Request to amend Native Vegetation Clearing Permit (CPS 3891/5)

Lucky Bay Garnet Project

Prepared for Australian Garnet Pty Ltd

July 2025

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E250239 RP2

July 2025

Version	Date	Prepared by	Reviewed by	Comments
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1	30 June 2025	N. Eisenlohr	C. Bell	Final

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1 Introduction

Australian Garnet Pty Ltd (Australian Garnet) operates the Lucky Bay Garnet Project (the project), which is a heavy mineral sands deposit located at the southern margin of the Carnarvon Basin, approximately 40 kilometres (km) south of Kalbarri and 540 km north of Perth, in the Shire of Northampton.

The project includes an above-groundwater progressive open pit mine, with a mobile mining unit plant that feeds to a central processing area with associated plant infrastructure and utilities to produce a heavy mineral concentrate, including garnet and ilmenite final products.

Clearing for the project operates under several clearing permits, including CPS 3891/5, which is the subject of the amendment application this document supports.

1.1 Proposed amendment

The purpose of this native vegetation clearing permit amendment application is to extend the duration of CPS 3891/5 by 5 years in order to support ongoing mining activities. There is no change being sought to the permit clearing area of up to 90 hectares (ha), nor the permit boundary area of approximately 142.3 ha (shown in Figure 1.1).

The project has an approximate Life of Mine of 15 years from the Menari deposit. Mining of this deposit is approved via a Mining Proposal granted under the *Mining Act 1978* (RegID 102866). Mining to date has been focused on the southern portion of the Menari deposit, which is largely addressed under the NVCP CPS 9057, and is yet to substantially progress into the northern portion of the deposit, which is addressed under NVCP CPS 3891.

No clearing under CPS 3891/5 was undertaken during the 2024-2025 reporting period. The Annual Report for 2023-2024 is attached to this application, which describes that clearing to date under the permit is 7.45 ha, with 77.95 ha remaining.

Mining is anticipated to continue in a northerly direction over the next 5 years, therefore an extension to CPS 3891 is required to enable mining to continue.

This supporting document provides a summary of flora and fauna surveys undertaken for the project and provides an updated assessment against clearing principles for consideration by the Department of Energy, Mines, Industry Regulation and Safety.

1.1.1 Previous amendments

To date, there have been five versions of the permit granted, as outlined in Table 1.1.

Table 1.1 Previous versions of CPS 3891

Version	Grant Date	Amendments
3891/1	25 November 2010	Original permit to clear 90 ha within a permit footprint of 144.518 ha, with a duration of five years expiring 31 December 2015.
3891/2	30 July 2015	Removal of the 'avoid, minimise, reduce' condition and to extend duration by five years to 31 December 2020.
3891/3	29 October 2020	To extend purpose to 'and associated activities'; to reinstate the 'avoid, minimise, reduce' condition; to add erosion management conditions; and to extend duration by five years to 31 December 2025.
3891/4	7 September 2021	To change the shape and size of permit footprint with an overall increase to 145.785 ha.

Version	Grant Date	Amendments
3891/5	22 June 2023	Amendment as a result of an appeal. The permit boundary was changed (resulting in a reduction in the boundary area to 142.3 ha) so that it avoids potential impact to priority flora.



Figure 1.1 Map of the boundary of the area within which clearing may occur (CPS 3891/5)

2 Environmental survey outcomes

Multiple ecological surveys have been conducted at the project site historically to inform clearing activities.

At the time of the original permit application, the environmental baseline was informed by data and findings from a Level 1 flora and fauna Survey conducted in September 2008 by Ecoscape Environmental Services (Ecoscape, 2008). No threatened flora, priority flora, threatened ecological communities (TECs) or priority ecological communities (PECs) were identified during the survey work.

As further versions of the permit have been granted, additional survey work has been undertaken for the project. A Level 2 flora and vegetation Survey (Onshore, 2013) and a Level 1 fauna and habitat assessment (Bamford, 2013) were conducted in 2013 to inform the CPS 3891/3 permit amendment. These surveys provided an increased level of detail to inform the assessment of the proposed boundary extension of CP S3891/3.

More recently, a detailed flora and vegetation survey was conducted by Onshore Environmental in 2021, as a follow up to their 2013 survey. A short range endemics (SRE) Survey was conducted by Bennelongia Environmental Consultants in 2023, and targeted flora survey was conducted by Botany Lens in 2024.

Survey results from 2013 onwards are summarised below and considered in the assessment against the clearing principles presented in Section 3. Copies of the most recent survey reports (2024 flora/vegetation and 2023 short range endemic surveys) not previously submitted to DEMIRS for CPS 3891 are also provided as Appendix A and Appendix B.

2.1 Flora and vegetation surveys

A Level 2 survey by Onshore (2013) described and mapped the vegetation and flora in a study area covering a large area of 1,736 ha. Only a small portion of the survey study area is relevant to the area covered by CPS 3891/5. Within the study area, vegetation was categorised into 19 vegetation associations (VA). None of the VAs were affiliated with any Commonwealth listed TECs. However, VA 4 does show similarities to the State listed PEC 'Coastal sands dominated by *Acacia rostellifera, Eucalyptus oraria* and *Eucalyptus obtusiflora* (Priority 1)'. There is a pocket of VA 4 adjacent to the clearing permit area, but none within the permit boundary. The 2013 survey recorded a total number of 151 plant taxa (including varieties and subspecies) from 54 families and 116 genera. Species representation was greatest among the Poaceae, Asteraceae, Fabaceae, Chenopodaceae and Myrtaceae families. There were four priority flora taxa found; *Melaleuca huttensis, Cryptandra glabriflora, Anthocercis intricata* and *Beyeria cinerea* subsp*. cinerea*, however only two (*M. huttensis* and *B. cinerea* subsp*. cinerea*) were found around the clearing permit area[1].

In 2021, another flora and vegetation survey was conducted by Onshore Environment (Onshore 2022). As with the Onshore 2013 survey, the study area for the 2021 survey covered a large area (1,589 ha) with only a small portion relevant to the area covered by clearing permit CPS 3891/5. No threatened flora taxa protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), or the *Biodiversity Conservation Act 2016* (BC Act) were recorded within the survey area, however the desktop assessment identified six threatened flora taxa listed under the BC Act and EPBC Act, along with 39 state-listed priority flora taxa likely to occur within the broader Lucky Bay Garnet Project area (Onshore 2022). Importantly, the records identified in the 2013 survey as *B. cinerea* subsp*. cinerea* were revised to *Beyeria cinerea* subsp. *borealis* following the 2021 survey and a re-examination of specimens collected during both surveys. B. *cinerea* subsp. *borealis* is not a listed species.

[1] After revisiting the site in 2021 and re-examining multiple specimens collected in both 2013 and 2021, the identification of *B. cinerea* subsp*. cinerea* was revised to *Beyeria cinerea* subsp. *borealis* (Onshore 2022). This subspecies is not listed as a Priority flora taxon by DBCA.

Searches of federal and state threatened flora databases revealed a population of the threatened orchid *Caladenia. bryceana* subsp*. cracens* (listed under the BC Act and EPBC Act), located less than 1.5 km from suitable habitat within the survey area. Although the nearby known population was surveyed in 2021 during the appropriate flowering period, poor seasonal conditions resulted in no plants being found. Onshore (2022) recommended conducting targeted searches for the orchid at the study site during flowering periods when seasonal conditions are optimal.

Subsequently in 2024, Botany Lens was commissioned to conduct a targeted survey for conservation-significant flora, and specifically to search for *C. bryceana* subsp. *cracens* (Northern Dwarf Spider Orchid) in and around the clearing permit area (Appendix A). The study area for this survey was constrained to the clearing permit area, plus an area excluded from the clearing permit, to the north-east, where priority flora were previously identified. A desktop assessment identified 94 conservation significant flora taxa as having the potential to occur within the project area, however the field survey found no plants of *C. bryceana* subsp. *cracens*, and no other threatened flora taxa within the survey area.

The field survey documented two priority 3 (P3) flora taxa within the survey area, one of which had previously been documented in the 2013 flora and vegetation survey (Onshore, 2013). The species recorded were *Bossiaea calcicola* (P3) and *M. huttensis* (P3), and both were exclusively found within the remnant vegetation that has remained uncleared since at least 1982. The CPS 3891/5 permit boundary avoids this vegetation remnant and both clusters of priority flora recorded by Botany Lens (2024).

Figure 2.1 illustrates the clearing permit boundary with the results of the 2013 flora and vegetation survey and the 2024 targeted flora survey.

2.2 Fauna and habitat assessment

Bamford Consulting Ecologists was commissioned in 2013 to conduct a Level 1 fauna assessment (desktop review and site inspection) on a study area of 1,176 ha. As with Onshore 2013 and Onshore 2022, only a small portion of the study area is relevant to the clearing permit area. The desktop survey identified an assemblage of 187 vertebrate fauna species potentially occurring in the study area. This comprised of 10 frog, 64 reptile, 87 bird, 14 native mammal and eight introduced mammal species. However, as the study area was extensively cleared, many of the species expected to be present probably only occur infrequently and may not be dependent on the study area for habitat functions.

During field investigations, three vegetation and substrate associations (VSAs) that provide habitat for fauna were identified:

- VSA 1: Pasture
- VSA 2: *Acacia rostellifera* shrubland to tall shrubland on yellow-brown sands.
- VSA 3: *Melaleuca cardiophylla* shrubland to tall shrubland on shallow grey sands over limestone, with extensive limestone outcropping.

Vegetation within the clearing permit area is mostly made up of VSA2, which generally corresponds to VAs 5, 6a and 6B defined by Onshore 2013, and shown in Figure 2.1.

A total of 30 fauna species were recorded during the field survey: four reptiles, 23 bird, two native mammal and four introduced mammal species. Of nine conservation-listed species (under the BC Act and/or EPBC Act) identified as potentially occurring within the study area, none were recorded during the field survey.

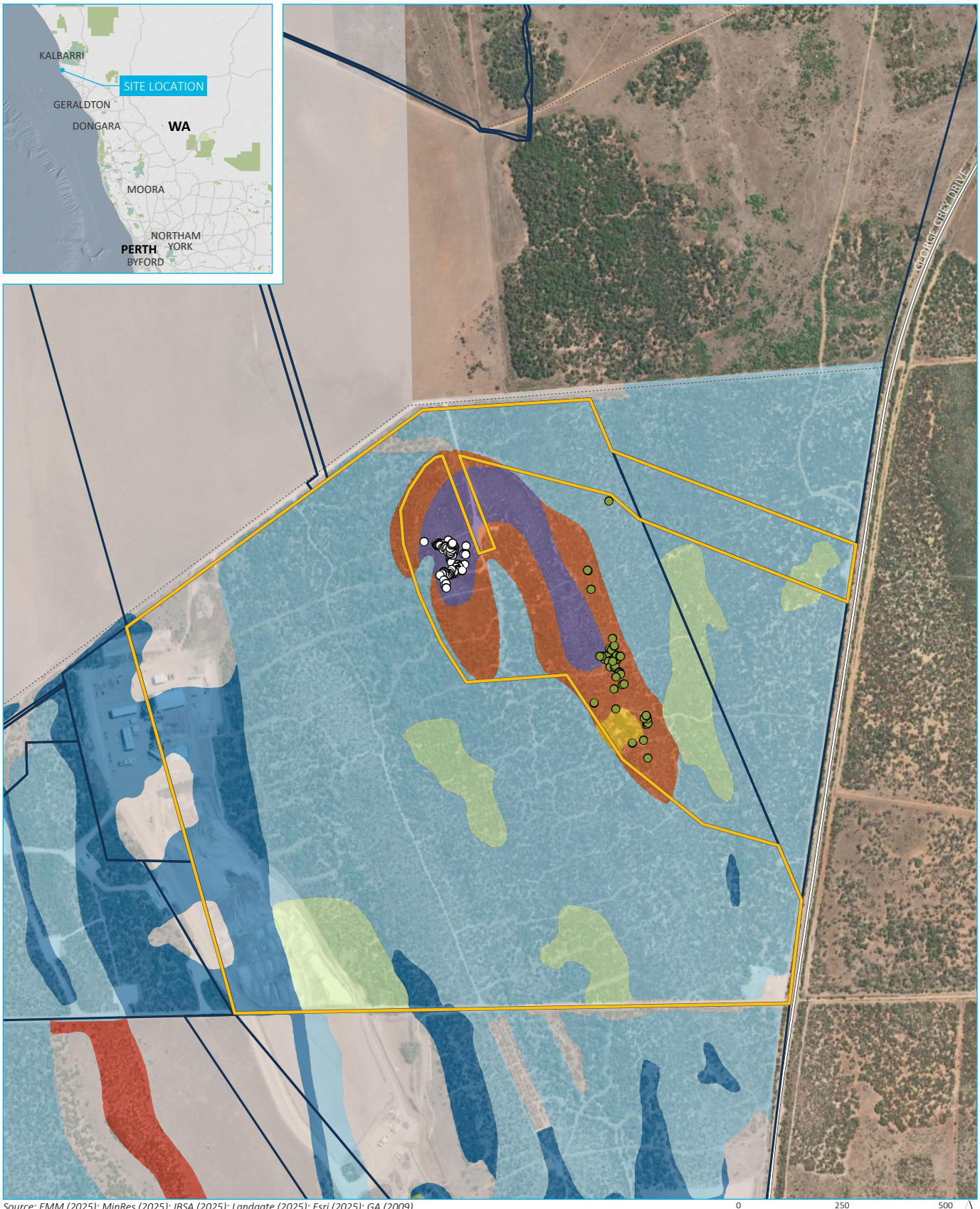
The field survey conducted by Botany Lens in 2024 (discussed in section 2.1) reported vegetation within the clearing permit to be in a condition consistent with that described in Onshore 2013, indicating vegetation and habitat condition is unlikely to have changed since 2013.

2.2.1 Short range endemic species

During the Bamford 2013 survey, an isopod (slater) species, *Buddelundia '81'*, was collected. This was the first known example of an undescribed species and is likely to be a short range endemic (SRE). It was recorded only in areas of native vegetation where limestone was present on the surface and therefore may be restricted to those areas.

To further explore the potential conservation values of SRE species in the area, including *Buddelundia '81'* , Bennelongia Environmental Consultants were commissioned to conduct a SRE survey in 2023 (desktop assessment and field survey, see Appendix B). The desktop review indicated that several potential (likely) SRE species could be found in the Project area, including several species of the millipede *Antichiropus* and two species of the land snail *Bothriembryon*. Additionally, the desktop review recovered two species listed as critically endangered or extinct as occurring near the Project. The field survey collected 530 samples identifiable to 34 species belonging to SRE Groups (i.e. invertebrate groups with a high proportion of SRE species). Of the 34 species found, 17 were considered widespread or likely to have widespread distributions.

One vegetation type within the project, VSA 3, is likely important for supporting the local SRE fauna, with the slater *Buddelundia* `BIS497`, appearing to occur only within this vegetation system. Activities such as clearing, loss of habitat, and interruptions in habitat connectivity have the potential to affect the species' populations, however, the significance of these potential impacts is expected to be minor as VSA 3 appears to be moderately widespread in the region. VSA 3 closely corresponds to VA 12 and 13, mapped by Onshore 2013. As shown in Figure 2.1, the clearing permit boundary largely avoids VA 12 and VA 13 with only a narrow strip of clearing required for an infrastructure corridor and the construction and installation of a communications tower.



Source: EMM (2025); MinRes (2025); IBSA (2025); Landgate (2025); Esri (2025); GA (2009)

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GDA2020 MGA Zone 50

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KEY

- Clearing permit area
- Tenement boundary

Priority flora

- *Bossiaea calcicola*
- *Melaleuca huttensis*

Vegetation type

- Cleared
- 2
- 4
- 5
- 6a
- 6b
- 12
- 13
- 16

Existing environment

- Major road
- Vehicular track

INSET KEY

- Major road
- National Park
- Reserve
- Other conservation/ management area

Vegetation associations and priority flora locations

Australian Garnet Lucky Bay Project
NVCP Amendment (CPS 3891/5)
Figure 2.1

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3 Assessment against 10 clearing principles

Under Schedule 5 of the *Environmental Protection Act 1986* (EP Act), there are 10 principles that are designed to guide decisions regarding the clearing of native vegetation. These principles aim to protect biodiversity, ecological communities, and environmental values.

An updated assessment against the 10 clearing principles, to support the proposed extension to the duration of CPS 3891, is provided in Table 3.1 below.

Table 3.1 Timeframe extension against the clearing principles

Clearing Principle	Outcome	Discussion and Potential Impacts	Additional Management and Mitigation Measures
a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	**Not likely** to be at variance	There are no Threatened or Priority Ecological Communities or threatened flora located within the clearing area. There are Priority flora species recorded in the uncleared area adjacent to the clearing area, however none have been recorded within the clearing area itself. **This amendment**: This proposal was previously considered to be at variance due to potential habitat for *Beyeria cinerea* subsp. *cinerea*; however subsequent survey data (Onshore 2022 re-examined the specimens and revised the identification of this species to *Beyeria cinerea* subsp. *borealis*. Considering this, and the fact that the permit boundary is not changing, this assessment outcome is suggested to be revised to 'not likely to be at variance'.	No additional measures are proposed.
b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	**Not likely** to be at variance	Three fauna habitat types have been identified within the broader application area, these being VSA 1, VSA 2 and VSA 3 (Bamford, 2013). One fauna habitat type VSA 3, is likely important for supporting the SRE slater *Buddelundia* `BIS497`. **This amendment**: Updated survey information from Bennelongia (2023) confirmed presence of *Buddelundia* `BIS497` species. A small portion of VSA 3 will be cleared for the construction of an infrastructure corridor; however, as a result of the appeal determination on CPS 3891/4, the width of the infrastructure corridor has been reduced from 57-67m to 40m, reducing the overall area of VSA 3 clearing. As this amendment is not changing the permit boundary, and VSA 3 (although less abundant than other VSAs) appears to be moderately widespread in the region (Bennelongia 2023), this assessment outcome is suggested to be revised to 'not likely to be at variance'.	No additional measures are proposed.
c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	Not likely to be at variance	The area proposed to be cleared is unlikely to contain habitat for flora species listed under the BC Act. **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing and updated survey information has not identified additional rare flora within the permit boundary.	Current mapped Priority Flora locations will be avoided by the clearing permit boundary.

Clearing Principle	Outcome	Discussion and Potential Impacts	Additional Management and Mitigation Measures
d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a Threatened Ecological Community (TEC).	Not likely to be at variance	There are no known Threatened Ecological Communities (TECs) located within or in close proximity to the application area. A flora and vegetation survey of the application area did not identify any TECs Priority Ecological Communities (PEC). (Onshore, 2022). **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing, and updated survey information has not identified new TECs.	No additional measures are proposed.
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.	At variance	The extent of the mapped vegetation type in the local area is inconsistent with the national objectives and targets for biodiversity conservation in Australia (Government of Western Australia, 2019). The vegetation proposed to be cleared is considered to be part of a significant ecological linkage in the local area. **This amendment**: There has been no reduction of clearing of native vegetation (90 ha) requested, therefore there is no suggested change to this outcome.	No additional measures are proposed.
f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	Not at variance	According to available databases, there are no watercourses or wetlands within the application area. There is a low surface runoff due to the high infiltration rates associated with the sand and sandy soils present within the application area **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing and there is no new information available that would change the assessment.	No additional measures are proposed.
g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	May be at variance	The soils of the application area have been broadly described as being calcareous deep sands. As the application area is already within a predominantly cleared agricultural landscape, it is not likely that the proposed clearing will contribute to a rise in groundwater table and salinity. The sandy soils of the amendment area may be at risk of wind erosion. **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing and there is no new information available that would change the assessment.	EPBC 2019/8606
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 areas.	May be at variance	There are no conservation areas within the application area. The nearest DBCA managed land is the Utcha Well Nature Reserve, located approximately 2.5 kilometres south of the application area, at its nearest point. Most of the separating area has been cleared for agriculture and has resulted in the fragmentation of habitat between the application area and the nature reserve. Whilst highly mobile species such as birds may not be disrupted, the proposed clearing may disrupt some ecological linkages to the Utcha Well Nature Reserve. **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing and there is no new information available that would change the assessment.	No additional measures are proposed.

Clearing Principle	Outcome	Discussion and Potential Impacts	Additional Management and Mitigation Measures
i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	Not likely to be at variance	Given no water courses, wetlands or Public Drinking Water Sources Areas are recorded within the application area, the proposed clearing is unlikely to impact surface or ground water quality. **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing, and there is no new information available that would change the assessment.	No additional measures are proposed.
j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	Not likely to be at variance	The proposed clearing is considered unlikely to have any significant impact on surface or groundwater quality, or on the incidence or intensity of flooding. **This amendment**: There are no changes to this assessment outcome, as the permit boundary is not changing, and there is no new information available that would change the assessment.	No additional measures are proposed.

4 Conclusion

The proposed 5-year extension of the existing permit duration is not expected to result in any additional impact on local ecological values or increases in the likelihood of variances against any of the clearing principles.

No changes to the permit boundary or permit clearing area are being sought under the amendment and updated biological survey results have not identified any new risks to ecological values inside the boundary of CPS 3891/5. The 2024 targeted flora survey identified additional priority flora individuals in the vicinity, but not within the clearing boundary. The 2023 SRE survey confirmed the presence of the slater *Buddelundia* `BIS497` within VSA 3; however, VSA 3 occurs mostly outside of the clearing boundary and is considered to be moderately widespread in the region. As such, clearing is expected to have minimal impact on the SRE species.

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Appendix A

Australian Garnet Lucky Bay Project – Targeted Flora Survey (Botany Lens, 2024)

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Australian Garnet Lucky Bay Project

Targeted Flora Survey for:

1. *Caladenia bryceana* subsp. *cracens* and,
2. Threatened and Priority Flora

Prepared for Australian Garnet Pty Ltd

October 24





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EXECUTIVE SUMMARY

Australian Garnet Pty Ltd commissioned Botany Lens to conduct a targeted survey for conservation significant flora, and specifically to search for *Caladenia bryceana* subsp. *cracens* (Northern Dwarf Spider Orchid), to support the environmental approvals necessary for the ongoing operation of the Lucky Bay Garnet Project. The Project is located west of George Grey Drive, approximately 35 km south of Kalbarri in the Shire of Northampton, Western Australia. Much of the current vegetation was cleared for agriculture in the 1980's.

A desktop assessment identified 94 conservation significant flora taxa as having the potential to occur within the project area.

Over ten field days in August and September 2024, an experienced botanist traversed over 100 km on foot, maintaining intervals of 10 to 40 meters in a regular linear pattern. The climatic conditions were exceptionally favourable for flora in the region, the timing was appropriate, and the survey intensity was well-suited to the target species, vegetation associations, and overall condition.

A desktop assessment identified 94 conservation significant flora taxa with the potential to occur within the project area.

The field survey results were:

- No Threatened Flora taxa protected by the EPBC Act 1999, or the BC Act 2016 were recorded within the survey area.
- Two Priority 3 Flora taxa were documented: *Bossiaea calcicola* and *Melaleuca huttensis*.

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1. Introduction

Botany Lens was commissioned in July 2024 by Australian Garnet Pty Ltd to conduct a targeted survey for conservation significant flora, and specifically to search for *Caladenia bryceana* subsp. *cracens* (Northern Dwarf Spider Orchid). The survey aims to support the environmental approvals required for the ongoing operation of the Lucky Bay Garnet Project.

1.1 Location

The Lucky Bay Garnet Project encompasses tenements M70/1280, M70/1387, and L70/134, along with their associated infrastructure footprints. It is situated west of George Grey Drive, approximately 35 km south of Kalbarri, within the Shire of Northampton, and about 460 km north of Perth, Western Australia (Map 1). The mining tenements cover an area of approximately 1,645 hectares, of which around 640 hectares consists of remnant native vegetation, while the remainder is cleared agricultural land. The survey area primarily lies within mining tenement M70/1280 and includes 174 hectares of native vegetation (Map 2).

1.2 Background

A reconnaissance flora and fauna survey (Level 1) was conducted in part of the survey area in 2008 (Ecoscape 2009). This was followed by a Level 2 flora and vegetation survey in October 2013, which encompassed the survey area and its surroundings (Onshore 2013). During the field assessment, the entire study area was ground-truthed at intervals of less than 100 meters, and opportunistic recordings of significant flora were made. In 2021, additional sampling was carried out to enhance sampling intensity, and previously identified locations of conservation significant flora were revisited (Onshore 2022).

Within the study area, two species listed as Priority flora (WAH 1998–) were recorded: *Melaleuca huttensis* and *Beyeria cinerea* subsp. *cinerea* (Map 2, Onshore 2013). The latter was later identified as *Beyeria cinerea* subsp. *borealis*, which is not a Priority species (Onshore 2022, WAH 1998–). Several species were not flowering during the initial survey, prompting Onshore (2013) to recommend an additional targeted survey for conservation significant species. A desktop assessment in 2021 identified six Threatened flora taxa listed under the BC Act and EPBC Act, along with 39 state-listed Priority flora taxa likely to occur within the broader Lucky Bay Garnet Project area (Onshore 2022).

Searches of federal and state threatened flora databases revealed a population of the Threatened orchid *C. bryceana* subsp. *cracens* (listed under the BC Act and EPBC Act), located less than 1.5 km from suitable habitat within the survey area (Map 2). Although the nearby known population was surveyed in 2021 during the appropriate flowering period, poor seasonal conditions resulted in no plants being found. Onshore (2022) recommended conducting targeted searches for the orchid at the study site during flowering periods when seasonal conditions are optimal.

1.3 Scope of Works

This report details the methodology and findings from targeted surveys for Threatened and Priority Flora conducted in August and September 2024 in areas identified by Australian Garnet within the proposed Disturbance Envelope of the Lucky Bay Project.

Onshore's (2022) desktop assessment is reviewed, new database searches undertaken and a list of likely and possibly occurring species compiled.

A targeted field survey was conducted to detect the presence of conservation significant flora species that have been previously recorded, as well as those believed to potentially occur in the area. Additionally, a specific survey was undertaken to search for *C. bryceana* subspecies *cracens*. Where these significant taxa are present, their extent and abundance were delineated.

The field surveys were undertaken in accordance with relevant Western Australian guidelines:

- *Technical Guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016a).
- *Draft Survey Guidelines for Australia's Threatened Orchids*. *Guidelines for Detecting Orchids Listed as 'Threatened' under the Environment Protection and Biodiversity Conservation Act 1999 Australia* (Commonwealth of Australia, 2013).
- *Environmental Factor Guideline: Flora and Vegetation* (EPA 2016b); and

Key legislation relevant to this survey include:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Biodiversity Conservation Act 2016* (BC Act).
- *Biodiversity Conservation Regulations 2018;* and
- *Environmental Protection Act 1986* (EP Act).

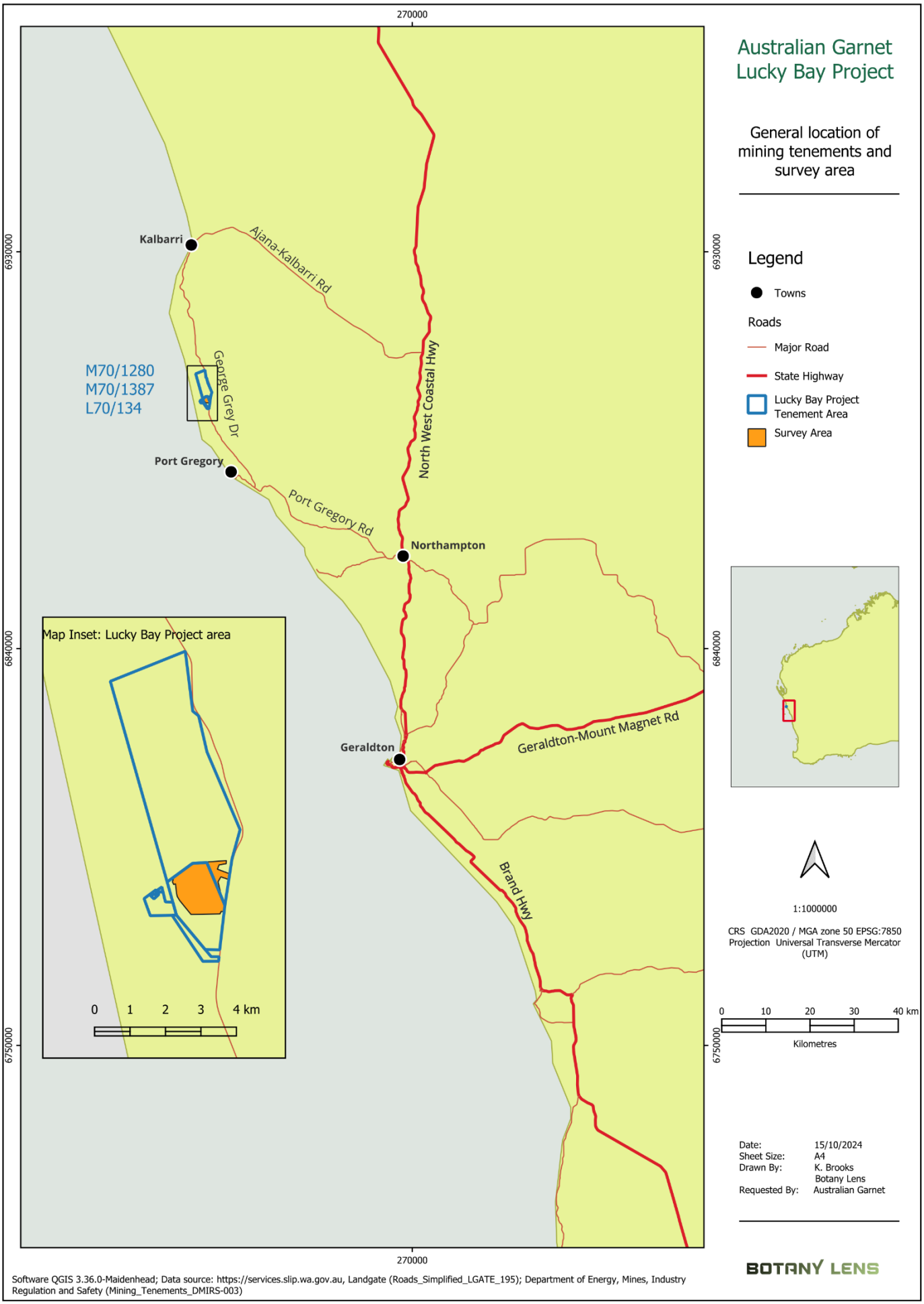
2. Site description

2.1 Landscape characteristics

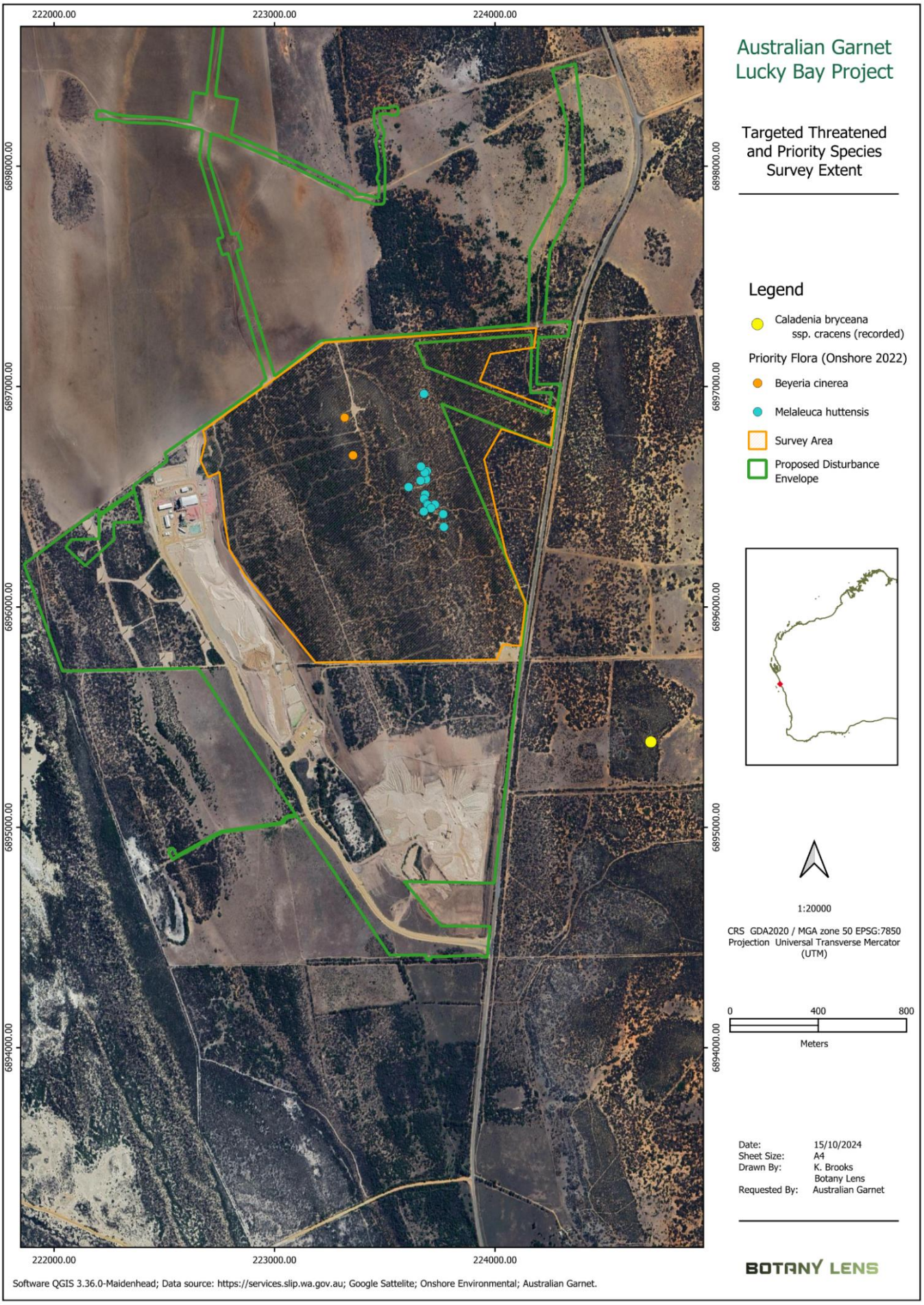
The Lucky Bay Project area is situated within the Geraldton Sandplains Bioregion and the Geraldton Hills Subregion (DCCEEW 2012). Vegetation in the study area is broadly mapped as *Acacia rostellifera* Thicket (Greenough 17) on dunes (Beard 1976). The low closed forest of *A. rostellifera* has been largely cleared and is now considered a rare feature within the bioregion (Desmond and Chant 2001).

The site is typical of coastal landforms found in the region. It consists of undulating terrain located approximately 1.8 km inland from the ocean. A primary vegetated dune runs parallel to the coast in a north-south direction, with dune heights ranging from about 15 m AHD at its lowest point to 75 m AHD at its highest. A limestone ridge runs through the centre of the site, composed of exposed limestone bedrock, along with 50-90% limestone cobbles, pebbles, and sand.

During the Geraldton Land Resource Survey (Rogers 1996), the area was mapped as the Tamala North 1 subsystem (DAFWA 2003), characterized by low hills with relict dunes and some limestone outcrops, forming a coastal band three to seven kilometres wide. This region features Aeolian calcareous sand dunes deposited during the Pleistocene, which have weathered to create leached sands over limestone. Tille's (2007) soil-landscape mapping places the study area within the Port Gregory Zone of the Carnarvon Province. This zone is described as coastal plains, sand plains, alluvial plains and sea cliffs.



Map 1. General location of Lucky Bay Garnet Project.



Map 2. Location of survey area, previous records of conservation significant flora, and proximity to *Caladenia bryceana* subsp. *cracens*.

2.2 Land Use

An aerial photograph from 1982 reveals that a significant portion of the Lucky Bay Project area was nearly entirely cleared for agriculture at that time (Plate 1A, Geoscience Australia 2024). Historical imagery from Google Earth indicates that by 1985, some revegetation had occurred, and by 2003, the area was predominantly covered with trees and shrubs. By 2024, it appears as uncleared vegetation (Plate 1B, Google 2024).

The uncleared area, shaped like an inverted U, follows the limestone ridge. The vegetation characterized by closed heath vegetation, dominated by *Melaleuca cardiophylla*, which provides habitat similar to that of the two nearest known populations of *C. bryceana* subsp. *cracens*. Notably, the closest known population is also located in an area that was vegetated in 1982 (Plate 1A).

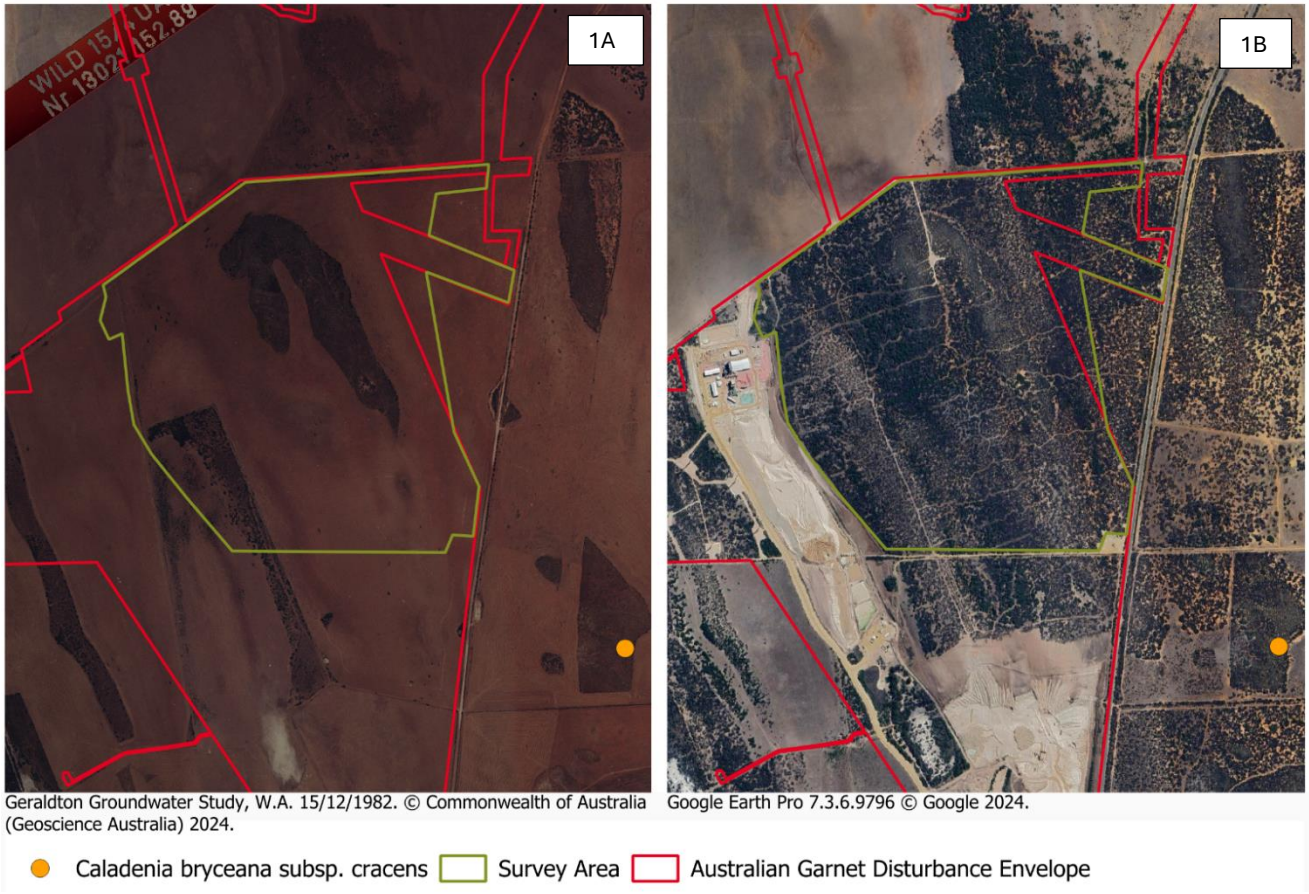


Plate 1. Aerial photograph from 1982 (1A), and satellite imagery from 2024 (1B), showing the extent of previous clearing within the proposed disturbance envelope and survey area, and the location of the nearest known population of Caladenia bryceana subsp. cracens.

2.3 Vegetation Associations

Onshore (2013, 2022) identified six broad floristic formations and evaluated the vegetation condition within the study area. The remnant vegetation on the limestone ridge and upper hillslopes primarily consists of low closed heath, dominated by *M. cardiophylla*, *Melaleuca campanae*, and *Cryptandra arbutiflora*, with a sparse herb layer featuring geophytes, annual forbs, and annual weed species (Plate 2). This approximately eight-hectare area was rated as being in good to very good condition according to the Keighery (1994) vegetation condition rating scale.



Plate 2. Melaleuca low closed heath occurring on limestone ridge in very good condition within the survey area.

Surrounding this area is approximately 15 hectares of mixed-species open shrubland, also in good condition, dominated by *M. cardiophylla*, *Rhagodia latifolia* var. *latifolia*, *Pimelea microcephala*, and *Olearia* sp. This shrubland includes stands of *Grevillea argyrophylla*, *Grevillea commutata*, *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Diplopeltis petiolaris*, *Jasminium calcareum*, *Santalum spicatum*, and *Alyxia buxiflora*, along with grasses such as *Austrostipa elegantissima* and *Austrostipa flavescens*, an open herb layer, and annual weeds (Plate 3). Additionally, there are pockets of *Eucalyptus oraria* and *Eucalyptus fruticosa* mallee over low grass of *Austrostipa flavescens*, herbs, and annual weeds.



Plate 3. Open shrubland on hillslopes surrounding limestone ridge within survey area.

Regrowth on the remainder of the site is dominated by open to closed scrub and high shrubland of *A. rostellifera* over Low Scrub of *R. latifolia var. latifolia, Stylobasium spathulatum, P. microcephala, Alyogyne hakeifolia*, *Olearia* sp. and *Scaevola anchusifolia* over a closed herb layer dominated by annual weeds (Plate 4). The regrowth was recorded as 'good condition' by Onshore 2013, with small pockets of degraded vegetation. However, native plant species diversity is low, and the annual weed burden is high. There are pockets of vegetation in good condition, but most of the area is degraded.



Plate 4. The regenerated low diversity open to closed, low and high shrubland over a forb layer of predominantly annual weeds.

3. Methods

3.1 Desktop assessment

The desktop assessment builds on the comprehensive analysis of conservation significant flora conducted by Onshore (2022). Current searches of relevant databases ensured that any new records were captured.

The desktop searches included information on significant flora previously collected or described within or near the study area. The following databases were searched:

- EPBC Act Protected Matters Database (50 km radial search) (DCCEEW 2024)
- BC Act Threatened and Priority Flora List (TPFL) database (50 km radial search) (DBCA 2024)
- Western Australian Herbarium Database (50 km radial search) (DBCA 2024)

3.1.1 Assessment of Likelihood of Occurrence in the Survey Area

A list of conservation significant flora taxa occurring within a 50 km radius was compiled. Onshore (2022) established criteria to determine the likelihood of occurrence for each taxon within the survey area. These criteria were adopted, and each taxon was assessed based on the presence of suitable landforms inferred from aerial imagery with contours overlaid, as well as knowledge of the area and existing habitat records (Table 1). An additional criterion based on Beard's vegetation mapping was applied, which recorded species located further from the study site but associated with the vegetation types typical of coastal dune systems between Kalbarri and Geraldton.

Table 1. Ranking system used to assign the likelihood that a species would occur in the survey area (modified from Onshore 2022).

Rank	Criteria
Recorded	The species has been recorded in the study area.
Likely to occur	The species has previously been recorded from a landform which is present within the study area, and there are previous records within a 20 km radius of the study area, or it occurs in the coastal dune vegetation between Kalbarri and Geraldton.
Possible to occur	The species has previously been recorded from a landform which is present within the study area, and there are previous records within a 50 km radius of the study area.
Unlikely to occur	The landform from which the species has previously been recorded is absent within the study area, and/or there are no previous records within a 50 km radius of the study area.

3.2 Field survey

3.2.1 Timing and Personnel

The targeted flora survey for conservation significant flora, and specifically, *Caladenia bryceana* subsp. *cracens* was conducted by Dr Kristine Brooks, a local botanist with extensive experience in surveying conservation significant flora, including threatened orchids. The survey took place between August 14th and September 15th, 2024

Survey dates:

- *Caladenia bryceana* subsp. *cracens* – 14th to 26th of August 2024
- Other Threatened and Priority Flora – 26th of August to 15th of September 2024

3.2.2 Seasonal conditions

Climate statistics were collected from Kalbarri (BOM Site Number 008251), using data from 2000 to 2023 to calculate long-term averages. For 2024, rainfall data is available up to September 30, while temperature data extends to August 31 (BOM 2024a).

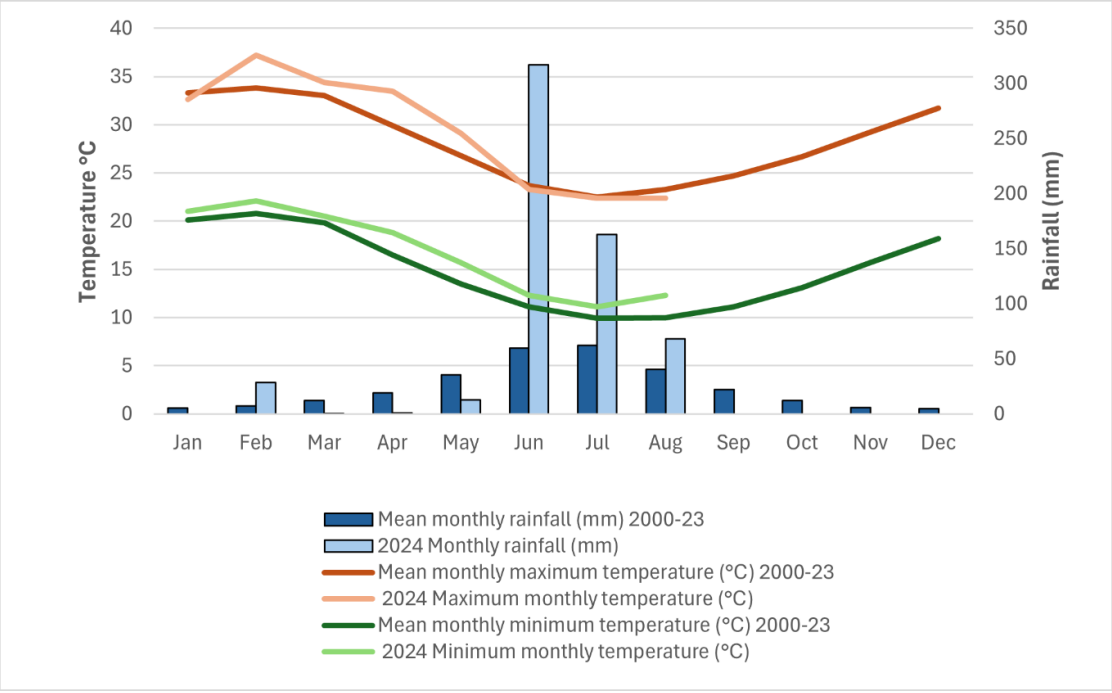


Figure 3. Comparison of 2024 rainfall and temperature data to mean climate data for the years 2000 to 2023.

The statistics indicate an exceptionally wet winter, with above-average rainfall recorded in June, July, and August. Both maximum and minimum temperatures have been higher than average for most of the year; however, maximum temperatures from June to August were around average or slightly cooler (Figure 1).

The Kalbarri BOM site is located approximately 35 km north of the Lucky Bay project, while the Balline weather station (BOM Site Number 008004) is only 4 km away. However, climate data for Balline is incomplete and not quality controlled. In June and July, Balline recorded lower rainfall than Kalbarri, with totals of 208.4 mm and 143 mm, respectively, but these amounts were still at least twice the average rainfall (BOM 2024b).

The above-average rainfall and typical daytime temperatures in the region created optimal growing and flowering conditions for flora species within the sandy soils of the survey area.

3.2.3 Caladenia bryceana subspecies *cracens* survey

3.2.3.1 Target species

Caladenia bryceana subsp. *cracens* (The Northen Dwarf Spider Orchid), is a small orchid growing from 30 to 80 mm in height. Its hairy leaf is 40-80 mm long, and 5 – 9 mm wide. It produces a single (rarely two) green to apricot flowers that are 10-15 mm across. The flower has a red tip on the labellum and dark red calli. The basal calli are fused to form a large, clubbed projection with two lobes. Flowering occurs from August to early September (Hopper and Brown 2001, DAWHA 2008, Newman and Brown 2024) (Plate 5). *Caladenia bryceana* subsp. *cracens* grows scattered in low heath in shallow soil on coastal limestone. Further north the subspecies forms colonies on winter-wet flats or in swales beneath thickets of *Melaleuca uncinata*, over open herbs in pale red-brown sandy loam or brown sandy clay (DAWHA 2008).

C. bryceana subsp. *cracens* is listed as Vulnerable under the EPBC Act and Endangered under the BC Act.



Plate 5. *Caladenia bryceana* subspecies *cracens*, at the two nearby known populations: Flower (A), scattered through litter under *Allocasuarina campestris*, and in a shade under *Melaleuca cardiophylla*.

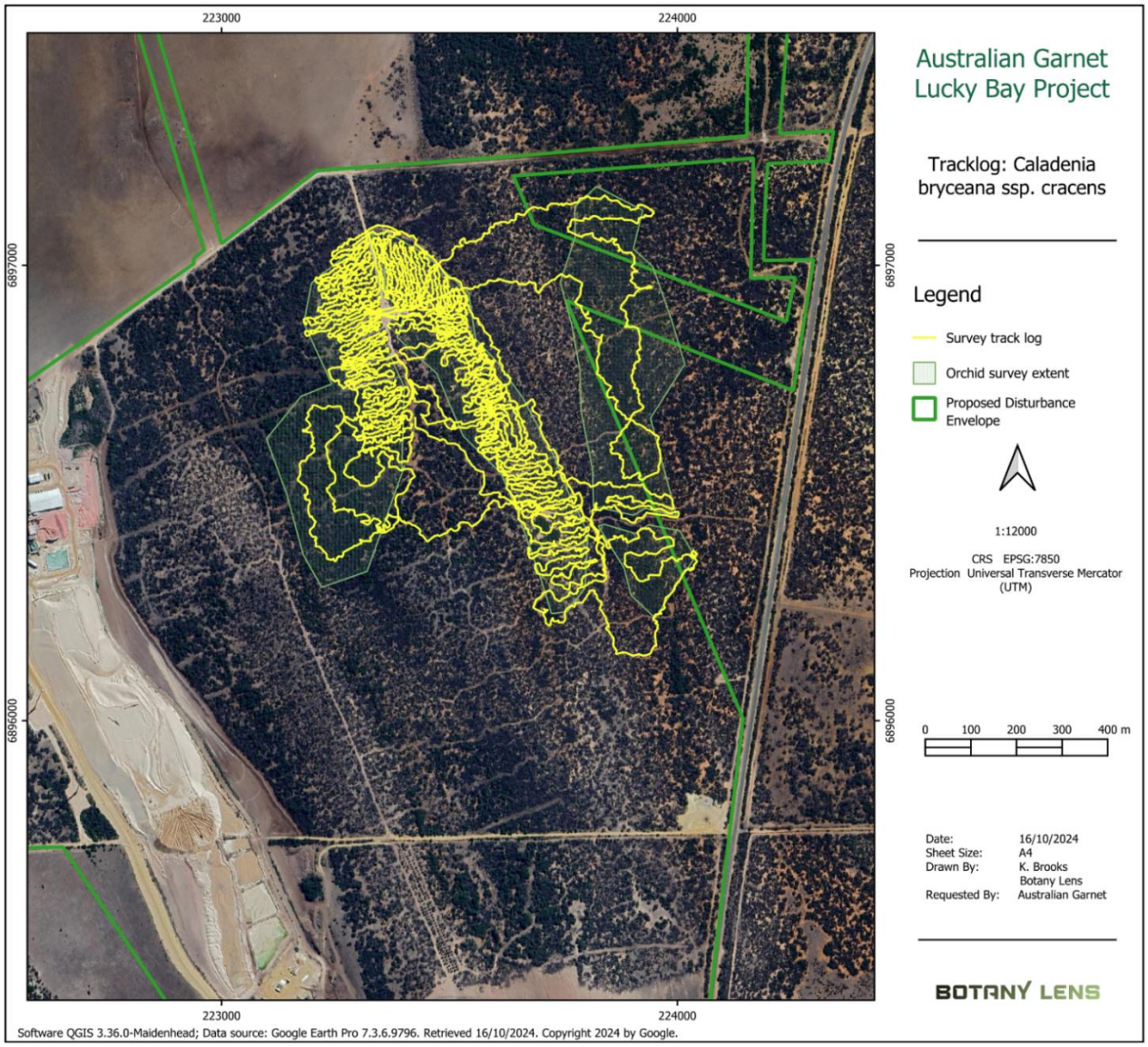
3.2.3.2 Field identification, Timing, and Habitat Assessment

Prior to the survey advice was sought from orchid expert Andrew Brown, local DBCA Flora Officer Alanna Chant, and Robyn Simkin, a local naturalist and orchid enthusiast, who first discovered one of the known populations in the area. Visits were made to two nearby known populations of *C. bryceana* subsp. *cracens* to both confirm flowering and for familiarisation with known habitat. Robyn Simkin assisted in the initial survey

(6th August 2024) of the nearest known population, providing valuable insights into its preferred microhabitat. Several clusters of leaves and plants in bud were located. A follow-up visit (12th August 2024) confirmed the identification, as flowers were present. A known population of *C. bryceana* subsp. *cracens*, located 10 km south on the GMA mining lease was also in flower and differences in micro habitat were noted. Orchid habitat in the known populations was analogous to the low closed *Melaleuca* heath found on the limestone ridge within the project area.

3.2.3.3 Survey Method

After confirming flowering, areas of analogous habitat in very good condition within the project area, as well as surrounding open scrub, were intensively surveyed on foot at 10-meter intervals in a regular linear pattern. This approach aligns with the guidelines for detecting orchids listed as 'Threatened' under the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth of Australia 2013). Additional traverses were conducted in adjacent areas identified by Australian Garnet as potential habitat. However, these areas were deemed unsuitable for orchid growth, consisting primarily of *Acacia rostellifera* scrub thickets and woodlands over a dense understorey of annual grasses. Consequently, they were sampled less intensively using a meander technique to search for suitable habitat. The survey track log is shown in Map 3.



Map 3. Track log from survey for *Caladenia bryceana* subsp. *cracens*

The survey coverage was high, due to the closely spaced traverse lines and the time dedicated to searching. A total of 37 km was walked over five days, taking 30 hours. The survey was conducted during favourable weather conditions, between 9:00 AM and 4:00 PM, to maximize visibility. Additionally, observations of other potential conservation significant species were made during the orchid search.

3.2.4 Conservation significant species

3.2.4.1 Field identification and Timing

Before the field survey, documentation was gathered for conservation significant taxa identified during the desktop survey as likely or possibly occurring in the area. This included photographs, drawings, scanned specimens, and plant descriptions, all stored in digital format for easy access in the field. A comprehensive species list from previous flora surveys was also compiled to serve as a reference when encountering unknown taxa.

The field survey was conducted in late August and early September, strategically timed to coincide with the peak flowering periods of conservation significant flora that may occur in the Lucky Bay Project area. This timing is deemed appropriate and consistent with the relevant survey guidelines (EPA 2016).

3.2.4.2 Survey Method

Occurrences of potential conservation significant flora were documented during the targeted orchid survey, with necessary revisits conducted as required. An additional five days were dedicated to surveying threatened and priority flora in the remaining survey area. Throughout the field surveys, the botanist utilized digital data layers, including the survey area boundary, proposed survey lines, and historical records of conservation significant flora.

The survey methodology involved foot traverses along mapped transect lines. Initially planned at 20-meter intervals, the survey was expanded to 40 meters due to low species diversity and dense annual weed cover in the understorey. The vegetation was partially very open, allowing good visibility for 20 meters on either side of the traverse. However, in some areas, large swathes of mature Acacia trees had been recently felled, likely by Cyclone Seroja, creating tangled obstacles up to 1.5 meters high. The dense recruitment of *Acacia* and *Rhagodia* species within these tangles often rendered these areas inaccessible, necessitating deviations around them.

On the western edge of the survey area, soil and vegetation had been disturbed by ongoing mining activities, and these areas were excluded from the survey. The survey adhered to the methods outlined in the Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).

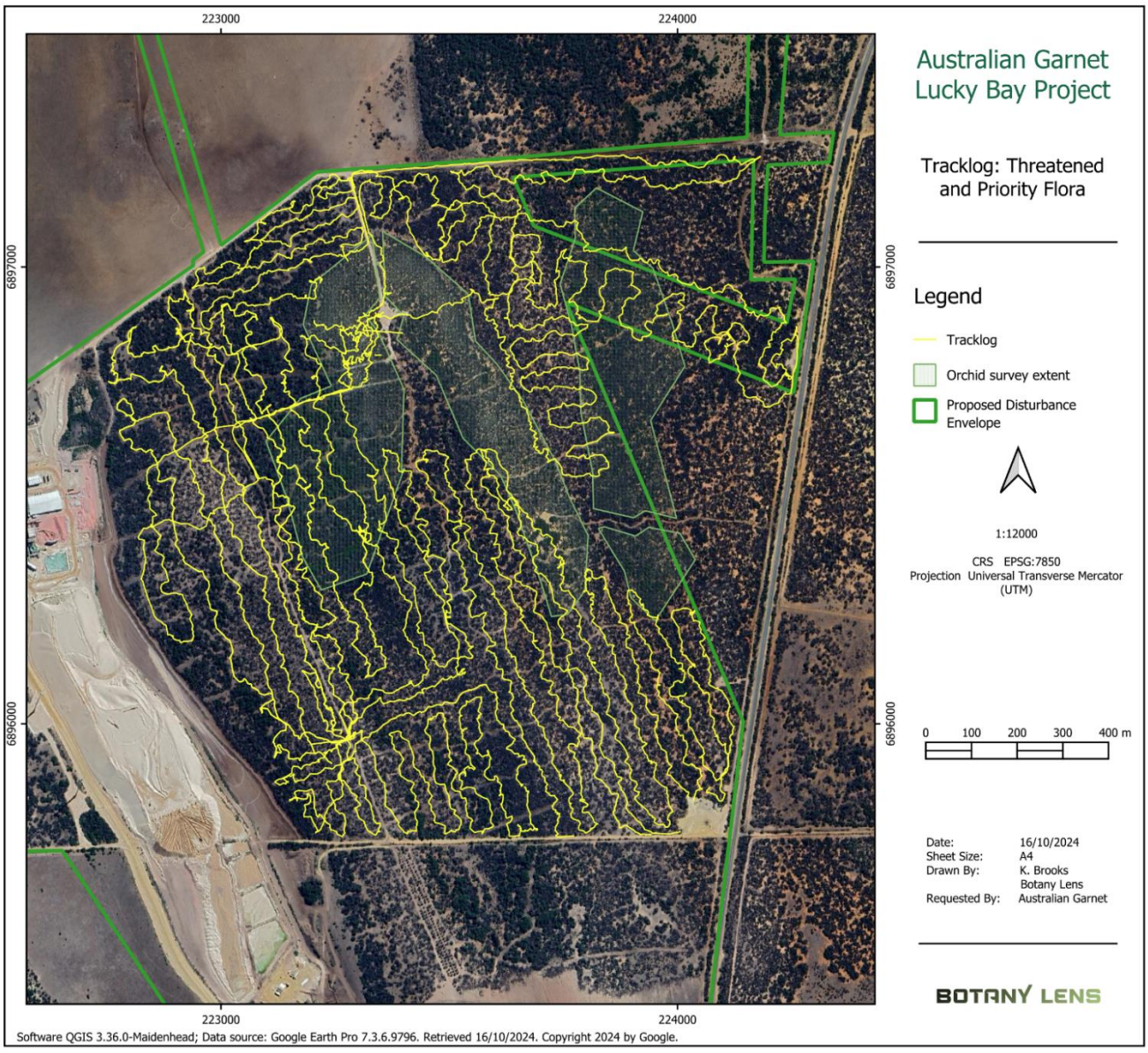
In total, 66 kilometres were walked over 40 hours across six days, conducted during favourable weather conditions between 9.00 AM and 4:30 PM to maximize visibility. The track log is provided in Map 4.

For any occurrences of suspected or known conservation significant flora species encountered, the following data were recorded:

- A colour photograph
- GPS location
- Associated habitat and landscape elements
- Time and date of observation

This information facilitated identification confirmation. For unidentified species that did not match descriptions under the EPBC or BC Act, specimens were collected. All plant specimens gathered during the

field surveys were dried and processed according to Western Australian Herbarium guidelines (WAH 2008). Identification of plant species was based on taxonomic literature and comparisons with pressed specimens housed at the Western Australian Herbarium.



Map 4: Tracklog from survey for Threatened and Priority Flora

3.2.5 Survey Limitations

The contextual information available prior to the 2024 surveys was sufficient to inform the methodology and expected flora within the project area. However, a review of current records within appropriate databases was undertaken. The botanist familiarised themself with threatened and priority flora likely to occur within the project area, and other flora species previously recorded from the site.

Several species of orchid were identified as likely to occur within the study area. Traverse widths of 40 m are not adequate to survey for orchids, however, the dense annual weed burden standing 30 to 50 cm high suggests it is unlikely orchids would be present (Plate 6). And if present, would be extremely difficult to detect even at five metre traverse intervals. Thickets of fallen branches with shrubs recruiting through them also created a dense layer of vegetation that inhibited the herb layer. Where the understorey was more open or

weed species gave way to a native herb layer traverses were closer together, these areas scanned carefully for orchids and other herbs and small shrubs.



Plate 6. Heavy annual weed burden and dense recruitment of shrubs through a tangle of felled Acacia trees: Limitations to survey for conservation significant small herbaceous species.

4. Results and Discussion

4.1 Desktop assessment

Information on conservation significant flora species that may occur in the area was compiled through searches of the DBCA Threatened and Priority Flora List and Western Australian Herbarium databases, requested in 2024 (search reference #72-0824FL DBCA 2024). Additionally, the EPBC Act Protected Matters Search Tool (DCCEEW 2024) was utilized. Each search was conducted within a 50 km radius of the following coordinates: -28.028849 S; 114.187953 E. Furthermore, a specific search was carried out for species found in the coastal vegetation strip between Kalbarri and Geraldton.

4.1.1 Threatened Flora listed under state and federal legislation

No threatened flora taxa listed under the EPBC Act, or the BC Act were reported within the survey area. However, the EPBC Act Protected Matters database identified twenty-three threatened flora taxa as either occurring or having suitable habitat within a 50 km radius of the study area (DCCEEW, 2024). Of these, fourteen taxa have been recorded within this radius and are also listed under the BC Act (DBCA 2024, State of Western Australia 2024).

- *Androcalva bivillosa*
- *Beyeria lepidopetala*
- *Caladenia barbarella*
- *Caladenia bryceana* subsp. *cracens*
- *Caladenia elegans*
- *Caladenia hoffmanii*
- *Caladenia wanosa*
- *Chorizema humile*
- *Diuris drummondii*
- *Drakaea concolor*
- *Drummondita ericoides*
- *Eucalyptus beardiana*
- *Eucalyptus cuprea*
- *Gastrolobium hamulosum*
- *Grevillea christineae*
- *Hypocalymma angustifolium* subsp. Hutt River (S.Patrick 2982)
- *Hypocalymma longifolium*
- *Lechenaultia chlorantha*
- *Leucopogon marginatus*
- *Paracaleana dixonii*
- *Pterostylis sinuata*
- *Stachystemon nematophorus*
- *Wurmbea tubulosa*

It is important to note that *Hypocalymma angustifolium* subsp. Hutt River (S. Patrick 2982) is no longer listed under the BC Act (State of Western Australia 2023). The only recorded specimen has since been reclassified as *Hypocalymma balbakiae* Tauss & Rye, which is not considered a threatened species (WAH 1998–).

The Protected Matters database reported four flora taxon listed under the EPBC Act as either occurring or having suitable habitat within the Lucky Bay Project survey area. Among these, the orchid *C. hoffmanii*, was noted as likely to occur, while three taxa—*A. bivillosa*, *C. bryceana* subsp. *cracens* and *C. elegans*—were classified as possibly occuring. However, there are no previous recordings of these species within the study area.

In contrast, based on the proximity of previous records and the recorded habitat, the desktop assessment identified three threatened flora taxa as 'likely' to occur within the study area. Additionally, four species were considered 'possible,' while seven taxa were deemed 'unlikely' to occur (see Table 2).

Table 2. Likelihood of occurrence and flowering time of Threatened flora taxa listed under the EPBC Act and BC Act and recorded within a 50 km radius of the Lucky Bay Garnet Project study area, or in coastal vegetation between Kalbarri and Geraldton.

Taxon	BC ACT	EPBC ACT	Habitat	Likelihood	Flowering
Androcalva bivillosa	T (CR)	CR	Dry white / yellow sand on sandplain slope.	Possible	Aug-Sep
Beyeria lepidopetala	T (VU)	VU	Yellow sand over limestone. Gully.	Likely	Jul-Aug
Caladenia barbarella	T (EN)	EN	Rocky ledges, alongside seasonal creeklines, in winter-wet depressions.	Unlikely	Aug-Sep
Caladenia bryceana subsp. *cracens*	T (EN)	VU	South of Kalbarri in low heath on limestone hills; north in winter-moist flats.	Likely	Aug-Sep
Caladenia elegans	T (CR)	CR	Clayey loam. Winter-wet clay flats.	Unlikely	Jul-Aug
Caladenia hoffmanii	T (EN)	EN	Clay, loam, laterite, granite. Rocky outcrops and hillsides, ridges, swamps and gullies. (open heath)	Possible	Aug-oct
Caladenia wanosa	T (EN)	EN	Sand. Sandstone outcrops, top edges of gorges.	Unlikely	Aug-Sep
Diuris drummondii	T (EN)	VU	Low-lying depressions, swamps.	Unlikely	Nov-Dec
Drakaea concolor	T (EN)	EN	Grey sand. (Dense heath / sedgeland)	Likely	Aug-Sep
Eucalyptus cuprea	T (EN)	EN	Shallow soils over granite.	Possible	Aug-Nov
Hypocalymma longifolium	T (VU)	VU	Grey sand or clay, sandstone. Rocky breakaways, swampland.	Unlikely	Aug-Sep
Lechenaultia chlorantha	T (CR)	CR	Rocky sandstone gullies & on ledges.	Unlikely	Aug-Sep
Pterostylis sinuata	T (CR)	CR	Winter wet flat below breakaway system. Clay loam and laterite.	Possible	Sep
Wurmbea tubulosa	T (VU)	VU	Clay, loam. Riverbanks, seasonally wet places.	Unlikely	Jun-Aug

4.1.2 Priority Flora

Priority flora are possible threatened taxa that are data-deficient or don't meet specific survey criteria (P1, P2 and P3). Species that are adequately known, and are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons are listed as Priority 4 (DBCA n.d.).

A total of 133 Priority Flora taxa listed on DBCA's TPFL and WAH databases have been recorded within a 50 km radius of the Lucky Bay Project, as well as within coastal vegetation associations between Kalbarri and Geraldton (DBCA 2024). Notably, *Melaleuca huttensis*, has been collected within the survey area (Onshore 2013, 2022). Based on recorded habitats and proximity of previous collections, an additional ten species were classified as 'likely' to occur (Table 3), while 77 taxa were deemed 'possible' and 44 taxa 'unlikely' to occur within the study area. The complete list is available in Appendix 1.

Onshore (2013) reported the occurrence of *Beyeria cinerea* subsp. *cinerea* (P3) within the study area. However, after revisiting the site in 2021 and re-examining multiple specimens collected in both 2013 and 2021, these collections were determined as *Beyeria cinerea* subsp. *borealis* (Onshore 2022). This subspecies is not listed as a Priority flora taxon by the DBCA (WAH 1998–).

Additionally, *Comesperma rhadinocarpum* (P3) was previously recorded within the Lucky Bay project area, though not specifically within the study area. Onshore Environmental visited the location in September 2021 but found no plants at or near the site (Onshore 2022).

Table 3. Priority flora assessed as 'likely' to occur within the Lucky Bay Garnet Project survey area.

Taxon	Priority	Habitat	Likelihood	Flowering
Acacia latipes subsp. *licina*	3	White sand, granitic soils. Limestone hills, sandplains.	Likely	Jun-Sep
Acanthocarpus parviflorus	3	Sand over limestone or sandstone.	Likely	May-Jun
Anthocercis intricata	3	Sand or loam over limestone. Consolidated sand dunes.	Likely	Jun-Sep
Bossiaea calcicola	3	Compacted sand over limestone. Exposed sites on coastal cliffs and slopes.	Likely	Jul-Sep
Carpobrotus sp. Thevenard Island (M. White 050)	3	Coarse white sand. Dune tops, disturbed areas.	Likely	Aug
Comesperma rhadinocarpum	3	Low limestone ridge, sand over limestone. Sandy-soils.	Likely	Oct-Nov
Geleznowia amabilis	2	Brown, yellow or red sand on slopes and sandplains	Likely	Sep-Dec
Grevillea stenomera	2	Red or yellow sand on limestone. Coastal areas.	Likely	May-Jun
Lasiopetalum oldfieldii	3	White, grey or yellow sand, gravel, laterite. Sandplains, rises.	Likely	Aug-Nov
Macarthuria intricata	3	Red or black soil over limestone, grey sand over sandstone, sandy clay. Sandplains & sand dunes.	Likely	Sep-Dec
Melaleuca huttensis	3	Light yellow or beige sand. Lower slopes of undulating plains, sandplains.	Recorded	Jun-Sep
Scaevola kallophylla	4	Sandy soils over limestone. Coastal plain	Likely	Aug-Dec
Scholtzia oleosa	3	Light brown or grey sand or clay. Sandplains, undulating rises and depressions.	Likely	Sep-Nov
Thryptomene conica	2	Shallow sandy soils. Coastal limestone cliffs, stream beds.	Likely	Aug

4.2 Field surveys

4.2.1 Caladenia bryceana subsp. cracens survey

No plants of *Caladenia bryceana* subsp. *cracens* were recorded within the Lucky Bay project area. Despite above average rainfall leading to an abundance of flowering orchids throughout the region, there was a striking scarcity of orchids at the survey site. Only one cluster of orchid leaves was recorded (7A), which appeared to be *Cyrtistylis huegelii*, or Midge Orchid. This species was recorded in flower at the nearest known population of the target orchid. In contrast, both known populations of *C. bryceana* spp. *cracens* contained other orchid species. Notably, *Caladenia longicauda*, or the Common White Spider Orchid, was clearly visible in the habitat and co-occurred with the target orchid at both sites (Plates 7B, 7C).

The *Melaleuca* low heath habitat, characterised by sandy soils and limestone cobbles, closely resembled that of the two known orchid populations, with *Melaleuca cardiophylla* dominant in the vegetation at all locations. While a common suite of species was present, some exceptions were observed. In particular, the low shrub *Pimelea sessilis* and the tall shrub *Allocasuarina campestris* were visible in the landscape at both the known populations but were relatively uncommon at the study site.

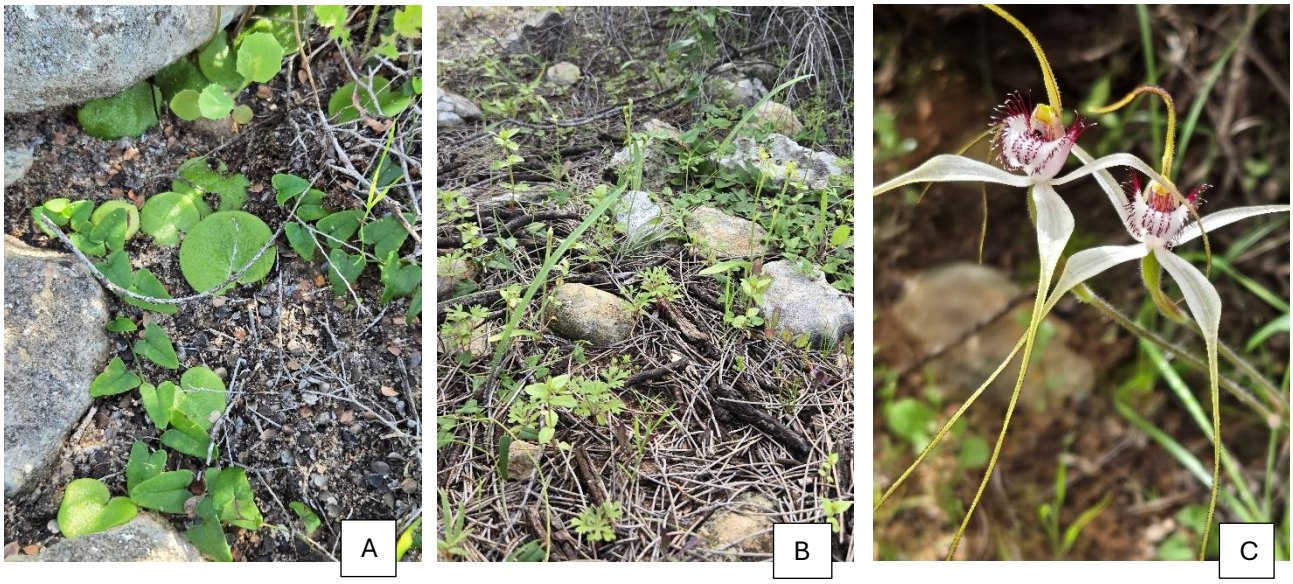
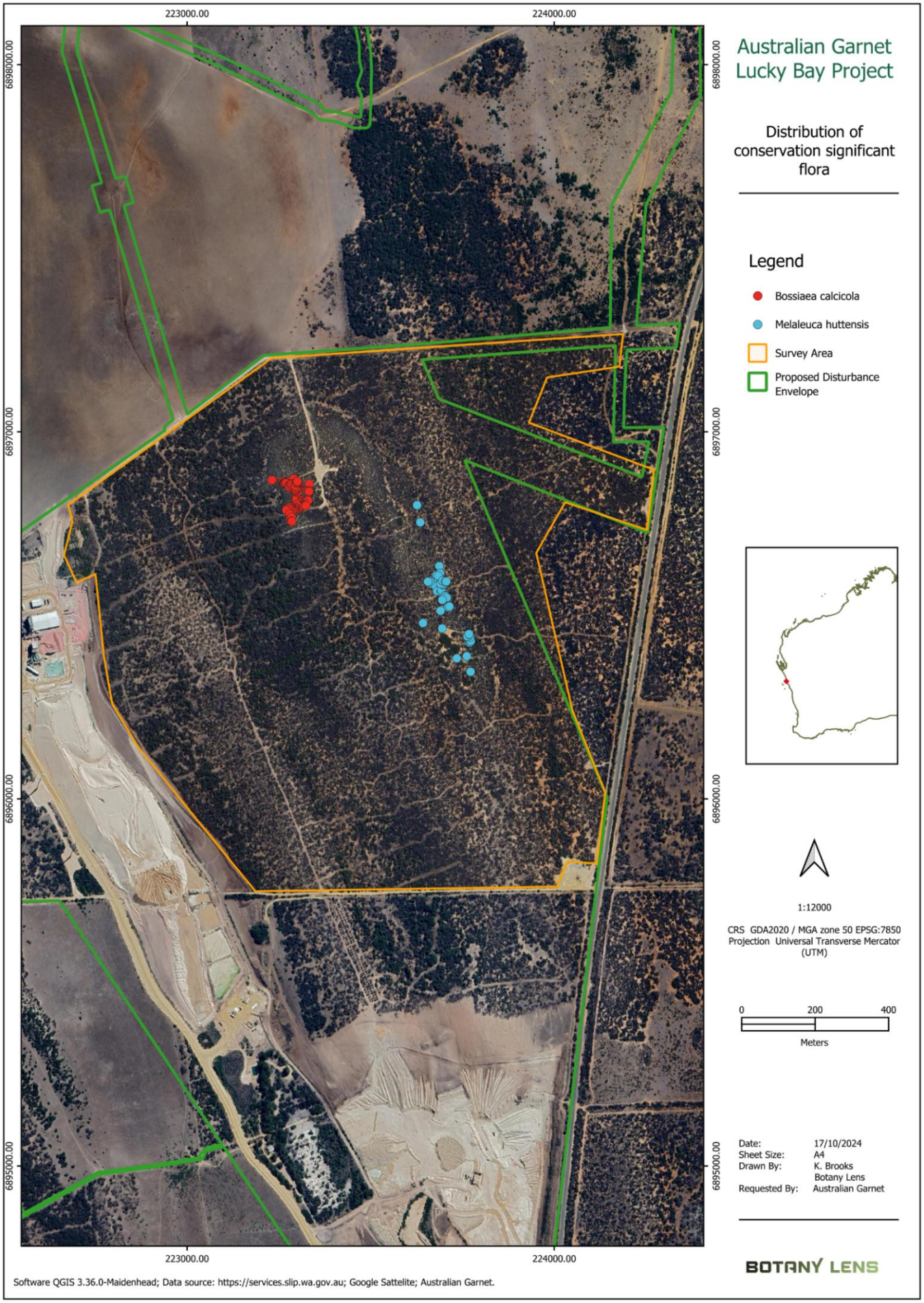


Plate 7. The only cluster of orchids recorded during the survey (A). Long leaves of *Caladenia longicauda* growing within a cluster of *Caladenia bryceana* subsp. *cracens* plants (B), and its highly visible flower (C) at a nearby known population.

4.2.2 Threatened and Priority species survey

No threatened flora species listed under the EPBC Act (DCCEEW 2024) or the BC Act (State of Western Australia 2024) were recorded within the Lucky Bay Project survey area. However, two species of Priority flora as listed by the DBCA (WAH 1998–) were recorded: *Bossiaea calcicola* (P3) and *Melaleuca huttensis* (P3) (Map 5). Geographic co-ordinates are provided in Appendix 2. Both species were exclusively found within the vegetation remnant that has remained uncleared since at least 1982.

Both, *B. calcicola* and *M. huttensis* were recorded during a 2021 survey encompassing the wider area under exploration licence E 70/2509 (Onshore 2022). These records were not shown on the database searches provided by DBCA (2024).



Map 5. Distribution of *Bossiaea calcicola* (P3) and *Melaleuca huttensis* (P3) plants within the survey area, 2024.

4.2.2.1 *Bossiaea calcicola* Ross **(P3) - FABACEAE**

Bossiaea calcicola (P3) Priority List (WAH 1998–). *Bossiaea calcicola* is a compact, spinescent shrub, to 0.7 m high. Flowers are multicoloured, yellow and red, occurring from July to September. Plants have been recorded in compacted sand over limestone in exposed sites on coastal cliffs and slopes. (Ross 2006, Hollister and Thiele n.d., WAH 1998–).

One hundred and nineteen plants were recorded on the west facing slope of the uncleared limestone ridge. In white-grey sands with 50 to 90 % limestone cobbles (Plate 8).

Onshore (2022) recorded over 350 plants of *B. calcicola* 34-point locations in adjacent bushland to the south-east of the study area.



Plate 8. *Bossiaea calcicola* (P3) flowers and leaves

4.2.2.2 *Melaleuca huttensis* Craven **(P3) - MYRTACEAE**

Melaleuca huttensis (P3) Priority List (DBCA 2024b). *Melaleuca huttensis* is an upright shrub to three metres tall, with gnarled white to grey bark. Flowers are cream-yellow, occurring from June to September (Plate 9). It's been recorded growing in light yellow or beige sand, on lower slopes of undulating plains, and sandplains (Craven 1999, WAH 1998–).

Forty-nine live plants were recorded at the study site. The plants were growing on the east facing slopes below the limestone ridge within the area of remnant uncleared in 1982. This location is in line with previously recorded plants. Onshore (2013) recorded one disjunct plant of *M. huttensis* to the north within the once cleared area. This plant was searched for during the current survey, but not found.

Melaleuca huttensis was recorded in the study area by Onshore (2013, 2022). Over a broader project area Onshore (2022) also recorded approximately 600 plants of *M. huttensis* from 53-point locations on hillslopes and sandplains.



Plate 9. *Melaleuca huttensis* (P3) flowers, leaves and fruit.

5. Summary

A targeted survey for conservation significant flora, and specifically to search for *Caladenia bryceana* subsp. *cracens* (Northern Dwarf Spider Orchid) was conducted under exceptionally favourable seasonal conditions in August and September 2021. This survey aimed to support the environmental approvals necessary for the ongoing operation of the Lucky Bay Garnet Project.

A desktop assessment identified 13 Threatened and Priority flora taxa as likely to occur within the study area, with an additional 81 taxa classified as possibly occurring.

The field survey found:

- No Threatened Flora taxa protected by the EPBC Act, or the BC Act within the survey area.
- Two Priority 3 Flora taxa were recorded: *Melaleuca huttensis* and *Bossiaea calcicola*.

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7. Appendices

Appendix 1. Likelihood of occurrence and flowering time of Priority flora taxa listed under the EPBC Act and BC Act and recorded within a 50 km radius of the Lucky Bay Garnet Project study area, or in coastal vegetation between Kalbarri and Geraldton.

Taxon	Priority	Habitat	Likelihood	Flowering
Acacia gelasina	2	Yellow sand. Sandplains, low rises.	Possible	Jun-Sep
Acacia latipes subsp. *licina*	3	White sand, granitic soils. Limestone hills, sandplains.	Likely	Jun-Sep
Acacia leptospermoides subsp. *obovata*	2	Yellow/brown sand. Sandplains, sand ridges.	Possible	Jul-Aug
Acacia pelophila	1	Clay. Saline creeklines.	Possible	Jul-Aug
Acacia ridleyana	3	Grey or yellow/brown sand, gravelly clay, granitic loam	Possible	Aug-Dec
Acacia stereophylla var. *cylindrata*	2	Sand. Sandstone cliffs.	Unlikely	Aug-Sep
Acanthocarpus parviflorus	3	Sand over limestone or sandstone.	Likely	May-Jun
Androcalva microphylla	2	White grey or orange brown sand over sandstone.	Possible	Aug-Nov
Angianthus microcephalus	2	Sandy or clayey soils. Salt swamps & pans.	Unlikely	Sep-Dec
Anthocercis intricata	3	Sand or loam over limestone. Consolidated sand dunes.	Likely	Jun-Sep
Arnocrinum drummondii	3	White or yellow sand.	Possible	Sep-Dec
Baeckea sp. Western Australia (J. Drummond s.n.)	1	Yellow sand. Sandplains, gentle lower slopes, road verges.	Unlikely	Dec-Feb
Baeckea subcuneata	2	Red/yellow sand. Sandstone outcrops, dunes.	Possible	Aug-Nov
Balladonia aervoides	3	Unknown.	Possible	
Beyeria cinerea subsp. *cinerea*	3	Light yellow sand on dry flats.	Possible	Aug-Nov
Beyeria gardneri	3	Yellow sand.	Unlikely	Aug-Sep
Blackallia nudiflora	3	Clay or sandy clay with granite. On hills or breakaways, plains.	Possible	Aug-Sep
Bossiaea calcicola	3	Compacted sand over limestone. Exposed sites on coastal cliffs and slopes.	Likely	Jul-Sep
Bossiaea inundata	2	Sand, sandstone. River beds and banks, seasonally inundated areas.	Possible	May-Sep

Taxon	Priority	Habitat	Likelihood	Flowering
Brachyloma pirara	2	Sand.	Possible	Jun-Aug
Caladenia bigeminata	1	Broken sandstone on clay or in damper areas around low areas and along drainages.	Unlikely	Aug
Caladenia longicauda subsp. *minima*	2	Unknown.	Possible	Aug
Calectasia browneana	2	White-grey sand, laterite. Adjacent to wet areas of creekline.	Possible	Jun-Aug
Calothamnus cupularis	2	Yellow or yellow-white sand. Hillslopes, flats and breakaways.	Possible	Sep-Oct
Calytrix formosa	3	White or yellow sand. Sandplains.	Possible	Sep-Nov
Calytrix harvestiana	2	White or yellow sand. Flats.	Possible	Sep-Dec
Calytrix paucicostata	2	Yellow or grey sand. Sand dunes.	Possible	Sep-Oct
Calytrix pimeleoides	3	Grey or yellow-brown sand, laterite. Sandplains, flats, hills, outcrops.	Possible	Aug-Oct
Calytrix purpurea	2	White, grey or yellow sand, often over laterite. Sandplains, sand dunes.	Possible	Sep-Dec
Carpobrotus sp. Thevenard Island (M. White 050)	3	Coarse white sand. Dune tops, disturbed areas.	Likely	Aug
Centrolepis cephaloformis subsp. *murrayi*	3	Sand, granite. Moss, salt flats.	Unlikely	Aug-Oct
Chamaescilla maculata	1	Stony brown clay loam in seasonally wet and low lying areas brown loam / clay over sandstone.	Possible	Aug-Sep
Chamelaucium marchantii	3	Sand. Breakaway slopes, near creeks.	Possible	Aug-Nov
Chamelaucium sp. Coolcalalaya (A.H. Burbidge 4233)	1	Sand over Kaolinite.	Possible	Oct-Nov
Chthonocephalus tomentellus	2	Red sand. Undulating plains, sand dunes, near saline depressions.	Possible	Aug-Nov
Comesperma rhadinocarpum	3	Low limestone ridge, sand over limestone.Sandy soils.	Likely	Oct-Nov
Corynotheca acanthoclada	1	Open area, grye/white sand near creek bed	Unlikely	Oct-Dec
Cryptandra glabriflora	2	Yellow or grey sand, gravelly soils. Plains.	Possible	May_Aug
Dampiera krauseana	3	Sand.	Unlikely	Jun-Nov
Desmocladus ferruginipes	1	Midslope on dark grey sand and grey sand	Possible	Aug-Oct
Dicrastylis linearifolia	3	Red sand, sandplain	Unlikely	Nov-Dec
Diuris recurva	4	Loam. Clay, rocky, Winter-wet areas.	Possible	Jul-Aug
Drosera eremaea	3	Not recorded	Possible	Aug
Drosera radicans	3	Sand or sandy clay. Winter-wet areas.	Possible	Aug-Sep

Taxon	Priority	Habitat	Likelihood	Flowering
Drosera rechingeri	3	Pale yellow or grey sand.	Unlikely	Sep-Oct
Enekbatus cristatus	2	Yellow sand, sandy gravel, clay over sandstone. Sloping sand plains.	Unlikely	Aug-Sep
Eremophila brevifolia	2	Red/brown gravelly clay/loam. Breakaway. Steep river bank.	Unlikely	Jul-Sep
Eremophila microtheca	4	Sandy clay. Winter wet flats, saline flats, sandplains.	Unlikely	Aug-Sep
Eucalyptus blaxellii	4	Grey sand, clay. Rocky hillsides, creek flats.	Unlikely	Aug-Nov
Frankenia confusa	4	Wet pale brown sand, brown clay, grey soil. Banks of rivers & waterholes, river floodplains.	Unlikely	Sep
Gastrolobium propinquum	3	Clay, clay-loam or sandy clay soils, granite, shale. Hills, flats, drainage lines, winter-wet areas.	Possible	Jun-Sep
Geleznowia amabilis	2	Brown, yellow or red sand on slopes and sandplains	Likely	Sep-Dec
Geleznowia narcissoides	3	White, grey, red, brown, sand, Gentle slopes and flats	Possible	Aug-Nov
Gnephosis cassiniana	3	Sand, clay loam. Saline depressions, low wet areas.	Unlikely	Sep-Oct
Gompholobium cinereum	3	Yellow sand, clayey sand, brown loam, sandy gravel, laterite. Well-drained open sites, slopes, plains,	Unlikely	Sep-Oct
Grevillea candicans	3	Deep yellow sand. Sandplains.	Unlikely	Aug-Oct
Grevillea costata	3	Alluvial sand, clay. In or near river beds among sandstone or granite rocks.	Unlikely	Jul-Sep
Grevillea leptopoda	3	Loam & lateritic gravel, sand, clay.	Possible	Aug-Sep
Grevillea leucoclada	3	Red or yellow sand over sandstone. River gorges.	Unlikely	Aug-Sep
Grevillea stenomera	2	Red or yellow sand on limestone. Coastal areas.	Likely	May-Jun
Grevillea triloba	3	Sandy loam on sandstone or limestone, lateritic soils.	Possible	Jun-Oct
Guichenotia impudica	3	Laterite	Unlikely	Aug-Oct
Guichenotia quasicalva	2	Sandy clay over laterite. Drainage line.	Unlikely	Sep-Oct
Hemiandra sp. Kalbarri (D. Bellairs 1505)	2	White or grey sand on sandplains	Unlikely	Sep-Oct (Feb)
Hemigenia pimeleifolia	2	Sandstone shale, plains	Unlikely	Sep-Oct
Homalocalyx chapmanii	2	Yellow or grey/brown sand. Undulating plains, weathered granite.	Unlikely	Sep-Oct
Jacksonia velutina	4	Yellow sand. Sandplains & sandhills.	Possible	Aug-Sep
Lasiopetalum oldfieldii	3	White, grey or yellow sand, gravel, laterite. Sandplains, rises.	Likely	Aug-Nov

Taxon	Priority	Habitat	Likelihood	Flowering
Lasiopetalum oppositifolium	3	Sandy soils over sandstone or limestone. Sandstone cliffs & crevices.	Possible	Aug-Oct
Lepidobolus densus	4	Yellow lateritic sand, lateritic gravel. Dry kwongan.	Possible	Aug-Sep
Lepidosperma rupestre	4	River beds, sandstone.	Unlikely	Aug-Sep
Leucopogon psammophilus	1	Breakaways.	Possible	Aug-Oct
Leucopogon sp. Moresby Range (S. Patrick 2614)	3	Brown sandy loam, gravel, sandstone. Middle slopes of valleys, steep rocky hillsides, ridges, roadverges.	Possible	Jun-Jul
Leucopogon sp. Port Gregory (C. Page 33)	1	Breakaways or hillslopes. Brown sand or loam	Possible	May-Jul
Liparophyllum congestiflorum	4	Drainage lines, swapms, flats and gullies. Sandstone with grey sand.	Unlikely	Oct
Macarthuria intricata	3	Red or black soil over limestone, grey sand over sandstone, sandy clay. Sandplains & sand dunes.	Likely	Sep-Dec
Malleostemon costatus	2	Yellow brown, red brown clayey sand or clay.	Possible	Jul-Oct
Malleostemon pentagonus	3	Hillcrests upper slopes, sandplains and wetlands.	Unlikely	Aug-Oct
Malleostemon pustulatus	2	Yellow silty sand, clayey sand or red loam with ironstone. Sandplains and broad depressions	Possible	Sep-Oct
Melaleuca huttensis	3	Light yellow or beige sand. Lower slopes of undulating plains, sandplains.	Recorded	Jun-Sep
Melaleuca oldfieldii	2	Red or brown sand over sandstone or limestone, sandy clay.	Possible	Aug-Dec
Melaleuca sclerophylla	3	Gravelly sand, clayey sand. Granite outcrops, rises.	Unlikely	Jun-Sep
Micromyrtus collina	1	Midslope above creek. Dry sandstone gravel.	Possible	May-Aug
Millotia jacksonii	2	Shallow sandy soils. In depressions on sandstone.	Unlikely	Sep
Mirbelia corallina	3	Yellow, white or brown sand. Sandplains or flats	Possible	Aug-Sep
Olearia adpressa	1	Base of shale breakaways. Dry, rocky brown clayloam.	Possible	July
Ozothamnus vespertinus	1	Brown /red loam or white clay loam. Breakaways	Possible	Nov
Persoonia brachystylis	2	Yellow or grey sand, often over laterite. Sandplains.	Possible	Nov-Dec
Physopsis chrysophylla	3	Red or yellow sandy soils. Sandplains.	Possible	Sep-Dec
Pileanthus bellus	3	Yellow sand or shallow grey sand over sandstone. Sand dunes.	Possible	Oct-Dec
Pityrodia viscida	4	Lateritic sand.	Possible	Sep-Dec
Platysace sp. Kalbarri (D. & B. Bellairs 1383)	2	Red gravelly soils & sandstone. Coastal areas.	Unlikely	Oct-Nov

Taxon	Priority	Habitat	Likelihood	Flowering
Prostanthera scutata	2	Gravelly sand.	Possible	Oct-Dec
Pterostylis argillacea	2	Yellow sandplain. Brown clay. Winter wet.	Possible	Sep
Pterostylis macrocalymma	1	Rocky red clay-loam. Flats.	Possible	Sep-Oct
Ptilotus chortophytus	1	Yellow or brown loam or sandy loam. Breakaways and hillslopes	Possible	Sep-Nov
Rhodanthe sp. Yuna (G.J. Keighery, B.J. Keighery & B. Moyle 2820)	3	On rocky outcrop.	Possible	Sep-Nov
Scaevola kallophylla	4	Sandy soils over limestone. Coastal plain	Likely	Aug-Dec
Scaevola oldfieldii	3	Sand, loam, clay. Near rivers. Sand over limestone.	Possible	Aug-Dec
Scaevola sp. Golden hairs (D. & B. Bellairs 1450 A)	1	Grey or white sand. Sandplain sand plains.	Possible	Aug-Nov
Scholtzia bellairsiorum	3	Yellow, brown or grey sand. Flat sandplain.	Possible	Sep-Nov
Scholtzia kalbarri	2	Unknown.	Possible	Aug-sep
Scholtzia sp. Folly Hill (M.E. Trudgen 12097)	2	Yellow or red sand. Sand dunes.	Unlikely	Aug-Oct
Scholtzia tenuissima	2	Brown clay over laterite or dull yellow sand. Sandplains and dune swales.	Unlikely	Sep-Nov
Serichonus gracilipes	3	sandy clay. Sandy loam over sandstone. Gullies, rock crevices.	Unlikely	Aug-Sep
Stachystemon nematophorus	4	Dry sand, sandy gravel over laterite, sandstone. Exposed rocky sites, disturbed ground.	Unlikely	? Nov
Stenanthemum divaricatum	3	White or yellow sand over sandstone.	Possible	? Jun
Stylidium torticarpum	3	Sandy clay and clay loam over laterite. Adjacent to creeklines, depressions, and beneath breakaways. Heath or mallee shrubland.	Possible	Sep-Nov
Styphelia allittii	3	Plain. Dry gravelly yellow clayey sand.	Possible	?Jun
Styphelia cernua	2	Grey, yellow or white sand on sandplains	Possible	May-Aug
Styphelia inopinata	1	Pale brown clay loam. Rocky shale breakaway.	Possible	?Jun
Teucrium sp. Hutt River (W.H. Butler 54)	1	Unknown.	Possible	?Oct
Thryptomene calcicola	2	Red brown clay or loam and red or grey sand. Hillslopes and sandplains.	Possible	Jul-Sep
Thryptomene conica	2	Shallow sandy soils. Coastal limestone cliffs, stream beds.	Likely	Aug
Thryptomene johnsonii	2	Grey sand, sandstone. Sandplain slopes.	Possible	Sep-Oct
Thryptomene stenophylla	2	Red or yellow sand, loam. Limestone hills, sandplains.	Possible	Jun-Aug

Taxon	Priority	Habitat	Likelihood	Flowering
Thryptomene striata	2	Sandy & loamy soils with ironstone pebbles.	Possible	Sep
Thysanotus fragrans	2	Yellow sand. Sandy clay. Sandy creekline.	Unlikely	Aug-Sep
Thysanotus kalbarriensis	2	Yellow or grey sand. Sandplains	Possible	Sep-Nov
Triodia bromoides	4	Red, grey & calcareous sand. Dunes, sandplains, stony rises.	Possible	Jul-Oct
Triodia dielsii	3	White/grey sand over sandstone or with lateritic gravel. Sandplains, near gorges.	Unlikely	Jul-sep
Trithuria australis	4	Waterhole on a granite platform.	Unlikely	Nov
Verticordia capillaris	4	Yellow sand, sandy loam, sandy clay. Sandplains.	Possible	Oct-Nov
Verticordia cooloomia	3	Yellow sand. Undulating terrain, ridges.	Possible	Sep-Nov
Verticordia dasystylis subsp. *kalbarriensis*	2	Clay-silt. Winter-wet areas.	Unlikely	Oct-Nov
Verticordia densiflora var. *roseostella*	3	Sandy gravelly soils.	Possible	Sep-Dec
Verticordia dichroma var. *dichroma*	3	Yellow sand. Sandplains.	Possible	Oct-Dec
Verticordia dichroma var. *syntoma*	3	Yellow or red sand. Sandplains.	Possible	Oct-Nov
Verticordia polytricha	4	Sand, gravelly clay. Sandstone outcrops.	Unlikely	Sep-Oct
Vittadinia cervicularis var. *occidentalis*	1	Unknown.	Possible	Aug-Sep
Wurmbea murchisoniana	4	Clay, sandy clay, loam. Seasonally inundated clay hollows, rock pools.	Unlikely	Jul-Sep

Appendix 2. Geographic co-ordinates of plants identified as Priority taxa within the Lucky Bay Garnet Project study area (GDA2020 MGA zone 50).

Taxon	Easting	Northing
Bossiaea calcicola	223284.28	6896783.93
Bossiaea calcicola	223231.35	6896868.66
Bossiaea calcicola	223268.34	6896864.97
Bossiaea calcicola	223267.56	6896864.73
Bossiaea calcicola	223265.89	6896864.36
Bossiaea calcicola	223264.82	6896864.00
Bossiaea calcicola	223271.46	6896862.04
Bossiaea calcicola	223272.99	6896863.97
Bossiaea calcicola	223276.24	6896863.71
Bossiaea calcicola	223290.12	6896872.01
Bossiaea calcicola	223260.08	6896864.44
Bossiaea calcicola	223262.13	6896861.16
Bossiaea calcicola	223263.15	6896859.63
Bossiaea calcicola	223263.95	6896859.10
Bossiaea calcicola	223265.02	6896859.68
Bossiaea calcicola	223266.67	6896860.60
Bossiaea calcicola	223268.81	6896861.76
Bossiaea calcicola	223269.74	6896859.90
Bossiaea calcicola	223275.91	6896852.61
Bossiaea calcicola	223278.14	6896849.56
Bossiaea calcicola	223283.28	6896857.22
Bossiaea calcicola	223282.37	6896858.41
Bossiaea calcicola	223283.68	6896856.78
Bossiaea calcicola	223281.68	6896853.96
Bossiaea calcicola	223284.17	6896856.90
Bossiaea calcicola	223287.11	6896853.42
Bossiaea calcicola	223291.98	6896847.21
Bossiaea calcicola	223289.41	6896843.27
Bossiaea calcicola	223294.35	6896838.06
Bossiaea calcicola	223295.01	6896839.63
Bossiaea calcicola	223299.44	6896835.30
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Bossiaea calcicola	223300.49	6896819.57
Bossiaea calcicola	223297.47	6896818.28
Bossiaea calcicola	223305.68	6896854.85
Bossiaea calcicola	223304.24	6896848.94
Bossiaea calcicola	223303.13	6896845.59
Bossiaea calcicola	223303.77	6896843.71
Bossiaea calcicola	223301.32	6896843.10
Bossiaea calcicola	223300.84	6896838.21
Bossiaea calcicola	223300.01	6896836.09

Taxon	Easting	Northing
Bossiaea calcicola	223300.51	6896835.76
Bossiaea calcicola	223295.94	6896837.32
Bossiaea calcicola	223294.21	6896839.83
Bossiaea calcicola	223294.67	6896841.29
Bossiaea calcicola	223294.91	6896843.95
Bossiaea calcicola	223297.20	6896846.67
Bossiaea calcicola	223299.40	6896849.71
Bossiaea calcicola	223303.62	6896858.46
Bossiaea calcicola	223301.64	6896858.97
Bossiaea calcicola	223299.23	6896857.03
Bossiaea calcicola	223297.28	6896856.10
Bossiaea calcicola	223297.28	6896856.21
Bossiaea calcicola	223297.48	6896855.88
Bossiaea calcicola	223295.17	6896853.61
Bossiaea calcicola	223294.71	6896852.49
Bossiaea calcicola	223297.96	6896860.77
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Bossiaea calcicola	223300.33	6896864.82
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Bossiaea calcicola	223320.81	6896809.06
Bossiaea calcicola	223323.12	6896811.11
Bossiaea calcicola	223325.27	6896811.71
Bossiaea calcicola	223329.77	6896813.04
Bossiaea calcicola	223317.12	6896806.76
Bossiaea calcicola	223315.90	6896808.39
Bossiaea calcicola	223309.54	6896807.03
Bossiaea calcicola	223309.88	6896805.15
Bossiaea calcicola	223308.57	6896806.12
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Bossiaea calcicola	223311.73	6896797.09
Bossiaea calcicola	223305.05	6896796.94
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Bossiaea calcicola	223306.65	6896791.21
Bossiaea calcicola	223303.42	6896790.80
Bossiaea calcicola	223302.27	6896793.44
Bossiaea calcicola	223304.62	6896794.27
Bossiaea calcicola	223304.38	6896796.04

Taxon	Easting	Northing
Bossiaea calcicola	223298.35	6896801.44
Bossiaea calcicola	223294.74	6896795.59
Bossiaea calcicola	223295.91	6896791.85
Bossiaea calcicola	223294.91	6896788.50
Bossiaea calcicola	223292.61	6896790.00
Bossiaea calcicola	223291.00	6896791.29
Bossiaea calcicola	223286.79	6896790.64
Bossiaea calcicola	223285.93	6896789.51
Bossiaea calcicola	223288.83	6896787.58
Bossiaea calcicola	223288.45	6896787.02
Bossiaea calcicola	223285.08	6896788.05
Bossiaea calcicola	223280.25	6896796.59
Bossiaea calcicola	223278.52	6896795.11
Bossiaea calcicola	223281.25	6896791.95
Bossiaea calcicola	223280.90	6896789.95
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Bossiaea calcicola	223269.81	6896788.70
Bossiaea calcicola	223270.15	6896786.71
Bossiaea calcicola	223279.44	6896776.16
Bossiaea calcicola	223281.19	6896764.34
Bossiaea calcicola	223285.06	6896767.31
Bossiaea calcicola	223284.82	6896756.66
Bossiaea calcicola	223285.32	6896756.33
Bossiaea calcicola	223323.70	6896798.92
Melaleuca huttensis	223667.68	6896585.15
Melaleuca huttensis	223673.80	6896593.06
Melaleuca huttensis	223681.95	6896580.83
Melaleuca huttensis	223682.09	6896579.28
Melaleuca huttensis	223681.53	6896577.71
Melaleuca huttensis	223684.27	6896578.77
Melaleuca huttensis	223679.57	6896577.55
Melaleuca huttensis	223676.77	6896579.38
Melaleuca huttensis	223681.11	6896566.06
Melaleuca huttensis	223691.96	6896565.09
Melaleuca huttensis	223693.05	6896569.33
Melaleuca huttensis	223703.84	6896553.83
Melaleuca huttensis	223703.17	6896552.59
Melaleuca huttensis	223706.92	6896548.24
Melaleuca huttensis	223694.96	6896541.97
Melaleuca huttensis	223710.46	6896522.81
Melaleuca huttensis	223714.55	6896524.35
Melaleuca huttensis	223690.32	6896512.59
Melaleuca huttensis	223642.47	6896479.21
Melaleuca huttensis	223694.78	6896464.33

Taxon	Easting	Northing
Melaleuca huttensis	223769.27	6896426.35
Melaleuca huttensis	223771.21	6896431.94
Melaleuca huttensis	223770.34	6896431.03
* *Melaleuca huttensis*	223772.53	6896430.08
Melaleuca huttensis	223771.11	6896440.59
Melaleuca huttensis	223763.49	6896442.41
Melaleuca huttensis	223769.38	6896447.31
Melaleuca huttensis	223767.85	6896449.27
Melaleuca huttensis	223761.77	6896388.80
Melaleuca huttensis	223697.65	6896583.07
Melaleuca huttensis	223695.94	6896584.48
Melaleuca huttensis	223690.88	6896586.36
Melaleuca huttensis	223683.92	6896610.82
Melaleuca huttensis	223679.13	6896609.60
Melaleuca huttensis	223661.42	6896592.22
Melaleuca huttensis	223656.01	6896591.87
Melaleuca huttensis	223734.55	6896382.85
Melaleuca huttensis	223772.10	6896346.34
Melaleuca huttensis	223684.27	6896607.38
Melaleuca huttensis	223696.04	6896594.22
Melaleuca huttensis	223696.28	6896594.02
Melaleuca huttensis	223627.32	6896799.06
Melaleuca huttensis	223626.21	6896800.36
Melaleuca huttensis	223635.06	6896753.43
Melaleuca huttensis	223686.92	6896634.29
Melaleuca huttensis	223689.14	6896614.71
Melaleuca huttensis	223684.09	6896607.72
Melaleuca huttensis	223696.22	6896594.02
Melaleuca huttensis	223704.24	6896591.65
Melaleuca huttensis	223705.90	6896592.25

* Dead plant

Appendix B

Balline Garnet Project Short Range Endemics Survey Report (Bennelongia, 2023)

EMM
creating opportunities

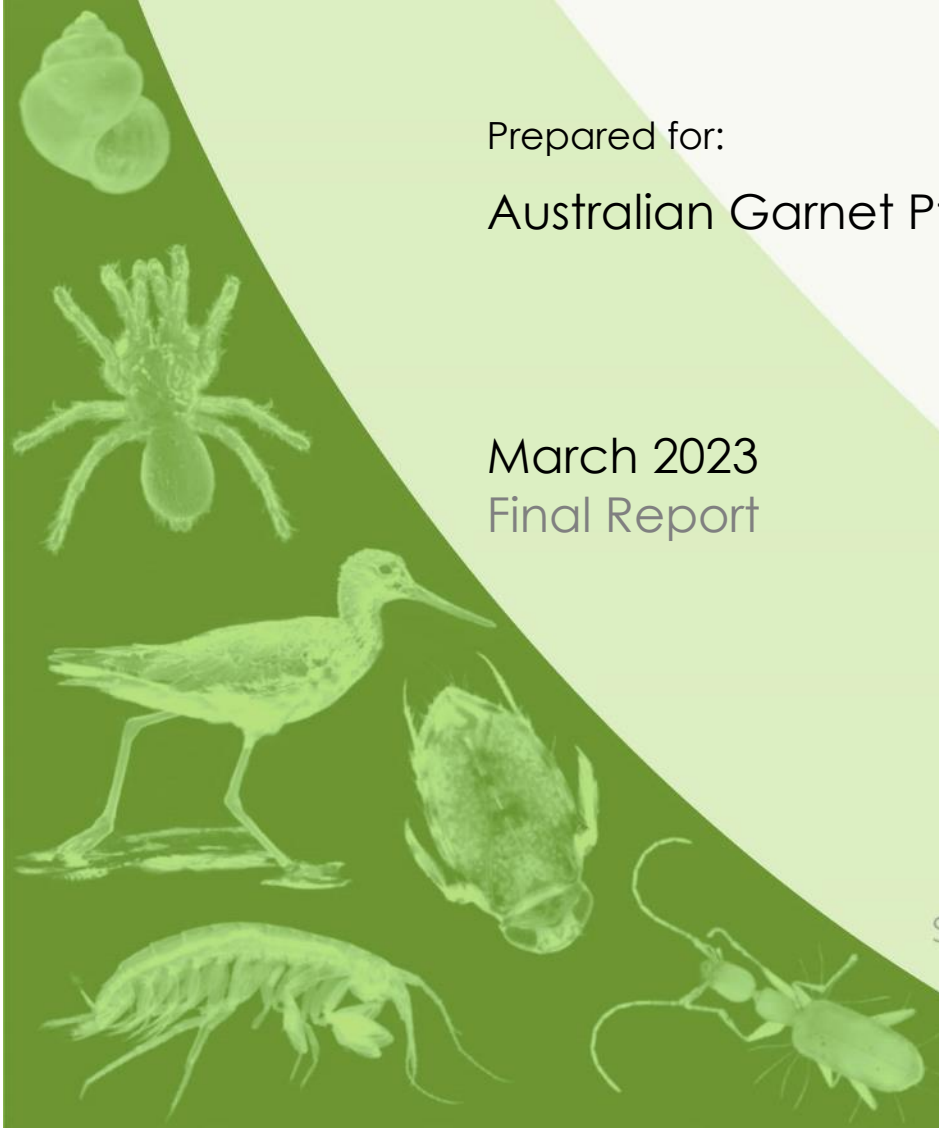
Bennelongia Environmental Consultants

Balline Garnet Project Short Range Endemics Survey Report

Prepared for:

Australian Garnet Pty Ltd

March 2023
Final Report



Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands

Balline Garnet Project Short Range Endemics Survey Report

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Report Version	Prepared by	Reviewed by	Submitted to Client	
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Survey results-Final	Kevin Sagastume-Espinoza		Email	20-03-2023

K:\Projects\B_GAR_01\8_Report\Draft\GAR_01_BallineGarnet_SRE_Draft_of_Final_03.03.2023_ForClient.docx

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EXECUTIVE SUMMARY

Australian Garnet Pty Ltd (Australian Garnet) is undertaking environmental investigations to support environmental impact assessments of its future operations at the Balline Garnet Mine (henceforth `the Project`). The Project is located approximately 35 km south of Kalbarri in the Shire of Northampton, Western Australia. Future operations have the potential to impact upon terrestrial short-range endemic (SRE) fauna through the clearing of habitat. This report presents results of a desktop assessment and subsequent field survey of SRE fauna in the Project area and describes the potential conservation values of SRE species in the area.

The desktop review indicated that several Potential (Likely) SRE species could be found in the Project area, including several species of the millipede *Antichiropus* and two species of the land snail *Bothriembryon*. Additionally, the desktop review recovered two species listed as Critically Endangered or Extinct as occurring near the Project.

The subsequent survey collected 530 samples identifiable to 34 species belonging to SRE Groups (i.e. invertebrate groups with a high proportion of SRE species). At least four species of mygalomorph spiders were collected during the field survey, as well as at least five species of pseudoscorpions, four species of scorpions, one species of geophilid centipede, two species of scolopendrid centipedes, three species of millipedes, five species of slaters, and at least ten species of land snails. Of the 34 species found, 17 were considered Widespread or likely to have widespread distributions. Three species were categorised as Data Deficient given the scarcity of records and research, and one species was determined to be Invasive.

Of the 34 species identified as belonging to SRE Groups, 13 are considered Potential SREs, including 11 Unlikely Potential SREs, and 2 Likely Potential SREs, listed below by taxonomic group (* indicates Likely Potential SREs):

Spiders
- *Aname exulans**
- *Cethegus* `BMYG174`
- *Hesperonatalius harrietae*

Slaters
- *Buddelundia* `BIS497`*
- *Buddelundia* `BIS504`
- *Laevophiloscia* `BIS502`
- Platyarthridae `BIS503`

Millipedes
- *Antichiropus* `BDI074`

Pseudoscorpions
- *Austrochthonius* `BPS475`
- *Beierolpium* 8/4 `BPS477`
- Cheiridiidae `BPS478`
- Chernetidae `BPS476`

Land snails
- *Notiasemus glauerti*

The Project poses two main threats to populations of species belonging to SRE Groups: clearing and interruptions to habitat connectivity. Although the scale of clearing and any potential impacts that might arise from the Project development are considered minor, one vegetation type within the Project, VSA 3, is probably highly important for supporting the local SRE fauna. The sole species likely to be affected by Project development, the slater *Buddelundia* `BIS497`, appears to occur only within this vegetation system.

Although it is likely *Buddelundia* `BIS497`occurs outside of the Project area at hillslope habitats, activities such as intense clearing within the Project area have the potential to affect local populations, which may in turn affect other populations of the species. Further sampling is required to determine whether the species occurs beyond the Project envelope, and to estimate the effects of the Project development on the species across its range.

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1. INTRODUCTION

Australian Garnet Pty Ltd (Australian Garnet) is undertaking environmental investigations to support environmental impact assessments of its future operations at the Balline Garnet Mine (the Project).

The Project is located approximately 35 south of Kalbarri in the Shire of Northampton, Western Australia (Figure 1). A mining proposal was approved in 2015 for the establishment of the mine on M 70/1280 and an access road through L 70/134, works which to date have not been completed.

Through studies subsequent to the 2015 approval, Australian Garnet have expanded the resource model into tenements further north and south; the Project is currently proposed to be located across Mining Leases M 70/1387 and M 70/1280, and within L 70/134 and the wider Exploration tenements E 70/2509 (north) and E 70/5117 (south).

The latest mining proposal (REGID 102866) was approved on 27 September 2022, and covers tenements M 70/1280, M70/1387, G70/253, L70/134, L70/166, L70/167, L70/168, L70/169, L70/170, L70/178, and L70/215, targeting heavy mineral sands with areas adjacent for associated processing. The leases encompass historically cleared pastoral land (>1,000 ha) and large stands of remnant vegetation and regrowth (>700 ha) located on private farmland.

Areas within tenement M 70/1280, M 70/1387, and the wider E 70/5117 have previously undergone Level 1 fauna assessments (Ecoscape 2009; Bamford and McHarrie 2013). More recently, Onshore Environmental (2022) conducted a detailed and targeted vertebrate fauna survey covering M70/1387, E70/2509, and E70/5117. A subterranean fauna pilot study (Goater and Knott, 2009) was also conducted and included reference to invertebrates and potential SREs. These now dated invertebrate surveys provide an indicative fauna assemblage, but the presence of specific conservation-significant species and/or SREs populations have not been confirmed to date.

This report provides and describes the results of a survey targeting SREs in the Project area. The specific aims of the report are:

- Report the occurrence of species collected in SRE fauna surveys conducted at the Project.
- Evaluate the ranges and habitats of taxa detected to identify the occurrence of Potential SRE species at the Project.
- Identify potential changes to the environment as a result of Project activities and assess whether these may lead to conservation-significant impacts on Potential or Confirmed SRE species.

2. LANDSCAPE SETTING

Short-range endemic species are vulnerable to changes of landscape or habitat given their restricted and usually specific habitat requirements. The north-western region of Western Australia provides suitable habitat for endemic invertebrates and the Pilbara in particular is rich in species from SRE Groups (Castalanelli *et al.* 2014; Abrams *et al.* 2020; Car *et al.* 2019; Huey *et al.* 2019). Vegetation clearing and habitat connectivity interruptions associated with the proposed Project developments are considered a potential threat to SRE invertebrate fauna.

2.1. Project Location

The Project area is located in the Geraldton Hills Subregion (GS2) of the Geraldton Sandplains Bioregion, which consists of proteaceous scrub-heaths on undulating sand plains mesa, coastal sands, and limestones. The subregion is rich in endemics and encompasses both the southern end of the Carnarvon Basin and the northern end of the Perth Basin. Exposed areas are of Permian/Silurian siltstone and Jurassic sandstones mostly overlain by sandplains, alluvial plains, and coastal limestones. The dominant land use is mainly dry-land agriculture, with smaller areas of conservation, native grazing pastures, Unallocated Crown Land, and Crown reserves (Desmond and Chant 2001).

In the Balline area specifically, climate is semi-arid to Mediterranean and the primary land use is dry-land agriculture; other land uses include small conservation areas, native pasture, and other sands mining operations amongst Freehold, Unallocated Crown Land, and Crown Reserves (Bamford and McHarrie 2013).

The region hosts a diversity and abundance of flora, with many sandplain genera having a high degree of endemism. This diverse flora serves to host and/or protect from predators breeding seabirds, sea lions (at Houtman Abrolhos islands), carpet pythons, and spiny-tailed skinks (Desmond and Chant 2001). Floral species diversity is highest in the sandplain shrubland on Moresby Range, sandplain shrubland of Burma Rd area, and Kalbarri National Park, all of which provide suitable habitat for SRE species. The extensive agricultural land use in the area has caused native vegetation to be limited to islands of varying size and isolation, which probably remain because they are unsuitable for agriculture (e.g. limestone outcroppings).

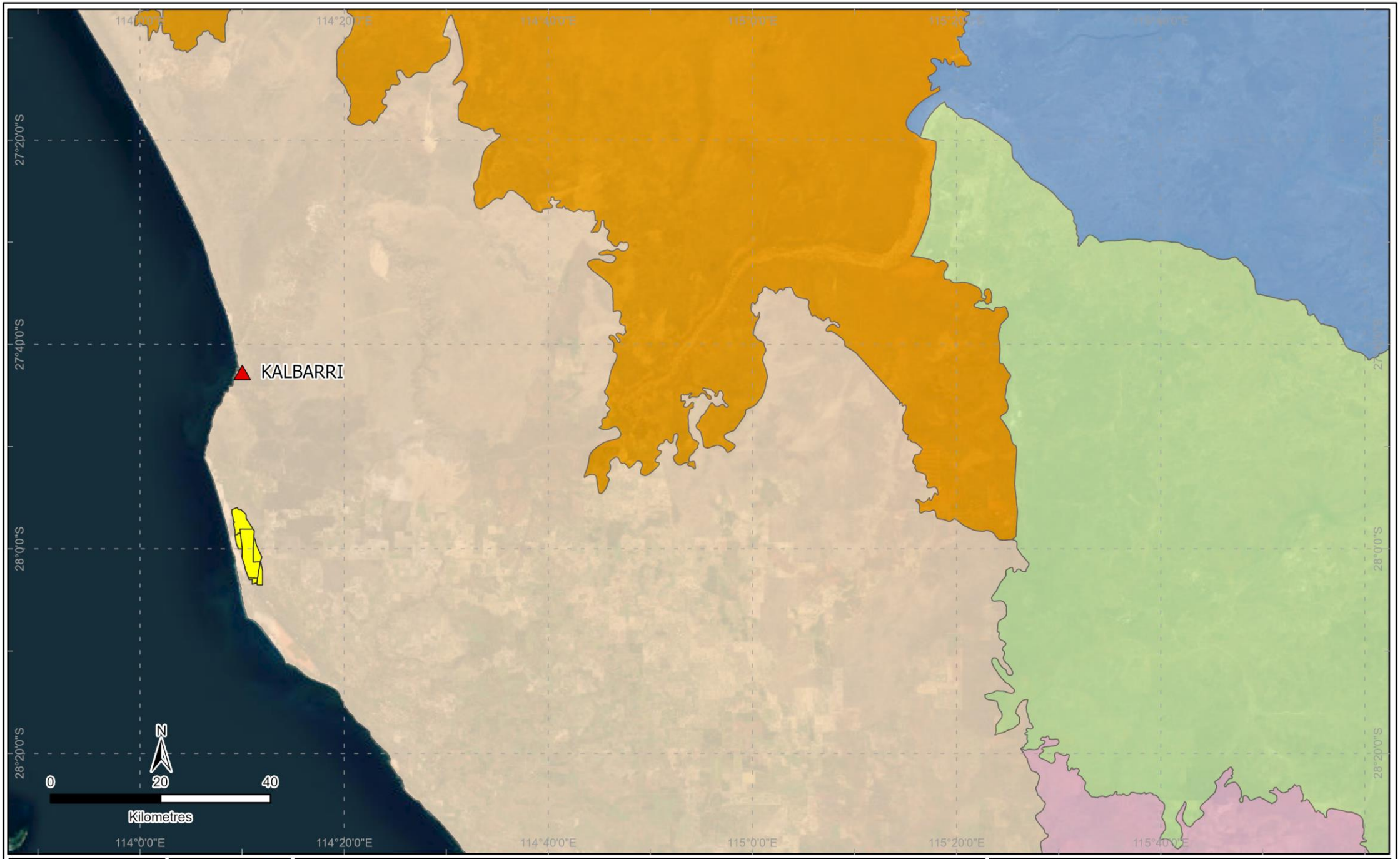


Figure 1. Project location in reference to adjacent IBRA Subregions.

2.2. Geology

The Project is located within the Mid West administrative region of Western Australia, a region with development potential for numerous significant resources including mineral sands, gold, copper, zinc, iron ore, and gas. In broad terms the Mid West can be subdivided into a coastal plain, coastal plateau, and a partially bisected interior plateau coinciding with the geologically distinct superficial formations, Mesozoic sediments of the Perth Basin, and Precambrian rocks of the Yilgarn Craton.

The coastal plain is up to 20 km wide and rises gently to approximately 50 m above sea level along the edge of the coastal plateau. It is characterised by gently undulating sand dunes that form sub-parallel to the coastline. The coastal plateau, further inland, reaches a maximum elevation of approximately 300 m and is characterised by a relatively flat sandplain interspersed by ridges and mesas formed by resistant strata. The interior plateau is generally of low relief and characterised by large playa lakes occupying broad alluvial valleys, known as palaeodrainages, between erosional escarpments of lateritised bedrock highs (Department of Water 2017).

Most of the Mid West area lies within the Murchison Province, which is the westernmost of three granite-greenstone terranes in the Archaean Yilgarn Craton. In the north and north-west, the Murchison Province is in tectonic contact with the Narryer Gneiss Complex of the Western Gneiss Terrane; in the north-east the granite-greenstone rocks are overlain by Proterozoic sediments of the Nabberu Basin. Overlying the basement rocks, in particular along the palaeodrainages, are alluvial, colluvial, and calcrete deposits of Cainozoic age (Figure 2).

Soil landscapes place the Project within the Western Region soil landscape, characterised by undulating plateaux with plains, hills, ranges, and coastal plains over rocks of the Yilgarn and Pilbara Cratons, Capricorn and Albany-Fraser orogens, and Carnarvon and Perth Basins. The Project lies within the Carnarvon Province in the Western Region (Tille 2006).

The Carnarvon Province consists of sandplains with alluvial plains and some stony plains, hills, and mesas over Cainozoic deposits of sedimentary rocks of the southern Carnarvon Basin. Deep red sands with loamy earths provide substrate for *Acacia* shrublands with some halophytic and currant bush shrublands, spinifex grasslands, and tree-heaths, which are considered suitable habitats for SRE species (EPA 2016b).

The Carnarvon Province overlies the sedimentary rocks of the Southern Carnarvon Basin. In the west, the Cretaceous chalky deposits, clayey siltstone, and greensand of the Toolonga Calcilutite-Alinga Formation are found on the Gascoyne Platform. South of the Murchison River, the Ordovician Tumblagooda Sandstone outcrops on the Gascoyne Platform along with some Jurassic sandstone and conglomerate and Triassic shale and siltstone. In the north-east are the Permian and Carboniferous sandstone, siltstone, shale, and radiolarite of the Merlinleigh Sub-basin. Devonian rocks outcrop along the eastern margin of this sub-basin and there are also some outlying granitic rocks of the Gascoyne Complex.

In the south-east, the Carnarvon Province overlies the northern extension of the Coolcalalaya Sub-basin of the Perth Basin. This has similar Permian and Carboniferous sediments to the Carnarvon Basin, with some Tumblagooda sandstone on its western margin. Quaternary alluvium and aeolian sand are found over much of the surface. Extensive alluvial deposits are found on ancient deltas of the Lyndon, Minilya, Gascoyne, and Wooramel Rivers. The aeolian deposits are largely derived from Tertiary laterite formed over the sedimentary rocks. Quaternary Tamala Limestone is found along the coast from Shark Bay southwards. Elsewhere coastal dunes overlie calcrete (Tille 2006; Figure 2).

Sandplains make up approximately half of the Carnarvon Province, covering most of the south and much of the east. These are predominantly flat to gently undulating, though sandplains with linear (and occasionally reticulate) dunes and broad depressions also occur. The floors of these depressions may be broad sandy swales, clayey interdunal plains (with discrete drainage foci), saline flats, or limestone plains. There are also some sandy alluvial plains, stony alluvial plains, and narrow, active flood plains. Gently undulating stony plains (with sluggish drainage, stony rises, sandy banks, and low summits) are found on the Permian sediments in the east. Low hills, mesas, breakaways, and ridges of sandstone and siltstone are also found on the Permian sediments. These typically have extensive stony slopes.

Within the Carnarvon Province we find the Kalbarri Sandplain Zone which is a moderately bisected sandplain (with plateaux, valleys, and gorges) on deeply weathered mantle and colluvium over Cretaceous (and some Silurian) sedimentary rocks of the Carnarvon Basin. It is located in the northern Mid West between Horrocks, Ajana, and Kalbarri. Almost flat, sandy surfaced hardpan plains with sandy banks and sand sheets are another feature (Tille 2006).

There are some deeply bisected plateaux, mesas, and hills on the Permian sedimentary rocks. These typically have steep footslopes and narrow valleys. The most notable example is the Kennedy Range which has elevated sandy plains with large linear and reticulate dunes on the plateau surface.

The geological characteristics that occur within and around the Project area, in particular sandy plains, rocky outcrops, and hillslope formations all represent suitable habitat for species belonging to SRE Groups. Paired with flora such as saltbush and/or mallee, a variety of microhabitats are formed which are easily colonized by SRE species.

2.3. Hydrogeology and Climate

The majority of the region is externally draining to the west into the Murchison, Greenough, and Irwin River catchments, and subsequently to the Indian Ocean. All drainages are ephemeral except the Murchison River, which is intermittent and may flow for long periods after heavy rainfall. The remainder of the area, mainly in the east and south-east, is characterised by internal drainage into inland salt lakes such as Lake Moore and Lake Austin. The water in these broad alluviated valleys flows south-west in the west and south-east in the east. A number of these drainages in the east, including Lake Mason and Lake Noondie, form the headwaters of the Raeside and Carey Palaeodrainages which subsequently discharge into the Eucla Basin (Johnson and Commander 2006).

The bioclimate is described by Beard (1990) as mainly Sub-Eremaean. This is a mostly semi-desert Mediterranean climate with 9-11 dry months and average annual rainfall of 200-250 mm. This rain is primarily concentrated in winter, but there is a mix of summer and winter rain along the coastal strip north of Carnarvon. In the south-west (between Shark Bay and Kalbarri) rainfall increases to 400 mm and the bioclimate becomes Thermoxeric (extra dry Mediterranean climate with 7-8 dry months). In the north-east rainfall drops below 200 mm and the bioclimate becomes Eremaean (desert with 12 dry months; Tille 2006).

2.4. Vegetation

The Greenough Province is covered by scrub-heath. *Banksia attenuata* and *B. menziesii* are often present on the northern sandplains. Also present in places are bowgada (*Acacia ramulosa*) scrub and acacia-casuarina thickets. A scrub of *Acacia* spp. and sheoaks (*Casuarina obesa*) with *Eucalyptus obtusiflora* and *E. transcontinentalis* is found on the hardpan shallow loams. York gum (*E. loxophleba*) and jam (*Acacia acuminata*) may also be present.

Southern sandplains and areas of dissected plateaux have a proteaceous scrub-heath with *Acacia, Banksia, Allocasuarina, Grevillea, Dryandra, Melaleuca* and *Verticordia* spp. Woodlands of banksias (*Banksia grandis, B. prionotes, B. attenuata, B. menziesii* and *B. ilicifolia*) and sheoak (*Casuarina humilis*)

are found in the south along with open forests of marri (*Corymbia calophylla*), jarrah (*Eucalyptus marginata*), and some (*E. todtiana*) in the far south. In the central portion there are some areas of wandoo (*E. wandoo*) woodland as well as scattered Western Australian Christmas tree (*Nuytsia floribunda*) and river red gum (*E. camaldulensis*). The red loams and duplexes of the Northampton Complex support a scrub of jam (*Acacia acuminata*) and *Hakea* spp. with scattered York gum (*Eucalyptus loxophleba*) and river red gum (*E. camaldulensis*). In the north, *Acacia tetragonophylla* and *Casuarina huegeliana* become common. The calcareous coastal dunes and yellow deep sands over limestone host thickets and scrub of *Acacia rostellifera*, *Banksia* spp., and *Melaleuca* spp.; *Eucalyptus erythrocorys* may also be present. On the alluvial flats, river red gum is often present. A low woodland of *E. todtiana* and *Banksia* spp. Is found in the Eneabba district (Tille 2006).

The Carnarvon Province sandplains are dominated by grasslands of hard spinifex (*Triodia lanigera* and *T. basedowii*) with some soft spinifex (*T. pungens*). These grasslands support scattered emergent *Acacia sclerosperma*, kanji (*A. inaequilatera*), prickly wattle (*A. victoriae*), and *Grevillea* spp. Central sandplains have tall shrublands of bowgada (*A. ramulosa*), sandplain gidgee (*A. anastema*), *A. sclerosperma*, and *A. subtessarogona*, sometimes with a hard spinifex understorey. Gidgee (*A. pruinocarpa*) and mulga (A. *aneura*) are present on loamy interdune plains. To the south, scattered eucalypts (*Eucalyptus eudesmioides* and *E. obtusiflora*) and cypress pine (*Callitris columellaris*) start appearing in the bowgada shrublands on the sandplains. Further south is scrub- and tree-heath with *Banksia ashbyi*, *Grevillea gordoniana, Melaleuca* spp., and mallee eucalypts predominating.

On the alluvial plains are acacia shrublands with currant bush (*Scaevola spinescens*), curara (*A. tetragonophylla*), snakewood (*A. xiphophylla*), *A. sclerosperma*, prickly wattle, *Hakea preissii*, and *Eremophila* spp. Also present are shrublands of Gascoyne bluebush (*Maireana polypterygia*), *M. platycarpa*, bladder saltbush (*Atriplex vesicaria*), and Gascoyne mulla mulla (*Ptilotus polakii*). Bowgada and sandplain gidgee are found on the sandy banks and rises. The stony plains support shrublands of snakewood and prickly wattle with bluebush (*Maireana* spp.), saltbush (*Atriplex bunburyana*), and currant bush. The wash plains host acacia shrublands with bowgada and mulga. The hilly terrain also hosts acacia shrublands with mulga, gidgee, curara, A. *cuspidifolia*, snakewood, and *A. subtessarogona*. The calcrete plains of Shark Bay have shrublands of minniritchie (*A. grasbyi*) and *A. drepanophylla* (Tille 2006).

The Kalbarri Sandplain Zone is a dissected sandplain (with plateaux, valleys, and gorges) on deeply weathered mantle and colluvium over Cretaceous (and some Silurian) sedimentary rocks of the Carnarvon BasinScrub-heath with some jam-sheoak woodlands occur in the northern Mid West between Horrocks, Ajana, and Kalbarri (Tille 2006; Figure 2).

The Project area is located within the Irwin Botanical District of the South-west Botanical Province and vegetation mapping revealed *Acacia-Casuarina* thickets and scrub categorizable to two units of the Greenough Pre-European Vegetation System: a) Low Forest of *Acacia rostellifera*; and b) *A. rostellifera* thicket on dunes (Figure 2).

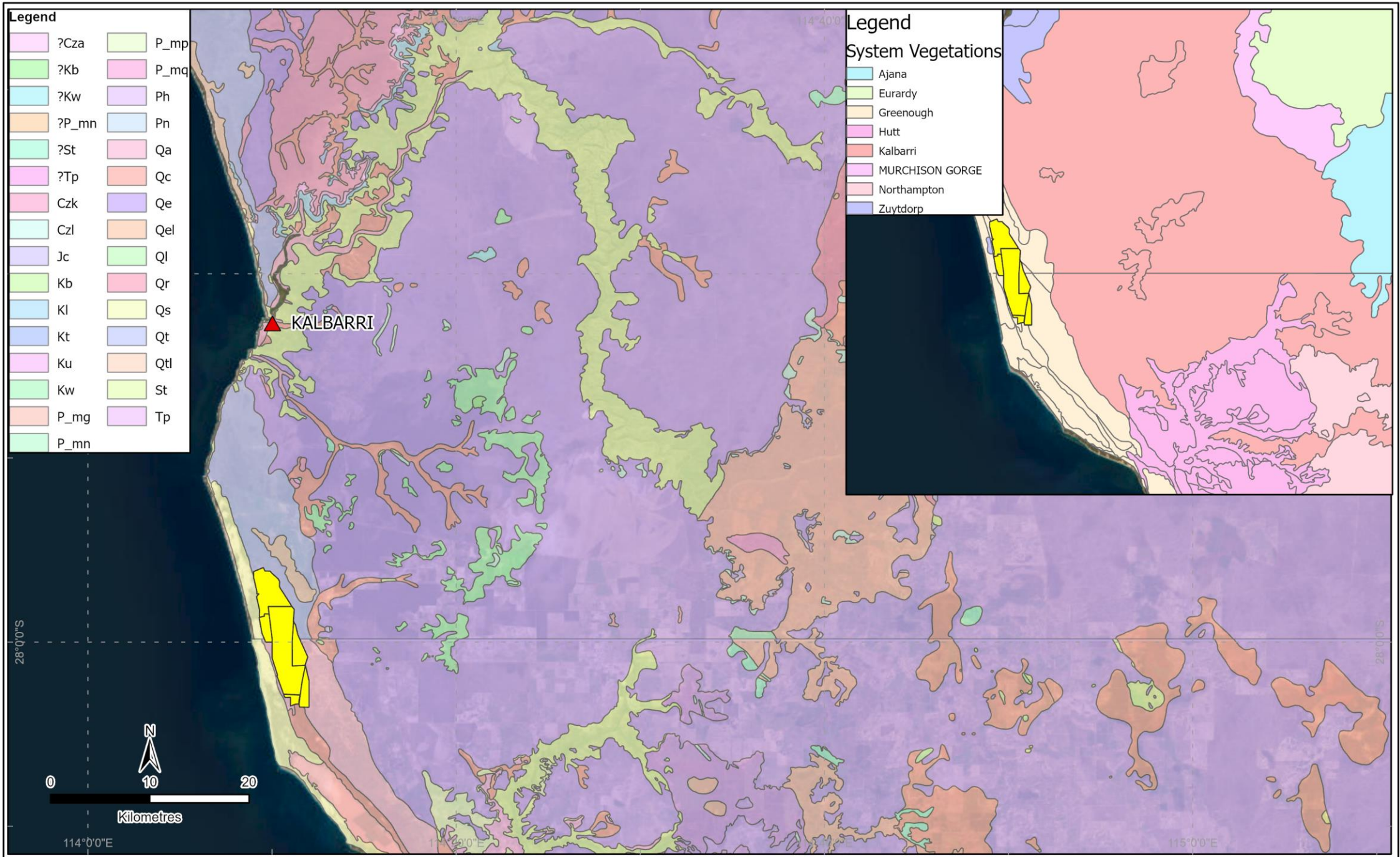
Bamford and McHarrie (2013) recognized three vegetation and substrate associations (VSAs) during their study:

- **VSA1**: Pasture. Very extensive across the Project area. It includes one area that might be inundated for short periods in winter. Considered widespread and well represented in cleared lands along the region. It is considered a low-value habitat for conservation-significant fauna.

- **VSA2**: *Acacia rostellifera* shrubland to tall shrubland on yellow-brown sands. Appears restricted to remnants in the study area, with patches in the south, centre, and north. Degraded by grazing where livestock is not excluded, and generally found along the coastal locations of the region. Provides connectivity across the landscape and appears to be important for most of the native fauna assemblages.

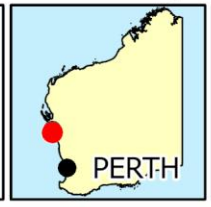
- **VSA3**: *Melaleuca cardiophylla* shrubland to tall shrubland on shallow grey sands over limestone, with extensive limestone outcropping. This vegetation associated with limestone close to the surface occurs largely in the west, but also on the hilltop in the southern block. Currently restricted to remnants in the study area, with patches in the west and on a low hill in the south. It has been degraded by grazing where livestock is not excluded. Considered important for most of the native fauna assemblages still present within the Project area, providing habitat and connectivity across the landscape.

The vegetation associations and ecosystem types reported from the Project area, paired with the soil characteristics of the region, indicate appropriate habitat for species belonging to SRE Groups occurs in the Project area.



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Date: 13/12/2022



Legend

- Project Area
- Kalbarri
- Project Point

Figure 2. Surface geology and Pre-European Vegetation Systems.

3. SRE FRAMEWORK

3.1. Conservation Framework

The *Biodiversity Conservation Act 2016* (BC Act) in Western Australia deals with the protection, conservation, and sustainable use of the state's biodiversity, and provides general protection for all native species (DBCA 2016). Some species are given special protection under the BC Act, primarily because they are rare, and are referred to as Threatened species. Species may also be recognised and protected as Threatened at the national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act; EPBC 1999). There is a general concordance of species listed under the two acts, but the BC Act has greater invertebrate coverage. Additionally, the Department of Biodiversity, Conservation and Attractions (DBCA) lists some Priority species for conservation; species are typically listed as Priority primarily when they are considered potentially under threat but there is insufficient evidence to support listing them as Threatened.

Ecological communities are defined as naturally occurring biological assemblages associated with a particular type of habitat (DEC 2010). Both the BC and EPBC Acts list certain communities as Threatened Ecological Communities (TECs), with the BC Act list for Western Australia being the larger of the two. In addition to TECs, Priority Ecological Communities (PECs) are also listed by the DBCA. PECs are communities that do not meet the survey criteria to be listed as TECs but may be vulnerable to disturbance. Criteria for different priority levels are defined by the total area and number of occurrences, as well as being subject to specific conservation programs. Currently, 43 PECs are listed for the Pilbara (DPAW 2021).

Information available from the BC and EPBC Acts, as well as from the DBCA's list of Priority species, is often used to complement a species' SRE assessment. Additionally, when a taxon listed in these sources is found in a project area, the potential impact of development on that taxon requires additional consideration of that taxon's taxonomy, distribution, and habitat requirements.

3.2. Short-Range Endemics

Short-range endemic (SRE) species are terrestrial invertebrates with known distributions <10,000 km^2 (Harvey 2002). In addition to having ranges notionally less than 10,000 km^2, SRE species usually have patchy distributions within their ranges, slow growth, low fecundity, and poor dispersal capabilities.

Guidelines for the consideration and assessment of SRE invertebrates in Western Australia are provided in the documents *Environmental Factor Guideline: Terrestrial Fauna* (EPA 2016a) and *Technical Guidance: Sampling of short range endemic invertebrate fauna* (EPA 2016b). Assessment typically focusses on taxonomic groups (the SRE Groups) that are known to contain moderate to high proportions of SRE species. These groups include land snails (Gastropoda), millipedes (Diplopoda), centipedes (Chilopoda), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), spiders (Araneae, mainly trapdoor spiders) and slaters (Isopoda). Some other groups, such as velvet worms (Onychophora) and earthworms (Oligochaeta), are SRE Groups in mesic landscapes, but either do not occur or are of no concern in the Pilbara.

Not all species in SRE Groups have restricted ranges; some or indeed many may be widespread due to high vagility, ecological plasticity, or xeric adaptation (e.g. Framenau *et al.* 2008; López-López *et al.* 2016; Rix *et al.* 2015). Determining whether a species belonging to an SRE Group is in fact an SRE is often difficult. One approach is to assume that the distribution of a species reflects the extent of its preferred or obligate habitats, and that species found only in restricted or patchy habitats have smaller ranges than those collected from extensive or common habitats. However, in cases where short range

endemism is driven by life history characteristics, a species may be a true SRE but inhabit a widespread, apparently connected habitat (Harvey 2002; Harvey *et al.* 2015b; Harvey *et al.* 2011; Rix *et al.* 2015). Therefore, several factors are considered in conjunction when evaluating the SRE status of a species, and the likelihood of threat to that species. These factors including the known range of the species; habitat(s) at the collection site(s), and the spatial extent and connectivity of these habitats; and the distribution patterns of phylogenetically related surrogate species (ideally members of the same genus).

This report considers these factors by following the Western Australia Museum (WAM)'s schema for SREs, which recognises three categories:

1. **Confirmed SRE** species have a known distribution smaller than 10,000 km^2. The taxonomy is well known, and the group well represented in collections and/or via comprehensive sampling.
2. **Potential SRE** species belong to a group with gaps in our knowledge of its distribution, either because the group is not well represented in collections, taxonomic knowledge is incomplete, or the distribution is poorly understood due to insufficient sampling.
3. **Widespread (not SRE)** species have a known distribution range larger than 10,000 km^2. The taxonomy is well known, and the group well represented in collections via comprehensive sampling.

In many surveys, most species fit the **Potential SRE** category, but the likelihood of species within the category actually being SREs varies substantially. In an attempt to increase the accuracy of categorisation, this report further subdivides Potential SREs into three sub-categories:

A. **Data deficient**, indicating that insufficient data are available to determine SRE status. Insufficiency of data may be caused either by a lack of geographic or taxonomic information, or because the individuals sampled are not identifiable to species level (e.g. nondiagnostic sex, juvenile, damaged). This category is applied only to those species that belong to a known SRE Group, rather than being applied to any undescribed species in the survey.
B. **Unlikely SRE** species are either from taxonomic groups that are not usually SREs or were collected from many sites and/or widespread or multiple habitats.
C. **Potential SRE** species (in this case no modifying word is added) are from taxonomic groups in which SREs are likely, and when specimens have been collected from one or very few sites and/or habitats.

In the context of these categories, identifying a species as a Potential or Confirmed SRE is often only the first step in determining the impacts of mining activities on that species. Even a Confirmed SRE species may be locally widespread around a project area, and therefore at minimal risk of disturbance. The actual level of threat to an SRE species depends on its distribution relative to the development footprint, rather than its SRE status alone. Determining the likely level of threat to a species therefore requires further consideration of the extent of the species' preferred habitat, both within and beyond the area of activity.

4. DESKTOP ASSESSMENT

Prior to the field survey, existing records of terrestrial invertebrates and associated habitat information were examined to appraise the likelihood of SRE and/or conservation listed invertebrate species occurring in the vicinity of the Project.

4.1. Previous records

The databases of Bennelongia Environmental Consultants and the Western Australian Museum (WAM) were searched, and published research papers and available environmental reports were consulted, to determine which species were likely to be present in the Project area. Data were compiled for a search area of 100 by 100 km centred on the Project area (top left corner: -27.5216, 113.6625; bottom right corner: -28.4906, 114.7245; Figure 3). Only two records were found directly within the proposed tenement boundaries (Figure 3). However, several records were found near the coastal area and closer to Kalbarri.

The desktop search recovered 369 records from at least 52 species belonging to SRE Groups, including 15 species of mygalomorph spiders, 9 species of scorpion, 1 species of harvestman, 7 species of millipedes, 4 species of pseudoscorpions, 6 species of centipedes, 2 species of slater, 4 species of land snails, and 4 species of bees (Appendix 1).

Out of the reported species, 17 were categorised as Widespread. The remaining 34 species are all Potential SREs; 16 are Data Deficient, 6 are Unlikely Potential SRE, 11 are Likely Potential SRE, and 1 is a Confirmed SRE. One species is categorised as Extinct (discussed in section 4.1.1; see also Appendix 1 and Figure 3). Ten records were identifiable only to higher taxonomic levels because they were juvenile or of the non-diagnostic sex, preventing lower-level identification; these records may belong to identifiable species and so are not considered as discrete species here.

The single Confirmed SRE species recorded from the database search was the short-tongued bee *Neopasiphae simplicior*. However, its presence within the search area is considered dubious (discussed in section 4.1.1). Of the 11 Likely Potential SRE species recorded, 7 are undescribed species from the typically SRE millipede genus *Antichiropus* (Car *et al.* 2013); 2 are mygalomorph (trapdoor) spiders; and two are land snail species from the genus *Bothriembryon*.

4.1.1. Listed Invertebrate Species at the Search Area

There are no SRE-related Priority Ecological Communities (PECs) or Threatened Ecological Communities (TECs) in the vicinity of the search area. However, the Kalbarri ironstone community Priority 1 PEC is found close to the Project area and consists of winter wet mallee/*Melaleuca* over herbs and a dense shrubland surrounded by sandplain (DPAW 2021).

Two listed species were recovered from the database search: *Bothriembryon whitleyi* (a camaenid land snail) and *Neopasiphae simplicior* (a native bee). *B. whitleyi* is probably extinct. Recent targeted surveys near the type locality of Geraldton were unsuccessful, although researchers do not dismiss the possibility of an extant population within the area (Whisson *et al.* 2017). Regardless, because it has been adequately sought and there is no evidence suggesting it persists, it is presumed Extinct in this report.

The native bee *Neopasiphae simplicior* is considered Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and managed as 'Endangered' (according to IUCN criteria) by the Western Australian Government. *N. simplicior* is found at a single location within Forrestdale Lake Nature Reserve in metropolitan Perth; the area of occupancy is estimated to be 1 km^2, with a documented decline of the species' geographic distribution (DEWHA 2008). The record found in the desktop search area was probably misidentified as it appears to expand the species' distribution by

more than 460 km. Accordingly, this recorded is considered dubious and is not considered accurately to reflect the species' distribution according to the latest conservation advice (DEWHA 2008).

4.2. Likelihood of SRE species

4.2.1. Mygalomorph spiders

Open-holed trapdoor spiders (Anamidae)

The family Anamidae was represented by at least five species in three genera. The genus *Aname* contains a very large diversity of described and undescribed species, and whereas the Pilbara fauna is relatively well studied (Castalanelli *et al.* 2020; Rix *et al.* 2021), there are still many undescribed species in the surrounding areas. *Aname* `MYG630`, *Aname* `MYG633`, and *Aname* `*mainae*` have been recorded in the desktop search area. *A.* `*mainae*` is considered Widespread and is likely part of a species group; the other two species are categorised as Data Deficient as they are recognised by molecular data only and little is known about their actual distribution.

The genus *Kwonkan* is currently represented by nine described species from Western Australia and South Australia, but numerous other undescribed species are known from museum collections, and molecular data suggest a highly diverse fauna (Castalanelli *et al.* 2014; Harvey *et al.* 2018). One unidentified species of this genus was reported from the search area and is considered a Data Deficient SRE.

The genus *Teyl* was represented by the species *T. luculentus* which is Widespread throughout the Geraldton Sandplains (Main 1975; Harvey *et al.* 2018).

Spiny trapdoor spiders (Idiopidae)

The family Idiopidae is a highly diverse group of trapdoor spiders, famous for their longevity and the conservation significance of some species (Rix *et al.* 2017). Six species of this family have been recorded in the search area: *Idiosoma aranaceum, Euoplos kalbarri, Bungulla keirani, Bungulla bertmaini*, *Bungulla ajana,* and *Idiommata blackwalli*.

Of these, *Bungulla ajana* is categorised as a Likely Potential SRE because it is reported to be restricted to parts of the Geraldton Sandplain bioregion (Rix *et al.* 2018b). *Euoplos kalbarri* is also considered to be a Likely Potential SRE as it is known from a single locality in the Kalbarri region (Rix *et al.* 2019. *E. kalbarri* is not expected to occur within the Project area, but *B. ajana* was recorded from less than 500 m east of the Project boundary (Figure 3), suggesting it is likely to be found inside the Project area.

Idiosoma aranaceum and *Bungulla bertmaini*, are considered Widespread species without conservation priority. *B. keirani* and *Idiommata blackwalli* are considered Unlikely Potential as their currently known distribution is less than 10,000 km^2 but given their preferred habitat they are not expected to show restricted distribution.

Brush-footed spider (Barychelidae)

The family Barychelidae contains 40 genera, including the genus *Synothele* which comprises 24 species (World Spider Catalog 2022). One unidentified species recognised by molecular markers was found through the database search, *Synothele* `MYG203`. The species is categorised as a Data Deficient species and is not expected to be restricted to the Project area.

4.2.2. Scorpions

Nine species of scorpions were recorded in the search area. The framework for formal scorpion identification in Australia needs revision, so determining the distribution of morphospecies of the genus *Urodacus* requires comparison with a range of specimens from the region. *Urodacus* is endemic to Australia, and there are currently 20 described species, but several undescribed species are known from the Western Australian Museum collection. Some of the described species are widespread, but even in these species the populations are restricted and only occupy small and patchy areas of the available

habitat. At the same time, other *Urodacus* species are confirmed SREs and therefore, undescribed *Urodacus* are usually considered Potential SREs.

The three recorded species, *U. armatus, U. hartmeyeri, and U. hoplurus,* are widespread species found across the country. *Urodacus hoplurus* is widespread throughout the continent, except for Queensland and Victoria, and hence is not an SRE. *Urodacus hartmeyeri* is known from the coastal areas of Western Australia, extending from Cape Range National Park (Exmouth) to near Lane Pool Reserve (Mandurah); it is therefore a widespread species likely to occur in the Project area.

Three species of the genus *Lychas* were recorded from the desktop search: *L. `splendens`*, *L. `subsplendens`*, and *L. `austraccidentalis* group`. The three species are considered as Data Deficient given they are morphologically distinct but undescribed species. The probable species complex *Isometroides `vescus`* was also recorded and is Widespread species.

Two species of *Cercophonius, C. granulosus* and *C. michaelseni*, were found in the desktop search area. Both species are Widespread.

4.2.3. Millipedes

Nine species from the genus *Antichiropus* were recorded in the desktop search area (Appendix 1; Figure 3). This diverse genus has been extensively studied (Car and Harvey 2014; Car *et al.* 2019; Car *et al.* 2013), and the vast majority of described species, and most of the undescribed species, are Confirmed SREs. All species here reported are considered as Likely Potential SREs. *Antichiropus* `DIP116, OR1` was recorded from less than 500 m east of the Project boundary, and hence is likely to occur within the development envelope.

4.2.4. Centipedes

Six Widespread species of centipedes were recovered in the search (Appendix 1). Scolopendrid centipedes are not typically found to be SREs.

4.2.5. Pseudoscorpions

Epigean pseudoscorpion species are generally considered to have widespread distributions and it has been suggested that few species are SREs (Harvey 2002). Phoresy (dispersal by means of attachment to a host organism) has been documented for many families of pseudoscorpions (Jhasser Martínez *et al.* 2018; Lira and Tizo-Pedroso 2017; Muchmore 1972), which might allow movement outside of restricted habitats. Notably, however, some species are restricted to specialist habitats including granite outcrops and have limited distributions (Harvey 2010; Harvey *et al.* 2012; Harvey 2018; Harvey *et al.* 2015a). Nevertheless, pseudoscorpion taxonomy is poorly resolved, largely due to high diversity, and thus accurate range determination can be difficult.

At least 13 species of pseudoscorpions have been collected from the search area, representing 8 genera belonging to 5 families. Four undescribed species were recorded from within the search area, all categorised as Data Deficient expect for *Beierolpium* `sp. 8/4` which is a morphologically distinct group with a widespread distribution around the Pilbara and surroundings, and accordingly was categorised as an Unlikely Potential SRE.

4.2.6. Isopods

In Australia, the order Isopoda contains a diverse and largely undescribed group of terrestrial epigean crustaceans (suborder Oniscidae) that, due to poor dispersal capabilities and specific habitat preferences, are often SREs (Judd 2004; Judd and Perina 2013; Judd and Tati 2011). Two unidentified species were recovered in the desktop search: *Buddelundia* sp. and *Spherillo* sp., both categorised as Data Deficient species.

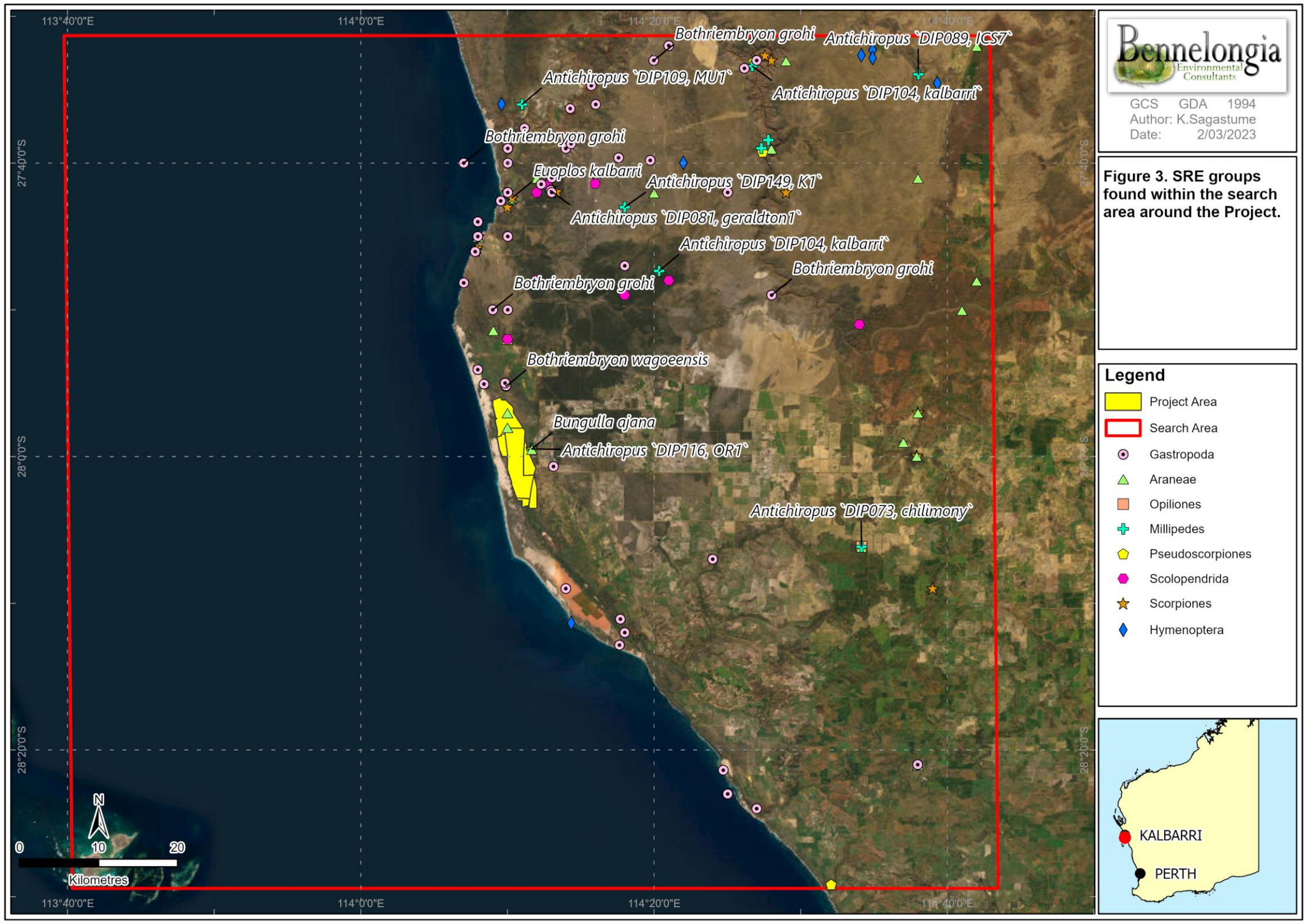
4.2.7. Land snails (Gastropoda)

Four species in two families of land snails were recovered in the desktop search. The species *Pleuroxia abstans* is considered an Unlikely Potential SRE as its current known linear range extends over 589 km (ALA 2022). The other three species belong to the known SRE genus *Bothriembryon*. Of these, *B. grohi* and *B. wagoeensis* are categorised as Likely Potential SREs given they are currently known only from a small area bordered by the Murchison River (Morrison and Schneider 2022).. The fourth species, *B. whitley*, is probably extinct (see section 4.1.1).

Following the findings from the desktop search, the SRE Groups most likely to be found in the Project area are:

- Mygalomorph spiders (Idiopidae, Anamidae)
- Scorpions (Urodacidae, Buthidae)
- Millipedes (*Antichiropus*)
- Centipedes (Scolopendridae)
- Isopoda (*Buddelundia*)

Even though the desktop search reported individuals from several SRE groups, the ones listed above are those more likely to be found within the Project area given their habitat requirements and database records.



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Date: 2/03/2023

Figure 3. SRE groups found within the search area around the Project.

Legend

- Project Area
- Search Area
- Gastropoda
- Araneae
- Opiliones
- Millipedes
- Pseudoscorpiones
- Scolopendrida
- Scorpiones
- Hymenoptera

5. FIELD SURVEY

5.1. Methods

A field survey targeting invertebrates belonging to SRE Groups was carried out from 22 to 26 August 2022 by Huon Clark and Ella Carstens. The aim of the survey was to collect species from recognised SRE Groups from representative habitat types in the vicinity of the Project, focussing on those species recovered during the desktop assessment. A total of 20 sites were sampled within the Project area (Figure 4; see Appendix 2 and 3 for site details and photographs). Sampling used active search methods that varied at each site according to habitat, biology of target taxa, and visual observations of burrows or other tell-tale signs of target species.

5.1.1. Sampling techniques

Sampling techniques followed published guidelines (EPA 2016b). At least one hour was spent on each site, with two team members conducting the different techniques depending on the site type. Two sampling techniques were used: hand foraging and wet trapping.

Hand foraging consisted of actively searching for taxa belonging to SRE Groups in their preferred habitats, making basic assumptions about the target species' (or Group's) biology. Hand foraging techniques included:

- Log flipping and raking: turning over and breaking apart logs and dead wood in search of isopods, myriapods, and pseudoscorpions. Raking also helps to uncover camouflaged mygalomorph spider burrows or to uncover buried land snails that may aestivate below the surface.
- Rock flipping: turning over rocks and other debris in search of harvestmen, centipedes, and isopods. Rocks were returned to their natural position when possible.
- Leaf litter sieving: sieving leaf litter to target litter- and soil-dwelling species. Leaf litter sieving also uncovers small-bodied SRE species (such as pseudoscorpions, millipedes, and land snails). Two leaf litter samples per site were collected and transported in cloth bags to the laboratory and placed in Tullgren funnels to collect litter-dwelling invertebrates.
- Leaf blowing: hand-held leaf blowers were used to remove leaf litter and reveal mygalomorph spider burrows covered by litter or otherwise difficult to identify unaided. If found, burrows were examined; burrows likely to house a mygalomorph spider were then excavated.
- Bark peeling and tree digging: removing pieces of bark from trees with smooth and exfoliating bark for inspection, and removing dirt from the bases of trees to search for SRE taxa. These techniques were only applied at sites containing trees (i.e. not only shrubs or spinifex).
- Night searching: with the aid of ultraviolet torches, selected sites were visited at night in search of scorpions, which fluoresce under ultraviolet light and are thereby easily detected.

Wet trapping was also employed to collect wandering SREs that may have evaded hand foraging techniques. Five pitfall traps were left at each trapping site for approximately 30-40 days. Each trap consisted of a 500-ml polycarbonate tube with a 70-mm aperture filled with 300 ml preservation fluid (30% propylene glycol; 70% ethanol) buried within 1 cm of the aperture. A 150 x 150-mm sheet of mesh (25 x 25-mm holes) was placed over the top of the tube to prevent vertebrates from entering while allowing SRE species, which tend to be small, to enter. A 30-cm lid on brackets was installed above each trap to provide shelter and to prevent the traps from filling with rain. Drift fences, which tend to channel vertebrates into traps, were not used.

5.1.2. Preservation and identification techniques

Specimens collected in the field through hand foraging techniques were placed in 100% ethanol. Specimens collected via all foraging techniques were transported to Bennelongia's laboratory for identification. Specimens were first sorted and separated from by-catch. When a specimen belonging to an SRE Group was found during this process, it was transferred to a labelled vial of 100% ethanol for further identification.

Several team members were involved in the identification process (Table 1), each bringing their own area of expertise and following any available literature that might aid the process. Leica stereomicroscopes were used for assisting the identification process. No animals have been lodged to the WAM at this stage.

Table 1. Details of personnel involved in the Balline Garnet SRE survey.
ID: identification.

Name	Contribution	Role	Taxonomic group
Stuart Halse	Report revision and approval	Managing Director	
Kevin Sagastume-Espinoza	Report writing; morphological IDs	Principal Biologist	Spiders and scorpions
Huon Clark	Field survey; morphological IDs	Principal Biologist	Isopods and harvestmen
Melanie Fulcher	Morphological IDs; DNA interpretations	Senior Biologist	Centipedes and pseudoscorpions
Jane McRae	Morphological IDs	Senior Taxonomist	Pseudoscorpions
Heather McLetchie	Morphological IDs; DNA extraction	Biologist	
Vitor Marques	GIS specialist	Biologist	
Ella Carstens	Field survey	Biologist	

5.1.3. Molecular methods

During the identification process, unidentifiable specimens (e.g. juvenile or damaged specimens) were flagged for DNA sequencing. Nineteen animals from the Project area were identified and subsequently sequenced using this method.

For all samples, DNA was extracted using a Qiagen DNeasy Blood & Tissue kit (Qiagen 2006). For smaller animals such as pseudoscorpions, legs and other body parts (e.g. sections of the abdomen) were used for DNA extraction. For larger animals, and where possible, muscle tissue was collected from the legs. Elute volumes varied from 50 µL to 100 µL, and were dependent on the age, condition, and quantity of material available.

Primer combinations used for PCR amplifications were LCO1490:HCO2198 and C1J1718:HCO2198, targeting the COI region of the mitochondrial genome, and 16SAR-L:16SBR-H targeting the 16S gene (Folmer *et al.* 1994; Schwendinger and Giribet 2005). PCR products were sequenced using dual-direction Sanger sequencing carried out by the Australian Genome Research Facility (AGRF). The returned sequences were edited and aligned manually in Geneious (version 2022.2.2; Kearse *et al.* 2012). Geneious was also used to calculate neighbour-joining phylogenetic trees with 1,000 bootstrap permutations.

Tamura-Nei genetic distances were measured as uncorrected *p*-distances (total percentage of nucleotide differences between squares). Sequences on GenBank and in grey literature were included in the phylogenetic analysis to provide a framework for assessing intra- and interspecific variation, as well as to examine levels of differentiation among individuals within described species across their geographic ranges.

5.2. Survey timing and limitations

Many SRE Groups are active and therefore more likely to be collected during and immediately following substantial rainfall. No rain fell on site during the survey, but rain was recorded prior to the field survey by the Balline Station (7-18 August 2022), with a total of 78.1 mm of rain for the month of August 2022 (BOM 2022). This suggests the survey timing was optimal for accessing SRE fauna.

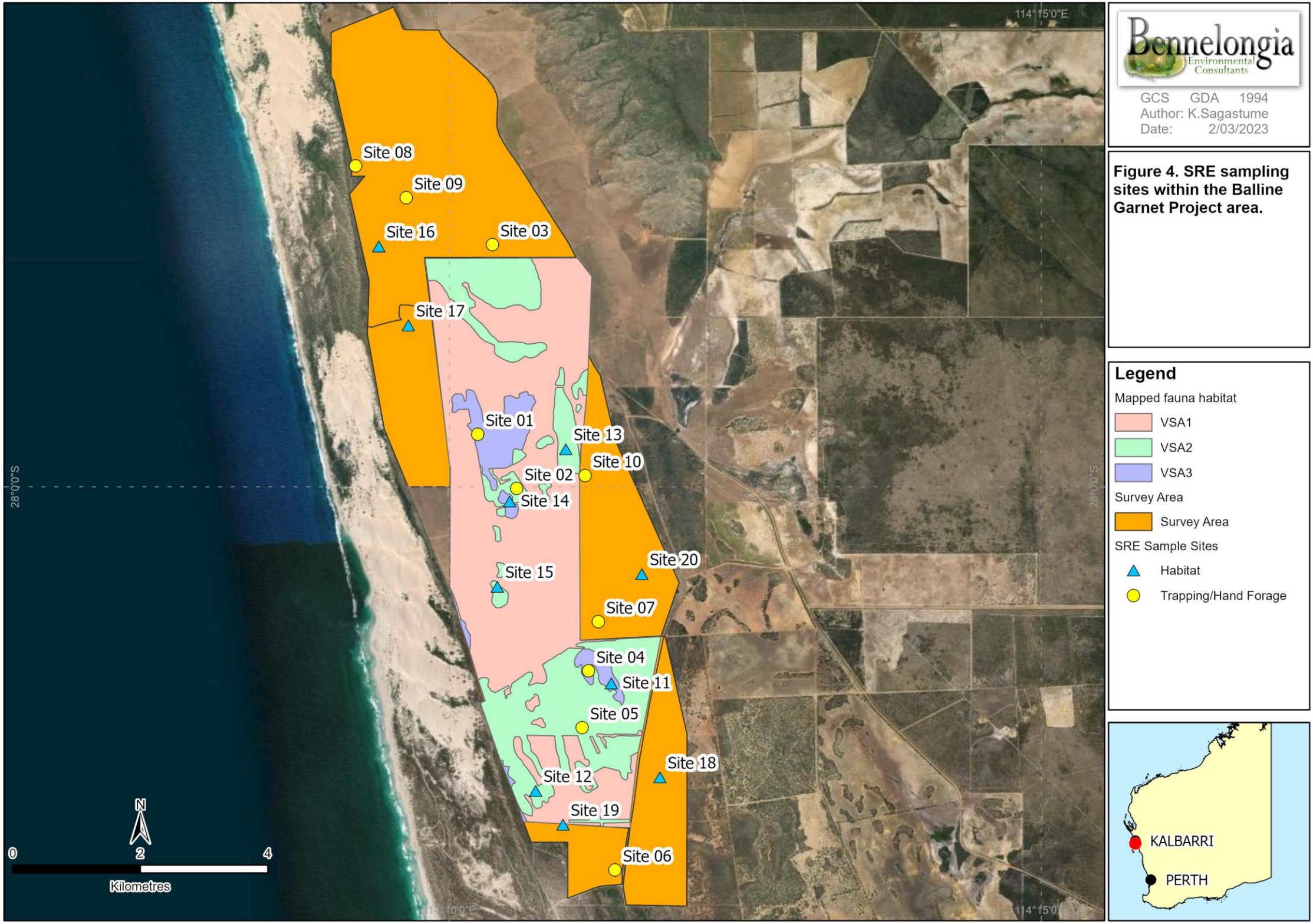
Of the 20 sampling sites, 10 were sampled using trapping/hand foraging techniques and the remaining ten were sampled for habitat characterisation only (Appendix 3). Form the 10 habitat sites, only 4 (sites 11, 12, 14, and 16) yielded samples; no fauna was recorded at the other habitat sites. No traps were lost from any of the 10 wet-trapping sites.

5.3. Habitat

Five primary habitat types were identified and sampled in the field. Characteristics of the habitats observed and sampled in the field were relatively consistent with what was identified in the desktop review. Most sites corresponded to sand plain habitats (Table 2).

Table 2. Summary of habitats sampled for SRE invertebrates at the Project area.

Landform	Vegetation	Sun Exposure	Soil/geology	Survey sites
Sand plain	Moderately dense low-lying shrub of acacia and gum associations, with occasional trees.	Very high; little protection around bushes and trees	Brown loamy to clayey sandy soils	Sites 01, 07, 16
Sand dunes	Dense tall shrubland of acacia with weeds covering sections of the soil.	High; some protection under vegetated areas	Brown loamy to clayey sandy soils	Sites 13, 17, 19, 20
Hillslope	Moderately dense low-lying shrub of acacia and gum associations, with occasional trees and openings with extensive weed growth.	Very high; some protection under trees and in litter	Brown sandy to loamy sandy soils	Sites 02-05, 09, 11, 14-15
Open woodland	Regrowth eucalyptus and acacia trees with scarce weed covering the soil.	Moderate; plenty of protection from the sun by the numerous trees	Brown to orange sandy to clayey/loamy soils	Sites 06, 08, 10, 12
Minor drainage lines	Extremely dense weeds with acacia shrubbery dense in some areas.	Very high; some protection provided by bushes or under leaf litter	Orange sandy soils	Site 18


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Date: 2/03/2023
Figure 4. SRE sampling sites within the Balline Garnet Project area.
Legend
Mapped fauna habitat
VSA1
VSA2
VSA3
Survey Area
Survey Area
SRE Sample Sites
Habitat
Trapping/Hand Forage
Site 08
Site 09
Site 16
Site 03
Site 17
Site 01
Site 13
Site 10
Site 02
Site 14
Site 15
Site 20
Site 07
Site 04
Site 11
Site 05
Site 18
Site 12
Site 19
Site 06
114°15'0"E
28°0'0"S
N
0
2
4
Kilometres
KALBARRI
PERTH

5.4. Survey results

The survey collected 530 specimens identifiable to 34 species belonging to SRE Groups. Some specimens were immature or belonged to the nondiagnostic sex, so could not be identified to a sufficiently low level to align them with other recorded species; such specimens were therefore not considered distinct species.

At least four species of mygalomorph spiders were collected during the field survey, as well as at least five species of pseudoscorpions, four species of scorpions, one species of geophilid centipede, two species of scolopendrid centipedes, three species of millipedes, five species of slaters, and at least ten species of land snails (Table 3). Land snails were the most abundant SRE group in the survey, accounting for almost 73% of all collected samples (Figure 6). It is important to note that most of the land snail specimens belonged to a single introduced species, *Theba pisana*.

5.4.1. Species Accounts

Of the species sampled, 17 are Widespread or likely to be. Three species were categorised as Data Deficient, and one species was Invasive. Eleven species were categorised as Unlikely Potential SREs and two as Likely Potential SREs: the mygalomorph *Aname exulans* and the slater *Buddelundia* `BIS497` (Figure 5; Table 3).

Mygalomorph spiders

Four species of mygalomorph spiders from three families (Anamidae, Euagridae, and Idiopidae) were collected during the field survey, all identified molecularly. Two species were categorised as Unlikely Potential SREs: *Cethegus* `BMYG174` and *Hesperonatalius harrietae*.

Although molecular studies have suggested species of *Cethegus* have limited or restricted dispersal abilities and molecular divergence can be found among neighbouring (100-km radius) populations (ecologia 2009), sequenced specimens of *C.* `BMYG174` were matched molecularly with specimens previously recorded from Iron Hill and Mt. Mulgine, approximately 305 km southeast of the Project area, for which reason this species is not considered to be restricted. *Hesperonatalius harrietae* is known from sand dunes in Oakajee, north of Geraldton and approximately 110 km south of the Project area (Castalanelli *et al.* 2017). Given their linear range and apparent habitat requirements, these two species are considered unlikely to have restricted distributions.

The species *Idiosoma kwongan* is listed as Priority 1 by the DBCA Threatened and Priority Fauna List (DBCA 2022). Described in 2018 from the Geraldton Sandplains bioregion by Rix *et al.* (2018a) who suggested that the species may be restricted, but that too little of its biology is known to be certain. Even though its known occurrence encompasses approximately 500 km^2, Rix *et al.* (2018a) suggest this is an underestimate; there is a large amount of suitable habitat (heathland) for the species to inhabit. Accordingly, *Idiosoma kwongan* is categorised as Data Deficient for the purposes of conservation assessment (Rix *et al.* 2018a).

One juvenile specimen collected from Site 05 in this survey, approximately 65 km from the type locality (Figure 5), was sequenced molecularly. The sequenced specimen is only 1.2% different in the 16S gene from *Aname exulans* (Appendix 2a), a species currently known only from the Houtman Abrolhos Islands (Harvey *et al.* 2020a).. This could represent the first inland record for the species; communication with WAM personnel has been established to better assess the species determination. Given the species is currently known from few localities in an apparently restricted area, it is here categorised as a Likely Potential SRE. Any potential impacts arising from the Project development are considered low for this species, as it is not restricted to the Project area; rather, this sample appears to represent a range extension for the species.

Pseudoscorpions

The 66 specimens of pseudoscorpions collected from the Project area were identifiable to 5 species using either morphological or molecular characters (Appendix 2b). The undescribed morphospecies Atemnidae `BPS479` is considered as Data Deficient given it comes from a single specimen and little is known about its habitat requirements. The other four species, *Austrochthonius* `BPS475`, *Beierolpium* 8/4 `BPS477`, Cheiridiidae `BPS478`, and Chernetidae `BPS476` are categorised as Unlikely Potential SREs as all were sampled multiply from multiple localities and different habitats. Unidentified juvenile specimens could not be assigned to any of the recognised species, but it is expected they belong to some of the morphologically distinct species identified here.

Myriapods

Three species of centipedes were collected from the Project area: *Ballophilus australiae, Scolopendra laeta*, and *Notiasemus glauerti*. All but the latter are Widespread species with patchy distributions. *Notiasemus glauerti* is categorised as an Unlikely Potential SRE because its linear range is approximately 500 km but it is poorly sampled.

Three millipede species were recorded from the Project area. Two of these, *Phryssonatus novaehollandiae* and *Lophoturus madecassus*, belong to a group of millipedes whose Western Australian species are typically Widespread (e.g. Short and Huynh 2011, 2013).

The third millipede species belongs to the classic SRE genus *Antichiropus* (Car and Harvey 2014; Car *et al.* 2013), *Antichiropus* `BDI074` (Table 3). This species was recognised based on molecular sequencing and no matches were found with other species, for which reason it was assigned a new internal code (prefix B-). Based on the known biology of the genus genus (Car and Harvey 2014; Car *et al.* 2013), *Antichiropus* `BDI074`is categorised as an Unlikely Potential SRE as it is expected to occur outside of the Project area based on its habitat requirements (acacia litter).

Slaters

Five species of slaters were recorded in the survey: *Buddelundia* `BIS497`, *B.* `BIS504`, *B.* `BIS507`, *Leavophiloscia* `BIS502`, and *Platyarthridae* `BIS503`. *Buddelundia* `BIS507` is Widespread, whereas *L.* `BIS502` and *P.* `BIS503` are categorised as Unlikely Potential SREs as they have been recorded from widespread habitats or in high densities (as in *L.* `BIS502`), for which reason they are not expected to be restricted. The species *Buddelundia* `BIS497` has been recorded from only two specimens at a single locality: Site 4 on which is a hillslope habitat with loamy sand soils and falls under the VSA 3 recognized by Bamford and McHarrie (2013) (Figure 5). Given VSA 3 is one of the less abundant vegetation systems identified within the Project area (see Figure 4) and appears to be restricted, *B.* `BIS497`, the least abundant slater species recovered from the survey, is categorised as a Likely Potential SRE.

To confirm the accuracy of morphological identifications in capturing interspecific variation, all putative isopod species were analysed through molecular methods. However, no matches were found between any of the putative species and lodged sequences. It appears, based on the molecular analyses, that the species are closely related but are sufficiently divergent to qualify as discrete species (Appendix 2c).

Scorpions

Four species of scorpions were recorded within the Project area: *Cercophonius granulosus, Isometroides* `SCO051`, *Lychas* `SCO039` (annulatus complex), and *Lychas* `BSCO085` `multipunctatus group` (Table 3). Molecular sequencing was used to confirm the species identities for specimens of *Isometroides* and *Lychas*, as they are suspected species complexes composed of many undescribed species (Appendix 2d). Sequencing resulted in a molecular match for *I.* `SCO051` with a species previously recorded from Erramurra near Karratha, approximately 760 km north of the Project area. This species is accordingly considered Widespread.

Sequenced specimens of *Lychas* resulted in two different species. The first, *L.* `SCO039` (annulatus complex), was previously recorded from Carnarvon, Sheila Valley, Lake Rebecca, and Woodie Woodie and is therefore Widespread. The other species, *L.* `BSCO085`, was collected as a single juvenile specimen at Site 06. No molecular matches were found, and a new code was assigned to the species. Given that little is known of this species, it is here categorised as Data Deficient (Table 3).

Snails

At least 10 species of land snails were collected during the field survey (Table 3). All the identified species are considered as Widespread except for *Theba pisana* which is an Introduced species and represents approximately 49.4% of all the collected samples.

No evidence was found of the known SRE group *Bothriembryon,* although as was found in the desktop assessment, it probably occurs in the area.

General species discussion

Most of the samples (72.3%) in the survey were land snails. One species, *Theba pisana*, singlehandedly accounted for 262 of records (Figure 6; Table 3). This is an invasive species with no conservation significance. Centipedes represented the least abundant group, followed by scorpions and mygalomorph spiders (Figure 6).

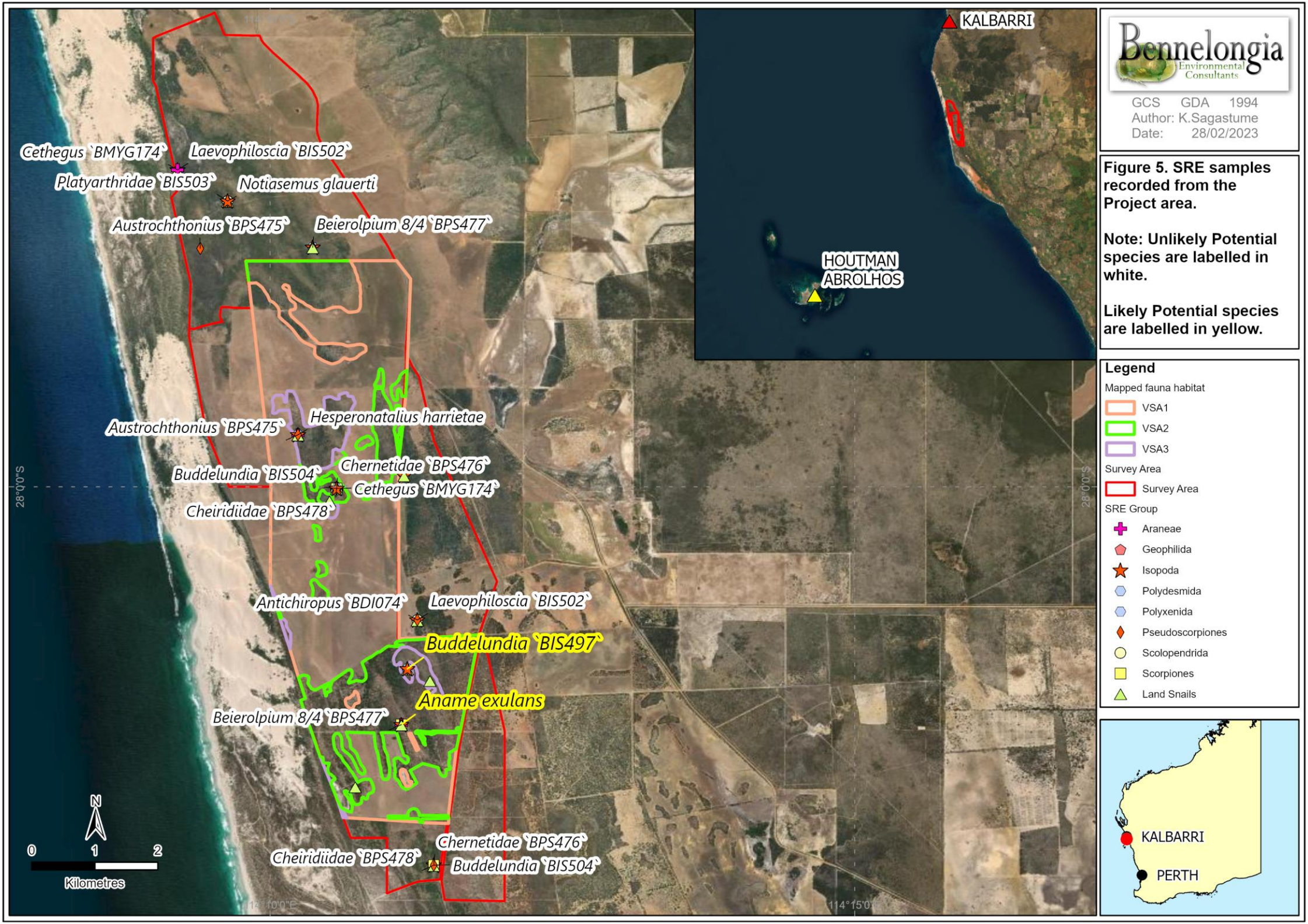
Table 3. Species from SRE Groups collected during field survey at the Project Area.
Note: Blue denotes species considered as Likely Potential SREs. * denotes species identified through molecular sequencing.

No.	Lowest ID	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Site 11	Site 12	Site 14	Site 16	Count	SRE Status	Comments
	Araneae																	
1	*Aname exulans**					1										1	Likely Potential	An unidentifiable juvenile anamid specimen was analysed through molecular sequencing and returned a 5.3% difference in COI and a 1.2% difference in 16S from *Aname exulans* from Houtman Abrolhos (Harvey *et al.* 2020b), suggesting it is the same species.
2	*Cethegus* `BMYG174`*		1						4							5	Unlikely Potential	Adult and juvenile specimens were sequenced and returned a match only 8%-9.1% divergent from a species previously sequenced from Iron Hill and Mt Mulgine, approximately 305 km south-east from the Project area. Given the extent of its linear range, it is not expected that this species will be restricted.
3	*Idiosoma kwongan**	1							1							2	Data Deficient; Priority 1	The specimens were identified by both morphological data and molecular sequencing. It is a species with an apparently restricted distribution in the southern Geraldton Sandplains bioregion (Rix *et al.* 2018a).
4	*Hesperonatalius harrietae**	1														1	Unlikely Potential	Specimens were identified through molecular sequencing and resulted in a match only 4.7% different from *Hesperonatalius harrietae*, a species known from the Oakajee region north of Geraldton and approximately 110 km south from the Project area. It is not expected the species will have a restricted distribution as suitable habitat (sand dunes; Castalanelli *et al.* 2017) appear abundant within its linear range.
	Geophilida																	
5	*Ballophilus australiae*								1							1	Widespread	
	Isopoda																	
6	*Buddelundia* `BIS497`*				2											2	Likely Potential	Specimen was sequenced and no molecular match was found. It has been recorded only from the VSA 3 area.

No.	Lowest ID	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Site 11	Site 12	Site 14	Site 16	Count	SRE Status	Comments
																		Might align with *Buddelundia* `81` from Phoenix Environmental.
7	*Buddelundia* `BIS504`*		1				3									4	Unlikely Potential	Specimen was sequenced and no molecular match was found. Its closes relative appears to be *Buddelundia* `BIS507`, collected abundantly within the Project area. Collected from widespread habitat, it is not expected to have a restricted distribution.
8	*Buddelundia* `BIS507`*	2	1	2	5	3	1	4		1	5					24	Widespread	DNA
9	*Laevophiloscia* `BIS502`*		2					1	12							15	Unlikely Potential	Specimen was sequenced and no molecular match was found. Closest relative comes from Arrowsmith, over 220 km from the Project area. The species appears to be abundant in the area and is not expected to have a restricted distribution.
10	Platyarthridae `BIS503`*									2						2	Unlikely Potential	Specimen was sequenced and no molecular match was found. Collected from widespread habitat; not expected to have a restricted distribution.
	Polydesmida																	
11	*Antichiropus* `BDI074`*							4			1					5	Unlikely Potential	Specimen was sequenced and a molecular match was found with a species previously sampled from Arrowsmith North, approximately 220 km south from the Project. It is not expected the species will have a restricted distribution.
	Polyxenida																	
12	*Lophoturus madecassus*						1									1	Widespread	
13	*Phryssonotus novaehollandiae*				1											1	Widespread	
	Unixenus sp.	1	1	2	1											5	NA	
	Pseudoscorpiones																	
14	Atemnidae `BPS479`*							1								1	Data Deficient	Specimen was sequenced but no molecular match was found. Given little is known of its actual distribution or habitat requirement it is here considered as Data Deficient.

No.	Lowest ID	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Site 11	Site 12	Site 14	Site 16	Count	SRE Status	Comments
15	*Austrochthonius* `BPS475`*	7						6							7	20	Unlikely Potential	Representatives of the species were sequenced, and no molecular match was found. Given it has been recorded from multiple habitats and in high densities per site, it is not considered the species will have a restricted distribution.
16	*Beierolpium* 8/4 `BPS477`	1	1	5	7	1		2	2							19	Unlikely Potential	Recorded from multiple habitats; it is not expected the species will have a restricted distribution.
17	Cheiridiidae `BPS478`*		6				1									7	Unlikely Potential	Specimen was sequenced with no resulting match. Recorded from widespread habitat; it is not expected to have a restricted distribution.
18	Chernetidae `BPS476`*		1				1			1						3	Unlikely Potential	Specimen was sequenced with no resulting match. Recorded from widespread habitat; it is not expected to have a restricted distribution.
	Chernetidae sp.	4	1							4						9	NA	Likely the above species.
	Chthoniidae sp.				2				4							6	NA	
	Olpiidae sp.								1							1	NA	
	Scolopendrida																	
19	*Notiasemus glauerti*									2						2	Unlikely Potential	Recorded from John Forrest National Park and Kings Park, Perth, approximately 500 km away.
20	*Scolopendra laeta*						1	1								2	Widespread	
	Scorpiones																	
21	*Cercophonius granulosus*		1				3									4	Widespread	
22	*Isometroides* `SCO051`*					1										1	Widespread	Specimens sequenced and matched to species previously recorded from Erramurra, near Karratha, approximately 760 km north of the Project. Considered widespread.
23	*Lychas* `BSCO085` `multipunctatus group`*						1									1	Data Deficient	Specimen was sequenced without any molecular match found. It appears to belong to the `multipunctatus` species complex. Little is known of the habitat requirements and actual distribution of the species.

No.	Lowest ID	Site 01	Site 02	Site 03	Site 04	Site 05	Site 06	Site 07	Site 08	Site 09	Site 10	Site 11	Site 12	Site 14	Site 16	Count	SRE Status	Comments
24	*Lychas* `SCO039` (annulatus complex)*					2										2	Widespread	Species was sequenced and matched with specimens collected from Carnarvon, Sheila Valley, Lake Rebecca, and Woodie Woodie.
	Stylommatophora																	
25	*Austrosuccinea australis*	4	2	1			2		6	2	2			15		34	Widespread	
26	*Cochlicella acuta*					11	20									31	Widespread	
	Cochlicella sp.						1									1	NA	
27	*Gastrocopta margaretae*		2	2	1			1	3	1						10	Widespread	
28	*Omegapilla australis*			2		15					1					18	Widespread	
29	*Prietocella barbara*					5	12	1								18	Widespread	
30	*Pupoides beltianus*			1												1	Widespread	
31	*Theba pisana*	19	26	28		42	59	12		1	58	8	9			262	Introduced	
32	*Westralaoma aprica*			3		1										4	Widespread	
33	*Westralaoma experta*		1								1					2	Widespread	Recorded from King George's Sound, Coolgardie, and Kemerton, Western Australia.
34	*Westralaoma expicta*							1								1	Widespread	
	Westralaoma sp.						1									1	NA	Likely one of the above species
	Specimen count	**40**	**47**	**46**	**19**	**82**	**107**	**34**	**34**	**14**	**69**	**8**	**9**	**15**	**7**	**530**		



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Date: 28/02/2023

Figure 5. SRE samples recorded from the Project area.

Note: Unlikely Potential species are labelled in white.

Likely Potential species are labelled in yellow.

Legend

Mapped fauna habitat
- VSA1
- VSA2
- VSA3

Survey Area
- Survey Area

SRE Group
- Araneae
- Geophilida
- Isopoda
- Polydesmida
- Polyxenida
- Pseudoscorpiones
- Scolopendrida
- Scorpiones
- Land Snails

6. POTENTIAL IMPACTS

The potential impacts of the Project on SRE species can be divided into direct impacts from clearing and indirect impacts from changes in habitat connectivity.

6.1.1. Clearing

Within 15 km of the Project area, 47% of native vegetation remains, but remnant vegetation within the Project area represents 2% of native vegetation within a 15 km radius. The area of native vegetation to be cleared within the Project area represent 33% of native vegetation within the Project area, but only 0.3% of native vegetation within a 15-km radius (Bamford and McHarrie 2013).

The extent of clearing has the potential to affect the populations of SREs. However, most of the species recorded from the field survey were found at numerous sites and from habitats found extensively near the Project area. The two species most likely to be affected by habitat clearing activites are *Buddelundia* `BIS497` and *Hesperonatalius harrietae*. Even though they have been recorded from only one of the three recognised VSAs, the hillslope and sandplains habitats where they have been collected appear to be abundant outside of the Project area. Given that *H. harrietae* has been found abundantly within the Geraldton Sandplains bioregion and is not expected to be affected by the Project development.

Given the extent of habitat clearing expected from the Project development, it is not expected that clearing will significantly affect the populations of any of the other SRE species sampled during the survey.

6.1.2. Habitat connectivity

The most likely potential impact to arise from the Project development is interruption to habitat connectivity. Habitat connectivity appears to have been interrupted already by previous clearing activities. Pasture areas (VSA1) are abundant both within and outside of the Project area, whereas *Acacia* shrublands (VSA2) and *Melaleuca* shrublands (VSA3) are rare (Figure 4). However, it has been suggested that both *Acacia* and *Melaleuca* shrublands provide connectivity across the Project landscape and might be an important source of habitat for native fauna species (Bamford and McHarrie 2013).

7. CONCLUSIONS

The current survey aimed to appraise the values of short-range endemic invertebrates within the Balline Garnet Project. Desktop review indicated the area was likely to harbour species from SRE Groups. A field survey undertaken in August 2022 recorded 34 species belonging to SRE Groups, including two Likely Potential SREs: the mygalomorph *Aname exulans*, and the slater *Buddelundia* `BIS497`.

The only species expected to be affected by the Project development is *Buddelundia* `BIS497`. Activities such as clearing, loss of habitat, and interruptions in habitat connectivity have the potential to affect the species' populations, particularly since the species shows affinity with Vegetation and Substrate Association 3 (VSA 3), which is rare in the Project area. Further sampling is required to determine whether the species occurs beyond the Project envelope, and to estimate the effects of the Project development on the species across its range. Nevertheless, the significance of these potential impacts is expected to be minor as VSA 3, although less abundant than other VSAs, appears to be moderately widespread in the region.

In agreement with what was suggested by Bamford and McHarrie (2013), this report recommends actions such as minimising the Project's footprint and, where possible, avoiding vegetation clearing especially of VSA 3 in order to reduce the potential impacts of the Project on the species' populations. No other species are considered to be affected by the Project development.

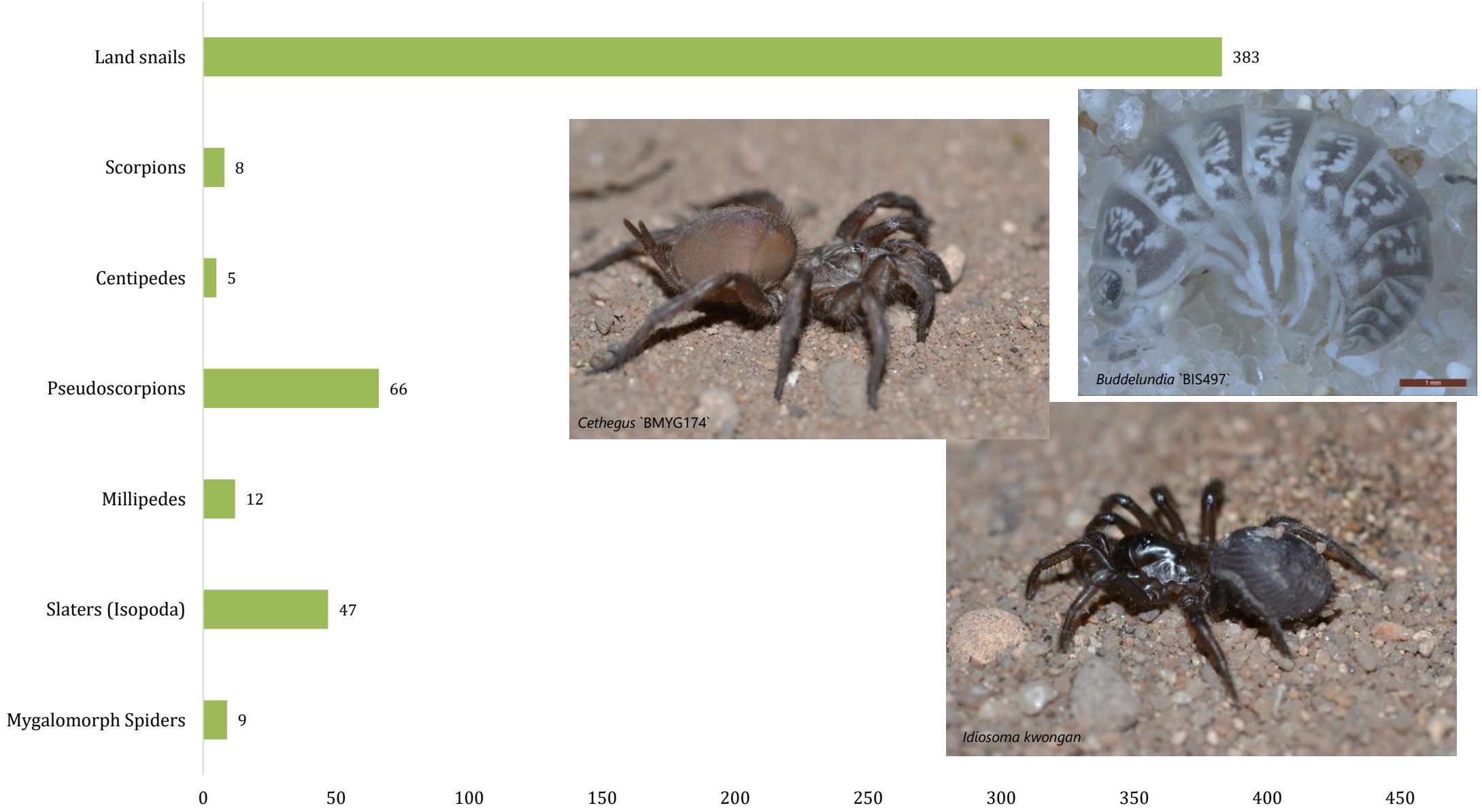


Figure 6. Abundance of SRE Groups collected at the Project area.

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Appendix 1- Species of SRE invertebrate groups found within the Desktop assessment for the Project area and its vicinity.

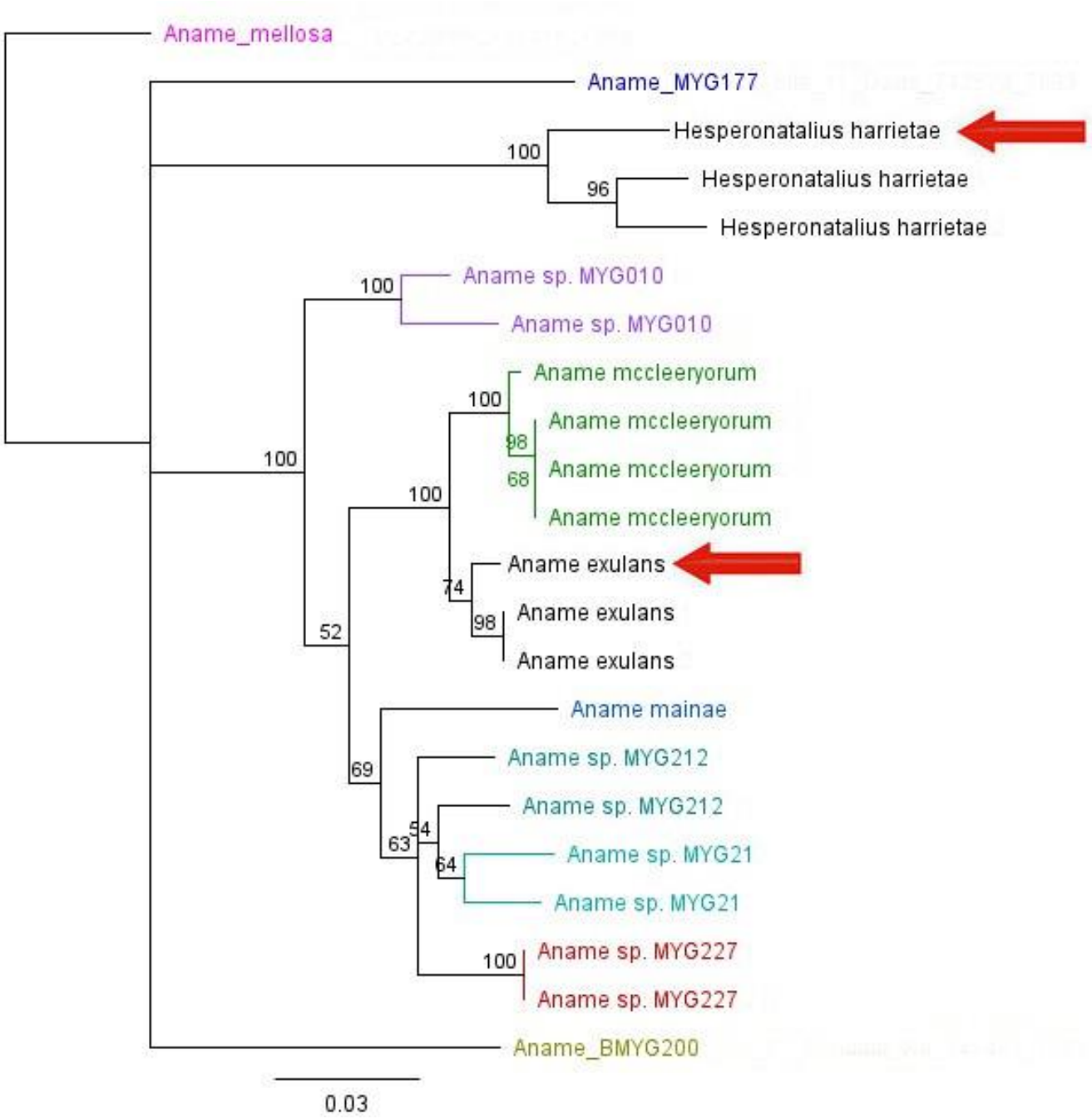
Lowest Identification	Count	SRE Status	Listed Species	Comments
Araneae				
Aname `*mainae*`	9	Widespread	Not listed	Widespread species likely to be a species group
Aname `MYG630`	2	Data Deficient	NA	Undescribed molecularly recognised species.
Aname `MYG633`	1	Data Deficient	NA	Undescribed molecularly recognised species part of the `*mainae*` group
Aname sp.	21	NA		Likely one of the above species
Bungulla ajana	2	Likely Potential	Not listed	According to Rix et al. 2018, the species is highly restricted and known only from south-west of Ajana, near Kalbarri National Park, in the Geraldton Sandplains bioregion.
Bungulla bertmaini	1	Widespread	Not listed	Found throughout arid Western Australia, in the Avon Wheatbelt, Coolgardie, Yalgoo, Murchison, Carnarvon, Gascoyne and Pilbara bioregions (Rix et al. 2018)
Bungulla keirani	1	Unlikely Potential	Not listed	Species has a relatively restricted distribution in the northern Geraldton Sandplain, north-western Yalgoo and southern Carnarvon bioregions of WA (Rix et al. 2018). It is not expected to be a restricted species.
Cethegus sp.	3	Data Deficient	NA	Unidentified species likely part of the *C. fugax* complex
Euoplos kalbarri	1	Likely Potential	Not listed	Known from a single location in the Kalbarri region, on the north-western Geraldton Sandplains (Rix et al. 2019).
Idiommata blackwalli	1	Unlikely Potential	Not listed	Mostly found around Perth suburbs (Main 1964). Current known distribution is just under 10,000 km2, but it is expected to be wider than that (ALA, 2022)
Idiommata sp.	2	NA		Likely the above species.
Idiosoma arenaceum	6	Widespread	Not listed	Found widespread within the Geraldton Sandplains and Wheatbelt bioregions from near Yandanooka, Canna, and Geraldton north to Zuytdorp (Rix et al. 2018)
Kwonkan sp.	3	Data Deficient	NA	Unidentified species within the genus.
Missulena granulosa	3	Widespread	NA	Found widespread within the south-west Western Australia region (ALA, 2022).
Synothele `MYG203`	1	Data Deficient	NA	Undescribed molecularly recognised species.
Synothele sp.	1	NA		Juvenile specimens not able to be identified but likely to belong to the above species, or to one of the described species.
Teyl luculentus	2	Widespread	Not listed	Found widespread throughout the Geraldton Sandplains and south-west Western Australia (ALA, 2022).
Teyl sp.	3	NA		Likely to be the above species.
Theraphosidae sp.	1	Data Deficient	NA	Unidentified tarantula species.
Scorpiones				
Cercophonius granulosus	2	Widespread	Not listed	Found in west Western Australia (Learmonth-Exmouth gulf, Moonyoonooka, Geraldton, Drummonds Cove, Kalbarri, and Mt. Yokine; Acosta 1990).
Cercophonius michaelseni	2	Widespread	Not listed	Found throughout south-west Western Australia (Acosta 1990).

Lowest Identification	Count	SRE Status	Listed Species	Comments
Cercophonius sp.	2	NA		Likely to be one of the above species.
Isometroides `vescus`	5	Widespread	Not listed	Likely to be a species complex with many unrecognised species.
Lychas `austroccidentalis group`	1	Data Deficient	NA	Undescribed species likely to be composed of several undescribed species.
Lychas `subsplendens`	1	Data Deficient	NA	Undescribed species likely to be composed of several undescribed species.
Lychas `splendens`	4	Data Deficient	NA	Undescribed species likely to be composed of several undescribed species.
Lychas sp.	13	NA		Likely to be one of the above species.
Urodacus `armatus`	45	Widespread	Not listed	The species is likely composed of several undescribed species; however, they are not expected to have restricted distributions
Urodacus hartmeyeri	8	Widespread	Not listed	From Northwest Cape to Hamel (Koch 1977)
Urodacus hoplurus	2	Widespread	Not listed	
Urodacus sp.	5	NA		Likely one of the above species
Opiliones				
Megalopsalis `sp. indet.`	1	Data Deficient	NA	Morphologically distinct undescribed species.
Diplopoda				
Antichiropus `DIP073, chilimony`	9	Likely Potential	Not listed	The genus *Antichiropus* is considered to have many species with restricted distributions (Car & Harvey, 2014). Although the species here recorded are undescribed, it is likely their distributions will be restricted as is typical for the genus.
Antichiropus `DIP081, geraldton1`	4	Likely Potential		
Antichiropus `DIP089, ICS7`	1	Likely Potential		
Antichiropus `DIP104, kalbarri`	6	Likely Potential		
Antichiropus `DIP109, MU1`	1	Likely Potential		
Antichiropus `DIP116, OR1`	2	Likely Potential		
Antichiropus `DIP149, K1`	1	Likely Potential		
Antichiropus sp.	5	NA		Likely one of the above species
Pseudoscorpiones				
Austrochthonius `PSE192, lesueuri`	4	Data Deficient	NA	Undescribed species not expected to have a restricted distribution.
Beierolpium `sp. 8/4`	2	Unlikely Potential	NA	The `*Beierolpium* 8/4` group is widespread within the Pilbara and Southwest regions, and thus it is not expected the undescribed species will represent an SRE.
Synsphyronus `PSE207, kalbarri`	18	Data Deficient	NA	Morphologically distinct undescribed species.
Synsphyronus sp.	2	NA		Likely to belong to the above, or already described species.
Austrohorus sp.	1	Data Deficient		Unidentified species within the genus.
Scolopendrida				
Chilopoda				
Thereuopoda lesueurii	1	Widespread	Not listed	
Cormocephalus aurantiipes	1	Widespread	Not listed	
Cormocephalus turneri	4	Widespread	Not listed	
Ethmostigmus rubripes	10	Widespread	Not listed	
Scolopendra laeta	11	Widespread	Not listed	
Scolopendra morsitans	12	Widespread	Not listed	

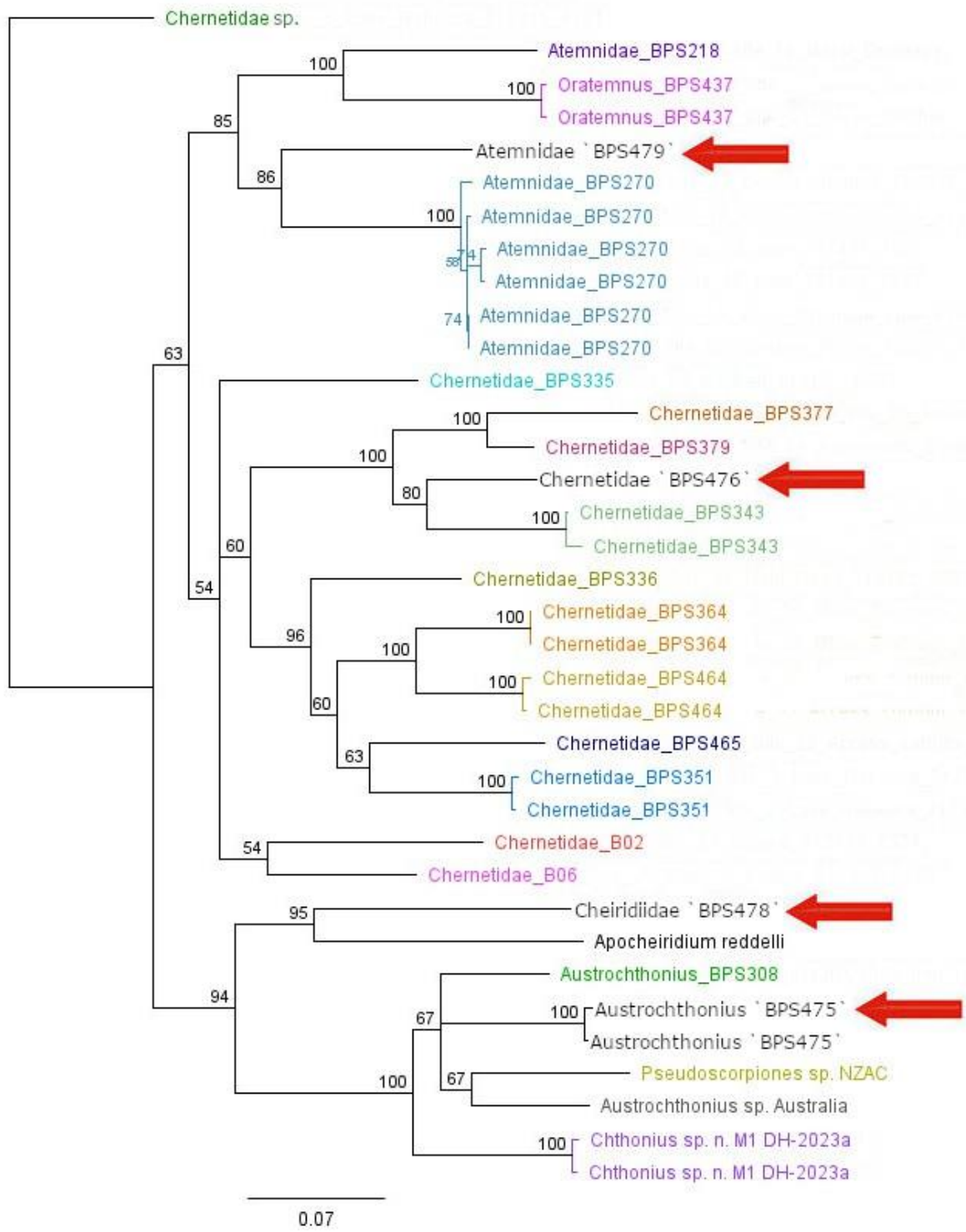
Lowest Identification	Count	SRE Status	Listed Species	Comments
Isopoda				
Buddelundia sp.	1	Data Deficient	NA	Unidentified species. Some species within the genus have restricted distributions.
Spherillo sp.	1	Data Deficient	NA	Unidentified species. Some species within the genus have restricted distributions.
Gastropoda				
Bothriembryon grohi	10	Likely Potential	Not listed	Known from a small area bordered by the Murchison River (Morrison and Schneider 2022).
Bothriembryon wagoeensis	4	Likely Potential	Not listed	Currently only known from a small undisturbed shrub area east of George Grey Drive (Morrison and Schneider 2022).
Bothriembryon whitleyi	8	Extinct	Extinct	Species records found at WAM database correspond to old collection records within the Geraldton area. The species is now presumed extinct under the Biodiversity Conservation Act 2016 (Schedule 4 of the Wildlife Conservation [Specially Protected Fauna] Notice 2018).
Bothriembryon sp.	52	NA		Unidentified species likely to be any of the above.
Pleuroxia abstans	11	Unlikely Potential	Not listed	Linear range for the species is approximately 589 km (ALA 2022), making it unlikely to have a restricted distribution of less than 10,000 km2
Insecta				
Hylaeus sp.	17	Data Deficient	NA	Unidentified species. Some species might have restricted distributions.
Brachyhesma grossopedalis	2	Unlikely Potential	NA	Linear range approximately 60 km. Unlikely the species is restricted.
Leioproctus pachyodontus	12	Unlikely Potential	NA	Most records come from Yallingup but has also been recorded from Geraldton and Hamersley Range (Maynard 1977).
Neopasiphae simplicior	1	Confirmed SRE	Critically Endangered	Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

APPENDIX 2. RECONSTRUCTED PHYLOGENETIC TREES AFTER MOLECULAR SEQUENCING OF SRE SPECIES COLLECTED AT THE BALLINE GARNET PROJECT AREA

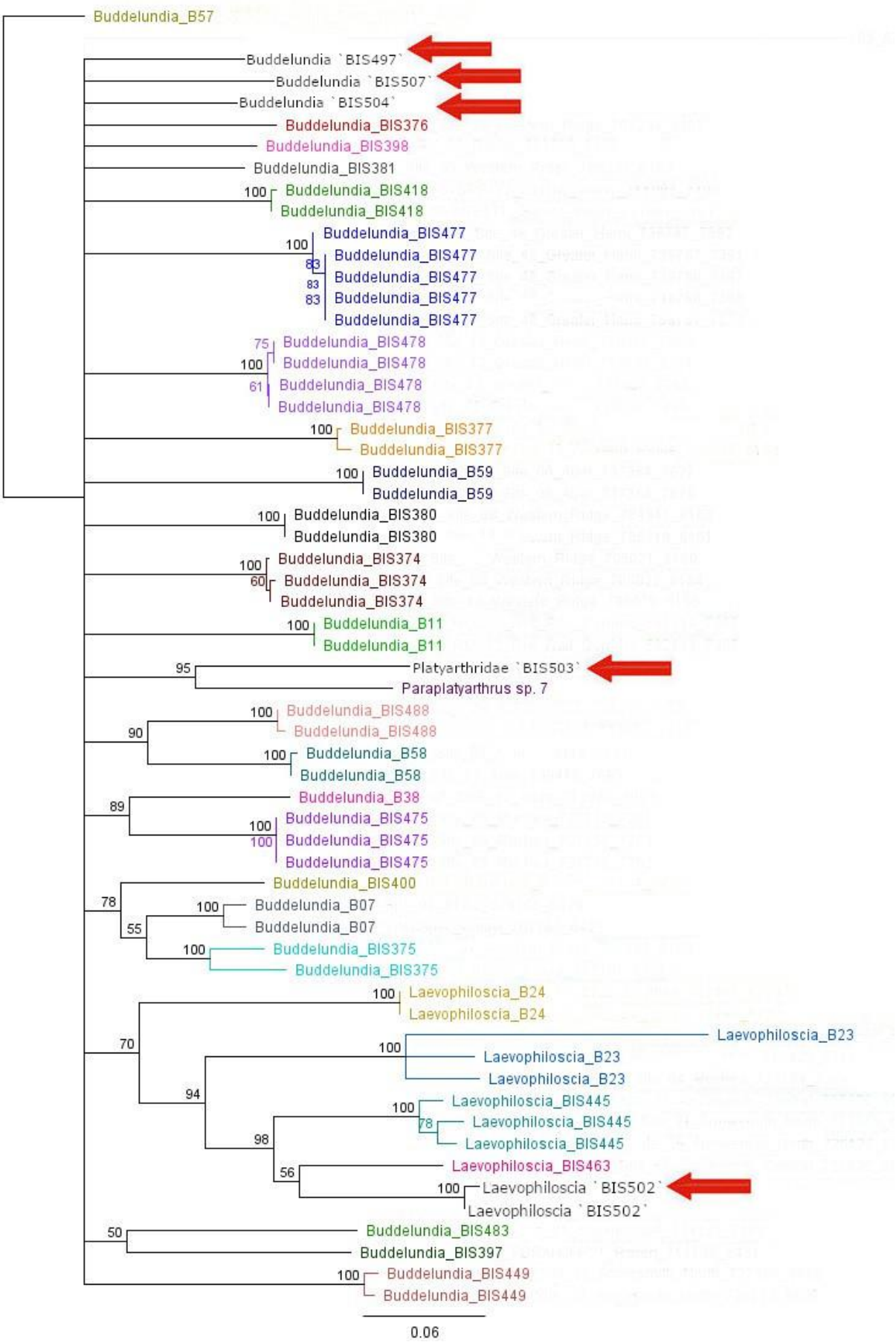
2a. Mygalomorph spider (Anamidae) phylogenetic tree.



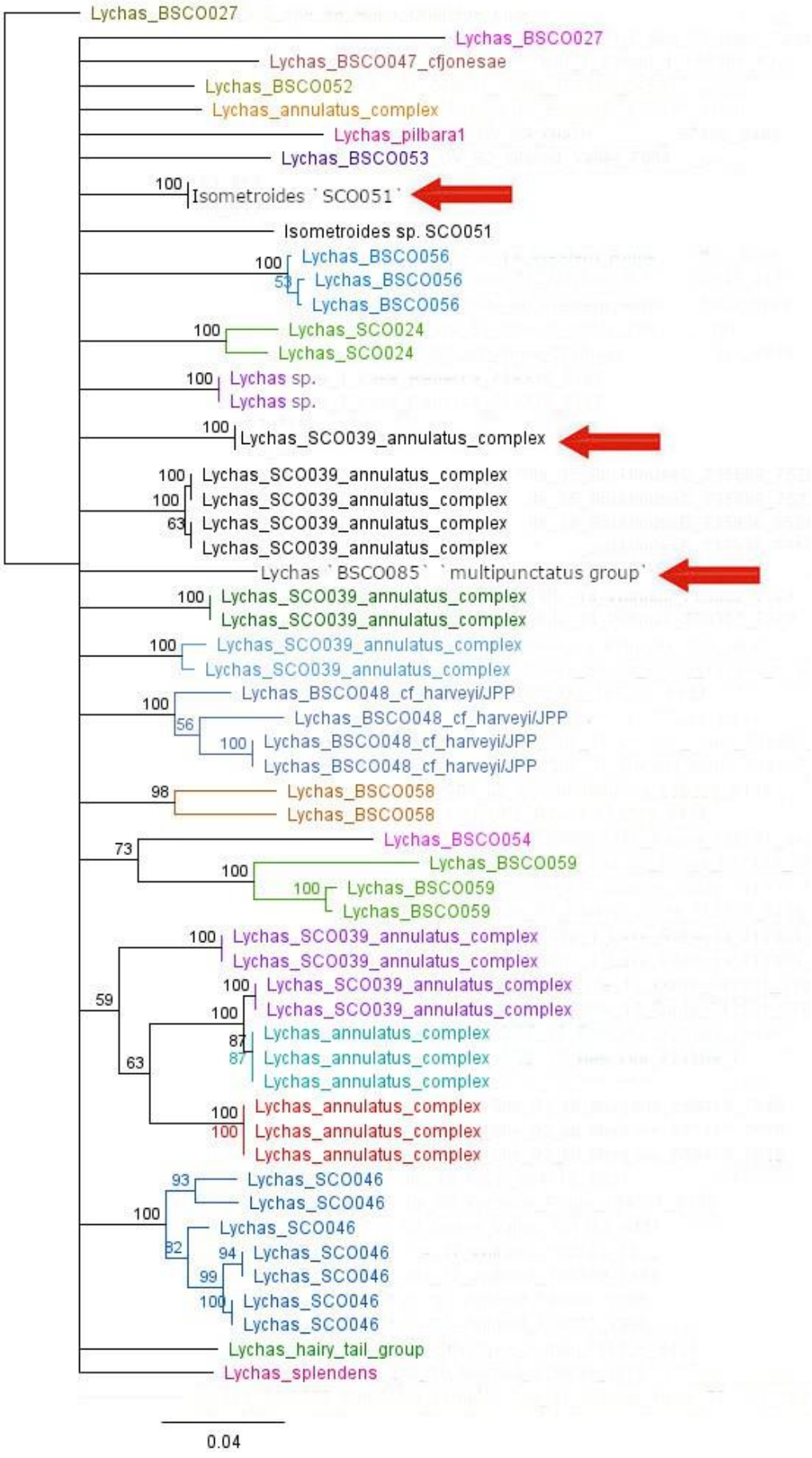
2b. Pseudoscorpion phylogenetic tree.



2c. Slaters phylogenetic tree.



2d. Scorpions phylogenetic tree.



Appendix 3. Sampling site details for the Balline Garnet Project SRE Survey.

Site Code	Sampling method	Latitude	Longitude	Targeted Habitat	Soil Type
01	Trapping	-27.9926	114.1706	Sandplain	Loamy Sand
02	Trapping	-28.0002	114.1761	Hillslope	Loamy Sand
03	Trapping	-27.9659	114.1727	Hillslope	Sand
04	Trapping	-28.0259	114.1862	Hillslope	Loamy Sand
05	Trapping	-28.0339	114.1854	Hillslope	Loamy Sand
06	Trapping	-28.0539	114.19	Open woodland	Sand
07	Trapping	-28.019	114.1876	Sandplain	Loamy Sand
08	Trapping	-27.9549	114.1535	Open woodland	Clay Loam
09	Trapping	-27.9593	114.1606	Hillslope (low)	Loamy Sand
10	Trapping	-27.9984	114.1858	Open woodland	Loamy Sand
11	Habitat	-28.0275	114.1895	Hillslope	Loamy Sand
12	Habitat	-28.0427	114.1788	Open woodland	Sand
13	Habitat	-27.9946	114.183	Sand dune	Loamy Sand
14	Habitat	-28.002	114.1751	Hillslope	Loamy Sand
15	Habitat	-28.014	114.1734	Hillslope (low)	Loamy Sand
16	Habitat	-27.9661	114.1567	Sandplain	Clayey Sand
17	Habitat	-27.9772	114.1609	Sand dune	Clayey Sand
18	Habitat	-28.0408	114.1963	Minor drainage line	Sand
19	Habitat	-28.0474	114.1826	Sand dune	Loamy Sand
20	Habitat	-28.0122	114.1938	Sand dune	Loamy Sand

Appendix 4. Photographs of SRE collection sites at the Balline Garnet Project

Site 01



Site 01



Site 02



Site 02



Site 03



Site 03



Site 04



Site 04



Site 05



Site 05



Site 06



Site 06



Site 07



Site 07



Site 08



Site 08



Site 09



Site 09



Site 10



Site 10



Site 11



Site 11



Site 12



Site 12



Site 13



Site 13



Site 14



Site 14



Site 15



Site 15



Site 16



Site 16



Site 17



Site 17



Site 18



Site 18



Site 19



Site 19



Site 20



Site 20



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30 June 2024

Chief Executive officer
Department of Water and Environmental Regulation
Prime House, 8 Davidson Terrace
JOONDALUP WA 6027

RE: Lucky Bay Garnet Project – Annual Report for Clearing Permit 3891-5 for the 2023/2024 Reporting Period

Australian Garnet Pty Ltd (AGPL) operates the Lucky Bay Garnet Project (previously referred to as Balline), a heavy mineral sands deposit located at the southern margin of the Carnarvon Basin, approximately 40 km south of Kalbarri and 540 km north of Perth, in the Shire of Northampton.

The Purpose Permit was granted under Section 51E of the *Environmental Protection Act 1986* (EP Act) and is valid from 25 December 2010 to 31 December 2025 for the clearing of up to 90 ha of native vegetation within a 143.2 ha application area for the purpose of Mineral Production and Associated Activities on Mining Lease 70/1280 and Miscellaneous Lease 70/134, as amended.

Condition 9(a) of the permit specifies a report is to be submitted to the Chief Executive Officer of the Department of Mines, Industry Regulation and Safety (DMIRS) or an Officer with delegated authority under Section 20 of the EP Act, on or before 31 July each year for the life of the permit, demonstrating adherence to all conditions of the permit and setting out the records required under the permit conditions in relation to clearing carried out between 1 July to 30 June of the preceding financial year.

This report satisfies the requirements of Condition 9(a). Compliance to the conditions stipulated in clearing permit CPS 3891-5 are demonstrated in Table 1. Compliance is classified as 'Compliant (C)', 'Non-Compliant" (NC) or Not Required (NR) for the current reporting period.

Yours sincerely,

Marcius Brown
Registered Manager
Lucky Bay Garnet Mine
Australian Garnet PTY LTD

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Table 1: Compliance to CPS 3891-5 Permit Conditions

Condition Number	Condition	Compliance Status
1	**Land of which clearing is to be done:** Mining Lease 70/1280 Miscellaneous Lease 70/134	C
2	**Clearing authorised (purpose):** The permit holder is authorised to clear native vegetation for the purpose of mineral production and associated activities.	C
3	**Area of clearing:** The permit holder must not clear more than 90 hectares of native vegetation within the area cross-hatched yellow in Figure 1 of Schedule 1.	C
4	**Direction of Clearing** The Permit Holder must conduct clearing activities in a slow, progressive manner into one direction to allow fauna to move into adjacent native vegetation ahead of the clearing activity.	C
5	**Avoid, minimise and reduce the impacts and extent of clearing:** In determining the amount of native vegetation to be cleared authorised under this Permit, the Permit Holder must apply the following principles, set out in order of preference:	C
5a	Avoid the clearing of native vegetation;	C
5b	Minimise the amount of native vegetation to be cleared; and	C
5c	Reduce the impact of clearing on any environmental value.	C
6	**Weed control:** When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of weeds:	C
6a	Clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;	C
6b	Ensure that no weed-affected soil, mulch, fill or other material is brought into the area to be cleared; and	C
6c	Restrict the movement of machines and other vehicles to the limits of the areas to be cleared.	C
7	**Erosion management** The Permit Holder must implement and adhere to the document titled "Balline Garnet Project Dust Management Plan" (Document No: 96.1.4-0000-G-PLN-002, dated 22 October 2020), as retained on Department of Mines, Industry Regulation and Safety File No. A1501/201001 as Doc ID 7811019, or future versions as approved by the CEO.	C
8	**Records to be Kept:** The permit holder must maintain records relating to the listed relevant matters in accordance with the specifications detailed in Table 1 of the permit (see table 2 of this document).	C
9	**Reporting**	
9a	The Permit Holder shall provide a report to the CEO by 31 July each year for the life of this Permit, demonstrating adherence to all conditions of this Permit, and setting out the records required under condition 8 of this Permit in relation to clearing carried out between 1 July and 30 June of the previous financial year.	C

9b	If no clearing authorised under this Permit was undertaken between 1 July and 30 June of the previous financial year, a written report confirming that no clearing under this permit has been carried out, must be provided to the CEO by 31 July of each year.	NR
9c	Prior to 31 December 2025, the Permit Holder must provide to the CEO a written report of records required under condition 8 of this Permit where these records have not already been provided under condition 9(a) or 9(b) of this Permit.	NR

Table 2: Records that must be kept

Relevant Matter	Specifications	Compliance Status
8) In relation to the authorised clearing activities generally, the following records must be kept:	(a) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings;	C
	(b) the date that the area was cleared;	C
	(c) the size of the area cleared (in hectares);	C
	(d) actions taken to avoid, minimise, and reduce the impacts and extent of clearing in accordance with condition 5;	C
	(e) actions taken to minimise the risk of the introduction and spread of weeds in accordance with condition 6;	C
	(g) actions undertaken in accordance with condition 7;	C

Activities Undertaken During the Reporting Period

During the reporting period, 4.6 ha of native vegetation clearing occurred within the purpose permit clearing area (Table 3) for the relocation of a services corridor and access to site communications aerial. The purpose permit area and areas of clearing are shown in Figure 2.

Table 3: Clearing of native vegetation within the purpose permit area

Purpose of clearing	Area of native vegetation clearing (ha)
Mining Lease 70/1280	4.60
Miscellaneous Lease 70/134	0
Total 'new' native vegetation clearing reported	**4.60**
Total previous native vegetation clearing reported	**7.45**
Permitted native vegetation clearing area	**90**
Remaining area of native vegetation clearing permitted	**77.95**

Summary of Compliance

During the reporting period AGPL were compliant with all conditions of the permit.

Activities Planned for the Next Reporting Period

AGPL intend to engage in further authorised clearing of native vegetation stipulated within CPS 3891-5 permitted areas during the next reporting period (1 July 2024 – 30 June 2025) for the progression of the mine in alignment with Mining Proposal Reg ID 102886. Clearing and ground disturbance activities will be undertaken in adherence to the conditional requirements of this Permit. AGPL will maintain and provide records of adherence required under Condition 8 of the permit.

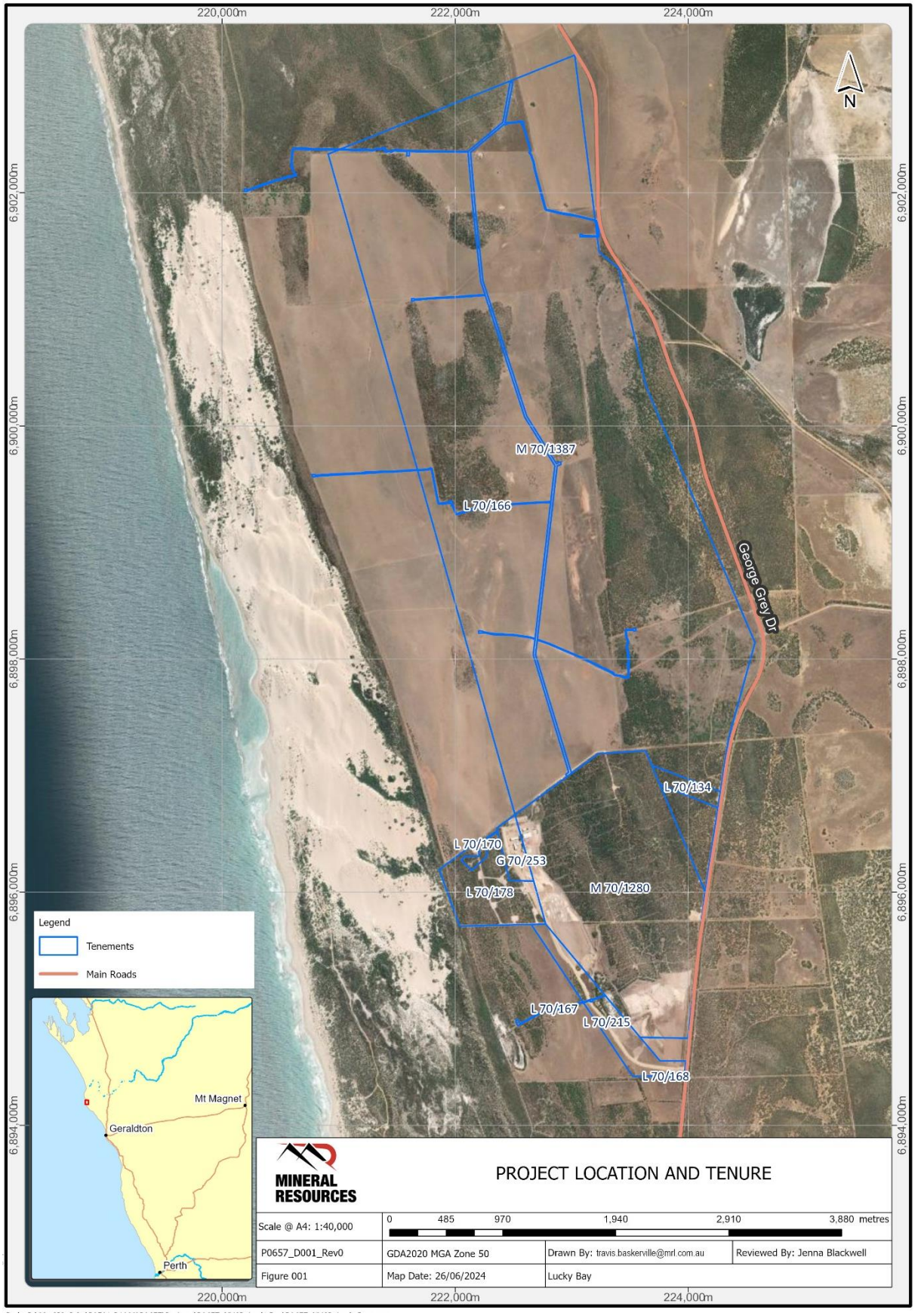


Figure 1: Project location and tenure

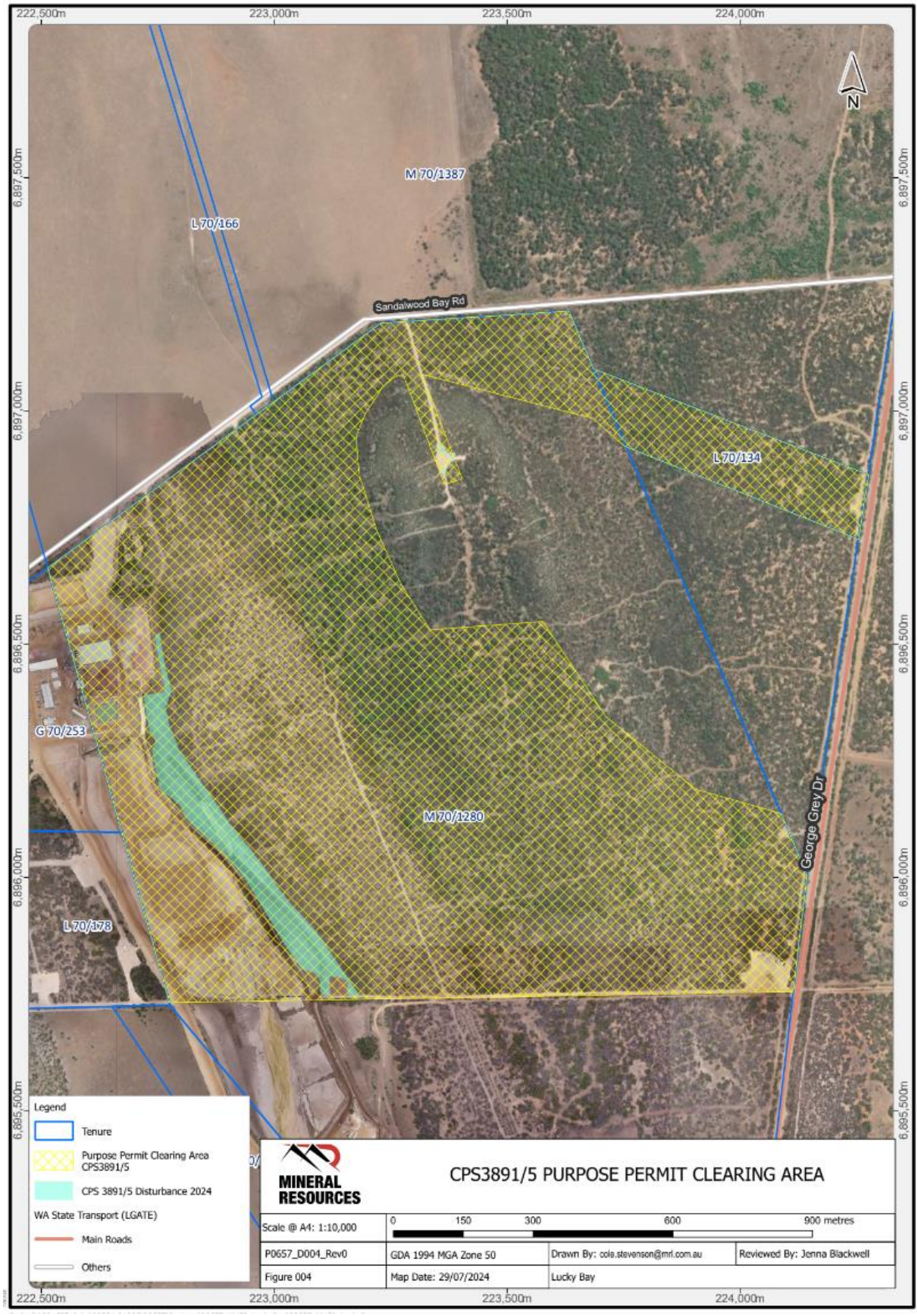


Figure 2: Permit Clearing Area and Clearing Undertaken in Reporting Period