvals Required

Clearing of Native Vegetation in Western Australia is regulated under the *Environmental Protection Act 1986* and *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. The Department of Regulation (DER) has delegated authority to the Department of Mines and Petroleum (DMP) to approve clearing activities on Mining Tenements. All clearing (mining or exploration) on Northern Star tenements must be approved by the DMP via a Mining Proposal or Programme of Work (PoW).

In addition, Northern Star has an internal Clearing Activity Permit (SG-EN-FO-2001) that must be completed and approved prior to any clearing commencing (Figure 1). This form ensures the appropriate approvals are

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# CLEARING MANAGEMENT SAFE WORK PROCEDURE

in place prior to clearing and allows the Environment Department to track clearing as required under Northern Star's statutory obligations.

Saracen Metals Pty Ltd  
North Eastern Goldfields Operations  
**CLEARING ACTIVITY PERMIT**

No: \_\_\_\_\_

Saracen Metals Pty Ltd  
North Eastern Goldfields Operations  
**CLEARING ACTIVITY PERMIT**

<b>Site Details – applicant to complete</b>			
Project	Applicable Tenements		
Location of area to be cleared:			
Department responsible for clearing:			
Name (person requesting the permit)			
Date of Application:			
Proposed date of clearing	Area to be cleared (Ha):		
Reason for clearing:			
Method of clearing:			
Has a Work Instruction been completed? Y/N			
Plan/Map attached?	Y/N		
<b>1. CHECKS - ENVIRONMENTAL ONLY</b>			
Applicable Clearing Permit or Eo/No	Area Authorised (Ha):		
Mining Proposal Number:			
<b>Please tick:</b>	Yes	No	
Area to be cleared within Clearing Permit approved limit?	<input type="checkbox"/>	<input type="checkbox"/>	
Area to be cleared within hatched area on Clearing Permit Plan?	<input type="checkbox"/>	<input type="checkbox"/>	
Area to be cleared is within applicable tenements?	<input type="checkbox"/>	<input type="checkbox"/>	
DMP approvals received?	<input type="checkbox"/>	<input type="checkbox"/>	
Notifications to pastoral holders is complete?	<input type="checkbox"/>	<input type="checkbox"/>	
All other notifications complete?	<input type="checkbox"/>	<input type="checkbox"/>	
All other approvals in place?	<input type="checkbox"/>	<input type="checkbox"/>	
Does the 10Ha exception apply?	<input type="checkbox"/>	<input type="checkbox"/>	
If yes, provide details:			
<b>Regard for Guiding Principles:</b>	<input type="checkbox"/>	<input type="checkbox"/>	
L. Avoid over clearing native vegetation:	<input type="checkbox"/>	<input type="checkbox"/>	
i. Minimise the amount of native vegetation to be cleared; and	<input type="checkbox"/>	<input type="checkbox"/>	
ii. Reduce the impact of clearing on any environmental value.	<input type="checkbox"/>	<input type="checkbox"/>	
Weed control completed?	<input type="checkbox"/>	<input type="checkbox"/>	
Vegetation to be removed and stockpiled?	<input type="checkbox"/>	<input type="checkbox"/>	
Topsoil to be removed and stockpiled?	<input type="checkbox"/>	<input type="checkbox"/>	
Is vegetation present which must be avoided?	<input type="checkbox"/>	<input type="checkbox"/>	
If yes, provide details:			
Is significant unstockpiled present within area to be cleared?	<input type="checkbox"/>	<input type="checkbox"/>	
If yes, Forest Products Commission has been contacted to arrange removal?	<input type="checkbox"/>	<input type="checkbox"/>	
Clearing area greater than 50m from riparian vegetation or any watercourse or wetland?	<input type="checkbox"/>	<input type="checkbox"/>	

Are Aboriginal Archaeological sites present within the area to be cleared?			
If yes provide details of management in 'APPROVAL REQUIREMENTS'			
Any other special management conditions?			
If yes, provide details in 'APPROVAL REQUIREMENTS'			
<b>2. SURVEY CONTROL – SURVEY &amp; APPLICANT TO COMPLETE</b>			
Pegs required for cleared area?	Tap Colour:	Distance apart (m):	
Lease boundary pegs required?	Tap Colour:	Distance apart (m):	
Special notes:			
Has adequate survey control been implemented?	Y/N	Signature:	Date:
<i>Note: If Survey not available Mine Manager/Superintendent can sign off Survey control</i>			
<b>3. OPERATOR CHECKS</b>			
<b>Please tick:</b>	Yes	No	
Has the operator cited the Clearing Permit?	<input type="checkbox"/>	<input type="checkbox"/>	
Has the operator been issued with the Work Instruction?			
Does the operator understand the requirements of the Work Instruction and Clearing Permit?			
Operator Name/s:	Signature/s:	Date:	
Shift Boss Name/s:	Signature/s:	Date:	
<b>4. APPROVAL TO PROCEED</b>			
<i>Note: Only with these signatures is authorisation to proceed granted</i>			
Environmental Department Name:	Signature:	Date:	
Department Manager/ Superintendent Name:	Signature:	Date:	

Filename: SRA-PW-FO-2007 Clearing Activity Permit Issue Date: 13/04/2015 Revision: 2  
This document is confidential and is controlled by the date of printing 19/07/17. Refer to your Supervisor to ensure you have the latest version.

Page 1 of 5  
Authorised By: SS

Filename: SRA-PW-FO-2007 Clearing Activity Permit Issue Date: 13/04/2015 Revision: 2  
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Authorised By: SS

[illegible]

Figure 1 SGM Clearing Activity Permit

## 6.2 Site Requirements – Prior to Clearing

All personnel are to complete the Site Environmental Induction (specific to each area such as Carosue Dam and Thunderbox). Minimising disturbance of vegetation will be emphasised in the Environmental Induction, including the requirement for all vehicles and machinery to use designated tracks and roads, park only in designated locations and prevent the spread of weeds.

On completion of the Environmental Induction presentation, the Environmental Induction Questionnaire (SG-EN-TR-2152 Environmental Induction Questions and SM-EN-TR-2135 Environmental Induction Questions) will be completed by all personnel to ensure that they have an understanding of environmental requirements whilst working for or on behalf of Northern Star.

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Prior to commencing any clearing activity, a Northern Star Clearing Activity Permit (SG-EN-FO-2007 Clearing Activity Permit and SM-EN-FO-2007 Clearing Activity Permit) needs to be reviewed, approved and signed by the Environmental Department. Clearing cannot commence without this permit. The permit details key job specifics including clearing management controls (flagging tape), approved area and respective notifications (DMP/pastoral). The operator must first liaise with either the SGM environmental coordinator/officer regarding the task specifics.

## 6.3 Clearing for Exploration activity (away from mine sites)

Clearing must be conducted in accordance with the Guideline for Mineral Exploration / Rehabilitation Activities (2007) available on the DMP website, unless otherwise approved under the PoW.

Prior to commencing any clearing activity, a Northern Star Clearing Activity Permit (SG-EN-FO-2007 Clearing Activity Permit and SM-EN-FO-2007 Clearing Activity Permit) needs to be reviewed, approved and signed by the Environmental Department. Clearing cannot commence without this permit. The permit details key job specifics including clearing management controls (flagging tape), approved area and respective notifications (DMP/pastoral). The operator must first liaise with either the SGM environmental coordinator/officer regarding the task specifics. Clearing should only be undertaken by suitably trained staff or approved contractors. All contractors must be adequately supervised to ensure site policy and procedures are adhered to.

## 6.4 Records and Reporting

The Environmental Department maintains an electronic database of clearing approvals and site Clearing Activity Permits, as well as a digital database of spatial data relating to clearing (in Arc GIS). All clearing is reported in the monthly report. The Survey Department are responsible for picking up cleared areas on a monthly basis, which are then sent to all site Environmental Department staff at the end of the month. Records of clearing are then saved on the environmental drive, located at:

X:\04\_Environmental\GIS\Disturbance Database\Monthly Clearing Pickups from Survey

Clearing data will be included in the Annual Environmental Reports required under Northern Star's approvals to operate.

## 6.5 Unauthorised Clearing

Unauthorised clearing works fall under the following categories:

- Clearing of native vegetation or rehabilitated areas without Part V approval;
- Clearing of native vegetation or rehabilitated areas with a SGM Clearing Activity Permit;
- Clearing outside of the approved boundary;
- Clearing conducted by a person deemed to be not competent or inducted; and
- Clearing or disturbance to known heritage sites/artefacts.

In the event of any unauthorised clearing or clearing conducted inappropriately resulting in a breach of Northern Star procedures, an Incident Report shall be completed and thorough investigation completed to address the root cause. Penalties for breaches of this procedure will be negotiated between the General Manager- Operations and the Environmental Manager. Should clearing be outside an approved area or amount, the DMP will be notified at the discretion of the Environmental Manager. Advice on remediation procedures will be obtained from the relevant authorities if required.

## 7. RELATED DOCUMENTS

Document Name	Document Number
Clearing Activity Permit	
Topsoil Management Work Instruction	
Biodiversity Environmental Management Plan	
Weed and Feral Animal Control Work Instruction	
Weed Hygiene Certificate	

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Northern Star Resources Limited (Northern Star or the Company) has a duty of care and legal obligation to protect the environment, and is committed to managing its activities in an environmentally responsible manner. Through effective management practices, the Company aims to ensure its activities have a minimum impact on the environment.

The Company's success in environmental management is underpinned by its belief that business can and must be conducted in an environmentally sustainable manner, together with a desire that future generations have the right to enjoy and experience the world as it is today. This overriding commitment to the environment is demonstrated through our Environmental Management System.

Northern Star will drive our approach to environmental care by:

- Implementing and maintaining an Environmental Management System to identify, assess and minimise environmental risk at all stages of its operations as a fundamental part of its long-term strategy.
- Monitoring our environmental footprint, and setting and measuring annual targets for improved environmental performance.
- Complying with all applicable legal and statutory requirements as a minimum standard, and ensuring prompt and transparent reporting of any non-compliances.
- Engaging stakeholders on their concerns, aspirations and values regarding the development, operation and closure aspects of our projects.
- Minimise the environmental impacts of our operations through the efficient use of natural resources, the reduction of input materials and waste, and the minimisation of dust and emissions of gases.
- Pursuing biodiversity understanding through baseline assessments and regular monitoring to enhance the ability for biodiversity protection.
- Providing information, instruction, training and supervision to enable everyone to understand and comply with their environmental obligations and responsibilities.
- Ensuring managers and supervisors are authorised and accountable for taking remedial action in the event of an environmental non-compliance.
- Not compromising first world standards when exploring, building and operating in developing countries or regions.
- Communicating this policy and environmental performance in an open, transparent and accurate manner.

As a minimum, Northern Star will honour its duty of care obligations under all applicable legislation and will work to standards which at least meet or exceed these legal obligations.

Each and every person at Northern Star has a duty of care to ensure they work in a manner which complies with the Company's environmental policies and procedures, and they act in a manner that reflects our Code of Conduct and STARR Core Values.

The Environment Policy applies to all people employed by Northern Star, its subsidiaries, any contractors or visitors interacting in or with our business.

Northern Star encourages the participation and feedback of everyone in all matters relating to the environment, and commits to provide adequate resources to enable effective implementation of this policy.

Prepared by:	Liza Carpine	Document Status:	Uncontrolled
Approved by:	Board of Directors	Review Date:	21/08/2022
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