Karara Project Expansion

Detailed and Targeted Flora and Vegetation Assessment

KARARA MINING LIMITED

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Karara Project Expansion: Detailed and Targeted Flora and Vegetation Assessment

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Cover Photograph: *Rhodanthe collina* (P3) in the Karara Proposed Expansion Study Area (Woodman Environmental 2020)

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DISCLAIMER

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EXECUTIVE SUMMARY

Karara Mining Ltd (KML) operate the Karara Project mine, located at Karara, approximately 200 km east of Geraldton in the Midwest region of Western Australia. KML are planning a future expansion of the mining operation adjacent to the original study area (as specified in Woodman Environmental 2008c) which was investigated for the environmental impact assessment (EIA) of the Karara Iron Ore Project. While significant contextual information is available for the proposed expansion areas (the Study Area), additional data is required to provide adequate information to inform EIA for the proposed expansion.

KML commissioned Woodman Environmental Consulting Pty Ltd (Woodman) (now Umwelt (Australia) Pty Ltd (Umwelt)) to undertake a detailed and targeted flora and vegetation assessment of the proposed expansion areas, including updating taxonomy and current datasets to a standard suitable to support EIA.

The flora and vegetation component of the survey of the Study Area involved a Desktop Study, followed by a Detailed Survey and Targeted Survey as defined by appropriate guidance (*Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b)). All field surveys were undertaken during late winter/early spring in 2020. A total of 54 non-permanent flora survey quadrats were established and five existing quadrats surveyed within the Study Area during the current 2020 survey. Targeted survey for significant flora taxa and vegetation was undertaken for over the Proposed Expansion Footprints (the Footprint), with some survey undertaken in appropriate habitat outside of the Footprint.

A total of 271 discrete vascular flora taxa (including 10 introduced taxa) were recorded during the current 2020 survey within the Study Area. The taxa represent 54 families and 137 genera. A total of 526 discrete vascular flora taxa (including 32 introduced taxa), one known hybrid and three putative hybrids were recorded in the Study Area during the current 2020 survey and relevant previous surveys within the Study Area. The taxa and hybrids represent 65 families and 222 genera. The most well-represented families were Asteraceae (80 taxa), Fabaceae (63 taxa) and Chenopodiaceae (43 taxa).

A total of 27 significant flora taxa were recorded from the Study Area by the current 2020 survey and relevant previous surveys, including two Threatened taxa and 23 Priority flora taxa, as well as two taxa that are considered significant (as per EPA 2016a) as they represent undescribed or potentially undescribed taxa. A total of 32 introduced flora taxa were recorded from the Study Area by the current 2020 survey and relevant previous surveys, two of which are Declared Pests under the *Biosecurity and Agriculture Management Act* 2007. No Weeds of National Significance have been recorded in the Study Area.

A total of 32 vegetation units (VUs) were defined and mapped in the Study Area based on the results of the floristic classification analysis and subsequent examination of data from 265 quadrats from the Study Area. The VUs represent three broad groups of vegetation based on soils and topography:

- Group 1: *Eucalyptus* woodlands and *Acacia* and/or *Melaleuca* shrublands over mixed chenopods such as *Maireana* and *Sclerolaena* species on stony undulating plains, flat outwash and depression areas with no exposed bedrock (VUs 1 to 18);
- Group 2: *Acacia* shrublands with emergent *Eucalyptus* spp. over mixed shrubs including *Eremophila* and *Philotheca* species on rocky BIF or other substrates on lower slopes to crests and breakaways (VUs 19 to 28); and
- Group 3: *Acacia* shrublands with emergent *Eucalyptus* spp. over mixed shrubs including *Aluta aspera* subsp. *hesperia* on gravelly and stony undulating plains and slopes (VUs 29 to 32).

One listed significant vegetation entity is considered to occur in the Study Area, being the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) Priority Ecological Community (PEC) (P1). This PEC is considered to be represented by polygons of VUs 16, 19, 20, 21, 22, 24, 25, 26, 27 and 28 (where these VUs occur on BIF on crests and slopes that are higher in the landscape on restricted landforms; this primarily encompasses the crests and upper to lower slopes of Mount Karara, Blue Hills and Mungada Ridge in the central area of the Study Area). A total of 2,085.7ha (comprising 10.2 % of the total area of the Study Area) of the PEC was mapped by the current survey.

A total of 18 VUs are considered to be of local significance for reasons other than formal listing, due to their restricted occurrence in the Study Area (less than 1 % of the total area of the Study Area, or less than 2 % of the total area of the Study Area and are associated with restricted landform types). Of these, VUs 7, 9, 11, 12 and 15 occur on restricted landforms, being drainage depressions, saline claypans or granite outcrops. Of the locally significant VUs, nine VUs are also considered to be potentially significant vegetation in a regional context for reasons other than formal listing. This has been inferred from the results of floristic analysis with the Regional Mapping Survey dataset whereby quadrats from the current analysis showed similarity to those that represent regionally restricted regional FCTs. In addition, VU 9 potentially represents an occurrence of a lignum swamp.

Four VUs (VUs 7, 9, 11 and 15) and one additional area mapped in the Study Area contain riparian vegetation associated with ephemeral wetlands, claypans or drainage depressions. It is unlikely that any of the VUs mapped in the Study Area are groundwater dependent; however, information on the groundwater dependency of taxa recorded in the Study Area as well as depth to groundwater information is required to confirm this.

The majority of the Study Area (92.0 % of the Study Area; 99.64% of the mapped vegetation of the Study Area) was considered to be in 'Excellent' condition. Introduced flora taxa were often present, however were not serious weeds and/or were present at low levels. While historical disturbance from mining activities and historical grazing (ex-pastoral station) was present in many areas, this generally has not significantly affected the overall condition of the vegetation. One small area of VU 17 in the far western extent of the Study Area was mapped as 'Good'; this area displayed evidence of historic disturbance and grazing, leading to reduced diversity and abundance of native taxa and high levels of weeds. A total of 7.7% of the Study Area has been cleared or otherwise rehabilitated.

1. INTRODUCTION

1.1 Project Overview

Karara Mining Ltd (KML) operate the Karara Project mine, located at Karara, approximately 200 km east of Geraldton in the Midwest region of Western Australia (Figure 1). The mine includes a large open-cut magnetite pit, a processing plant to produce magnetite concentrate and all associated infrastructure, as well as hematite pits and associated infrastructure at surrounding deposits. KML are planning a future expansion of the mining operation as per Figure 1. These expansion areas are located adjacent to the original study area investigated for the environmental impact assessment (EIA) of the Karara Iron Ore Project between 2005 and 2008 (Woodman Environmental 2008c). The expansion areas lie within the regional vegetation assessment study area previously mapped by Woodman Environmental Consulting Pty Ltd (Woodman Environmental) between 2009 and 2012 (Woodman Environmental 2012b).

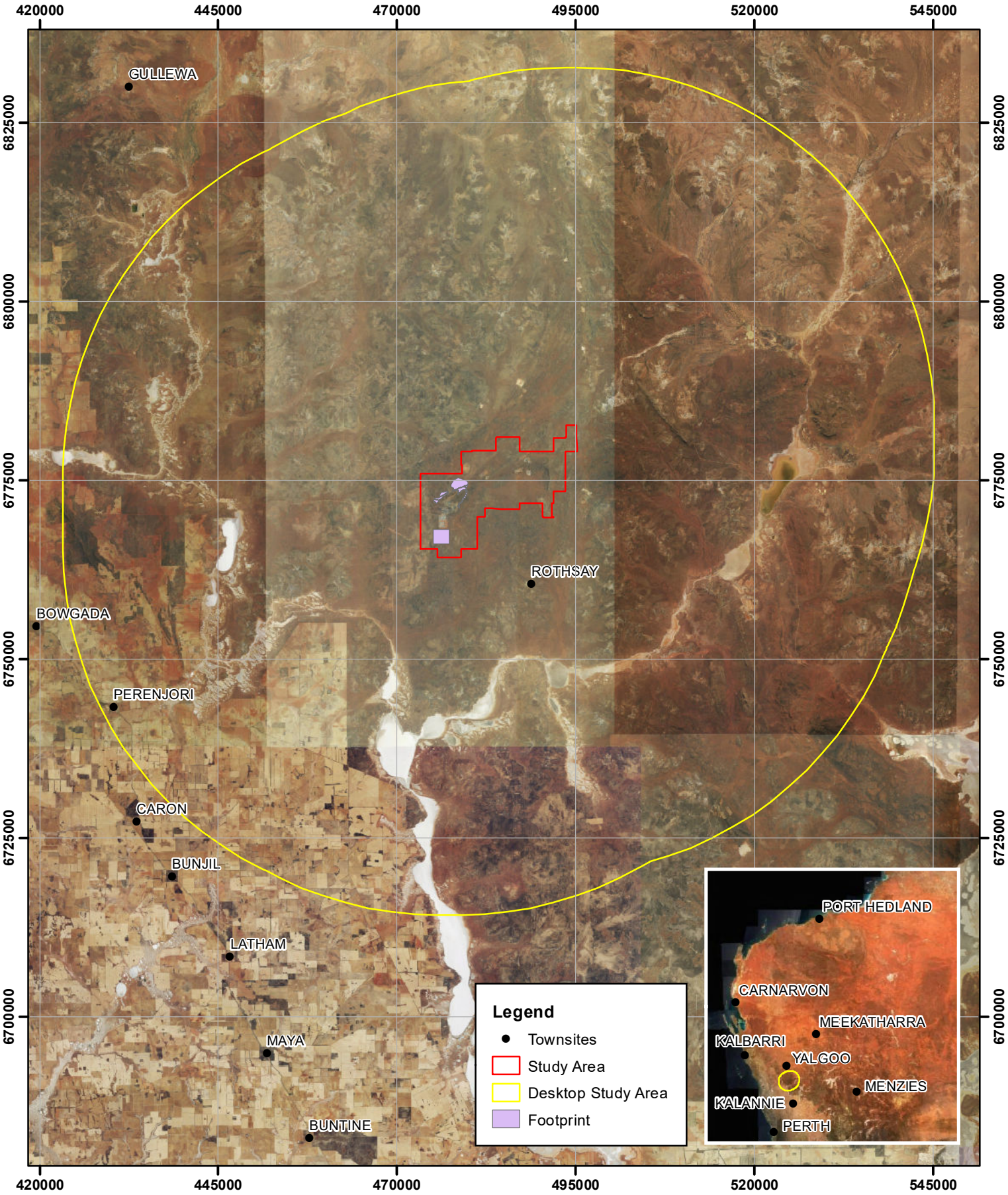
A desktop review by Woodman Environmental (Woodman Environmental 2020) of all available data against current Western Australian Environmental Protection Agency (EPA) requirements established that the age of existing data is now beyond what the EPA will accept in support of an EIA under the *Environmental Protection Act 1986* (EP Act). In addition, changes to EPA survey and reporting standards were introduced in 2016 that require the information in these historical reports to be updated in line with new technical guidance for flora and vegetation surveys for EIA (EPA 2016b). Changes have also occurred with respect to plant taxonomy and conservation status for many taxa since these studies were last reviewed and further revision is required to reflect these changes.

Therefore, while significant contextual information is available for the proposed expansion areas at Karara from regional mapping completed as part of the original environmental approval for the Karara mine, additional data needs to be collected to provide adequate and updated information to inform EIA for the proposed expansion.

KML commissioned Woodman Environmental (now Umwelt Australia) to undertake a detailed and targeted flora and vegetation assessment of the proposed expansion areas, including updating taxonomy and current datasets to a standard suitable to support EIA under the EP Act (the Project).

1.2 Study Area, Footprint and Desktop Study Area Definition

For the purposes of flora and vegetation assessment, the Project Study Area (the Study Area) has been defined, as shown on Figure 1. The Study Area is approximately 20,473 hectares (ha) in size. Additionally, KML has provided Proposed Expansion Footprints (the Footprint) which has an area of approximately 922ha. In the context of the flora and vegetation assessment, the Footprint was the area of focus for targeted survey for significant flora and vegetation (Figure 1). For the purposes of elements of the desktop study for the Project, including interrogation of databases and searches of relevant literature, a Desktop Study Area has also been defined; this encompasses the Study Area with a 50 km buffer, as shown on Figure 1.



Footprint, Study Area and Desktop Study Area Location	Author: Marlee Starcevich	N
	WEC Ref: KML20-33-01	
umwelt	Filename: KML20-33-01-f01	**Figure**
	Scale: 1:700,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report KML20-33-01.	Revision: A - 30 August 2021	

1.3 Aim and Objectives

The aim of the survey is to provide relevant flora and vegetation information to support the EIA process and subsequent approvals for the Project under the *Environmental Protection Act 1986* and associated legislation.

The overall objectives of the assessment were to:

- Review and consolidate findings of previous flora and vegetation assessments conducted within the Study Area, including by:
    - Updating the taxonomy of previous quadrats and reporting to current nomenclature;
    - Revisiting a selection of previous quadrats to verify vegetation mapping data collected is still current; and
    - Reassessing previous quadrats located within the Study Area that were surveyed out of season in the appropriate season;
- Compile an inventory of vascular flora taxa that occur within the Study Area;
- Search for and census populations of the following taxa (hereafter referred to as significant flora taxa) within the Footprint, as well as opportunistically within the wider Study Area to provide context for EIA:
    - Listed Threatened Species (T) under the *Environment Protection and Biodiversity Conservation* Act *1999* (EPBC Act) (Commonwealth);
    - Threatened Flora (T) under the *Biodiversity Conservation Act 2016* (BC Act) (WA);
    - Priority Flora taxa as classified by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA); and
    - Other significant flora taxa as defined by the EPA (2016a, b).
- Identify locations and determine the extent of introduced vascular flora taxa, with particular focus on those that are Weeds of National Significance (WoNS), or Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act);
- Identify, map and describe Vegetation Units (VUs) that occur within the Study Area;
- Identify, map and describe vegetation that occurs within the Study Area that is one of the following (hereafter referred to as significant vegetation), to provide context for EIA:
    - Threatened Ecological Communities (TECs) under the EPBC Act;
    - TECs under the BC Act;
    - Priority Ecological Communities (PECs) as classified by DBCA;
    - Other significant vegetation as defined by EPA (2016a, b); and
    - Wetland or riparian vegetation that is ground or surface water-dependent; and
- Describe and map vegetation condition within the Study Area as per the vegetation condition scale presented in EPA (2016b).

The survey and reporting works comply with the following documents:

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

1.4 Level of Assessment

The flora and vegetation assessment of the Study Area involved a Targeted Survey and Detailed Survey as defined in Sections 4.2 and 4.3 of the '*Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment*' (EPA 2016b). This is considered appropriate for the Study Area, as it is likely to support a high diversity of flora and vegetation, may comprise restricted landforms or vegetation units, and is likely to support significant flora or vegetation.

Due to the level of existing information available on the flora and vegetation of the Study Area, a reconnaissance survey prior to the detailed survey was not considered necessary. This survey builds on previous work conducted to inform the EIA process for the Project, with flora and vegetation assessments that considered much of the Study Area being conducted between 2005 to 2012 (Woodman Environmental 2008c, 2012b).

2. BACKGROUND

2.1 Climate

The Study Area is located within the Yalgoo subregion of the Murchison region in the Eremaean Province of Western Australia (Beard 1990). The Yalgoo subregion is characterised by a semi-desert Mediterranean climate with an average annual precipitation of 225–300 mm. Figure 2 displays monthly precipitation totals and average maximum temperature for the months preceding the commencement of the 2020 field survey (January–July 2020). Also presented on Figure 2 is long-term average monthly maximum temperature (1997–2020) and average monthly precipitation (1928–2020). All temperature data presented was recorded at Morawa Airport (station number 8296) and all precipitation data was recorded at Karara (station 10195), the nearest meteorological stations to the Study Area with long term temperature and rainfall data (BoM 2020).

Long-term monthly maximum temperature data from Morawa Airport reveals that temperatures typically peak in January (37.4 °C) and February (36.8 °C) (BoM 2020; Figure 2). Long-term average monthly rainfall data from Karara indicates that rainfall typically peaks from May to August (average of 157.5 mm received during this period) (BoM 2020; Figure 2), with this period being considered the most relevant in terms of promoting plant growth and flowering in the Midwest region.

Rainfall received at Karara from January to August 2020 was below the long-term average (192.1 mm compared to the long-term average for this period of 248.8 mm), with all months recording below-average rainfall except for February, which received 59.1 mm compared to the long-term average of 23.6 mm (BoM 2020; Figure 2). Average monthly maximum temperatures for 2020 were relatively consistent with the long-term monthly averages. The greatest deviations from the long-term averages were seen in June and July 2020 (2.3 °C and 2.2 °C greater than the long-term average, respectively) (BoM 2020; Figure 2).

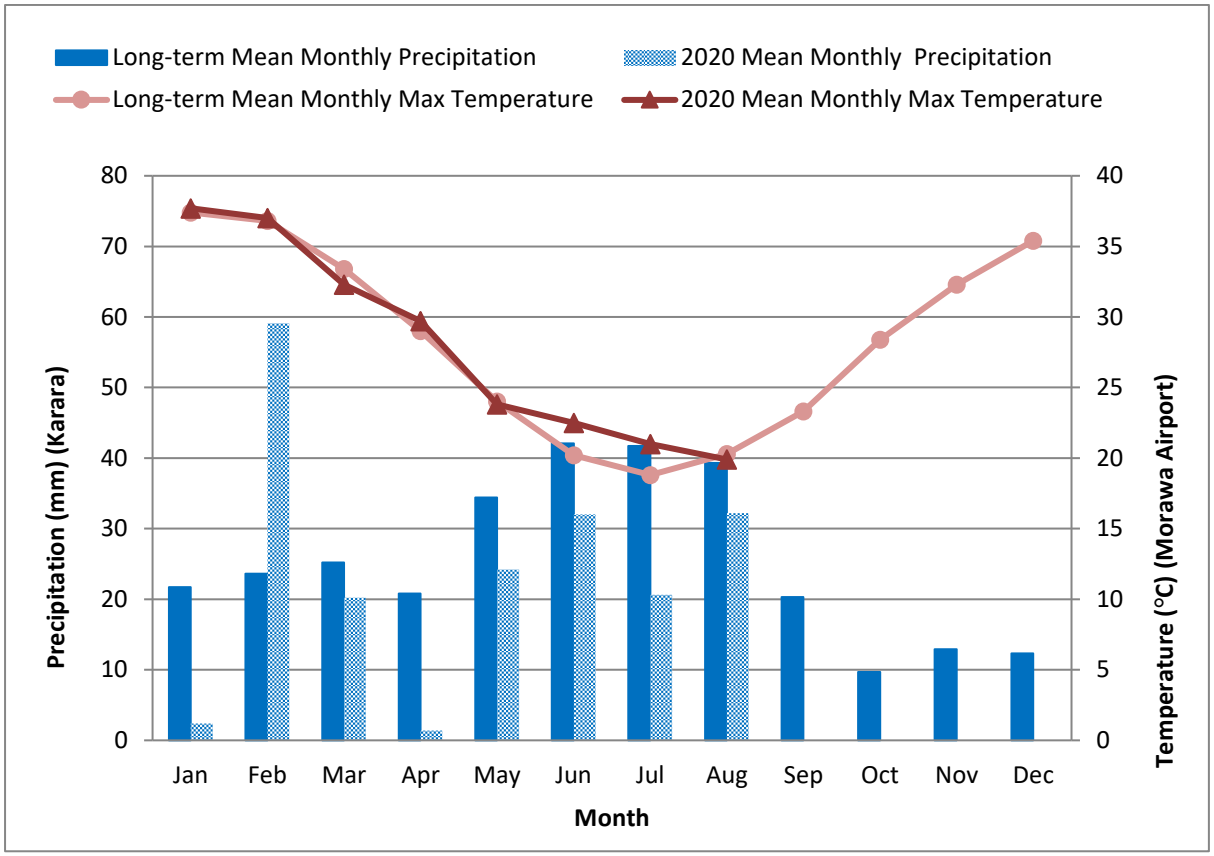


Figure 2: **Mean Monthly Maximum Temperature and Precipitation for January–August 2020, and Long-term Mean Monthly Maximum Temperature and Precipitation for Morawa Airport (Temperature) and Karara (Precipitation) (BoM 2020)**

2.2 Geology, Landforms and Soils

The Study Area is located within the Murchison Bioregion (Austin Botanical District), which consists of undulating topography, with occasional ranges of low hills and extensive sandplains within the eastern half of the region. Principal soils include shallow, earthy loam overlying red-brown hardpan, with shallow stony loams on hills and read earthy sands on sand plains. The geology of the region is that of Archaean granite with infolded volcanics and meta-sediments (greenstones) of like age, forming the Yilgarn Block (Beard 1990).

Beard (1990) denoted the south western portion of this bioregion (where the Study Area is situated) the Yalgoo subregion, which is equivalent to the Yalgoo Interim Biogeographic Regionalisation for Australia (IBRA) bioregion (Commonwealth of Australia 2012). The Yalgoo subregion is described as undulating and moderately dissected with low ranges of hills and small remnants of sandplains (Beard 1990).

Beard (1990) described seven principal soil units of the Yalgoo subregion; being:

- Shallow loams on hilly areas with rock outcrops;
- Sandplain and sandy upland soils comprising acidic yellow earths containing ironstone and overlying hardpan; shallow yellow earthy sands; and ironstone gravelly forms of these, in association with shallow red earthy sands and shallow red earths;
- Shallow earthy loams and red earths overlying red-brown hardpan on topography from ranges to plains;
- Neutral and acid red earths over hardpan on plains and flanking slopes;
- Shallow acid or neutral red earths either with shallow earthy loams in intimate microassociation overlying hardpan on plains with surface gravel;
- Alkaline, neutral and acid red earths on plains with extensive playa lakes and flanking dunes; and
- Saline soils of valleys and salt lakes.

The Study Area occurs within the Warriedar Fold Belt, which is a series of low undulating hills of Archaean greenstone composed of banded ironstone formation (BIF) and basalts. Greenstone belts consist of metamorphosed volcanic rocks, including mafic rocks such as basalt and gabbro, associated with sedimentary rocks, such as BIF, and are generally expressed at the surface as a series of ranges or hills. The Warriedar Fold Belt includes the larger area of the Blue Hills, Gnows Nest Range, Bullajungadeah Hills, Pinyalling Hill and the unnamed hills in the southwest surrounding Mount Mulgine and the abandoned town of Rothsay (Lipple *et al.* 1983, in Meissner and Coppen 2014).

2.3 Land Tenure

The Study Area is located within the Shire of Perenjori on Unallocated Crown Land (UCL) (LR384/824; former Karara pastoral lease), which is currently proposed for conservation. The tenure of the Study Area includes the following licences and leases:

- Mining leases M59/595-1, M59/596-1 (Sinosteel Midwest Corporation Ltd), M59/644-1, M59/645-1, M59/721-1, M59/730 (KML); M59/649-1 (DSO Ventures Pty Ltd),
- Exploration licences E59/817-1, E59/1690/1 (KML), E59/1068-1 (DSO Ventures), E59/2262, E59/2266 (Minjar Gold Pty Ltd); E59/2319 (Warrigal Mining Pty Ltd); E59/2323 (Jansvoon Resources Pty Ltd (Pending));
- General purpose leases G59/37, G59/38, G59/39, G59/44; G59/46 (KML); and
- Miscellaneous licences L59/62, L59/137, L59/157 (Sinosteel), L59/74, L59/76, L59/77, L59/78, L59/79, L59/90, L59/92, L59/93, L59/98, L59/109, L59/114, L59/115, L59/120, L59/128 (KML).

3. METHODS

3.1 Desktop Study Methods

Prior to commencement of the field survey, a review of all publicly available flora and vegetation data relevant to the Study Area was undertaken. This included obtaining and reviewing copies of reports of previous biological surveys carried out within the vicinity of the Study Area (where available) and interrogation of relevant databases and other sources as listed in Table 1.

Table 1: Searches Undertaken for the Desktop Study of the Study Area

Source	Search Attributes	Search Purpose
DBCA TEC and PEC Database (DBCA 2020a)	Database interrogated using Study Area boundary with a 20 km buffer (larger buffer could not be applied)	Obtain records of DBCA-classified TECs and/or DBCA-classified PECs within the Desktop Study Area
DBCA TEC and PEC lists (DBCA 2018a, 2020c)	Review of current DBCA TEC and PEC lists	Identify whether there are any additional DBCA listed TECs or PECs which could occur within the Desktop Study Area
DBCA Significant Flora Databases (WA Herbarium specimen database and Threatened and Priority Flora (TPFL) database) (DBCA 2020b)	Database interrogated using Desktop Study Area boundary	Obtain records of listed significant flora within the Desktop Study Area
Department of Agriculture, Water and the Environment (DAWE) Species Profile and Threats (SPRAT) Database (interrogated using the Protected Matters Search Tool (DAWE 2020)	Database interrogated using approximate Desktop Study Area boundary (exact boundary cannot be used; coordinates of database search provided in Appendix F). Search performed prior to survey, updated 13th August 2020	Identify Matters of National Environmental Significance (MNES), including Threatened flora and TECs listed under the EPBC Act that occur or have the potential to occur within the Desktop Study Area
DBCA *NatureMap* (WA Herbarium and TPFL records) (DBCA 2007–)	Database interrogated using approximate Desktop Study Area boundary (exact boundary cannot be used). Search performed prior to survey, updated 17th August 2020	Obtain records of listed significant flora and introduced flora within the Desktop Study Area
2018 Statewide Vegetation Statistics (formerly the CAR Reserve Analysis) (Government of Western Australia 2019a)	Study Area	Identify extent of Vegetation System Associations within the Study Area
Department of Agriculture and Food, Western Australia Inventory and Condition Survey of the Sandstone–Yalgoo–Paynes Find Area (Payne *et al.* 1998)	Study Area	Identify extent of Land Systems within the Study Area
Previous flora and vegetation surveys conducted for the Project or within the Study Area (various sources, see section 5.1.2)	Study Area	Identify records of significant flora and vegetation and introduced flora within the Study Area

3.2 Personnel and Licensing

Table 2 lists the personnel involved in both fieldwork and plant identifications for the survey. The Project Manager (Kim Kershaw) has extensive experience (> 10 years) in conducting similar flora surveys in the bioregion. David Coultas has extensive experience in undertaking plant identifications of flora from the bioregion. All plant material was collected under the *Flora Taking (Biological Assessment)* licences and *Authorisation to Take or Disturb Threatened Species* pursuant to the *BC Act*, sections 40, 274 and 275, as listed in Table 2.

Table 2: Personnel and Licensing Information

Personnel	Role	Relevant Qualifications	Flora Collecting Permit (BC Act (WA))
Cathy Godden	Field survey	BSc (Biology) (Hons)	FB62000050 TFL21-1819
Diana Barrie	Field survey	BSc (Agricultural Science and Conservation Biology)	–
Emma Marsh	Field survey	BSc (Biological Science and Conservation and Wildlife Science)	FB62000233
Greg Woodman	Field survey	BSc (Biology) (Hons)	FB62000053 TFL19-1819
Jaroslav Hruban	Field survey	Mgr (MSc equiv.) (Botany) BSc (Botany) (Hons)	FB62000251
Kim Kershaw	Project Manager, Field Manager, field survey	BSc (Biology)	FB62000054 TFL22-1819
Leah Firth	Field survey	BSc (Conservation Biology)	FB62000055 TFL145-19520
Marco Pratissoli	Field survey	PgD (Environmental Biology and Management)	FB62000057 TFL143-1920
Marlee Starcevich	Field Manager, field survey	BSc (Environmental Science) (Hons)	FB62000056 TFL26-1819
Will White	Field survey	BSc (Ecology) (Hons)	–
David Coultas	Plant identifications	BSc (Environmental Biology) (Hons)	NA
Margaret Collins	Plant identifications	MSc (Biotechnology and Molecular Biology) PhD ('Factors affecting the recovery of orchids in a post-mining landscape')	NA

3.3 Aerial Photography Interpretation and Survey Design

Initial interpretation of ortho-rectified aerial photography at a scale of 1:10,000 was conducted to determine preliminary vegetation patterns present within the Study Area, with quadrats allocated based on these patterns. A minimum of three quadrats were allocated to each major discernible vegetation pattern where possible; for smaller patterns, fewer quadrats were allocated based on the size of the pattern.

A large proportion of the Study Area has received considerable historical survey effort with regard to vegetation quadrat sampling, as summarised below and in Section 5.1.2:

- Karara–Mungada Project Survey Area Flora and Vegetation Assessment (Woodman Environmental 2008c) (hereafter referred to as 'Karara–Mungada Survey'): Level 2 (Detailed) Flora and Vegetation Assessment for Gindalbie Metals Limited. Survey work completed in winter 2006 with detailed recording sites data from previous surveys conducted in 2004 and 2005 (Woodman Environmental 2004, 2007e, g) and quadrats established by Markey and Dillon (2006) within the survey area utilised to aid in the VU mapping process. Karara–Mungada Survey survey work was undertaken entirely within the current Study Area; and
- Regional Flora and Vegetation Survey of the Karara to Minjar Block (Woodman Environmental 2012b) (hereafter referred to as 'Regional Mapping Survey'): Level 2 (Detailed) Flora and Vegetation Assessment for Karara Mining Limited. Survey work completed in spring 2008, autumn-winter 2009, and spring-summer 2010–2011. Quadrats previously established within the Woodman Environmental (2012b) survey area (Markey and Dillon 2008; Woodman Environmental 2007a, b, c, d, f, k, l, m, 2008c, 2009a, d, 2011) were also included in the statistical analysis. Current Study Area forms a component of the Regional Mapping Survey survey area.

Woodman Environmental (2020) conducted a review of aerial photography and existing quadrat data from 463 quadrats and relevés previously established in the Study Area (Woodman Environmental 2004, 2007g, 2008c, 2009b 2012b). The review considered the size of vegetated areas, visible vegetation patterns and previous quadrat/relevé density and locations in the Study Area. It was concluded that approximately 40 additional quadrats (located in vegetation outside the Karara–Mungada Survey survey area) were required to adequately characterise the vegetation of the Study Area and to ensure adequate coverage of areas previously surveyed at a different scale for regional mapping by the Regional Mapping Survey. In addition, five previously established quadrats were identified as requiring resurvey during the quadrat allocation process and were subsequently revisited to update taxon lists, as these quadrats had been surveyed out of season.

Data from the existing quadrats located within the Study Area, as well as from the additional quadrats established in 2020, were utilised for the floristic analysis (see Section 3.6) and for building a taxon inventory for the Study Area (see Section 5.2.1).

The above-listed surveys, as well as a number of other surveys, also included opportunistic and/or targeted significant flora and vegetation surveys. However, due to the timing of some of these surveys and the fact that changes have occurred to plant taxonomy and conservation status for many taxa and vegetation communities since these surveys were undertaken, the entirety of the Footprint (as per Figure 1) was reassessed for significant flora and vegetation as part of the current 2020 survey. The methods utilised to undertake the targeted significant flora assessment is described in Section 3.4.

3.4 Field Survey Methods

The 2020 field survey, during which quadrats were established and surveyed and the targeted survey for significant flora and vegetation was undertaken, occurred across three visits:

- 10th–18th August 2020: detailed flora and vegetation survey (quadrats and opportunistic significant flora searching);
- 24th–31st August 2020: targeted significant flora survey; and
- 17th–23rd September 2020: detailed flora and vegetation survey and targeted significant flora survey (quadrats and targeted significant flora searching).

The timing of the survey was selected to coincide with the most appropriate time to survey in the Yalgoo Bioregion (Southwestern Interzone); considered to be winter–spring, as the majority of taxa in this region flower at this time. This includes the majority of significant taxa that have the potential to occur in the Study Area (see Section 5.1.3).

The Study Area was accessed by vehicle using existing access tracks, and via foot transects. A total of 59 quadrats were surveyed by the current 2020 survey; a total of 54 quadrats were newly established in 2020 while five additional quadrats previously established for the Karara–Mungada Survey and Regional Mapping Survey were revisited and resampled in 2020 (Section 3.3). All quadrats had a total area of 400 m^2; most measured 20 m x 20 m, however this was modified as appropriate when quadrats were located in narrow areas of vegetation such as along creek lines. Note that more quadrats were established and surveyed during the current survey than the 40 initially proposed; this was due to having more time in the field than anticipated, allowing additional quadrats to be established in vegetation patterns identified by aerial imagery interpretation.

The quadrat size used by this survey is the indicative size for flora and vegetation surveys in the Yalgoo Bioregion, as outlined in Table 1 of EPA (2016b). Quadrat locations were selected to ensure that at least three quadrats (where possible) were surveyed within each vegetation pattern initially identified from aerial photography interpretation (as per Section 3.3).

All vascular flora taxa that were visually identifiable within each quadrat were recorded. At least one reference specimen of most taxa encountered (excluding common, distinctive taxa) was collected for verification and identification purposes.

The following information was recorded at each quadrat:

- Personnel;
- Unique quadrat number;
- Date of survey;
- GPS (Global Positioning System) coordinates at start corner of quadrat;
- Site photograph, taken diagonally into quadrat from start corner;
- Compass bearing for two sides of quadrat that commence at start corner of quadrat;
- Topography (including landform type and aspect);
- Soil colour and type (including the presence of any rock outcropping and surface stones);

- Vegetation condition (EPA 2016b; scale presented in Appendix A);
- Approximate time since fire;
- Presence and type of disturbance (if any);
- Percentage foliage cover for each taxon, including cover within the quadrat of individuals rooted outside of the quadrat;
- Average height (m) for each taxon, excluding climbers/aerial shrubs; and
- Additional flora taxa present immediately outside of the quadrat.

Notes on vegetation pattern boundaries and distribution were also taken while traversing the Study Area. These notes included a GPS location at the point that the notes were taken, and a brief description of the vegetation, including dominant and characteristic taxa. These notes were used to aid in mapping polygons of vegetation patterns that were not allocated quadrats. Not all vegetation pattern polygons could receive quadrats due to time limitations, however many polygons could be confidently allocated to a final VU using a combination of mapping notes and aerial photograph interpretation. Additional flora taxa, including significant flora and introduced flora taxa, were also recorded opportunistically in the Study Area during traverses on foot between quadrats, with GPS locations of such taxa recorded.

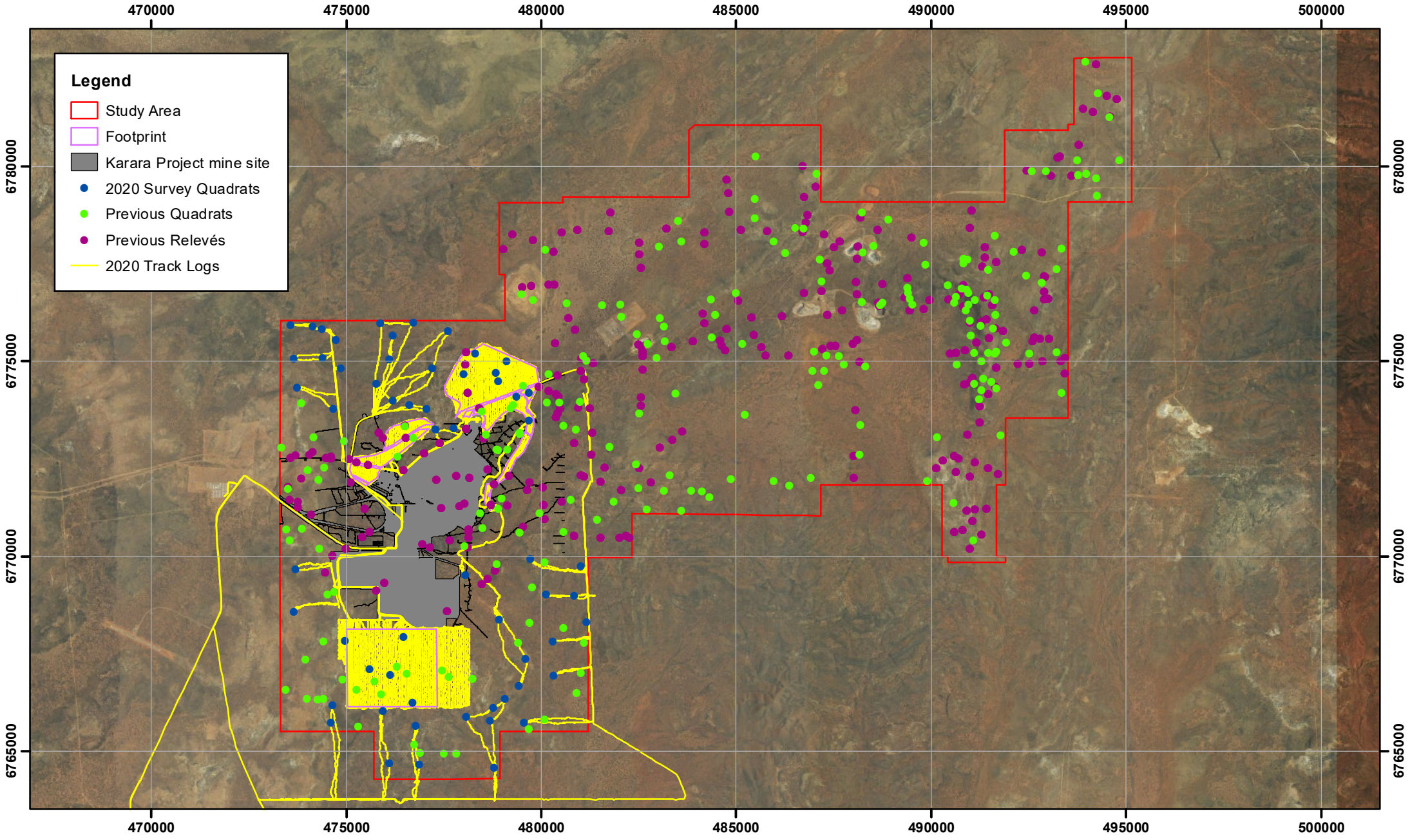
Targeted survey for significant flora taxa was undertaken as part of the 2020 survey, with a list of significant flora likely to be encountered compiled as part of the desktop study prior to undertaking field work. The entirety of the Footprint (as per Figure 1), as well as appropriate habitat for significant taxa elsewhere in the Study Area outside of the Footprint (time permitting), was specifically transected on foot, with transects 50 m apart in a grid pattern. However, transects deviated such that specific areas of habitat outside the defined grid were also searched. If populations of significant flora taxa were identified, a representative collection of material was made, and the following information recorded:

- Personnel and date;
- Taxon name;
- GPS location;
- Number of plants at location; and
- Any other relevant information, including condition of plants at location, habitat, reproductive stage, etc.

Due to the grid spacing used, numbers of plants recorded are not considered to be a full census of each taxon within the survey areas, but instead provide a conservative estimate of the numbers of individuals present.

A targeted survey was also undertaken for listed significant vegetation, with a list of significant vegetation likely to be encountered compiled as part of the desktop study prior to undertaking field work. This survey was conducted concurrently with the survey for significant flora taxa. If any occurrences of such significant vegetation were encountered, the boundary of the significant vegetation was recorded where possible, either via walking the boundary and recording the GPS track log, or by recording GPS waypoints. This allowed for the accurate calculation of the spatial areas of occurrences of significant vegetation.

Traverses in the Study Area from the 2020 survey are mapped as track logs in Figure 3, along with quadrat locations. Note that quadrat establishment track logs from previous surveys in the Study Area are not presented on this figure.



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This map should only be used in conjunction with WEC report KML20-33-01.

Previous Quadrat and Relevé Locations within the Study Area and Quadrats and Track Logs from the 2020 Survey	WEC Ref.: KML20-33-01	**Figure** 3
	Scale: 1:125,000 (A4)	
Author: Marlee Starcevich	Projection: GDA 1994 MGA Zone 50	
Filename: KML20-33-01-f03	Revision: A - 30 August 2021	

3.5 Plant Collection and Identification

Specimens of any unknown taxa that were collected were pressed for later identification at the WA Herbarium. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest.

Taxon nomenclature generally follows *FloraBase* (WA Herbarium 1998–) with all names checked against the current DBCA Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not yet been adopted on *FloraBase* due to time constraints, nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the WA Herbarium for consideration for vouchering as soon as practicable. However, this process is via donation, and the WA Herbarium may not voucher all specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms submitted to DBCA (Species and Communities Branch) in the case of listed significant flora (i.e. Threatened and Priority flora taxa).

3.6 Floristic Classification Analysis

Classification analysis of floristic data from the Study Area was conducted using 265 quadrats established in the Study Area. This included:

- 54 quadrats established in the Study Area in 2020 by this current survey (see Section 3.4); and
- 211 quadrats established for relevant previous surveys (Karara–Mungada Survey and Regional Mapping Survey), including five quadrats from the Regional Mapping Survey that were revisited and resurveyed in 2020 by this current survey.

All historical quadrats were reviewed thoroughly for taxonomic currency (both in a nomenclature and conceptual context), with nomenclature updated where required. Appendix B presents a record of taxonomic nomenclature changes made to the historic quadrat data. Note that *Acacia* species belonging to the Mulga (*Acacia aneura* and close relatives) complex were not updated to current names. This is an extremely large and taxonomically complex group, and unresolved variation, confounded by presumed hybridity, still exists despite the group undergoing significant taxonomic revision in 2012 (Maslin and Reid 2012). Therefore, it would be inappropriate to attempt to update these historic identifications without examining the associated specimen material. In any case, all taxa belonging to the Mulga group were combined in the classification analysis as discussed further below.

The analysis used 190 taxa, with taxa belonging to several categories removed prior to the analysis, as listed below:

- Ephemeral or annual taxa – the presence of ephemeral or annual taxa is strongly influenced by seasonal conditions, with fewer taxa and individuals usually present following below-average rainfall;
- Introduced taxa – the distributions of introduced taxa are often defined by the presence of disturbance (e.g. clearing, animal movement) rather than particular natural habitat types;
- Hybrids – hybrids are generally the result of random reproductive events that produce small numbers (often only one) of sterile offspring, and are often not associated with particular habitat types;
- Taxa where identification was unclear – taxa were removed from the analysis where identification was unclear due to poor available material in the field. However, if such a taxon was known to be unique within the dataset, it was included in the analysis; and
- Singletons – taxa that occur only once in the dataset were removed as published studies indicate that they provide little information in the dataset (e.g. Markey and Dillon 2008).

All taxa removed from the classification analysis (excluding taxa belonging to the abovementioned categories) are presented in Appendix C. Also presented in Appendix C are taxa that were amalgamated in the classification analysis; this was done, for example, where different infra-taxa could not be consistently positively identified due to inadequate material. As discussed above, all *Acacia* species belonging to the Mulga group were also amalgamated in the classification analysis (Appendix C).

A single-layer data matrix (i.e. presence/absence data only) was used in the classification analysis. PATN (V4.0) (Belbin and Collins 2013) was utilised to perform the classification and ordination analysis of the data matrix. The Bray-Curtis coefficient was used to generate an association matrix for the classification analysis. This association matrix consisted of pairwise coefficients of similarities between quadrats based on floristic data. Agglomerative hierarchical clustering, using flexible Unweighted Pair Group Method with Arithmetic Mean (UPGMA) (ß = -0.1), was used to generate a quadrat classification dendrogram (Sneath and Sokal 1973).

3.7 Vegetation Unit Definition, Mapping and Description

The resulting hierarchical cluster dendrogram and taxon group matrix were initially examined at a group level determined by PATN as potentially appropriate for the dataset, to determine the plausibility of groups with regard to taxon groups, as well as field observations and indicator taxon analysis. This process determined a final number of clusters, which were considered to represent VUs.

VU descriptions have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI 2003), as stipulated by EPA (2016b). This model follows nationally agreed guidelines to describe and represent VUs, so

that comparable and consistent data are produced nation-wide. It should be noted that the NVIS system utilises vegetation descriptions derived from structural characteristics of the individual community units, while the VUs presented in this report are defined based on the results of a floristic classification analysis, excluding any structural data. VUs therefore may include multiple structural types. Considering the effect of disturbance factors such as fire on vegetation structure, this approach is designed to provide a map of VUs that reflect taxon composition and the influences of the physical and chemical environment rather than disturbance history.

It should also be noted that this report describes VUs at the NVIS Sub-Association level, rather than the Association level as stipulated by EPA (2016b). This level is considered more appropriate for the vegetation of the Study Area, as often the vegetation possessed one or more additional strata to the traditional three-stratum classification system used at the Association level.

For each VU, indicator taxa were defined via Indicator Taxon Analysis (INDVAL). This was conducted using PC-Ord (V6.08) (McCune and Mefford 2011) via the method of Dufrene and Legendre (1997). This generates INDVAL values (a measure of taxon fidelity to a given VU) that range from 0 to 100; an INDVAL value of 100 indicates that a taxon is present in all quadrats within a particular VU and absent from all other quadrats included in the analysis. The INDVAL values were then tested for significance of the indicator taxa using a Monte Carlo permutation test. Indicator taxa were defined as taxa with a significance *p* value of either < 0.05, < 0.01 or < 0.001. The same taxa amalgamations (as per Appendix C) and exclusions (i.e. ephemeral/annual taxa, introduced taxa, hybrids and singletons) were employed for the indicator species analysis as per the floristic classification analysis.

The locations of quadrats within each VU were used in conjunction with aerial photograph interpretation and mapping notes taken during the field survey to develop VU mapping polygon boundaries, as well as data from 269 relevés established throughout the Study Area by previous surveys (Woodman Environmental 2004, 2007g, 2008c, 2009b). The VU mapping polygon boundaries were then digitised using Geographic Information System (GIS) software.

3.8 Vegetation Condition Mapping

Vegetation condition was described using the vegetation condition scale presented in EPA (2016b) for the Southwest and Interzone Botanical Province (presented in Appendix A). Notes on vegetation condition were taken during the field survey via vehicle traverses along access tracks, and during foot traverses undertaken within the Study Area. Vegetation condition was also recorded at all quadrats. Vegetation condition category polygon boundaries were developed using this information and were digitised using GIS software as for VU polygon boundaries.

3.9 Significant Flora and Vegetation

3.9.1 Significant Flora

As per EPA (2016a), flora taxa may be significant for a range of reasons, including, but not limited to the following:

- Being identified as a Threatened or Priority species (formally listed significant taxa – includes taxa listed under both State and Commonwealth legislation, and classified as Priority by DBCA);
- Locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or taxa with anomalous features that indicate a potential new species;
- Representative of the range of a species (particularly at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- Relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

Significant flora taxa recorded within the Study Area are discussed in Section 5.2.1.2 with reference to the above categories. Details on point locations, individuals and populations of significant flora known from the Study Area are presented in this section. A population in the context of this survey is defined as a discrete group of individuals of a taxon separated by more than 500 m from the nearest discrete group of individuals (DBCA 2017). However, this definition can only be tentatively applied if the intervening 500 m has not been surveyed.

3.9.2 Significant Vegetation

As per EPA (2016a), vegetation may be significant for a range of reasons, including, but not limited to the following:

- Being identified as a TEC or PEC (formally listed significant vegetation – includes vegetation listed under Commonwealth legislation, endorsed as a TEC by the Western Australian Government, or classified as a PEC by DBCA);
- Having restricted distribution;
- Having a degree of historical impact from threatening processes;
- Playing a role as a refuge; and
- Providing an important function required to maintain ecological integrity of a significant ecosystem.

With regard to TECs and PECs listed in Western Australia, only broad descriptions generally are provided in the respective lists to allow for diagnosis. The vegetation of the Study Area was therefore manually compared to such descriptions to determine whether any vegetation may represent a TEC or PEC. Analysis of VUs with FCTs described in the Karara-Mungada survey report (Woodman Environmental 2008) as well as qualitative review against FCTs described by Markey and Dillon (2008) was also undertaken.

With regard to TECs listed under the EPBC Act, the vegetation of the Study Area was assessed against the appropriate listing and conservation advice for any TECs likely to occur in the Study Area.

In addition to the above, the classification dendrogram used to define VUs in the Study Area was reviewed for the position of quadrats previously analysed by the Karara–Mungada Survey analysis. From this, similarities between VUs and the Floristic Community Types (FCTs) described by the Karara–Mungada Survey were inferred, with particular attention on FCTs that were identified to represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1). It is important to note that the original quadrat groupings that formed the basis of the original FCTs defined by the Karara–Mungada Survey analysis are not maintained in the current analysis dendrogram. A changing of relationship between quadrats from the analysis originally conducted for the Karara–Mungada Survey is to be expected due to addition of new data to the dataset as well as taxonomic changes relating to taxa in the area necessitating changes to the original quadrat data. As a result, there is inherent ambiguity in inferences made from examination of the dendrogram alone.

Further floristic analysis was also undertaken to determine similarities between VUs with FCTs defined by the Regional Mapping Survey (Woodman Environmental 2012b). This was conducted to assist in the determination of VUs that may be significant in a regional context. Analysis methods and parameters used for the analysis with the regional dataset were the same as those used for the analysis of Study Area quadrat dataset as outlined in Section 3.6. Classification analysis of floristic data was conducted using a total of 1,030 quadrats (consisting of 265 quadrats from the original analysis of the Study Area quadrat dataset and 765 quadrats from the Regional Mapping Survey).

The resultant analysis dendrogram was then reviewed to determine the position of the Study Area VU quadrat groupings in relation to grouping of quadrats from the Regional Mapping Survey analysis; from this, similarities between VUs and FCTs were inferred. It was assumed that dissolution of groups of quadrats from the first classification analysis within this regional analysis likely indicated that the vegetation represented by such quadrats was relatively dissimilar in a regional context; this may not have been obviously evident in the local context of the first classification analysis due to the comparatively limited size of the dataset being analysed. As mentioned above, it is important to note that this analytical approach does not maintain the original quadrat groupings that formed the basis of the original FCTs defined by the Regional Mapping Survey in the resultant dendrogram. Therefore, other information such as quadrat taxon lists, vegetation structure, soils, topography and geographical distribution data was also compared with the information presented for each of the Regional Mapping Survey FCTs in order to provide further support for the inferences made. Note also that the Regional Mapping Survey was undertaken at a much broader scale than the current survey; therefore, it is possible that multiple VUs may comprise a single Regional Mapping Survey FCT.

The remaining significant vegetation criteria listed above other than ‘being identified as a TEC and PEC’ were applied to VUs mapped in the Study Area to determine whether a VU is

significant in a local or regional context. In a local context, a VU can be considered locally significant if restricted within the Study Area (mapped over < 1 % of the total area of the Study Area) or moderately restricted (mapped over < 2 % of the total area of the Study Area), in combination with the type of landform and soils with which the VU is associated. Comments are provided if a VU is restricted within the Study Area; however, there is also consideration on whether it is likely that the VU occurs more widely outside the Study Area (i.e. if the Study Area is sampling only a small portion of a landform unit which is likely to be more widespread in the vicinity of the Study Area).

The regional significance of VUs was determined following review of the inferred relationships of VUs and FCTs from the above analysis of Study Area quadrat data with the quadrat data from the Regional Mapping Survey. VUs that were identified as having potentially restricted regional distribution and occurrence were considered to represent potentially significant vegetation in a regional context.

4. ADEQUACY AND LIMITATIONS OF SURVEY

4.1 Adequacy of Survey

The Study Area covers approximately 20,473 ha, with data from 265 quadrats used in the analysis. Quadrats were established in all preliminary vegetation patterns discernible by initial aerial photograph interpretation (Section 3.3), both to adequately sample variation in vegetation throughout the Study Area and to ensure adequacy of sampling for vascular plant taxa.

The number of quadrats established in the Study Area is considered to be an acceptable number given the diversity of topography and soil types noted in the Study Area, as well as the size of the Study Area (approximately 1 quadrat established per 77 ha of Study Area and approximately 1 quadrat per 71 ha of mapped native vegetation).

To provide an indication of the adequacy of this survey, a taxon accumulation curve was produced using PC-Ord (McCune and Mefford 2011). Taxon accumulation curves represent a theoretical model of the relationship between sampling intensity and taxon accumulation; when sampling intensity is increased, taxon accumulation is reduced, and a taxon accumulation curve becomes asymptotic.

The taxon accumulation curve for quadrat data from the Study Area was generated using all native taxa (both annual and perennial) recorded within each quadrat. Taxon accumulation calculations for the Study Area were then undertaken using the Chao-2 estimator for species richness (Chao 1987) and compared to the actual number of taxa recorded in the Study Area. This provides some indication as to whether sufficient quadrats were surveyed to adequately sample the species richness in the Study Area. As the generation of species accumulation curves includes quadrat data only, and not taxa recorded during targeted searching or otherwise opportunistically recorded, the indication of adequacy of survey provided is considered to be conservative.

Figure 4 presents the species accumulation curve generated from quadrat data from the Study Area. Using the Chao-2 estimator, the recorded number of taxa within quadrats is equivalent to 86.2 % of the estimated taxon richness in the Study Area; the estimated number of native taxa occurring in the Study Area using Chao-2 was 482, with a total of 416 native taxa recorded in the 265 quadrats established within the Study Area by this current survey and relevant previous surveys. It is of interest that when opportunistic records of taxa are included as well as taxa recorded at relevés, a total of 525 taxa were recorded in the Study Area (see Section 5.2.1.1). Sampling was therefore considered to be adequate using this estimation measure.

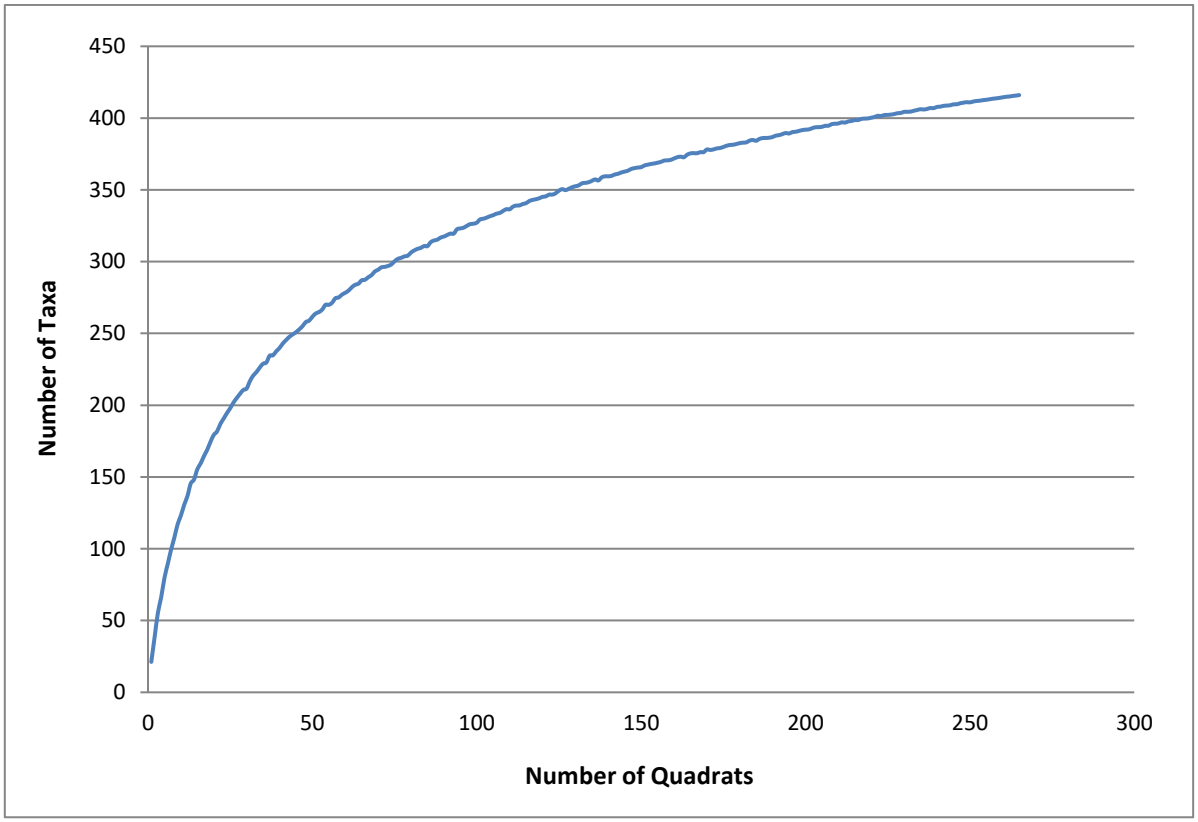


Figure 4: Study Area Quadrat Data Species Accumulation Curve

Another adequacy of survey measure is that developed by Mueller-Dombois and Ellenberg (1974), who suggest that an adequacy cut-off point might be when a 10 % increase in quadrats surveyed results in a 5 % (or less) increase in taxa recorded. This measure was also calculated using all native taxa recorded within each quadrat. The number of quadrats established in the Study Area satisfies this adequacy measure suggested by Mueller-Dombois and Ellenberg (1974), with the final taxon increase value of 2.10 % recorded following a 10 % increase in quadrats.

4.2 Limitations of Survey

Table 3 presents the limitations of the flora and vegetation survey of the Study Area in accordance with EPA (2016b). Note that this table deals specifically with the current survey conducted in 2020. For data used in this assessment that has originated from previous surveys, either for the purposes of taxon inventory, significant flora distribution and abundance, or floristic analysis, individual reports were reviewed to identify any specific limitations that may have significantly affected the results. In addition, a thorough assessment of data from the Karara–Mungada and Regional Mapping Surveys (Woodman Environmental 2008c, 2012b) has previously been conducted against the current EPA survey requirements (EPA 2016b) in Woodman Environmental (2020). As discussed in Sections 1.3, 3.3 and 3.6, issues relating to changes in plant taxonomy since these earlier surveys, as well as some of these surveys being conducted out of season, were addressed prior to commencing floristic analysis. This was achieved both via revisiting and resurveying previously established quadrats in the field, and thoroughly reviewing historical quadrats for taxonomic currency and

updating nomenclature where required. Therefore, no significant limitations were identified with the utilisation of historical quadrat data.

Table 3: Limitations of the Flora and Vegetation Assessment of the Study Area

Limitation	Limitation of Survey	Comment
Effort and Extent	No	Detailed survey undertaken across entire Study Area. Multiple quadrats were established in each vegetation pattern identified in the Study Area. No constraints prevented appropriate sampling techniques (quadrat establishment, foot transects) being employed. Relative ease of access within the Study Area enabled detailed vegetation unit and condition mapping to be undertaken throughout the Study Area via foot and vehicle transects. Mapping reliability is therefore considered to be relatively high. The detailed survey included targeted survey within the Footprint for significant flora taxa identified from the desktop study. The targeted significant flora survey was conducted on foot along transects undertaken at 50 m intervals (Section 3.4). A 50 m interval was considered to be adequate to provide appropriate data on the distribution of significant flora taxa within the Footprint. When searching for smaller, cryptic taxa such as *Gunniopsis divisa* (P3), small deviations of transects were undertaken to ensure all suitable habitat were checked carefully. Due to the intervals between transects, and large numbers of some taxa encountered (e.g. *Rhodanthe collina* (P3)), numbers of individuals presented are not considered to be a full census of each taxon within the survey areas. Instead, these are considered to be conservative estimates of the numbers of individuals actually present. The Footprint was not surveyed for significant taxa identified subsequent to the field survey being completed; further survey may be required for such taxa. Targeted searching for significant flora across the entire Study Area has not been undertaken. Further survey for significant flora taxa may be required depending on the precise location of future impact areas.
Competency/experience of the team carrying out the survey	No	The Project Manager has had extensive experience (> 10 years) in conducting similar assessments in the Midwest. Personnel conducting plant identifications have had > 10 years' experience in plant identification of the Midwest. Senior personnel provided guidance to less experienced botanists throughout the survey where necessary. Relevant experts at the WA Herbarium were consulted regarding taxonomic identifications where required.
Proportion of flora identified, recorded and/or collected	Partial	All vascular groups that were present in the Study Area were sampled. A high proportion of perennial vascular taxa were recorded based on the intensity and method of survey, and almost all could be positively identified. A reasonable proportion of annual and ephemeral vascular taxa were recorded based on the intensity and method of survey, despite below-average rainfall being received prior to survey (Section 2.1) (see timing/weather/season/cycle below). It is possible that a small number of particularly fragile taxa (e.g. some grass species) may not have been detectable or identifiable during the survey. Unknown vascular taxa were collected, with specimens identified at the WA Herbarium. Adequacy of survey measures indicate a high percentage (86.2 %) of taxa expected to occur in the Study Area was recorded (Chao-2 estimator), and the number of quadrats established in the Study Area satisfies the criterion suggested by Mueller-Dombois and Ellenberg (1974), with a final increase of 2.10 % in species recorded per increase of 10 % of quadrats (Section 4.1).

Limitation	Limitation of Survey	Comment
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	No	Good contextual information for the Study Area was available prior to the survey. Sources of information used included government databases (DBCA, DAWE), which are known to have been extensively populated with data from numerous surveys conducted in the general vicinity of the Study Area. In addition, numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the region, and previous surveys conducted in the Study Area were utilised.
Timing/weather/season/cycle	Partial	The field survey was conducted in late winter–early spring, corresponding with what is considered the optimum flowering period for the Midwest. However, the lower than average rainfall received in the months preceding the survey, in combination with higher than average temperatures in June and July 2020 (Section 2.1), likely resulted in some annual and ephemeral species not being detectable or identifiable during the survey, as well as most perennial taxa not being in flower. It is considered that the survey being conducted in the peak flowering season only is appropriate, as it is likely that most taxa that flower outside the peak flowering season could be identified during the survey.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	No	Some historical disturbances associated with exploration were apparent; however, these did not appear to have significantly impacted the flora taxa present and are therefore not considered to have affected the results of the survey. There was no evidence of fires having burnt the vegetation in recent years, or evidence of any other non-clearing related significant disturbances.
Remoteness and/or access problems	No	Although some areas were difficult to reach due to distances from available access tracks, this is not considered to have affected the results of the survey.

5. RESULTS

5.1 Desktop Study

5.1.1 Regional Vegetation

The Study Area is located in the Yalgoo IBRA bioregion, specifically within the Tallering IBRA subregion (Commonwealth of Australia 2012). The Yalgoo bioregion is broadly equivalent to the Yalgoo subregion described by Beard (1990). Beard (1990) described the vegetation of this area as one of transition between the Eremaean and the Southwestern Province, with *Acacia aneura* being replaced in dominance by other *Acacia* species in the southwest of the Province. The vegetation of the region is characterised by low woodlands to open woodlands of *Eucalyptus*, *Acacia* and *Callitris* on red sandy plains of the Western Yilgarn Craton and southern Carnarvon Basin (Desmond and Chant 2001). In the vicinity of the Study Area, the vegetation was described as *Acacia ramulosa–Acacia acuminata* scrub on hills and *Acacia ramulosa–Acacia murrayana* on sandplains, with thickets of *Acacia ramulosa*, *Acacia acuminata* and *Melaleuca uncinata* (now considered to be *Melaleuca hamata*) on mid slope positions, and scrub of *Acacia ramulosa* with scattered *Callitris* and *Eucalyptus* in valleys (Beard 1990).

The vegetation of Western Australia as it was presumed to have existed prior to European settlement has been mapped at a scale of 1:250,000 as vegetation system associations (VSAs), with the Pre-European Vegetation spatial database created (Beard *et al.* 2013). Eight VSAs occur in the Study Area as summarised in Table 4 and presented on Figure 5. Table 4 also presents the current extent of each VSA in relation to its pre-European extent and the percentage of the current extent of each VSA currently protected for conservation (in DBCA-managed land) (Government of Western Australia 2019).

The vegetation system associations within the Study Area have undergone minimal clearing, with all eight having over 80 % of their pre-European extent remaining and all but one having over 95 % of their pre-European extent. These vegetation system associations are not currently well-conserved (Table 4); however, significant proportions of these VSAs are proposed to be conserved within the former pastoral leases in the vicinity of the Study Area, including ex-Karara, ex-Lochada and ex-Warriedar Stations (Government of Western Australia 2019).

Table 4: Vegetation System Associations Occurring in the Study Area

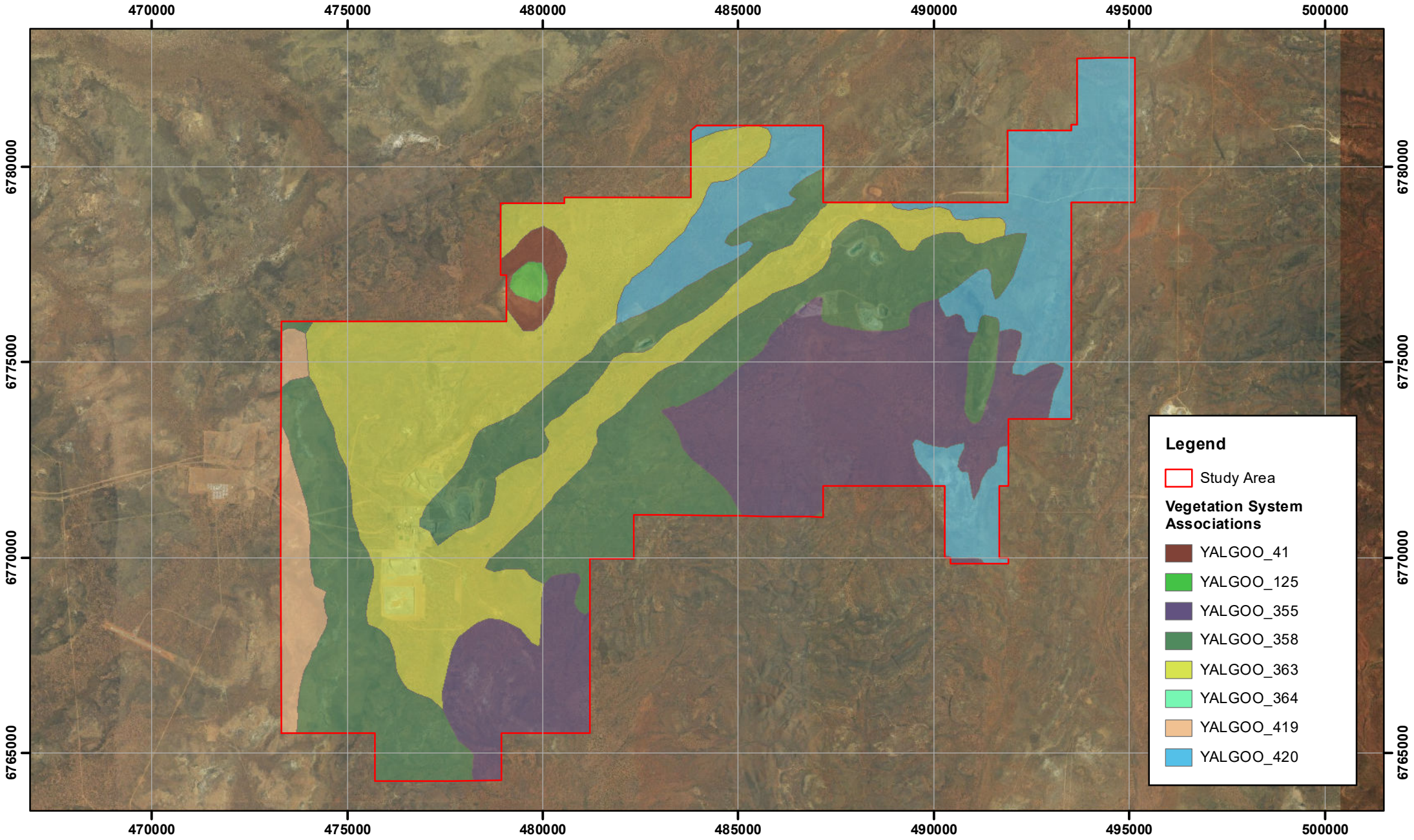
VSA	Description	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent Protected for Conservation (%)
Yalgoo_41	Shrublands; teatree scrub	287	100.00	0
Yalgoo_125	Bare areas; salt lakes	21,377	84.89	0
Yalgoo_355	Shrublands; bowgada and jam scrub with scattered York gum and red mallee	54,965	97.62	0
Yalgoo_358	Shrublands; bowgada and *Acacia quadrimarginea* on stony ridges	55,540	99.85	0
Yalgoo_363	Shrublands; bowgada scrub with scattered cypress pine	11,729	98.45	0

VSA	Description	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent Protected for Conservation (%)
Yalgoo_364	Shrublands; bowgada scrub with scattered eucalypts and cypress pine	108,537	99.75	0
Yalgoo_419	Shrublands; bowgada jam and *Melaleuca uncinata* thicket	289,773	95.71	0
Yalgoo_420	Shrublands; bowgada and jam scrub	456,619	99.76	0.02

The Department of Agriculture and Food, Western Australia described land systems within the Sandstone–Yalgoo–Paynes Find area, considering general ecological information, vegetation physiognomy and composition, patterns of variation, conservation status, gradational association and land system representation (Payne *et al.* 1998). A total of 15 land systems occur within the Study Area as summarised in Table 5 and presented on Figure 6.

Table 5: Land Systems Occurring in the Study Area

Land System	Description	Mapped Extent (ha)
Campsite	Alluvial plains supporting eucalypt woodlands with saltbush understoreys and eucalypt–Acacia shrublands	17,300
Carnegie	Salt lakes with fringing saline alluvial plains, kopi dunes and sandy banks, supporting halophytic shrublands	864,900
Challenge	Gently undulating gritty-surfaced plains, occasional granite hills, tors and low breakaways, with Acacia shrublands	365,500
Cunyu	Calcrete platforms and intervening drainage floors and minor areas of alluvial plains, with *Acacia* shrublands, *Casuarina* woodlands and minor halophytic shrublands	35,800
Doney	Alluvial plains with eucalypt woodlands	128,700
Euchre	Low granite breakaways with alluvial plains and sandy tracts supporting eucalypt woodlands and *Acacia* shrublands	176,900
Graves	Basalt and greenstone rises and low hills, supporting eucalypt woodlands with prominent saltbush and bluebush understoreys	17,200
Joseph	Undulating yellow sandplain supporting dense mixed shrublands with patchy mallees	461,200
Moriarty	Low greenstone rises and stony plains supporting halophytic and *Acacia* shrublands with patchy eucalypt overstoreys.	82,500
Nerramyne	Undulating sandy and gravelly plains with low plateaux and breakaways supporting *Acacia* shrublands	165,000
Pindar	Loamy plains surrounded by sandplain supporting York gum woodlands and *Acacia* shrublands	151,900
Singleton	Rugged greenstone ranges with dense *Casuarina* and *Acacia* shrublands	23,800
Tallering	Prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks supporting bowgada and other *Acacia* shrublands	32,900
Tealtoo	Level to gently undulating loamy plains with fine ironstone lag gravel supporting dense *Acacia* shrublands	69,300
Yowie	Loamy plains supporting shrublands of mulga and bowgada with patchy wanderrie grasses	918,900



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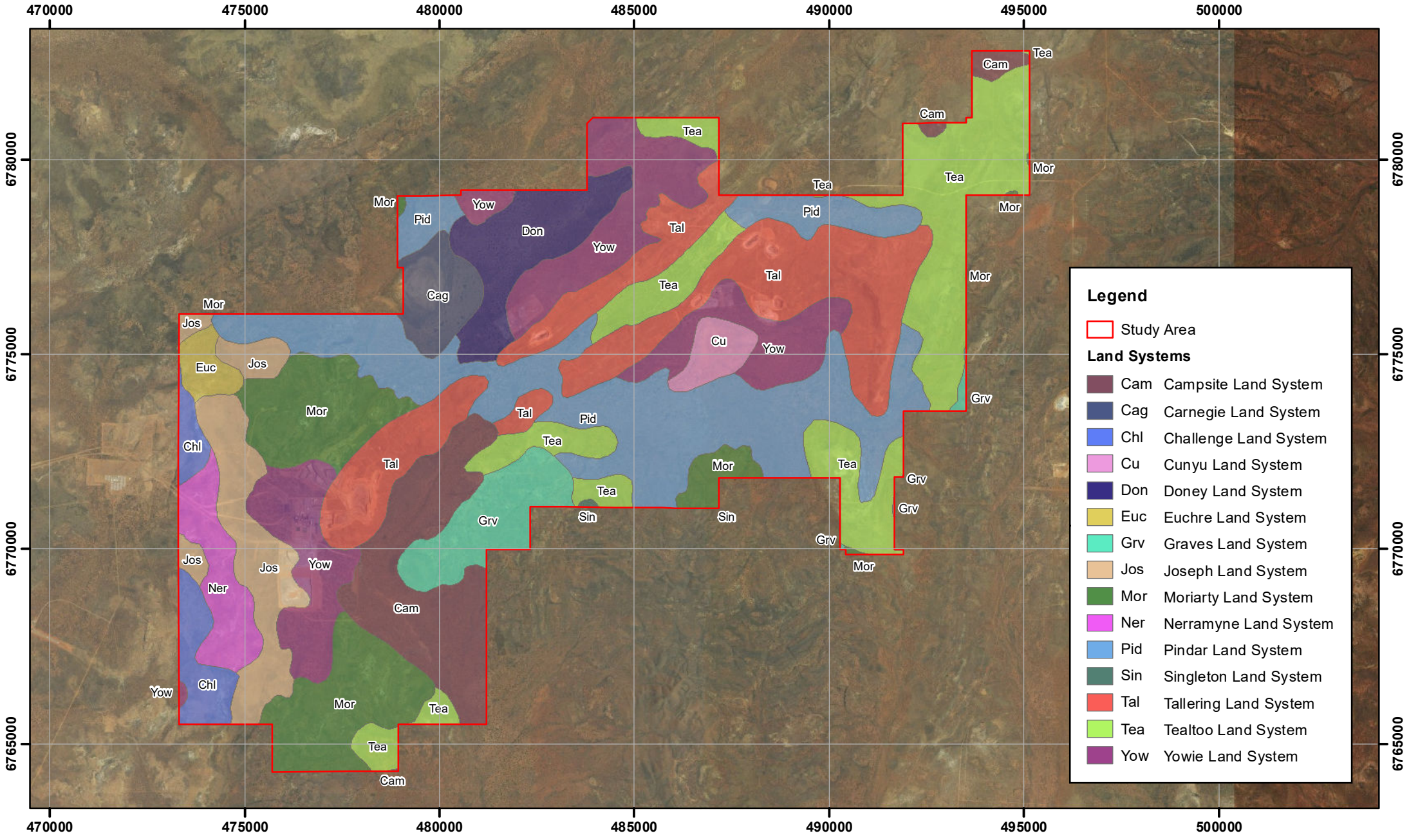
This map should only be used in conjunction with WEC report KML20-33-01.

Vegetation System Associations of the Study Area	WEC Ref.: KML20-33-01	**Figure**
	Scale: 1:125,000 (A4)	5
Author: Marlee Starcevich	Projection: GDA 1994 MGA Zone 50	
Filename: KML20-33-01-f05	Revision: A - 30 August 2021	



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This map should only be used in conjunction with WEC report KML20-33-01.

Land Systems of the Study Area	WEC Ref.: KML20-33-01	**Figure**
	Scale: 1:125,000 (A4)	6
Author: Marlee Starcevich	Projection: GDA 1994 MGA Zone 50	
Filename: KML20-33-01-f06	Revision: A - 30 August 2021	

5.1.2 Previous Flora and Vegetation Surveys

As mentioned in Section 3.3, Woodman Environmental previously undertook a flora and vegetation assessment of the Karara–Mungada Project survey area and a Regional Flora and Vegetation Survey of the Karara to Minjar Block, both of which considered most of the Study Area (Woodman Environmental 2008c, 2012b). These assessments both incorporated data from a number of other flora and vegetation surveys that had previously been undertaken within the local area. The results of these assessments are summarised in Table 6 while the survey locations are shown on Figure 7 (subject to the availability of spatial data). Note that the individual assessments incorporated into the Karara–Mungada and Regional Mapping Surveys have not been presented separately in Table 6, and data in Table 6 is sorted by year and then source.

Note that both assessments recorded *Chamelaucium* sp. Yalgoo (Y. Chadwick 1816) (P1) (Woodman Environmental 2008c, 2012b). This taxon is not currently known from within the local area and is likely a misidentification of *Chamelaucium pauciflorum* subsp. Perenjori (B.J. Conn 2181) (Woodman Environmental field observations). This taxon has therefore not been included in Table 6.

Similarly, *Angianthus prostratus* (P3) was previously identified by Woodman Environmental during several surveys within and in the vicinity of the Study Area, with the earliest records from 2005 from the Karara–Mungada Survey (Woodman Environmental 2008c). However, no material was lodged at the WA Herbarium as it was not considered to be a significant taxon at the time of survey. Collections of what was believed to be this taxon were made as part of a survey within the Study Area in 2009 (Woodman Environmental 2009a); by this time, the species had been listed as a Priority taxon. These collections were sent to the WA Herbarium for lodgement; however, the collections were rejected. No reason was provided for why the material was rejected, but it is presumed that the material was of insufficient quality to be identified with certainty. A collection of apparently identical material to that identified as *Angianthus prostratus* in 2009 was made in 2020 during the current survey and sent to the WA Herbarium for identification; this collection was identified as *Gilruthia osbornei*. It is now considered highly likely that all other historical identifications of *Angianthus prostratus* within and in the vicinity of the Study Area are erroneous and are likely to represent *Gilruthia osbornei*. According to DBCA records (DBCA 2007-), there have been no other collections of *Angianthus prostratus* in the vicinity of the Study Area and the nearest known collection of this species is located approximately 200 km east of the Study Area. Therefore, it is considered unlikely that this species occurs in the Study Area and has not been included in Table 6.

Table 6: Summary of Flora and Vegetation Surveys Previously Conducted Within and in the Vicinity of the Study Area

Project and Source	Location in Relation to Study Area	Survey Scope	Parameters of Assessment	Timing	Number of Flora Taxa	Significant Flora Taxa^	Introduced Flora Taxa^	Vegetation and Significant Vegetation*
Newmont – Golden Grove Operations Priority Flora (Mattiske 2004)	Approximately 30 km north of Study Area	• Targeted searching for significant flora	Not indicated	Not indicated	NA	4 taxa: • *Calytrix uncinata* (was P3, no longer listed as significant); • *Euryomyrtus patrickiae* (was P3, no longer listed as significant); • *Grevillea globosa* (P3); • *Micromyrtus trudgenii* (was *Micromyrtus* sp. Warriedar (S. Patrick 1879A)) (P3)	NA	NA
Flora and Vegetation of the Banded Ironstone Formations of the Yilgarn Craton – Central Tallering Landsystem (Markey and Dillon 2008)	Partially located within the Study Area (Karara and Mungada) and extending north to Minjar and east to Walagnumming Hill)	• Level 2 flora and vegetation survey; • No targeted flora survey	• 103 quadrats in total surveyed	September and October 2005	414 taxa and four hybrids	12 taxa: • *Austrostipa blackii* (P3) • *Gunniopsis divisa* (P3) • *Micromyrtus trudgenii* (P3) • *Micromyrtus acuta* (P3) • *Millotia dimorpha* (P3) • *Persoonia pentasticha* (P3) • *Polianthion colinum* (P3) • *Psammomoya implexa* (P3) • *Rhodanthe collina* (P3) Further five taxa noted as being endemic or near endemic taxa which were not listed as DRF or Priority flora at time of reporting	26 weed taxa recorded	• 8 FCTs described • Communities 1a, 1b, 2, 3, 4a and 4b were associated with the hillslopes, crests and plateaux sampled areas • Communities 5a and 5b were associated with lowerslopes, footslopes, colluvial outwashes and plains.
Impact Assessment of *Grevillea globosa* (Yilgarn Consulting 2006)	Approximately 30 km north of Study Area	• Targeted searching for significant flora	• Targeted flora searching and population mapping	September 2006	NA	1 taxon: • *Grevillea globosa* (P3)	NA	NA
Karara–Mungada Project Survey Area Flora and Vegetation Assessment (Woodman Environmental 2008c)	Forms central and eastern section of the Study Area	• Level 2 (Detailed) flora and vegetation survey; • Targeted searching for significant flora; • Incorporates data from Markey and Dillon (2006) and Woodman Environmental (2004, 2007e, g, h, i, j, n, 2008a, b)	• 155 quadrats; • 53 transects for targeted flora searching; • 119 significant flora monitoring quadrats	Main survey: • June–September 2006 (quadrats and targeted searching). Other surveys from which data has been incorporated in assessment: • September–October 2005 (quadrats, targeted searching); • April–May 2006 (targeted searching); • September 2007 (targeted searching)	• 514 taxa; • 202 genera; • 72 families	23 taxa: • *Acacia karina* (P1); • *Acacia woodmaniorum* (T); • *Austrostipa blackii* (P3); • *Calandrinia kalanniensis* (P2); • *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3); • *Drummondita fulva* (P3); • *Grevillea globosa* (P3); • *Grevillea scabrida* (P1); • *Grevillea subtiliflora* (P3); • *Gunniopsis divisa* (P3); • *Gunniopsis rubra* (was P3, no longer listed as significant); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Melaleuca barlowii* (P3); • *Micromyrtus acuta* (P3); • *Micromyrtus trudgenii* (P3); • *Millotia dimorpha* (P1); • *Persoonia pentasticha* (P3); • *Polianthion collinum* (P3); • *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (was *Prostanthera* aff. *campbellii* (A. Markey & S. Dillon 3386)) (P1); • *Rhodanthe collina* (P3); • *Stenanthemum poicilum* (P3); • *Teucrium disjunctum* (was *Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155–109), P3, no longer listed as significant); • *Stylidium scintillans* (was *Stylidium ?petiolare* (potentially undescribed)) (T)	26 taxa, including two Declared Pests: • *Echium plantagineum;* • *Galium aparine*	• 23 FCTs mapped; • One PEC identified: ○ Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (P1) (FCTs 4, 8, 9, 10a, 10b, 11, 12, 13, and 14); • FCTs 4, 7b, 7c, 9, 10a, 10b and 14 were identified as having moderate conservation significance (according to a conservation significance scale developed by Woodman Environmental (2008c)); • FCTs 8, 11, 12 and 13 were identified as having a high conservation significance (according to a conservation significance scale developed by Woodman Environmental (2008c))
Mount Mulgine Drilling Programme Proposed Drilling 2008 Flora and	Approximately 3 km east of Study Area	• Reconnaissance flora and vegetation survey;	• Structural vegetation notes;	July 2008	NA	10 taxa: • *Acacia diallaga* (P1); • *Acacia karina* (P1);	NA	• 10 FCTs described; • FCTs were not compared to any known PECs or TECs

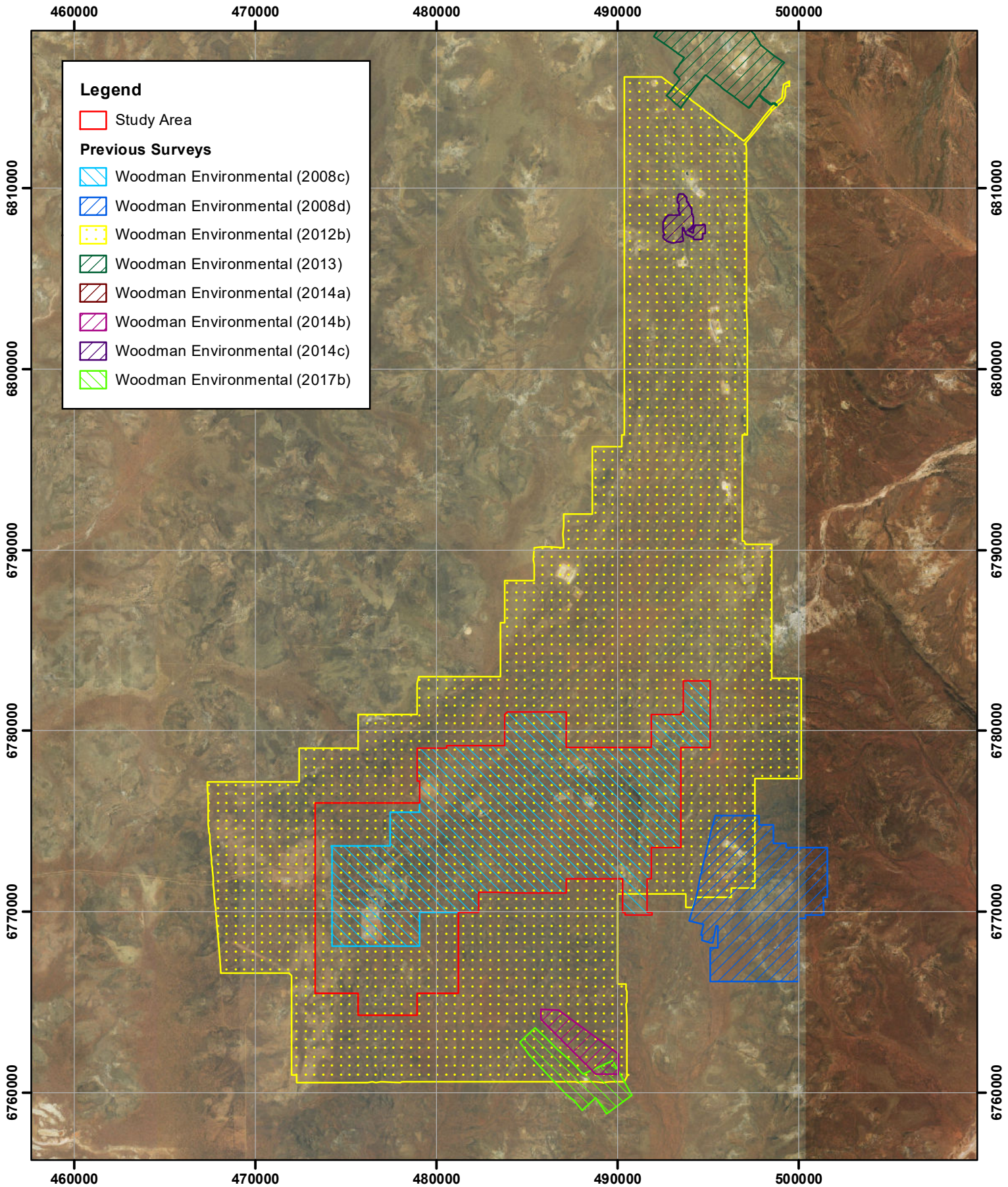
Project and Source	Location in Relation to Study Area	Survey Scope	Parameters of Assessment	Timing	Number of Flora Taxa	Significant Flora Taxa^	Introduced Flora Taxa^	Vegetation and Significant Vegetation*
Vegetation Assessment (Woodman Environmental 2008d)		• Targeted searching for significant flora	• Searching along proposed drill lines and access tracks			• *Acacia sulcaticaulis* (P1); • *Chamelaucium* sp. Warriedar (A.P. Brown & S. Patrick APB 1100) (P1); • *Dicrastylis linearifolia* (P3); • *Grevillea globosa* (P3); • *Grevillea scabrida* (P1); • *Grevillea subtiliflora* (P3); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Persoonia pentasticha* (P3)		
Golden Grove – Flora Survey & Vegetation Mapping for the Open Pit Project (Yilgarn Consulting 2008)	Approximately 30 km north of Study Area	• Reconnaissance flora and vegetation survey	• Mapping notes; • Opportunistic flora recording	May–July 2008	• 86 taxa	6 taxa: • *Calytrix uncinata* (was P3, no longer listed as significant); • *Drummondita fulva* (P3); • *Euryomyrtus patrickiae* (was P3, no longer listed as significant); • *Grevillea globosa* (P3); • *Micromyrtus trudgenii* (P3); • *Polianthion collinum* (P3)	No introduced flora recorded	• 16 VUs mapped; • VUs were not compared to any known PECs or TECs
Golden Grove – Flora Survey and Vegetation Mapping for TSF3 footprint – Site B&D and Northern Areas (Yilgarn Consulting 2009)	Approximately 30 km north of Study Area	• Reconnaissance flora and vegetation survey	• Mapping notes; • Opportunistic flora recording	April–September 2008	• 219 taxa	3 taxa: • *Acacia speckii* (P4); • *Calytrix uncinata* (was P3, no longer listed as significant); • *Gunniopsis rubra* (was P3, no longer listed as significant)	11 taxa, none of which are Declared Pests of WoNS	• 19 VUs mapped; • VUs were not compared to any known PECs or TECs
Golden Grove Targeted Searches for Conservation Significant Flora – Southern Leases & Gossan Hill South (Yilgarn Consulting 2010)	Approximately 30 km north of Study Area	• Targeted searching for significant flora	• Targeted flora searching transects	November 2010	NA	5 taxa: • *Calytrix uncinata* (was P3, no longer listed as significant); • *Drummondita fulva* (P3); • *Euryomyrtus patrickiae* (was P3, no longer listed as significant); • *Grevillea globosa* (P3); • *Micromyrtus trudgenii* (P3)	NA	NA
Golden Grove Targeted Searches for Threatened Flora '*Stylidium* sp. Yalgoo' & Gossan Valley Vegetation and Flora Survey (Yilgarn 2011)	Approximately 30 km north of Study Area	• Level 2 (Detailed) flora and vegetation survey; • Targeted searching for significant flora	• 49 quadrats; • Targeted flora searching transects; • 3 significant flora quadrats	August–September 2011	• 242 taxa; • 52 families	8 taxa: • *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3); • *Calytrix uncinata* (was P3, no longer listed as significant); • *Drummondita fulva* (P3); • *Grevillea globosa* (P3); • *Gunniopsis propinqua* (was P3, no longer listed as significant); • *Gunniopsis rubra* (was P3, no longer listed as significant); • *Micromyrtus trudgenii* (P3) • *Stylidium scintillans* (was *Stylidium* sp. Yalgoo (D. Coultas et al. Opp 01)) (T)	6 taxa, none of which are Declared Pests of WoNS	• 16 VUs mapped; • No TECs or PECs identified
Blue Hills Mungada West and East (Tenements M59/595 and M59/596) Infrastructure Areas; Targeted Flora Surveys (Maia 2012)	Within Study Area	• Targeted searching for significant flora	• Targeted flora searching transects	June–September 2011	• 179 taxa; • 104 genera; • 46 families	5 taxa: • *Acacia woodmaniorum* (T); • *Drummondita fulva* (P3); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Micromyrtus trudgenii* (P3); • *Persoonia pentasticha* (P3)	1 taxon, which is not a Declared Pest of WoNS	• 5 VUs from Karara–Mungada Survey identified within survey area; • One PEC identified: ○ Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (P1)
Jasper Hill Exploration Prospect Significant Flora Assessment (Woodman Environmental 2012a)	Approximately 100 m north of Study Area	• Targeted searching for significant flora and vegetation	• Searching along proposed drill lines and access tracks	August 2011	NA	6 taxa: • *Calandrinia* sp. Warriedar (F. Obbens 04/09) (P2); • *Drummondita fulva* (P3); • *Gunniopsis rubra* (was P3, no longer listed as significant); • *Menkea draboides* (P3); • *Persoonia pentasticha* (P3); • *Rhodanthe collina* (P3)	NA	NA
Regional Flora and Vegetation Survey of the Karara to Minjar	Overlaps the majority of the Study Area	• Level 2 (Detailed) regional flora and vegetation survey;	• 990 quadrats	Main survey: • September–October 2008;	• 640 taxa; • 2 known hybrids; • 14 putative hybrids;	33 taxa: • *Acacia diallaga* (P1); • *Acacia karina* (P1); • *Acacia subsessilis* (P3);	41 taxa, including two Declared Pests: • *Echium plantagineum;*	• 32 FCTs, two of which were split further into 4 subtypes each, and one additional plant community mapped; • Three PECs identified:

Project and Source	Location in Relation to Study Area	Survey Scope	Parameters of Assessment	Timing	Number of Flora Taxa	Significant Flora Taxa^	Introduced Flora Taxa^	Vegetation and Significant Vegetation*
Block (Woodman Environmental 2012b)		• Incorporates data from Markey and Dillon (2008) and Woodman Environmental (2007a, b, c, d, f, k, l, m, 2008c, 2009a, d, 2011)		• May, July–August, October–December 2009; • September–January 2010–2011. Other surveys from which data has been incorporated in assessment: • September–October 2005; • August 2006; • May–June 2007	• 241 genera; • 70 families	• *Acacia woodmaniorum* (T); • *Allocasuarina tessellata* (P1); • *Austrostipa blackii* (P3); • *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3); • *Calytrix uncinata* (was P3, no longer listed as significant); • *Chamelaucium* ?sp. Warriedar (A.P. Brown & S. Patrick APB 1100) (P1); • *Chamelaucium* sp. Warriedar (A.P. Brown & S. Patrick APB 1100) (P1); • *Cyanicula fragrans* (P3); • *Dicrastylis linearifolia* (P3); • *Drummondita fulva* (P3); • *Eremophila grandiflora* (P1); • *Grevillea globosa* (P3); • *Grevillea scabrida* (P1); • *Grevillea subtiliflora* (P3); • *Gunniopsis divisa* (P3); • *Gunniopsis rubra* (was P3, no longer listed as significant); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Melaleuca* ?*barlowii* (P3); • *Melaleuca barlowii* (P3); • *Micromyrtus acuta* (P3); • *Micromyrtus trudgenii* (P3); • *Millotia dimorpha* (P1); • *Persoonia pentasticha* (P3); • *Petrophile pauciflora* (P3); • *Polianthion collinum* (P3); • *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1); • *Psammomoya implexa* (P3); • *Rhodanthe collina* (P3); • *Stenanthemum poicilum* (P3); • *Stylidium scintillans* (was *Stylidium* sp. Yalgoo (D. Coultas et al. Opp 01)) (T)	• *Galium aparine*	○ Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (P1) (FCTs 1, 2, 3, 4, 5, 6, 10 and 12); ○ Yalgoo (Gnows Nest/Wolla Wolla and Woolgah–Wadgingarra) vegetation assemblages (banded ironstone formation) (P1) (FCTs 2 and 3); ○ Warriedar/Pinyalling/ Walagnumming Hills vegetation assemblages (banded ironstone formation) PEC (P1) (FCTs 1, 10 and 28); • FCTs 1, 2, 3, 4, 5, 6, 8, 10, 12, 14, 16, 19b, 19c, 19d, 21a, 21b, 21c and 30 were identified as having a high conservation significance (according to a conservation significance scale developed by Woodman Environmental (2008c))
Golden Grove Open Pit Expansion Project Baseline Flora and Vegetation Impact Assessment (Woodman Environmental 2013)	Approximately 30 km north of the Study Area	• Level 2 (Detailed) flora and vegetation survey; • Incorporates data from historical surveys	• 63 quadrats	October 2012	• 114 taxa; • 2 putative hybrids; • 53 genera; • 26 families	8 taxa: • *Acacia speckii* (P4); • *Calytrix uncinata* (was P3, no longer listed as significant); • *Drummondita fulva* (P3); • *Grevillea globosa* (P3); • *Micromyrtus trudgenii* (P3); • *Persoonia pentasticha* (P3); • *Polianthion collinum* (P3); • *Stylidium scintillans* (T)	No introduced flora recorded	• 13 VUs mapped; • One PEC identified: ○ Minjar/Gnows Nest vegetation complexes (banded ironstone formation) (P1), which has been subsequently split into two separate PECs: Minjar and Chulaar Hills vegetation assemblages (banded ironstone formation) (P1) and Yalgoo (Gnows Nest/Wolla Wolla and Woolgah–Wadgingarra) vegetation assemblages (banded ironstone formation) (P1); • One VU was identified as having high local conservation significance (according to a conservation significance scale presented in Woodman Environmental (2013)); • Three VUs were identified as having high regional conservation significance (according to a conservation significance scale presented in Woodman Environmental (2013))

Project and Source	Location in Relation to Study Area	Survey Scope	Parameters of Assessment	Timing	Number of Flora Taxa	Significant Flora Taxa^	Introduced Flora Taxa^	Vegetation and Significant Vegetation*
Blue Hills (Tenements M59/595 & M59/596) Targeted Flora Survey (Maia 2014)	Within Study Area	• Targeted searching for significant flora	• Targeted flora searching transects	June 2014	• 70 taxa; • 52 genera; • 33 families	7 taxa: • *Acacia karina* (P1); • *Acacia woodmaniorum* (T); • *Drummondita fulva* (P3); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Micromyrtus acuta* (P3); • *Micromyrtus trudgenii* (P3); • *Persoonia pentasticha* (P3)	2 taxa, neither of which are Declared Pests of WoNS	• 7 VUs from Karara–Mungada Survey identified within survey area; • One PEC identified: ○ Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (P1)
Flora and Vegetation of the Greenstone Ranges of the Yilgarn Craton: Warriedar Fold Belt (Meissner and Coppen 2014)	Western part of survey area overlaps Study Area	• Level 2 (Detailed) flora and vegetation survey	• 50 quadrats	September 2011	• 286 taxa; • 91 genera; • 36 families	23 taxa: • *Acacia diallaga* (P1); • *Acacia karina* (P1); • *Acacia subsessilis* (P3); • *Acacia sulcaticaulis* (P1); • *Allocasuarina tessellata* (P1); • *Austrostipa blackii* (P3); • *Calandrinia* sp. Warriedar (F. Obbens 04/09) (P2); • *Chamelaucium* sp. Warriedar (A.P. Brown & S. Patrick APB 1100) (P1); • *Cyanicula fragrans* (P3); • *Dodonaea amplisemina* (P4); • *Eremophila grandiflora* (P1); • *Grevillea scabrida* (P1); • *Grevillea subtiliflora* (P3); • *Gunniopsis rubra* (was P3, no longer listed as significant); • *Hydrocotyle dimorphocarpa* (was *Hydrocotyle* sp. Warriedar (P.G. Wilson 12267)) (P1); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Micromyrtus acuta* (P3); • *Micromyrtus trudgenii* (P3); • *Millotia dimorpha* (P1); • *Persoonia pentasticha* (P3); • *Rhodanthe collina* (P3); • *Stenanthemum poicilum* (P3); • *Tricoryne tuberosa* (was Tricoryne sp. Morawa (G.J. Keighery & N. Gibson 6759), P3, no longer listed as significant)	14 taxa, none of which are Declared Pests of WoNS	• 6 VUs identified; • VUs were not compared to any known PECs or TECs
Conservation Significant Flora Survey Northern Leases – Golden Grove (Woodman Environmental 2014a)	Approximately 45 km north of the Study Area	• Targeted searching for significant flora	• Targeted flora searching transects	June 2014	NA	2 taxa: • *Acacia speckii* (P4); • *Calytrix uncinata* (was P3, no longer listed as significant)	NA	• Two PECs identified: ○ Minjar and Chulaar Hills vegetation assemblages (banded ironstone formation) (P1); ○ Yalgoo (Gnows Nest/Wolla Wolla and Woolgah–Wadgingarra) vegetation assemblages (banded ironstone formation) (P1)
Rothsay Iron Ore Project Programme of Works Significant Flora and Vegetation Assessment (Woodman Environmental 2014b)	Approximately 5 km southeast of the Study Area	• Targeted searching for significant flora and vegetation	• Searching along proposed drill pads and access tracks	January 2014	NA	4 taxa: • *Micromyrtus acuta* (P3); • *Micromyrtus trudgenii* (P3); • *Persoonia pentasticha* (P3); • *Stenanthemum poicilum* (P3)	NA	• One PEC identified: ○ Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (P1)
Shine Project Targeted Biological Survey Shine Survey Area – Footprint and Buffer Area (Woodman Environmental 2014c)	Approximately 25 km north of the Study Area	• Targeted searching for significant and introduced flora	• Targeted flora searching transects	September 2014	NA	4 taxa: • *Calytrix uncinata* (was P3, no longer listed as significant); • *Drummondita fulva* (P3); • *Micromyrtus trudgenii* (P3); • *Rhodanthe collina* (P3)	4 taxa, none of which are Declared Pests of WoNS	NA
Rothsay Gold Project Flora and Vegetation	Approximately 4.5 km southeast of the Study Area	• Level 2 (Detailed) flora and vegetation survey;	• 35 quadrats	October 2016	• 300 taxa; • 1 putative hybrid;	17 taxa: • *Acacia karina* (P1); • *Allocasuarina tessellata* (P1);	22 taxa, including two Declared Pests:	• 9 VUs mapped; • One PEC identified:

Project and Source	Location in Relation to Study Area	Survey Scope	Parameters of Assessment	Timing	Number of Flora Taxa	Significant Flora Taxa^	Introduced Flora Taxa^	Vegetation and Significant Vegetation*
Assessment (Woodman Environmental 2017)		• Targeted searching for significant flora within selected areas of appropriate habitat			• 163 genera; • 59 families	• *Austrostipa blackii* (P3); • *Bossiaea* sp. Jackson Range (G. Cockerton & S. McNee LCS 13614) (P3); • *Calandrinia* sp. Warriedar (F. Obbens 04/09) (P2); • ?*Cyanicula fragrans* (P3); • *Grevillea globosa* (P3); • *Grevillea scabrida* (P1); • *Grevillea subtiliflora* (P3); • *Gunniopsis divisa* (P3); • *Hemigenia tichbonii* (P1); • *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1); • *Micromyrtus trudgenii* (P3); • *Millotia dimorpha* (P1); • *Persoonia pentasticha* (P3); • *Rhodanthe collina* (P3); • *Stenanthemum poicilum* (P3); Plus habitat for *Stylidium scintillans* (T) but survey potentially later than the flowering period of this taxon.	• *Echium plantagineum;* • *Rumex hypogaeus* (no longer a Declared Pest)	○ Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) (P1) (VUs 2 and 3); • VUs 2, 6, 7 and 9 were identified as being potential significant vegetation in a local context (as per EPA 2016a); • VUs 6, 7 and 9 were identified as being potential significant vegetation in a regional context (as per EPA 2016a)
Rothsay Gold Project – Targeted Survey for *Stylidium scintillans* (Threatened) (Woodman Environmental 2018)	Approximately 4.5 km southeast of the Study Area	• Targeted searching for significant flora within selected areas of appropriate habitat	• Targeted flora searching transects	August 2018	NA	4 taxa: • *Calandrinia* sp. Warriedar (F. Obbens 04/09) (P2); • *Menkea draboides* (P3); • *Micromyrtus acuta* (P3); • *Petrophile pauciflora* (P3)	NA	NA
Rothsay Gold Project – Targeted Survey for *Hemigenia tichbon*ii (Woodman Environmental 2019)	Approximately 7.5 km southeast of the Study Area	• Targeted searching for significant flora within selected areas of appropriate habitat	• Targeted flora searching transects	June 2019	NA	1 taxon: • *Hemigenia tichbonii* (P1)	NA	NA

^ Significant flora and introduced flora taxa status as per current *FloraBase* listing (WA Herbarium 1998–).
* Significant vegetation status as per current Commonwealth (EPBC Act) and State (BC Act and DBCA) listings.



Flora and Vegetation Surveys Previously Conducted Within and in the Vicinity of the Study Area	Author: Marlee Starcevich	N
	WEC Ref: KML20-33-01	
umwelt	Filename: KML20-33-01-f07	**Figure**
	Scale: 1:275,000 (A4)	7
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report KML20-33-01.	Revision: A - 30 August 2021	

5.1.3 Summary of Significant Flora

A list of significant flora taxa known from within the Study Area and surrounds is presented in Table 7. This list has been compiled from the results of desktop searches of DBCA's Threatened Flora Databases (TPFL, WA Herbarium, *NatureMap*) (DBCA 2007–, 2020b), DAWE's SPRAT Database (DAWE 2020), and the results of previous surveys as summarised in Section 5.1.2. Table 7 also presents the flowering period and habitat for each taxon (WA Herbarium 1998–). Figure 8 presents the known historical locations of significant flora taxa in the Desktop Study Area (subject to the availability of spatial data).

Conservation codes for listed taxa are explained in Appendix D (DBCA 2019).

A total of 78 significant taxa are known from within the vicinity of the Study Area, including five Threatened taxa and 73 DBCA-classified Priority flora. Of these, there are 24 taxa that have records within the Study Area (highlighted in green in Table 7), eight of which have been recorded previously within the Footprint; *Acacia karina* (P1); *Allocasuarina tessellata* (P3); *Calotis* sp. Perrinvale Station (R. J. Cranfield 7096) (P3); *Grevillea globosa* (P3); *Gunniopsis divisa* (P3); *Prostanthera* sp. Karara (D. Coultas and K. Greenacre (Opp 8), *Persoonia pentasticha* (3) and *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1) (presented with bolded text in Table 7).

In addition, according to DAWE (2020), there may be suitable habitat within the Desktop Study Area for an additional 10 Threatened taxa (highlighted in yellow in Table 7). However, these taxa have not been previously recorded in the area according to DBCA's databases. The SPRAT database search is based on Threatened flora known from regional areas rather than actual records and includes provision of species and species habitat which are 'likely to occur' and 'may occur' as well as 'known to occur'; it therefore returns flora known from a wider area than the DBCA database searches, and can be erroneous

Note that the DBCA database searches returned records of *Chamelaucium* sp. Yalgoo (Y. Chadwick 1816) (P1) from the interrogation area; as discussed in Section 5.1.2, these records are considered to be the result of misidentification of either *Chamelaucium pauciflorum* subsp. Perenjori (B.J. Conn 2181) or *Chamelaucium* sp. Warriedar (A.P. Brown & S. Patrick APB 1100) (P1) (Woodman Environmental field observations). Similarly, locations of *Angianthus prostratus* (P3) were recorded by the Regional Mapping Survey; as discussed in Section 5.1.2, this is considered to be a misidentification of *Gilruthia osbornei.* These taxa have therefore not been included in Table 7 or Figure 8 and are not discussed further in this report.

Table 7: Significant Flora Taxa Known from the Study Area and Surrounds

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Acacia diallaga	P1		• DBCA; • M & C (2014); • WEC (2008d); • WEC (2012b)	August–September	Skeletal, red, silty loam on the slopes, or occasionally crests, of low rocky basalt hills
Acacia formidabilis	P3		• DBCA	August–September	Yellow or red-brown sand. Undulating plains, hillsides
Acacia graciliformis	P1		• DBCA	September	Stony red-brown clay loams, laterite, BIF, basalt. Rock outcrops, base of rocky hills, gentle slopes
Acacia karina	**P1**		• **DBCA;** • **Maia (2014);** • **M & C (2014);** • **WEC (2008c);** • **WEC (2008d);** • **WEC (2012b);** • **WEC (2017)**	**May–July**	**Crest and upper slopes, the mid and lower slopes of BIFs and surrounding terrain. Shallow acidic orange to red-brown soils comprising silty clay loam, hard clay and silty stony clay over BIF or occasionally granite**
Acacia speckii	P4		• DBCA; • WEC (2013); • WEC (2014a); • Yilgarn (2009)	Unknown	Rocky soils over granite, basalt or dolerite. Rocky hills or rises
Acacia subsessilis	P3		• DBCA; • M & C (2014); • WEC (2012b)	July–August	Red sand or stony gravel over ironstone. Rocky hills
Acacia sulcaticaulis	P1		• DBCA; • M & C (2014); • WEC (2008d)	August–September	Red or brown loam. Slopes of dolerite, granite and greenstone hills, rocky creeklines
Acacia tuberculata	P2		• DBCA	September	Granite outcrops

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Acacia woodmaniorum	T	Endangered	• DAWE[#]; • DBCA; • Maia (2012); • Maia (2014); • WEC (2008c); • WEC (2012b)	June–August	Skeletal red silt, red-brown soil, BIF, laterite. Slopes, crests of ridges, ranges, disturbed overburden of mine sites
Acacia sp. Goodlands (B.R. Maslin 7761)	P1		• DBCA	September	Brown/yellow sandy loam. Flats
Allocasuarina tessellata	**P1**		• **DBCA;** • **M & C (2014);** • **WEC (2012b);** • **WEC (2017)**	**April, August**	**Red loam or red sandy loam or red-brown sandy clay loam over laterite, ironstone, granite, basalt, greenstone or dolerite**
Aluta aspera subsp. *localis*	P2		• DBCA	October–November	Sandplain
Angianthus micropodioides	P3		• DBCA	November–February	Saline sandy soils. River edges, saline depressions, claypans
Austrostipa blackii	P3		• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	September–November	Red-brown sandy clay loam or orange clay loam. BIF ranges and outcropping or basalt outcrops
Baeckea sp. Perenjori (J.W. Green 1516)	P2		• DBCA	August	Loam, clay
Banksia benthamiana	P4		• DBCA	November–January	Sandy loam, clay-loam, yellow sand, gravel
Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)	P3		• DBCA; • WEC (2017)	March–September	Breakaway, laterised ironstone, red-brown clay loam soils. Flats and lower slopes at base of weathered granite breakaways. Dry white-grey sandy loam. Mid slope of low BIF hills, growing on duricrust

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Caesia sp. Koolanooka Hills (R. Meissner & Y. Caruso 78)	P1		• DBCA	November	Orange-red-brown soils on BIF or granite. Steep to slight hill slopes and crests
Calandrinia kalanniensis	P2		• DBCA; • WEC (2008c)	November–January	Shallow brown clay, often gritty, derived from eroded granite. Rock outcrops, herbfields
Calandrinia sp. Warriedar (F. Obbens 04/09)	P2		• DBCA; • M & C (2014); • WEC (2012a); • WEC (2017)	September	Breakaway, laterite, red-brown clay loam soils. Granitic flat. Brown clay loam with granite stones. Lower slope of a small ironstone range
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	**P3**		• **DBCA;** • **WEC (2008c);** • **WEC (2012b);** • **Yilgarn (2011)**	**Unknown**	**Rocky areas, usually on BIF or laterised ridges and outcrops on yellow or red-brown soils**
Chamelaucium sp. Warriedar (A.P. Brown & S. Patrick APB 1100)	P1		• DBCA; • M & C (2014); • WEC (2008d); • WEC (2012b); • WEC (2018)	July–September	Red-brown rocky clay loam. Lower slope of basalt and minor quartz with red-brown deep sandy clay loam soils. Low rocky hill, skeletal silty clay loam over granite/greenstone
Chorizema humile	T	Endangered	• DAWE^	July–September	Sandy clay or loam. Plains
Cyanicula fragrans	P3		• DBCA; • M & C (2014); • WEC (2012b); • WEC (2017)	August–September	Red loam. Flat granite outcrops
Dasymalla axillaris	T	Critically Endangered	• DAWE^	July–December	Sandy soils. Possibly a disturbance opportunist; has only been recorded in areas of recent disturbance
Dicrastylis linearifolia	P3		• DBCA; • WEC (2008d); • WEC (2012b)	November–December	Red sand. Sandplains
Dodonaea amplisemina	P4		• DBCA; • M & C (2014)	August	Red-brown sandy clay on basalt and gabbro and BIF or on dolerite and quartzite. Rocky hills

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Drummondita fulva	P3		• DBCA; • Maia (2012); • Maia (2014); • WEC (2008c); • WEC (2012a); • WEC (2012b); • WEC (2013); • WEC (2014c); • Yilgarn (2008); • Yilgarn (2010); • Yilgarn (2011)	September–October	Lower slopes to upper slopes and hill crests of BIF and associated bedrock. Skeletal shallow acidic soils of orange-red or red-brown sandy loams and clayey silts
Elatine macrocalyx	P3		• DBCA	May–October	Shallow sands over clay. Margins of playa lakes and claypans
Enekbatus longistylus	P3		• DBCA	September–October	Yellow sand. Sandplains
Eremophila grandiflora	P3		• DBCA; • M & C (2014); • WEC (2012b)	June–September	Stony red-brown sandy-clay. On slopes and along drainage lines
Eremophila nivea	T	Endangered	• DAWE^	August–October	Sandy clay, clay loam. Undulating plains, areas of disturbance
Eremophila oldfieldii subsp. *papula*	P1		• DBCA	August–November	Red-brown clay loam on lower slopes of rocky hills
Eremophila rostrata subsp. *trifida*	T	Critically Endangered	• DAWE#; • DBCA	September–October	Hard, light brown, sandy loams, granite
Eremophila sericea	P1		• DBCA	September–November	Red-brown clay loam on the lower slopes of rocky hills
Eremophila viscida	T	Endangered	• DAWE~	September–November	Granitic soils, sandy loam. Stony gullies, sandplains
Eucalyptus beardiana	T	Vulnerable	• DAWE^	August–September	Red or yellow sand. Sand dunes and sand plains

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Eucalyptus jutsonii subsp. *kobela*	P1		• DBCA	Unknown	Deep yellow to orange sand. Broad and subdued rises high in the landscape
Eucalyptus synandra	T	Vulnerable	• DAWE[#]; • DBCA	December–February	Yellow or orange sand or grey-brown loam or red sandy loam. Lateritic soils. Summits of ironstone hills or flats
Euryomyrtus recurva	P3		• DBCA	July–September	Yellow or red sand, brown or yellow sandy clay. Areas of disturbance, gravel pits, catchment slopes
Eutaxia sp. Jasper Hill (R.J. Cranfield 8607)	P1		• DBCA	Unknown	Red brown clay, ironstone
Fitzwillia axilliflora	P2		• DBCA	September–November	Sand, clay loam. Margins of salt lakes, saline flats
Frankenia conferta	T	Endangered	• DAWE^	October	Clayey soils on the edge of salt lakes
Gnephosis cassiniana	P3		• DBCA	September–October	Sand, clay loam. Saline depressions, low wet areas
Gnephosis setifera	P1		• DBCA	September	Sand. Saline flats
Grevillea globosa	**P3**		• **DBCA;** • **Mattiske (2004);** • **WEC (2008c);** • **WEC (2008d);** • **WEC (2012b);** • **WEC (2013);** • **WEC (2017);** • **Yilgarn (2006);** • **Yilgarn (2008);** • **Yilgarn (2010);** • **Yilgarn (2011)**	**June, September–January**	**Red loam, yellow sand. Orange clay loam over ironstone (BIF)**
Grevillea granulosa	P3		• DBCA	July–October	Gravelly sand, loam, clay. Sandplains
Grevillea leptopoda	P3		• DBCA	August–September	Loam and lateritic gravel, sand, clay

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Grevillea obliquistigma subsp. *cullenii*	P2		• DBCA	March	Red sand
Grevillea rosieri	P1		• DBCA	July–September	Sandy soils, sometimes with granite and laterite
Grevillea scabrida	P1		• DBCA; • M & C (2014); • WEC (2008c); • WEC (2008d); • WEC (2012b); • WEC (2017)	July	Red clay loam, stony loam or brown loam over BIF, dolerite granite basalt or greenstone
Grevillea subtiliflora	P3		• DBCA; • M & C (2014); • WEC (2008c); • WEC (2008d); • WEC (2012b); • WEC (2017)	July–October	Red-brown loam or red-brown shallow sandy clay loam soils. Rocky basalt outcrops
Gyrostemon reticulatus	T	Critically Endangered	• DAWE~	September	Yellow-brown sandy slopes
Gunniopsis divisa	**P3**		• **DBCA;** • **WEC (2008c);** • **WEC (2012b);** • **WEC (2017)**	**August–September**	**Red sand, pale orange clay loam. Quartz, ironstone and granite gravelly flats, hilltops**
Haegiela tatei	P4		• DBCA	August–November	Clay, sandy loam, gypsum. Saline areas
Hemigenia tichbonii	P1		• DBCA; • WEC (2017); • WEC (2019)	August–October	Semi-arid open shrublands over granite or greenstone
Hybanthus cymulosus	T	Critically Endangered	• DAWE[#]	May–July	Clay, rocky loam clay
Hydrocotyle dimorphocarpa	P1		• DBCA; • M & C (2014)	September–October	Creekbanks or drainage lines containing red-brown clay loam soils

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Hydrocotyle spinulifera	P3		• DBCA	August–November	Moist margins of seasonal wetlands, freshwater and saline lakes
Korthalsella leucothrix	P1		• DBCA	August	Parasitic on *Acacia acuminata* and *Acacia craspedocarpa*
Lepidosperma gibsonii	T		• DBCA	September–February	Shallow soil over massive BIF. Gullies and slopes
***Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468)**	**P1**		• **DBCA;** • **Maia (2012);** • **Maia (2014);** • **M & C (2014);** • **WEC (2008c);** • **WEC (2008d);** • **WEC (2012b);** • **WEC (2017)**	**August–September**	**Red, brown and orange sandy loam or clay with BIF and quartz pieces. Plains, watercourses and lower slopes, adjacent to granite. Outwash zones at base of BIF ranges**
Lepidosperma sp. Koolanooka (K.R. Newbey 9336)	P1		• DBCA	May–June, October	Red and brown gravelly loam and clay over laterite. Rocky laterised ironstone and BIF, basalt outcrop
Leucopogon sp. Yanneymooning (F. Mollemans 3797)	P3		• DBCA	May	White-grey sandy clay, brown gritty loam over granite, skeletal soils. Tops of valleys, hills and breakaways
Melaleuca barlowii	P3		• DBCA; • WEC (2008c); • WEC (2012b)	April	Yellow-brown sand or red-brown clay loam. Lower hillslope of dolerite and BIF with brown soils. Lateritic light red sandplain
Menkea draboides	P3		• DBCA; • WEC (2012a); • WEC (2018)	August–September	Red sand or clay, granite

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Micromyrtus acuta	P3		• DBCA; • Maia (2014); • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2014b); • WEC (2018)	July–October	Grey-tan silty fine to coarse sand, laterite, granite. Rock outcrops
Micromyrtus trudgenii	P3		• DBCA; • Maia (2012); • Maia (2014); • Mattiske (2004); • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2013); • WEC (2014b); • WEC (2014c); • WEC (2017); • Yilgarn (2008); • Yilgarn (2010); • Yilgarn (2011)	June–October	Red-brown loamy clay, yellow-brown soils, gravel, siltstone, quartz, basalt, BIF, dolerite. Tops and slopes of hills and ridges
Millotia dimorpha	P1		• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	September–October	Red loamy soils. Hillslopes, outcropping granite. Rocky BIF outcrop with brown soils
Mirbelia ferricola	P3		• DBCA	August–October	Restricted to BIF. Shallow lateritic soils on lower to upper slopes and crests of BIF massifs and laterised BIF with haematite, as well as on ledges and between rock-cracks on BIF cliffs

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Persoonia kararae	P2		• DBCA	September–November	Red clay loam. Sandplains and gentle slopes
Persoonia pentasticha	**P3**		• **DBCA;** • **Maia (2012);** • **Maia (2014);** • **M & C (2014);** • **WEC (2008c);** • **WEC (2008d);** • **WEC (2012a);** • **WEC (2012b);** • **WEC (2013);** • **WEC (2014b);** • **WEC (2017)**	**August–November**	**Sand, loam. Base of granite outcrops. Basalt with red-brown deep sandy clay soils**
Petrophile pauciflora	P3		• DBCA; • WEC (2012b); • WEC (2018)	September	Decaying and dissected granite breakaways
Philotheca nutans	P1		• DBCA	April–October	Sandy soils. Low plains, undulating rises, edges of salt lakes
Podotheca pritzelii	P3		• DBCA	September–October	Sand. Sand ridges in salt flats
Podotheca uniseta	P3		• DBCA	September–December	White-grey sand, sandy loam. Samphire flats
Polianthion collinum	P3		• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2013); • Yilgarn (2008)	May–July	Red clay loam between blocks of BIF. Low hills and slopes
***Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8)**	**P1**		• **DBCA;** • **WEC (2008c);** • **WEC (2012b)**	**September**	**Orange sandy loam over BIF. Lower slope of low rises with red silty clay loam**

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Psammomoya implexa	P3		• DBCA; • WEC (2012b)	August–October	Stony rises. Yellow sandplain. Footslopes of BIF and laterite with red brown soils
Rhodanthe collina	P3		• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012a); • WEC (2012b); • WEC (2014c); • WEC (2017)	August–October	Loam. Rocky hills. Red-orange clay-loam over BIF. Lower slope of basalt with red-brown deep sandy clay soils
Roycea pycnophylloides	T	Endangered	• DAWE~	September	Sandy soils, clay. Saline flats
Sclerolaena sp. Koolanooka Hills (R. Meissner & Y. Caruso 437)	P1		• DBCA	Unknown	Red-brown soils, BIF. Lower slopes
Stenanthemum poicilum	P3		• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2014b); • WEC (2017)	May–June, September–November	Red clay or sandy clay, loam. BIF and chert outcrop with orange-brown soils
Stylidium scintillans	T		• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2013); • Yilgarn (2011)	August–September	Granite outcropping. Brown gravelly loam
Tecticornia bulbosa	T	Vulnerable	• DAWE^	April	Saline sandy clay or red-brown loam
Tecticornia fimbriata	P3		• DBCA	Unknown	Clay, loam. Margins of salt and gypsum lakes
Triglochin protuberans	P3		• DBCA	August–November	Red loam, grey mud over clay. Winter-wet sites, claypans, near salt lakes, margins of pools

Taxon	Status (WA)	Status (EPBC Act)	Source*	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)
Wurmbea murchisoniana	P4	•	• DBCA	July–September	Clay, sandy clay, loam. Seasonally inundated clay hollows, rock pools

* Sources are:
DBCA – Interrogation of DBCA WA Herbarium specimen and TPFL databases (DBCA 2007–, 2020b);
DAWE – Interrogation of DAWE SPRAT Database (DAWE 2020);
Maia (2012) –Blue Hills Mungada West and East (Tenements M59/595 and M59/596) Infrastructure Areas; Targeted Flora Surveys (Maia 2012);
Maia (2014) – Blue Hills (Tenements M59/595 & M59/596) Targeted Flora Survey (Maia 2014);
Mattiske (2004) – Newmont – Golden Grove Operations Priority Flora (Mattiske 2004)
M & C (2014) – Flora and Vegetation of the Greenstone Ranges of the Yilgarn Craton: Warriedar Fold Belt (Meissner and Coppen 2014);
WEC (2008c) – Karara–Mungada Project Survey Area Flora and Vegetation (Woodman Environmental 2008c);
WEC (2008d) – Mount Mulgine Drilling Programme Proposed Drilling 2008 Flora and Vegetation Assessment (Woodman Environmental 2008d);
WEC (2012a) – Jasper Hill Exploration Prospect Significant Flora Assessment (Woodman Environmental 2012a);
WEC (2012b) – Regional Flora and Vegetation survey of the Karara to Minjar Block (Woodman Environmental 2012b);
WEC (2013) – Golden Grove Open Pit Expansion Project Baseline Flora and Vegetation Impact Assessment (Woodman Environmental 2013);
WEC (2014a) – Conservation Significant Flora Survey Northern Leases – Golden Grove (Woodman Environmental 2014a);
WEC (2014b) – Rothsay Iron Ore Project Programme of Works Significant Flora and Vegetation Assessment (Woodman Environmental 2014b);
WEC (2014c) – Shine Project Targeted Biological Survey Shine Survey Area – Footprint and Buffer Area (Woodman Environmental 2014c);
WEC (2017) – Rothsay Gold Project Flora and Vegetation Assessment (Woodman Environmental 2017);
WEC (2018) – Rothsay Gold Project – Targeted Survey for *Stylidium scintillans* (Threatened) (Woodman Environmental 2018);
WEC (2019) – Rothsay Gold Project – Targeted Survey for *Hemigenia tichbonii* (Woodman Environmental 2019);
Yilgarn (2006) – Impact Assessment of *Grevillea globosa* (Yilgarn Consulting 2006);
Yilgarn (2008) – Golden Grove – Flora Survey & Vegetation Mapping for the Open Pit Project (Yilgarn Consulting 2008);
Yilgarn (2009) – Golden Grove – Flora Survey and Vegetation Mapping for TSF3 footprint – Site B&D and Northern Areas (Yilgarn Consulting 2009);
Yilgarn (2010) – Golden Grove Targeted Searches for Conservation Significant Flora – Southern Leases & Gossan Hill South (Yilgarn Consulting 2010); and
Yilgarn (2011) – Golden Grove Targeted Searches for Threatened Flora '*Stylidium* sp. Yalgoo' & Gossan Valley Vegetation and Flora Survey (Yilgarn Consulting 2011).

[#] Species or species habitat known to occur within area (DAWE 2020).
~ Species or species habitat likely to occur within area (DAWE 2020).
^ Species or species habitat may occur within area (DAWE 2020).

425000 450000 475000 500000 525000 550000

6825000 6800000 6775000 6750000 6725000 6700000 6675000

Legend

- Study Area
- Desktop Study Area
- Footprint

Significant Flora

- Threatened
- Priority 1
- Priority 2
- Priority 3
- Priority 4
- Potentially undescribed

425000 450000 475000 500000 525000 550000

umwelt

This map should only be used in conjunction with WEC report KML20-33-01.

N

Existing Significant Flora Records from the Study Area and Surrounds

Revision: A - 30 August 2021 Scale: 1:500,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f08

Projection: GDA 1994 MGA Zone 50

Figure

8

5.1.4 Summary of Introduced Flora

A list of introduced flora taxa known from within the Study Area and surrounds is presented in Table 8. This list has been compiled the results of desktop searches of DBCA databases (*NatureMap* WA Herbarium specimen data (DBCA 2007–)), DAWE's SPRAT Database (DAWE 2020), and the results of previous surveys as summarised in Section 5.1.2.

The search of the DAWE database with regard to MNES listed under the EPBC Act identified that five significant invasive flora taxa, or habitat for these taxa, may occur within the Study Area and surrounds (DAWE 2020), being:

- *Carrichtera annua* (Ward's Weed);
- *Cenchrus ciliaris* (Buffel grass);
- *Chrysanthemoides monilifera* (Boneseed);
- *Eichhornia crassipes* (Water Hyacinth); and
- *Tamarix aphylla* (Athel Pine).

These taxa are considered by the States and Territories to pose a particularly significant threat to biodiversity. However, of these, all but *Carrichtera annua* are considered unlikely to occur within the Study Area. *Cenchrus ciliaris*, *Chrysanthemoides monilifera* and *Tamarix aphylla* are not known from the vicinity of the Study Area, with the nearest known records according to DBCA databases being over 100 km, 650 km, and 200 km away, respectively (DBCA 2007–). *Eichhornia crassipes* is known from within 20 km of the Study Area (DBCA 2007–); however, this taxon is a floating aquatic that occurs in freshwater lakes or watercourses (WA Herbarium 1998–). As no such habitat is known to occur within or in the vicinity of the Study Area, it is considered very unlikely to occur within the Study Area.

A total of 82 introduced taxa are known from within the vicinity of the Study Area. Of these, five are WoNS and four are Declared Pests.

Table 8: Introduced Flora Taxa Known from the Study Area and Surrounds

Taxon	Common Name	Source*	Comments
Agave americana	Century Plant	• DBCA	
Aira caryophyllea	Silvery Hairgrass	• DBCA; • WEC (2012b)	
Arctotheca calendula	Cape Weed African Marigold	• DBCA; • Maia (2012); • WEC (2008c); • WEC (2012b); • WEC (2017)	
Avena barbata	Bearded Oat	• WEC (2012b)	
Brassica barrelieri subsp. *oxyrrhina*	Smooth-stem Turnip	• DBCA	
Brassica tournefortii	Mediterranean Turnip	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	
Bromus diandrus	Great Brome	• WEC (2012b)	

Taxon	Common Name	Source*	Comments
Bromus rubens	Red Brome	• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2017)	
Bulbine semibarbata	Leek Lily	• Yilgarn (2009)	
Carrichtera annua	Ward's Weed	• DAWE^	WoNS
Cenchrus ciliaris	Buffel Grass	• DAWE^	WoNS
Centaurea melitensis	Maltese Cockspur Malta Thistle	• DBCA; • WEC (2012b); • WEC (2017); • Yilgarn (2009)	
Centaurium erythraea	Common Centaury	• DBCA	
Chenopodium glaucum	Glaucous Goosefoot	• DBCA	
Chenopodium murale	Nettle-leaf Goosefoot	• DBCA; • WEC (2008c); • Yilgarn (2009)	
Chrysanthemoides monilifera	Boneseed	• DAWE^	Declared Pest; WoNS
Citrullus colocynthis	Colocynth	• DBCA	
Cleretum papulosum	–	• DBCA; • M & C (2014)	
Cleretum papulosum subsp. *papulosum*	–	• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2017)	
Corchorus sp.		• WEC (2008c)	Found throughout the dampland mapped for the Karara–Mungada Survey. Not able to be fully identified due to poor material
Crassula natans	Pigmyweed	• DBCA	
Cuscuta epithymum	Lesser Dodder, Greater Dodder	• DBCA; • Maia (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	
Cuscuta planiflora	Red Dodder	• DBCA; • M & C (2014); • WEC (2014c); • WEC (2017); • Yilgarn (2009); • Yilgarn (2011)	
Cyperus tenellus	Tiny Flatsedge	• DBCA	
Echium plantagineum	Paterson's Curse	• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2017)	Declared Pest
Ehrharta brevifolia	Annual Veldt Grass	• DBCA	
Ehrharta longiflora	Annual Veldt Grass	• DBCA; • WEC (2008c); • WEC (2012b)	

Taxon	Common Name	Source*	Comments
Eichhornia crassipes	Water Hyacinth	• DAWE~; • DBCA	Declared Pest; WoNS
Erodium aureum	–	• DBCA; • WEC (2012b)	
Erodium cicutarium	Common Storksbill	• DBCA; • WEC (2008c); • WEC (2012b)	
Galium aparine	Goosegrass	• DBCA; • WEC (2008c); • WEC (2012b)	Declared Pest
Gorteria personata	Gorteria	• DBCA; • WEC (2012b)	
Hordeum glaucum	Northern Barley Grass	• DBCA	
Hypochaeris glabra	Flatweed, Smooth Catsear	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2014c); • WEC (2017)	
Juncus bufonius	Toad Rush	• DBCA	
Lamarckia aurea	Goldentop	• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2017)	
Leontodon rhagadioloides	Cretan Weed	• DBCA; • Yilgarn (2009)	
Lolium perenne x rigidum	–	• DBCA	
Lysimachia arvensis	Scarlet Pimpernel, Blue Pimpernel	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017); • Yilgarn (2009)	
?*Malva parviflora*	Marshmallow	• WEC (2008c); • WEC (2012b)	
Medicago minima	Small Burr Medic	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	
Medicago polymorpha	Burr Medic	• WEC (2012b)	
Mesembryanthemum aitonis	Angled Iceplant	• DBCA	
Mesembryanthemum crystallinum	Iceplant	• WEC (2012b)	

Taxon	Common Name	Source*	Comments
Mesembryanthemum nodiflorum	Slender Iceplant	• DBCA; • Maia (2014); • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2014c); • WEC (2017); • Yilgarn (2009); • Yilgarn (2011)	
Monoculus monstrosus	Stinking Roger	• DBCA; • WEC (2012b)	
Oxalis corniculata	Yellow Wood Sorrel	• DBCA; • WEC (2012b)	
Parapholis incurva	Coast Barbgrass	• DBCA	
Parentucellia latifolia	Common Bartsia	• DBCA; • M & C (2014); • WEC (2012b); • WEC (2017); • Yilgarn (2011)	
Paspalum dilatatum	Dallis Grass	• DBCA	
Pentameris airoides	False Hairgrass	• DBCA; • WEC (2008c); • WEC (2012b); • Yilgarn (2011)	
Pentameris airoides subsp. *airoides*	False Hairgrass	• DBCA; • M & C (2014); • WEC (2014c); • WEC (2017)	
Petrorhagia dubia	Hairy Pink	• DBCA; • WEC (2012b); • WEC (2017)	
Plantago coronopus	Buckshorn Plantain	• DBCA	
Rostraria cristata	Mediterranean Hairgrass	• DBCA	
Rostraria pumila	Rough Cat's Tail, Tiny Bristle-grass	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	
Rumex hypogaeus	Double Gee	• DBCA; • WEC (2012b); • WEC (2017); • Yilgarn (2009)	
Rumex vesicarius	Ruby Dock	• M & C (2014); • WEC (2012b); • WEC (2017)	
Schinus molle var. *areira*	Pepper-tree	• DBCA	
Schismus barbatus	Kelch Grass	• DBCA; • M & C (2014); • WEC (2017)	
Silene gallica	French Catchfly	• DBCA; • Yilgarn (2009)	

Taxon	Common Name	Source*	Comments
Silene nocturna	Mediterranean Catchfly	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017)	
Sisymbrium erysimoides	Smooth Mustard	• WEC (2012b); • WEC (2017)	
Sisymbrium orientale	Indian Hedge Mustard	• DBCA	
Sisymbrium runcinatum	African Turnip Weed	• DBCA	
Sisymbrium ?runcinatum	African Turnip Weed	• WEC (2012b)	
Solanum nigrum	Black Berry Nightshade	• DBCA; • Yilgarn (2009)	
Sonchus oleraceus	Common Sowthistle	• DBCA; • M & C (2014); • WEC (2008c); • WEC (2012b); • WEC (2017); • Yilgarn (2009); • Yilgarn (2011)	
Spergula arvensis	Corn Spurry	• DBCA	
Spergula pentandra	Five Anther Spurrey	• DBCA; • WEC (2008c); • WEC (2012b); • WEC (2017); • Yilgarn (2011)	
Spergularia rubra	Sand Spurry	• DBCA	
Tamarix aphylla	Athel Pine	• DAWE~	WoNS
Tribulus terrestris	Caltrop	• DBCA	
Trifolium subterraneum	Subterranean Clover	• DBCA	
Urospermum picroides	False Hawkbit	• DBCA; • WEC (2008c); • WEC (2012b)	
Ursinia anthemoides	Ursinia	• DBCA; • WEC (2008c); • WEC (2012b)	
Ursinia anthemoides subsp. *anthemoides*	Mountain Marigold	• DBCA	
Vulpia muralis	Silver Grass	• DBCA; • WEC (2008c); • WEC (2012b)	
Vulpia myuros	Rat's Tail Fescue	• DBCA	
Vulpia myuros forma *myuros*	Rat's Tail Fescue	• DBCA; • WEC (2008c); • WEC (2012b)	
Zaluzianskya divaricata	Spreading Night Phlox	• WEC (2012b)	

* Sources are:
DBCA – Interrogation of DBCA WA Herbarium specimen database (DBCA 2007–);
DAWE – Interrogation of DAWE SPRAT Database (DAWE 2020);
Maia (2012) –Blue Hills Mungada West and East (Tenements M59/595 and M59/596) Infrastructure Areas; Targeted Flora Surveys (Maia 2012);
Maia (2014) – Blue Hills (Tenements M59/595 & M59/596) Targeted Flora Survey (Maia 2014);

M & C (2014) – Flora and Vegetation of the Greenstone Ranges of the Yilgarn Craton: Warriedar Fold Belt (Meissner and Coppen 2014);
WEC (2008c) – Karara–Mungada Project Survey Area Flora and Vegetation (Woodman Environmental 2008c);
WEC (2012b) – Regional Flora and Vegetation survey of the Karara to Minjar Block (Woodman Environmental 2012b);
WEC (2014c) – Shine Project Targeted Biological Survey Shine Survey Area – Footprint and Buffer Area (Woodman Environmental 2014c);
WEC (2017) – Rothsay Gold Project Flora and Vegetation Assessment (Woodman Environmental 2017);
Yilgarn (2009) – Golden Grove – Flora Survey and Vegetation Mapping for TSF3 footprint – Site B&D and Northern Areas (Yilgarn Consulting 2009); and
Yilgarn (2011) – Golden Grove Targeted Searches for Threatened Flora '*Stylidium* sp. Yalgoo' & Gossan Valley Vegetation and Flora Survey (Yilgarn Consulting 2011).

~ Species or species habitat likely to occur within area (DAWE 2020).
^ Species or species habitat may occur within area (DAWE 2020).

5.1.5 Summary of Significant Vegetation

A list of significant vegetation known from within the Study Area and surrounds is presented in Table 9. This list has been compiled from the results of desktop searches of DBCA's TEC and PEC Database (DBCA 2020a), DAWE's SPRAT Database (DAWE 2020), and the results of previous surveys as summarised in Section 5.1.2. Figure 9 presents indicative locations (where available) of significant vegetation in the Desktop Study Area; these consist of DBCA-applied buffers surrounding known locations of TECs and PECs (as per the database search metadata (DBCA 2020a)) and polygon boundaries of potential PECs from the Regional Mapping Surveys and other surveys conducted at Rothsay (east of Karara Station) (Woodman Environmental 2012b; 2017). Two significant vegetation communities are known from within the Study Area (highlighted in green in Table 9), one of which occurs within the Footprint (presented with bolded text in Table 9) (Figure 9). There is also the potential for the significant vegetation community 'Yalgoo/Gnows Nest (Wolla Wolla and Woolgah-Wadgingarrah) vegetation assemblages (banded ironstone formation) (P1) to occur in the Footprint (Figure 9).

Appendix E presents definitions, categories and criteria for TECs and PECs (DBCA 2013).

The interrogation of the DBCA TEC and PEC database (DBCA 2020a as per Section 3.1) did not return any Commonwealth or State-listed TECs within a 20 km buffer of the Study Area. However, two DBCA-listed PECs were identified that have records (represented by buffer polygons) within the interrogation area (Table 9). Of these, buffer polygons for the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) occur within the Study Area (Figure 9).

The search of the DAWE SPRAT database with regard to MNES listed under the EPBC Act (DAWE 2020) identified one TEC listed under the EPBC Act as being likely to occur within the Desktop Study Area, being the 'Eucalypt Woodlands of the Western Australian Wheatbelt' TEC (Critically Endangered).

The 'Eucalypt Woodlands of the Western Australian Wheatbelt' TEC is 'likely to occur within area' according to the search results (DAWE 2020). However, the Approved Conservation Advice (including listing advice) for the 'Eucalypt Woodlands of the Western Australian

Wheatbelt' TEC stipulates that the distribution of this TEC is limited to the AVW1 Merriden, AVW2 Katanning and MAL2 Western Mallee IBRA subregions, and some eastern parts of the JAF1 Northern Jarrah Forest and JAF2 Southern Jarrah Forest subregions (Threatened Species Scientific Committee 2015). As the Study Area is located within the Yalgoo IBRA subregion, the 'Eucalypt Woodlands of the Western Australian Wheatbelt' TEC cannot occur in the Study Area. It is therefore not discussed further in this report.

The results of the DAWE SPRAT database search are presented in Appendix F.

Table 9: Significant Vegetation Known from the Study Area and Surrounds

Community	Conservation Status (WA)	EPBC Act Ranking	Source*
Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation)	**PEC Priority 1**	**–**	• **DBCA;** • **Maia (2012);** • **Maia (2014);** • **WEC (2008c);** • **WEC (2012b);** • **WEC (2014b);** • **WEC (2017)**
Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)	PEC Priority 1	–	• DBCA; • WEC (2013); • WEC (2014a)
Warriedar/Pinyalling/Walagnumming Hills vegetation assemblages (banded ironstone formation)	PEC Priority 1	–	• WEC (2012b)
Yalgoo (Gnows Nest/Wolla Wolla and Woolgah–Wadgingarra) vegetation assemblages (banded ironstone formation)	PEC Priority 1	–	• WEC (2012b); • WEC (2013); • WEC (2014a)

* Sources are:
DBCA – Interrogation of DBCA TEC and PEC database (DBCA 2020a);
DAWE – Interrogation of DAWE SPRAT Database (DAWE 2020);
Maia (2012) –Blue Hills Mungada West and East (Tenements M59/595 and M59/596) Infrastructure Areas; Targeted Flora Surveys (Maia 2012);
Maia (2014) – Blue Hills (Tenements M59/595 & M59/596) Targeted Flora Survey (Maia 2014);
WEC (2008c) – Karara–Mungada Project Survey Area Flora and Vegetation (Woodman Environmental 2008c);
WEC (2012b) – Regional Flora and Vegetation survey of the Karara to Minjar Block (Woodman Environmental 2012b);
WEC (2013) – Golden Grove Open Pit Expansion Project Baseline Flora and Vegetation Impact Assessment (Woodman Environmental 2013);
WEC (2014a) – Conservation Significant Flora Survey Northern Leases – Golden Grove (Woodman Environmental 2014a);
WEC (2014b) – Rothsay Iron Ore Project Programme of Works Significant Flora and Vegetation Assessment (Woodman Environmental 2014b); and
WEC (2017) – Rothsay Gold Project Flora and Vegetation Assessment (Woodman Environmental 2017).

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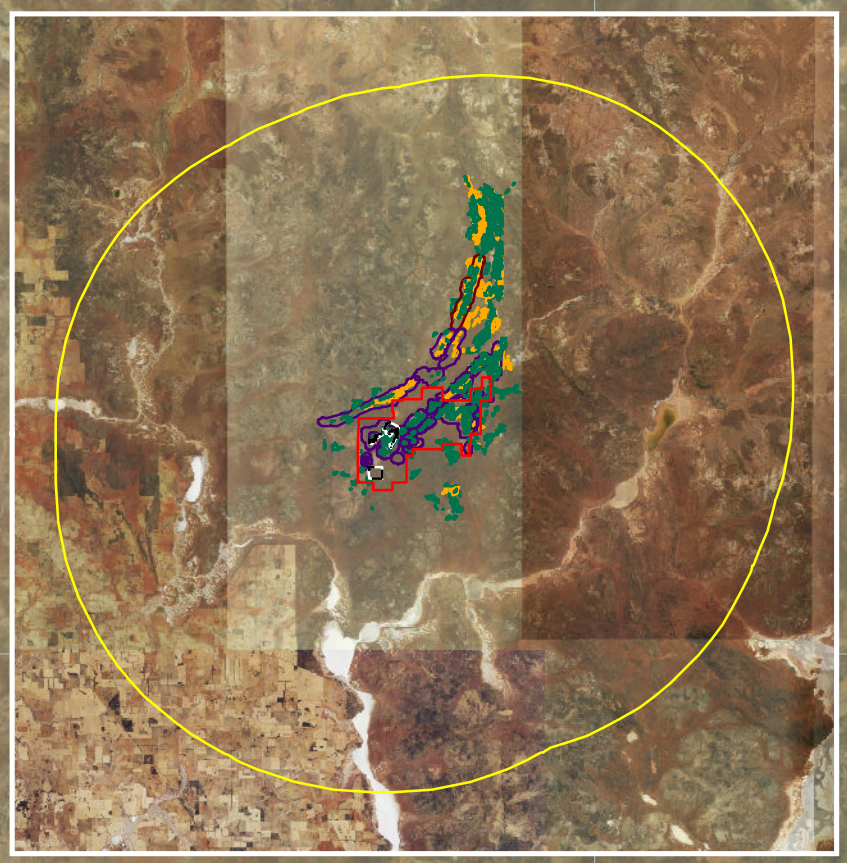

Legend

- Study Area
- Desktop Study Area
- Footprint

Significant Vegetation (Source: DBCA 2020a)

- Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1)
- Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) PEC (P1)

Potential Significant Vegetation (Source: Woodman Environmental 2008c, 2012b, 2017)

- Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1)
- Yalgoo (Gnows Nest/Wolla Wolla and Woolgah-Wadgingarra) vegetation assemblages (banded ironstone formation) PEC (P1)

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This map should only be used in conjunction with WEC report KML20-33-01.

N

Existing Significant Vegetation Records from the Study Area and Surrounds

Revision: A - 30 August 2021 Scale: 1:200,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f09

Projection: GDA 1994 MGA Zone 50

Figure

9

5.2 Field Survey Results

5.2.1 Flora

5.2.1.1 Vascular Flora Census

A total of 271 discrete vascular flora taxa (including 10 introduced taxa) were recorded during the 2020 survey within the Study Area. The taxa represent 54 families and 137 genera. The most well-represented families were Asteraceae (42 taxa), Fabaceae (32 taxa) and Chenopodiaceae (17 taxa).

Within quadrats established in 2020, the average taxon richness per quadrat was 21.5 (± 7.2), with the greatest number of taxa recorded in a single quadrat being 51 (KML25) and the lowest being nine (KML01).

A total of 526 discrete vascular flora taxa (including 32 introduced taxa), one known hybrid and three putative hybrids have been recorded in the Study Area during the current 2020 survey and relevant previous surveys within the Study Area (Markey and Dillon 2008; Woodman Environmental 2004, 2007a, b, c, d, e, f, g, k, l, m, 2008c, 2009a, d, 2011, 2012b). The taxa and hybrids represent 65 families and 222 genera. The most well-represented families were Asteraceae (80 taxa), Fabaceae (63 taxa) and Chenopodiaceae (43 taxa).

Within all quadrats utilised in the classification analysis, the average taxon richness per quadrat was 22.5 (± 12.7), with the greatest number of taxa recorded in a single quadrat being 79 (KARA20) and the lowest being 3 (GIND-51).

A full list of taxa is presented in Appendix G, with raw quadrat and relevé data presented in Appendix H.

Several collections could not be identified to species level due to poor material. Some are known to be distinct taxa relative to other taxa recorded by the survey, and are therefore included in the totals presented above and in Appendix G (e.g. *Cassytha* sp., *Ptilotus* ?*benlii*). Other collections may represent distinct taxa relative to other taxa recorded by the survey; however, it is more likely that they represent taxa already recorded elsewhere, with the quality of the material such that this distinction cannot be made (e.g. *Sclerolaena* sp.). Such collections are not included in the totals above but are presented in the raw quadrat data in Appendix H.

5.2.1.2 Significant Flora Taxa

Table 10 presents a summary of data relating to significant flora taxa recorded in the Study Area. A total of 27 significant flora taxa have been recorded from the Study Area by the current 2020 survey and relevant previous surveys, including two Threatened taxa and 23 Priority flora taxa (discussed in Section 5.2.1.3), as well as two taxa that are considered significant (as per EPA 2016a) as they represent undescribed or potentially undescribed taxa (discussed in Section 5.2.1.4).

Abundance information is provided for perennial taxa in Table 10, but is not considered appropriate for ephemeral or annual taxa, as the abundance of these taxa is strongly influenced by seasonal conditions, with fewer individuals usually present following below-average rainfall; instead, the number of locations is presented for ephemeral or annual taxa in Table 10. The number of locations of perennial taxa is not presented in Table 10 due to a conflict in the method by which this has been recorded by historical surveys.

Note that abundance information is not available for some historical data records; these records were prescribed a count of '1' for the purposes of Table 10 and are indicated with '≥' where these incomplete records represent the only records for the given taxon. The plant counts for these taxa are therefore likely to be conservative.

Historical records of significant flora taxa that were located in areas that are now cleared have been removed from the dataset as summarised in Table 10. Potential duplication of records elsewhere in the Study Area has been avoided by assessment of locations of significant flora recorded by the current survey against historical data in a GIS environment.

Due to the intensity of the significant flora targeted searching conducted for the current survey within the Footprint, and the fact that the current survey was conducted within what is considered to be the most appropriate time to survey in the Yalgoo Bioregion, the targeted searching data from the current survey is considered to supersede all historic data located within the Footprint. Locations of significant flora taxa recorded by the current survey were assessed against historical data in a GIS environment to ensure that there were no historical locations of significant flora that were not recorded by the current survey in the Footprint. The only exceptions were one location of the annual taxon *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3) recorded in 2005 and four locations of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1) recorded in 2008 (Table 10).

Locations of significant flora taxa recorded in the Study Area are presented in Appendix I (data from the current survey only) and on Figure 10.

Note that 346 individuals at 10 locations of the Threatened taxon *Stylidium scintillans* were recorded by the current survey, all occurring approximately 55 m south of the southwestern end of the Study Area in a localised, open area of weathered ironstone and granite. No individuals of this taxon were otherwise recorded within the Study Area by the current survey. Further details regarding the known occurrences of this taxon are presented below. No other Threatened flora taxa were recorded during the current survey.

As mentioned in Section 5.2.1.1, several collections from the current 2020 survey could not be identified to species level due to poor material; however, no such collections are considered likely to represent additional significant flora taxa.

Table 10: Summary of Significant Flora Taxa Known from the Study Area

Taxon	Status	Longevity	Number of Individuals (Perennial Taxa) / *Number of Locations (Annual Taxa)*						Number of Populations*	VUs
			Inside Footprint			Inside Study Area (excluding Footprint)			Grand Total	
			This Survey	Previous Surveys~	Total	This Survey	Previous Surveys~	Total		
Acacia karina	P1	Perennial	2,349		2,349	893	6,543	7,436	**9,785**	29	1, 2, **3^**, 5, 10, 16, 17, **18^**, **19^**, 20, 21, 22, 24, 25, **27^**, **28^**, 29, 30, **32^**
Acacia woodmaniorum	T	Perennial					24,295	24,295	**24,295**	8	6, 10, **19^**, **20^**, **21^**, **22^**, **24^**, 25, 26, **28^**, 30
Allocasuarina tessellata	P3	Perennial	138		138	135	126	261	**399**	10	1, 2, **3^**, 5, 10, 16, 17, **18^**, 28, 30, 32
Austrostipa blackii	P3	Perennial					14	14	**14**	3	17, **20^**, 21
Caesia sp. Koolanooka Hills (R. Meissner & Y. Caruso 78)	P1	Perennial	Not counted		Unknown	Not counted		Unknown	**Unknown**	2	**30^**, **32^**
Calandrinia ?kalanniensis	P2	Perennial					150	150	**150**	1	**17^**
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	P3	Annual		*1*	*1*		*5*	*5*	***6***	5	16, **21^**, 25, 28, 30
Drummondita fulva	P3	Perennial					2,221	2,221	**2,221**	18	10, **19^**, **20^**, **21^**, 24, 25, 26, 27, 29, 30, 31
Grevillea globosa	P3	Perennial	248		248	89	417	506	**754**	12	5, 10, 25, **27^**, 29, 30
Grevillea scabrida	P3	Perennial	471		471	355	102	457	**928**	11	1, 2, **3^**, 10, 14, 16, 17, **18^**, 30
Grevillea subtiliflora	P3	Perennial					≥ 2	≥ 2	**≥ 2**	2	**17^**
Gunniopsis divisa	P3	Annual	*1*		*1*		*65*	*65*	***66***	12	**1^**, **2^**, 5, 6, 10, 16, 30
Hibbertia cockertoniana	P3	Perennial				Not counted		Unknown	**Unknown**	1	**30^**, **32^**
Lepidosperma sp. Blue Hills (A. Markey & S. Dillon 3468)	P1	Perennial	772	7	779	352	30,313	30,665	**31,444**	20	5, 10, 16, 17, **19^**, **20^**, **21^**, **22^**, 23, 24, 25, 26, 27, **28^**, 29, 30, 32
Melaleuca barlowii	P3	Perennial					1	1	**1**	1	**25^**
Micromyrtus acuta	P3	Perennial					11,449	11,449	**11,449**	12	**19^**, **21^**, **22^**, 24, 25, 26, **27^**, 29, 30
Micromyrtus trudgenii	P3	Perennial	28		28		4,210	4,210	**4,238**	19	10, 17, **19^**, **20^**, **21^**, **22^**, 23, 24, 25, **26^**, 27, 28, 29, 30
Millotia dimorpha	P1	Annual					*42*	*42*	***42***	3	2, **3^**, **28^**
Persoonia pentasticha	P3	Perennial	269		269	47	381	428	**697**	44	**1^**, 2, 3, **5^**, 6, **10^**, 16, 17, 18, 19, 20, 21, 24, **27^**, **28^**, 29, 30
Petrophile pauciflora	P3	Perennial					≥ 4	≥ 4	**≥ 4**	3	**15^**, 23
Polianthion collinum	P3	Perennial					6,728	6,728	**6,728**	2	6, 10, 19, **20^**, **21^**, **22^**, 24, 25, **26^**, 27, 28, 30
Prostanthera sp. Karara (D. Coultas & K. Greenacre Opp 8)	P1	Perennial	2		2	36	3	39	**41**	5	2, **27^**, **30^**
Rhodanthe collina	P3	Annual	*103*		*103*	*9*	*148*	*157*	***260***	25	2, **3^**, 5, 10, 16, 18, 19, **20^**, **21^**, **22^**, 24, 25, **26^**, 28, 29, 30, 32
Stenanthemum poicilum	P3	Perennial					55	55	**55**	2	**10^**, **24^**
Stylidium scintillans	T	Ephemeral					*61*	*61*	***61***	4	**21^**, **24^**, 26
Swainsona sp. Karara (C. Godden & J. Hruban 24-26)	Undescribed	Annual				*1*		*1*	***1***	1	**17^**
Crassula sp. nov.	Potentially undescribed	Annual	*2*		*2*	*3*		*3*	***5***	5	5, **17^**, 30

~ Data from DBCA (2020b) and the Karara–Mungada and Regional Mapping Surveys (Woodman Environmental 2008c, 2012b). Note that these figures represent only significant flora that occur in uncleared vegetation (as per the mapping presented in this report; see Section 5.2.2.3) within the current survey Study Area, and therefore may be less than the figures presented in the original reports.
* Based on the definition of a population provided in Section 3.9.1.
'^' and bolded text denote preferred habitat based on abundance (proportional to the individual area of VUs in which the taxon is present) and landforms/soils.

475000 480000 485000 490000 495000

6780000 6775000 6770000 6765000 6760000 6755000

Legend

- Study Area
- Footprint
- Cleared or Rehabilitated Land

Significant Flora

- *Acacia karina* (P1)
- *Acacia woodmaniorum* (T)
- *Allocasuarina tessellata* (P3)
- *Austrostipa blackii* (P3)
- *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1)
- *Calandrinia ?kalanniensis* (P2)
- *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3)
- *Crassula* sp. nov. (potentially undescribed)
- *Drummondita fulva* (P3)
- *Grevillea globosa* (P3)
- *Grevillea scabrida* (P3)
- *Grevillea subtiliflora* (P3)
- *Gunniopsis divisa* (P3)
- *Hibbertia cockertoniana* (P3)
- *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1)
- *Melaleuca barlowii* (P3)
- *Micromyrtus acuta* (P3)
- *Micromyrtus trudgenii* (P3)
- *Millotia dimorpha* (P1)
- *Persoonia pentasticha* (P3)
- *Petrophile pauciflora* (P3)
- *Polianthion collinum* (P3)
- *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1)
- *Rhodanthe collina* (P3)
- *Stenanthemum poicilum* (P3)
- *Stylidium scintillans* (T)
- *Swainsona* sp. Karara (C. Godden & J. Hruban 24-26) (potentially undescribed)

475000 480000 485000 490000 495000

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This map should only be used in conjunction with WEC report KML20-33-01.

Overview of Significant Flora of the Study Area

Revision: A - 30 August 2021 Scale: 1:85,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f10

Projection: GDA 1994 MGA Zone 50

Figure

10

5.2.1.3 Listed Significant Flora Taxa

***Acacia karina* (P1)**

Acacia karina (P1) is a woody, openly branched shrub growing to approximately 3 m high (Plate 1) that occurs on red-brown silty clay loam on rocky slopes of BIF and basalt hills (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P1 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Acacia karina (P1) is endemic to the southeastern part of the Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 80 km, from near the Karara Project mine site in the northwest to near Lake Moore in the southeast (DBCA 2007–). There are 58 location records of this taxon in DBCA's databases representing approximately 33 regional populations, 21 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–). Woodman Environmental (2010) conducted a regional survey for this taxon in 2009 to attempt to quantify its distribution and abundance across its known range. As of December 2009, 233,387 individuals were known from 39 sub-populations. The majority of these sub-populations are located in the proposed conservation reserves of ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station (DBCA 2007–).

The current survey and relevant previous surveys have recorded a total of 9,785 individuals of *Acacia karina* (P1) in the Study Area, of which 2,349 individuals occur within the Footprint. The recorded locations represent approximately 29 populations across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring in the western extent of the Study Area including large populations on Mount Karara and Blue Hills, but a small number of populations have also been recorded to the east on Mungada Ridge. *Acacia karina* has been recorded in a total of 19 VUs, with VUs 3, 18, 19, 27, 28 and 32 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 1: ***Acacia karina*** **(P1) (Photos: Woodman Environmental 2020)**

Acacia woodmaniorum **(T)**

Acacia woodmaniorum (T) is an intricately branched, sprawling, harsh, prickly shrub growing to approximately 1–2 m high (Plate 2) that occurs relatively high in the landscape (over 400 m) on skeletal, acidic, red-brown loam, sandy loam or silt in rock crevices on exposed, steep slopes of BIF ridges of hematite and magnetite (Maslin and Buscumb 2007). This taxon is listed as Endangered under the EPBC Act and as Threatened (Endangered) under the BC Act (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Acacia woodmaniorum (T) is endemic to the southeastern part of the Midwest region of Western Australia (AVH 2021), occurring over a very restricted distribution of less than 8 km in the Blue Hill Range (DBCA 2007–). There are 21 location records of this taxon in DBCA's databases, all of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area) (DBCA 2007–). As of 2007, *Acacia woodmaniorum* was known from just three regional populations (at Mungada Ridge, Mungada West and Jasper Hill) over an area of approximately 40 km^2. The main population comprised several to many thousand individuals while the other two populations contained much smaller numbers (Maslin and Buscumb 2007). Woodman Environmental (2008a) conducted a regional survey for this taxon in 2007 to attempt to extend the distribution and increase the known number of individuals by discovering additional populations. Many of the locations visited during the survey possessed similar habitat, at least superficially, to that which the known populations occupy, however no further populations were found. It was therefore considered highly

unlikely that further substantial populations of *Acacia woodmaniorum* will be discovered in the future. While every potential location was not comprehensively searched during the survey, the most likely locations were searched, and a relatively wide geographical spread of locations was obtained (Woodman Environmental 2008a).

No individuals of *Acacia woodmaniorum* (T) were recorded by the current 2020 survey. Relevant previous surveys have recorded a total of 24,295 individuals of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent approximately eight populations across the Study Area (as per the definition of a population from DBCA (2017)), all restricted to Mungada Ridge. *Acacia woodmaniorum* has been recorded in a total of 11 VUs, with VUs 19, 20, 21, 22, 24 and 28 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 2: ***Acacia woodmaniorum*** **(T) (Photos: Woodman Environmental 2020 (main); B.R. Maslin (inset))**

Allocasuarina tessellata **(P3)**

Allocasuarina tessellata (P3) is a dioecious shrub or tree growing to approximately 3–5 m high (Plate 3) that occurs on loam and sand on greenstone (dolerite or basalt) hills (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P1 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Allocasuarina tessellata (P3) is endemic to the southeastern part of the Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 83 km, from north of Rothsay in the north to near Lake Moore in the south (DBCA 2007–). There are 68 location records of this taxon in DBCA's databases representing approximately 38 regional populations, 12 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–). Note that AVH (2021) displays one record of this taxon near Cuballing and a further three records near Esperance; these records are held in the State Herbarium of South Australia and are not represented in DBCA databases. It is more likely that these records represent the taxon *Allocasuarina campestris*, which is widespread in the Wheatbelt, extending from north of the Murchison River almost to the South Coast near Ravensthorpe and east of Esperance (Wilson and Johnson 2020).

The current survey and relevant previous surveys have recorded a total of 399 individuals of *Allocasuarina tessellata* (P3) in the Study Area, of which 138 individuals occur within the Footprint. The recorded locations represent approximately 10 populations across the Study Area (as per the definition of a population from DBCA (2017)), all occurring in the western extent of the Study Area including a number of populations south of the Karara Project mine, but one small population has also been recorded on Mount Karara. *Allocasuarina tessellata* has been recorded in a total of 11 VUs, with VUs 3 and 18 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 3: ***Allocasuarina tessellata*** **(P3) (Photos: Woodman Environmental 2020)**

***Austrostipa blackii* (P3)**

Austrostipa blackii (P3) is a tufted perennial grass growing to approximately 1 m high (Plate 4) that generally occurs on rocky hills (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Austrostipa blackii (P3) is widespread across the southern half of Australia, with records in Western Australia, South Australia, New South Wales, Victoria and Tasmania (AVH 2021). Within WA, it occurs over a distribution of approximately 580 km, from Koolanooka Hills in the northwest to Widgiemooltha in the southeast (DBCA 2007–). There are 66 location records of this taxon in DBCA's databases representing approximately 37 regional populations, four of which occur within conservation tenure (Kambalda Nature Reserve, Kangaroo Hills Timber Reserve, Mount Manning Range Nature Reserve and Tutanning Nature Reserve), while an additional 17 regional populations occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Credo, ex-Diemals, ex-Ennuin, ex-Jaurdi and ex-Warriedar Stations) (DBCA 2007–).

No individuals of *Austrostipa blackii* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded 14 individuals of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent three populations across the Study Area (as per the definition of a population from DBCA (2017)); two of these occur on Mungada Ridge and the third occurs southwest of the Karara Project mine. *Austrostipa blackii* has been recorded in VUs 17, 20 and 21, with VU 20 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 4: ***Austrostipa blackii*** **(P3) (Photo: Woodman Environmental scanned specimen)**

Caesia **sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1)**

Caesia sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) is a perennial herb growing to approximately 0.3 m high (Plate 5) that occurs on orange-brown or red-brown soils on BIF or granitic hill slopes and crests (WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P1 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Caesia sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a restricted distribution of approximately 45 km, from Koolanooka Hills in the west to just south of the Karara Project mine site in the east (DBCA 2007–). There are 15 location records of this taxon in DBCA's databases representing approximately seven regional populations, one of which occurs within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area) (DBCA 2007–).
Caesia sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) was recorded within two quadrats by the current survey, one of which was located within the Footprint. In addition to being cryptic and not readily identifiable in the field, this taxon is only able to be observed during a short period in the year when above-ground parts are visible. This taxon has not been

recorded by previous surveys and was only identified post-survey; therefore, it was not specifically searched for during the survey and counts of individuals were not undertaken. However, it was noted as being uncommon. The recorded locations currently represent two populations of this taxon across the Study Area (as per the definition of a population from DBCA (2017)), one north of Mount Karara and the other southwest of the Karara Project mine. The locations occur in VUs 30 and 32, both of which are currently considered to represent the preferred habitat for this taxon (Figure 10, Appendix I, Appendix J). VU 30, and to a lesser extent VU 32, have been mapped relatively widely throughout the Footprint and Study Area, and therefore it is possible that there may be additional occurrences of this taxon elsewhere in the Footprint and Study Area. This record represents a slight range extension to the known range of this taxon by approximately 39 km (DBCA 2007–).

Plate 5: ***Caesia*** **sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) (Photo: Woodman Environmental scanned specimen)**

Calandrinia kalanniensis **(P2)**

Calandrinia kalanniensis (P2) is a semi-erect to erect tuberous perennial herb growing to approximately 20–85 mm high (Plate 6) that occurs in shallow brown clay that is often gritty

and derived from eroded granite, in the apron areas of granite outcrops or soil pockets on granite (Obbens 2006; WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P2 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Calandrinia kalanniensis (P2) is endemic to an area at the junction of the Midwest, Goldfields and Wheatbelt regions of Western Australia (AVH 2021), occurring over a distribution of approximately 315 km, from near the Karara Project mine site in the west to west of Menzies in the east (DBCA 2007–). There are 14 location records of this taxon in DBCA's databases representing approximately seven regional populations, two of which occur within conservation tenure (Xantippe Nature Reserve and Yanneymooning Nature Reserve), while an additional regional population occurs within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area) (DBCA 2007–).

No individuals of *Calandrinia kalanniensis* (P2) were recorded by the current 2020 survey, however relevant previous surveys have recorded a total of 150 individuals of *Calandrinia* ?*kalanniensis* within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent a single population within the Study Area (as per the definition of a population from DBCA (2017)), located south of Mungada Ridge. This population occurs within VU 17, which is currently considered to represent the preferred habitat for this taxon (Table 10, Figure 10, Appendix J).

Plate 6: *Calandrinia kalanniensis* (P2) (Photos: F. Obbens)

***Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3)**

Calotis sp. Perrinvale Station (R.J. Cranfield 7096) (P3) is an annual herb growing to approximately 5–20 cm high (Plate 7) that occurs on yellow and red-brown soils in rocky areas,

usually on BIF or laterised ridges and outcrops (WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Calotis sp. Perrinvale Station (R.J. Cranfield 7096) (P3) is endemic to the central Midwest region and western Goldfields region of Western Australia (AVH 2021), occurring over a wide distribution of approximately 530 km, from near Narryer Homestead in the northwest to Ularring in the southeast (DBCA 2007–). There are 24 location records of this taxon in DBCA's databases representing approximately 20 regional populations, 10 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–).

No individuals of *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded this taxon at six point locations within the Study Area (recorded in 2005, 2011 and 2015), of which one point location occurs within the Footprint. The recorded locations represent five populations across the Study Area (as per the definition of a population from DBCA (2017)); two of these occur on Mount Karara and three on Mungada Ridge. *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) has been recorded in VUs 16, 21, 25, 28 and 30, with VU 21 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 7: ***Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3) (Photo: Woodman Environmental)**

***Drummondita fulva* (P3)**

Drummondita fulva (P3) is an erect branching shrub growing to approximately 0.5–1.5 m high (Plate 8) that occurs on the footslopes, lower slopes to upper slopes and hill crests of BIF and associated metasedimentary bedrock on skeletal, shallow, acidic soils of orange-red or red-brown sandy loams and clayey silts (Meissner and Markey 2007; WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Drummondita fulva (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 62 km, from near the Golden Grove mine site in the northeast to ex-Lochada Station in the southwest (DBCA 2007–). There are 18 location records of this taxon in DBCA's databases representing approximately 13 regional populations, nine of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Lochada and ex-Warriedar Stations) (DBCA 2007–).

No individuals of *Drummondita fulva* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded a total of 2,221 individuals of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent approximately 18 populations across the Study Area (as per the definition of a population from DBCA (2017)), all restricted to Blue Hills, Mungada Ridge, and a small BIF ridgeline northeast of Mungada Ridge and southeast of Jasper Hills. *Drummondita fulva* has been recorded in a total of 11 VUs, with VUs 19, 20 and 21 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 8: *Drummondita fulva* (P3) (Photo: S. Dillon from Meissner and Markey (2007))

Grevillea globosa (P3)

Grevillea globosa (P3) is a spreading, non-lignotuberous shrub growing to approximately 1–3 m high (Plate 9) that occurs in Mulga shrubland or mallee woodland on red, yellow or orange loam and clay loam (Makinson 2020; WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Grevillea globosa (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a relatively wide distribution of approximately 190 km, from Tallering Station in the north (southern Murchison Shire) to near Lake Moore in the south (DBCA 2007–). There are 47 location records of this taxon in DBCA's databases representing approximately 42 regional populations, 11 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar and ex-Barnong Stations) (DBCA 2007–).

The current survey and relevant previous surveys have recorded a total of 754 individuals of *Grevillea globosa* (P3) in the Study Area, of which 248 individuals occur within the Footprint. The recorded locations represent approximately 12 populations across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring in the western extent of the Study Area including several relatively large populations north of Mount Karara and south of the Karara Project mine, but small scattered populations have also been recorded on the outwash plains of Blue Hills and Mungada Ridge. *Grevillea globosa* has been recorded in VUs 5, 10, 25, 27, 29 and 30, with VU 27 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 9: ***Grevillea globosa*** **(P3) (Photos: Woodman Environmental 2020)**

Grevillea scabrida **(P3)**

Grevillea scabrida (P3) is a densely and irregularly branched shrub growing to approximately 0.6–1.5 m high (Plate 10) that occurs on red clay loam that is often stony (WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Grevillea scabrida (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 85 km, from north of Rothsay in the northwest to near Lake Moore in the southeast (DBCA 2007–). There are 74 location records of this taxon in DBCA's databases representing approximately 41 regional populations, 13 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar and ex-Thundelarra Stations) (DBCA 2007–).

The current survey and relevant previous surveys have recorded a total of 928 individuals of *Grevillea scabrida* (P3) in the Study Area, of which 471 individuals occur within the Footprint. The recorded locations represent approximately 11 populations across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring in the western extent of the Study Area including several relatively large populations north of Mount Karara and southeast of the Karara Project mine, but one small population has also been recorded

south of Mungada Ridge. *Grevillea scabrida* has been recorded in a total of nine VUs, with VUs 3 and 18 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 10: ***Grevillea scabrida*** **(P3) (Photos: Woodman Environmental 2016)**

Grevillea subtiliflora **(P3)**

Grevillea subtiliflora (P3) is an open erect shrub growing to approximately 1–2.5 m high (Plate 11) that is restricted to greenstone (basalt, dolerite) hills (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Grevillea subtiliflora (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 80 km, from near Karara Homestead in the west to Paynes Find in the east (DBCA 2007–). There are 57 location records of this taxon in DBCA's databases representing approximately 29 regional populations, six of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–).

No individuals of *Grevillea subtiliflora* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded at least two individuals of this taxon in the Study Area (specific abundance data not available for this taxon). This taxon has not been recorded within the Footprint. The recorded locations represent two populations across the Study Area (as per the definition of a population from DBCA (2017)), both occurring on the far western extent of the Study Area northeast of Karara Village. These populations occur within VU 17, which is considered to represent the preferred habitat for this taxon (Table 10, Figure 10, Appendix J).

Plate 11: ***Grevillea subtiliflora*** **(P3) (Photo: M. Fagg 2018)**

Gunniopsis divisa **(P3)**

Gunniopsis divisa (P3) is a succulent, prostrate annual herb with large white flowers (Plate 12) that generally occurs in slightly saline clay soils on flats and plains (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Gunniopsis divisa (P3) is endemic to the Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 340 km, from east-northeast of Meekatharra near Mount Gould in the north to near the Karara Project mine site in the south (DBCA 2007–). There are 30 location records of this taxon in DBCA's databases representing approximately 23 regional populations, six of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Woolgorong Station) (DBCA 2007–).

The current survey and relevant previous surveys have recorded *Gunniopsis divisa* (P3) at a total of 66 point locations within the Study Area, of which one point location occurs within the Footprint. The recorded locations represent approximately 12 populations across the Study Area (as per the definition of a population from DBCA (2017)), with all but one population occurring on the flats and plains south of Blue Hills and Mungada Ridge. The final population occurs on a small area of saline soils on the lower slopes of Mount Karara.

Gunniopsis divisa has been recorded in VUs 1, 2, 5, 6, 10, 16 and 30, with VUs 1 and 2 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 12: *Gunniopsis divisa* (P3) (Photos: Woodman Environmental 2016)

***Hibbertia cockertoniana* (P3)**

Hibbertia cockertoniana (P3) is an erect shrub growing to approximately 0.4–1 m high (Plate 13) that occurs on BIF, laterite, at the edge of granite outcrops and on sand over laterite (Thiele and Cockerton 2015; WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Hibbertia cockertoniana (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 165 km, from south of Tardun in the northwest to Mount Gibson in the southeast (DBCA 2007–). There are 25 location records of this taxon in DBCA's databases representing approximately 20 regional populations, one of which occurs within conservation tenure (Canna Nature Reserve) (DBCA 2007–).

Hibbertia cockertoniana (P3) was recorded within two quadrats by the current survey, both of which are located outside the Footprint. This taxon was not recorded by previous surveys or identified during the desktop assessment as being potentially present; it was identified post-survey during the plant identification process and therefore it was not specifically searched for during the survey and counts of individuals were not undertaken. However, it is considered to be uncommon in the area, having an average foliage cover of 0.2 % of the total area of the quadrats within which it was recorded (Appendix H). The recorded locations currently represent a single population of this taxon within the Study Area (as per the

definition of a population from DBCA (2017)), located southwest of the Karara Project mine. The locations occur in VUs 30 and 32, both of which are currently considered to represent the preferred habitat for this taxon (Figure 10, Appendix I, Appendix J). VU 30, and to a lesser extent VU 32, have been mapped relatively widely throughout the Footprint and Study Area, and therefore it is possible that there may be additional occurrences of this taxon elsewhere in the Footprint and Study Area. The locations of this taxon recorded by the current survey fill a distribution gap in the known range of this taxon (DBCA 2007–).

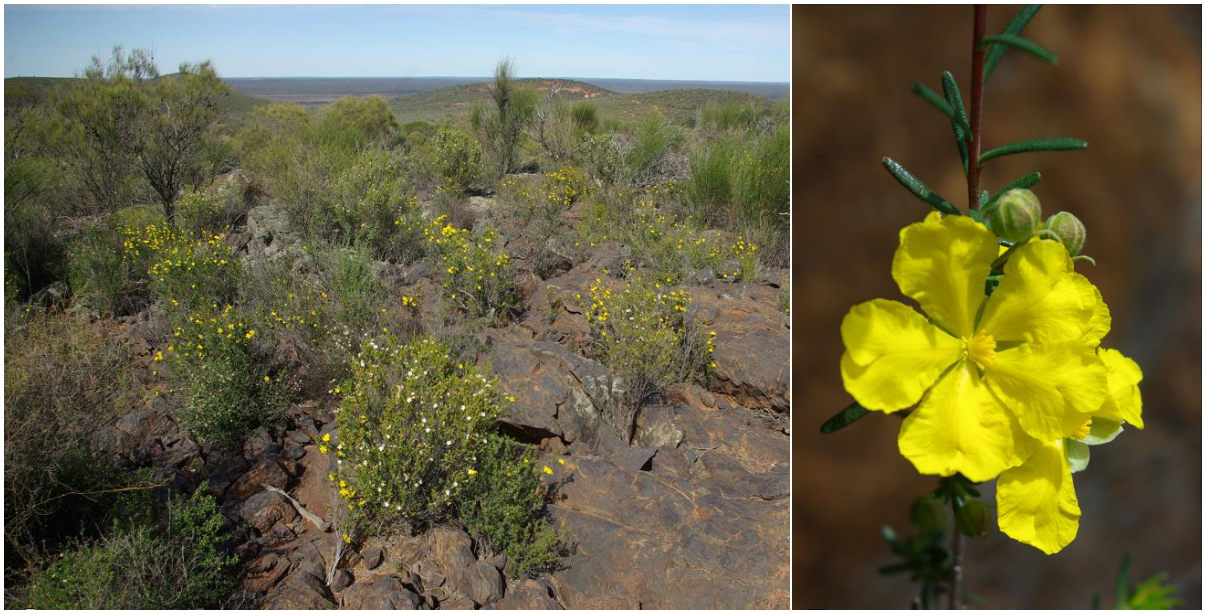

Plate 13: ***Hibbertia cockertoniana*** **(P3) (Photos: G. Cockerton from Thiele and Cockerton (2015))**

Lepidosperma **sp. Blue Hills (A. Markey & S. Dillon 3468) (P1)**

Lepidosperma sp. Blue Hills (A. Markey & S. Dillon 3468) (P1) is a sedge growing to approximately 0.7 m high (Plate 14) that occurs on ironstone or granite hills and along drainage lines associated with such features (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P1 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

The distribution of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1) in Western Australia, where it is endemic (AVH 2021), is currently unclear, owing to the uncertainty surrounding the taxonomy of the genus *Lepidosperma*. However, according to DBCA Threatened and Priority Flora and WA Herbarium Specimen Databases, the taxon has a range of approximately 85 km, from northeast of Perenjori in the northwest to Mount Gibson in the southeast (DBCA 2007–). However, previous surveys by Woodman Environmental indicate that its distribution is far wider, with records stretching from near Mullewa in the northwest to Ninghan Station in the southeast over a distance of approximately 200 km (Woodman Environmental 2008c, 2009c). DBCA Threatened and Priority Flora and WA Herbarium Specimen Database records indicate that this taxon is known from approximately 29 records and 24 regional populations (eight of which occur within the proposed conservation reserves of ex-Karara and ex-Warriedar Stations) (DBCA 2007–). However, Woodman Environmental

(2009c) indicates that the number of known populations is in excess of 30, and the number of known individuals in excess of 80,000 (Woodman Environmental 2008c, 2009c).

The current survey and relevant previous surveys have recorded a total of 31,439 individuals of *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1) in the Study Area, of which 774 individuals occur within the Footprint. The recorded locations represent approximately 20 populations across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring on Mount Karara, Blue Hills and Mungada Ridge. *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) has been recorded in a total of 17 VUs, with VUs 19, 20, 21, 22 and 28 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 14: *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1) (Photos: Woodman Environmental 2020)

***Melaleuca barlowii* (P3)**

Melaleuca barlowii (P3) is an open erect shrub growing to approximately 1.5–1.8 m high (Plate 15) that occurs on lower slopes of dolerite and BIF and lateritic sandplains (WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Melaleuca barlowii (P3) is endemic to Western Australia, extending from the central southern Midwest region to the central northern Wheatbelt region (AVH 2021). It occurs over a

relatively wide distribution of approximately 250 km, from north of Mullewa in the north to Kalannie in the south (DBCA 2007–). There are 38 location records of this taxon in DBCA's databases representing approximately 30 regional populations, two of which occur within conservation tenure (Wilroy Nature Reserve) while an additional three regional populations occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area) (DBCA 2007–).

No individuals of *Melaleuca barlowii* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded one individual of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded location represents a single population within the Study Area located on Mungada Ridge. This location occurs within VU 25, which is currently considered to represent the preferred habitat for this taxon (Table 10, Figure 10, Appendix J).

Plate 15: ***Melaleuca barlowii*** **(P3) (Photo: M. Fagg 2014)**

Micromyrtus acuta **(P3)**

Micromyrtus acuta (P3) is an erect shrub growing to approximately 0.8–2 m high (Plate 16) that occurs on silty fine to coarse sand on laterite or granite substrates and rocky outcrops (Rye 2006; WA Herbarium 1998; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Micromyrtus acuta (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 160 km, from near Three

Springs in the west to near Paynes Find in the east (DBCA 2007–). There are 28 location records of this taxon in DBCA's databases representing approximately 16 regional populations, eight of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Lochada, ex-Thundelarra and ex-Warriedar Stations) (DBCA 2007–).

No individuals of *Micromyrtus acuta* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded a total of 11,449 individuals of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent approximately 12 populations across the Study Area (as per the definition of a population from DBCA (2017)), all restricted to Blue Hills, Mungada Ridge, and a small BIF ridgeline northeast of Mungada Ridge and southeast of Jasper Hills. *Micromyrtus acuta* has been recorded in a total of nine VUs, with VUs 19, 21, 22 and 27 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 16: ***Micromyrtus acuta* (P3) (Photos: Woodman Environmental (2018) (main); B. L. Rye from Rye (2006) (inset))**

***Micromyrtus trudgenii* (P3)**

Micromyrtus trudgenii (P3) is an erect, spindly shrub growing to approximately 1–2 m high (Plate 17) that occurs on the tops and slopes of hills and ridges of BIF, dolerite, duricrust and greenstone (Rye 2007; WA Herbarium 1998–; Woodman Environmental field observations).

This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Micromyrtus trudgenii (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a restricted distribution of approximately 55 km, from near Minjar Gold mine site (Badja Station) in the north to southeast of Karara Project mine site in the south (DBCA 2007–). There are 41 location records of this taxon in DBCA's databases representing approximately 31 regional populations, 18 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–).

The current survey and relevant previous surveys have recorded a total of 4,238 individuals of *Micromyrtus trudgenii* (P3) in the Study Area, of which 28 individuals occur within the Footprint. The recorded locations represent approximately 19 populations across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring on Blue Hills and Mungada Ridge, but small scattered populations have also been recorded elsewhere in the Study Area. *Micromyrtus trudgenii* has been recorded in a total of 14 VUs, with VUs 19, 20, 21, 22 and 26 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 17: ***Micromyrtus trudgenii*** **(P3) (Photos: Woodman Environmental 2016)**

***Millotia dimorpha* (P1)**

Millotia dimorpha (P1) is an erect annual herb growing to approximately 11 cm high (Plate 18) that is restricted to red loamy soil in shaded sites on ironstone, granite and basalt hills (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P1 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Millotia dimorpha (P1) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 77 km, from Koolanooka Hills in the west to near Warriedar in the east (DBCA 2007–). There are 33 location records of this taxon in DBCA's databases representing approximately 18 regional populations, nine of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Lochada Station) (DBCA 2007–).

No locations of *Millotia dimorpha* (P1) were recorded by the current 2020 survey. Relevant previous surveys have recorded this taxon at 42 point locations within the Study Area. No locations of this taxon have been recorded within the Footprint. The recorded locations represent three populations across the Study Area (as per the definition of a population from DBCA (2017)); two of these occur on Mount Karara while the third occurs southeast of Mount Karara. *Millotia dimorpha* has been recorded in VUs 2, 3 and 28, with VUs 3 and 28 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 18: *Millotia dimorpha* (P1) (Photos: Woodman Environmental)

***Persoonia pentasticha* (P3)**

Persoonia pentasticha (P3) is a low, spreading shrub growing to approximately 0.4–1.5 m high (Plate 19) that occurs on a variety of soils and topographic sites (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Persoonia pentasticha (P3) is endemic to the southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 250 km, from north of Tenindewa in the northwest to Mount Gibson in the southeast (DBCA 2007–). There are 58 location records of this taxon in DBCA's databases representing approximately 44 regional populations, seven of which occur within conservation tenure (Bowgarder Nature Reserve, Barrabarra Nature Reserve, East Yuna Nature Reserve and unnamed Timber Reserve O 2 10) while an additional 13 regional populations occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar and ex-Barnong Stations) (DBCA 2007–).

The current survey and relevant previous surveys recorded a total of 697 individuals of *Persoonia pentasticha* (P3) in the Study Area, of which 269 individuals occur within the Footprint. The recorded locations represent approximately 44 populations across the Study Area (as per the definition of a population from DBCA (2017)); these occur widely throughout the entirety of the Study Area, predominately on flats and plains of *Eucalyptus* woodlands and *Acacia* shrublands. *Persoonia pentasticha* has been recorded in a total of 17 VUs, with VUs 1, 5, 10, 27 and 28 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 19: *Persoonia pentasticha* (P3) (Photos: Woodman Environmental 2020)

***Petrophile pauciflora* (P3)**

Petrophile pauciflora (P3) is an open shrub growing to approximately 1 m high (Plate 20) that occurs on decaying and dissected granite breakaways (WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Petrophile pauciflora (P3) is endemic to the southern Midwest region of Western Australia (AVH 2021), occurring over a relatively wide distribution of approximately 330 km, from Woolgorong in the northwest to near Bimbijy Station Homestead in the southeast (DBCA 2007–). There are 32 location records of this taxon in DBCA's databases representing approximately 21 regional populations, 10 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Lakeside, ex-Lochada and ex-Woolgorong Stations) (DBCA 2007–).

No individuals of *Petrophile pauciflora* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded at least four individuals of this taxon within the Study Area (specific abundance data not available for this taxon). No individuals have been recorded within the Footprint. The recorded locations represent three populations across the Study Area (as per the definition of a population from DBCA (2017)); two of these occur west of the Karara Project mine while the third occurs southeast of Mount Karara. *Petrophile pauciflora* has been recorded in VUs 15 and 23, with VU 15 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 20: ***Petrophile pauciflora*** **(P3) (Photos: Woodman Environmental (2018) (main); G. Byrne (inset))**

Polianthion collinum **(P3)**

Polianthion collinum (P3) is a rounded spreading shrub growing to approximately 0.7–1.25 m high (Plate 21) that occurs on hills and slopes in red clayey soil between blocks of BIF (Kellermann *et al.* 2006; WA Herbarium 1998–). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Polianthion collinum (P3) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a restricted distribution of approximately 40 km, from Gossan Hill in the north to Mungada Ridge in the south (DBCA 2007–). There are 26 location records of this taxon in DBCA's databases representing approximately 12 regional populations, eight of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–).

No individuals of *Polianthion collinum* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded a total of 6,728 individuals of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent two populations across the Study Area (as per the definition of a population from DBCA (2017)), one on Blue Hills and the second on Mungada Ridge. *Polianthion collinum* has

been recorded in a total of 12 VUs, with VUs 20, 21, 22 and 26 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 21: ***Polianthion collinum*** **(P3) (Photos: Woodman Environmental)**

Prostanthera **sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1)**

Prostanthera sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1) is an erect shrub growing to approximately 0.3–1.5 m high (Plate 22) that occurs on clay-loam on flats and lower slopes (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P1 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Prostanthera sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a restricted distribution of approximately 17 km within the eastern part of ex-Lochada Station and the northern part of ex-Karara Station (DBCA 2007–). There are only seven location records of this taxon in DBCA's databases representing approximately six regional populations, four of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Lochada Station).

The current survey and relevant previous surveys have recorded a total of 41 individuals of *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1) in the Study Area, of which two individuals occur within the Footprint. The recorded locations represent five populations

across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring on the outwash plains of Mount Karara and Blue Hills and south of the Karara Project mine. *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) has been recorded in VUs 2, 27 and 30, with VUs 27 and 30 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 22: ***Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1) (Photos: Woodman Environmental 2020)**

***Rhodanthe collina* (P3)**

Rhodanthe collina (P3) is an erect annual herb growing to approximately 25 cm high (Plate 23) that generally occurs on loam on rocky hills and in drainage lines associated with such hills (WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Rhodanthe collina (P3) is endemic to the southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 180 km, from Yalgoo in the north to Mount Gibson in the south and west to Mingenew (DBCA 2007–). There are 61 location records of this taxon in DBCA's databases representing approximately 35 regional populations, one of which occurs within conservation tenure (Mingenew Nature Reserve) while an additional 22 regional populations occur within UCL proposed for conservation

(ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar, ex-Thundelarra and ex-Kadji Kadji Stations) (DBCA 2007–).

The current survey and relevant previous surveys have recorded *Rhodanthe collina* (P3) at a total of 260 point locations within the Study Area, of which 103 point locations occur within the Footprint. The recorded locations represent approximately 25 populations across the Study Area (as per the definition of a population from DBCA (2017)), predominately occurring on Mount Karara, Blue Hills and Mungada Ridge, but several populations have also been recorded to the west and east of Mount Karara and south of the Karara Project mine. *Rhodanthe collina* has been recorded in a total of 17 VUs, with VUs 3, 20, 21, 22 and 26 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 23: *Rhodanthe collina* (P3) (Photos: Woodman Environmental 2020)

***Stenanthemum poicilum* (P3)**

Stenanthemum poicilum (P3) is an erect to decumbent shrub growing to approximately 0.15–0.5 m high (Plate 24) that occurs on clay or sandy clay on rocky (often basalt, ironstone or laterite) hill slopes and breakaways (Rye 1995; WA Herbarium 1998–; Woodman Environmental field observations). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Stenanthemum poicilum (P3) is endemic to the southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 170 km, from Wilroy in the northwest to White Wells in the southeast (DBCA 2007–). There are 40 location records of this taxon in DBCA's databases representing approximately 21 regional populations, six of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar Station) (DBCA 2007–).

No individuals of *Stenanthemum poicilum* (P3) were recorded by the current 2020 survey. Relevant previous surveys have recorded a total of 55 individuals of this taxon within the Study Area. No individuals have been recorded within the Footprint. The recorded locations represent two populations across the Study Area (as per the definition of a population from DBCA (2017)), one on a small lateritic ironstone crest southeast of Mount Karara and the second on the lower slopes of Mungada Ridge. *Stenanthemum poicilum* has been recorded in VUs 10 and 24, both of which are considered to represent the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 24: ***Stenanthemum poicilum*** **(P3) (Photos: Woodman Environmental 2016)**

Stylidium scintillans **(T)**

Stylidium scintillans (T) is a microgeophytic herb growing to approximately 3–9 cm high (Plate 25) that is confined to the upper slopes and summits of low rises and breakaways composed of highly weathered granitic basement rock with weathered or colluvial ironstone rock and kaolinitic residue. It grows in rocky, shallow, pale brown clay-loam soils, with individuals sometimes growing out of rock fissures (Wege 2012). This taxon is not listed under the EPBC Act but is classified as Threatened (Vulnerable) under the BC Act (DAWE 2021; Smith and Jones 2018; WA Herbarium 1998–).

Stylidium scintillans (T) is endemic to the central southern Midwest region of Western Australia (AVH 2021), occurring over a distribution of approximately 90 km, from near Gutha (Mellenbye Station) in the west to ex-Warriedar Station in the east (DBCA 2007–). There are 57 location records of this taxon in DBCA's databases representing approximately 33 regional populations, 27 of which occur within UCL proposed for conservation (ex-Karara Station, part of which overlaps the Study Area, as well as ex-Warriedar and ex-Lochada Stations) (DBCA 2007–).

No individuals of *Stylidium scintillans* (T) were recorded by the current 2020 survey in the Footprint. The taxon was recorded at 10 point locations approximately 55 m south of the southwestern end of the Study Area (outside of the Footprint) in a localised, open area of weathered ironstone and granite. No historical locations of this taxon have been recorded within the Footprint.

Relevant previous surveys have recorded this taxon at 61 point locations within the Study Area. The recorded locations represent four populations across the Study Area (as per the definition of a population from DBCA (2017)), all restricted to Mungada Ridge, east of the Terapod mining area (Appendix J; Sheets J13, J14), approximately 20km to the east north-east of the population recorded during the current survey. These populations of *Stylidium scintillans* are located in VUs 21, 24 and 26 within the Study Area, with VUs 21 and 24 representing the taxon's preferred habitat (Table 10, Figure 10, Appendix J).

Plate 25: *Stylidium scintillans* (T) (Photos: Woodman Environmental 2016)

5.2.1.4 Other Flora Taxa of Interest

The following two flora taxa were recorded in the Study Area during the current 2020 survey. Following consultation with internal and external experts at the WA Herbarium, it is believed that they may represent undescribed entities.

With the exception of the taxa discussed below, no taxa recorded in the Study Area during the current survey are considered to be short-range endemics.

***Swainsona* sp. Karara (C. Godden & J. Hruban 24-26) (undescribed)**

One collection of an undescribed *Swainsona* entity was made in the Study Area during the current 2020 survey. A representative specimen of this entity was provided to Rob Davis, an expert on *Swainsona* at the WA Herbarium, who believes it represents an unrecognised taxon (R. Davis *pers. comm*. 2021). The phrase name '*Swainsona* sp. Karara (C. Godden & J. Hruban 24-26)' was raised for the entity collected in the Study Area during the current survey. Currently the taxon is only officially known from this single collection; therefore, additional material is required to assist in the formal description of this taxon and to undertake a conservation assessment. However, as a precaution, and given that it appears to occur in relatively specific habitat (potentially being granite endemic) and is apparently not common, this taxon is considered to be a significant taxon as per EPA (2016a).

Swainsona sp. Karara (C. Godden & J. Hruban 24-26) was recorded in a single quadrat located outside the Footprint during the current survey (Figure 10, Appendix I, Appendix J). Counts of individuals were not undertaken for this taxon as it was not recognised as a significant taxon at the time of field survey; however, it was uncommon, having a foliage cover of < 0.1 % of the total area of the quadrat within which it was recorded (Appendix H). This location occurs in VU 17 on brown sandy loam with granite stones and some granite outcropping; therefore, VU 17 is currently considered to represent the preferred habitat for this taxon. VU 17 is primarily restricted to the western edge of the Study Area, with the majority of polygons mapped west and southwest of the Karara Project mine. A small area of VU 17 occurs within the Footprint. Therefore, it is possible that there may be additional occurrences of this taxon elsewhere in the Study Area and Footprint.

An anecdotal second location of this potential new taxon was recorded by Umwelt in 2021 (Plate 26). This location is approximately 11 km south of Karara camp on a granite sheet area, outside the Study Area. Approximately 20 individuals of the taxon were recorded.

Plate 26: ***Swainsona*** **sp. Karara (C. Godden & J. Hruban 24-26) (undescribed) (Photo: Umwelt 2021)**

Crassula **sp. nov. (potentially undescribed)**

Two collections of a potentially undescribed *Crassula* entity were made in the Study Area during the current 2020 survey. A representative specimen of this entity was sent to the WA Herbarium for identification, who remarked that the entity is likely undescribed (M. Hislop *pers. comm.* 2021). The entity's affinities appear to lie with *Crassula tetramera* and *Crassula extrorsa*; it possesses the small flower size and smooth seeds of *Crassula tetramera* but lacks the saccate follicles of that taxon, and in addition has remarkably long styles (Plate 27). A collection of what is likely the same entity has been previously examined by Hellmut Toelken, an expert on *Crassula* at the State Herbarium of South Australia, who believes it may represent an unrecognised taxon (H. Toelken *pers. comm*. 2017). However, the collections made in the Study Area were very depauperate and better material is required to confirm these differences before a phrase name for the entity can be raised and conservation assessment undertaken. Until such time, and as a precaution, this entity is considered to be a significant taxon as per EPA (2016a).

The current survey recorded *Crassula* sp. nov. at five point locations (one location recorded within a quadrat and four locations recorded opportunistically); two of these five locations occur within the Footprint (Figure 10, Appendix I, Appendix J). However, this taxon was only identified as potentially significant post-survey; therefore, it was not specifically searched for

during the survey and it is possible that it may be present elsewhere in the Study Area. The recorded locations occur within VUs 5, 17 and 30, of which VU 17 is currently considered to represent the preferred habitat for this taxon. As aforementioned, VU 17 is primarily restricted to the western edge of the Study Area, and a small area of VU 17 occurs within the Footprint. However, VUs 5 and 30 have been mapped widely throughout the Study Area and Footprint. Therefore, it is possible that there may be additional occurrences of this taxon elsewhere in the Study Area and Footprint.

Plate 27: ***Crassula*** **sp. nov. (potentially undescribed) (Photos: Damian Juniper 2017 (top); Woodman Environmental 2020 (bottom))**

5.2.1.5 Distribution Extensions and Distribution Gaps

Table 11 presents taxa where collections from the Study Area during the current 2020 survey represent extensions to the known distribution of such taxa or otherwise fill gaps within their known distributions, according to *NatureMap* (DBCA 2007–). The locations of six taxa recorded during the current survey represent range extensions or fill gaps within known distributions (Table 11). Although collections of taxa that are 'representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)' can be considered significant taxa as per EPA (2016a), none of the taxa listed in Table 11 are considered to be significant taxa in this context as discussed below.

With respect to significant flora taxa, all populations recorded in the Study Area occur within known ranges, with the exception of *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1); the new records of this taxon from the current survey extend the known distribution of this taxon to the northeast (Section 5.2.1.3, Table 11). The new records of *Hibbertia cockertoniana* (P3) from the current survey fill a gap in the known distribution of this taxon.

Acacia sp. Wondinong (A.A. Mitchell 917) is an unpublished phrase name, with the known distribution of this taxon extending over approximately 520 km (DBCA 2007–). The taxon was first collected in 1980, and while relatively few collections have been lodged at the WA Herbarium since, collection information does not indicate that the taxon has restricted habitat requirements (WA Herbarium 1998–). Therefore, it is not believed that this taxon is significant in the context of the Study Area, but rather is poorly collected.

Atriplex stipitata subsp. *stipitata* is a recently published new subspecies of *Atriplex stipitata* (Walsh and Sluiter 2020). *Atriplex stipitata* is a widespread taxon, occurring in all mainland states of Australia. The taxon is readily identified when fruit are available, and this reliance on fruit characters alone may have led to a simplistic appreciation of the species. Walsh and Sluiter (2020) recognised a new form of the taxon, being *Atriplex stipitata* subsp. *miscella*. While subsp. *miscella* is apparently rare in WA, the type subspecies, subsp. *stipitata*, is moderately common (Walsh and Sluiter 2020). The fact that *Atriplex stipitata* subsp. *stipitata* is widespread, occurring over a range of almost 800 km (DBCA 2007–), and the reliance on fruiting material for meaningful specimens of the taxon may have resulted in underrepresentation at the WA Herbarium. Therefore, the taxon is not considered to be a significant taxon in the context of the Study Area.

Phyllanthus erwinii is a common, widespread taxon, occurring over a range of approximately 1,580 km and within 12 IBRA regions (DBCA 2007–), as well as extending into the Northern Territory and South Australia (AVH 2021). This record is not considered to represent a significant extension to the known range of this taxon, with the absence of other records in the general vicinity of the Study Area likely reflecting a lack of lodgement of the taxon to the WA Herbarium. It is likely to occur in other areas in the vicinity of the Study Area. Therefore, this taxon is not considered to be a significant taxon in the context of the Study Area.

Similarly, *Thysanotus speckii* is also a widespread taxon, occurring over a range of approximately 1,220 km and within seven IBRA regions (DBCA 2007–). This taxon is a tuberous perennial herb with annual leaves that flowers from July to September (Brittan 2020; WA Herbarium 1998–). The taxon is therefore only able to be identified during a short period in the year when above-ground parts are visible. This record is not considered to represent a significant extension to the known range of this taxon, with the absence of other records in the general vicinity of the Study Area likely reflecting a lack of lodgement of the taxon to the WA Herbarium or surveys being conducted outside the short flowering period for the taxon. It is likely to occur in other areas in the vicinity of the Study Area. Therefore, this taxon is not considered to be a significant taxon in the context of the Study Area.

Table 11: Taxa Where Collections Made during the Current Survey Represent Range Extensions or Fill Distribution Gaps (DBCA 2007–)

Taxon	Description
Acacia sp. Wondinong (A.A. Mitchell 917)	Extends known distribution approximately 55 km to the southwest
Atriplex stipitata subsp. *stipitata*	Fills gap in known distribution
Caesia sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1)	Extends known distribution approximately 39 km to the northeast
Hibbertia cockertoniana (P3)	Fills gap in known distribution
Phyllanthus erwinii	Extends known distribution approximately 70 km to the southwest
Thysanotus speckii	Fills gap in known distribution

5.2.1.6 Likelihood of Occurrence of Further Significant Flora Taxa

As detailed in Section 5.1.3, a total of 88 listed significant flora taxa were identified prior to the current 2020 survey as known to occur in, or otherwise is likely or may occur or have habitat occurring within the Study Area and surrounds. Of these, 23 had been previously recorded within the Study Area (Table 7) and two were recorded in the Study Area for the first time during the current survey (*Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) and *Hibbertia cockertoniana* (P3), the latter of which was not identified by the Desktop Assessment) (Table 10).

Table 12 presents an assessment of the likelihood of the remaining 64 taxa occurring within the Study Area. This assessment considered whether a taxon was identifiable at the time of survey, whether the taxon's preferred habitat was present in the Study Area, the known range of the taxon, and proximity of known records to the Study Area when determining the potential for a taxon to occur in the Study Area. It is worthy of note that suitable habitat has been determined using details recorded at known locations. However, for many of the taxa known from the general vicinity of the Study Area, suitable habitat is difficult to define, as habitat information is often vague or very broad and difficult to interpret; for example, an area described as a flat with brown clay loam could feasibly occur almost anywhere in Western Australia. Therefore, a precautionary approach has been adopted when assessing whether suitable habitat for a species is present in the Study Area. Note also that this likelihood of occurrence assessment has considered the Study Area as a whole, despite the 2020 survey being restricted to the western portion of the Study Area.

It is considered that all of the remaining 64 taxa were identifiable during the survey period of this and previous surveys, either because the survey periods coincided with the taxon's flowering period or the taxon can be identified reliably when in fruit or sterile. Of these, it is considered that 16 Priority flora taxa and one Threatened taxon could potentially still occur in the Study Area, despite being identifiable at the time of this and previous surveys, based on suitable habitat occurring or potentially occurring in the Study Area, and the Study Area being within the known range of the taxon or generally within close proximity (Table 12). However, the fact that these taxa have not been recorded in the Study Area despite the history of relatively intensive surveys being conducted over the Study Area over time reduces the probability of occurrence.

The remaining 47 taxa are considered unlikely to occur in the Study Area; in some cases, no suitable habitat is present, while in other cases, although potentially suitable habitat may be present, the Study Area is not within the known range of the taxon and the nearest records are not within close proximity to the Study Area. Note that in terms of taxa with habitats of drainage lines, saline depressions and claypans or salt lakes; there are areas of these habitats present in the Study Area, but they are likely not sufficiently large to support these taxa.

It is considered unlikely that any of the taxa identified in Table 12 are present within the Footprint (Table 12). This is based on the fact that these taxa have not been recorded despite intensive survey having been conducted in the Footprint during the current 2020 survey (and relatively intensive survey having been conducted historically), in combination with other factors such as lack of habitat for some of the taxa.

As discussed in Sections 5.2.1.3 and 5.2.1.4, it is possible that *Hibbertia cockertoniana* (P3) and *Swainsona* sp. Karara (C. Godden & J. Hruban 24-26) (undescribed) may occur within the Footprint, while additional occurrences of *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) and *Crassula* sp. nov. (potentially undescribed) may occur within the Footprint. These taxa were not expected to occur in the Study Area and/or were not identified as significant until after the current survey, and therefore were not specifically searched for within the Footprint.

Table 12: Likelihood of Occurrence of Additional Listed Significant Flora Taxa in the Study Area

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Acacia diallaga	P1	August–September	Skeletal, red, silty loam on the slopes, or occasionally crests, of low rocky basalt hills	2 km to south	Yes	Unlikely – habitat not known to be present
Acacia formidabilis	P3	August–September	Yellow or red-brown sand. Undulating plains, hillsides	29 km to south	Yes	Unlikely – habitat possibly present, but nearest known location 29 km to south represents most north-westerly extent of known range
Acacia graciliformis	P1	September	Stony red-brown clay loams, laterite, BIF, basalt. Rock outcrops, base of rocky hills, gentle slopes	38 km to southwest	Yes	Unlikely – habitat present, but nearest known location 38 km to southwest represents most easterly extent of known range
Acacia sp. Goodlands (B.R. Maslin 7761)	P1	September	Brown/yellow sandy loam. Flats	43 km to south	Yes	Unlikely – habitat possibly present, but nearest known location 43 km to south represents most northerly extent of known range
Acacia speckii	P4	Unknown	Rocky soils over granite, basalt or dolerite. Rocky hills or rises	38 km to north	Yes	Unlikely – habitat possibly present, but nearest known location 38 km to north represents most southerly extent of known range
Acacia subsessilis	P3	July–August	Red sand or stony gravel over ironstone. Rocky hills	16 km to east	Yes	Unlikely – habitat possibly present, however Study Area occurs south of southern edge of distribution
Acacia sulcaticaulis	P1	August–September	Red or brown loam. Slopes of dolerite, granite and greenstone hills, rocky creeklines	3 km to east	Yes	Unlikely – habitat not known to be present, taxon has a very distribution of only 3 km
Acacia tuberculata	P2	September	Granite outcrops	31 km south	Yes	Unlikely – habitat present, but nearest record to Study Area is doubtful (has been identified as *Acacia* ?*tuberculata*); next closest record with confident identification is 350 km to south

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Aluta aspera subsp. *localis*	P2	October-November	Sandplain	192 km to southeast	Yes	Unlikely – habitat possibly present, but nearest known 192 km to southeast represents most northerly extent of its quite restricted range (record in Desktop Study Area is erroneous)
Angianthus micropodioides	P3	April, August–February	Saline sandy soils. River edges, saline depressions, claypans	22 km to southeast	Yes	Unlikely – habitat not considered to be present
Baeckea sp. Perenjori (J.W. Green 1516)	P2	August	Loam, clay	26 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 26 km to southwest represents most easterly extent of known range
Banksia benthamiana	P4	November–January	Sandy loam, clay-loam, yellow sand, gravel	24 km to northwest	Yes	Unlikely – habitat possibly present, but nearest known location 24 km to northwest is on the eastern edge of its known range
Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)	P3	March, May, July, September	Breakaway, laterised ironstone, red-brown clay loam soils. Flats and lower slopes at base of weathered granite breakaways. Dry white-grey sandy loam. Mid slope of low BIF hills, growing on duricrust	5 km to east	Yes	**Possible** – habitat present, Study Area occurs on the northwestern edge of known range **Unlikely to occur in the surveyed Footprint area**
Calandrinia sp. Warriedar (F. Obbens 04/09)	P2	September	Breakaway, laterite, red-brown clay loam soils. Granitic flat. Brown clay loam with granite stones. Lower slope of a small ironstone range	165 m to west	Yes	**Possible** – habitat present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Chamelaucium sp. Warriedar (A.P. Brown & S. Patrick APB 1100)	P1	July–September	Red-brown rocky clay loam. Lower slope of basalt and minor quartz with red-brown deep sandy clay loam soils. Low rocky hill, skeletal silty clay loam over granite/greenstone	2 km to south	Yes	**Possible** – habitat possibly present, Study Area occurs on the northwestern edge of known range **Unlikely to occur in the surveyed Footprint area**
Chorizema humile	T	July–September	Sandy clay or loam. Plains	81 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 81 km to southwest is on the eastern edge of its known range
Cyanicula fragrans	P3	August–September	Red loam. Flat granite outcrops	1 km to southeast	Yes	**Possible** – habitat present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**
Dasymalla axillaris	T	July–December	Sandy soils. Possibly a disturbance opportunist; has only been recorded in areas of recent disturbance	51 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 51 km to southwest represents most northerly extent of known range
Dicrastylis linearifolia	P3	November–December	Red sand. Sandplains	7 km to southeast	Yes	Unlikely – habitat not considered to be present
Dodonaea amplisemina	P4	August	Red-brown sandy clay on basalt and gabbro and BIF or on dolerite and quartzite. Rocky hills	7 km to east	Yes	**Possible** – habitat present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**
Elatine macrocalyx	P3	May–October	Shallow sands over clay. Margins of playa lakes and claypans	41 km to south	Yes	Unlikely – habitat not considered to be present
Enekbatus longistylus	P3	September–October	Yellow sand. Sandplains	32 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 32 km to southwest represents most easterly extent of known range

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Eremophila grandiflora	P3	June–September	Stony red-brown sandy-clay. On slopes and along drainage lines	16 km to east	Yes	Unlikely – habitat possibly present, but nearest known location 16 km to east represents most westerly extent of known range
Eremophila nivea	T	August–October	Sandy clay, clay loam. Undulating plains, areas of disturbance	41 km to west	Yes	Unlikely – habitat possibly present, but nearest known location 41 km to west represents most easterly extent of known range
Eremophila oldfieldii subsp. *papula*	P1	August–November	Red-brown clay loam on lower slopes of rocky hills	2 km to south	Yes	**Possible** – habitat possibly present **Unlikely to occur in the surveyed Footprint area**
Eremophila rostrata subsp. *trifida*	T	September–October	Hard, light brown, sandy loams, granite	41 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 41 km to southwest represents most northeasterly extent of known range
Eremophila sericea	P1	September–November	Red-brown clay loam on the lower slopes of rocky hills	3 km to south	Yes	**Possible** – habitat present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**
Eremophila viscida	T	September–November	Granitic soils, sandy loam. Stony gullies, sandplains	62 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 62 km to southwest represents most northeasterly extent of known range
Eucalyptus beardiana	T	August–September	Red or yellow sand. Sand dunes and sand plains	140 km to northwest	Yes	Unlikely – habitat not considered to be present
Eucalyptus jutsonii subsp. *kobela*	P1	Unknown	Deep yellow to orange sand. Broad and subdued rises high in the landscape	7 km to north	Yes	Unlikely – habitat not considered to be present

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Eucalyptus synandra	T	December–February	Yellow or orange sand or grey-brown loam or red sandy loam. Lateritic soils. Summits of ironstone hills or flats	5 km to west	Yes	**Possible** – habitat possibly present, Study Area occurs on edge of known range **Unlikely to occur in the surveyed Footprint area**
Euryomyrtus recurva	P3	July–September	Yellow or red sand, brown or yellow sandy clay. Areas of disturbance, gravel pits, catchment slopes	22 km to south	Yes	Unlikely– habitat not considered to be present
Eutaxia sp. Jasper Hill (R.J. Cranfield 8607)	P1	Unknown	Red brown clay, ironstone	7 km to east	Yes	**Possible** – habitat possibly present, however taxon known from only one record from 1992 **Unlikely to occur in the surveyed Footprint area**
Fitzwillia axilliflora	P2	September–November	Sand, clay loam. Margins of salt lakes, saline flats	36 km to west	Yes	Unlikely – habitat possibly present, but nearest known location 36 km to west represents most northeasterly extent of known range
Frankenia conferta	T	October	Clayey soils on the edge of salt lakes	60 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 60 km to southwest represents most northerly extent of known range
Gnephosis cassiniana	P3	September–October	Sand, clay loam. Saline depressions, low wet areas	24 km to east	Yes	**Possible** – habitat possibly present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Gnephosis setifera	P1	September	Sand. Saline flats	11 km to south	Yes	**Possible** – habitat possibly present, Study Area occurs slightly northeast of known range **Unlikely to occur in the surveyed Footprint area**
Grevillea granulosa	P3	July–October	Gravelly sand, loam, clay. Sandplains	11 km to east	Yes	Unlikely – habitat not considered to be present
Grevillea leptopoda	P3	August–September	Loam and lateritic gravel, sand, clay	6 km to southwest	Yes	Unlikely – habitat not considered to be present
Grevillea obliquistigma subsp. *cullenii*	P2	March	Red sand	44 km to southeast	Yes	Unlikely – habitat possibly present, but nearest known location 44 km to southeast represents most westerly extent of known range
Grevillea rosieri	P1	July–September	Sandy soils, sometimes with granite and laterite	41 km to northwest	Yes	Unlikely – habitat not considered to be present
Gyrostemon reticulatus	T	September	Yellow-brown sandy slopes	55 km to southwest	Yes	Unlikely – habitat not considered to be present
Haegiela tatei	P4	August–November	Clay, sandy loam, gypsum. Saline areas	38 km to north	Yes	Unlikely – habitat not considered to be present
Hemigenia tichbonii	P1	August–October	Semi-arid open shrublands over granite or greenstone	2 km to south	Yes	**Possible** – habitat present, Study Area occurs slightly north of known range **Unlikely to occur in the surveyed Footprint area**
Hybanthus cymulosus	T	May–July	Clay, rocky loam clay	43 km to southeast	Yes	Unlikely – habitat possibly present, but nearest known location 43 km to southeast represents most northerly extent of known range, has a restricted distribution

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Hydrocotyle dimorphocarpa	P1	September–October	Creekbanks or drainage lines containing red-brown clay loam soils	3 km to east	Yes	**Possible** – habitat possibly present, Study Area occurs slightly west of known range **Unlikely to occur in the surveyed Footprint area**
Hydrocotyle spinulifera	P3	August–November	Moist margins of seasonal wetlands, freshwater and saline lakes	26 km to west	Yes	Unlikely – habitat not considered to be present
Korthalsella leucothrix	P1	August	Parasitic on *Acacia acuminata* and *Acacia craspedocarpa*	22 km to southwest	Yes	**Possible** – host taxa present in Study Area. While nearest known location 22 km to southwest represents most westerly extent of known range, taxon known from few records over a wide distribution (approximately 990 km) **Unlikely to occur in the surveyed Footprint area**
Lepidosperma gibsonii	T	September–February	Shallow soil over massive BIF. Gullies and slopes	43 km to south	Yes	Unlikely – habitat present, but nearest known location 43 km to south represents most northwesterly extent of known range, has a restricted distribution
Lepidosperma sp. Koolanooka (K.R. Newbey 9336)	P1	May–June, October	Red and brown gravelly loam and clay over laterite. Rocky laterised ironstone and BIF, basalt outcrop	36 km to west	Yes	Unlikely – habitat present, but nearest known location 36 km to west represents most easterly extent of known range, has a restricted distribution

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Leucopogon sp. Yanneymooning (F. Mollemans 3797)	P3	May	White-grey sandy clay, brown gritty loam over granite, skeletal soils. Tops of valleys, hills and breakaways	31 km to southwest	Yes	Unlikely – habitat possibly present, but nearest known location 31 km to southwest represents most northerly extent of known range, has a restricted distribution
Menkea draboides	P3	August–September	Red sand or clay, granite	165 m to north	Yes	**Possible** – habitat present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**
Mirbelia ferricola	P3	August–October	Restricted to BIF. Shallow lateritic soils on lower to upper slopes and crests of BIF massifs and laterised BIF with haematite, as well as on ledges and between rock-cracks on BIF cliffs	36 km to west	Yes	Unlikely – although habitat present, Study Area is not within the range of this taxon
Persoonia kararae	P2	September–November	Red clay loam. Sandplains and gentle slopes	2 km to west	Yes	Unlikely – habitat not considered to be present
Philotheca nutans	P1	April–October	Sandy soils. Low plains, undulating rises, edges of salt lakes	35 km to southeast	Yes	Unlikely – habitat possibly present, but nearest known location 35 km to southeast represents most westerly extent of known range
Podotheca pritzelii	P3	September–October	Sand. Sand ridges in salt flats	32 km to south	Yes	Unlikely – habitat not considered to be present
Podotheca uniseta	P3	September–December	White-grey sand, sandy loam. Samphire flats	33 km to south	Yes	Unlikely – habitat present, but nearest known location 33 km to south is on the northern edge of its known range
Psammomoya implexa	P3	August–October	Stony rises. Yellow sandplain. Footslopes of BIF and laterite with red brown soils	2 km to north	Yes	**Possible** – habitat present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**

Taxon	Status (WA)	Flowering Period (WA Herbarium 1998–)	Habitat (WA Herbarium 1998–)	Nearest Known Location to Study Area (DBCA 2007–)	Identifiable During Survey?	Likelihood of Occurrence in Study Area / Surveyed Footprint
Roycea pycnophylloides	T	September	Sandy soils, clay. Saline flats	260 km to south	Yes	Unlikely – nearest known location 260 km to south represents most northerly extent of known range
Sclerolaena sp. Koolanooka Hills (R. Meissner & Y. Caruso 437)	P1	Unknown	Red-brown soils, BIF. Lower slopes	49 km to west	Yes	Unlikely – habitat present, but nearest known location 49 km to west is the only known record of this taxon
Tecticornia bulbosa	T	April	Saline sandy clay or red-brown loam	50 km to west	Yes	Unlikely – habitat possibly present, but nearest known location 50 km to west is on the eastern edge of its known range
Tecticornia fimbriata	P3	Unknown	Clay, loam. Margins of salt and gypsum lakes	26 km to west	Yes	Unlikely – habitat possibly present, but nearest known location 50 km to west is on the eastern edge of its known range
Triglochin protuberans	P3	August–November	Red loam, grey mud over clay. Winter-wet sites, claypans, near salt lakes, margins of pools	30 km to south	Yes	Unlikely – habitat not considered to be present
Wurmbea murchisoniana	P4	July–September	Clay, sandy clay, loam. Seasonally inundated clay hollows, rock pools	12 km to south	Yes	**Possible** – habitat possibly present, Study Area occurs within known range **Unlikely to occur in the surveyed Footprint area**

5.2.1.7 Introduced Flora Taxa

Table 13 presents a summary of data relating to introduced flora taxa recorded in the Study Area, including comments regarding the significance of the taxa and their ecological impact and invasiveness ratings under the *Weed Prioritisation Process for Department of Parks and Wildlife* for the Midwest region (DBCA 2014).

Historical records of introduced flora taxa that were located in areas that are now cleared have been removed from the dataset as summarised in Table 13. Potential duplication of records in the Study Area has been avoided by assessment of locations of introduced flora recorded by the current survey against historical data in a GIS environment.

A total of 32 introduced flora taxa have been recorded from the Study Area by the current survey and relevant previous surveys, two of which are Declared Pests under the BAM Act (*Echium plantagineum* and *Galium aparine*). No WoNS have been recorded in the Study Area. Note that the count of 32 introduced flora taxa excludes *Cuscuta* sp. presented in Table 13; poor material prevented full identification of this entity, and given other *Cuscuta* taxa have been previously recorded in the Study Area it is unlikely to represent a different, unique taxon.

Introduced taxa were generally most abundant around areas associated with historical disturbance and grazing (Section 5.2.2.10) or in areas that experience periodic inundation. Locations of introduced flora taxa recorded in the Study Area are presented on Figure 11 and in Appendix I.

Two introduced taxa recorded within the Study Area have not been rated for ecological impact and invasiveness by DBCA (2014), being *Rostraria pumila* and *Sisymbrium runcinatum* (Table 13). These taxa are not considered to be serious weeds according to Hussey *et al.* (2007).

A total of eight of the introduced taxa recorded in the Study Area are rated as having 'Low' ecological impact (Table 13); these taxa are typically cosmopolitan species that generally cause minimal disruption to ecological processes or loss of biodiversity (DBCA 2014).

Eight introduced taxa recorded in the Study Area are rated as having 'High' ecological impact; these are considered significant weeds capable of causing acute disruption of ecological processes, as well as dominating and/or significantly altering the vegetation structure, composition and function of ecosystems (DBCA 2014). However, these weeds do not appear to be of significant concern in the Study Area as none were widespread in the Study Area (Table 13).

The majority of introduced taxa recorded within the Study Area are rated as having 'Rapid' invasiveness in native vegetation (Table 13) (DBCA 2014). These taxa are typically disturbance opportunists and are relatively common around disturbance areas associated with historical mining and disturbance.

Table 13: Summary of Introduced Flora Taxa Recorded within the Study Area

Taxon	Common Name	Number of Locations			Significance	Ecological Impact (DBCA 2014)	Invasiveness (DBCA 2014)
		This Survey	Previous Surveys*	Total			
Aira caryophyllea	Silvery Hairgrass		4	4		High	Rapid
Arctotheca calendula	Cape Weed African Marigold		2	2		High	Rapid
Brassica tournefortii	Mediterranean Turnip		1	1		High	Rapid
Bromus diandrus	Great Brome		2	2		High	Rapid
Bromus rubens	Red Brome		2	2		Unknown	Rapid
Cleretum papulosum subsp. *papulosum*	–		14	14		Unknown	Rapid
Corchorus sp.	–		3	3		–	–
Cuscuta epithymum	Lesser Dodder, Greater Dodder	2	31	33		Unknown	Rapid
Cuscuta planiflora	Red Dodder		1	1		Unknown	Rapid
Cuscuta sp.	–	4		4		–	–
Echium plantagineum	Paterson's Curse		8	8	Declared Pest	High	Rapid
Ehrharta longiflora	Annual Veldt Grass		2	2		Unknown	Rapid
Erodium cicutarium	Common Storksbill		2	2		Low	Rapid
Galium aparine	Goosegrass		3	3	Declared Pest	Unknown	Rapid
Gorteria personata	Gorteria		1	1		Unknown	Rapid
Hypochaeris glabra	Flatweed, Smooth Catsear	1	8	9		Low	Rapid
Lamarckia aurea	Goldentop		5	5		Unknown	Rapid
Lysimachia arvensis	Scarlet Pimpernel, Blue Pimpernel	1	2	3		Low	Rapid
?*Malva parviflora*	Marshmallow		1	1		Low	Slow
Medicago minima	Small Burr Medic	1	2	3		Low	Moderate
Mesembryanthemum nodiflorum	Slender Iceplant	7	10	17		High	Moderate
Oxalis ?*corniculata*	Yellow Wood Sorrel		1	1		Unknown	Slow
Pentameris airoides subsp. *airoides*	False Hairgrass	1	45	46		Unknown	Rapid
Petrorhagia dubia	Hairy Pink		1	1		Low	Rapid
Rostraria pumila	Rough Cat's Tail, Tiny Bristle-grass	2		2		Unknown	Unknown
Silene nocturna	Mediterranean Catchfly		4	4		Low	Rapid

Taxon	Common Name	Number of Locations			Significance	Ecological Impact (DBCA 2014)	Invasiveness (DBCA 2014)
		This Survey	Previous Surveys*	Total			
Sisymbrium runcinatum	African Turnip Weed	2		2		Unknown	Unknown
Sonchus oleraceus	Common Sowthistle		5	5		Unknown	Rapid
Spergula pentandra	Five Ather Spurrey	1	1	2		Low	Rapid
Urospermum picroides	False Hawkbit		1	1		High	Rapid
Ursinia anthemoides	Ursinia		2	2		High	Rapid
Vulpia muralis	Silver Grass		1	1		Unknown	Rapid
Vulpia myuros forma *myuros*	Rat's Tail Fescue		1	1		Unknown	Rapid

* Data from Karara–Mungada and Regional Mapping Surveys (Woodman Environmental 2008c, 2012b). Note that these figures represent only introduced flora that occurs in uncleared vegetation (as per the mapping presented in this report; see Section 5.2.2.3) within the current survey Study Area, and therefore may be less than the figures presented in the original reports.

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Legend

- Study Area
- Footprint
- Cleared or Rehabilitated Land

Introduced Flora

Aic	**Aira caryophyllea*
Brd	**Bromus diandrus*
Brr	**Bromus rubens*
Clp	**Cleretum papulosum*
Clpp	**Cleretum papulosum* subsp. *papulosum*
?Clpp	**?Cleretum papulosum* subsp. *papulosum*
Cue	**Cuscuta epithymum*
Cup	**Cuscuta planiflora*
Csp	**Cuscuta* sp.
Ecp	**Echium plantagineum*
Gop	**Gorteria personata*
Hyg	**Hypochaeris glabra*
Lya	**Lysimachia arvensis*
Mem	**Medicago minima*
Men	**Mesembryanthemum nodiflorum*
Peaa	**Pentameris airoides* subsp. *airoides*
Ped	**Petrorhagia dubia*
Rop	**Rostraria pumila*
Sis	**Sisymbrium runcinatum*
Sol	**Sonchus oleraceus*
Spp	**Spergula pentandra*

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umwelt

This map should only be used in conjunction with WEC report KML20-33-01.

N

Introduced Flora of the Study Area

Revision: A - 30 August 2021 Scale: 1:85,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f11

Projection: GDA 1994 MGA Zone 50

Figure

11

5.2.2 Vegetation

5.2.2.1 Floristic Classification Results

The PATN software package (Belbin and Collins 2013) initially suggested that a 17-cluster classification of quadrats may be appropriate for the Study Area quadrat data. The resulting dendrogram (Appendix K) and taxon group matrix were therefore initially examined at this level to determine the plausibility of these clusters with regard to taxon groups as well as field observations. This examination determined that seven clusters contained obvious sub-grouping of quadrats; inspection of these quadrats and the taxon group matrix found that these subgroups were worthy of distinction as individual clusters. In addition, two clusters (one containing three quadrats and one containing one quadrat) were found to have been misclassified and did not represent distinct clusters; these quadrats were manually reassigned following detailed investigation of individual quadrat datasets (including soil, topography and taxon composition/dominant taxa), and examination of field notes and the taxon group matrix. Finally, six quadrats were identified that were considered to have been misclassified; this appeared to be due to quadrats that were particularly species poor and/or quadrat placement in vegetation that was transitional. These quadrats were also manually reassigned to VUs that better reflected their topography, soil type and vegetation composition.

The above examination resulted in the identification of 32 plausible clusters that are considered to represent VUs in the Study Area. These results were supported by review of the final dendrogram from the current analysis with the FCTs assigned to quadrats also analysed for the Karara–Mungada Survey (Woodman Environmental 2008c). The final clusters and associated VUs, as well as the designated FCTs for the quadrats analysed for the Karara–Mungada Survey, are presented in Appendix K. FCT descriptions from the Karara–Mungada Survey are presented in Appendix L.

5.2.2.2 Vegetation Units

A total of 32 VUs were defined and mapped based on the results of the floristic classification analysis and subsequent examination of quadrat data. The 32 VUs represent three broad groups of vegetation based on soils and topography:

- Group 1: *Eucalyptus* woodlands and *Acacia* and/or *Melaleuca* shrublands over mixed chenopods such as *Maireana* and *Sclerolaena* species on stony undulating plains, flat outwash and depression areas with no exposed bedrock on soils that had a tendency to be saline (VUs 1 to 18). The VUs comprising this group generally corresponded with the Yalgoo_41, Yalgoo_125, Yalgoo_355, Yalgoo_363, Yalgoo_364 and Yalgoo_419 VSAs and the Campsite, Carnegie, Challenge, Cunyu, Doney, Euchre, Graves, Moriarty, Nerramyne, Pindar, Singleton and Yowie land systems (Section 5.1.1);
- Group 2: *Acacia* shrublands with emergent *Eucalyptus* spp. over mixed shrubs including *Eremophila* and *Philotheca* species on rocky BIF or other substrates on lower slopes to crests and breakaways (VUs 19 to 28). The VUs comprising this group were predominately mapped on Mount Karara, Blue Hills and Mungada Ridge and generally corresponded with the Yalgoo_358 VSA and the Tallering land system (Section 5.1.1); and

- Group 3: *Acacia* shrublands with emergent *Eucalyptus* spp. over mixed shrubs including *Aluta aspera* subsp. *hesperia* on gravelly and stony undulating plains and slopes (VUs 29 to 32). The VUs comprising this group generally corresponded with the Yalgoo_420 VSA and the Joseph and Tealtoo land systems (Section 5.1.1).

Figure 12 presents an overview of the distribution of VUs throughout the Study Area. Detailed VU mapping with locations of quadrats and relevés are presented in Appendix M.

Table 14 presents a description of each VU mapped in the Study Area (based on quadrat data only), including location, area mapped, sampling regime, significant flora recorded within quadrats ('^' denotes preferred habitat for a significant taxon), average native perennial taxon richness recorded within quadrats and a summary of variation found within quadrats within the VU. Appendix N presents the taxon–VU matrix, while the indicator taxon analysis data is presented in Appendix O. A summary of the misclassified and manually reassigned quadrats, including reasoning for their movement within the classification analysis output, is presented in Appendix P.

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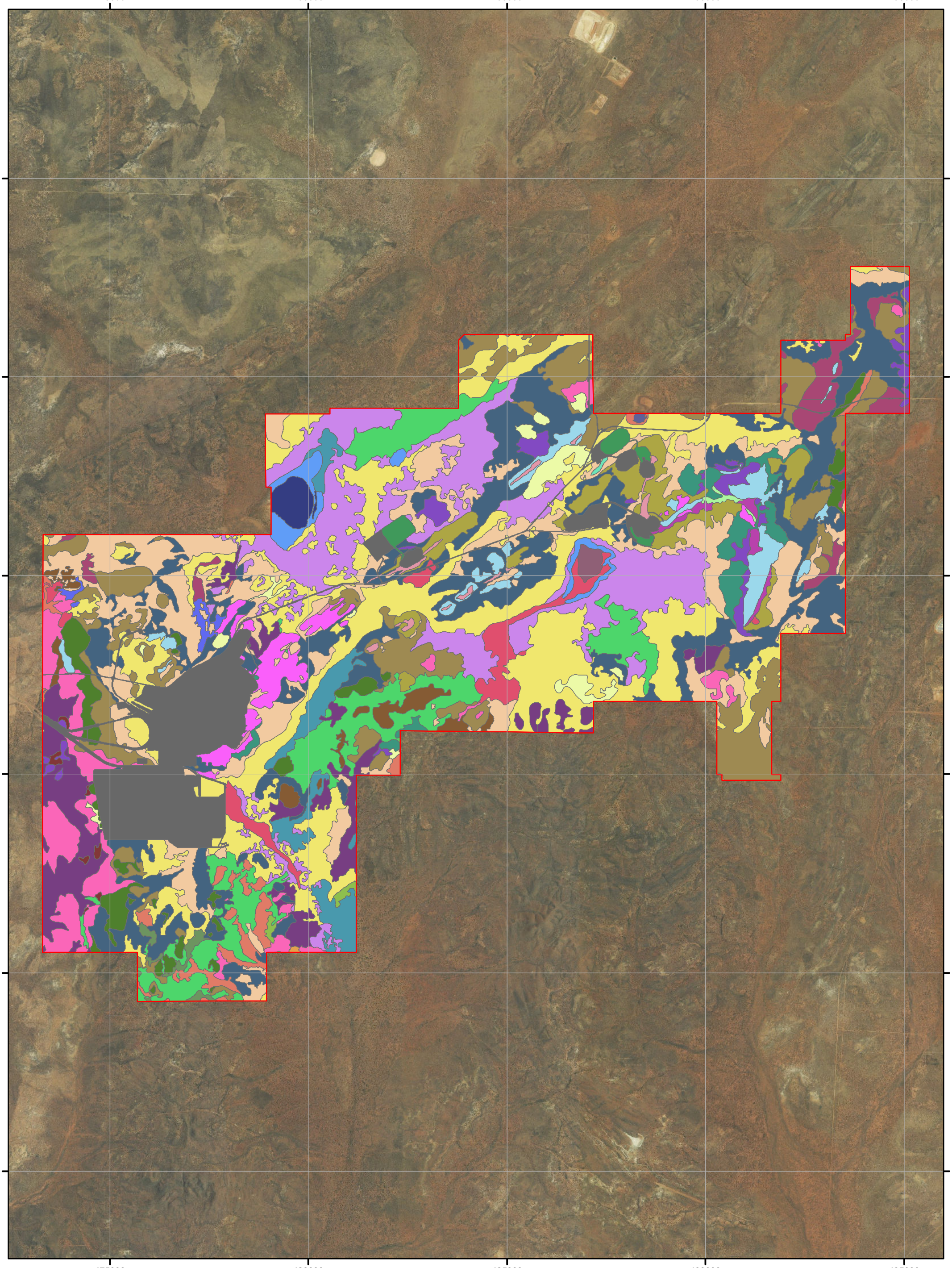

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This map should only be used in conjunction with WEC report KML20-33-01.

N

Overview of Vegetation Units of the Study Area

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f12-1

Revision: A - 30 August 2021

Scale: 1:85,000

Projection: GDA 1994 MGA Zone 50

Figure

12.1

Legend

Study Area

Vegetation Units

1 Tall shrubland to open shrubland dominated by *Acacia acuminata*/*Acacia burkittii* and *Acacia tetragonophylla* and occasionally *Exocarpos aphyllus* over mid sparse shrubland of mixed species including *Hakea recurva* subsp. *recurva*, *Acacia obtecta* and *Eremophila pantonii* over low sparse shrubland of mixed species including *Rhagodia drummondii*, *Ptilotus obovatus* var. *obovatus*, *Sida* sp. dark green fruits (S. van Leeuwen 2260), *Persoonia pentasticha* (P3) and *Solanum nummularium* over low sparse chenopod shrubland of mixed species including *Maireana thesioides*, *Maireana carnosa*, *Sclerolaena diacantha* and *Sclerolaena fusiformis* on red-brown or red clay loam and silty clay loam, occasionally with ironstone, granite and quartz stones on plains and flats.

2 Low woodland to open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and occasionally *Eucalyptus clelandiorum* and *Eucalyptus salubris* over tall open shrubland to sparse shrubland of mixed species dominated by *Acacia tetragonophylla* and occasionally *Eremophila oppositifolia* subsp. *angustifolia* over mid open shrubland to sparse shrubland of mixed species including *Dodonaea inaequifolia*, *Senna artemisioides* subsp. *filifolia*, *Senna artemisioides* subsp. *petiolaris*/*Senna* sp. Austin (A. Strid 20210) and *Eremophila pantonii* over low sparse shrubland of mixed species dominated by *Scaevola spinescens* and *Ptilotus obovatus* var. *obovatus* over low sparse chenopod shrubland of mixed species including *Sclerolaena fusiformis*, *Enchylaena lanata* and *Maireana carnosa* over low sparse tussock grassland of *Austrostipa elegantissima* over low sparse forbland of mixed species including *Cephalipterum drummondii* and * *Mesembryanthemum nodiflorum* on red-brown, red or brown clay loam and silty loam with granite, ironstone and quartz stones and occasionally with granite, ironstone or quartz outcropping on plains and slopes of low hills.

3 Tall open shrubland to sparse shrubland of mixed species dominated by *Acacia tetragonophylla*, *Eremophila oldfieldii* subsp. *oldfieldii* and occasionally *Acacia acuminata*/*Acacia burkittii* over mid open shrubland to sparse shrubland of mixed species dominated by *Dodonaea inaequifolia* and *Acacia ramulosa var. ramulosa* over low sparse shrubland of mixed species dominated by *Ptilotus obovatus* var. *obovatus*, *Scaevola spinescens* and *Sida* sp. dark green fruits (S. van Leeuwen 2260) on red-brown, red or brown clay loam and silty loam with ironstone and quartz stones on slopes of low hills and plains

4 Low open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* or occasionally *Eucalyptus salubris* or *Eucalyptus clelandiorum* over mid open shrubland to sparse shrubland of mixed species dominated by *Eremophila pantonii* and *Acacia obtecta* over low sparse shrubland of mixed species including *Rhagodia drummondii*, *Senna stowardii*, *Ptilotus obovatus* var. *obovatus*, *Senna artemisioides subsp. filifolia* and *Acacia acanthoclada* subsp. *glaucescens* over low sparse chenopod shrubland of mixed species including *Sclerolaena fusiformis* and *Maireana thesioides* over low sparse forbland of mixed species including *Cephalipterum drummondii* and *Pogonolepis muelleriana* on red or red-brown clay loam and silty clay loam with laterite, ironstone and quartz stones on plains.

5 Low open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* over tall open to sparse shrubland of mixed species including *Acacia obtecta* and *Acacia ramulosa* var. *ramulosa* over mid open shrubland to sparse shrubland of mixed species including *Acacia tetragonophylla* over low sparse shrubland of mixed species dominated by *Rhagodia drummondii*, *Ptilotus obovatus* var. *obovatus*, *Senna artemisioides subsp. filifolia* and occasionally *Sida* sp. dark green fruits (S. van Leeuwen 2260) over low sparse chenopod shrubland of mixed species dominated by *Sclerolaena fusiformis* and occasionally *Maireana carnosa* and *Sclerolaena diacantha* on red-brown or red silty clay loam and sandy clay with ironstone and quartz stones on flats and plains.

6 Low woodland to open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* over low sparse shrubland of mixed species including *Senna artemisioides subsp. filifolia*, *Ptilotus obovatus* var. *obovatus* and *Rhagodia drummondii* over low sparse chenopod shrubland of mixed species dominated by *Maireana carnosa* and *Sclerolaena fusiformis* and occasionally *Sclerolaena diacantha* and *Sclerolaena gardneri* on red-brown, red or orange-brown silty clay loam and sandy clay with sparse ironstone and quartz gravel on flats, outwash plains and minor drainage areas.

7 Tall to mid sparse shrubland of mixed species including *Acacia obtecta*, *Exocarpos aphyllus* and *Eremophila glabra* over low sparse shrubland dominated by *Ptilotus obovatus* var. *obovatus*, **Corchorus* sp. and *Duma florulenta* over mid open samphire shrubland to sparse samphire shrubland of *Tecticornia disarticulata* over low sparse chenopod shrubland of mixed species including *Sclerolaena diacantha*, *Sclerolaena fusiformis*, *Maireana carnosa* and *Salsola australis* on brown and red-brown clay loam and silty clay loam in clay pans.

8 Low open woodland of *Eucalyptus salubris* over low sparse chenopod shrubland of mixed species dominated by *Maireana carnosa*, *Sclerolaena fusiformis* and *Maireana trichoptera* on red-brown or red clay loam and clayey sand with ironstone, quartz and granite stones on plains and minor depression areas.

9 Low open forest to woodland of *Eucalyptus loxophleba* subsp. *supralaevis* over low open shrubland to sparse shrubland of *Duma florulenta*, *Ptilotus obovatus* var. *obovatus*, *Teucrium racemosum* and *Eremophila pantonii* over low sparse chenopod shrubland of mixed species including *Sclerolaena fusiformis*, *Atriplex semilunaris*, *Enchylaena lanata* and *Maireana brevifolia* over low sparse tussock grassland of *Amphipogon caricinus* var. *caricinus* and *Austrostipa elegantissima* on red-brown silty clay loam in depressions.

10 Low open woodland of mixed species dominated by *Eucalyptus kochii* subsp. *amaryssia*/*Eucalyptus kochii* subsp. *plenissima* and/or *Eucalyptus loxophleba* subsp. *supralaevis* over tall sparse shrubland to open shrubland of mixed species including *Acacia latior*, *Acacia sibina*, *Acacia ramulosa* var. *ramulosa* and *Melaleuca leiocarpa* over mid sparse shrubland of mixed species dominated by *Acacia tetragonophylla* and occasionally *Acacia assimilis* subsp. *assimilis*, *Philotheca brucei* subsp. *brucei*, *Hakea recurva* subsp. *recurva* and *Alyxia buxifolia* over low sparse shrubland of mixed species dominated by *Ptilotus obovatus* var. *obovatus*, *Rhagodia drummondii* and occasionally *Olearia humilis*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Acacia exocarpoides* on red-brown or red clay loam and sandy clay loam with ironstone and quartz stones on flats, plains, and slopes and crests of low hills.

11 Tall isolated clumps of shrubs of *Acacia aneura* and *Melaleuca eleuterostachya* over low isolated clumps of shrubs of *Rhagodia drummondii* on red medium clay in drainage depressions.

12 Low woodland of *Eucalyptus clelandiorum* or tall shrubland of *Melaleuca acutifolia* over low sparse chenopod shrubland of mixed species dominated by *Maireana thesioides*, *Maireana carnosa*, *Sclerolaena diacantha* and *Maireana georgei* on red-brown or brown-red silty clay loam, occasionally with calcrete stones in drainage depressions and on the edges of saline clay pans.

13 Low open woodland of *Eucalyptus clelandiorum* over mid sparse shrubland of mixed species including *Eremophila pantonii* and *Acacia obtecta* over low sparse shrubland of mixed species including *Ptilotus obovatus* var. *obovatus*, *Acacia acanthoclada* subsp. *glaucescens*, *Acacia erinacea* and *Senna charlesiana* over low sparse chenopod shrubland of mixed species including *Sclerolaena drummondii*, *Maireana marginata*, *Maireana georgei* and *Enchylaena tomentosa* var. *tomentosa* over low sparse forbland of mixed species including *Cephalipterum drummondii*, *Goodenia pusilliflora* and *Calotis multicaulis* on red-brown or red-orange clay loam on plains and lower slopes.

14 Low woodland of *Eucalyptus salubris* over low open chenopod shrubland of mixed species including *Sclerolaena drummondii*, *Atriplex codonocarpa*, *Atriplex semilunaris*, *Maireana carnosa* and *Maireana tomentosa* subsp. *tomentosa* over low sparse forbland of mixed species including **Mesembryanthemum nodiflorum* on brown clay loam with granite, ironstone and quartz stones on drainage lines and drainage depressions.

15 Low isolated clumps of shrubs of mixed species including *Ptilotus schwartzii*, *Calytrix leschenaultii* and *Dodonaea inaequifolia* over low isolated clumps of chenopod shrubs of mixed species including *Maireana carnosa* and *Sclerolaena densiflora* over low isolated clumps of tussock grasses of mixed species including *Aristida contorta* and *Tripogonella loliiformis* over low sparse forbland of mixed species including *Calandrinia baccata*, **Mesembryanthemum nodiflorum*, *Goodenia cycnopotamica*, *Crassula colorata*, *Lemooria burkittii* and *Rhodanthe spicata* over low isolated clumps of ferns of *Cheilanthes sieberi* subsp. *sieberi* on skeletal grey clay loam with granite stones on granite outcropping.

16 Tall open shrubland to sparse shrubland of mixed species dominated by *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla*, *Hakea recurva subsp. recurva* and occasionally *Acacia acuminata*/*Acacia burkittii* over low sparse shrubland of mixed species including *Solanum lasiophyllum*, *Ptilotus obovatus* var. *obovatus*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Eremophila eriocalyx* over low sparse forbland of mixed species including *Borya sphaerocephala*, *Podolepis lessonii*, *Myriocephalus guerinae* and *Gilruthia osbornii* on red, red-brown or brown clay loam and sandy clay loam with granite, ironstone, quartz and laterite stones and occasionally with granite, dolerite or laterite outcropping on plains, slopes of low hills and drainage lines.

17 Tall sparse shrubland of mixed species including *Acacia tetragonophylla*, *Acacia umbraculiformis* and *Acacia acuminata*/*Acacia burkittii* over mid sparse shrubland of mixed species including *Thryptomene costata* and *Acacia kochii* over low sparse shrubland of mixed species including *Ptilotus obovatus* var. *obovatus* and *Solanum lasiophyllum* over low open forbland to sparse forbland of mixed species dominated by *Borya sphaerocephala* and occasionally *Goodenia rosea*, *Erodium cygnorum* and **Pentameris airoides* subsp. *airoides* on red, red-brown or brown clay loam and sandy clay with granite, ironstone and quartz stones and occasionally with granite outcropping on slopes of low hills, flats and plains.

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This map should only be used in conjunction with WEC report KML20-33-01.

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Overview of Vegetation Units of the Study Area

Revision: A - 30 August 2021 Scale: 1:85,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f12-2

Projection: GDA 1994 MGA Zone 50

Figure

12.2

Legend

Vegetation Units (continued)

18	Tall shrubland to open shrubland of mixed species dominated by *Acacia acuminata*/*Acacia burkittii*, *Melaleuca hamata*, *Acacia ramulosa* var. *ramulosa* and occasionally *Acacia karina* (P1) and *Allocasuarina acutivalvis* subsp. *prinsepiana* over low sparse shrubland of mixed species including *Ptilotus obovatus* var. *obovatus*, *Mirbelia microphylla*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Senna charlesiana* over low open forbland to sparse forbland of mixed species including *Borya sphaerocephala*, *Waitzia acuminata* var. *acuminata*, *Trachymene ornata* and *Podolepis lessonii* on red or red-brown clay loam and medium clay with granite, ironstone and quartz stones and occasionally with granite outcropping on plains, slopes and drainage lines.
19	Tall shrubland to open shrubland of mixed species including *Calycopeplus paucifolius*, *Acacia acuminata*/*Acacia burkittii*, *Acacia aneura* spp., *Hakea recurva* subsp. *recurva*, *Melaleuca nematophylla* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid open shrubland of mixed species dominated by *Acacia exocarpoides*, *Eremophila latrobei* subsp. *latrobei*, *Eremophila clarkei*, *Philotheca brucei* subsp. *brucei* and *Philotheca sericea* over low open shrubland to sparse shrubland of mixed species including *Sida* sp. dark green fruits (S. van Leeuwen 2260), *Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Xanthosia kochii* on red-brown or red silty loam and silty clay loam with BIF stones and BIF outcropping on moderately inclined to steep upper slopes and crests.
20	Tall shrubland to open shrubland of mixed species including *Calycopeplus paucifolius*, *Acacia aneura* spp., *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid open shrubland of mixed species dominated by *Philotheca sericea*, *Micromyrtus trudgenii* (P3), *Eremophila clarkei* and *Eremophila latrobei* subsp. *latrobei* over low open shrubland of mixed species including *Ptilotus obovatus* var. *obovatus*, *Acacia exocarpoides*, *Acacia woodmaniorum* (T) and *Prostanthera patens* over low sparse forbland of mixed species including *Trachymene ornata*, *Calandrinia eremaea*, *Crassula tetramera* and *Rhodanthe battii* on red clay loam with BIF stones and generally with BIF outcropping on gently inclined to very steep lower slopes, upper slopes and crests.
21	Tall shrubland to open shrubland of mixed species including *Acacia umbraculiformis*, *Acacia assimilis* subsp. *assimilis*, *Acacia aneura* spp. and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid shrubland to open shrubland of mixed species dominated by *Philotheca sericea*, *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Eremophila clarkei* and *Eremophila latrobei* subsp. *latrobei* over low open shrubland to sparse shrubland of mixed species dominated by *Styphelia serratifolia*, *Hibbertia arcuata*, *Xanthosia kochii* and occasionally *Prostanthera patens* and *Acacia andrewsii* on red-brown silty clay loam and silty loam with BIF or granite stones and BIF or granite outcropping on gently inclined to steep mid slopes, upper slopes, crests and breakaways.
22	Low isolated clumps of trees of *Eucalyptus petraea* over tall shrubland to open shrubland of mixed species dominated by *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Calycopeplus paucifolius*, *Alyxia buxifolia* and *Persoonia hexagona* over mid shrubland to open shrubland of mixed species dominated by *Acacia tetragonophylla*, *Dodonaea inaequifolia*, *Acacia exocarpoides*, *Eremophila clarkei* and *Hakea recurva* subsp. *recurva* over low open shrubland to sparse shrubland of mixed species dominated by *Acacia woodmaniorum* (T), *Ptilotus obovatus* var. *obovatus*, *Eremophila serrulata*, *Hemigenia yalgensis* and *Prostanthera magnifica* on red-brown clay loam with BIF stones and generally with BIF outcropping on moderately inclined to steep upper slopes and crests.
23	Tall sparse shrubland to isolated clumps of shrubs of mixed species including *Acacia aulacophylla*, *Acacia ramulosa* var. *ramulosa*, *Acacia incognita* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid open shrubland to sparse shrubland of mixed species including *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Philotheca brucei* subsp. *brucei*, *Micromyrtus trudgenii* and *Grevillea extorris* over low sparse shrubland of mixed species including *Prostanthera patens*, *Styphelia serratifolia* and *Petrophile pauciflora* (P3) over low open forbland to sparse forbland of mixed species including *Borya sphaerocephala*, *Podolepis lessonii*, *Lawrencella rosea* and *Hyalosperma glutinosum* on pale brown sandy loam and clay loam with granite stones and granite outcropping on crests and breakaways.
24	Tall shrubland to open shrubland of mixed species including *Acacia assimilis* subsp. *assimilis*, *Acacia aneura* spp., *Acacia ramulosa* var. *ramulosa*, *Grevillea obliquistigma* subsp. *obliquistigma* and occasionally *Acacia acuminata*/*Acacia burkittii* over mid shrubland to open shrubland of mixed species dominated by *Eremophila latrobei* subsp. *latrobei*, *Philotheca sericea*, *Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Eremophila clarkei* over low open shrubland to sparse shrubland of mixed species including *Hibbertia arcuata*, *Prostanthera magnifica* and *Xanthosia kochii* on red-brown or brown silty clay loam with BIF and ironstone stones and occasionally with BIF and ironstone outcropping on slopes, crests and ridges.
25	Tall open shrubland of mixed species dominated by *Acacia assimilis* subsp. *assimilis* and occasionally *Acacia aneura* spp. and *Acacia latior* over mid shrubland to open shrubland dominated by *Hibbertia arcuata*, *Eremophila latrobei subsp. latrobei*, *Philotheca sericea* and *Aluta aspera subsp. hesperia* over low sparse shrubland of mixed species including *Xanthosia kochii* and *Prostanthera magnifica* over an occasional mid to low sparse forbland of mixed species including *Dianella revoluta* var. *divaricata* on red brown or brown silty clay loam with ironstone stones on lower slopes and mid slopes.
26	Mid shrubland to open shrubland of mixed species dominated by *Aluta aspera* subsp. *hesperia* and *Philotheca sericea* and occasionally *Acacia assimilis* subsp. *assimilis*, *Micromyrtus trudgenii* and *Eremophila latrobei* subsp. *latrobei* over low sparse shrubland of mixed species including *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) and *Xanthosia kochii* on red-brown or brown-red silty clay loam with ironstone rocks on lower slopes and mid slopes.
27	Tall open shrubland to sparse shrubland of mixed species including *Melaleuca nematophylla*, *Acacia latior*, *Acacia ramulosa* var. *ramulosa* and *Calycopeplus paucifolius* over mid open shrubland to sparse shrubland of mixed species dominated by *Aluta aspera* subsp. *hesperia* and *Eremophila clarkei* and occasionally *Eremophila forrestii* subsp. *forrestii* and *Eremophila latrobei* subsp. *latrobei* over low sparse shrubland of mixed species including *Philotheca brucei* subsp. *brucei*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Philotheca deserti* subsp. *deserti* on red-brown or brown silty clay loam and sandy clay with ironstone, laterite and quartz gravel and stones on plains, lower slopes and mid slopes.
28	Tall shrubland to open shrubland of mixed species dominated by *Allocasuarina acutivalvis* subsp. *prinsepiana* and *Melaleuca nematophylla* and occasionally *Calycopeplus paucifolius* and *Acacia latior* over mid shrubland to sparse shrubland of mixed species dominated by *Acacia assimilis* subsp. *assimilis* and occasionally *Aluta aspera* subsp. *hesperia*, *Grevillea paradoxa* and *Gastrolobium laytonii* over low sparse shrubland of mixed species including *Philotheca sericea* and *Xanthosia kochii* on red or red-brown silty clay loam and sandy clay with ironstone, BIF and granite stones and occasionally with ironstone, BIF and granite outcropping on lower to upper slopes.
29	Tall open shrubland to sparse shrubland of mixed species including *Acacia sibina*, *Acacia latior* and *Melaleuca hamata* and occasionally *Acacia assimilis* subsp. *assimilis* and *Acacia acuminata*/*Acacia burkittii* over mid sparse shrubland of mixed species including *Aluta aspera* subsp. *hesperia* and *Philotheca brucei* subsp. *brucei* over low sparse shrubland of mixed species including *Philotheca deserti* subsp. *deserti* and *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) over mid to low sparse forbland of mixed species including *Dianella revoluta* var. *divaricata* over low sparse tussock grassland of mixed species dominated by *Amphipogon caricinus* var. *caricinus* and occasionally *Monachather paradoxus* on red, red-brown and brown-red silty clay loam and sandy loam with ironstone and quartz gravel and stones on plains, lower slopes and mid slopes.
30	Low isolated clumps of trees of mixed species dominated by *Eucalyptus leptopoda* subsp. *arctata* over tall shrubland to open shrubland of mixed species including *Acacia latior*, *Melaleuca leiocarpa* and *Acacia longispinea* over mid sparse shrubland of mixed species including *Aluta aspera* subsp. *hesperia* and *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) over low sparse shrubland of mixed species including *Philotheca deserti* subsp. *deserti*, *Hakea recurva* subsp. *recurva* and *Persoonia hexagona* over low sparse tussock grassland of mixed species dominated by *Monachather paradoxus* and *Amphipogon caricinus* var. *caricinus* over mid to low sparse forbland of mixed species including *Dianella revoluta* var. *divaricata* on red-brown silty clay loam with ironstone, quartz and granite gravel on plains and slopes.
31	Tall open shrubland to sparse shrubland of mixed species dominated by *Acacia latior*, *Acacia sibina* and *Melaleuca hamata* and occasionally *Melaleuca leiocarpa* and *Melaleuca nematophylla* over mid open shrubland to sparse shrubland of mixed species including *Aluta aspera* subsp. *hesperia* and *Hakea minyma* on red and red-brown silty clay loam and sandy clay with ironstone gravel on plains and mid slopes.
32	Tall shrubland to open shrubland of mixed species including *Acacia acuminata*/*Acacia burkittii*, *Acacia sibina*, *Melaleuca hamata* and *Acacia ramulosa* var. *ramulosa* over mid open shrubland to sparse shrubland dominated by *Aluta aspera* subsp. *hesperia* and occasionally *Eremophila forrestii* subsp. *forrestii* and *Malleostemon tuberculatus* on red-brown, red or brown clay loam and sandy clay with ironstone and laterite gravel on slopes and undulating plains.
Claypan	Bare clay playa lake claypan, unvegetated when dry. Periodically fills with water, with a forbland of *Myriophyllum decussatum* developing following inundation.
R	Rehabilitated Land
CL	Cleared Land

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This map should only be used in conjunction with WEC report KML20-33-01.

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Overview of Vegetation Units of the Study Area

Revision: A - 30 August 2021 Scale: 1:85,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f12-3

Projection: GDA 1994 MGA Zone 50

Figure

12.3

Table 14: Description of Vegetation Units Mapped in the Study Area

VU	Summary from Quadrat Data	Representative VU Photograph
1	**Description:** Tall shrubland to open shrubland dominated by *Acacia acuminata*/*Acacia burkittii* and *Acacia tetragonophylla* and occasionally *Exocarpos aphyllus* over mid sparse shrubland of mixed species including *Hakea recurva* subsp. *recurva*, *Acacia obtecta* and *Eremophila pantonii* over low sparse shrubland of mixed species including *Rhagodia drummondii*, *Ptilotus obovatus* var. *obovatus*, *Sida* sp. dark green fruits (S. van Leeuwen 2260), *Persoonia pentasticha* (P3) and *Solanum nummularium* over low sparse chenopod shrubland of mixed species including *Maireana thesioides*, *Maireana carnosa*, *Sclerolaena diacantha* and *Sclerolaena fusiformis* on red-brown or red clay loam and silty clay loam, occasionally with ironstone, granite and quartz stones on plains and flats **Area mapped (proportion of Study Area):** 1,890 ha (9.2 %) **Sampling:** 19 quadrats (GIND-01, GIND-02, GIND-03, GIND-06, GIND-08, GIND-58, GIND-61, GIND-63, GIND-66, GIND-67, GIND-76, GIND-77, GIND-82, GIND-84, KIOP 008, KIOP 157, KIOP 182, KK07, KMLL04) **Average Native Perennial Taxon Richness per Quadrat:** 18 ± 4 **Indicator Taxa:** No statistically significant indicator taxa **Significant Taxa:** *Gunniopsis divisa* (P3)^, *Persoonia pentasticha* (P3)^ **Variation:** This VU had a generally structurally uniform shrubland across the Study Area, although one quadrat (GIND-01) possessed a low open woodland stratum of *Eucalyptus loxophleba* subsp. *supralaevis*. Generally no rock outcropping was present; one quadrat had minor outcropping of granite and ironstone (KIOP 157; Plate 29), but apart from having a greater diversity of annual taxa the species composition of this quadrat did not differ greatly from the typical VU 1	 **Plate 28: Typical VU 1 (Quadrat GIND-06)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 29: Variant of VU 1 with Minor Granitic and Ironstone Outcropping (Quadrat KIOP 157)

VU	Summary from Quadrat Data	Representative VU Photograph
2	**Description:** Low woodland to open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* and occasionally *Eucalyptus clelandiorum* and *Eucalyptus salubris* over tall open shrubland to sparse shrubland of mixed species dominated by *Acacia tetragonophylla* and occasionally *Eremophila oppositifolia* subsp. *angustifolia* over mid open shrubland to sparse shrubland of mixed species including *Dodonaea inaequifolia*, *Senna artemisioides* subsp. *filifolia*, *Senna artemisioides* subsp. *petiolaris*/*Senna* sp. Austin (A. Strid 20210) and *Eremophila pantonii* over low sparse shrubland of mixed species dominated by *Scaevola spinescens* and *Ptilotus obovatus* var. *obovatus* over low sparse chenopod shrubland of mixed species including *Sclerolaena fusiformis*, *Enchylaena lanata* and *Maireana carnosa* over low sparse tussock grassland of *Austrostipa elegantissima* over low sparse forbland of mixed species including *Cephalipterum drummondii* and **Mesembryanthemum nodiflorum* on red-brown, red or brown clay loam and silty loam with granite, ironstone and quartz stones and occasionally with granite, ironstone or quartz outcropping on plains and slopes of low hills **Area mapped (proportion of Study Area):** 1,213 ha (5.9 %) **Sampling:** 8 quadrats (GIND-62, KARA20, KARA21, KIOP 224, KIOP 232, KML10, KML15, KML35) **Average Native Perennial Taxon Richness per Quadrat:** 21 ± 4 **Indicator Taxa:** *Scaevola spinescens*, *Senna artemisioides* subsp. *petiolaris*/*Senna* sp. Austin (A. Strid 20210) **Significant Taxa:** *Gunniopsis divisa* (P3)^ **Variation:** This VU was generally structurally and compositionally uniform, although a small number of quadrats lacked the upper woodland stratum	 **Plate 30: Typical VU 2 (Quadrat KML10)**

VU	Summary from Quadrat Data	Representative VU Photograph
3	**Description:** Tall open shrubland to sparse shrubland of mixed species dominated by *Acacia tetragonophylla*, *Eremophila oldfieldii* subsp. *oldfieldii* and occasionally *Acacia acuminata*/*Acacia burkittii* over mid open shrubland to sparse shrubland of mixed species dominated by *Dodonaea inaequifolia* and *Acacia ramulosa var. ramulosa* over low sparse shrubland of mixed species dominated by *Ptilotus obovatus* var. *obovatus*, *Scaevola spinescens* and *Sida* sp. dark green fruits (S. van Leeuwen 2260) on red-brown, red or brown clay loam and silty loam with ironstone and quartz stones on slopes of low hills and plains **Area mapped (proportion of Study Area):** 187 ha (0.9 %) **Sampling:** 6 quadrats (GIND-92, GIND-93, GIND-96, KIOP 001, KIOP 003, KML07) **Average Native Perennial Taxon Richness per Quadrat:** 17 ± 3 **Indicator Taxa:** *Eremophila oldfieldii* subsp. *oldfieldii*, *Grevillea scabrida* (P3) **Significant Taxa:** *Acacia karina* (P1)^, *Grevillea scabrida* (P3)^, *Rhodanthe collina* (P3)^ **Variation:** This VU was generally structurally and compositionally uniform, although two quadrats possessed a low open woodland stratum of *Eucalyptus loxophleba* subsp. *supralaevis* and *Eucalyptus clelandiorum*	 **Plate 31: Typical VU 3 (Quadrat GIND-92)**

VU	Summary from Quadrat Data	Representative VU Photograph
4	**Description:** Low open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* or occasionally *Eucalyptus salubris* or *Eucalyptus clelandiorum* over mid open shrubland to sparse shrubland of mixed species dominated by *Eremophila pantonii* and *Acacia obtecta* over low sparse shrubland of mixed species including *Rhagodia drummondii*, *Senna stowardii*, *Ptilotus obovatus* var. *obovatus*, *Senna artemisioides subsp. filifolia* and *Acacia acanthoclada* subsp. *glaucescens* over low sparse chenopod shrubland of mixed species including *Sclerolaena fusiformis* and *Maireana thesioides* over low sparse forbland of mixed species including *Cephalipterum drummondii* and *Pogonolepis muelleriana* on red or red-brown clay loam and silty clay loam with laterite, ironstone and quartz stones on plains **Area mapped (proportion of Study Area):** 396 ha (1.9 %) **Sampling:** 7 quadrats (GIND-12, GIND-13, KIOP 178, KIOP 181, KIOP 183, KML17, KML18) **Average Native Perennial Taxon Richness per Quadrat:** 14 ± 4 **Indicator Taxa:** *Rhagodia drummondii*, *Senna stowardii* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** This VU was generally structurally and compositionally uniform, although one quadrat was missing the upper *Eucalyptus* woodland stratum	 **Plate 32: Typical VU 4 (Quadrat KML18)**

VU	Summary from Quadrat Data	Representative VU Photograph
5	**Description:** Low open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* over tall open to sparse shrubland of mixed species including *Acacia obtecta* and *Acacia ramulosa* var. *ramulosa* over mid open shrubland to sparse shrubland of mixed species including *Acacia tetragonophylla* over low sparse shrubland of mixed species dominated by *Rhagodia drummondii*, *Ptilotus obovatus* var. *obovatus*, *Senna artemisioides subsp. filifolia* and occasionally *Sida* sp. dark green fruits (S. van Leeuwen 2260) over low sparse chenopod shrubland of mixed species dominated by *Sclerolaena fusiformis* and occasionally *Maireana carnosa* and *Sclerolaena diacantha* on red-brown or red silty clay loam and sandy clay with ironstone and quartz stones on flats and plains **Area mapped (proportion of Study Area):** 3,144 ha (15.4 %) **Sampling:** 14 quadrats (GIND-15, GIND-21, GIND-46, GIND-56, GIND-74, GIND-83, KIOP 006, KIOP 217, KIOP 316, KIOP 468, KML05, KML16, KMLL03, KMLL05) **Average Native Perennial Taxon Richness per Quadrat:** 16 ± 4 **Indicator Taxa:** No statistically significant indicator taxa **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** This VU was generally compositionally uniform across the Study Area, although there was some minor structural variation. The upper woodland stratum of this VU was typically quite uniform, although *Eucalyptus kochii* subsp. *amaryssia*/*Eucalyptus kochii* subsp. *plenissima* was the only tree taxon present in quadrat KIOP 217 while GIND-56 did not possess this stratum at all. There was some variation in the density of the tall, mid and low shrubland strata; for example, quadrat GIND-46 did not possess a mid shrubland stratum and had sparse tall and low shrubland strata (Plate 34)	 **Plate 33: Typical VU 5 (Quadrat GIND-74)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 34: Variant of VU 5 with Sparse Shrubland Strata (Quadrat GIND-46)

VU	Summary from Quadrat Data	Representative VU Photograph
6	**Description:** Low woodland to open woodland of *Eucalyptus loxophleba* subsp. *supralaevis* over low sparse shrubland of mixed species including *Senna artemisioides subsp. filifolia*, *Ptilotus obovatus* var. *obovatus* and *Rhagodia drummondii* over low sparse chenopod shrubland of mixed species dominated by *Maireana carnosa* and *Sclerolaena fusiformis* and occasionally *Sclerolaena diacantha* and *Sclerolaena gardneri* on red-brown, red or orange-brown silty clay loam and sandy clay with sparse ironstone and quartz gravel on flats, outwash plains and minor drainage areas **Area mapped (proportion of Study Area):** 312 ha (1.5 %) **Sampling:** 6 quadrats (GIND-52, GIND-64, KIOP 004, KIOP 236, KMLL06, KMLL07) **Average Native Perennial Taxon Richness per Quadrat:** 12 ± 2 **Indicator Taxa:** *Eucalyptus loxophleba* subsp. *supralaevis*, *Sclerolaena gardneri* **Significant Taxa:** *Gunniopsis divisa* (P3) **Variation:** This VU was generally structurally and compositionally uniform, although a small number of quadrats had a tall and/or mid sparse shrubland stratum of mixed species including *Exocarpos aphyllus*, *Acacia acuminata/Acacia burkittii*, *Acacia colletioides*, *Acacia obtecta* and *Acacia erinacea* (Plate 36). These quadrats tended to be associated with areas of lower relief, including drainage lines and drainage areas	 **Plate 35: Typical VU 6 (Quadrat GIND-52)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 36: **Variant of VU 6 with Tall Shrubland Stratum (Quadrat KMLL07)**

VU	Summary from Quadrat Data	Representative VU Photograph
7	**Description:** Tall to mid sparse shrubland of mixed species including *Acacia obtecta*, *Exocarpos aphyllus* and *Eremophila glabra* over low sparse shrubland dominated by *Ptilotus obovatus* var. *obovatus*, **Corchorus* sp. and *Duma florulenta* over mid open samphire shrubland to sparse samphire shrubland of *Tecticornia disarticulata* over low sparse chenopod shrubland of mixed species including *Sclerolaena diacantha*, *Sclerolaena fusiformis*, *Maireana carnosa* and *Salsola australis* on brown and red-brown clay loam and silty clay loam in claypans **Area mapped (proportion of Study Area):** 106 ha (0.5 %) **Sampling:** 2 quadrats (GIND-80, GIND-81) **Average Native Perennial Taxon Richness per Quadrat:** 11 ± 2 **Indicator Taxa:** *Eremophila glabra*, *Roepera aurantiaca*, *Tecticornia disarticulata* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 37: Typical VU 7 (Quadrat GIND-81)**

VU	Summary from Quadrat Data	Representative VU Photograph
8	**Description:** Low open woodland of *Eucalyptus salubris* over low sparse chenopod shrubland of mixed species dominated by *Maireana carnosa*, *Sclerolaena fusiformis* and *Maireana trichoptera* on red-brown or red clay loam and clayey sand with ironstone, quartz and granite stones on plains and minor depression areas **Area mapped (proportion of Study Area):** 54 ha (0.3 %) **Sampling:** 2 quadrats (KIOP 195, KML11) **Average Native Perennial Taxon Richness per Quadrat:** 12 ± 1 **Indicator Taxa:** *Atriplex codonocarpa*, *Eucalyptus salubris*, *Maireana trichoptera*, *Olearia muelleri* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 38: Typical VU 8 (Quadrat KML11)**

VU	Summary from Quadrat Data	Representative VU Photograph
9	**Description:** Low open forest to woodland of *Eucalyptus loxophleba* subsp. *supralaevis* over low open shrubland to sparse shrubland of *Duma florulenta*, *Ptilotus obovatus* var. *obovatus*, *Teucrium racemosum* and *Eremophila pantonii* over low sparse chenopod shrubland of mixed species including *Sclerolaena fusiformis*, *Atriplex semilunaris*, *Enchylaena lanata* and *Maireana brevifolia* over low sparse tussock grassland of *Amphipogon caricinus* var. *caricinus* and *Austrostipa elegantissima* on red-brown silty clay loam in depressions **Area mapped (proportion of Study Area):** 44 ha (0.2 %) **Sampling:** 2 quadrats (GIND-69, GIND-70) **Average Native Perennial Taxon Richness per Quadrat:** 9 ± 1 **Indicator Taxa:** *Duma florulenta, Teucrium racemosum* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 39: Typical VU 9 (Quadrat GIND-70)**

VU	Summary from Quadrat Data	Representative VU Photograph
10	**Description:** Low open woodland of mixed species dominated by *Eucalyptus kochii* subsp. *amaryssia*/*Eucalyptus kochii* subsp. *plenissima* and/or *Eucalyptus loxophleba* subsp. *supralaevis* over tall sparse shrubland to open shrubland of mixed species including *Acacia latior*, *Acacia sibina*, *Acacia ramulosa* var. *ramulosa* and *Melaleuca leiocarpa* over mid sparse shrubland of mixed species dominated by *Acacia tetragonophylla* and occasionally *Acacia assimilis* subsp. *assimilis*, *Philotheca brucei* subsp. *brucei*, *Hakea recurva* subsp. *recurva* and *Alyxia buxifolia* over low sparse shrubland of mixed species dominated by *Ptilotus obovatus* var. *obovatus*, *Rhagodia drummondii* and occasionally *Olearia humilis*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Acacia exocarpoides* on red-brown or red clay loam and sandy clay loam with ironstone and quartz stones on flats, plains, and slopes and crests of low hills **Area mapped (proportion of Study Area):** 2,275 ha (11.1 %) **Sampling:** 31 quadrats (GIND-10, GIND-11, GIND-24, GIND-25, GIND-33, GIND-60, GIND-78, GINM-02, KARA15, KARA18, KIOP 140, KIOP 159, KIOP 274, KIOP 276, KK03, KML04, KML06, KML13, KML14, KML19, KML20, KML26, KML30, KML32, KML34, KML36, KML37, KML38, WIND10, WIND13, WIND16) **Average Native Perennial Taxon Richness per Quadrat:** 16 ± 5 **Indicator Taxa:** *Eucalyptus kochii* subsp. *amaryssia*/*Eucalyptus kochii* subsp. *plenissima*, *Olearia humilis* **Significant Taxa:** *Micromyrtus trudgenii* (P3), *Persoonia pentasticha* (P3)^, *Stenanthemum poicilum* (P3)^ **Variation:** This VU demonstrated some variation relating to differences in landscape position and topography. A small number of quadrats were missing the upper woodland stratum (e.g. Plate 41); these quadrats were typically located on or near lateritic and/or ironstone crests and had shallow soil profiles. These quadrats also contained some taxa typical of more rocky habitats that were not recorded elsewhere in the VU, including the significant taxon *Micromyrtus trudgenii* (P3). The species composition of quadrat GIND-60 was slightly atypical for this VU, likely being influenced by its proximity to the edge of a saline depression. These variations are	 **Plate 40: Typical VU 10 (Quadrat GIND-11)**

VU	Summary from Quadrat Data	Representative VU Photograph
	considered to be relatively minor in the context of this unit, reflecting the relatively high taxon richness and the large mapping area and sampling of this VU across the Study Area	 **Plate 41: Variant of VU 10 with Lateritic Influence (Quadrat KIOP 140)**
11	**Description:** Tall isolated clumps of shrubs of *Acacia aneura* and *Melaleuca eleuterostachya* over low isolated clumps of shrubs of *Rhagodia drummondii* on red medium clay in drainage depressions **Area mapped (proportion of Study Area):** 5 ha (0.03 %) **Sampling:** 1 quadrat (GIND-51) **Average Native Perennial Taxon Richness per Quadrat:** 3 **Indicator Taxa:** NA (1 quadrat in VU) **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 42: VU 11 (Quadrat GIND-51)**

VU	Summary from Quadrat Data	Representative VU Photograph
12	**Description:** Low woodland of *Eucalyptus clelandiorum* or tall shrubland of *Melaleuca acutifolia* over low sparse chenopod shrubland of mixed species dominated by *Maireana thesioides*, *Maireana carnosa*, *Sclerolaena diacantha* and *Maireana georgei* on red-brown or brown-red silty clay loam, occasionally with calcrete stones in drainage depressions and on the edges of saline claypans **Area mapped (proportion of Study Area):** 171 ha (0.8 %) **Sampling:** 3 quadrats (GIND-65, GIND-68, GIND-79) **Average Native Perennial Taxon Richness per Quadrat:** 7 ± 1 **Indicator Taxa:** *Maireana thesioides*, *Melaleuca acutifolia* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** Quadrat GIND-79 on the edge of a saline claypan possessed a low woodland stratum of *Eucalyptus clelandiorum* (Plate 43) while quadrats GIND-65 and GIND-68 in an area of drainage depression lacked this upper tree strata and instead possessed a tall shrubland stratum of *Melaleuca acutifolia* (Plate 44). However, both variants of this VU exhibited similar structures and compositions of understorey strata	 **Plate 43: VU 12 with Low Woodland Stratum (Quadrat GIND-79)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 44: VU 12 with Tall Shrubland Stratum (Quadrat GIND-65)

VU	Summary from Quadrat Data	Representative VU Photograph
13	**Description:** Low open woodland of *Eucalyptus clelandiorum* over mid sparse shrubland of mixed species including *Eremophila pantonii* and *Acacia obtecta* over low sparse shrubland of mixed species including *Ptilotus obovatus* var. *obovatus*, *Acacia acanthoclada* subsp. *glaucescens*, *Acacia erinacea* and *Senna charlesiana* over low sparse chenopod shrubland of mixed species including *Sclerolaena drummondii*, *Maireana marginata*, *Maireana georgei* and *Enchylaena tomentosa* var. *tomentosa* over low sparse forbland of mixed species including *Cephalipterum drummondii*, *Goodenia pusilliflora* and *Calotis multicaulis* on red-brown or red-orange clay loam on plains and lower slopes **Area mapped (proportion of Study Area):** 25 ha (0.1 %) **Sampling:** 2 quadrats (KIOP 112, KML12) **Average Native Perennial Taxon Richness per Quadrat:** 12 ± 2 **Indicator Taxa:** *Eremophila pantonii*, *Eucalyptus clelandiorum*, *Ptilotus exaltatus*, *Rhagodia eremaea*, *Sclerolaena drummondii* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 45: Typical VU 13 (Quadrat KIOP 112)**

VU	Summary from Quadrat Data	Representative VU Photograph
14	**Description:** Low woodland of *Eucalyptus salubris* over low open chenopod shrubland of mixed species including *Sclerolaena drummondii*, *Atriplex codonocarpa*, *Atriplex semilunaris*, *Maireana carnosa* and *Maireana tomentosa* subsp. *tomentosa* over low sparse forbland of mixed species including **Mesembryanthemum nodiflorum* on brown clay loam with granite, ironstone and quartz stones on drainage lines and drainage depressions **Area mapped (proportion of Study Area):** 52 ha (0.3 %) **Sampling:** 1 quadrat (KK01) **Average Native Perennial Taxon Richness per Quadrat:** 11 **Indicator Taxa:** NA (1 quadrat in VU) **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 46: VU 14 (Quadrat KK01)**

VU	Summary from Quadrat Data	Representative VU Photograph
15	**Description:** Low isolated clumps of shrubs of mixed species including *Ptilotus schwartzii*, *Calytrix leschenaultii* and *Dodonaea inaequifolia* over low isolated clumps of chenopod shrubs of mixed species including *Maireana carnosa* and *Sclerolaena densiflora* over low isolated clumps of tussock grasses of mixed species including *Aristida contorta* and *Tripogonella loliiformis* over low sparse forbland of mixed species including *Calandrinia baccata*, **Mesembryanthemum nodiflorum*, *Goodenia cycnopotamica*, *Crassula colorata*, *Lemooria burkittii* and *Rhodanthe spicata* over low isolated clumps of ferns of *Cheilanthes sieberi* subsp. *sieberi* on skeletal grey clay loam with granite stones on granite outcropping **Area mapped (proportion of Study Area):** 4 ha (0.02 %) **Sampling:** 1 quadrat (KIOP 158) **Average Native Perennial Taxon Richness per Quadrat:** 9 **Indicator Taxa:** NA (1 quadrat in VU) **Significant Taxa:** *Petrophile pauciflora* (P3)^ **Variation:** There was little structural and compositional variation in this VU based on the limited area mapped in the Study Area	 **Plate 47: VU 15 (Quadrat KIOP 158)**

VU	Summary from Quadrat Data	Representative VU Photograph
16	**Description:** Tall open shrubland to sparse shrubland of mixed species dominated by *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla*, *Hakea recurva subsp. recurva* and occasionally *Acacia acuminata/Acacia burkittii* over low sparse shrubland of mixed species including *Solanum lasiophyllum*, *Ptilotus obovatus* var. *obovatus*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Eremophila eriocalyx* over low sparse forbland of mixed species including *Borya sphaerocephala*, *Podolepis lessonii*, *Myriocephalus guerinae* and *Gilruthia osbornei* on red, red-brown or brown clay loam and sandy clay loam with granite, ironstone, quartz and laterite stones and occasionally with granite, dolerite or laterite outcropping on plains, slopes of low hills and drainage lines **Area mapped (proportion of Study Area):** 818 ha (4.0 %) **Sampling:** 12 quadrats (GIND-14, GINM-12, KARA16, KIOP 005, KIOP 023, KIOP 173, KIOP 180, KIOP 214, KIOP 216, KIOP 240, KML08, KML28) **Average Native Perennial Taxon Richness per Quadrat:** 11 ± 3 **Indicator Taxa:** *Acacia ramulosa* var. *ramulosa* **Significant Taxa:** *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3), *Persoonia pentasticha* (P3) **Variation:** This VU was generally structurally and compositionally uniform across the Study Area. Quadrat GINM-12 was manually grouped with this VU. This quadrat was located on an outwash plain and was relatively comparatively species poor but otherwise exhibited a composition that was consistent with the typical VU 16 (Plate 49) (Appendix P)	 **Plate 48: Typical VU 16 (Quadrat KIOP 216)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 49: Species Poor Variant of VU 16 (Quadrat GINM-12)

VU	Summary from Quadrat Data	Representative VU Photograph
17	**Description:** Tall sparse shrubland of mixed species including *Acacia tetragonophylla*, *Acacia umbraculiformis* and *Acacia acuminata/Acacia burkittii* over mid sparse shrubland of mixed species including *Thryptomene costata* and *Acacia kochii* over low sparse shrubland of mixed species including *Ptilotus obovatus* var. *obovatus* and *Solanum lasiophyllum* over low open forbland to sparse forbland of mixed species dominated by *Borya sphaerocephala* and occasionally *Goodenia rosea*, *Erodium cygnorum* and **Pentameris airoides* subsp. *airoides* on red, red-brown or brown clay loam and sandy clay with granite, ironstone and quartz stones and occasionally with granite outcropping on slopes of low hills, flats and plains **Area mapped (proportion of Study Area):** 672 ha (3.3 %) **Sampling:** 15 quadrats (GIND-71, GINM-05, GINM-07, KIOP 137, KIOP 138, KIOP 192, KIOP 223, KIOP 225, KIOP 238, KIOP 239, KIOP 267, KK06, KML24, KML25, KML29) **Average Native Perennial Taxon Richness per Quadrat:** 10 ± 3 **Indicator Taxa:** No statistically significant indicator taxa **Significant Taxa:** *Austrostipa blackii* (P3), *Grevillea subtiliflora* (P3)^ **Variation:** This VU was generally compositionally uniform, although there was some structural variation. A number of quadrats lacked either an upper shrubland stratum (Plate 51) or mid shrubland stratum while one quadrat (KML25) located in an open area surrounding a granite outcrop lacked shrubland strata entirely. The species richness of annual taxa in this VU was generally quite high, with quadrat KML24 containing the maximum for this VU at 34 annual taxa species	 **Plate 50: Typical VU 17 (Quadrat KML29)** 

VU	Summary from Quadrat Data	Representative VU Photograph
		Plate 51: **Variant of VU 17 missing Tall Shrubland Stratum (Quadrat KIOP 137)**
18	**Description:** Tall shrubland to open shrubland of mixed species dominated by *Acacia acuminata*/*Acacia burkittii*, *Melaleuca hamata*, *Acacia ramulosa* var. *ramulosa* and occasionally *Acacia karina* (P1) and *Allocasuarina acutivalvis* subsp. *prinsepiana* over low sparse shrubland of mixed species including *Ptilotus obovatus* var. *obovatus*, *Mirbelia microphylla*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Senna charlesiana* over low open forbland to sparse forbland of mixed species including *Borya sphaerocephala*, *Waitzia acuminata* var. *acuminata*, *Trachymene ornata* and *Podolepis lessonii* on red or red-brown clay loam and medium clay with granite, ironstone and quartz stones and occasionally with granite outcropping on plains, slopes and drainage lines **Area mapped (proportion of Study Area):** 244 ha (1.2 %) **Sampling:** 7 quadrats (GIND-45, KIOP 193, KIOP 194, KIOP 220, KIOP 432, KK04, KML26A) **Average Native Perennial Taxon Richness per Quadrat:** 10 ± 2 **Indicator Taxa:** *Acacia acuminata*/*Acacia burkittii* **Significant Taxa:** *Acacia karina* (P1)^, *Allocasuarina tessellata* (P3)^, *Grevillea scabrida* (P3)^, *Rhodanthe collina* (P3) **Variation:** While the composition of the tall shrubland stratum of this VU was relatively consistent, the low shrubland stratum exhibited some variation. In addition, two quadrats possessed isolated clumps of trees of *Eucalyptus leptopoda* subsp. *arctata* and *Eucalyptus loxophleba* subsp. *supralaevis*. Quadrat GIND-45 was located on the edge of a claypan and possessed a very open structure (Plate 53) but otherwise exhibited a composition that was relatively consistent with the typical VU 18	 **Plate 52:** **Typical VU 18 (Quadrat KML26A)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 53: Variant of VU 18 with Open Structure (Quadrat GIND-45)

VU	Summary from Quadrat Data	Representative VU Photograph
19	**Description:** Tall shrubland to open shrubland of mixed species including *Calycopeplus paucifolius*, *Acacia acuminata/Acacia burkittii*, *Acacia aneura* spp., *Hakea recurva* subsp. *recurva*, *Melaleuca nematophylla* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid open shrubland of mixed species dominated by *Acacia exocarpoides*, *Eremophila latrobei* subsp. *latrobei*, *Eremophila clarkei*, *Philotheca brucei* subsp. *brucei* and *Philotheca sericea* over low open shrubland to sparse shrubland of mixed species including *Sida* sp. dark green fruits (S. van Leeuwen 2260), *Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Xanthosia kochii* on red-brown or red silty loam and silty clay loam with BIF stones and BIF outcropping on moderately inclined to steep upper slopes and crests **Area mapped (proportion of Study Area):** 68 ha (0.3 %) **Sampling:** 7 quadrats (GIND-04, GIND-28, GIND-43, GIND-49, GIND-54, KARA17, WIND02) **Average Native Perennial Taxon Richness per Quadrat:** 20 ± 3 **Indicator Taxa:** *Comesperma integerrimum*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) **Significant Taxa:** *Acacia karina* (P1)^, *Acacia woodmaniorum* (T)^, *Drummondita fulva* (P3)^, *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1)^, *Micromyrtus trudgenii* (P3)^, *Rhodanthe collina* (P3) **Variation:** This VU was generally quite compositionally uniform, although there was some variation in the density of the tall and mid shrubland strata. Most quadrats possessed relatively dense tall and mid shrubland strata, although a small number were comparatively more open (including GIND-04, Plate 54). Generally, quadrats that straddled crests had more open tall and mid shrubland strata than those situated on upper slopes	 **Plate 54: Typical VU 19 (Quadrat GIND-04)**

VU	Summary from Quadrat Data	Representative VU Photograph
20	**Description:** Tall shrubland to open shrubland of mixed species including *Calycopeplus paucifolius*, *Acacia aneura* spp., *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid open shrubland of mixed species dominated by *Philotheca sericea*, *Micromyrtus trudgenii* (P3), *Eremophila clarkei* and *Eremophila latrobei* subsp. *latrobei* over low open shrubland of mixed species including *Ptilotus obovatus* var. *obovatus*, *Acacia exocarpoides*, *Acacia woodmaniorum* (T) and *Prostanthera patens* over low sparse forbland of mixed species including *Trachymene ornata*, *Calandrinia eremaea*, *Crassula tetramera* and *Rhodanthe battii* on red clay loam with BIF stones and generally with BIF outcropping on gently inclined to very steep lower slopes, upper slopes and crests **Area mapped (proportion of Study Area):** 61 ha (0.3 %) **Sampling:** 6 quadrats (GIND-38, KIOP 480, WIND04, WIND14, WIND18, WIND19) **Average Native Perennial Taxon Richness per Quadrat:** 17 ± 6 **Indicator Taxa:** *Micromyrtus trudgenii* (P3), *Philotheca sericea* **Significant Taxa:** *Acacia woodmaniorum* (T)^, *Micromyrtus trudgenii* (P3)^, *Polianthion collinum* (P3)^ **Variation:** While the lower strata of this VU were generally quite compositionally uniform, the composition of the tall shrubland stratum varied somewhat. In addition, quadrat KIOP 480 located lower in the landscape was more species poor than the remaining five quadrats. However, the taxa that were present within this quadrat were relatively consistent with the typical VU 20	 **Plate 55: Typical VU 20 (Quadrat GIND-38)**

VU	Summary from Quadrat Data	Representative VU Photograph
21	**Description:** Tall shrubland to open shrubland of mixed species including *Acacia umbraculiformis*, *Acacia assimilis* subsp. *assimilis*, *Acacia aneura* spp. and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid shrubland to open shrubland of mixed species dominated by *Philotheca sericea*, *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Eremophila clarkei* and *Eremophila latrobei* subsp. *latrobei* over low open shrubland to sparse shrubland of mixed species dominated by *Styphelia serratifolia*, *Hibbertia arcuata*, *Xanthosia kochii* and occasionally *Prostanthera patens* and *Acacia andrewsii* on red-brown silty clay loam and silty loam with BIF or granite stones and BIF or granite outcropping on gently inclined to steep mid slopes, upper slopes, crests and breakaways **Area mapped (proportion of Study Area):** 368 ha (1.8 %) **Sampling:** 11 quadrats (GIND-32, GIND-34, GIND-35, GIND-48, GINM-01, GINM-08, GINM-14, WIND08, WIND09, WIND12, WIND15) **Average Native Perennial Taxon Richness per Quadrat:** 24 ± 6 **Indicator Taxa:** *Acacia andrewsii*, *Drummondita fulva* (P3), *Polianthion collinum* (P3), *Styphelia serratifolia* **Significant Taxa:** *Austrostipa blackii* (P3), *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3)^, *Drummondita fulva* (P3)^, *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1)^, *Micromyrtus acuta* (P3)^, *Micromyrtus trudgenii* (P3)^, *Persoonia pentasticha* (P3), *Polianthion collinum* (P3)^, *Rhodanthe collina* (P3)^ **Variation:** This VU was generally quite uniform, although there were minor compositional differences in quadrats located higher in the landscape on the main part of Mungada Ridge than those located lower in the landscape. In addition, two quadrats contained low isolated clumps of trees of *Eucalyptus leptopoda* subsp. *arctata* and *Eucalyptus ewartiana* (Plate 57). Quadrat GINM-01 was manually grouped with this VU. This quadrat was located on a granite breakaway with pale brown sandy clay loam. Despite the difference in geology of this quadrat with the typical VU, it had	 **Plate 56: Typical VU 21 (Quadrat GINM-08)**

VU	Summary from Quadrat Data	Representative VU Photograph
	a composition that was quite similar and shared most taxa with the remaining quadrats (Appendix P)	 **Plate 57: Variant of VU 21 with Isolated Clumps of Trees (Quadrat GIND-35)**

VU	Summary from Quadrat Data	Representative VU Photograph
22	**Description:** Low isolated clumps of trees of *Eucalyptus petraea* over tall shrubland to open shrubland of mixed species dominated by *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Calycopeplus paucifolius*, *Alyxia buxifolia* and *Persoonia hexagona* over mid shrubland to open shrubland of mixed species dominated by *Acacia tetragonophylla*, *Dodonaea inaequifolia*, *Acacia exocarpoides*, *Eremophila clarkei* and *Hakea recurva* subsp. *recurva* over low open shrubland to sparse shrubland of mixed species dominated by *Acacia woodmaniorum* (T), *Ptilotus obovatus* var. *obovatus*, *Eremophila serrulata*, *Hemigenia yalgensis* and *Prostanthera magnifica* on red-brown clay loam with BIF stones and generally with BIF outcropping on moderately inclined to steep upper slopes and crests **Area mapped (proportion of Study Area):** 17 ha (0.1 %) **Sampling:** 3 quadrats (GIND-36, GIND-37, WIND05) **Average Native Perennial Taxon Richness per Quadrat:** 19 ± 3 **Indicator Taxa:** *Acacia exocarpoides*, *Acacia tetragonophylla*, *Acacia woodmaniorum* (T), *Alyxia buxifolia*, *Dodonaea inaequifolia*, *Eremophila serrulata*, *Eucalyptus petraea*, *Hemigenia yalgensis*, *Persoonia hexagona*, *Prostanthera magnifica* **Significant Taxa:** *Acacia woodmaniorum* (T)^, *Rhodanthe collina* (P3)^ **Variation:** This VU was generally structurally and compositionally uniform	 **Plate 58: Typical VU 22 (Quadrat GIND-37)**

VU	Summary from Quadrat Data	Representative VU Photograph
23	**Description:** Tall sparse shrubland to isolated clumps of shrubs of mixed species including *Acacia aulacophylla*, *Acacia ramulosa* var. *ramulosa*, *Acacia incognita* and *Allocasuarina acutivalvis* subsp. *prinsepiana* over mid open shrubland to sparse shrubland of mixed species including *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Philotheca brucei* subsp. *brucei*, *Micromyrtus trudgenii* and *Grevillea extorris* over low sparse shrubland of mixed species including *Prostanthera patens*, *Styphelia serratifolia* and *Petrophile pauciflora* (P3) over low open forbland to sparse forbland of mixed species including *Borya sphaerocephala*, *Podolepis lessonii*, *Lawrencella rosea* and *Hyalosperma glutinosum* on pale brown sandy loam and clay loam with granite stones and granite outcropping on crests and breakaways **Area mapped (proportion of Study Area):** 25 ha (0.1 %) **Sampling:** 2 quadrats (KIOP 025, KIOP 213) **Average Native Perennial Taxon Richness per Quadrat:** 13 ± 1 **Indicator Taxa:** *Acacia aulacophylla*, *Acacia incognita*, *Borya sphaerocephala*, *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Petrophile pauciflora* (P3), *Philotheca brucei* subsp. *brucei*, *Prostanthera patens* **Significant Taxa:** *Micromyrtus trudgenii* (P3), *Petrophile pauciflora* (P3) **Variation:** Structurally, this VU graded towards a sparse shrubland or having isolated clumps of shrubs in areas with significant rock outcrop at the surface, as was observed at quadrat KIOP 213 (Plate 60). There was also some minor compositional variation between areas of little and significant rock outcrop; for example, *Thryptomene costata* was present only at quadrat KIOP 213 where granite outcropping was significant	 **Plate 59: Typical VU 23 (Quadrat KIOP 025)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 60: Variant of VU 23 with Significant Rock Outcropping (Quadrat KIOP 213)

VU	Summary from Quadrat Data	Representative VU Photograph
24	**Description:** Tall shrubland to open shrubland of mixed species including *Acacia assimilis* subsp. *assimilis*, *Acacia aneura* spp., *Acacia ramulosa* var. *ramulosa*, *Grevillea obliquistigma* subsp. *obliquistigma* and occasionally *Acacia acuminata*/*Acacia burkittii* over mid shrubland to open shrubland of mixed species dominated by *Eremophila latrobei* subsp. *latrobei*, *Philotheca sericea*, *Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Eremophila clarkei* over low open shrubland to sparse shrubland of mixed species including *Hibbertia arcuata*, *Prostanthera magnifica* and *Xanthosia kochii* on red-brown or brown silty clay loam with BIF and ironstone stones and occasionally with BIF and ironstone outcropping on slopes, crests and ridges **Area mapped (proportion of Study Area):** 512 ha (2.5 %) **Sampling:** 11 quadrats (GIND-05, GIND-44, GIND-53, GIND-55, GIND-75, GIND-91, GIND-94, WIND01, WIND06, WIND17, WIND20) **Average Native Perennial Taxon Richness per Quadrat:** 18 ± 3 **Indicator Taxa:** No statistically significant indicator taxa **Significant Taxa:** *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3), *Drummondita fulva* (P3), *Micromyrtus trudgenii* (P3), *Polianthion collinum* (P3), *Rhodanthe collina* (P3) **Variation:** This VU was generally structurally and compositionally uniform	 **Plate 61: Typical VU 24 (Quadrat GIND-55)**

VU	Summary from Quadrat Data	Representative VU Photograph
25	**Description:** Tall open shrubland of mixed species dominated by *Acacia assimilis* subsp. *assimilis* and occasionally *Acacia aneura* spp. and *Acacia latior* over mid shrubland to open shrubland dominated by *Hibbertia arcuata*, *Eremophila latrobei subsp. latrobei*, *Philotheca sericea* and *Aluta aspera subsp. hesperia* over low sparse shrubland of mixed species including *Xanthosia kochii* and *Prostanthera magnifica* over an occasional mid to low sparse forbland of mixed species including *Dianella revoluta* var. *divaricata* on red brown or brown silty clay loam with ironstone stones on lower slopes and mid slopes **Area mapped (proportion of Study Area):** 286 ha (1.4 %) **Sampling:** 8 quadrats (GIND-23, GIND-30, GIND-31, GIND-39, GIND-42, KARA06, KIOP 002, WIND07) **Average Native Perennial Taxon Richness per Quadrat:** 17 ± 4 **Indicator Taxa:** *Hibbertia arcuata* **Significant Taxa:** *Drummondita fulva* (P3), *Micromyrtus trudgenii* (P3) **Variation:** A small number of quadrats in this VU contained isolated clumps of trees of *Eucalyptus leptopoda* subsp. *arctata* indicating the presence of a deeper soil profile in these areas. These quadrats also typically had slightly higher species richness and vegetation cover than the remaining quadrats (Plate 63). Quadrat KIOP 002 was located in an area with lighter coloured soils than usual for this VU, possibly indicating a slightly different underlying geology than the typical VU 25	 **Plate 62: Typical VU 25 (Quadrat GIND-30)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 63: Variant of VU 25 with Isolated Clumps of Trees (Quadrat GIND-39)

VU	Summary from Quadrat Data	Representative VU Photograph
26	**Description:** Mid shrubland to open shrubland of mixed species dominated by *Aluta aspera* subsp. *hesperia* and *Philotheca sericea* and occasionally *Acacia assimilis* subsp. *assimilis*, *Micromyrtus trudgenii* and *Eremophila latrobei* subsp. *latrobei* over low sparse shrubland of mixed species including *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) and *Xanthosia kochii* on red-brown or brown-red silty clay loam with ironstone rocks on lower slopes and mid slopes **Area mapped (proportion of Study Area):** 271 ha (1.3 %) **Sampling:** 7 quadrats (GIND-07, GIND-22, GIND-29, GIND-41, GIND-47, KIOP 028, WIND11) **Average Native Perennial Taxon Richness per Quadrat:** 10 ± 4 **Indicator Taxa:** *Aluta aspera* subsp. *hesperia* **Significant Taxa:** *Micromyrtus trudgenii* (P3)^, *Polianthion collinum* (P3)^ **Variation:** This VU exhibited some structural variation, with a small number of quadrats possessing a tall sparse shrubland stratum of mixed species including *Acacia aneura* spp., *Acacia umbraculiformis* and *Grevillea obliquistigma* subsp. *obliquistigma* (Plate 65)	 **Plate 64: Typical VU 26 (Quadrat GIND-07)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 65: Variant of VU 26 with Tall Shrubland Stratum (Quadrat KIOP 028)

VU	Summary from Quadrat Data	Representative VU Photograph
27	**Description:** Tall open shrubland to sparse shrubland of mixed species including *Melaleuca nematophylla*, *Acacia latior*, *Acacia ramulosa* var. *ramulosa* and *Calycopeplus paucifolius* over mid open shrubland to sparse shrubland of mixed species dominated by *Aluta aspera* subsp. *hesperia* and *Eremophila clarkei* and occasionally *Eremophila forrestii* subsp. *forrestii* and *Eremophila latrobei* subsp. *latrobei* over low sparse shrubland of mixed species including *Philotheca brucei* subsp. *brucei*, *Sida* sp. dark green fruits (S. van Leeuwen 2260) and *Philotheca deserti* subsp. *deserti* on red-brown or brown silty clay loam and sandy clay with ironstone, laterite and quartz gravel and stones on plains, lower slopes and mid slopes **Area mapped (proportion of Study Area):** 219 ha (1.1 %) **Sampling:** 7 quadrats (GIND-18, GIND-50, GIND-72, GINM-06, KIOP 007, KMLL01, KMLL02) **Average Native Perennial Taxon Richness per Quadrat:** 13 ± 3 **Indicator Taxa:** No statistically significant indicator taxa **Significant Taxa:** *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1)^ **Variation:** This VU exhibited some structural and compositional variation across the Study Area. One quadrat (GIND-18) contained isolated clumps of trees of *Eucalyptus loxophleba* subsp. *supralaevis*, which is typically found lower in the landscape on deeper silty clay soils. In addition, quadrats GIND-72 and GINM-06 exhibited minor compositional variations likely due to being located on outwash areas, containing taxa including *Acacia umbraculiformis*, *Thryptomene costata* and *Borya sphaerocephala* that were absent from most other VU 27 quadrats	 **Plate 66: Typical VU 27 (Quadrat GIND-50)**

VU	Summary from Quadrat Data	Representative VU Photograph
28	**Description:** Tall shrubland to open shrubland of mixed species dominated by *Allocasuarina acutivalvis* subsp. *prinsepiana* and *Melaleuca nematophylla* and occasionally *Calycopeplus paucifolius* and *Acacia latior* over mid shrubland to sparse shrubland of mixed species dominated by *Acacia assimilis* subsp. *assimilis* and occasionally *Aluta aspera* subsp. *hesperia*, *Grevillea paradoxa* and *Gastrolobium laytonii* over low sparse shrubland of mixed species including *Philotheca sericea* and *Xanthosia kochii* on red or red-brown silty clay loam and sandy clay with ironstone, BIF and granite stones and occasionally with ironstone, BIF and granite outcropping on lower to upper slopes **Area mapped (proportion of Study Area):** 307 ha (1.5 %) **Sampling:** 13 quadrats (GIND-16, GIND-17, GIND-20, GIND-40, KARA04, KARA13, KARA14, KARA19, KIOP 479, KIOP 481, KIOP 482, KK05, WIND03) **Average Native Perennial Taxon Richness per Quadrat:** 13 ± 5 **Indicator Taxa:** *Acacia assimilis* subsp. *assimilis*, *Allocasuarina acutivalvis* subsp. *prinsepiana*, *Grevillea paradoxa* **Significant Taxa:** *Acacia karina* (P1)^, *Acacia woodmaniorum* (T)^, *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3), *Lepidosperma* sp. Blue Hills (A. Markey & S. Dillon 3468) (P1)^, *Micromyrtus trudgenii* (P3), *Millotia dimorpha* (P1)^, *Rhodanthe collina* (P3) **Variation:** This VU exhibited some compositional variation between the two occurrences on Mount Karara and Mungada Ridge. Quadrats located on Mungada Ridge contained taxa more strongly associated with BIF, including the significant taxa *Acacia woodmaniorum* (T) and *Micromyrtus trudgenii* (P3), which were absent from the Mount Karara quadrats. A number of these quadrats also contained *Acacia aneura*	 **Plate 67: Typical VU 28 (Quadrat GIND-16)**

VU	Summary from Quadrat Data	Representative VU Photograph
	spp. in their tall shrubland stratum, which was not recorded within quadrats in this VU on Mount Karara. Finally, two quadrats within this VU varied structurally, containing isolated clumps of trees of *Eucalyptus kochii* subsp. *amaryssia*/*Eucalyptus kochii* subsp. *plenissima* (quadrat KARA14) and *Eucalyptus leptopoda* subsp. *arctata* (quadrat GIND-40)	
29	**Description:** Tall open shrubland to sparse shrubland of mixed species including *Acacia sibina*, *Acacia latior* and *Melaleuca hamata* and occasionally *Acacia assimilis* subsp. *assimilis* and *Acacia acuminata*/*Acacia burkittii* over mid sparse shrubland of mixed species including *Aluta aspera* subsp. *hesperia* and *Philotheca brucei* subsp. *brucei* over low sparse shrubland of mixed species including *Philotheca deserti* subsp. *deserti* and *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) over mid to low sparse forbland of mixed species including *Dianella revoluta* var. *divaricata* over low sparse tussock grassland of mixed species dominated by *Amphipogon caricinus* var. *caricinus* and occasionally *Monachather paradoxus* on red, red-brown and brown-red silty clay loam and sandy loam with ironstone and quartz gravel and stones on plains, lower slopes and mid slopes **Area mapped (proportion of Study Area):** 1,716 ha (8.4 %) **Sampling:** 18 quadrats (GIND-19, GIND-27, GIND-73, GIND-86, GIND-88, GIND-90, GIND-95, GINM-10, GINM-11, KIOP 139, KIOP 273, KIOP 275, KIOP 277, KIOP 422, KML02, KML22, KML23, KML33) **Average Native Perennial Taxon Richness per Quadrat:** 13 ± 3 **Indicator Taxa:** *Amphipogon caricinus* var. *caricinus*, *Dianella revoluta* var. *divaricata*, *Philotheca deserti* subsp. *deserti* **Significant Taxa:** *Acacia karina* (P1), *Persoonia pentasticha* (P3) **Variation:** This VU exhibited reasonable compositional variation, likely a reflection of the large mapping area and sampling across the Study Area and the natural variation that this brings. Generally, quadrats were compositionally most similar to those situated in close proximity. For example, *Chamelaucium pauciflorum* subsp. Perenjori (B.J. Conn 2181), *Hemigenia* sp. Yalgoo (A.M. Ashby 2624) and *Eremophila forrestii*	 **Plate 68: Typical VU 29 (Quadrat KML02)**

VU	Summary from Quadrat Data	Representative VU Photograph
	subsp. *forrestii* were only recorded in the easternmost quadrats of this VU, while *Acacia assimilis* subsp. *assimilis* and *Melaleuca nematophylla* were only recorded in the westernmost quadrats. However, this variation is considered to be relatively minor in the context of this unit. In addition, a small number of quadrats exhibited structural variation in that they contained isolated clumps of trees of *Eucalyptus leptopoda* subsp. *arctata* and *Eucalyptus kochii* subsp. *amaryssia*/*Eucalyptus kochii* subsp. *plenissima*. Note that despite the observed compositional variation of this VU across the Study Area, the indicator taxa for this VU were present across the range of the VU (particularly in the case of *Amphipogon caricinus* var. *caricinus* that was present in all VU 29 quadrats)	
30	**Description:** Low isolated clumps of trees of mixed species dominated by *Eucalyptus leptopoda* subsp. *arctata* over tall shrubland to open shrubland of mixed species including *Acacia latior*, *Melaleuca leiocarpa* and *Acacia longispinea* over mid sparse shrubland of mixed species including *Aluta aspera* subsp. *hesperia* and *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) over low sparse shrubland of mixed species including *Philotheca deserti* subsp. *deserti*, *Hakea recurva* subsp. *recurva* and *Persoonia hexagona* over low sparse tussock grassland of mixed species dominated by *Monachather paradoxus* and *Amphipogon caricinus* var. *caricinus* over mid to low sparse forbland of mixed species including *Dianella revoluta* var. *divaricata* on red-brown silty clay loam with ironstone, quartz and granite gravel on plains and slopes **Area mapped (proportion of Study Area):** 2,740 ha (13.4 %) **Sampling:** 17 quadrats (GIND-26, GIND-57, GIND-59, GIND-87, GIND-89, GIND-97, GINM-00, GINM-03, KIOP 199, KIOP 218, KIOP 219, KIOP 230, KIOP 502, KK02, KML21, KML27, KML39) **Average Native Perennial Taxon Richness per Quadrat:** 10 ± 4 **Indicator Taxa:** *Acacia longispinea*, *Eucalyptus leptopoda* subsp. *arctata*, *Monachather paradoxus* **Significant Taxa:** *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1)^, *Drummondita fulva* (P3), *Grevillea globosa* (P3), *Hibbertia cockertoniana* (P3)^, *Persoonia pentasticha* (P3), *Prostanthera* sp. Karara (D. Coultas & K. Greenacre Opp 8) (P1)^	 **Plate 69: Typical VU 30 (Quadrat KML27)**

VU	Summary from Quadrat Data	Representative VU Photograph
	Variation: This VU exhibited reasonable compositional variation, particularly in the mid and low shrubland strata, likely a reflection of the large mapping area and sampling across the Study Area and the natural variation that this brings. In addition, some quadrats exhibited structural variation in that they were missing the upper *Eucalyptus* layer. These quadrats tended to be situated lower in the landscape and had less of an ironstone influence. Quadrats located in areas long unburnt also possessed a dense tall shrubland stratum that tended towards being closed	
31	**Description:** Tall open shrubland to sparse shrubland of mixed species dominated by *Acacia latior*, *Acacia sibina* and *Melaleuca hamata* and occasionally *Melaleuca leiocarpa* and *Melaleuca nematophylla* over mid open shrubland to sparse shrubland of mixed species including *Aluta aspera* subsp. *hesperia* and *Hakea minyma* on red and red-brown silty clay loam and sandy clay with ironstone gravel on plains and mid slopes **Area mapped (proportion of Study Area):** 311 ha (1.5 %) **Sampling:** 6 quadrats (GIND-85, GINM-09, KIOP 430, KIOP 487, KML09, KML31) **Average Native Perennial Taxon Richness per Quadrat:** 7 ± 2 **Indicator Taxa:** *Acacia latior* **Significant Taxa:** No significant taxa recorded in quadrats **Variation:** This VU was generally structurally and compositionally uniform, although two quadrats possessed a low open woodland stratum of *Eucalyptus ewartiana* (Plate 71)	 **Plate 70: Typical VU 31 (Quadrat KML31)**

VU	Summary from Quadrat Data	Representative VU Photograph
		

Plate 71: **Variant of VU 31 with Low Woodland Stratum (Quadrat GIND-85)**

VU	Summary from Quadrat Data	Representative VU Photograph
32	**Description:** Tall shrubland to open shrubland of mixed species including *Acacia acuminata*/*Acacia burkittii*, *Acacia sibina*, *Melaleuca hamata* and *Acacia ramulosa* var. *ramulosa* over mid open shrubland to sparse shrubland dominated by *Aluta aspera* subsp. *hesperia* and occasionally *Eremophila forrestii* subsp. *forrestii* and *Malleostemon tuberculatus* on red-brown, red or brown clay loam and sandy clay with ironstone and laterite gravel on slopes and undulating plains **Area mapped (proportion of Study Area):** 383 ha (1.9 %) **Sampling:** 10 quadrats (GINM-04, KIOP 221, KIOP 222, KIOP 231, KIOP 237, KIOP 431, KIOP 433, KIOP 434, KML01, KML03) **Average Native Perennial Taxon Richness per Quadrat:** 9 ± 2 **Indicator Taxa:** *Eremophila forrestii* subsp. *forrestii*, *Malleostemon tuberculatus* **Significant Taxa:** *Acacia karina* (P1)^, *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1)^, *Hibbertia cockertoniana* (P3)^ **Variation:** This VU exhibited reasonable compositional variation, particularly in the mid and low shrubland strata, likely a reflection of the large mapping area and sampling across the Study Area and the natural variation that this brings. Generally, quadrats were compositionally most similar to those situated in close proximity. For example, *Hysterobaeckea setifera* subsp. *setifera* was only recorded in the easternmost quadrats of this VU, while the indicator taxa *Eremophila forrestii* subsp. *forrestii* and *Malleostemon tuberculatus* were absent. However, this variation is considered to be relatively minor in the context of this unit and the remaining taxa that were present within these quadrats was relatively consistent with the typical VU 32	 **Plate 72: Typical VU 32 (Quadrat KML01)**

5.2.2.3 Other Areas Described

Areas where natural vegetation has been completely and apparently permanently removed, with no native taxa remaining, have been mapped as 'Cleared Land' (CL) (where discernible at 1:10,000 scale). This includes roads (and associated infrastructure including culverts), tracks and areas cleared for mining activities. A total of 1,474 ha of 'Cleared Land' was mapped, representing approximately 7.2 % of the Study Area (Figure 12, Appendix M). Note that there are many exploration drill lines in the Study Area; these areas have been mapped as parts of the VUs within which they occur due to their small size and historical attempts to rehabilitate at least a portion of these lines. It is considered that the status of these lines in the context of remnant vegetation is better assessed in an EIA context.

In addition to cleared areas, areas of rehabilitation have been mapped as 'Rehabilitated Areas' (R). A total of 97 ha of 'Rehabilitated Areas' were mapped, representing approximately 0.5 % of the Study Area (Figure 12, Appendix M).

One playa lake claypan was mapped north of Mungada Ridge, covering 6 ha (0.03 % of the Study Area). This lake consists of bare clay and is completely devoid of vegetation when dry. It periodically fills with water, and in the subsequent weeks while water is still present (or when the clay is still waterlogged), a forbland of *Myriophyllum decussatum* establishes (Plate 73).

Plate 73: Playa Lake Claypan North of Mungada Ridge (Photo: Woodman Environmental 2011)

5.2.2.4 Comparison of Vegetation Units with Previous Studies

Karara–Mungada Flora and Vegetation Assessment (Woodman Environmental 2008c)

The clusters of quadrats produced by the classification analysis conducted as part of the Karara–Mungada Survey (Woodman Environmental 2008c) were generally maintained in the current analysis classification. However, with the addition of quadrat data utilised in the current classification analysis, there was migration of a small number of quadrats from their original cluster positions to other clusters in the current analysis classification. In particular, some quadrats that classified on the outer fringes of clusters in the Karara–Mungada Survey dendrogram (i.e. those that were least similar to other quadrats in the cluster) migrated to new clusters. This was to be expected, given a much larger quadrat dataset was analysed here than for the Karara–Mungada Survey (265 quadrats for the current analysis as opposed to 155 in the former assessment) and over a larger study area (20,473 ha as opposed to 16,050 ha), resulting in a re-definition of relationships between quadrats. In addition, there have been a number of taxonomic changes published since the original analysis that relate to taxa in the area, necessitating changes to the original quadrat data.

Many quadrats from the Karara–Mungada Survey FCTs that migrated in the current analysis contain high proportions of taxa that were common throughout the Study Area. This migration may also have been a result of quadrat positioning with respect to community boundaries, where edge effects (ecotones) influenced the species composition of the quadrat. In addition, quadrats located on sites with characteristics that do not support the full complement of indicator species for a given VU would be expected to migrate more readily. For example, quadrats established on small outcrops may not contain all indicator species typical of larger landforms with more extensive outcropping.

A comparison of the 23 FCTs defined by the Karara–Mungada Survey with the VUs defined by the current analysis are presented in Table 15. Presented for each VU is the Karara–Mungada FCT(s) that contributed the predominant number or proportion of quadrats to the VU, and other FCTs that contributed quadrats to the VU. Potential significance of Karara–Mungada FCTs identified by Woodman Environmental (2008c) are provided below Table 15. FCT descriptions from the Karara–Mungada Survey are presented in Appendix L.

Six Karara–Mungada FCTs had 100 % of their quadrats contribute to a single VU (VUs 7, 9, 11, 17, 21 and 30). With the exception of VU 30, these VUs typically occurred on distinctive, restricted landform types (e.g. claypans, BIF outcropping) and therefore possessed taxa compositions that were unique within the Study Area. VU 30 was mapped widely throughout the Study Area but was typically found on the lower slopes of rocky hills and contained many taxa that were generally not found in other VUs (e.g. *Acacia longispinea*, *Grevillea globosa* (P3)).

Excluding the aforementioned six FCTs, nine Karara–Mungada FCTs had 75 % or more of quadrats contribute to a single VU (VUs 1, 10, 12, 16, 20, 22, 26, 28 and 29). Of these, VUs 12, 20, 22 and 28 typically occurred on distinctive, restricted landform types, with VUs 20, 22 and 28 only being recorded on Mungada Ridge and Mount Karara.

The cluster of quadrats that comprised Karara–Mungada FCT 12 was disrupted to the greatest extent by the current analysis, with quadrats being distributed across five different VUs (VUs 10, 19, 24, 25, 28 and 29). The largest proportions of quadrats that comprised this FCT were contributed to VUs 28 (40 % of quadrats) and 25 (30 % of quadrats). This FCT was mapped relatively broadly across Mungada Ridge and is associated mid to lower slopes, as well as on Blue Hills, a small occurrence on Mount Karara and a small rise southeast of Mount Karara. The inclusion of additional data appears to have clarified the relationships between quadrats that comprised this FCT and other quadrats in the Study Area; quadrats from this FCT located on the lower slopes classified together within the cluster that comprises VU 10, while those on BIF outcropping on crests classified together within the cluster that comprises VU 19.

Four VUs were not represented by any quadrats that comprised Karara–Mungada FCTs (VUs 13, 14, 15 and 23). VUs 13 and 15 were mapped in the southern part of the Study Area while VU 23 was mapped in the far southwestern part of the Study Area, all outside the area assessed by the Karara–Mungada Survey. Much of the vegetation in these parts of the Study Area is quite dissimilar to that recorded elsewhere due to a greater granitic influence, and indeed VU 15 was mapped on a granite outcrop. VU 14 was represented by a single quadrat established in 2020 for the current survey in the western part of the Study Area. This area was identified from aerial photography interpretation prior to the current survey as having unique vegetation patterning. While part of the polygon of this VU that contains the aforementioned quadrat falls within the area mapped for the Karara–Mungada Survey, no quadrat was established within it due to its limited extent in the area mapped; therefore, it was allocated to an FCT based on aerial photography interpretation.

Table 15: Comparison of Karara–Mungada Survey FCTs with VUs from Current Analysis

VU	Predominant Karara–Mungada FCT	Comment
1	1b	Of the 19 quadrats representing VU 1: • 12 were originally grouped into FCT 1b (92 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 1a (11 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 3 (8 % of the total number of quadrats representing this FCT); and • 5 were not assessed as part of the Karara–Mungada Survey
2	2	Of the 8 quadrats representing VU 2: • 3 were originally grouped into FCT 2 (60 % of the total number of quadrats representing this FCT); and • 5 were not assessed as part of the Karara–Mungada Survey
3	5b	Of the 6 quadrats representing VU 3: • 2 were originally grouped into FCT 5b (67 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 1a (11 % of the total number of quadrats representing this FCT); and • 3 were not assessed as part of the Karara–Mungada Survey
4	2	Of the 7 quadrats representing VU 4: • 2 were originally grouped into FCT 2 (40 % of the total number of quadrats representing this FCT); and • 5 were not assessed as part of the Karara–Mungada Survey
5	1a	Of the 14 quadrats representing VU 5: • 6 were originally grouped into FCT 1a (67 % of the total number of quadrats representing this FCT); and • 8 were not assessed as part of the Karara–Mungada Survey
6	1a / 7c^	Of the 6 quadrats representing VU 6: • 1 was originally grouped into FCT 7c (25 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 1a (11 % of the total number of quadrats representing this FCT); and • 4 were not assessed as part of the Karara–Mungada Survey
7	7a	The 2 quadrats representing VU 7 were originally grouped into FCT 7a (100 % of / the only quadrats representing this FCT)
8	-	The 2 quadrats representing VU 8 were not assessed as part of the Karara–Mungada Survey
9	7b^	The 2 quadrats representing VU 9 were originally grouped into FCT 7b (100 % of / the only quadrats representing this FCT)
10	3	Of the 31 quadrats representing VU 10: • 10 were originally grouped into FCT 3 (77 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 17 (33 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 12 (10 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 1b (8 % of the total number of quadrats representing this FCT); and • 18 were not assessed as part of the Karara–Mungada Survey

VU	Predominant Karara–Mungada FCT	Comment
11	6	The 1 quadrat representing VU 11 was originally grouped into FCT 6 (100 % of / the only quadrat representing this FCT)
12	7c^	The 3 quadrats representing VU 12 were originally grouped into FCT 7c (75 % of the total number of quadrats representing this FCT)
13	-	The 2 quadrats representing VU 13 were not assessed as part of the Karara–Mungada Survey
14	-	The 1 quadrat representing VU 14 was not assessed as part of the Karara–Mungada Survey
15	-	The 1 quadrat representing VU 15 was not assessed as part of the Karara–Mungada Survey
16	4~^	Of the 12 quadrats representing VU 16: • 3 were originally grouped into FCT 4 (75 % of the total number of quadrats representing this FCT); and • 9 were not assessed as part of the Karara–Mungada Survey
17	5a	Of the 15 quadrats representing VU 17: • 3 were originally grouped into FCT 5a (100 % of / the only quadrats representing this FCT); and • 12 were not assessed as part of the Karara–Mungada Survey
18	5b	Of the 7 quadrats representing VU 18: • 1 was originally grouped into FCT 5b (33 % of the total number of quadrats representing this FCT); and • 6 were not assessed as part of the Karara–Mungada Survey
19	8~*	Of the 7 quadrats representing VU 19: • 4 were originally grouped into FCT 8 (29 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 10a (25 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 10b (17 % of the total number of quadrats representing this FCT); and • 1 was originally grouped into FCT 13 (17 % of the total number of quadrats representing this FCT)
20	10b~^	Of the 6 quadrats representing VU 20: • 5 were originally grouped into FCT 10b (83 % of the total number of quadrats representing this FCT); and • 1 was not assessed as part of the Karara–Mungada Survey
21	9~^	Of the 11 quadrats representing VU 21: • 10 were originally grouped into FCT 9 (100 % of / the only quadrats representing this FCT); and • 1 was originally grouped into FCT 8 (7 % of the total number of quadrats representing this FCT)
22	10a~^	The 3 quadrats representing VU 22 were originally grouped into FCT 10a (75 % of the total number of quadrats representing this FCT)
23	-	The 2 quadrats representing VU 23 were not assessed as part of the Karara–Mungada Survey

VU	Predominant Karara–Mungada FCT	Comment
24	8~* / 14~^	Of the 11 quadrats representing VU 24: • 6 were originally grouped into FCT 8 (43 % of the total number of quadrats representing this FCT); • 3 were originally grouped into FCT 14 (60 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 12 (10 % of the total number of quadrats representing this FCT); and • 1 was originally grouped into FCT 3 (8 % of the total number of quadrats representing this FCT)
25	12~* / 14~^	Of the 8 quadrats representing VU 25: • 3 were originally grouped into FCT 12 (30 % of the total number of quadrats representing this FCT); • 2 were originally grouped into FCT 14 (40 % of the total number of quadrats representing this FCT); • 2 were originally grouped into FCT 11 (25 % of the total number of quadrats representing this FCT); • 1 was not assessed as part of the Karara–Mungada Survey
26	11~*	Of the 7 quadrats representing VU 26: • 6 were originally grouped into FCT 11 (75 % of the total number of quadrats representing this FCT); and • 1 was not assessed as part of the Karara–Mungada Survey
27	8~*	Of the 7 quadrats representing VU 27: • 3 were originally grouped into FCT 8 (21 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 3 (8 % of the total number of quadrats representing this FCT); and • 3 were not assessed as part of the Karara–Mungada Survey
28	13~*	Of the 13 quadrats representing VU 28: • 5 were originally grouped into FCT 13 (83 % of the total number of quadrats representing this FCT); • 4 were originally grouped into FCT 12 (40 % of the total number of quadrats representing this FCT); and • 4 were not assessed as part of the Karara–Mungada Survey
29	15	Of the 18 quadrats representing VU 29: • 8 were originally grouped into FCT 15 (89 % of the total number of quadrats representing this FCT); • 1 was originally grouped into FCT 12 (10 % of the total number of quadrats representing this FCT); and • 9 were not assessed as part of the Karara–Mungada Survey
30	16	Of the 17 quadrats representing VU 30: • 7 were originally grouped into FCT 16 (100 % of / the only quadrats representing this FCT); • 1 was originally grouped into FCT 4 (25 % of the total number of quadrats representing this FCT); and • 9 were not assessed as part of the Karara–Mungada Survey
31	17	Of the 6 quadrats representing VU 31: • 2 were originally grouped into FCT 17 (67 % of the total number of quadrats representing this FCT); and • 4 were not assessed as part of the Karara–Mungada Survey

VU	Predominant Karara–Mungada FCT	Comment
32	15	Of the 10 quadrats representing VU 32: • 1 was originally grouped into FCT 15 (11 % of the total number of quadrats representing this FCT); and • 9 were not assessed as part of the Karara–Mungada Survey

~ FCT identified by Woodman Environmental (2008c) as possibly representing the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1).
* FCT identified by Woodman Environmental (2008c) as having a high conservation significance.
^ FCT identified by Woodman Environmental (2008c) as having a moderate conservation significance.

Karara to Minjar Block Regional Flora and Vegetation Survey (Woodman Environmental 2012b)

As described in Section 3.9.2, further floristic analysis was undertaken to identify possible relationships and assess similarities between VUs defined by the current analysis with regional FCTs described by the Regional Mapping Survey (Woodman Environmental 2012b) (FCTs defined in Appendix Q), with the aim of determining the potential regional distribution and significance of VUs. Additionally, taxon lists of quadrats from the current analysis were also compared to the typical and common taxa lists for FCTs, as well as soils, topography and geographical distribution data from both studies. The resultant dendrogram is presented in Appendix R and detailed summaries of the combined dataset analysis results and comparisons are presented in Appendix S. Table 16 presents an overall summary of the results of this process.

With the addition of quadrat data from the current survey to the Regional Mapping Survey dataset, there was significant migration of quadrats from their original cluster positions. As discussed in the previous section, this is to be expected, especially considering the Regional Mapping survey dataset has a significantly larger number of quadrats than the current survey dataset.

The Regional Mapping Survey analysis (Woodman Environmental 2012b) determined and described FCTs at a higher-level regional scale in comparison to that presented in this report for the Study Area. As a result, multiple VUs have shown similarity to several regional FCTs; in addition, many VUs have shown similarity to more than one regional FCT (Table 16).

A summary of the findings of the combined dataset analysis is presented in Table 16 and below:

- Eight VUs can be considered representative of regional FCTs with a reasonable degree of confidence (VUs 7, 11, 12, 14, 15, 19, 23 and 26). These VUs typically occurred on restricted landforms and possessed taxa compositions very dissimilar to those recorded elsewhere in the Study Area and wider region (e.g. granite outcrops, wetlands, etc.);
- 22 VUs show similarity to at least one or two regional FCTs, and generally also show similarity to a number of other regional FCTs (VUs 1, 2, 3, 4, 5, 6, 8, 9, 10, 13, 16, 17, 20, 21, 22, 24, 25, 28, 29, 30, 31 and 32). Although they could not be aligned with any specific regional FCT, there is evidence of regional representation of the VUs in the wider region; and
- Two VUs had limited similarity to any one or two regional FCTs (VUs 18 and 27). The quadrats of these VUs generally classified into a number of groupings of quadrats, both from other VUs in the Study Area, and quadrats established outside the Study Area representing a range of regional FCTs. Although these VUs cannot be attributed to any particular regional FCT, they are broadly represented elsewhere in the region (Table 16, Appendix S).

Table 16: Summary of Similarities of VUs to Regional Mapping Survey FCTs

VU	Similarity of VU to Regional FCTs
1	Quadrats from VU 1 show greatest similarity to regional FCT 27 quadrats, with similarity also to regional FCT 19a and 23 quadrats
2	Quadrats from VU 2 show similarity to regional FCT 19a and 28 quadrats
3	Quadrats from VU 3 show similarity to regional FCT 28 quadrats, with some (lesser) potential similarity to regional FCT 32 and 19a quadrats
4	Quadrats from VU 4 show similarity to regional FCT 19a quadrats, with some (lesser) similarity to regional FCT 27 and 20 quadrats
5	Quadrats from VU 5 show similarity to regional FCT 19a and 27 quadrats, with some (lesser) similarity to regional FCT 15 quadrats
6	Quadrats from VU 6 show similarity to regional FCT 19a quadrats, with some (lesser) similarity to regional FCT 27 quadrats
7	Quadrats from VU 7 are representative of regional FCT 19b. This VU occurs on a restricted landform (saline claypan) and is clearly dissimilar to all other regional FCTs. A review of FCT descriptions and quadrat data of the most closely related quadrats supports this determination, particularly in terms of species composition, indicator taxa and landform. Note that regional FCT 19b was only represented by the two quadrats described by the current analysis as VU 7
8	Quadrats from VU 8 are most similar to regional FCT 21a quadrats, with close similarity also to regional FCT 19a quadrats. The analysis result is relatively conclusive and is supported by a review of FCT descriptions and quadrat data of the most closely related quadrats, particularly in terms of species composition
9	Quadrats from VU 9 show similarity to regional FCT 20 quadrats, with close similarity also to quadrats from the regional FCT 19 group (particularly 19b/19c/19d)
10	Quadrats from VU 10 show similarity to regional FCT 26 quadrats, with some (lesser) similarity to quadrats from other regional FCTs including 29, 19a, 13 and 2
11	The single quadrat representing VU 11 is representative of regional FCT 21b. The analysis result is conclusive and reflects the localised nature of this VU, and a review of FCT descriptions and quadrat data of the most closely related quadrats rules out other FCTs, particularly in terms of the landform and soils. Note that regional FCT 21b was represented only by the one quadrat described by the current analysis as VU 11
12	Quadrats from VU 12 are representative of regional FCT 19c/19d. Taking into account lack of replication in the dataset due to the localised nature of this VU, the results of the analysis are relatively conclusive. A review of FCT descriptions and quadrat data of the most closely related quadrats rules out other FCTs, particularly in terms of the landform, soils and indicator taxa. Note that regional FCTs 19c and 19d were represented only by the three quadrats described by the current analysis as VU 12
13	Quadrats from VU 13 show similarity to regional FCT 19a and 22 quadrats, with lesser similarity to regional FCT 21a quadrats. The vegetation descriptions and dominant taxa of this VU have similarities to that of regional FCTs 19a and 22
14	The single quadrat representing VU 14 shows similarity to regional FCT 19a and 21a quadrats, although it was an outlier to this group (Appendix R). The description of the vegetation in this quadrat is similar to that of regional FCT 21a
15	The single quadrat representing VU 15 is representative of regional FCT 16, although there are similarities to other regional FCTs including 25, 26 and 29. However, this VU occurs on a restricted landform (granite outcrop), with this landform not present in these other regional FCTs
16	Quadrats from VU 16 show similarity to regional FCT 23 quadrats, with some (lesser) similarity to quadrats from other regional FCTs including 28, 26 and 1. While some quadrats representing VU 16 grouped relatively conclusively with quadrats representing regional FCT 23, the overall analysis results and review of FCT descriptions and quadrat data indicated the other quadrats representing VU 16 have high similarity to quadrats representing a number of different regional FCTs

VU	Similarity of VU to Regional FCTs
17	Quadrats from VU 17 show greatest similarity to regional FCT 23 and 32 quadrats, with lesser similarity to quadrats from other regional FCTs such as 17. While some quadrats representing VU 17 grouped relatively conclusively with quadrats representing regional FCT 32, the overall analysis results and review of FCT descriptions and quadrat data indicated the other quadrats representing VU 17 have high similarity to quadrats representing a number of different regional FCTs
18	The results of the analyses and review of FCT descriptions and quadrat data suggests that the quadrats that represent VU 18 are not strongly similar to any one regional FCT, with some similarity evident to quadrats from a range of regional FCTs including 31, 29, 17, 28 and 24
19	Quadrats from VU 19 are representative of regional FCT 1. The analysis result is relatively conclusive and is supported by a review of FCT descriptions and quadrat data of the most closely related quadrats, particularly in terms of landform and geology, including the presence of BIF outcropping
20	Quadrats from VU 20 show greatest similarity to regional FCT 1 quadrats, with some similarity also to regional FCT 2 and 3 quadrats
21	Quadrats from VU 21 show greatest similarity to regional FCT 1 quadrats, with some similarity also to regional FCT 2 and 3 quadrats
22	Quadrats from VU 22 show greatest similarity to regional FCT 4 quadrats, with lesser similarity to regional FCT 1 and 3 quadrats
23	Quadrats from VU 23 are representative of regional FCT 3, with some lesser similarity to regional FCT 5 quadrats. The analysis result is relatively conclusive and is supported by a review of FCT descriptions and quadrat data of the most closely related quadrats, particularly in terms of landform, geology and soils, including the presence of granitic soils and outcropping
24	Quadrats from VU 24 show greatest similarity to regional FCT 1 quadrats, with some (lesser) similarity to regional FCT 2, 12 and 7 quadrats (although landforms common to these latter FCTs differ to those common to VU 24)
25	Quadrats from VU 25 are most similar to regional FCT 1 and 2 quadrats, with some (lesser) similarity to regional FCT 6 and 10 quadrats
26	Quadrats from VU 26 are representative of regional FCT 10. The analysis result is relatively conclusive and is supported by a review of FCT descriptions and quadrat data of the most closely related quadrats, particularly in terms of indicator taxa, landform and geology
27	Quadrats from VU 27 show similarity to quadrats from a variety of regional FCTs, primarily 12 and 7, and to a lesser extent 9, 6, 26 and 28. However, quadrats from VU 27 did not show high similarity to any particular regional FCT, and were split variously across the dendrogram, reflecting a low similarity to each other on a regional scale. The results of the analyses and review of FCT descriptions and quadrat data suggests that the quadrats that represent this VU are not especially similar to any one regional FCT
28	Quadrats from VU 28 show similarity to regional FCT 4 and 10 quadrats, with some (lesser) similarity to regional FCT 6 and 9 quadrats
29	Quadrats from VU 29 show similarity to regional FCT 7 quadrats, with some (lesser) similarity to regional FCT 9, 10 and 11 quadrats
30	Quadrats from VU 30 show similarity to regional FCT 7 quadrats, with some (lesser) similarity to regional FCT 13, 10, 6 and 18 quadrats
31	Quadrats from VU 31 are broadly similar to regional FCT 8 and 13 quadrats, with lesser similarity to regional FCT 7 and 9 quadrats
32	Quadrats from VU 32 show greatest similarity to regional FCT 11 quadrats

5.2.2.6 Significant Vegetation

Table 17 presents a summary of the local and potential regional significance of the VUs defined by the current analysis. Also presented in Table 17 is the mapped area of each VU in the Study Area (presented as a proportion of the total area of the Study Area). Figure 13 presents the distribution of potentially significant vegetation of the Study Area.

A total of 10 VUs are considered potentially significant in a regional context due to forming part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Section 5.2.2.4 and discussed in more detail in Section 5.2.2.7) (Table 17).

A total of 18 VUs are considered potentially significant in a local and/or regional context for reasons other than formal listing, as per EPA (2016a) (Section 3.9.2). These VUs are also identified in Table 17 and are discussed further in Section 5.2.2.8.

Table 17: Summary of Significance of VUs Mapped in the Study Area

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
1	9.2	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted within the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 27, which is not considered significant (mapped over 5.1 % of the Regional Mapping survey area); • Some similarity to regional FCTs 19a and 23, neither of which are considered significant (mapped over 19.6 % and 4.7 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
2	5.9	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted within the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCTs 19a and 28, neither of which are considered significant (mapped over 19.6 % and 1.8 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
3	0.9	**Considered significant in a local context:** • Mapped over a small number of occurrences in the Study Area; • Does not occur on a restricted landform; • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	Not considered potentially significant in a regional context: • Similar to regional FCT 28, which is not considered significant (mapped over 1.8 % of the Regional Mapping survey area); • Some similarity to regional FCTs 32 and 19a, neither of which are considered significant (mapped over 5.2 % and 19.6 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
4	1.9	Not considered significant in a local context: • Mapped over a number of relatively large occurrences in the Study Area; • Does not occur on a restricted landform; • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 19a, which is not considered significant (mapped over 19.6 % of the Regional Mapping survey area); • Some similarity to regional FCTs 27 and 20, neither of which are considered significant (mapped over 5.1 % and 1.5 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
5	15.4	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted in the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCTs 19a and 27, neither of which are considered significant (mapped over 19.6 % and 5.1 % of the Regional Mapping survey area, respectively); • Some similarity to regional FCT 15, which is not considered significant (mapped over 1.2 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
6	1.5	Not considered significant in a local context: • Mapped over a small number of relatively large occurrences in the Study Area; • Does not occur on a restricted landform; • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 19a, which is not considered significant (mapped over 19.6 % of the Regional Mapping survey area); • Some similarity to regional FCT 27, which is not considered significant (mapped over 5.1 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
7	0.5	**Considered significant in a local context:** • Mapped in one occurrence in the Study Area; • Occurs on restricted landform (saline claypan); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted):** • Considered representative of regional FCT 19b, which is considered potentially significant at a regional scale (mapped over 0.1 % of the Regional Mapping survey area); • The area mapped as VU 7 is the only occurrence of regional FCT 19b in the Regional Mapping survey area and it is therefore considered restricted in the region; • Quadrats mainly classified in proximity to other quadrats which were established in the Study Area in the dendrogram (Appendix R, Appendix S)
8	0.3	**Considered significant in a local context:** • Mapped in a small number of small occurrences in the Study Area; • Does not occur on a restricted landform; • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted):** • Similar to regional FCT 21a, which is considered potentially significant at a regional scale (mapped over 0.97 % of the Regional Mapping survey area); • Some similarity to regional FCT 19a, which is not considered significant (mapped over 19.6 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
9	0.2	**Considered significant in a local context:** • Mapped in one small occurrence in the Study Area; • Occurs on restricted landform (drainage depression); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted; Lignum swamp):** • Similar to regional FCT 20, which although is not considered significant, is not widespread through the region (mapped over 1.5 % of the Regional Mapping survey area); • Some similarity to regional FCTs 19b/19c/19d, which are considered potentially significant at a regional scale (mapped over 0.13 %, 0.07 % and 0.19 % of the Regional Mapping survey area, respectively); • Vegetation in this VU is similar to that described as occurring in the Thundelarra Lignum Swamp (located approximately 27 km northeast of the Study Area), which is a listed swamp in the Australian Wetlands Database Directory of Important Wetlands (DAWE 2019) and covers an area of approximately 135 ha. The Thundelarra Lignum Swamp supports a significant example of 'lignum-canegrass' community which occurs very sparsely from Carnarvon to Kalgoorlie. Inundation of the Thundelarra Lignum Swamp is very sporadic and is a significant breeding area for waterbird species (DAWE 2019). • Payne *et al.* (1998) refers to 'drainage focus sclerophyll habitats' as making up a very small proportion of the Sandstone–Yalgoo–Paynes Find area, and VU 9 is similar to LISW (Lignum swamp) habitat described by Payne *et al* (1998); • Quadrats mainly classified in proximity to other quadrats which were established in the Study Area in the dendrogram (Appendix R, Appendix S)
10	11.1	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted in the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 26, which is not considered significant (mapped over 6.5 % of the Regional Mapping survey area); • Some similarity to other regional FCTs including 29, 19a, 13 and 2, none of which are considered significant (mapped over 1.2 %. 19.6 %, 3.2 % and 4.5 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
11	0.03	**Considered significant in a local context:** • Mapped in one small occurrence in the Study Area; • Occurs on restricted landform (drainage depression); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted):** • Considered representative of regional FCT 21b, which is considered potentially significant at a regional scale (mapped over 0.005 % of the Regional Mapping survey area); • The area mapped as VU 11 is the only occurrence of regional FCT 21b in the Regional Mapping survey area and it is therefore considered restricted in the region; • Quadrat classified with few quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
12	0.8	**Considered significant in a local context:** • Mapped in three small occurrences in the Study Area; • Occurs on restricted landforms (drainage depression and edges of saline claypans); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted):** • Considered representative of regional FCTs 19c/19d, which are considered potentially significant at a regional scale (mapped over 0.07 % and 0.2 % of the Regional Mapping survey area, respectively); • The areas mapped as VU 12 are the only occurrences of regional FCTs 19c/19d in the Regional Mapping survey area, and it is therefore considered restricted in the region; • Quadrats mainly classified in proximity to other quadrats which were established in the Study Area in the dendrogram (Appendix R, Appendix S)
13	0.1	**Considered significant in a local context:** • Mapped in two small occurrences in the Study Area; • Does not occur on a restricted landform; • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCTs 19a and 22, neither of which are considered significant (mapped over 19.6 % and 1.5 % of the Regional Mapping survey area, respectively); • Some similarity to regional FCT 21a, which is considered potentially significant at a regional scale (mapped over 0.97 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
14	0.3	**Considered significant in a local context:** • Mapped in two small occurrences in the Study Area; • Does not occur on a restricted landform; • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 19a (not considered significant; mapped over 19.6 % of the Regional Mapping survey area) and regional FCT 21a (considered potentially significant at a regional scale; mapped over 0.97 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
15	0.02	**Considered significant in a local context:** • Mapped in one very small occurrence in the Study Area; • Occurs on restricted landform (granite outcrop); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted):** • Considered representative of regional FCT 16, which is considered potentially significant at a regional scale (mapped over 0.02 % of the Regional Mapping survey area); • The area mapped as VU 15 is the only occurrence of regional FCT 16 in the Regional Mapping survey area and it is therefore considered restricted in the region; • Quadrat classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
16	4.0	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted in the Study Area	**Considered potentially significant in a regional context (partially forms part of the PEC):** • Similar to regional FCT 23, which is not considered significant (mapped over 4.7 % of the Regional Mapping survey area); • Some similarity to regional FCTs 28, 26 and 1, none of which are considered significant (mapped over 1.8 %, 6.5 % and 1.3 % of the Regional Mapping survey area, respectively); • Regional FCT 1 was considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7) (not all polygons form part of the PEC)
17	3.3	Not considered significant in a local context: • Mapped over several large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted in the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCTs 23 and 32, neither of which are considered significant (mapped over 4.67 % and 5.2 % of the Regional Mapping survey area, respectively); • Some similarity to other regional FCTs including 17, which is not considered significant (mapped over 1.3 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
18	1.2	Not considered significant in a local context: • Mapped over several relatively large occurrences in the Study Area; • Does not occur on a restricted landform; • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Although VU 18 did not have strong similarities to any one particular regional FCT, it shows similarities to a variety of FCTs including 31, 29, 17, 28 and 24. Each of these regional FCTs are fairly limited in mapped extent, however none are considered potentially significant (mapped over 2.8 %, 1.2 %, 1.3 %, 1.8 % and 1.1 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
19	0.3	**Considered significant in a local context:** • Mapped in several very small occurrences in the Study Area; • Occurs on restricted landform (BIF); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted; forms part of the PEC):** • Considered representative of regional FCT 1, which is considered potentially significant at a regional scale (moderately regionally restricted, mapped over 1.3 % of the Regional Mapping survey area; however, quadrats representing this regional FCT are primarily restricted to the major ridgelines of Jasper Hills, Blue Hills, Mount Karara and Mungada Ridge); • Regional FCT 1 was considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together and were not classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)
20	0.3	**Considered significant in a local context:** • Mapped in a small number of small occurrences in the Study Area; • Occurs on restricted landform (BIF); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (forms part of the PEC):** • Similar to regional FCT 1, with some similarities to regional FCTs 2 and 3. These regional FCTs are moderately regionally restricted (mapped over 1.3 %, 4.5 % and 1.0 % of the Regional Mapping survey area, respectively), and they were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together and were not classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
21	1.8	**Considered significant in a local context:** • Mapped over several occurrences in the Study Area; • Occurs on restricted landform (BIF); • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area)	**Considered potentially significant in a regional context (forms part of the PEC):** • Similar to regional FCT 1, with some similarities to regional FCTs 2 and 3. These regional FCTs are moderately regionally restricted (mapped over 1.3 %, 4.5 % and 1.0 % of the Regional Mapping survey area, respectively), and they were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together and were not classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)
22	0.1	**Considered significant in a local context:** • Mapped in two very small occurrences in the Study Area; • Occurs on restricted landform (BIF); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted; forms part of the PEC):** • Similar to regional FCT 4, with some similarities to regional FCTs 1 and 3. These regional FCTs are regionally restricted (mapped over 0.2 %, 1.3 % and 1.0 % of the Regional Mapping survey area, respectively), and they were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together and were not classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)
23	0.1	**Considered significant in a local context:** • Mapped in a small number of very small occurrences in the Study Area; • Occurs on restricted landform (granite); • Restricted extent in the Study Area (mapped over < 1 % of the total area of the Study Area)	**Considered potentially significant in a regional context (regionally restricted):** • Considered representative of regional FCT 3, which is considered potentially significant at a regional scale (mapped over 0.995 % of the Regional Mapping survey area); • Although regional FCT 3 was considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1), VU 23 is not considered to form part of that PEC due to differences in substrate with that of the PEC; • Quadrats classified together in the dendrogram, however also classified in proximity to some quadrats which were established outside the Study Area (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
24	2.5	Not considered significant in a local context: • Mapped over several relatively large occurrences in the Study Area; • Occurs on restricted landform (BIF); • Not restricted in the Study Area	**Considered potentially significant in a regional context (forms part of the PEC):** • Similar to regional FCT 1, which is considered potentially significant at a regional scale (moderately restricted, mapped over 1.3 % of the Regional Mapping survey area; however, quadrats representing this regional FCT are primarily restricted to the major ridgelines of Jasper Hills, Blue Hills, Mount Karara and Mungada Ridge); • Some similarity to regional FCTs 2, 12 and 7, none of which are regionally restricted (mapped over 4.5 %, 3.0 % and 11.6 % of the Regional Mapping survey area, respectively); • Regional FCTs 1, 2 and 12 were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together in the dendrogram, however also classified in proximity to some quadrats which were established outside the Study Area (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)
25	1.4	**Considered significant in a local context:** • Mapped in a small number of relatively large occurrences in the Study Area; • Associated with restricted landform (BIF); • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area)	**Considered potentially significant in a regional context (forms part of the PEC):** • Similar to regional FCTS 1 and 2, which are considered potentially significant at a regional scale (moderately restricted, mapped over 1.3 % and 4.5 % of the Regional Mapping survey area, respectively; however, they were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together and were not classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
26	1.3	**Considered significant in a local context:** • Mapped over several relatively large occurrences in the Study Area; • Associated with restricted landform (BIF); • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area)	**Considered potentially significant in a regional context (forms part of the PEC):** • Considered representative of regional FCT 10, which is considered potentially significant at a regional scale (mapped over 3.7 % of the Regional Mapping survey area; however, this FCT was considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified together in the dendrogram, however also classified in proximity to some quadrats which were established outside the Study Area (Appendix R, Appendix S). These quadrats are primarily restricted to the major ridgelines of Jasper Hills, Blue Hills, Chulaar Hill, Mount Karara and Mungada Ridge); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)
27	1.1	**Considered significant in a local context:** • Mapped over several very small to relatively large occurrences in the Study Area; • Associated with restricted landform (BIF); • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area)	**Considered potentially significant in a regional context (forms part of the PEC):** • Although VU 27 did not have strong similarities to any one particular regional FCT, it shows similarities to a variety of FCTs, primarily 12 and 7 (neither of which are regionally restricted; mapped over 3.0 % and 11.6 % of the Regional Mapping survey area, respectively), and to a lesser extent 9, 6, 26 and 28 (none of which are regionally restricted; mapped over 5.0 %, 2.9 %, 6.5 % and 1.8 % of the Regional Mapping survey area, respectively); • Regional FCTs 6 and 12 were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified with other quadrats which were established both within and outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7) (not all polygons)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
28	1.5	**Considered significant in a local context:** • Mapped over several large occurrences in the Study Area; • Occurs on restricted landform (BIF and granite); • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area)	**Considered potentially significant in a regional context (forms part of the PEC):** • Similar to regional FCTs 4 (regionally restricted; mapped over 0.2 % of the Regional Mapping survey area) and 10 (not regionally restricted; mapped over 3.7 % of the Regional Mapping survey area); • Some similarity to regional FCTs 6 and 9, neither of which are regionally restricted (mapped over 2.9 % and 5.0 % of the Regional Mapping survey area, respectively); • Regional FCTs 4, 6 and 10 were considered by Woodman Environmental (2012b) to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on the comparison with the Karara–Mungada Survey FCTs; • Quadrats classified with other quadrats which were established both within and outside the Study Area in the dendrogram (Appendix R, Appendix S); • Considered to form part of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) based on comparison with Karara–Mungada Survey FCTs (Sections 5.2.2.4 and 5.2.2.7)
29	8.4	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted in the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 7, which is not considered significant (mapped over 11.6 % of the Regional Mapping survey area); • Some similarity to regional FCTs 9, 10 and 11, none of which are regionally restricted (mapped over 5.0 %, 3.7 % and 2.2 % of the Regional Mapping survey area, respectively); • Quadrats classified with other quadrats which were established both within and outside the Study Area in the dendrogram (Appendix R, Appendix S)
30	13.4	Not considered significant in a local context: • Mapped over many large occurrences in the Study Area; • Does not occur on a restricted landform; • Not restricted in the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 7, which is not considered significant (mapped over 11.6 % of the Regional Mapping survey area); • Some similarity to regional FCTs 13, 10, 6 and 18, none of which are regionally restricted (mapped over 3.2 %, 3.7 %, 2.9 % and 1.4 % of the Regional Mapping survey area, respectively); • Quadrats classified with other quadrats which were established both within and outside the Study Area in the dendrogram (Appendix R, Appendix S)

VU	% of Total Area of Study Area	Summary of Significance	
		Local Context	Regional Context (with Reference to Woodman Environmental (2012b) Regional FCTs)
31	1.5	Not considered significant in a local context: • Mapped over several relatively large occurrences in the Study Area; • Does not occur on a restricted landform; • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCTs 8 (regionally restricted; mapped over 0.4 % of the Regional Mapping survey area) and 13, (not regionally restricted; mapped over 3.2 % of the Regional Mapping survey area); • Some similarity to regional FCTs 7 and 9, none of which are considered significant (mapped over 11.6 % and 5.0 % of the Regional Mapping survey area, respectively); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)
32	1.9	Not considered significant in a local context: • Mapped over several relatively large occurrences in the Study Area; • Does not occur on a restricted landform; • Moderately restricted extent in the Study Area (mapped over < 2 % of the total area of the Study Area); however, it is likely this VU extends more broadly outside the Study Area	Not considered potentially significant in a regional context: • Similar to regional FCT 11, which is not considered significant (mapped over 2.2 % of the Regional Mapping survey area); • Quadrats classified in proximity to quadrats which were established outside the Study Area in the dendrogram (Appendix R, Appendix S)

475000 480000 485000 490000 495000

6785000 6780000 6775000 6770000 6765000 6760000

Legend

- Study Area
- Footprint

Potentially Significant Vegetation

- Study Area VU 3 - restricted local extent
- Study Area VU 7 - restricted local and regional extent
- Study Area VU 8 - restricted local and regional extent
- Study Area VU 9 - restricted local and regional extent, potential lignum swamp
- Study Area VU 11 - restricted local and regional extent
- Study Area VU 12 - restricted local and regional extent
- Study Area VU 13 - restricted local extent
- Study Area VU 14 - restricted local extent
- Study Area VU 15 - restricted local and regional extent
- Study Area VU 19 - restricted local and regional extent
- Study Area VU 20 - restricted local extent
- Study Area VU 21 - restricted local extent
- Study Area VU 22 - restricted local and regional extent
- Study Area VU 23 - restricted local and regional extent
- Study Area VU 25 - restricted local extent
- Study Area VU 26 - restricted local extent
- Study Area VU 27 - restricted local extent
- Study Area VU 28 - restricted local extent
- WA PEC 'Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation)'

475000 480000 485000 490000 495000

umwelt

N

This map should only be used in conjunction with WEC report KML20-33-01.

Potentially Significant Vegetation of the Study Area

Revision: A - 30 August 2021 Scale: 1:85,000

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f13

Projection: GDA 1994 MGA Zone 50

Figure

13

5.2.2.7 Listed Significant Vegetation

It is considered that the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) occurs in the Study Area. This PEC is considered to possibly be represented by VUs 16, 19, 20, 21, 22, 24, 25, 26, 27 and 28 (where these VUs occur on BIF on crests and slopes that are higher in the landscape on restricted landforms; this primarily encompasses the crests and upper to lower slopes of Mount Karara, Blue Hills and Mungada Ridge in the central area of the Study Area) (Figure 13). A total of 2,085.7 ha (comprising 10.2 % of the total area of the Study Area) of the PEC was mapped by the current survey. Of this, 93.5 ha occurs within the current Footprint (comprising 10.1 % of the total area of the Footprint).

The determination that VUs 16, 19, 20, 21, 22, 24, 25, 26, 27 and 28 possibly represent this PEC has been made following comparison of VUs to Karara–Mungada Survey FCTs (Woodman Environmental 2008c) (Sections 3.9.2 and 5.2.2.4). In the classification dendrogram produced by the current analysis, quadrats within the Karara–Mungada FCTs that were identified as possibly representing the PEC (FCTs 4, 8, 9, 10a, 10b, 11, 12, 13, and 14) contributed quadrats to these VUs. Furthermore, these quadrats are predominantly restricted to BIF hills (primarily on the major ridgelines of Blue Hills, Mount Karara and Mungada Ridge). These FCTs were associated with the floristic communities originally identified on hillslopes, crests and upland plateaux within the Study Area by Markey and Dillon (2008), the report of which was used to determine the presence of the PEC (DBCA 2020c). This is considered to be adequate justification for these VUs being a component of the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1).

Further to the above, several mapped polygons of two of these VUs are not considered to represent the PEC. Likewise, some VUs which are considered at least partially representative of Karara-Mungada FCTs which were identified as potentially represent the PEC are also not considered to represent the PEC. These are described below.

Note that only one mapped occurrence of VU 16 is considered to possibly represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1), despite Karara–Mungada FCT 4, which was identified by Woodman Environmental (2008c) as possibly representing the PEC, contributing three quadrats to VU 16 (KARA16, GIND-14 and GINM-12). Of these, KARA16 is the only quadrat considered to possibly represent the PEC. This quadrat is located on the lower slope of Mount Karara and contains taxa that occur on BIF, including *Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3) and *Mirbelia* sp. Bursarioides (T.R. Lally 760). The extent of the VU polygon in this area is 31.7ha.

GIND-14 is located in a drainage line with exposed dolerite and granite, and therefore is not considered to represent the PEC. GINM-12 misclassified in the current analysis (Appendix K), likely due to being relatively species-poor (containing nine native perennial taxa) and being placed in transitional vegetation. This quadrat was manually reassigned to VU 16 following review of the species composition (Appendix P). The quadrat is not located on BIF and is therefore not considered to represent the PEC. All other occurrences of VU 16 are not

considered to represent the PEC as they predominately have granite, dolerite or laterite influence.

Similarly, nine of 11 mapped occurrences of VU 27 are considered to represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1). Karara–Mungada FCT 8, which was identified by Woodman Environmental (2008c) as possibly representing the PEC, contributes three quadrats to this VU (GIND-50, GIND-72 and GINM-06). North of Mt Karara the vegetation is lower in the landscape and although not directly located on the BIF it is located on the outskirts of the range and the vegetation is influenced by this landform (KMLL01, KMLL02). The extent of VU 27 which comprises the PEC is 163.8ha. The two polygons of VU 27 which have been determined not to represent the PEC are located on the flats south-west of Mungada Ridge (KIOP 007), outside the BIF range and therefore these areas are not considered to represent the PEC.

VU 10 is not considered to represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1), despite one quadrat representing Karara–Mungada FCT 12, which was identified by Woodman Environmental (2008c) as possibly representing the PEC, being a component of this VU (GIND-25) (Table 15). This quadrat classified with quadrats representing VU 25 in the current analysis dendrogram (Appendix K); however, it was manually reassigned to VU 10 following review of the species composition and topography of the quadrat (Appendix P). It was determined that this quadrat was placed within transitional vegetation, and it was subsequently allocated to VU 10 based on the presence of taxa common to the VU, as well as being located lower in the landscape on a plain (as opposed to on lower slopes and mid slopes of BIF hills as for VU 25). Of the 30 other quadrats representing VU 10, 11 were also analysed as part of the Karara–Mungada Survey; nine of these also represented Karara–Mungada FCT 3, with one quadrat each representingFCTs 1b and 17. None of these FCTs were identified by Woodman Environmental (2008c) as possibly representing the PEC. Therefore, this is considered to be adequate justification for VU 10 not being considered a component of the PEC.

Similarly, VU 30 is not considered to represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1), despite one quadrat representing Karara–Mungada FCT 4 being a component of VU 30 (GIND-59) (Table 15). This quadrat was relatively species poor, containing only seven native perennial taxa, and classified on the outer fringe of the cluster of FCT 4 quadrats in the Karara–Mungada Survey analysis. With additional quadrat data added in the current analysis, the quadrat migrated to classify with quadrats representing VU 30. This VU contains quadrats representing Karara–Mungada FCT 16, which was not identified by Woodman Environmental (2008c) as possibly representing the PEC. This is considered to be adequate justification for VU 30 not being considered a component of the PEC.

One quadrat representing Karara–Mungada FCT 12 contributes to VU 29 (GIND-95) (Table 15). It is unclear why this quadrat migrated in the current analysis to group with the other quadrats comprising this VU; as discussed in Section 5.2.2.4, the quadrats representing this FCT were disrupted from their original cluster positions. However, this quadrat is not considered to

represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) as it does not contain BIF.

The Warriedar/Pinyalling/Walagnumming Hills vegetation assemblages (banded ironstone formation) PEC (P1) and Yalgoo (Gnows Nest/Wolla Wolla and Woolgah–Wadgingarra) vegetation assemblages (banded ironstone formation) PEC (P1) identified by Woodman Environmental (2012b) as potentially occurring within the Regional Mapping survey area are not considered to occur within the Study Area. While the Woodman Environmental (2012b) regional FCTs that were identified as potentially representing these PECs (regional FCTs 1, 10 and 28 for the Warriedar/Pinyalling/Walagnumming Hills vegetation assemblages (banded ironstone formation) PEC and regional FCTs 2 and 3 for the Yalgoo (Gnows Nest/Wolla Wolla and Woolgah–Wadgingarra) vegetation assemblages (banded ironstone formation) PEC) grouped with quadrats from the current survey in the analysis with the Regional Mapping dataset (Section 5.2.2.4), thus indicating that the quadrats from the current analysis are floristically similar to those that represent these two PECs, it is considered that the Study Area is located outside the geographical ranges of the PECs. For similar reasons, the Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) PEC (P1) identified in the desktop assessment as possibly occurring in the Desktop Study Area (Section 5.1.5) is not considered to occur within the Study Area.

None of the VUs mapped in the Study Area are considered to represent any listed TECs or any other listed PECs.

5.2.2.8 Other Significant Vegetation

It is considered that of the VUs mapped in the Study Area by the current survey, 18 are of potential local and/or regional significance for reasons other than formal listing, as per EPA (2016a) (Section 3.9.2). These are listed in Table 18 and presented on Figure 13.

Table 18: VUs of Potential Local and/or Regional Significance for Reasons other than Formal Listing

VU	Potential Significance for Reasons Other Than Formal Listing	
	Local Context	Regional Context
3	Y	
7	Y	Y
8	Y	Y
9	Y	Y
11	Y	Y
12	Y	Y
13	Y	
14	Y	
15	Y	Y
19	Y	Y
20	Y	
21	Y	
22	Y	Y
23	Y	Y
25	Y	
26	Y	
27	Y	
28	Y	-

All of the 18 VUs listed in Table 18 are considered to be significant vegetation in a local context due to their restricted occurrence in the Study Area; all have been mapped over a limited number of occurrences that constitute less than 1 % of the total area of the Study Area, or they have been mapped over less than 2 % of the total area of the Study Area and are associated with restricted landform types in line with one of the criteria that EPA determines the significance of the vegetation (EPA 2016a)) (Figure 13). Of these, VUs 7, 9, 11, 12 and 15 occur on restricted landforms comprised of drainage depressions, saline claypans or granite outcrops.

Of the locally significant VUs, nine VUs (VUs 7, 8, 9, 11, 12, 15, 19, 22 and 23) are also considered to be potentially significant vegetation in a regional context for reasons other than formal listing. This has been inferred from the results of the floristic analysis with the Regional Mapping dataset whereby quadrats from the current analysis showed similarity to those that represent regionally restricted regional FCTs. (Section 5.2.2.4 and 5.2.2.5).

Further to the above, VU 9 potentially represents an occurrence of a lignum swamp. This is based on the description of the vegetation of the Thundelarra Lignum Swamp in the Australian Wetlands Database Directory of Important Wetlands (DAWE 2019), located approximately 27 km northeast of the Study Area, and the LISW (Lignum swamp) habitat described by Payne et al. (1998). The Thundelarra Lignum Swamp supports a significant example of 'lignum-canegrass' community which occurs very sparsely from Carnarvon to Kalgoorlie. Inundation of the Thundelarra Lignum Swamp is very sporadic and is a significant breeding area for waterbird species (DAWE 2019).

The remaining 14 VUs mapped in the Study Area (VUs 1, 2, 4, 5, 6, 10, 16, 17, 18, 24, 29, 30, 31 and 32) are not considered to be significant vegetation in a local or regional context. A number of relatively large occurrences of each were mapped in the Study Area; they are therefore considered to be locally common and widespread. It is likely that they are all represented by numerous large occurrences in the region based on the results of the floristic analysis with the Regional Mapping dataset; quadrats within these VUs classified within large clusters with numerous quadrats from Woodman Environmental (2012b) that are located throughout the region, and these VUs showed similarity to regional FCTs that are not restricted in the Regional Mapping survey area.

It is considered that the VUs mapped in the Study Area do not meet any further criteria for significant vegetation as defined by EPA (2016a).

5.2.2.9 Wetlands, Groundwater and Surface Water Dependent Vegetation

Riparian vegetation is defined as plant habitats and communities occurring in association with watercourses, both ephemeral and permanent. Four VUs and one other described area ('playa lake claypan') mapped in the Study Area contain riparian vegetation, or otherwise are associated with ephemeral wetlands:

- VU 7: mapped on an ephemeral claypan. A total of 106 ha (comprising 0.5 % of the total area of the Study Area) was mapped in the Study Area;
- VU 9: mapped in an ephemeral drainage depression/swamp. A total of 44 ha (comprising 0.2 % of the total area of the Study Area) was mapped in the Study Area;
- VU 11: mapped in an ephemeral drainage depression/claypan. A total of 5 ha (comprising 0.03 % of the total area of the Study Area) was mapped in the Study Area;
- VU 12: mapped in an ephemeral drainage depression/wetland. A total of 171 ha (comprising 0.8 % of the total area of the Study Area) was mapped in the Study Area; and
- Ephemeral playa lake claypan mapped north of Mungada Ridge. A total of 6 ha (comprising 0.03 % of the total area of the Study Area) was mapped.

It is unlikely that any of the VUs mapped in the Study Area are groundwater dependent. VUs 7, 9, and 12 are predominately associated with drainage depressions, swamps and claypans, and possess dominant species including *Melaleuca acutifolia*, *Melaleuca eleuterostachya*, *Duma florulenta*, *Teucrium racemosum* and *Tecticornia disarticulata*, all of which are known to inhabit drainage flats, claypans, salt pans and other wet areas (DBCA 2007–) and are tolerant of at least periodic waterlogging (Brophy *et al.* 2013; Craig *et al.* 1991; Toelken 1985). However, the claypan substrates associated with these VUs may not allow for root penetration to groundwater, and at present the depth to groundwater in these areas is unknown. Further, at current there is no literature available on the groundwater dependency of these taxa. While it is doubtful these taxa are phreatophytes, they are certainly at least surface water dependent.

VUs 1, 2, 4, 5, 6, 8, 11, 13 and 14 are likely to at least be dependent on surface water in the form of sheet flow originating from higher ground (e.g. Mungada Ridge) during periodic heavy rainfall events. These VUs are located on flats and plains between areas of higher relief, and therefore form the main depository for rainfall in the local area. These areas also form the floodway for 1 in 100 year flooding events. It is unlikely that these areas are groundwater dependent based on species composition; however, further information on depth to groundwater and the groundwater-dependency of the taxa present in these VUs would be required to confirm this.

Based on species composition and the lack of potential phreatophytic taxa, it is unlikely that VUs occurring on BIF areas with substantial rock-based substrate and those occurring on areas where depth to groundwater is > 10–20 m would be groundwater dependent. Therefore, the vegetation of these VUs would be reliant upon sufficient surface water for survival.

5.2.2.10 Vegetation Condition

Excluding the areas mapped as 'Cleared Land' and 'Rehabilitated Areas', the majority of the vegetation of the Study Area (99.64 %) was considered to be in 'Excellent' condition (EPA 2016b; Appendix A). Introduced flora taxa were often present, however were not serious weeds and/or were present at low levels. Historical disturbance from mining and exploration activities (for example drill lines) and historical grazing (evidence of use of the area as pastoral station) was present in many areas, and there was historical and current evidence of kangaroo, rabbit, goat and cattle activity throughout the Study Area (Appendix H). Although the vegetation condition within some individual quadrats was determined to be 'Pristine', in the wider context of the Study Area the overall vegetation condition has been ranked 'Excellent'.

The vegetation condition of one small area of VU 17 in the far western extent of the Study Area was mapped as 'Good'; this area displayed evidence of historic disturbance and grazing. This has led to reduced diversity and abundance of native taxa and high levels of weeds, particularly **Pentameris airoides* subsp. *airoides*, **Aira caryophyllea* and **Echium plantagineum*. This area constitutes a total of 68 ha (comprising 0.36 % of the total area of the Study Area).

As mentioned in Section 5.2.2.3, there are many exploration drill lines in the Study Area. These lines have been mapped as the same condition as their surrounding VU, as their small size and dynamic state of use prevents them from being assessed in detail in a vegetation condition context.

Note that areas mapped as 'Cleared Land' and 'Rehabilitated Areas' were not allocated condition scores, as they do not constitute vegetation in the context of the condition scale used by this survey (EPA 2016b; Appendix A) These areas constitute a total of 1,571 ha (comprising 7.7 % of the total area of the Study Area).

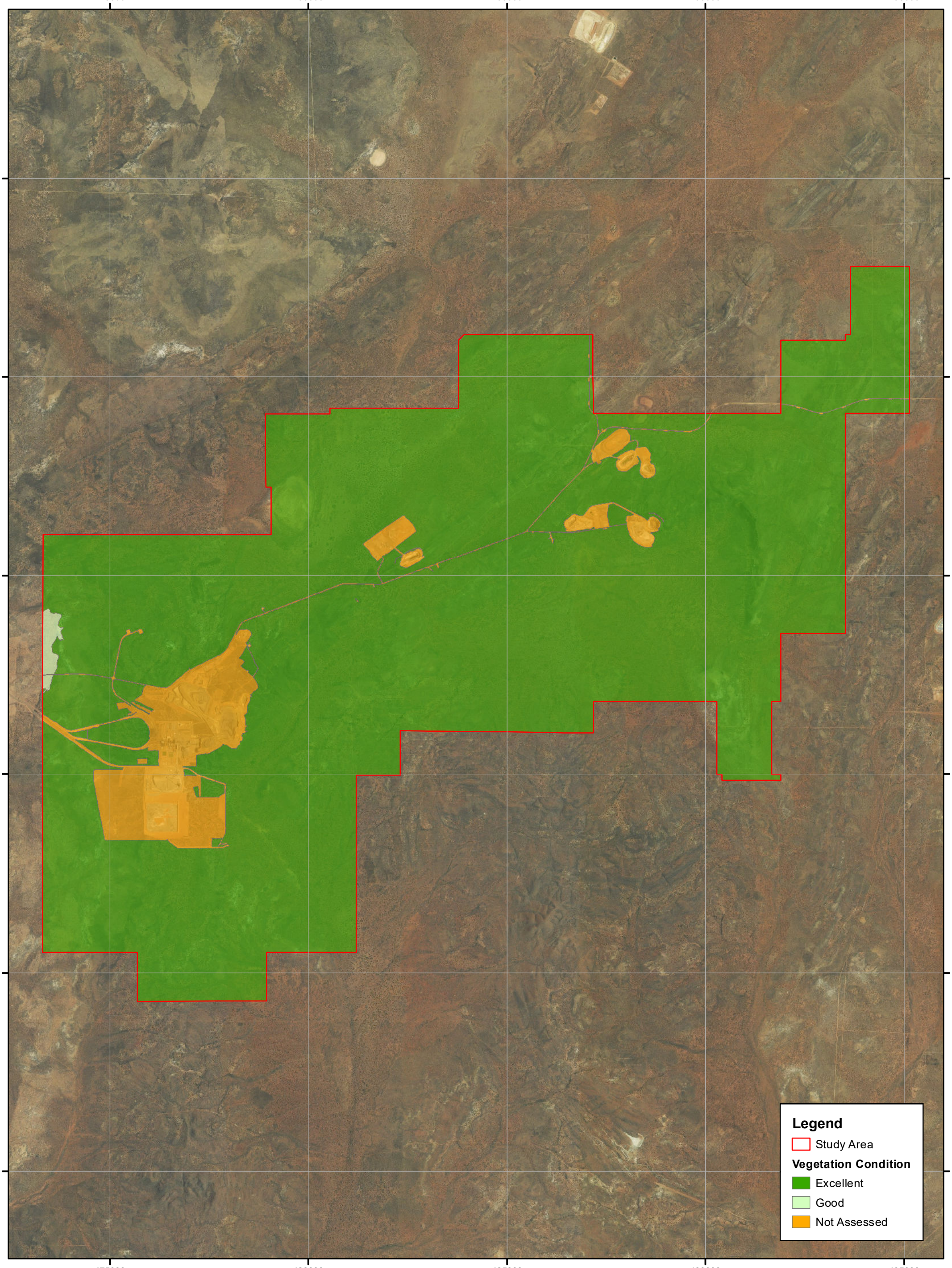
Extents of each vegetation condition category mapped in the Study Area are presented in Table 19. Figure 14 presents an overview of vegetation condition throughout the Study Area.

Table 19: Extents of Vegetation Condition Rankings Mapped in the Study Area

Condition Ranking	Area Mapped (ha)	Proportion of Study Area (%)
Pristine	0	0
Excellent	18,833	92
Very Good	0	0
Good	68	0.3
Degraded	0	0
Completely Degraded	0	0
NA	1,571	7.7

475000 480000 485000 490000 495000

6785000 6780000 6775000 6770000 6765000 6760000



475000 480000 485000 490000 495000

umwelt

This map should only be used in conjunction with WEC report KML20-33-01.

N

Overview of Vegetation Condition of the Study Area

Author: Marlee Starcevich

WEC Ref: KML20-33-01

Filename: KML20-33-01-f14

Revision: A - 30 August 2021 Scale: 1:85,000

Projection: GDA 1994 MGA Zone 50

Figure

14

6. DISCUSSION AND CONCLUSIONS

6.1 Flora of the Study Area

The Study Area is considered to have high diversity in terms of taxon richness, with 526 discrete vascular flora taxa, one known hybrid and three putative hybrids recorded in the Study Area during the current 2020 survey and relevant previous surveys within the Study Area. This was generally expected, as both the greenstone and BIF hills within and in the vicinity of the Study Area are known to contain relatively diverse floras; however, these floras are relatively dissimilar to each other (Meissner and Coppen 2014). The Study Area also contains valleys and plains with deeper soils, which contributed further taxa to the overall total. The taxon total from the current survey and relevant previous surveys compares favourably to that recorded by the Markey and Dillon (2008) study (414 discrete taxa and 4 putative hybrids) and the Meissner and Coppen (2014) study (286 discrete taxa); however these studies focused only on the vegetation of BIF and greenstone ranges, respectively, of the Yilgarn Craton. The total taxa recorded the current and previous relevant surveys also compares favourably to that recorded by the Regional Mapping Survey (640 discrete taxa, 2 hybrids and 14 putative hybrids), despite this survey being conducted over a much larger geographical area (Figure 7) and is slightly greater than the total number of taxa recorded by the Karara–Mungada Survey (514 discrete taxa).

Although further taxa may be present in the Study Area, it is considered that the Study Area has been well sampled; this is supported by the adequacy of survey measures presented in Section 4.1. Comparison of the quadrat taxon richness from the current survey and relevant previous surveys (416 native taxa) to the estimate made by the Chao-2 estimator (482 native taxa) indicates that the Study Area was well-sampled. This was supported by the result of the Mueller-Dombois and Ellenberg adequacy measure, whereby a final taxon increase value of 2.10 % was recorded following a 10 % increase in quadrats assessed.

The current 2020 survey was conducted in the most appropriate time for survey (late winter to early spring). Despite below-average rainfall being received in the months prior to the current survey, it is considered to have been a relatively good flowering season. This is reflected in the relatively high number of ephemeral taxa recorded (190 ephemeral taxa), which compares favourably to that recorded by the Markey and Dillon survey (180 ephemeral taxa) and the Meissner and Coppen survey (137 ephemeral taxa).

The number of significant flora taxa recorded in the Study Area was also considered to be high. A total of 27 taxa known to occur in the Study Area are considered to be significant, including:

- Two Threatened taxa (*Acacia woodmaniorum* being listed as Endangered under the EPBC Act and as Threatened (Endangered) under the BC Act, and *Stylidium scintillans* being listed as Threatened (Vulnerable) under the BC Act),
- 23 DBCA-classified Priority flora taxa, and
- Two taxa considered significant for other reasons (as per EPA 2016a).

The large number of significant flora taxa was expected given the high levels of endemism of flora taxa on the greenstone and banded ironstone hills in the vicinity of the Study Area (Markey and Dillon 2008; Meissner and Coppen 2014), which has resulted in many taxa being listed as significant. Indeed, the BIF vegetation communities sampled within the Study Area (VUs 19, 20, 21, 22, 24, 25, 26 and 28) represent preferred habitat for 15 of the 27 significant flora taxa known to occur in the Study Area.

The two taxa considered to be significant for other reasons, *Swainsona* sp. Karara (C. Godden & J. Hruban 24-26) (undescribed) and *Crassula* sp. nov. (potentially undescribed), require further investigation by relevant experts to determine their taxonomic status, which in turn will allow for their conservation significance to be appropriately assessed. These taxa are considered significant in the interim.

Given the comprehensive survey undertaken in the Footprint for the current survey, it is considered that sufficient survey for 23 of the 27 significant flora taxa now known to occur in the Study Area has been conducted to inform an assessment of impacts of the Project, with the exceptions being *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1), *Crassula* sp. nov. (potentially undescribed), *Hibbertia cockertoniana* (P3) and *Swainsona* sp. Karara (C. Godden & J. Hruban 24-26) (undescribed). These taxa were not expected to occur in the Study Area and /or were not identified as significant until after the current survey. Of these four taxa, *Caesia* sp. Koolanooka Hills (R. Meissner & Y. Caruso 78) (P1) and *Crassula* sp. nov. (potentially undescribed) were recorded in the Footprint and *Swainsona* sp. Karara (C. Godden & J. Hruban 24-26) (undescribed)) and *Hibbertia cockertoniana* (P3) were not recorded in the Footprint; however, the distribution and abundance in the Footprint and in the wider Study Area for each of these four taxa remain to be clarified.

The likelihood of occurrence assessment indicated that 16 Priority flora taxa and one Threatened taxon identified in the desktop assessment could potentially still occur in the Study Area, despite being identifiable at the time of this and previous surveys. This is based on suitable habitat occurring or potentially occurring in the Study Area and Footprint, and the Study Area and Footprint being within the known range of the taxon or generally within close proximity. However, the fact that these taxa have not been recorded despite a history of relatively intensive surveys having been conducted within the Study Area reduces the probability of occurrence. It is considered unlikely that any additional significant flora taxa identified in the desktop assessment are present within the Footprint, for similar reasons.

A total of 32 introduced flora taxa were recorded in the Study Area during the current 2020 survey and relevant previous surveys within the Study Area, including the Declared Pests *Echium plantagineum* (Paterson's Curse) and *Galium aparine* (Goosegrass). Introduced taxa were generally most abundant around areas associated with historical disturbance and grazing or in areas that experience periodic inundation; however, no serious infestations were recorded, and it is unlikely that introduced taxa will cause significant impacts to native vegetation in the Study Area.

6.2 Vegetation of the Study Area

A total of 32 VUs were defined and mapped in the Study Area. This number was expected, given the variety of geologies and topographies in the Study Area, coupled with the differing floras on the predominant geological and topographical units (ironstone and granite). The number of VUs occurring in the Study Area also compares favourably with the Karara–Mungada Survey (23 Karara–Mungada FCTs mapped over a portion of the Study Area) and the Regional Mapping Survey (37 regional FCTs and one additional plant community mapped over a larger survey area, of which the Study Area forms a component; refer to Figure 7).

A comparison of the 23 FCTs defined by the Karara–Mungada Survey with the VUs defined by the current analysis aligned 15 VUs with Karara–Mungada FCTs relatively conclusively. Four VUs were not represented by any quadrats that comprised FCTs; three of these VUs were mapped outside the area assessed by the Karara–Mungada Survey, while one VU was mapped from a quadrat established for the current survey.

Floristic analysis was undertaken to determine relationships between VUs defined by the current analysis with FCTs described by the Regional Mapping Survey. However, with the addition of quadrat data from the current survey to the Regional Mapping Survey dataset, there was significant migration of quadrats from their original cluster positions. Nevertheless, some similarities between VUs from the current analysis and regional FCTs could be gleaned; eight VUs were considered representative of regional FCTs, 22 VUs show similarity to at least one or two regional FCTs (and generally also show similarity to a number of other regional FCTs), while the remaining two VUs had limited similarity to any one or two regional FCTs.

The Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) is considered to occur in the Study Area. It is considered that some or all mapped polygons of VUs 16, 19, 20, 21, 22, 24, 25, 26, 27 and 28 represent this PEC in the Study Area. These VUs occur on BIF crests and associated slopes that are higher in the landscape on restricted landforms, which primarily encompasses the crests and upper to lower slopes and some outskirts of Mount Karara, Blue Hills and Mungada Ridge in the central area of the Study Area). This was determined following comparison of VUs to Karara–Mungada Survey FCTs, with the above VUs being primarily composed of quadrats that also represent the Karara–Mungada FCTs identified by Woodman Environmental (2008c) as possibly representing the PEC. As the PEC mapping produced by the Karara–Mungada Survey has been previously agreed with DBCA, this was considered an appropriate way of mapping the PEC from VUs defined by the current analysis. A total of 2,085.7ha (comprising 10.2 % of the total area of the Study Area) of the PEC was mapped by the current survey. Of this, 93.5 ha occurs within the Footprint (comprising 10.1 % of the total area of the Footprint). None of the VUs mapped in the Study Area are considered to represent any listed TECs or any other listed PECs.

It should be noted that only one mapped occurrence of VU 16 and nine of 11 mapped occurrences of VU 27 are considered to possibly represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1). All other quadrats from VUs 16 and 27 are not considered to represent the PEC, as they do not contain BIF, and are not influenced by the BIF landform.

VUs 10, 29 and 30 were not considered to represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) despite a small number of quadrats representing Karara–Mungada FCTs that were identified as possibly representing the PEC being components of the VU. These quadrats were determined to have been placed in transitional vegetation or were species poor, resulting in their migration in the current analysis from their original cluster positions in the Karara–Mungada Survey analysis. The current analysis indicated that these quadrats were floristically similar to other quadrats in the Study Area that are components of Karara–Mungada FCTs, which were not identified as possibly representing the PEC. Furthermore, they were typically located lower in the landscape and did not contain BIF or taxa indicative of BIF. This justifies that these VUs are not a component of the PEC.

Several VUs are considered to potentially represent significant vegetation, in both a local and regional context. VUs 3, 7, 8, 9, 11, 12, 13, 14, 15, 19, 20, 21, 22, 23, 25, 26, 27 and 28 are considered to be significant vegetation in a local context due to their restricted occurrences in the Study Area. All have been mapped over a limited number of occurrences that constitute less than 1 % of the total area of the Study Area, or they have been mapped over less than 2 % of the total area of the Study Area and are associated with restricted landform types. Of these, VUs 7, 9, 11, 12 and 15 occur on restricted landforms, being drainage depressions, saline claypans or granite outcrops.

As discussed above, VUs considered to possibly represent the Blue Hills (Mount Karara/Mungada Ridge/Blue Hills) vegetation complexes (banded ironstone formation) PEC (P1) are considered to be potentially significant in a regional context. In addition, analysis with the Regional Mapping Survey dataset identified VUs 7, 8, 9, 11, 12, 15, 19, 22, 23 and 28 are potentially also significant in a regional context as these VUs show similarity to regional FCTs that are restricted in the region (mapped over < 1 % of the Regional Mapping survey area) or are otherwise associated with landforms and soil types which are restricted in the region (such as VU 9).

Further to the above, VU 9 was identified as potentially representing an occurrence of a lignum swamp. This is based on the description of the vegetation of the Thundelarra Lignum Swamp in the Australian Wetlands Database Directory of Important Wetlands (DAWE 2019), located approximately 27 km northeast of the Study Area, and the LISW (Lignum swamp) habitat described by Payne *et al.* (1998). The Thundelarra Lignum Swamp supports a significant example of 'lignum-canegrass' community which occurs very sparsely from Carnarvon to Kalgoorlie.

VUs 7, 9, 11 and 12 and one additional area mapped in the Study Area ('playa lake claypan') contain riparian vegetation associated with ephemeral wetlands, claypans or drainage depressions. It is unlikely that any of the VUs mapped in the Study Area are groundwater dependent; however, information on the groundwater dependency of taxa recorded in the Study Area as well as depth to groundwater information is required to confirm this.

The majority of the vegetation in the Study Area (92.0 % of the Study Area; 99.64% of the vegetation of the Study Area) was considered to be in 'Excellent' condition. Introduced flora

taxa were often present, however they were not serious weeds and/or were present at low levels. Historical disturbance from mining and exploration activities and historical and current grazing was present in many areas, although this has generally had little affect on the overall condition of the vegetation. One small area of VU 17 in the far western extent of the Study Area was mapped as 'Good'; this area displayed evidence of historic disturbance and grazing, leading to reduced diversity and abundance of native taxa and high levels of weeds. This area constitutes a total of 68 ha (comprising 0.36 % of the total area of the Study Area).

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