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SKA-Low Boolardy Airstrip Upgrade
Native Vegetation Clearing Permit
Supporting Document

Prepared For:	CSIRO
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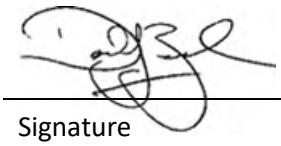
Reviewed by:	Paul Zuvela Principal Environmental Scientist		18 September 2024
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1 INTRODUCTION

1.1 PROJECT BACKGROUND

The Square Kilometre Array (SKA) is a landmark international radio project (the Project) which aims to construct the world's most powerful radio astronomy observatory. The Project consists of two radio astronomy observatories, the SKA1-Low hosted in Australia and the SKA-Mid in South Africa. The Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) is managing the development of the SKA-Low, which is currently in the construction phase. The final SKA-Low observatory will consist of an array of over 130,000 antennas grouped into 512 stations arranged into spiral arms 65 kilometres (km) across.

The SKA-1 Low Frequency Aperture Array (SKA1-Low) is located on Ilyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory (MRO) in Murchison Western Australia (WA), approximately 270 km northeast of Geraldton (Figure 1). The Observatory overlies the ex-pastoral Boolardy Station.

Upgrades to the existing airstrip at the Boolardy Aerodrome are necessary to support the SKA1-Low. The proposed airstrip upgrades will involve clearing of up to 44.16 hectares (ha) of native vegetation.

1.2 PROJECT AREA

Ilyarrimanha Ilgari Bundara or the CSIRO MRO has an area of 343,308 ha and is located approximately 222 km inland of northeast of Kalbarri and 130 km west of Meekatharra. The MRO lease is on Lot 18 on Deposited Plan 220344 and is held by CSIRO. It lies within the Western Murchison (MUR02) sub-region of the Murchison Interim Biogeographic Regionalisation of Australia (IBRA) region, which has a total area of 6,985,517 ha (Department of Climate Change, Energy, the Environment and Water [DCCEEW], 2020). A majority of this region, including the MRO lease, is within the Wajarri Yamatji Native Title Determination Area (Landgate, 2024).

The Boolardy Aerodrome, where upgrades to the existing airstrip are proposed, is located in the southwest of the MRO, at the eastern end of the Boolardy Station Access Road, which intersects with Beringarra-Pindar Road (Figure 1). Beringarra-Pindar Road runs southwest to northeast bisecting the MRO site and provides access to other aspects of the SKA1-Low.

1.3 SCOPE OF WORKS

Aurora Environmental Pty Ltd (Aurora) has been commissioned by the CSIRO to prepare this Native Vegetation Clearing Permit (NVCP) application for the proposed Boolardy Aerodrome upgrade.

A reconnaissance flora and vegetation and basic fauna assessment was undertaken by Umwelt (Australia) Pty Ltd (Umwelt, 2024) on behalf of Aurora in September 2023. The assessment was completed within a 61.68 ha survey area, which included approximately 17.52 ha of cleared land (the existing airstrip and associated structures). The findings of the assessment have been used to support this application and are discussed further in Section 2.3.

1.4 LEGISLATIVE AND REGULATORY CONTEXT

Aurora Environmental conduct survey and environmental impact assessments in accordance with relevant legislation, guidelines and other regulatory/statutory elements. A summary of these is provided in Table A.

For assessments of applications for NVCPs, Section 51 and Schedule 5 of the *Environmental Protection Act 1986* (EP Act) and *A Guide to the Assessment of Applications to Clear Native Vegetation Under Part V of the Environmental Protection Act 1986* (Department of Environment and Regulation [DER], 2014) are the most relevant. CSIRO is a Commonwealth agency, and as such, the *Significant Impact Guidelines 1.2* (DSEWPaC, 2013) require consideration to determine if the proposed clearing requires referral to the DCCEEW for assessment under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

TABLE A: LEGISLATION AND GUIDANCES

ITEM	DESCRIPTION
FEDERAL	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act is the principal environmental legislation of the Commonwealth of Australia. It exists to provide an additional level of protection for matters of national environmental significance (MNES) as well as assessing the environmental impacts of Commonwealth agencies.
Significant impact guidelines 1.1: Matters of National Environmental Significance (Department of the Environment [DotE], 2013)	The significant impact guidelines provide project proponents a framework to assess whether their actions may constitute a significant impact on MNES that would require assessment by the DCCEEW.
Significant impact guidelines 1.2: Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth Agencies (DSEWPaC, 2013)	These guidelines apply to any person who proposes to take action on land which is either situated on Commonwealth land or which may impact on Commonwealth land, and/or representatives of Commonwealth agencies who propose to take an action on the environment anywhere in the world. These Guidelines are to assist proponents in either of these categories to determine whether there are grounds for referral to DCCEEW for assessment.
Weeds of National Significance (Centre for Invasive Species Solutions, 2021)	There are 32 Weeds of National Significance (WoNS) that have been selected based on their capacity for substantial ecological impacts.
STATE	
Environmental Protection Act 1986 (EP Act)	The EP Act is an Act to provide for an Environmental Protection Authority (EPA), for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing. Part V, Division 2 relates to the clearing of native vegetation, with the Principles for Clearing Native Vegetation contained in Schedule 5.
Environmental Protection Act 1986 (EP Act) – Part V Clearing Regulations	The clearing regulations provide information on the types and scale of clearing of native vegetation for which a native vegetation clearing permit will not be required.

ITEM	DESCRIPTION
Biodiversity Conservation Act 2016 (BC Act)	The BC Act provides for the conservation and protection of biodiversity and biodiversity components in WA; and the ecologically sustainable use of biodiversity components in WA, and the repeal of the *Wildlife Conservation Act 1950* and the *Sandalwood Act 1929*; and consequential amendments to other Acts, and for related purposes. In the context of the clearing principles, of particular relevance are threatened species and communities, which are protected specifically under provision of this Act, in addition to the protections afforded by the EP Act.
Biosecurity and Agriculture Management Act 2007 (BAM Act) and *Biosecurity and Agriculture Management Regulations 2013* (BAM Regulations)	The BAM Act is an Act to provide for the control of certain organisms; and the use of agricultural and veterinary chemicals; and the identification and attainment of standards of quality and safety for agricultural products, animal feeds, fertilisers and other substances and things; and the establishment of a Declared Pest Account, a Modified Penalties Revenue Account and accounts for industry funding schemes; and related matters. In the context of environmental impact assessment as they pertain to NVCPs, the key relevance of the BAM Act is Section 22, which provides for assigning the class Declared Pest to an organism. Methods of control that apply to Declared Pests are detailed in Regulation 7 of the BAM Regulations.
Environmental Factor Guideline: Flora and Vegetation (EPA, 2016a)	This guideline relates to the environmental factor Flora and Vegetation, with the objective of protecting flora and vegetation so that biological diversity and ecological integrity are maintained. This guideline states how flora and vegetation are considered by the EPA in the environmental impact assessment process.
Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b)	This guidance provides broad instructions for ecologists and botanists undertaking surveys for environmental impact assessments, with the objective of ensuring that there is consistency across the industry and that data is collected in a methodological manner.
Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016c)	This guideline relates to the environmental factor Terrestrial Fauna, with the objective of protecting terrestrial fauna so that biological diversity and ecological integrity are maintained. This guideline states how terrestrial fauna are considered by the EPA in the environmental impact assessment process.
Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020)	This guidance provides broad instructions for ecologists and zoologist undertaking surveys for environmental impact assessments, with the objective of ensuring that there is consistency across the industry and that data is collected in a methodological manner.
Environmental Factor Guideline: Inland Waters (EPA, 2018)	This guideline defines what the EPA considers inland waters to be when assessing impacts to the environment. In the context of the applications to clear native vegetation, this information can be used to guide assessments of potential impacts to vegetation growing in association with a watercourse and local hydrological processes.

ITEM	DESCRIPTION
A guide to the assessment of applications to clear native vegetation Under Part V of the Environmental Protection Act 1986 (DER, 2014)	This guide has been developed to assist project proponents to assess proposed impacts to the environment in the context of Part V applications to clear native vegetation.

1.5 APPROVALS SUMMARY

1.5.1 EPBC Act

The SKA1-Low on Boolardy Station, Murchison WA was referred by CSIRO to the Department of the Environment and Energy (now the Department of Climate Change, Energy, the Environment and Water or DCCEEW) in 2017 under referral number EPBC 2017/7874. The project was determined to have no significant impact to MNES and was therefore deemed not a controlled action.

Approval Outcome: Not a controlled action.

1.5.2 EP Act – Part IV

The SKA1-Low was referred to the EPA under Section 38 of the EP Act in 2017. The project was considered not to be assessed under Part IV of the EP Act and instead managed under Part V Division 2 (Clearing of native vegetation).

Approval Outcome: Not assessed.

1.5.3 EP Act Part V Clearing Regulations

Four NVCPs have been applied for and granted under Part V Division 2 of the EP Act by CSIRO for the SKA1-Low on Boolardy Station, including the following:

- CPS 7562/2 – Granted 17/03/2018;
- CPS 9547/2 – Granted 09/01/2023;
- CPS 10114/2 – Granted 24/07/2023; and
- CPS 10329/1 – Granted 22/07/2024.

These account for an approved total clearing area of 780.7 ha, or 0.23%, of the 343,308.2 ha within Boolardy Station.

1.6 KEY DEFINITIONS

To guide the assessment of significant values for flora, fauna and vegetation, the EPA provide broad definitions in the Environmental Factor Guideline: Flora and Vegetation (EPA, 2016a) and the Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016c). A summary of these is provided in Table B.

TABLE B: DEFINITIONS OF SIGNIFICANT FLORA, FAUNA AND VEGETATION (EPA, 2016A; 2016C)

TERM	EXPLANATION
Significant flora (EPA, 2016a)	• Being identified as a threatened or priority species. • Locally endemic or associated with a restricted habitat type (e.g., surface water or groundwater dependent ecosystems). • New species or 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 main range). • Unusual species, including restricted subspecies, varieties or naturally occurring hybrids. • Relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.
Significant fauna (EPA, 2016c)	• Being identified as a threatened or priority species. • Species with restricted distribution. • Degree of historical impact from threatening processes. • Providing an important function required to maintain the integrity of a significant ecosystem.
Significant vegetation (EPA, 2016a)	• Being identified as threatened or priority ecological communities. • Restricted distribution. • Degree of historical impact from threatening processes. • A role as a refuge. • Providing an important function required to maintain ecological integrity of a significant ecosystem.

2 ENVIRONMENTAL CONTEXT

2.1 PHYSICAL ENVIRONMENT

2.1.1 IBRA Sub-region

The application area is within the Western Murchison (MUR2) sub-region of the Murchison bioregion of the IBRA (DCCEEW, 2020). This sub-region covers an area of 7,847,966 ha and has an arid climate with bimodal rainfall, with most rain falling in winter (Desmond, Cowan and Chant, 2001). Vegetation is comprised of mulga low woodlands, often rich in ephemerals that occurs on outcrop and fine-textured Quaternary alluvial and eluvial surfaces; this vegetation type on extensive hardpans dominates and characterise the sub-region. Surfaces with occluded drainage occur throughout the sub-region, with hummock grasses on sandplains, saltbush on calcareous soils and *Halosarcia* (*Tecticornia*) low shrublands on saline alluvials (Desmond, Cowan and Chant, 2001). The Murchison and Wooramel Rivers are key surface hydrological features, draining through the sub-region westwards to the coast (Desmond, Cowan and Chant, 2001). The primary land use in the sub-region is associated with pastoral activities, accounting for over 96% of the land, with limited land in conservation reserves (Desmond, Cowan and Chant, 2001)

2.1.2 Land Systems

The application area is entirely within the Yanganoo soil landscape system, which has a total area of 20,545 ha. The Yanganoo soil landscape system is described as “Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting mulga shrublands and wanderrie grasses on banks” (Department of Primary Industries and Regional Development [DPIRD], 2022). To the immediate north of the application area, the soil landscape system is Beringarra soil landscape system, which is characterised as “Riverine plains with floodplains and channels, supporting halophytic shrublands, mixed Acacia shrublands and low woodlands with minor perennial grasses” (DPIRD, 2022).

2.1.3 Surface Geology

The application area intersects two surface geology units, with the majority area of the application area being colluvium and/or residual deposits (Raymond et al., 2012). Channel and floodplain alluvium is also present along ephemeral drainage lines to the north and within the southern corner of the application area. Surface geology units identified are further detailed in Table C.

TABLE C: 1:1 MILLION SURFACE GEOLOGY (RAYMOND ET AL., 2012)

MAP SYMBOL	NAME	DESCRIPTION	EXTENT IN APPLICATION AREA
Qrc	Colluvium 38491	Colluvium and/or residual deposits, sheetwash, talus, scree; boulder, gravel, sand; may include minor alluvial or sand plain deposits, local calcrete and reworked laterite.	61.68 ha
Qa	Alluvium 38485	Channel and flood plain alluvium; gravel, sand, silt, clay; may be locally calcreted.	0.4 km north of the Development Envelope

2.1.4 Soils

The application area is entirely within the Mz23 soil type classification area, as described in Table D. This soil type is well represented within the Western Murchison IBRA sub-region, with a total area of approximately 2.5 million ha (Bureau of Rural Sciences, 2009).

TABLE D: SOIL UNITS - AREA ATLAS OF AUSTRALIAN SOILS (BUREAU OF RURAL SCIENCES, 2009)

MAP SYMBOL	DESCRIPTION	EXTENT IN APPLICATION AREA
Mz23	Extensive flat and gently sloping plains with a scatter of surface gravels, similar in topography to unit My5O: chief soils are shallow acid red earths (Gn2.11) and shallow earthy loams (Um5.3) often occurring in intimate micro-association. Red-brown hardpan occasionally outcrops and is normally present within a depth of 30 inches. As mapped, soils of units Oc47 and My5O may be included.	61.68 ha

2.1.5 Inland Waters

Surface water features surrounding the application area (Figure 2) are characterised by non-perennial lakes and floodplains or 'Land Subject to Inundation' (Crossman and Li, 2015). The application area is within the Roderick River sub-catchment, which is part of the greater Murchison River catchment (Department of Water and Environmental Regulation [DWER], 2024a). Roderick River, a minor creek line approximately 2.7 km northwest of the application area, flows towards Wooleen Lake, a listed wetland under the Directory of Important Wetlands (DIWA) (Department of Biodiversity, Conservation and Attractions [DBCA], 2018). Wooleen Lake located 26 km west of the Boolardy Airstrip and the closest significant water body to the application area, consists of a collection of hardpans that, on average, receive water once every four years and fill once every ten (Shire of Murchison, 2024). The lake has cultural significance to the Wajarri Yamatji people and is a registered Aboriginal Cultural Heritage Site (Shire of Murchison, 2024; Department of Planning, Lands and Heritage [DPLH], 2024a). No Ramsar wetlands or Public Drinking Water Source Areas (PDWSAs) have been identified within 100 km of the airstrip (DotE, 2015; DWER, 2024b).

2.2 CONSERVATION AND CULTURAL AREAS

2.2.1 Conservation Reserves

The proximity of the application area to conservation reserves was assessed against the DBCA Legislated Lands and Waters dataset (DBCA-11) (DBCA, 2024) and the Collaborative Australian Protected Areas Database (CAPAD) (DCCEEW, 2022). The application area is 62 km southeast of Muggon National Park and approximately 70 km north of the Narloo reserve area.

2.2.2 Aboriginal Heritage

A database search of lodged, registered and historic aboriginal cultural heritage sites was conducted (Figure 3) and identified several sites near the development envelope (DPLH, 2024a; 2024b; 2024c). These included one historic site, 13 lodged sites and 52 registered sites. Sites within 20 km of the application area have been listed in Table E.

TABLE E: ABORIGINAL HERITAGE SITES

ID	STATUS	NAME	TYPE	DISTANCE (km)
39548	Lodged	Assigned site identifier: CSIRO-20-090	Artefacts/Scatter; Modified Tree	1.14
39560	Registered	CSIRO-20-091	Modified Tree	1.23

ID	STATUS	NAME	TYPE	DISTANCE (km)
39547	Lodged	Assigned site identifier: CSIRO-20-089	Artefacts/Scatter	1.36
37098	Historic	Boolardy West 2017/01	Artefacts/Scatter	2.27
39546	Registered	CSIRO-20-063	Artefacts/Scatter	4.00
39531	Registered	CSIRO-19-034	Artefacts/Scatter	12.74
39528	Registered	Boolardy Pool (HEA-05)	Camp; Landscape/Seascape Feature	15.08
39530	Registered	CSIRO-19-028	Artefacts/Scatter	15.55
39520	Registered	CSIRO-19-006	Artefacts/Scatter	15.92
39521	Registered	CSIRO-19-010	Artefacts/Scatter	16.57
39549	Registered	CSIRO-21-002	Artefacts/Scatter; Modified Tree	17.32
39525	Registered	Claypan HEA-04	Camp; Landscape/Seascape Feature	18.59
39552	Registered	CSIRO-21-003	Artefacts/Scatter	18.67
39522	Registered	CSIRO-19-043	Artefacts/Scatter	18.81

2.3 BIOLOGICAL VALUES

Umwelt (2024; Appendix A) conducted a reconnaissance level flora and vegetation survey, as defined in EPA (2016c), and a basic fauna assessment as defined in EPA (2020), over a survey area of 61.68 ha, inclusive of the existing airstrip and associated infrastructure. The survey was conducted over two days in September 2023 and involved assessments of flora and vegetation at seven relevès and fauna assessments at six points, plus the use of five motion sensing cameras and three acoustic recordings (Umwelt, 2024). The survey effort was considered adequate to assess the ecological values of the survey area. It was noted that rainfall received in the months preceding the survey was below the long-term average, and this may have affected the presence of some ephemeral and annual flora taxa and potentially the presence of some fauna species (Umwelt, 2024).

2.3.1 Vegetation

Umwelt (2024) defined one vegetation type (VT) within the application – a low open woodland of *Acacia* spp., which is considered consistent with both soil landscape mapping (Refer Section 2.1.2 and pre-European vegetation (refer Section 2.3.2).

The vegetation within the survey area was also considered comparable to and consistent with the vegetation defined and delineated in other flora and vegetation surveys conducted for the SKA project (Umwelt, 2024).

2.3.1.1 Significant Vegetation

The VT within the survey area was not considered to be representative of any known Threatened Ecological Community (TEC) or a Priority Ecological Community (PEC), nor was it considered to align with any other categories of significance (Umwelt, 2024). In addition to this, there are no records of any TECs close to the survey area, with the nearest recorded occurrence approximately 168 km southwest (DBCA, 2024).

There were records of four PECs in the desktop study area in Umwelt (2024), two of which were associated with calcrete and paleodrainage (the Meka PEC and the Meeberrie PEC) or banded ironstone formations (the New Forest PEC and the Mount Dugel/Mount Nairn PEC). Neither calcrete or banded ironstone were present in the application area when surveyed.

Umwelt (2024) noted that the VT in the application area was not habitat for the majority of conservation-dependent significant flora in the area, nor was it associated with a watercourse, restricted landform or any other feature that may confer a level of significance.

2.3.1.2 Vegetation Condition

Vegetation condition was assessed and mapped in the survey area by Umwelt (2024), with the majority being assessed as 'Very Good' condition (34.69 ha, 56.24 % of the survey area). The northern portion of the survey area was assessed as Good condition (7.73 ha, 12.53 %) and 'Poor' (1.74 ha, 2.82 %). The existing airstrip and tracks do not have any vegetation. Vegetation within the survey area was noted as being affected by historic land use associated with pastoral activities, as well as clearing for roads, tracks, laydown areas and infrastructure.

2.3.2 Pre-European Vegetation

An assessment of statewide pre-European vegetation mapping (DPIRD, 2019) was conducted to identify vegetation system associations (VSAs) within and adjacent to the application area. The entirety of the application area is within the Upper Murchison 29 VSA, which is described as "Sparse low woodland; mulga, discontinuous in scattered groups" (Shepherd et al., 2002).

The VSA Upper Murchison_204 lies to the north of the application area but will not be impacted by the proposed clearing.

Table F summarises the current extent of Upper Murchison 29 VSA relative to the pre-European extent in WA, the IBRA region and sub-region, and the Shire of Murchison.

TABLE F: VEGETATION STATISTICS – UPPER MURCHISON 29 VSA (GOVERNMENT OF WESTERN AUSTRALIA, 2019)

SCALE	REGION	PRE-EUROPEAN EXTENTN (ha)	CURRENT EXTENT (ha)	CURRENT EXTENT PROTECTED
Statewide	Western Australia	7,903,991.45	7,898,973.24 (99.94%)	6.28%
IBRA region	Murchison	2,956,382.06	2,955,695.34 (99.98%)	3.15%
IBRA sub-region	MUR02 – Western Murchison	2,160,146.79	2,159,669.31 (99.98%)	0.43%
Local Government	Shire of Murchison	1,297,282.39	1,297,265.74 (100%)	0%

2.3.3 Flora

During the Umwelt (2024) survey, a total of 45 discrete vascular flora taxa were recorded from 16 families and 26 genera. Taxa from the families Fabaceae (11 taxa and one hybrid) and Chenopodiaceae (eight taxa) represented the most common collections. Umwelt (2024) noted that the survey was a reconnaissance assessment (EPA, 2016) and as such, a detailed census of the flora has not been developed; however, opportunistic collections were made.

During other flora and vegetation surveys completed for the SKA, the census of the flora ranged from as low as 41 taxa (56.44 ha; AECOM, 2023) to 454 taxa (1,520 ha; 360 Environmental, 2017). The comparatively high census of the flora in the 360 Environmental (2017) survey reflects the size and shape of the survey area, which consisted of a linear corridor 152 km in length along three sections of road.

A search of Atlas of Living Australia records for an area of approximately 128,783 ha (46 km east/west, 28 km north/south) returned 188 species from 34 families and 89 genera. The records were dominated by Fabaceae (45 species, nine genera), Poaceae (22 species, 16 genera), Scrophulariaceae (21 species, one genus) and Chenopodiaceae (18 species, six genera).

2.3.3.1 Significant Flora

Umwelt (2024) recorded two Priority taxa within the survey area – *Gunniopsis divisa* (P3) and *Hemigenia tysonii* (P3), with each of these species recorded at two locations each.

Umwelt (2024) noted that *G. divisa* has a distribution of approximately 340 km, from northeast of Meekatharra to Karara, with 29 recorded populations, of which seven are within Unallocated Crown Land (UCL) lands proposed for conservation.

The distribution of *H. tysonii* spans approximately 800 km within the Carnarvon, Gascoyne and Murchison IBRA regions and is known from 22 records, which represent 18 regional populations, with one occurring within UCL land proposed for conservation (Umwelt, 2024). Umwelt (2024) observed that the population of *H. tysonii* within the survey area adds to the known distribution of this species.

Umwelt (2024) completed a likelihood of occurrence assessment and concluded that of the 24 species with records identified from the DBCA database search, there were 22 species that were considered unlikely to occur, with the remaining two species discussed above. There were no threatened species listed in the database search. During other surveys near the application area, no threatened flora was recorded (Umwelt, 2024).

A search of the anonymised data contained in the Threatened and Priority Flora (DBCA-036) spatial dataset (DBCA, 2022) has no records of threatened species close to the application area, with the nearest record being approximately 137 km southeast. The absence of closer records may reflect a lack of survey work within the region; however, numerous surveys conducted for the SKA project have not found any threatened species in the surrounding landscape.

2.3.3.2 Non-native Flora

No WoNS or Declared Pest (Plants) pursuant to section 22 of the BAM Act were recorded in the survey area or have been recorded during surveys by AECOM (2014) or 360 Environmental (2017) (Umwelt, 2024).

2.3.4 Fauna

Umwelt (2024) observed 58 terrestrial vertebrate fauna, comprising 40 birds, 14 mammals and four reptiles. Except for the observation of *Aphelocephala leucopsis* (Southern whiteface, refer Section 2.3.4.1), no significant fauna was observed.

Regional fauna records reviewed by Umwelt (2024) identified 227 fauna species that are known to occur, or with the potential to occur in the survey area and surrounds. This comprised 174 bird species, 28 reptiles, 23 mammals and two amphibians (Umwelt, 2024). Based on this, the census of fauna

species from the Umwelt survey is considered a comparatively low number, potentially reflecting the lack of habitat variation in the survey area and the effects of historic and ongoing disturbance.

2.3.4.1 Significant Fauna

During the Umwelt (2024) survey, *Aphelocephala leucopsis* (Southern whiteface; EPBC Act Vulnerable), was opportunistically observed. Two individuals of this species were observed moving through low shrubs in the southern extent of the survey area.

DCCEEW (2023) define three broad habitats for this species which includes the following:

- Relatively undisturbed open woodlands and shrublands with an understory of grasses or shrubs, or both.
- Habitat with low tree densities and an herbaceous understory litter cover which provides essential foraging habitat.
- Living and dead trees with hollows and crevices which are essential for roosting and nesting.

Vegetation in the area where this species was observed is likely to constitute foraging habitat, based on the habitats defined in DCCEEW (2023). It is noted that this species is not listed as a conservation dependent significant species in WA.

Of the significant fauna species listed in the DBCA database search conducted prior to the survey, only one species, Fork-tailed swift, was identified as having a moderate likelihood of occurrence in the application area. It was noted that this species feeds for invertebrates above vegetation, and as such, the assessment as moderate for likelihood is a reflection on the lack of specificity in foraging habitat requirements.

Eight species were identified by Umwelt (2024) as having a low likelihood of occurrence. Of these, six were migratory species with a requirement for wetlands or watercourses, none of which are within the application area. The remaining two species, Peregrine falcon and Malleefowl, may occur in the area, although Peregrine falcons typically inhabit areas with cliffs. No other surveys in the region, with the exception of Bamford (2016) have recorded evidence of the presence of Malleefowls within comparable vegetation to the survey area.

2.3.4.2 Non-native Fauna

Umwelt (2024) recorded five non-native mammal species were recorded during the survey:

- *Canis lupus familiaris* (Dog);
- *Capra aegagrus hircus* (Goat);
- *Oryctolagus cuniculus* (Rabbit);
- *Felis catus* (Cat); and
- *Bos taurus* (European cattle).

2.4 DISTURBANCES AND THREATENING PROCESSES

2.4.1 Fires

There are no mapped fire events for the application and surrounding area (DBCA, 2024).

2.4.2 Other

The application area is located to the southeast and east of the existing airstrip on Boolardy Station, which is to the south of the homestead. The Station was a site of pastoral activities from 1890 – 2013, after which it was destocked. Impacts of the historic pastoral activities including grazing, clearing and the spread of weeds are still evident in the landscape.

3 ASSESSMENT AGAINST TEN PRINCIPLES FOR CLEARING NATIVE VEGETATION

An assessment of the proposed clearing associated with the project was completed based on the DER (2014) assessment against the 10 principles for clearing native vegetation as detailed in Schedule 5 of the EP Act and presented in Table G. The assessment was based on a clearing area of 44.16 ha within a potential development footprint of 61.68 ha which includes 17.52 ha of cleared land on which the current airstrip and associated infrastructure is located. The actual extent of clearing needed for the airstrip upgrade is currently unknown due to aspects related to runway design and drainage requirements. Less clearing may be needed than being applied for, pending the results of flood modelling and drainage design.

TABLE G: ASSESSMENT AGAINST 10 PRINCIPLES FOR CLEARING NATIVE VEGETATION

PRINCIPLE:
a) Native vegetation should not be cleared if it comprises a high level of biological diversity.
NOT AT VARIANCE TO THIS PRINCIPLE Umwelt (2024) recorded 45 flora taxa, 58 terrestrial vertebrate fauna taxa and one vegetation type/fauna habitat. No threatened flora was observed. Two P3 taxa, *Gunniopsis divisa* and *Hemigenia tysonii,* were collected. These were considered to represent new populations. It is noted that no additional survey work was conducted for these species outside of the survey area, and as such, the distribution and abundance of these species outside of the proposed clearing area is unknown. These species have both been recorded in previous surveys associated with the SKA development and have substantial ranges within the Murchison bioregion. The absence of information on other populations is likely to be an artifact of survey effort in the region. Impacts to these individuals within the application area is unlikely to significantly impact on the presence of this species in the surrounding landscape. None of the other significant flora contained in DBCA database searches were considered likely to occur in the application area. The balance of the census of the flora consisted of species that are common in the area. No novel taxa, range extensions or other flora that might meet the significance criteria in EPA (2016a) were recorded. There were no WoNS or Declared Pest (Plants) collected. A search of the ALA database for flora records within a 46 km (east/west) and 28 km (north/south) area surrounding the Boolardy airstrip returned 188 species from 34 families and 89 genera, and the census of the flora in other surveys over a similar area was comparable. Umwelt (2024) recorded 58 terrestrial fauna taxa within the application area, comprised of 40 birds, 14 mammals and four reptiles. There were two individuals of *Aphelocephala leucopsis* (Southern whiteface), which is an EPBC Act listed species, in the southern section of the survey area. The area they were observed is considered to be foraging habitat. No other significant species were recorded. One vegetation type was recorded during the survey, with Umwelt (2024) noting that this was analogous to other vegetation recorded during surveys for the SKA development. The vegetation, a mulga community, is considered widespread in the region and does not constitute a known TEC or PEC, nor does it meet any of the other criteria for significance in EPA (2016a). The vegetation within the application area was noted as having been impacted by historic grazing and other pastoral activities, the station homestead and the existing airstrip. This vegetation does not represent a significant fauna habitat nor is it considered to be a critical habitat for significant fauna. Given the comparatively low census of the flora and fauna, the limited records of significant species, and the presence of a widespread vegetation type, which has 99.94% of the pre-European extent remaining at a Statewide scale, the proposed clearing is considered to not be at variance to this principle.
Methods: Umwelt (2024) *Reconnaissance flora and vegetation and basic fauna assessment: Square Kilometre Array Projec*t.

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

NOT AT VARIANCE TO THIS PRINCIPLE

Umwelt (2024) recorded 58 terrestrial fauna taxa during surveys within the application area, comprised of 40 birds, 14 mammals (inclusive of five non-native species) and four reptiles, including one EPBC-listed species – *Aphelocephala leucopsis* (Southern whiteface). The majority of records were made in the southern section of the application area, which has not been impacted by the presence of the current airstrip and homestead. One fauna habitat was identified in the application area – a form of mulga, which is a widespread vegetation type within much of the Eremaean. The cleared areas were not considered to be fauna habitat as no habitat values remain.

Umwelt (2024) completed a likelihood of occurrence assessment for conservation dependent significant fauna, with the following 11 species considered to be unlikely to occur in the survey area, eight considered to have a low likelihood of occurrence, of which six were migratory, and one assessed as having a moderate likelihood of occurrence, the Fork-tailed swift. None of these species were identified as requiring mulga vegetation as a critical habitat. It is noted that of the species considered to have a low probability of occurring in the Umwelt survey area, six have a requirement for wetlands or other seasonally inundated areas. The absence of cliffs removes the potential that Peregrine falcons would be resident in the area, although they may hunt for prey in the vegetation of the survey area. Malleefowl may occupy vegetation in the survey area, but Umwelt (2024) note that no individuals have been observed with the exception of Bamford (2016) who observed an old nest, but this was not in close proximity to the survey area.

The Fork-tailed Swift was considered to have a moderate likelihood of occurrence not due to a specific habitat requirement, but rather that they will graze for insects above any vegetation and given that the species may transit into arid areas, there is potential for them to graze on insect above mulga (Umwelt, 2024).

Bamford (2016) identified four vegetation and substrate associations (VSAs) within the landscape surrounding the application area that were considered of particular significance. These are listed below, with an assessment in relation to the application area.

- Major drainage lines – the Murchison and Roderick Rivers, provide habitat for birds in the form of large trees and seasonal and permanent pools, which support freshwater fish, waders and waterbirds.
- Granite outcrops – support a highly restricted fauna assemblage including the Western spiny-tailed skink.
- Rocky, lateritic hills and breakaways supporting dense Acacia shrublands – provide habitat for Malleefowl and *Idiosoma nigrum.*
- Floodplain depressions supporting chenopod shrublands – potential habitat for Slender-billed thornbill.

The application area does not intersect either the Murchison or Roderick Rivers, with the latter located approximately 2.7 km to the north. Based on this, species that require this type of habitat are not impacted by the proposed clearing. The presence of the Southern whiteface in vegetation within the application area may reflect the proximity to these river systems, and other surface water features such as Lake Wooleen, with the Acacia shrublands providing suitable foraging habitat.

Egernia stokesii badia (Western Spiny-tailed Skink), which is a threatened species under the BC Act and the EPBC Act, has two broad varieties – the “normal” and the “black form” (DEC, 2012). The application area is to the north of the known distribution for the “normal” form, which is associated with *Acacia*-dominated shrublands and is typically found in the Geraldton sandplains and the Yalgoo IBRA regions, the latter of which is to the south of the application area. While the “black form” is known to occur in the Murchison settlements, the area in which the application area is located. Known threats for both forms include clearing. It should be noted that a key part of the habitat requirement for both forms of this species are niche refugia such as old buildings and logs for the “normal” form and areas of outcropping granite and ironstone breakaways for the “black form” (Department of Environment and Conservation [DEC], 2012). While the vegetation within the application area is consistent with the habitat for the “normal” form, there are no niche refugia being impacted by the clearing. There are no suitable landforms for the “black form” in the application area, while the application area is potentially outside of the range of the “normal” form (the Yalgoo IBRA bioregion is approximately 100 km south – southeast of the application area) but may contain suitable habitat.

The application area is located entirely on the Yanganoo Land System, which is characterised as "Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting mulga shrublands and wanderrie grasses on banks". This description is not consistent with the habitat requirements for Malleefowl or *Idiosoma nigrum* and as such, the proposed clearing is not impacting on their habitat.

There are no floodplain depressions supporting chenopod shrublands within the application area. Therefore, there are no impacts to potential habitat for Slender-billed thornbill.

The fauna habitat within the application area is a form a mulga, which is a widespread vegetation type within much of the Eremaean. The pre-European vegetation within the application area is Murchison_29 (Mulga), which covers over 8,000,000 ha and has almost 100% of its pre-European extent remaining. The scale of proposed clearing will not impact on the local, regional or statewide extent of this vegetation. Based on this, the proposed clearing is within an area in which there are not defined VSAs that are considered critical habitat for significant fauna. The application area contains one fauna habitat that is widespread and intact. The proposed clearing will not remove habitat for significant fauna, nor will it comprise the whole, or a part of a significant habitat for native fauna, and as such, is not at variance to this principle.

Methods:

DEC (2012) Western Spiny-tailed Skink *Egernia stokesii* Recovery Plan.

Umwelt (2024) *Reconnaissance flora and vegetation and basic fauna assessment: Square Kilometre Array Project.*

Bamford Consulting Ecologists (Bamford) (2016) *Square Kilometre Array (SKA) Main Roads Upgrade Fauna Assessment.*

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

NOT AT VARIANCE TO THIS PRINCIPLE

There are no existing records of threatened flora within the application area, with the nearest mapped record approximately 138 km southeast (DBCA-036). Umwelt (2024) did not collect any threatened flora during their survey over the application area, nor have any collections of threatened flora been made in other surveys associated with the SKA project (Umwelt, 2024).

Given the absence of records within the application area or surrounding landscape, the proposed clearing is not impacting on populations or habitat necessary for the condition existence of rare flora. Therefore, the proposed clearing is not at variance to this principle.

Methods:

Threatened and Priority Flora (DBCA-036).

Umwelt (2024) *Reconnaissance flora and vegetation and basic fauna assessment: Square Kilometre Array Project.*

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

NOT AT VARIANCE TO THIS PRINCIPLE

The nearest mapped occurrence of a TEC is approximately 168 km southwest of the survey area (DBCA-038). Umwelt (2024) did not consider the vegetation within the application area to be representative of any known TEC, nor was it considered to be representative of vegetation that would meet any of the significant criteria in EPA (2016b).

Given the distance to the nearest mapped extent of a TEC and the absence of any vegetation that could be considered to have characteristics of any known TEC within the application area, the proposed clearing is not at variance to this principle.

Methods:

Threatened Ecological Communities (DBCA-038).

Umwelt (2024) *Reconnaissance flora and vegetation and basic fauna assessment: Square Kilometre Array Project.*

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

NOT AT VARIANCE TO THIS PRINCIPLE

The application area is located on the Upper Murchison_29 Vegetation Association (DPIRD, 2019), of which there is 99.94% remaining at the state, 99.98% at the IBRA region and sub-region, and 100% at the local government authority level (Government of Western Australia, 2019). The extent of clearing associated with this application will not significantly impact on the extent remaining of this VSA.

The application area is within a region in which there has been limited clearing of native vegetation, reflected in the extent remaining, and as such, the proposed clearing is not at variance to this principle.

Methods:

Pre-European Vegetation (DPIRD-006).

Government of Western Australia (2019) *2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of March 2019.*

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

NOT AT VARIANCE TO THIS PRINCIPLE

There are no mapped surface water features in the application area, with the nearest feature being Roderick River, a tributary of the Murchison River, located approximately 2.8 km north (DWER, 2018). The vegetation within the application area was mapped as an open low woodland of *Acacia* spp., which was not considered to be a groundwater dependent ecosystem (Umwelt, 2024).

Given the vegetation is not a groundwater dependent ecosystem and there are no mapped surface water features in the application area, the proposed clearing is considered to not be at variance to this principle.

Methods:

Hydrography, Linear (Hierarchy) (DWER-031).

Umwelt (2024) *Reconnaissance flora and vegetation and basic fauna assessment: Square Kilometre Array Project.*

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

MAY BE AT VARIANCE TO THIS PRINCIPLE

The Umwelt (2024) vegetation condition assessment of the application area identified areas that were considered 'Very Good' condition (34.69 ha, 56.24 % of the application area), 'Good' condition (7.73 ha, 12.53 %) and 'Poor' condition (1.74 ha, 2.82 %), according to the scale of Trudgen (1988). Vegetation condition assessed as 'Poor' was between the northern and northeastern ends of the existing runways and ancillary structures associated with the airstrip and the former pastoral lease homestead. Vegetation assessed as being 'Good' was located to the north of the intersection of the two sections of the runway while vegetation assessed as being in 'Very Good' condition was located to the south of the intersection of the two runways.

Umwelt (2024) noted evidence of erosion, which is likely to be associated with the combination of damage to surface cryptogamic crusts, where present, which removes the protection associated with these, and the loss of groves of *Acacia* spp., particularly mulga, which can result in a higher speed of surface flows, contributing to local erosion.

Clearing associated with the extension of the airstrip will result in the loss of section of vegetation in 'Very Good' condition. While these impacts are localised, there is the potential that these will cause land degradation, and as such, the proposed clearing may be at variance to this principle.

To manage these risks the following measures will be implemented:

- Limiting the extent of clearing to minimum area required for the upgraded airstrip, noting that detailed design for the airstrip upgrade has not yet been completed.
- Prioritise the use of existing cleared areas for temporary activities such as construction laydown.
- Careful planning and construction to minimise channelling of overland flows.

- Rehabilitating temporary areas cleared where practical.

The above avoidance and mitigation measures are consistent with the Applicants EPA referral document *Square Kilometre Array Radio Telescope SKA EP Act Referral (2017).*

Methods:

Umwelt (2024) *Reconnaissance flora and vegetation and basic fauna assessment: Square Kilometre Array Project*.

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

NOT AT VARIANCE TO THIS PRINCIPLE

The nearest DBCA Legislated Lands and Waters to the application area are Muggon National Park, approximately 62 km east, and the Narloo Reserve Area, approximately 70 km south. There are no other conservation areas that form part of the National Reserve System closer than these two reserves.

The nearest registered offset area is approximately 90 km east of the application area and is associated with the Sinosteel Midwest Corporation Limited Weld Range Iron Ore Project.

There are no Ramsar wetlands near the application area. The nearest Directory of Important Wetlands of Australia is Wooleen Lake, which is located approximately 26 km to the west of the application area.

Given the distance to conservation areas and in consideration of the size of the application area, there are likely to be no situations in which the proposed clearing will impact on the environmental values of these. Therefore, the proposed clearing is not at variance to this principle.

Methods:

DBCA Legislated Lands and Waters (DBCA-011).

CAPAD 2022.

Offsets Register – Offsets (DWER-078).

Ramsar Sites (DBCA-010).

Directory of Important Wetlands of Australia – Western Australia (DBCA-045).

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

NOT LIKELY TO BE AT VARIANCE TO THIS PRINCIPLE

The application area is located on the Yanganoo soil landscape system, which is characterised by a flat topography and a hardpan, typically covered with a shallow soil layer (DPIRD-027). This type of soil landscape system is associated with surface flows after rainfall events, with drainage patterns varying in response to local variation in topography. Paleodrainage channels in the area are more commonly associated with calcrete, such as the Cunyu land system, on which one of the calcrete PECs is located. Established minor rivers, such as the Roderick River to the north of the application area, are associated with Beringarra system, which are riverine plains with floodplains and channels (DPIRD-027).

The proposed clearing may have a minor impact on some sheetflows, as drainage across the survey area and surrounds tends northwesterly towards the Roderick River; however, this is likely to only have any appreciable impact in a small area and during periods of peak flow after significant rainfall events. It is noted that the Boolardy Station Access Road and the Beringarra Pindar Road both lie within the path of drainage into the Roderick River.

Given the absence of mapped surface water features in the application area and the low probability of underground water systems, combined with the limited extent of clearing associated with the project, the proposed clearing is not likely to cause deterioration in the quality of surface or underground water.

Methods:

Soil Landscape Mapping – System (DPIRD-027).

Hydrography, Linear (Hierarchy) (DWER-031).

j) Native vegetation should not be cleared if the clearing of vegetation is likely to cause, or exacerbate, the incidence of flooding.
NOT LIKELY TO BE AT VARIANCE TO THIS PRINCIPLE The application area is within a region in which there is a weakly bimodal rainfall pattern, with the bulk of the rainfall falling in winter. Rainfall variability is high, ranging from the lowest annual total of 30.7 mm in 1981 to the highest annual rainfall of 517.9 mm in 1975. Flooding events are typically triggered in the region after high single rainfall events, where infiltration rates into soil are low. It should be noted that the landscape has evolved with this climatic variability. Hardpan flats, such as the Yanganoo soil landscape system on which the application area is located, being characterised by series of anastomosing shallow drainage lines that feed into established minor and major creeks and rivers, the former characterised by Acacia species and hummock grasslands and the latter by groundwater dependent vegetation. A surface water modelling study will be commissioned by the applicant to consider the impact of the airstrip upgrade on localised overland sheetflow. The findings of the modelling will be used to inform the design of the upgraded airstrip ensuring that adequate measures are implemented through design and construction to ensure that overland flow is not disrupted while protecting critical infrastructure. Based on the descriptions of vegetation and landscape in Umwelt (2024), it is considered unlikely that the proposed clearing will cause or exacerbate the incidence of flooding.
Methods: Soil Landscape Mapping – System (DPIRD-027). Hydrography, Linear (Hierarchy) (DWER-031). Monthly Rainfall – Boolardy Weather Station (Bureau of Meteorology [BoM], 2024).

4 CONCLUSIONS

The proposed clearing of 44.16 ha for upgrades to the Boolardy Airstrip is required for the expansion and operation of the SKA and other associated elements of the observatory. Ecological values associated with the area in which it is proposed to undertake clearing largely comprise species and vegetation that are common within the local and regional landscape. The two Priority flora species recorded, while potentially new populations, are known to have distributions over large geographic areas, with information on the extent and size of occurrences likely to be an artefact of sampling effort rather than reflecting a scattered and disjunct distribution.

The presence of *A. leucopsis* within the survey area is considered indicative of the presence of suitable foraging habitat. While this species is EPBC-listed, with clearing of habitat identified as a threatening process, it is noted that the known distribution is extensive and includes agricultural areas in which the amount of remaining vegetation is a significant factor associated with reduction in population numbers. It is noted that species is not listed as conservation dependent in WA.

The proposed clearing was assessed against the 10 clearing principles, as was considered to not be at variance to Principles A-F and H, not likely to be at variance to Principles I and J, and may be at variance to Principle G. The proposed extent of clearing is small and focused on areas adjacent to existing infrastructure. Given the small clearing footprint and scale of ecological impacts, there are no residual significant impacts attached to the clearing.

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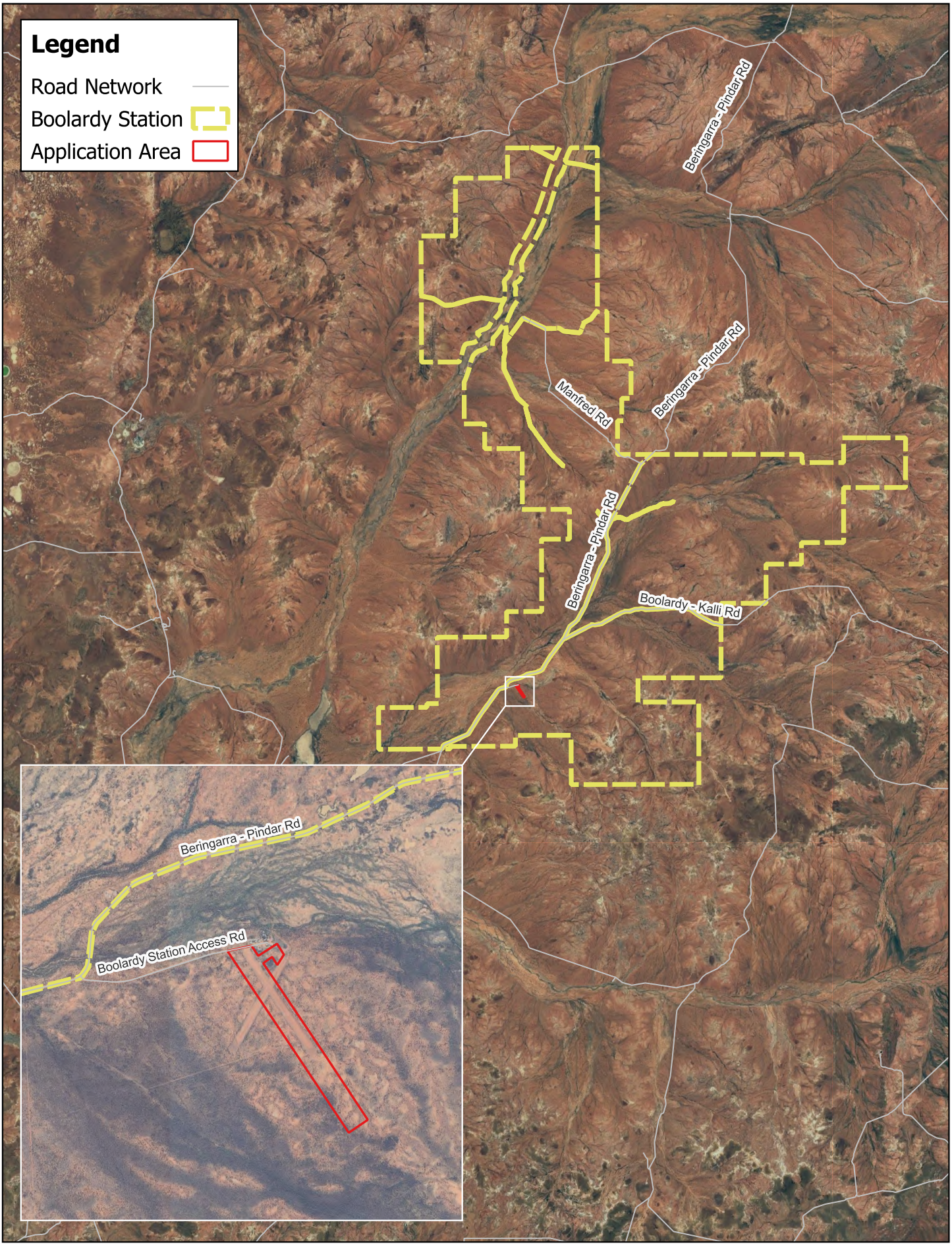
FIGURES



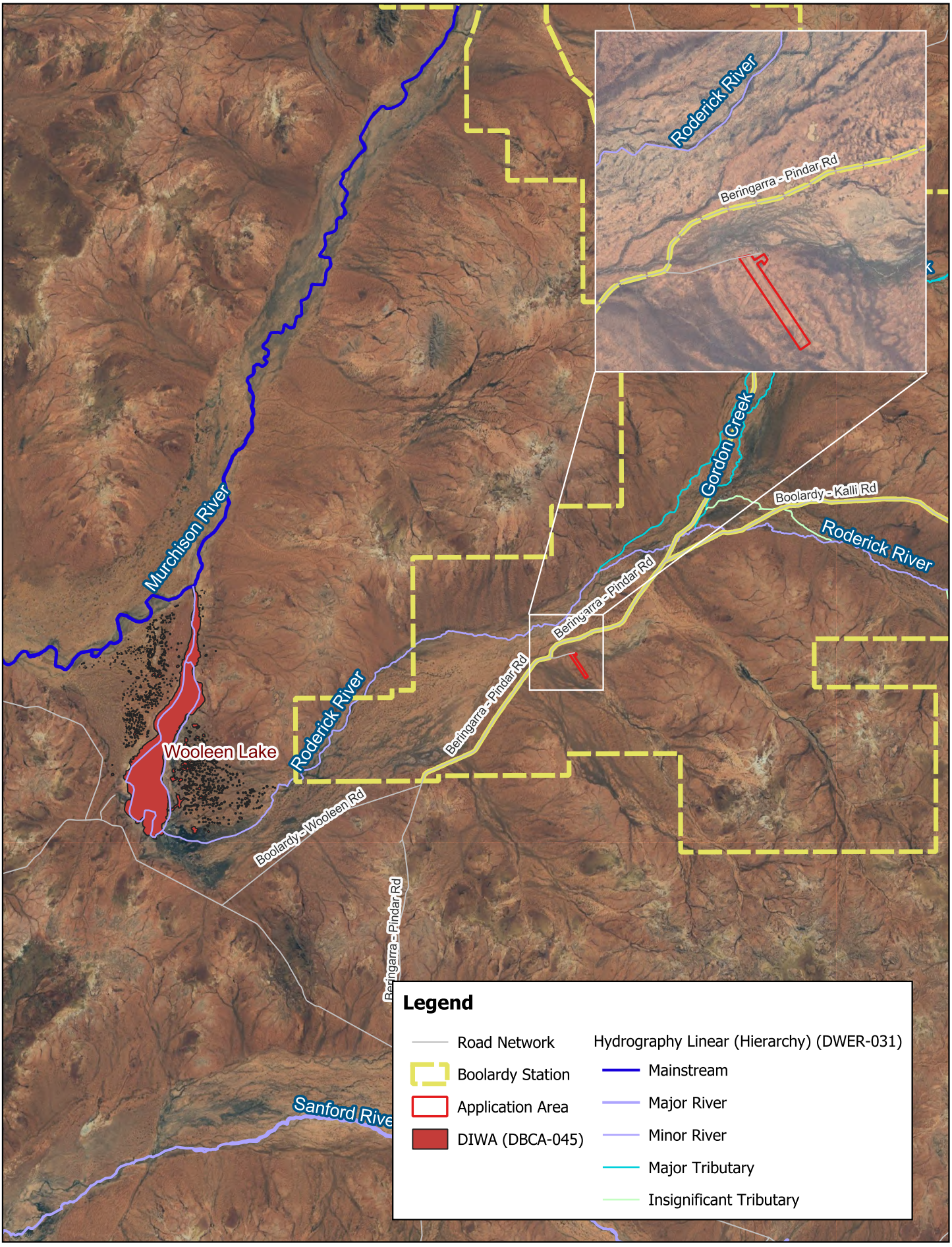
0 10 20 30 km

CSIRO
SKA Airstrip NVCP Application
Boolardy Station, Murchison WA

Figure 1
Site Location

Aurora environmental
ASSESS • ADVISE • APPLY

Project Code: CLW-PP03704
Doc: CLW-PP03704_NVCP_001_SHBN
Date: 17/09/2024
Author: SH
Ph: (08) 9227 2660
Fax: (08) 9227 2699



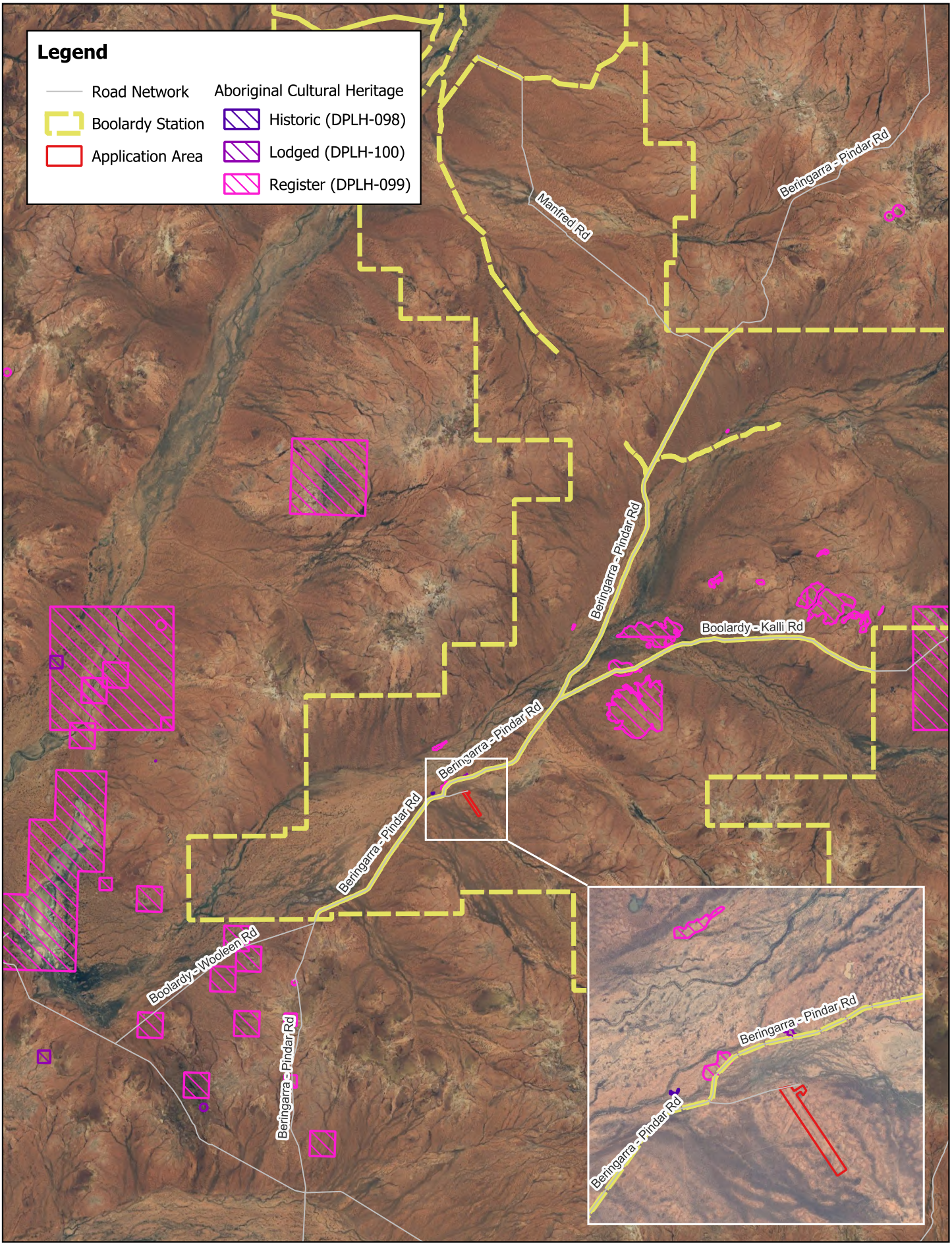
0 5 10 15 km

CSIRO
SKA Airstrip NVCP Application
Boolardy Station, Murchison WA

Figure 2
Inland Waters

Aurora environmental
ASSESS • ADVISE • APPLY

Project Code: CLW-PP03704
Doc: CLW-PP03704_NVCP_001_SHBN
Date: 17/09/2024
Author: SH
Ph: (08) 9227 2660
Fax: (08) 9227 2699



0 5 10 15 km

CSIRO
SKA Airstrip NVCP Application
Boolardy Station, Murchison WA

Figure 3
Aboriginal Heritage

Aurora environmental
ASSESS • ADVISE • APPLY

Project Code: CLW-PP03704
Doc: CLW-PP03704_NVCP_001_SHBN
Date: 17/09/2024
Author: SH
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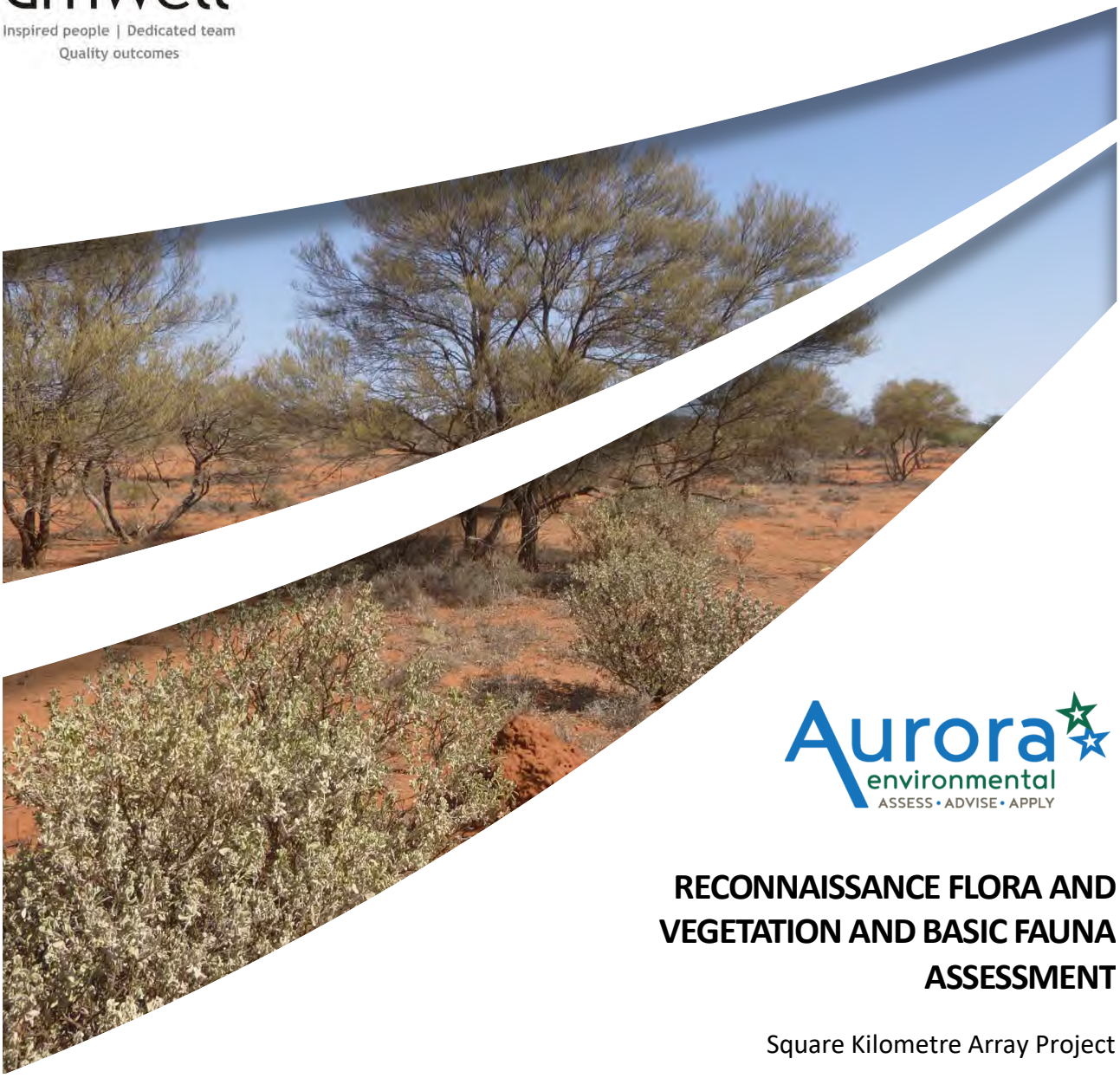
APPENDIX 1

Umwelt (2024) Reconnaissance Flora and Vegetation and Basic Fauna Assessment: Square Kilometre Array Project.

umwelt

Inspired people | Dedicated team
Quality outcomes



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RECONNAISSANCE FLORA AND VEGETATION AND BASIC FAUNA ASSESSMENT

Square Kilometre Array Project

FINAL

September 2024

RECONNAISSANCE FLORA AND VEGETATION AND BASIC FAUNA ASSESSMENT

Square Kilometre Array Project

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Aurora Environmental (Perth) Pty Limited
(for Wajarri Enterprises Limited and CSIRO)

Project Director: Cathy Godden
Project Manager: Marlee Starcevich
Report No. 23395/R01
Date: September 2024

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	Marlee Starcevich Brittany Osborn Cathy Godden Loren Appleby Paul Zuvela Kerry Ardern	1/12/2023	Cathy Godden	4/12/2023
V2	Marlee Starcevich Brittany Osborn	8/01/2024	Cathy Godden	8/01/2024
V3	Marlee Starcevich	18/09/2024	Cathy Godden	18/09/2024

Executive Summary

The Square Kilometre Array (SKA) Project ('the Project') is a large international radio telescope project which aims to answer key cosmological questions using radio waves from across the universe. The SKA project will draw on the skills, experiences and support of 14 countries, with the first phase of the project being hosted by South Africa and Australia. Australia will host the SKA1-Low Frequency Aperture Array (SKA1-Low), which is an entirely new array consisting of up to 512 array stations, planned to be constructed on Boolardy Station, located approximately 270 kilometres (km) northeast of Geraldton, Western Australia (WA).

Aurora Environmental (Perth) Pty Limited (Aurora) is engaged by Wajarri Enterprises Limited (WEL) to undertake planning and managing of ecological surveys for and on behalf of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for the Project, with surveys previously undertaken in 2014 and from 2018 to 2022 by others for infrastructure, array stations and corridors. However, CSIRO has required further biological surveys for the Project for an existing landing strip extension ('the Survey Area'). Umwelt (Australia) Pty Limited (Umwelt) were commissioned by Aurora, on behalf of WEL and CSIRO, to undertake a Reconnaissance flora and vegetation and Basic fauna assessment for the Project, within a 62 hectares (ha) Survey Area.

The flora, vegetation and fauna field survey was undertaken over a single two-day site visit, from 19th to 20th September 2023.

Flora and Vegetation

A total of seven non-permanent flora and vegetation survey relevés were established in the Survey Area, and systematic targeted survey for significant flora taxa and vegetation was undertaken over the entirety of the Survey Area (excluding the large cleared area of the existing airstrip).

While not intended to be a complete census of the flora diversity of the Survey Area, a total of 45 discrete vascular flora taxa and one formally named hybrid (as per WA Herbarium (1998-)) were recorded in the Survey Area. This includes two significant flora taxa, being *Gunniopsis divisa* (P3) and *Hemigenia tysonii* (P3), both recorded within the southern part of the Survey Area.

One vegetation type (VT) was defined in the Survey Area using the structural vegetation classification technique. This VT represents a mulga community, and given mulga communities have been documented to be dependent on the interception of sheet flow water runoff during heavy rainfall events (Dunkerley, 2002a, 2002b), this VT is consequently considered to be surface water dependent. However, it is not groundwater dependent. VT 1 is not considered to represent any formally listed TECs or PECs, or otherwise be of any local or regional significance.

The vegetation in the southern part of the Survey Area was rated and mapped as being in 'Very Good' condition due to evidence of historical grazing, including loss of biomass, and soil surface erosion and compaction. The northern part of the Survey Area was mapped as 'Good' to 'Poor' due to greater levels of animal and human activity, including clearing, edge effects, dumping and minor weeds levels.

Fauna

Five motion sensing cameras were deployed across the Survey Area, and acoustic recordings were undertaken at three sites, for one night each. In addition, a total of six fauna habitat assessment points were assessed during the field survey, and non-systematic opportunistic observations of fauna species were made and recorded throughout the duration of the survey. Secondary evidence of fauna such as tracks, diggings and scats were also noted while traversing the Survey Area.

While not intended to be a complete census of the fauna diversity of the Survey Area, a total of 58 fauna species were recorded during the Basic Fauna Survey, comprising 40 birds, 14 mammals and 4 reptiles. One conservation significant species, the Southern Whiteface (*Aphelocephala leucopsis*), was recorded during the field survey via opportunistic observation, and one additional species was considered to have a 'Moderate' likelihood of occurrence in the Survey Area, being the Fork-Tailed Swift (*Apus pacificus*) (Migratory).

Two fauna habitats were identified in the Survey Area; Low Open Woodland over Open Shrubland (equivalent to VT 1) and cleared land. The Survey Area is in close proximity to remnant native vegetation including a drainage line and associated vegetation to the north. This habitat may provide refuge for fauna and act as a dispersal pathway through the landscape.

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1.0 Introduction

1.1 Project Overview

The Square Kilometre Array (SKA) Project ('the Project') is a large international radio telescope project which aims to answer key cosmological questions using radio waves from across the universe. The SKA project will draw on the skills, experiences and support of 14 countries working collaboratively to construct and operate elements of the SKA project, with the first phase of the project being hosted by South Africa and Australia. Australia will host the SKA1-Low Frequency Aperture Array (SKA1-Low), which is an entirely new array consisting of up to 512 array stations, planned to be constructed on Boolardy Station, located approximately 270 kilometres (km) northeast of Geraldton, Western Australia (WA).The SKA1-Low project is being developed in stages and this first stage of the project requires early site development works where native vegetation clearing will be required.

Aurora Environmental (Perth) Pty Limited (Aurora) is engaged by Wajarri Enterprises Limited (WEL) to undertake planning and managing of ecological surveys for and on behalf of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for the Project, with surveys previously undertaken in 2014 and from 2018 to 2022 by others for infrastructure, array stations and corridors. However, CSIRO has required further biological surveys for the Project for an existing landing strip extension ('the Survey Area').

Umwelt (Australia) Pty Limited (Umwelt) were commissioned by Aurora, on behalf of WEL and CSIRO, to undertake a Reconnaissance flora and vegetation and Basic fauna assessment for the Project, within a 62 hectares (ha) Survey Area. This report documents the desktop assessment, survey methods, and results of field surveys.

1.2 Project Location

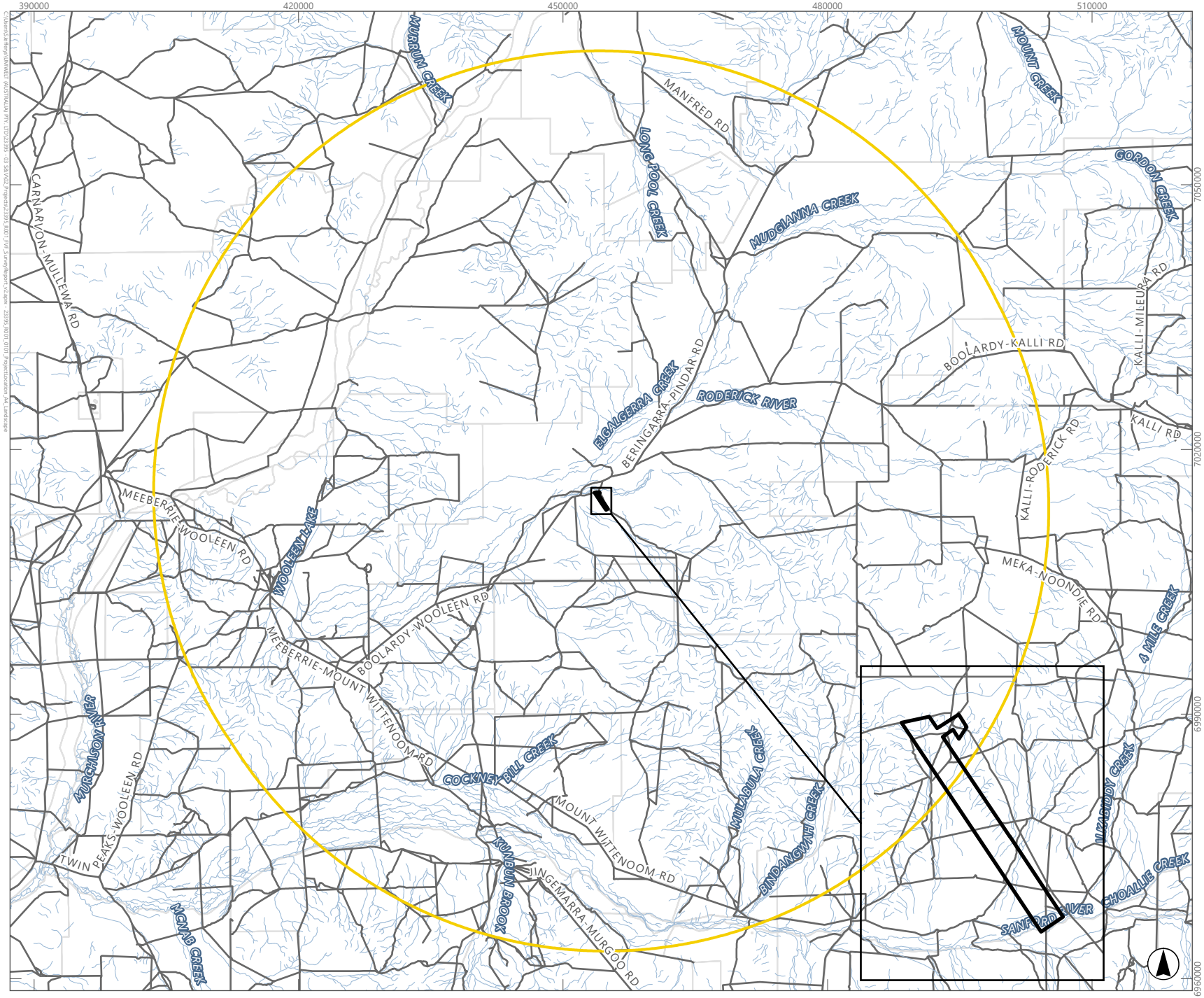
Aurora have supplied relevant boundaries for the Survey Area (provided by Stephan Fritz, 22 August 2023), which was the focus of the ecological survey. The Survey Area is approximately 62 hectares (ha) in size (**Figure 1.1**).

A Desktop Study Area was defined for the purposes of interrogation of databases and searches for relevant literature; this encompasses the Survey Area with a 50 km buffer (**Figure 1.1**).

The Survey Area is located southeast of Beringarra-Pindar Road, approximately 250 km east-northeast of Kalbarri and 140 km west-northwest of Cue, within the Murchison region and the Shire of Murchison. The Survey Area is entirely situated within former Boolardy pastoral station, with stations Meeberrie, Wooleen, Murgoo, Mt Wittenoom, Meka and Kalli in close proximity (DPLH, 2023) (**Figure 1.2**). The nearest DBCA conservation reserve to the Survey Area is Toolonga Nature Reserve, located approximately 110 km to the west (DBCA, 2023a).

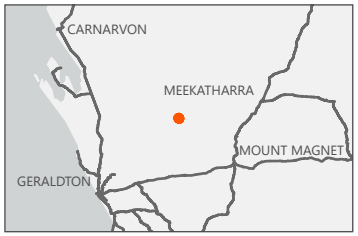
The main land use of the West Murchison subregion is grazing native pastures (96.2 % in 2001), with lesser areas of Unallocated Crown Land (UCL) and Crown reserves. Conservation lands constitute a very small proportion of the subregion (0.06 % in 2001); a significant proportion of conservation estate in the subregion falls outside the International Union for Conservation of Nature (IUCN) I-IV categories (**Section 2.3**). Mining interest in nickel and gold mining in particular are considerable, however most mining leases still come under the *Land Administration Act 1997* and as such are still required to be stocked (Desmond et al., 2002).

FIGURE 1.1
Project Location



Legend

- Desktop Study Area
- Survey Area
- Road
- Watercourse
- Waterbody
- Property Boundary



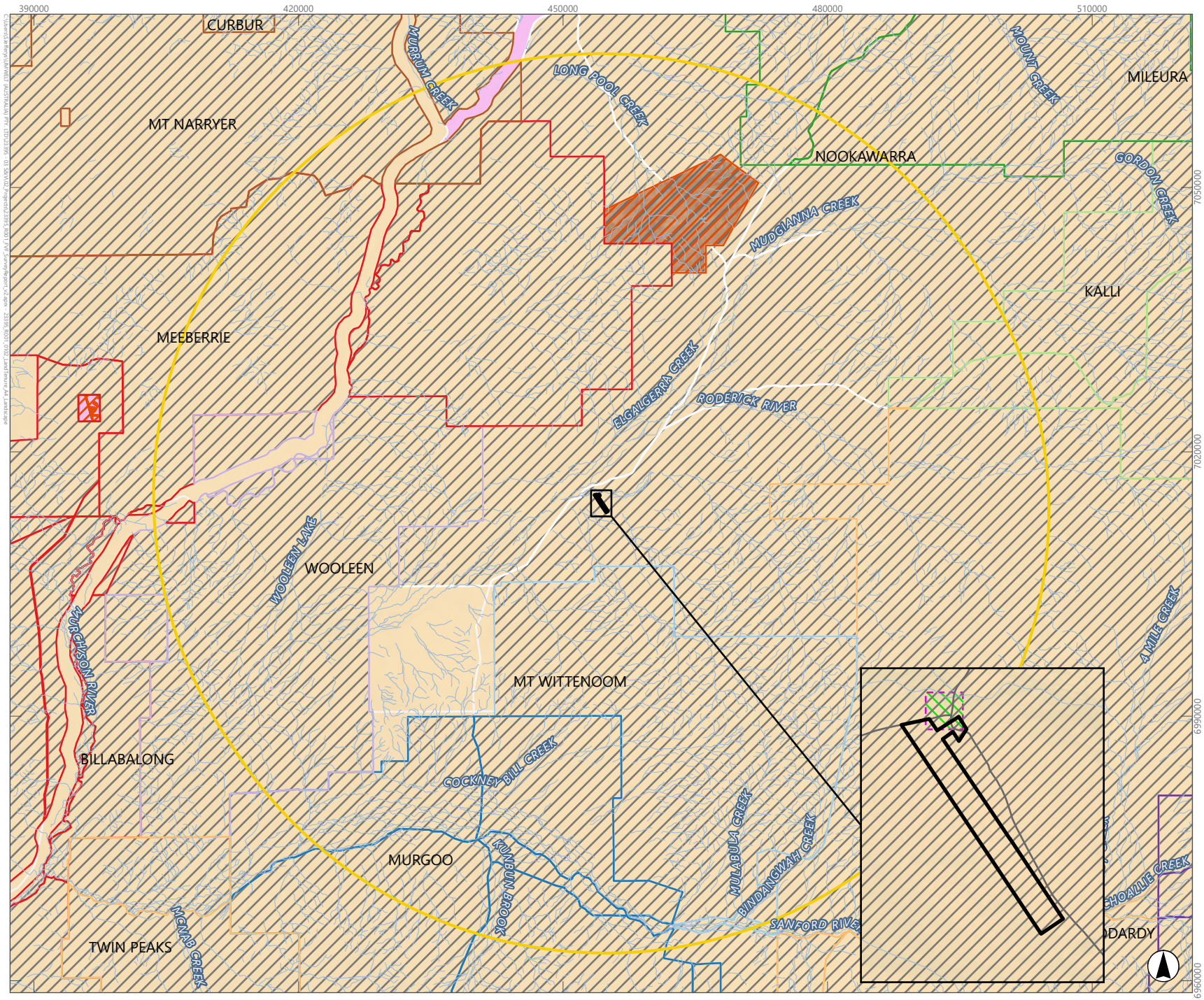
0 12 24

Kilometres

Scale 1:600,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

FIGURE 1.2
Land Tenure



Legend

- Desktop Study Area
- Survey Area
- Road
- Watercourse
- Waterbody
- Easements
- Other Interests
- Crown Lease
- Crown Reserve
- Public Road
- Unallocated Crown Land; Closed Road
- Crown Allotment (Type 2)
- Lot on Survey (Type 1)

Pastoral Station

- BILLABALONG
- COODARDY
- CURBUR
- KALLI
- MEEBERRIE
- MEKA
- MILEURA
- MT NARRYER
- MT WITTENOOM
- MURGOO
- NOOKAWARRA
- TWIN PEAKS
- WOOLEEN

0 12 24

Kilometres

Scale 1:600,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

1.3 Aims and Objectives

The primary aim of the ecological assessment was to characterise the flora, vegetation and fauna values of the Survey Area by conducting a Reconnaissance flora and vegetation assessment and a Basic fauna assessment in accordance with current WA Environmental Protection Authority (EPA) Technical Guidance (EPA, 2016d, 2020).

The specific objectives of the assessment were to:

- Undertake low-intensity sampling of **vascular flora and vertebrate fauna** to gather data on the general floral and faunal assemblages present in the Survey Area. Note that this assessment does not attempt to record a full census of vascular flora taxa and vertebrate fauna that occur in the Survey Area.
- Search for **significant flora taxa** identified as occurring or potentially occurring within the Survey Area. Significant flora taxa includes taxa that belong to one of the following categories as defined by EPA (2016d, 2016a):
    - Formally listed significant taxa – includes Threatened (T) taxa listed under both State (*Biodiversity Conservation Act 2016* (BC Act)) and Commonwealth (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) legislation, and classified as Priority (P) by the WA Department of Biodiversity, Conservation and Attractions (DBCA)[1])
    - locally endemic taxa or taxa associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems (GDEs))
    - new species or taxa having 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
    - having a relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.
- Opportunistically search for **significant vertebrate fauna taxa** identified as occurring or potentially occurring within the Survey Area. Significant fauna taxa includes taxa that belong to one of the following categories as defined by EPA (2016c, 2020):
    - Formally listed significant taxa – includes Threatened and Specially Protected (SP) taxa listed under both State (BC Act) and Commonwealth (EPBC Act) legislation, and classified as Priority by DBCA
    - species with restricted distribution
    - having a degree of historical impact from threatening processes

[1] DBCA (2020) presents conservation codes for DBCA-listed taxa. Further information about Commonwealth taxa conservation categories is provided in Threatened Species Scientific Committee's (TSSC) 'Guidelines for assessing the conservation status of native species according to the *Environment Protection and Biodiversity Conservation Act 1999* and *Environment Protection and Biodiversity Conservation Regulations 2000*' (TSSC, 2021).

- providing an important function required to maintain the ecological integrity of a significant ecosystem.

- Opportunistically 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).
- Opportunistically identify locations and determine the extent of **introduced fauna taxa**.
- Identify, map and describe the different **fauna habitats** occurring within the Survey Area, and their potential value to significant fauna.
- Identify, map and describe **vegetation types** (VTs) and fauna habitats within the Survey Area.
- Identify, map and describe **significant vegetation** that occurs within the Survey Area. Significant vegetation includes communities that belong to one of the following categories as defined by EPA (2016d, 2016a):
    - Formally listed significant vegetation – includes vegetation listed as a Threatened Ecological Community (TEC) or Priority Ecological Community (PEC)[2] under State (BC Act) legislation, or as a TEC under Commonwealth (EPBC Act) legislation
    - having a restricted distribution
    - having a degree of historical impact from threatening processes
    - playing a role as a refuge
    - providing an important function required to maintain ecological integrity of a significant ecosystem.
- Map the **vegetation condition** in accordance with EPA Technical Guidance (EPA, 2016d).

1.4 Level of Assessment

The flora and vegetation survey of the Survey Area involved a Reconnaissance assessment as defined in Section 4.1 of the *Technical Guidance for Flora and Vegetation Surveys for Environmental Impact* (EPA, 2016d).

The fauna survey involved a Basic assessment as defined in Section 4.1 of the *Technical Guidance for Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA, 2020).

[2] Definitions, categories and criteria for WA TECs and PECs are presented by Department of Environment and Conservation (DEC; now DBCA) (DEC, 2013). Further information about Commonwealth conservation categories is provided in TSSC's 'Guidelines for nominating and assessing the eligibility for listing of ecological communities as threatened according to the *Environment Protection and Biodiversity Conservation Act 1999* and the EPBC Regulations 2000' (TSSC, 2017).

This level of assessment is considered appropriate for the Project, as the scale and nature of potential impacts are not likely to be significant. The Project was referred in 2017 to EPA and Department of Environment and Energy (now Department of Climate Change, Energy, the Environment and Water (DCCEEW)), at which time it was considered as 'Not Assessed' and 'Not a Controlled Action', respectively. Following a change in the array configuration and discussion with the Department of Water and Environmental Regulation (DWER) regarding the Project impacts, EPA confirmed that the Project was not significantly different to the previously referred project and would therefore still not require assessment under Part IV of the WA *Environmental Protection Act 1986* (EP Act). Similarly, DCCEEW has advised that an EPBC referral is not required as the project is unlikely to be considered a controlled action.

The survey and reporting works comply with the following documents:

- *Environmental Factor Guideline – Flora and Vegetation* (EPA, 2016b).
- *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016d).
- *Environmental Factor Guideline – Terrestrial Fauna* (EPA, 2016c).
- *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA, 2020).

2.0 Background

2.1 Climate

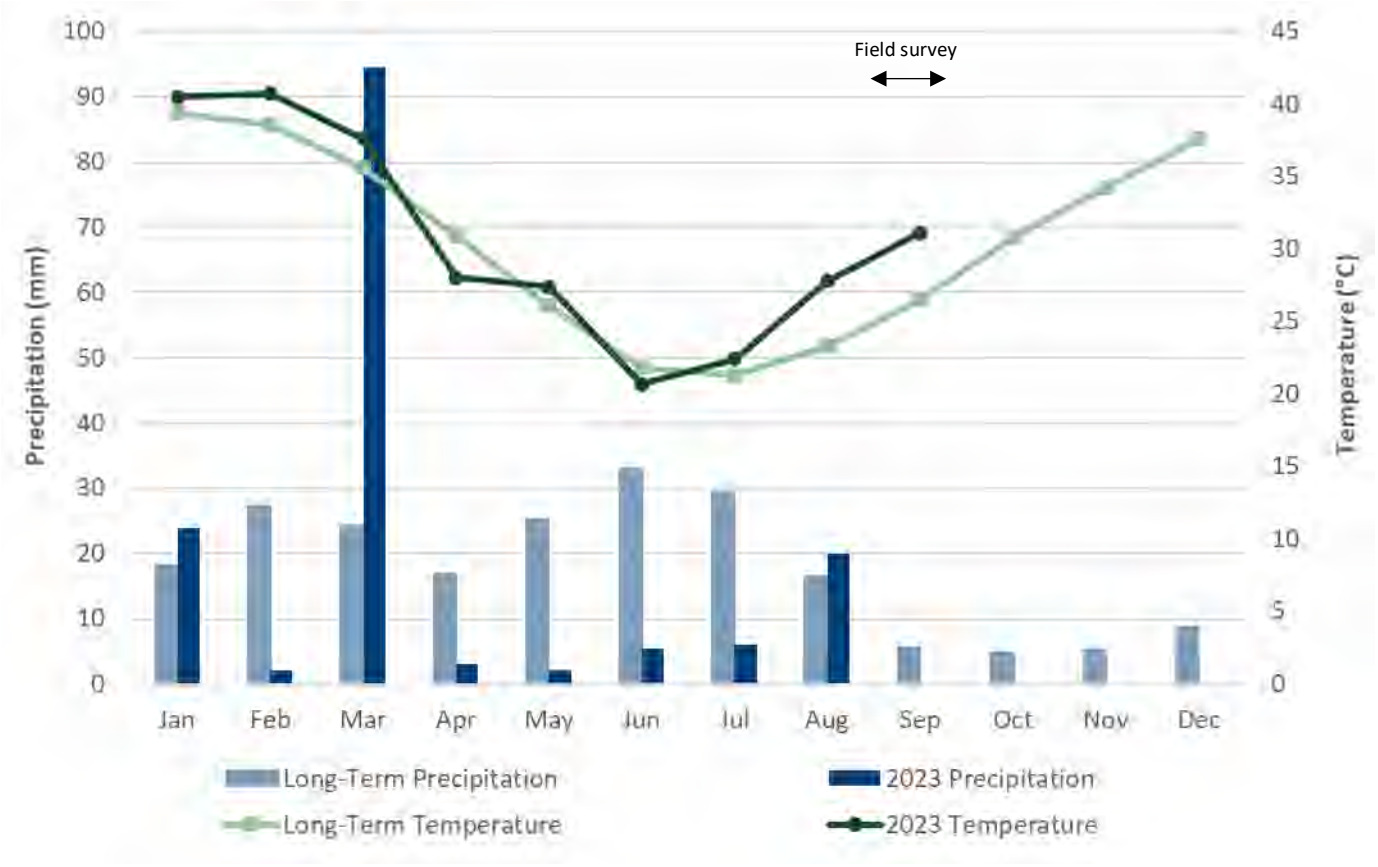
The Survey Area is located in the Western Murchison subregion in the Murchison Interim Biogeographic Regionalisation for Australia (IBRA) region (DCCEEW, 2023a, 2023c). The Murchison region (Austin Botanical District) is characterised by an arid climate with bimodal rainfall (summer and winter) and an annual precipitation around 200 millimetres (mm) (Beard, 2015). The region experiences a large variation in monthly precipitation from year to year, correlating to the climatic conditions of that particular year, with influences from both remnants of cyclonic/tropical low activity extending from the Pilbara and Kimberley Region (typical from December to March), and winter precipitation extending inland from the southern coastal regions (typical from June to August).

Graph 2.1 presents 2023 and long-term monthly mean precipitation and monthly mean maximum temperature statistics for Bureau of Meteorology (BoM) Boolardy station (precipitation; station 7007, data from 1891 to present) and Murchison station (temperature; station 6099, data from 1987 to present) (BoM, 2023a), the stations in closest proximity to the Survey Area. Note that the data for these stations have been taken from BoM monthly climate statistics data, which is calculated by BoM from daily temperature and precipitation records. Review of the daily and monthly data from these BoM stations reveals that there are some gaps in these datasets over the history of data collection. However, given these stations have been monitored for a significant period of time (particularly Boolardy station, which has over 130 years of data history), a small number of gaps is unlikely to significantly affect the long-term averages. It is worth noting that the BoM datasets for these stations for 2022 and 2023 appear to be complete.

Precipitation at Boolardy is bimodal, typically peaking around February and June. On average, Boolardy station receives 214.9 mm of precipitation annually. The maximum temperatures at Murchison peak from December to February, and the average maximum temperature for this period is 38.5 °C. The average winter (June to August) maximum temperature is 22.1 °C (BoM, 2023a) (**Graph 2.1**).

The precipitation received at Boolardy Station in the six months preceding the start of the 2023 field survey (i.e. February to July 2023) (113.1 mm) was slightly below the long-term average for this period (155.8 mm). However, rainfall received in March 2023 (94.5 mm), was significantly above the long-term average for the month (24.2 mm) as a result of Tropical Cyclone Herman, with the majority of this rainfall received late in the month (BoM, 2023a) (**Graph 2.1**).

When averaged over the six months preceding the 2023 field survey, temperatures at Murchison Station were very similar to the long-term average (26.5 °C in 2023 cf. the average of 29.1 °C), with the 2023 temperatures fluctuating above and below the long-term average over this period (BoM, 2023a) (**Graph 2.1**).



Graph 2.1 2023 and Long-Term Monthly Mean Climate Statistics for Boolardy (precipitation) and Murchison (maximum temperature) Stations (BoM, 2023a)

2.2 Geology, Landform and Soils

The Murchison region is formed of Archaean granite with infolded volcanics and meta-sediments (greenstones) of like age, forming the Yilgarn Block (Beard, 2015). The Western Murchison subregion is dominated by extensive hardpan washplains of outcrop and fine-textured Quaternary alluvial and eluvial surfaces, mantling granitic and greenstone strata of the northern part of the Yilgarn Craton. Surfaces associated with the occluded drainage occur throughout with hummock grasslands on Quaternary sandplains, saltbush shrublands on calcareous soils and Tecticornia low shrublands on saline alluvia. The Western Murchison subregion contains the headwaters of the Murchison and Wooramel Rivers, which drain the subregion westwards to the coast (Desmond et al., 2002). The principal soil type is shallow earthy loam overlying red-brown hardpan; shallow stony loams on hills and red earth sands on sandplains (Beard, 2015).

In 1994, the Department of Agriculture (now the Department of Primary Industries and Regional Development (DPIRD)) described land systems (currently referred to as soil landscape units) within the Murchison River catchment, considering general ecological information, vegetation physiognomy and composition, patterns of grazing impact, conservation status, gradational association and land system representation (Curry et al., 1994). The Survey Area occurs entirely within the Yanganoo soil-landscape system, with the northeastern part of the Survey Area approximately 18 m from the boundary with the Beringarra system (DPIRD, 2022) (**Table 2.1**, **Figure 2.1**). Neither of these soil landscape systems are listed as TECs under the EPBC Act (DCCEEW, 2023e) or listed as TECs or PECs by DBCA (2023h, 2023i).

Table 2.1 Soil Landscape Systems of the Survey Area

Unit	Description*	Survey Area Extent (ha)*
272Yg: Yanganoo System	Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting mulga shrublands and wanderrie grasses on banks	62
272Bg: Beringarra System	Riverine plains with floodplains and channels, supporting halophytic shrublands, mixed acacia shrublands and low woodlands with minor perennial grasses	0 (immediately north of Survey Area)

** Source: Soil Landscape Mapping - Best Available spatial dataset (DPIRD-027) (DPIRD, 2022).*

2.3 Regional Vegetation

The vegetation of the Western Murchison subregion is dominated by Mulga low woodlands often rich in ephemerals (usually with bunch grasses), also with some areas of hummock grasslands, saltbush shrublands and Tecticornia low shrublands (Desmond et al., 2002).

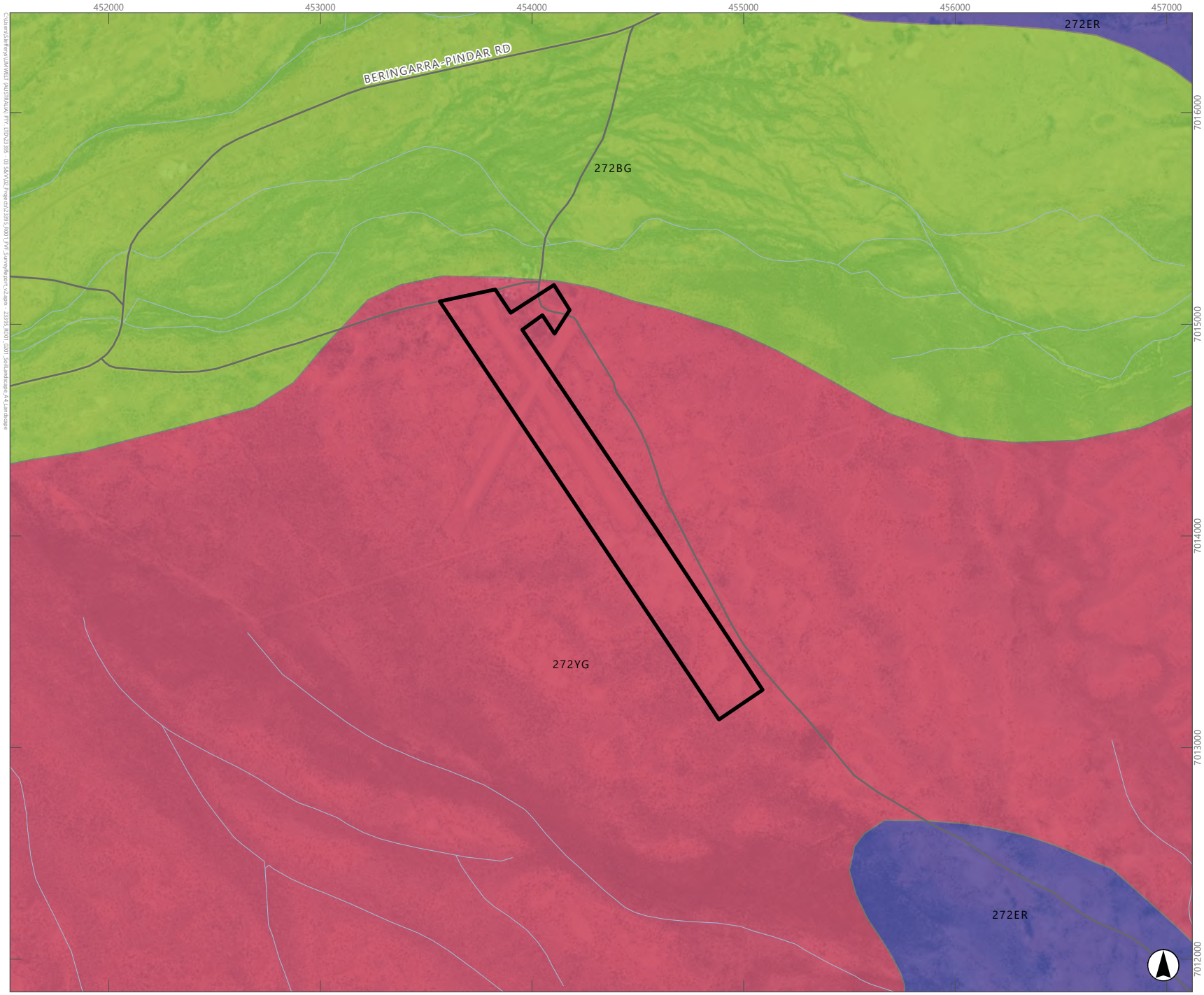
The vegetation of WA as it was presumed to have existed prior to European settlement has been mapped at a scale of 1:250,000 as vegetation system associations (VSAs), with the Pre-European Vegetation spatial database created (Beard et al., 2013; DPIRD, 2019). The Survey Area occurs entirely within the Upper Murchison 29 VSA, with the northwestern part of the Survey Area approximately 1.5 km from the boundary with the Upper Murchison 204 VSA (**Table 2.2**, **Figure 2.2**). These VSAs are summarised in **Table 2.2**, which also presents the current extent of each VSA in relation to its pre-European extent within the Western Murchison IBRA subregion, and the percentage of the current extent of each VSA currently protected for conservation (as a proportion of the current extent) within the Western Murchison IBRA subregion (DBCA, 2019). Note that as per DBCA Statewide Vegetation Statistics report (DBCA, 2019), protected areas in this context are considered to be any areas listed in DBCA-Legislated Lands and Waters dataset as either Crown reserves or lands managed under Section 8A of the *Conservation and Land Management Act 1984* that have an IUCN category of I to IV.

According to the 2018 DBCA Statewide Vegetation Statistics report (DBCA, 2019), all VSAs that occur within the Survey Area have all their pre-European extents remaining (100 %) in the West Murchison subregion, but none have any areas reserved for conservation in the subregion (**Table 2.2**).

2.4 Fire History

There is currently no information on fire history for the Survey Area or Desktop Study Area in the DBCA Fire History dataset (last updated 25 July 2022 (DBCA, 2022a)). However, there are recorded fires from 2011/2012 approximately 51 km south of the Survey Area, south of Sanford River.

FIGURE 2.1
Soil Landscape Mapping



Scale 1:25,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), DPIRD (2022)

Table 2.2 Vegetation System Associations of the Survey Area

VSA	Description*	Extent (ha)			Pre-European Extent Remaining (%)*	Current Extent Protected for Conservation (%)*
		Survey Area^	Pre-European*	Current*		
Upper Murchison_29	Sparse low woodland; mulga, discontinuous in scattered groups	62	1,817,292	1,816,815	> 99.9 %	0
Upper Murchison_204	Succulent steppe with open scrub; scattered mulga & *Acacia sclerosperma* over saltbush & bluebush	0 (1.5 km north of Survey Area)	110,559	110,556	> 99.9 %	0

** Source: 2018 DBCA Statewide Vegetation Statistics report (DBCA, 2019).*

^ Source: Pre-European Vegetation spatial dataset (DPIRD-006) (DPIRD, 2019).

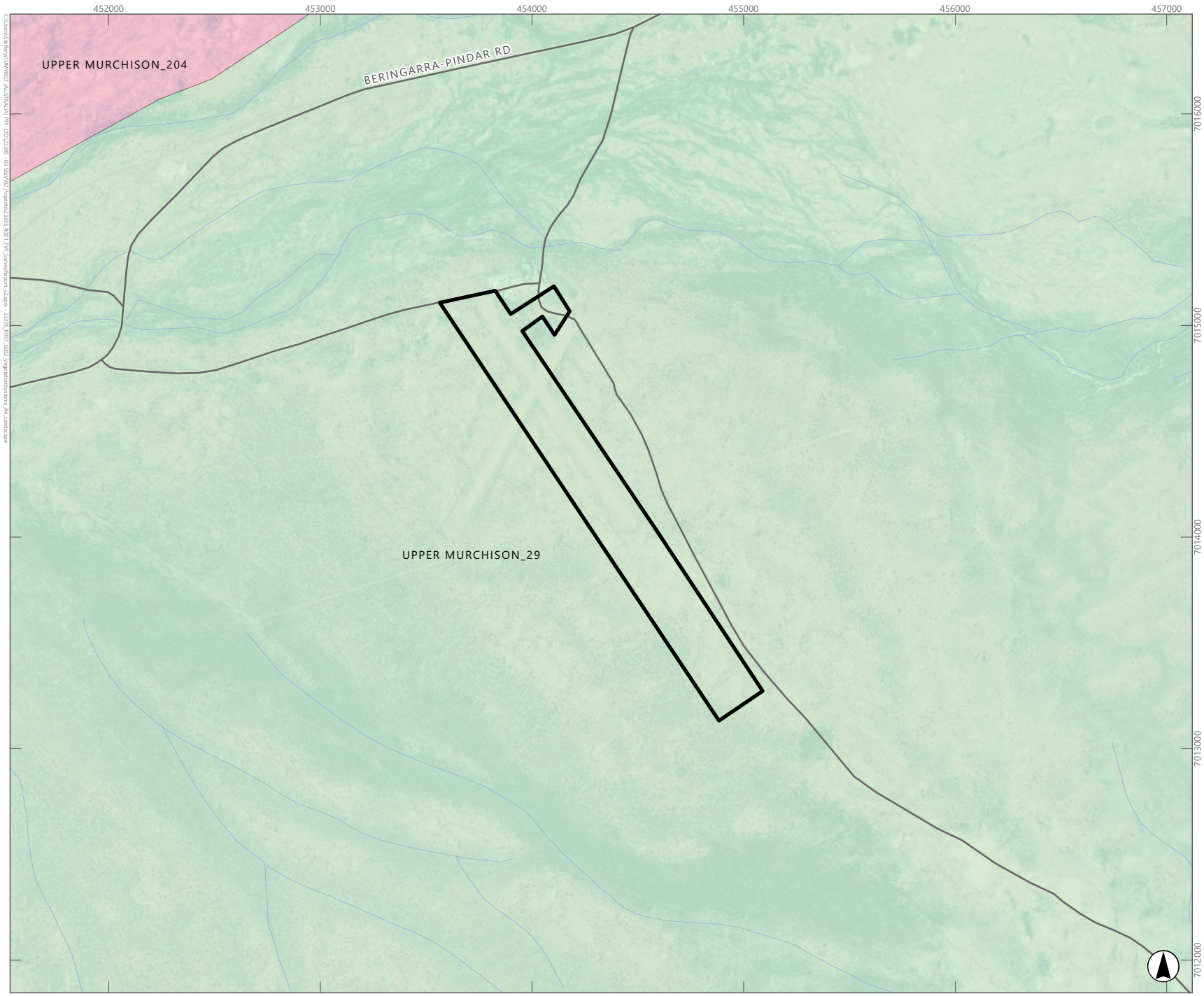


FIGURE 2.2
Vegetation System Associations

Legend

- Survey Area
- Road
- Watercourse

Vegetation System Associations

- UPPER MURCHISON_29
- UPPER MURCHISON_204

0 500 1,000
Metres

Scale 1:25,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), DPIRD (2019)

2.5 Groundwater and Surface Water Values

The Survey Area is located in the Roderick River hydrographic subcatchment within the Murchison River basin (DWER, 2018). The Roderick River channel is located immediately north of the Survey Area, with Elgalgerra Creek flowing into Roderick River approximately 17 km northeast of the Survey area. Both Roderick River and Elgalgerra Creek are non-perennial. A number of other minor watercourses also occur in the vicinity of the Survey Area (Landgate, 2022) (**Figure 2.3**); however, these are ephemeral watercourses and would only flow after heavy rainfall events.

According to the BoM Groundwater Dependent Ecosystems (GDE) Atlas, there are aquatic GDEs in the Desktop Study Area at Wooleen Lake, approximately 80 km west of the Survey Area (discussed further in **Section 2.6**), as well as associated with the Roderick, Murchison and Sanford Rivers, and Elgalgerra/Gordon Creek (high potential GDEs from national assessment) (**Figure 2.3**). The Roderick, Murchison and Sanford Rivers and Elgalgerra/Gordon Creek have also been mapped from a national assessment as high to moderate potential terrestrial GDEs, with associated floodplains and hardpan wash plains being mapped as low potential terrestrial GDEs. The Survey Area occurs within an area mapped as low potential terrestrial GDE (**Figure 2.3**), and has been described as low lying flat hardpan wash plain, with or without small wanderrie banks and weak grooving, supporting mulga shrublands and wanderrie grasses on banks, with outgoing drainage and salt lakes, broken by ridges of metamorphic rocks and granite (BoM, 2023b).

2.6 Recognised Sensitive Areas

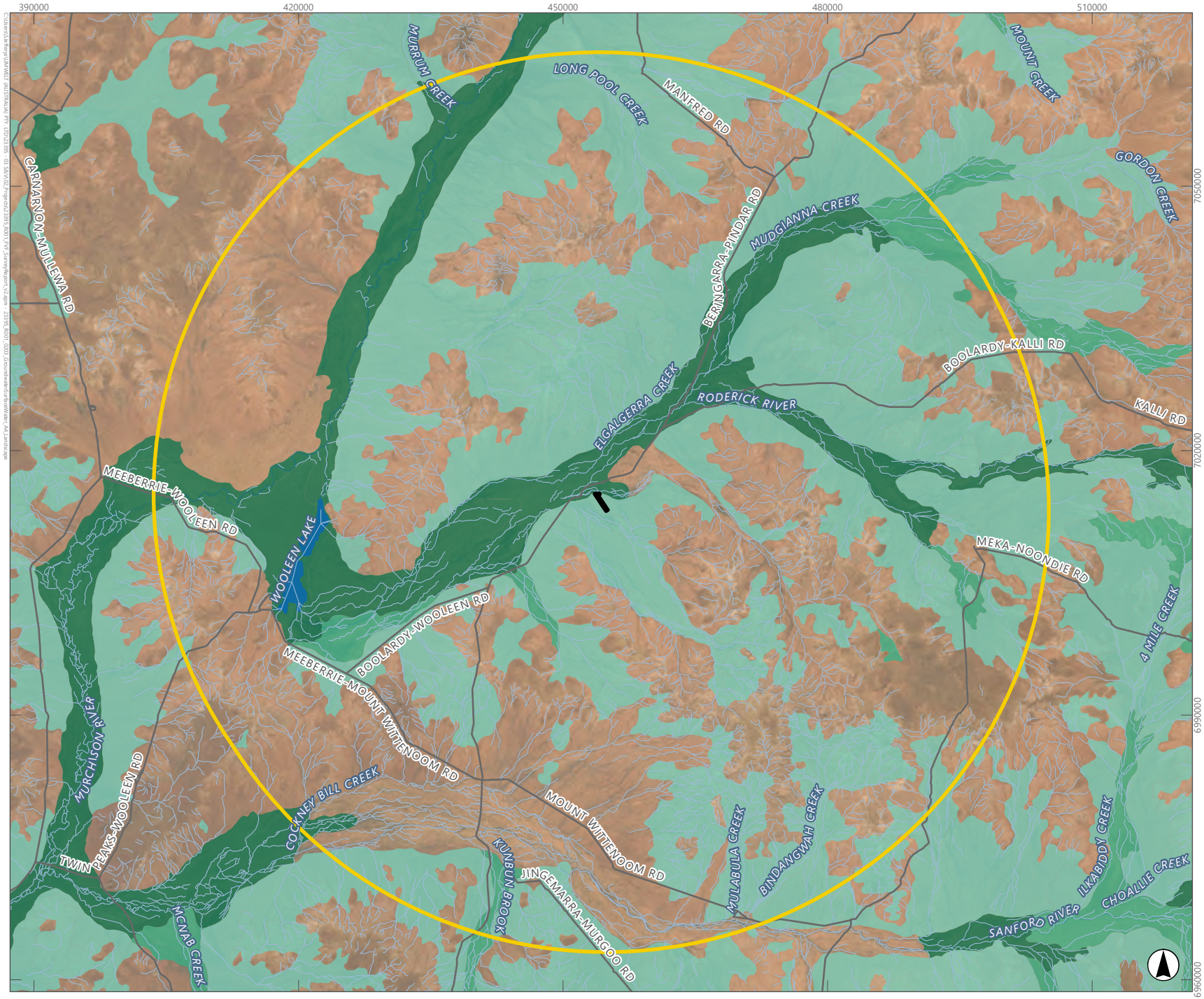
There are no Ramsar sites within the Desktop Study Area (DBCA, 2017a). Wooleen Lake, approximately 80 km west of the Survey Area, is listed as a Nationally Important Wetland and Environmentally Sensitive Area (DBCA, 2018; DWER, 2021).

Wooleen Lake is a macroscale elongate sumpland with numerous associated microscale ovoid sumplands (claypans and marshes). The lake is situated in the Yilgarn Craton in alluvial and lacustrine valley-fill deposits in the floodplain of the Roderick River. It receives surface inflow predominately from the Roderick River, originating 110 km east-northeast, but also from creeks originating up to 12 km southwest and south of the south basin and east of the north basin. These catchments are moderately disturbed. Outflow from the lake occurs from the north end. Some inundation occurs in most years, with episodic filling of the whole lake and surrounding marsh following summer-autumn rain events (once every five to ten years) of tropical origin. The water is probably several metres deep when fully inundated, probably brackish-saline when shallowly inundated, and fresh when fully inundated (DCCEEW, 2019).

Wooleen Lake is a major breeding area for Gull-billed Tern in WA (*Gelochelidon nilotica*; listed as Marine and Migratory by the Commonwealth). It consists of low shrubland (samphire; *Tecticornia* spp.) in periform or latiform arrangement in the lake; low shrubland (lignum; *Duma florulenta*); and low open woodland (*Eucalyptus camaldulensis*) in parts of the lake margins (e.g. the north end) and in adjacent claypans. The surrounding vegetation is tall open shrubland. The lake is a good example of a major floodplain lake, and is one of the few in southern WA (DCCEEW, 2019).

FIGURE 2.3

Groundwater and Surface Water Values



Legend

- Desktop Study Area
- Survey Area
- Road
- Watercourse

Aquatic GDEs – from GDE Atlas

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment

Terrestrial GDEs – from GDE Atlas

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

0 12 24

Kilometres

Scale 1:600,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), BOM (2023b)

3.0 Methods

3.1 Flora and Vegetation

3.1.1 Desktop Assessment

Prior to commencement of the flora and vegetation survey, a review of all publicly available flora and vegetation data relevant to the Survey Area was undertaken, as listed in **Table 3.1**. This included obtaining and reviewing copies of reports of previous biological surveys carried out within the vicinity of the Survey Area (where available), including via interrogation of the Index of Biodiversity Surveys for Assessments (IBSA) database. Where TECs or PECs were identified by the desktop assessment, appropriate DBCA or DCCEEW nomination/listing descriptions and recovery plans of the TEC or PEC were also reviewed prior to field survey, as well as the 'Methods for survey and identification of Western Australian threatened ecological communities' report from DBCA (2023f).

Table 3.1 Searches Undertaken for the Flora and Vegetation Desktop Assessment

Source	Search Attributes	Search Purpose
DCCEEW Species Profile and Threats (SPRAT) Database (interrogated using the Protected Matters Search Tool) (DCCEEW, 2023d)	Database interrogated using Desktop Study Area boundary. Initial search undertaken, 5 September 2023 and updated 23 October 2023	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 (DBCA, 2023g)	Database interrogated using Desktop Study Area boundary. Search performed 29 August 2023, reference 92-0823NM	Obtain records of DBCA-listed significant flora taxa within the Desktop Study Area
DBCA Significant Flora Database (WA Herbarium Specimen Database and Threatened and Priority Flora (TPFL) Database) (DBCA, 2023e)	Database interrogated using Desktop Study Area boundary. Search performed 31 August 2023, reference 73-0823FL	Obtain records of DBCA-listed significant flora taxa within the Desktop Study Area
DBCA Threatened and Priority Ecological Communities Database (DBCA, 2023c)	Database interrogated using Desktop Study Area boundary. Search performed 4 September 2023, reference 53-0823EC	Obtain records of DBCA-classified TECs and PECs within the Desktop Study Area
DBCA TEC and PEC records spatial data (DBCA-038) (DBCA, 2017b)	Review of mapped DBCA TECs and PECs within or in proximity to the Desktop Study Area	Identify whether there are any DBCA-classified TECs or PECs that could occur within the Desktop Study Area
DBCA TEC and PEC lists (DBCA, 2023h, 2023i)	Review of current DBCA TEC and PEC lists for the Murchison Interim Biogeographic Regionalisation for Australia (IBRA) region / Midwest DBCA region	Identify whether there are any additional DBCA-classified TECs or PECs that could occur within the Desktop Study Area

Source	Search Attributes	Search Purpose
IBSA database (DWER, 2022)	Approximate Desktop Study Area boundary	Obtain copies of reports and associated spatial data (where available) to identify records of significant flora and vegetation and introduced flora in the vicinity of the Survey Area
Previous flora and vegetation survey reports conducted for the Project or within or in the vicinity of the Survey Area (various sources)	Approximate Desktop Study Area boundary	Identify records of significant flora and vegetation and introduced flora in the vicinity of the Survey Area

3.1.2 Personnel and Licensing Information

Table 3.2 lists the personnel involved in fieldwork, plant identifications, vegetation mapping and report preparation for the flora and vegetation assessment. The Project Manager and Field Manager have previous experience (7 years and > 15 years, respectively) in conducting flora and vegetation surveys in WA, including in the Murchison region.

All plant material was collected under the relevant *Flora Taking (Biological Assessment) Licence* (under Regulation 62 of the Biodiversity Conservation Regulations 2018 (BC Regs)) and *Authorisation to Take or Disturb Threatened Species* (pursuant to Section 40 of the BC Act) as outlined in **Table 3.2**. Personnel managing plant identifications have had extensive previous experience (> 15 years) in plant identifications of Western Australian flora, including flora of the Murchison region, and checked plant identifications undertaken by less experienced personnel for accuracy.

Table 3.2 Flora and Vegetation Assessment Personnel and Licensing Information

Personnel	Experience	Flora Collecting Permit	Role
Kim Kershaw BSc (Biology)	> 30 years	FB62000054-2 TFL133-2122	• Field survey
Bethea Loudon BSc (Biology)	> 15 years	NA	• Plant identifications and review
Marlee Starcevich BSc (Environmental Science) (Hons)	7 years	NA	• Project management • Plant identifications • Data analysis and VT mapping • Report preparation

3.1.3 Aerial Photography Interpretation and Survey Design

The design of the flora and vegetation survey complies with the requirements of EPA Technical Guidance (EPA, 2016d) and is consistent with the methods used for other similar flora and vegetation assessments conducted within the vicinity of the Survey Area (**Section 5.1.1**) and the wider Murchison Bioregion.

Initial interpretation of ortho-rectified aerial photography at a scale of 1:10,000 was conducted to determine preliminary vegetation patterns present within the Survey Area (including areas of restricted or unusual landforms and types). This review considered the size of vegetated areas and visible vegetation patterns. Relevé locations were proposed to ensure that a minimum of three relevés sampled each major discernible vegetation pattern where possible; for smaller patterns, fewer relevés were allocated based on the size of the pattern, while for widespread vegetation patterns, relevés were allocated across their geographic range.

3.1.4 Field Survey

3.1.4.1 Survey Timing and Access

The flora and vegetation field survey was undertaken over a single two-day site visit, from 19th to 20th September 2023. Note that EPA Technical Guidance recommends that primary flora and vegetation surveys in the Eremaean botanical province be undertaken approximately six to eight weeks post wet season (generally March to June); this recommendation is based on the assumption that this period aligns with the flowering period of most flora taxa in the botanical province. However, it is considered that this recommendation is generally less applicable to the southern part of the Eremaean botanical province, where most flora taxa flower in spring following winter rainfall. The region within which the Survey Area is located occurs in this transitional area between the Eremaean and South-Western Interzone provinces, and indeed the majority of significant flora taxa that potentially occur in the Survey Area flower from August to October (see **Section 5.1.3**). Therefore, the timing of the field survey is considered appropriate for a primary flora and vegetation assessment of the Survey Area.

The Survey Area was accessed by vehicle using existing access tracks and via foot traverses. Appropriate landholder/manager permissions were obtained prior to undertaking the field survey.

3.1.4.2 Sample Sites

A total of seven non-permanent flora and vegetation survey relevés were established in the Survey Area during the field survey. Relevé locations were selected to ensure that at least three relevés sampled each vegetation pattern initially identified from aerial photography interpretation, where possible (as per **Section 3.1.3**). Vegetation boundaries or transition zones were avoided. Additional relevés were established in areas that were not identified by the initial aerial photography interpretation but were observed in the field to differ from pre-identified areas, or areas of unusual habitat. The final relevé locations were adjusted from the initial proposed locations where:

- variations in floristic patterning were observed, including placing additional relevés in areas of unusual habitat
- the vegetation had been recently disturbed
- the vegetation had been recently burnt (< 2 years) (where possible)
- access or safety issues were encountered.

Relevés surveyed an area within a radius of approximately 10 m around a central point. Within each relevé, dominant vascular flora taxa (native and introduced) that were visually identifiable in each stratum level were recorded. At least one reference specimen of most taxa recorded (excluding common, distinctive taxa) was collected for verification and identification purposes (**Section 3.1.5**).

The following information was recorded at each relevé:

- personnel
- unique site name
- survey date
- Global Positioning System (GPS) coordinates at the centre of the relevé (recorded using handheld GPS units) (Geocentric Datum of Australia 1994 (GDA94), Zone 50)
- site photograph, taken at the centre of the relevé
- topography (including landform type and slope class)
- soil colour and type (including the presence of any rock outcropping and surface stones)
- vegetation condition (as per EPA Technical Guidance (EPA, 2016d) for the Eremaean and Northern Provinces; scale presented in **Table 3.3**) and a description of disturbances (where relevant)
- approximate time since fire
- foliage cover (%) and average height (m, excluding climbers/aerial shrubs) for all dominant taxa (native and introduced) within each stratum level
- additional flora taxa not previously recorded elsewhere.

All relevé locations and traverses made during the flora and vegetation field survey are presented in **Figure 3.1**.

3.1.4.3 Targeted Survey for Significant Flora and Vegetation

Systematic targeted survey for significant flora taxa and vegetation was undertaken as part of the field survey over the entirety of the Survey Area (excluding the large cleared area of the existing airstrip). For significant flora taxa that have known flowering periods, all but one taxon identified by the desktop assessment as potentially occurring within the Survey Area were considered to be theoretically identifiable during the field survey (**Section 5.1.3**). In addition, all significant vegetation communities identified by the desktop assessment were considered to be identifiable irrespective of time of survey. Therefore, all such taxa and vegetation were targeted during the field survey.

Information relating to identifying characteristics, flowering period and habitat of significant flora taxa, and relating to dominant taxa, soil and landform characteristics for significant vegetation, was provided to all field team members prior to undertaking targeted survey. Targeted survey was undertaken in a grid pattern via traverses spaced approximately 40 m apart. Where plants of significant flora taxa were encountered, or where transects intersected habitat of less conspicuous flora, survey was undertaken between transects.

The following information was recorded along traverses (where significant flora taxa and/or significant vegetation was encountered):

- location (including GPS coordinates and datum, recorded using handheld GPS units), taxon and count of any significant flora encountered at location within a radius of approximately 5 m from GPS coordinates

- location (including GPS coordinates and datum, recorded using handheld GPS units), community name and extent of any significant vegetation encountered within a radius of approximately 5 m from GPS coordinates

- comments on habitat, including landform and soils, vegetation condition, description of disturbances and any apparent correlation between vegetation and landform features, as necessary.

If new locations of significant flora taxa were identified, a representative collection of material was made (**Section 3.1.5**). Targeted significant flora and vegetation searching was also undertaken opportunistically while traversing to relevé locations. Information recorded at such locations was the same as that recorded during targeted searching. No counts of taxa were made where hitherto unknown significant flora taxa were identified from plant collections taken at relevé locations or opportunistically. Similarly, boundaries of hitherto unknown significant vegetation communities were not recorded during the field survey.

All traverses made during the flora and vegetation field survey are mapped as track logs in **Figure 3.1**.

3.1.4.4 Introduced Flora Taxa

Opportunistic locations of introduced flora taxa encountered while traversing between relevés, and while undertaking targeted survey for significant flora taxa and vegetation, were recorded using the same method as for significant flora taxa, with particular emphasis given to WoNS and Declared Pests.

3.1.5 Plant Collection, Identification and Nomenclature

Specimens of any unknown flora taxa encountered during the field survey were collected and pressed as per Western Australian Herbarium (WA Herbarium) guidelines (WA Herbarium, 2020). Plant identifications were undertaken at the WA Herbarium and were overseen by a Principal Botanist with extensive previous experience (> 15 years) in plant identifications for flora of WA, including flora of the Murchison region (**Section 3.1.2**). The identification of all flora taxa (including significant taxa) used the most up to date information available, including taxonomic keys published in books, journals and online, comparison with herbarium specimens, and consultation with taxonomic experts. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest, including botanists at the WA Herbarium.

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 WA.

As per section 7.2 of EPA Technical Guidance (EPA, 2016d), specimens of interest, including significant flora taxa, taxa representing range extensions, potential new taxa, and key species in new occurrences of TECs and PECs, 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).

3.1.6 Vegetation Type Definition, Description and Mapping

Floristic and structural data recorded at relevés was examined to define discrete VTs of the Survey Area. Locations of relevés were used in conjunction with aerial photograph interpretation and desktop information to develop VT mapping polygon boundaries. Mapping boundaries were developed using aerial photography on a scale of 1:5,000 and reflected changes in vegetation patterns visible at this scale. The VT mapping polygon boundaries were then digitised using Geographic Information System (GIS) software.

VT descriptions have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI, 2003), as stipulated by EPA Technical Guidance (EPA, 2016d). This model follows nationally-agreed guidelines to describe and represent VTs, so that comparable and consistent data are produced nation-wide. VTs were defined and described using the structural vegetation classification technique as outlined in EPA Technical Guidance. This classification uses vegetation structure and dominant species to describe VTs, with information provided on height of strata, foliage cover and dominant species, as well as substrate and landscape factors.

This report describes VTs at the NVIS Sub-Association level; this level is considered most appropriate for the vegetation of the Survey Area, as often the vegetation possessed one or more additional strata to the traditional three-stratum classification system used at the Association level.

3.1.7 Vegetation Condition Mapping

Vegetation condition was described using the vegetation condition scale presented in EPA Technical Guidance (EPA, 2016d) for the Eremaean and Northern Botanical Provinces (as per **Table 3.3**). Notes on vegetation condition were recorded at all relevés. Vegetation condition category polygon boundaries were developed using this information in conjunction with introduced flora taxa location data and were digitised using GIS software as for VT polygon boundaries.

Table 3.3 Vegetation Condition Scale for the Eremaean/Northern Botanical Provinces (EPA, 2016d)

Ranking	Description
Excellent (E)	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement
Very Good (VG)	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks
Good (G)	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds
Poor (P)	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds
Degraded (D)	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species
Completely Degraded (CD)	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs

3.1.8 Significant Vegetation

To determine the presence of TECs and PECs defined from quadrat-derived data, EPA Technical Guidance (EPA, 2016d) requires comparison of the quadrat data with that of the survey in which the TEC or PEC was originally described. However, limited information is available for TECs and PECs of the Murchison region. Generally, only broad descriptions are provided in the respective TEC and PEC lists to allow for diagnosis. The vegetation of the Survey Area was therefore manually compared to such descriptions to determine whether any vegetation may represent a TEC or PEC; specifically, comparisons of dominant taxa, soils, topography and geographical distribution of VTs were made to those of any relevant TEC or PEC. A similar process was followed for TECs listed under the EPBC Act, with comparisons made to the appropriate listing and conservation advice for any TECs likely to occur in the Survey Area.

The remaining significant vegetation criteria other than "being identified as a TEC and PEC" were applied to VTs mapped in the Survey Area to determine whether a VT was significant in a local or regional context. However, in a regional context, limited information is available for comparison with VTs in the Survey Area. This is discussed further in **Section 5.2.5**.

3.1.9 Likelihood of Occurrence Assessments

A likelihood of occurrence assessment was completed for significant flora taxa and vegetation that were identified as part of the desktop assessment as potentially occurring within the Desktop Study Area but were not recorded by the flora and vegetation field assessment in the Survey Area. The likelihood of occurrence rated species and vegetation communities as "likely", "possible" or "unlikely" to still occur in the Survey Area, based on whether the Survey Area is located within the known range of the taxon/community, whether potentially suitable habitat is present in the Survey Area, and appropriate survey timing to be able to adequately detect and identify the taxon.

3.2 Fauna

3.2.1 Desktop Assessment

Prior to commencement of the fauna survey, a review of all publicly available fauna data relevant to the Survey Area, as listed in **Table 3.4**, was undertaken to identify the potential presence of significant fauna species within the Survey Area. This included obtaining and reviewing copies of reports of previous biological surveys carried out within the vicinity of the Survey Area (where available), including via interrogation of the IBSA database. It should be noted that the desktop assessment focussed only on terrestrial vertebrate fauna; invertebrates and aquatic species were excluded.

The list of fauna expected to occur in the Survey Area was reviewed against a number of sources, including publications that provide information on general patterns of distribution of frogs (M. J. Tyler et al., 2000), reptiles (Storr et al., 1983, 1990, 1999, 2002; Wilson & Swan, 2017), birds (Barrett et al., 2003; Johnstone & Storr, 1998, 2004) and mammals (Churchill, 2007; Menkhorst & Knight, 2011; van Dyck & Strahan, 2008). This was to ensure that all potential species were accounted for.

Table 3.4 Searches Undertaken for the Fauna Desktop Assessment

Source	Search Attributes	Search Purpose
Atlas of Living Australia (ALA) Spatial Portal (ALA, 2023)	Approximate Desktop Study Area boundary	Identify significant fauna taxa with records in the Approximate Desktop Study Area
DCCEEW SPRAT Database (interrogated using the Protected Matters Search Tool) (DCCEEW, 2023d)	Database interrogated using Desktop Study Area boundary, 5 September 2023	Identify MNES, including Threatened fauna and migratory species listed under the EPBC Act, that occur or have the potential to occur within the Desktop Study Area
DBCA Dandjoo Database (DBCA, 2023b)	Database interrogated using Desktop Study Area boundary, 29 August 2023	Obtain records of DBCA-listed significant fauna taxa within the Desktop Study Area
DBCA NatureMap (DBCA, 2023g)	Database interrogated using Desktop Study Area boundary. Search performed 29 August 2023, reference 92-0823NM	Obtain records of DBCA-listed significant fauna taxa within the Desktop Study Area
DBCA Significant Fauna Database (DBCA, 2023d)	Database interrogated using Desktop Study Area boundary. Search performed 28 August 2023, reference 7896	Obtain records of DBCA-listed significant fauna taxa within the Desktop Study Area
IBSA database (DWER, 2022)	Approximate Desktop Study Area boundary	Obtain copies of reports and associated spatial data (where available) to identify records of significant and introduced fauna in the vicinity of the Survey Area
Previous fauna surveys conducted for the Project or within or in the vicinity of the Survey Area (various sources)	Approximate Desktop Study Area boundary	Identify records of significant and introduced fauna in the vicinity of the Survey Area

3.2.2 Personnel and Licensing Information

Table 3.2 lists the personnel involved in fieldwork, fauna habitat mapping and report preparation for the fauna assessment.

Table 3.5 Fauna Assessment Personnel and Licensing Information

Personnel	Experience	Licence	Role
Brittany Osborn MBiolSc (Zoology) BAnimSc (Hons)	4.5 years	Scientific use licence U321/2022-2024	• Field survey • Fauna habitat mapping • Report preparation

3.2.3 Aerial Photography Interpretation and Survey Design

The design of the fauna survey complies with the requirements of EPA Technical Guidance (EPA, 2020) and is consistent with the methods used for other similar fauna assessments conducted within the vicinity of the Survey Area (**Section 6.1.1**) and the wider Murchison Bioregion.

As with the flora and vegetation survey, initial interpretation of ortho-rectified aerial photography at a scale of 1:10,000 was conducted to determine preliminary vegetation patterns present within the Survey Area in order to propose fauna habitat sampling locations. Greater sampling was proposed for widespread and/or variable vegetation patterns, with sampling locations allocated across their geographic range.

3.2.4 Field Survey

3.2.4.1 Survey Timing and Access

The fauna field survey was undertaken over a single two-day site visit, from 19th to 20th September 2023, concurrently with the flora and vegetation assessment. The timing of the field survey was selected to coincide with what is considered to be the most appropriate time to survey in the Eremaean climatic region; as per EPA Technical Guidance (EPA, 2020), this is generally September to April for reptiles, and immediately after significant rain events for amphibians and birds. Survey timing for mammals is not as constrained as it is for reptiles, given they are homeothermic, and therefore for efficiency, it is recommended that mammal surveys be concurrent with reptile surveys.

The Survey Area was accessed by vehicle using existing access tracks and via foot traverses. Appropriate landholder/manager permissions were obtained prior to undertaking the field survey.

3.2.4.2 Fauna Habitat Assessment

The fauna habitat assessment was undertaken to record fauna habitat values in accordance with the methods defined in section 4.1 of the *Technical Guidance for Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA, 2020). These assessments provide an indication of likely fauna utilisation and suitability for fauna species, including conservation significant fauna. Habitat attributes recorded during the field survey included:

- Vegetation structure and dominant species, including a description of canopy, shrub and ground layer structure and composition.

- Soil characteristics including type, composition, and colour.
- Bare ground and the presence of bedrock.
- Presence and abundance of tree hollows in multiple size classes:
    - 1-5 cm
    - 5-10 cm
    - > 10 cm
- Presence and abundance of woody debris such as habitat logs and ground timber.
- Presence, abundance and depth of leaf litter.
- Presence of rocky habitat such as surface rock, boulders, crevices, overhangs, and caves.
- Proximity to water bodies (both permanent and ephemeral).
- Disturbance by invasive weeds or pests.
- Other disturbances such as grazing pressure, clearing, and thinning for fire.
- Evidence of fire history
- Any other significant habitat features, microhabitats or other environmental values.

All habitat sampling locations and traverses made during the fauna field survey are presented in **Figure 3.1**, with coordinates and images of the deployment locations presented in **Appendix A**.

3.2.4.3 Camera Trapping

Five motion sensing cameras (Reconyx Hyperfire 2) were deployed across the Survey Area, targeting a variety of fauna habitat types (**Figure 3.1**; **Appendix A**). Cameras were baited with fish oil spread on the ground adjacent to the camera to attract fauna to the area.

3.2.4.4 Ultrasonic Bat Detectors

Acoustic recordings were undertaken at three sites for one night each using a Wildlife Acoustics SongMeter SM4BAT FS Ultrasonic Bat Detector. The detectors were spread out across the Survey Area to include different fauna habitat types (**Figure 3.1**; **Appendix A**), and set to record between sunset and sunrise. The recordings were later processed by Bat Call WA Pty Limited (Bob Bullen) to identify the presence of specific species.

3.2.4.5 Opportunistic surveys

Non-systematic opportunistic observations of fauna species were made and recorded throughout the duration of the survey. Secondary evidence of fauna such as tracks, diggings and scats were also noted while traversing the Survey Area.

FIGURE 3.1

Track Logs and Sample Sites

Legend

- Survey Area
- Road
- Watercourse
- Property Boundary
- Track Log
- Relevé
- Fauna Camera Trap
- Ultrasonic Bat Detector
- Fauna Habitat Assessment

0 250 500

Metres

Scale 1:12,500 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

3.2.5 Nomenclature

Nomenclature and organisation of species lists generally follows recognised checklists. Names and sequences follows the Checklist of the Terrestrial Vertebrate Fauna of WA (WA Museum, 2023) for mammals and herpetofauna, and the Australian Faunal Directory (ABRS, 2023) for birds. However, in cases where names of fauna taxa have been published recently in scientific literature but have not yet been adopted on the abovementioned sources due to time constraints, nomenclature in the published literature is followed.

3.2.6 Likelihood of Occurrence Assessment

A likelihood of occurrence assessment was undertaken for fauna listed under the EPBC Act and/or the BC Act identified as potentially occurring within the Desktop Study Area during the desktop assessment.

Fauna of conservation significance were assessed and ranked for their likelihood of occurrence in the Survey Area according to the criteria presented in **Table 3.6**. Categories were assigned following review of fauna distribution, available records, known habitat preferences, field verified broad habitat types and availability of suitable microhabitat within the Survey Area.

Table 3.6 Criteria for Assessing Significant Fauna Likelihood of Occurrence

Category	Description
High	The species has been previously recorded in the Survey Area or in the immediate vicinity. The Survey Area contains preferred habitat resources which may support a population of the species.
Moderate	The species is known from the broader area (desktop search extent) and some of the preferred habitat is present within the Survey Area. Note that aerial foragers and other migratory birds that may overfly the Survey Area are also included in this category.
Low	The Survey Area supports some suitable habitat, often marginal. The species may disperse through the Survey Area infrequently and is unlikely to depend on the habitat for survival.
Unlikely	The Survey Area offers limited to no potential habitat for the species, is outside its known range, and/or is lacking broader habitat requirements.

4.0 Adequacy and Limitations of Survey

4.1 Flora and Vegetation

4.1.1 Adequacy of Survey

The Survey Area covers 62 ha, with seven relevés established within it during the flora and vegetation field survey. Relevés were established in all preliminary vegetation patterns discernible by initial aerial photograph interpretation and adjusted based on vegetation patterns and variation observed during the field survey. The number of relevés established in the Survey Area is considered to be acceptable given the small size (approximately 1 relevé established per 8.9 ha of Survey Area) and low diversity of vegetation patterns.

Targeted survey for significant flora taxa and vegetation was undertaken over the entirety of the Survey Area (excluding the large cleared area of the existing airstrip) (**Section 3.1.4.3**).

4.1.2 Limitations of Survey

Table 4.1 presents the limitations of the flora and vegetation assessment of the Survey Area in accordance with EPA Technical Guidance (EPA, 2016d). It is considered that there were no significant limitations associated with the flora and vegetation assessment. However, the low rainfall levels received in the six months prior to the 2023 survey is considered to be a minor limitation of the assessment.

Table 4.1 Assessment of Potential Limitations of the Flora and Vegetation Survey of the Survey Area

Limitation	Determination	Comment
Effort and extent	Not a limitation	A Reconnaissance Survey was undertaken across the entire Survey Area over two days. The number of relevés surveyed for the 2023 survey is considered adequate to characterise the flora and vegetation of the Survey Area, which contains one VT and was sampled by seven relevés across its distribution in the Survey Area. Mapping of vegetation boundaries was undertaken using a combination of aerial photography and information collected at relevés. Systematic Targeted survey for significant flora taxa and significant vegetation identified by the desktop assessment was conducted across the entirety of the Survey Area in a grid pattern via foot traverses spaced approximately 40 m apart. Opportunistic targeted survey for significant flora and vegetation was also undertaken while traversing the Survey Area to establish relevés. It is considered that there was no limitation in terms of survey extent. No constraints prevented appropriate sampling techniques (relevé establishment, foot traverses) being employed. All areas were relatively easy to access using available roads/access tracks. Data reliability is therefore considered to be relatively high.
Competency / experience of the team carrying out the survey	Not a limitation	The Project Manager has previous experience (7 years) in conducting similar assessments in WA, including in the Murchison Region. The Field Manager has extensive experience (> 15 years) in conducting systematic sampling in WA and the Murchison Region. Senior personnel provided guidance to less experienced botanists throughout all aspects of the assessment where necessary. Information relating to identifying characteristics of significant flora taxa and vegetation identified by the desktop assessment as potentially occurring in the Survey Area was provided to the field team prior to undertaking the field survey. Personnel overseeing plant identifications have > 15 years' experience in plant identification in flora of the Murchison Region. Relevant taxonomic experts (including botanists at the WA Herbarium) were consulted for any specimens considered to be difficult to identify or of taxonomic interest.
Proportion of flora recorded and/or collected and identified	Potential minor limitation	The Reconnaissance survey was not intended to provide a full census of the flora of the Survey Area. At least one reference specimen of all taxa recorded (excluding common, distinctive taxa) was collected for verification and identification purposes, and at least one collection was made of all recorded significant flora taxa. All unknown vascular taxa were collected, with specimens identified at the WA Herbarium. All dominant taxa recorded in relevés could be adequately identified to inform the VT definition process. The field survey was undertaken in September 2023, while EPA Technical Guidance recommends that primary flora and vegetation surveys in the Eremaean botanical province be undertaken approximately six to eight weeks post wet season (generally March to June). However, it is considered that this recommendation is generally less applicable to the southern part of the Eremaean botanical province, where most flora taxa flower in spring following winter rainfall; indeed, the majority of

Limitation	Determination	Comment
		significant flora taxa identified by the desktop assessment flower from August to October (see **Section 5.1.3**). Therefore, the timing of the field survey is considered appropriate for a primary flora and vegetation assessment of the Survey Area. Precipitation received at Boolardy Station in the six months preceding the start of the 2023 field survey (113.1 mm) was below the long-term average for this period (155.8 mm). Given the low rainfall levels, annual and ephemeral species presence and diversity was low, and the condition of many perennial taxa, particularly medium to large sized shrubs, was poor, and many were not in flower or had senesced. It is possible that a small number of particularly fragile taxa (e.g. some grass species) may not have been detectable or identifiable. While this current assessment was not intended to provide a full census of the flora of the Survey Area, it is possible that some annual or ephemeral significant flora taxa that may occur in the Survey Area may not have been detectable. Therefore, this is considered a potential minor limitation of this assessment.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	Not a limitation	Reasonable contextual information for the Survey Area was available prior to the 2023 field survey. Sources of information used included government databases (DBCA, DCCEEW) and numerous general sources pertaining to the climate, geomorphology, and flora and vegetation of the Murchison Region, all of which are considered to have high reliability. Previous reports and data from the vicinity of the Survey Area as summarised in **Section 5.1.1** are also considered to be generally reliable unless where stated.
Survey timing and weather/season/cycle	Potential minor limitation	The 2023 field survey was conducted in September, which falls within the typical flowering period of the majority of significant flora taxa that were identified by the desktop assessment as potentially occurring in the Survey Area. While September is outside the period recommended by EPA Technical Guidance to undertake primary flora and vegetation surveys in the Eremaean botanical province (six to eight weeks post wet season; generally March to June), the survey timing is considered to be appropriate for the transitional area between the Eremaean and South-Western Interzone provinces, within which the Survey Area is located. Therefore, this is not considered to be a limitation of the assessment. All perennial significant flora taxa identified during the desktop assessment were considered to be identifiable during the field survey, either because the survey period coincided with the taxon's flowering period, or the taxon can be identified reliably when in fruit or sterile. However, as discussed above, below-average precipitation was received in the six months prior to the field survey. While the annual taxon *Gunniopsis divisa* (P3) was recorded by the 2023 survey, it is possible that particularly fragile annual or ephemeral significant flora taxa that may occur in the Survey Area may not have been detectable. Therefore, this is considered a potential minor limitation of this assessment.
Disturbances (e.g. fire, flood, accidental human intervention etc.) that may have affected results of survey	Not a limitation	Evidence of historical grazing was relatively ubiquitous throughout the Survey Area. However, this is a reflection of the land use history in the region and is not specific to the Survey Area. Furthermore, this did not hinder the ability to assess relevés, assign VTs or undertake targeted survey; consequently, this is not considered to be a limitation of the assessment. Small areas of vegetation in the northeastern part of the Survey Area were rated as being in 'Poor' condition. This vegetation was generally fragmented into small, isolated patches by clearing for roads, tracks, laydown areas and infrastructure, with greater evidence of edge effects, dumping, minor weeds levels, and some historical clearing. However, the condition of this vegetation was sufficient to be able to confidently assign a VT, and therefore this is not considered a limitation.

Limitation	Determination	Comment
Remoteness and/or access restrictions	Not a limitation	The Survey Area was relatively easy to access using available roads and access tracks. Areas where access tracks were absent were accessed on foot; the flat terrain and generally low, open vegetation allowed foot access to be relatively straight-forward.

4.2 Fauna

Table 4.2 presents the limitations of the fauna assessment of the Survey Area in accordance with EPA Technical Guidance (EPA, 2020). It is considered that there were no significant limitations associated with the fauna assessment. Comprehensive database records, including conservation significant species, were available and considered adequate to provide appropriate contextual information for the Survey Area. The Survey Area is located in a region within which a number of previous surveys have been undertaken. Umwelt also has previous experience conducting surveys in this region.

It should be noted that the scope of the survey was limited to a Basic Assessment, and therefore no trapping equipment was deployed. Targeted searching for conservation significant fauna was also not included in this assessment. Therefore, cryptic species and those that are not readily identified are unlikely to have been detected during the survey.

In general, various factors are likely to influence the occurrence of some fauna species. These factors include:

- timing (season) of the survey period
- availability of reproductive material such as flowers, fruits and/or seed capsules that fauna feed upon
- species with an expansive home range may not occur on site during the survey period
- difficulties with species identification, such as cryptic species and species that occur in low densities.

Table 4.2 Assessment of Potential Limitations of the Fauna Survey of the Survey Area

Limitation	Determination	Comment
Availability of data and information	Not a limitation	Sufficient contextual information for the Survey Area was available from databases and previous studies prior to the 2023 field survey (**Sections 2.0** and **6.1.1**). Sources of information used included government databases (DBCA, DCCEEW) and numerous general sources pertaining to fauna and fauna habitats of the region, all of which are considered to have high reliability. Previous reports and data from the vicinity of the Survey Area are also considered to be generally reliable unless where stated.
Competency/experience of the survey team	Not a limitation	The Project Manager has previous experience (7 years) in conducting similar assessments in WA, including in the Murchison Region. The zoologist conducting the survey has previous experience (4 years) conducting basic fauna surveys throughout WA.
Scope of survey	Not a limitation	The scope was a Basic fauna survey focusing on terrestrial vertebrate fauna and fauna values. The survey was undertaken across the entire Survey Area over two days.
Timing, weather and season	Not a limitation	The 2023 field survey was conducted in September, which coincides with what is considered to be the most appropriate time to survey in the Eremaean climatic region as per EPA Technical Guidance (EPA, 2020); being September to April for reptiles, and immediately after significant rain events for amphibians and birds. Climactic conditions during and preceding the survey were generally consistent with long-term averages.
Disturbance that may have affected results	Not a limitation	No disturbance occurred during or immediately prior to the survey. There was evidence of historical grazing, in addition to clearing for roads, tracks, laydown areas and infrastructure (resulting in edge effects), dumping, and minor weeds levels. These areas may support a slightly less biodiverse range of fauna species. However, this is not considered to be a limitation of the assessment, as these disturbances (in particular, historical grazing) are relatively ubiquitous throughout the region and are not specific to the Survey Area.
Proportion of fauna identified, recorded or collected	Not a limitation	The Basic survey was not intended to provide a full census of the fauna of the Survey Area; however, all fauna observed opportunistically were able to be identified.
Adequacy of survey intensity and proportion of survey achieved	Not a limitation	The site was adequately surveyed to the level appropriate for a Basic level assessment. Fauna database searches covered a 50 km radius beyond the centroid of the Survey Area. The Basic level assessment was completed.
Access	Not a limitation	The Survey Area was relatively easy to access using available roads and access tracks. Areas where access tracks were absent were accessed on foot; the flat terrain and generally low, open vegetation allowed foot access to be relatively straight-forward

5.0 Results – Flora and Vegetation

5.1 Desktop Assessment

5.1.1 Local Flora and Vegetation Surveys

Flora and vegetation surveys undertaken within and in the vicinity of the Survey Area that are relevant to the Project are summarised in **Table 5.1** (surveys that have been undertaken within the last 10 years only). Note that the nomenclature and conservation status of the taxa presented in **Table 5.1** has been updated where required, and taxa that are no longer listed as significant are not presented.

Table 5.1 Summary of Results of Local Flora and Vegetation Surveys

Project, Author, and Source	Survey Location	Survey Timing	Scope and Parameters of Survey (Flora and Vegetation)	Number of Taxa Recorded	Vegetation	Significant Flora Taxa^	Significant Vegetation	Introduced Taxa^
Square Kilometre Array Ecological Assessment (AECOM, 2014)	Proposed configurations of SKA1-Survey and SKA1-Low, including outline of the Murchison Radio-astronomy Observatory area. Closest location approx. 9 km north of Survey Area	August to September 2014	Reconnaissance and Detailed flora and vegetation survey. • 65 quadrats • Relevés (number not provided) • Traverses on foot targeting suitable habitat likely to support significant flora taxa	• 199 taxa • 82 genera • 36 families	• 15 vegetation communities described and mapped • Majority of vegetation considered to in be Very Good condition	7 Priority taxa recorded	No significant vegetation recorded	4 introduced taxa recorded, none of which are WoNS or Declared Pests
Murchison SKA Road Upgrade Flora and Vegetation Assessment (360 Environmental, 2017)	Three continuous road sections, extending 100 m either side of the sections (Boolardy to Kalli Road, approx. 23 km length; Twin Peaks to Wooleen Road, approx. 51 km; Carnarvon to Mullewa Road, approx. 78 km), as well as eight borrow pits. Closest location approx. 10 km northeast of Survey Area (Boolardy to Kalli Road section)	September to October 2016	Reconnaissance flora and vegetation survey. • 34 quadrats measuring 20 m x 20 m • 129 relevés • Mapping notes • Traverses on foot targeting suitable habitat likely to support significant flora taxa	• 454 taxa • 166 genera • 51 families	• 33 vegetation associations described and mapped • Vegetation condition ranged from Excellent to Completely Degraded, with the majority considered to in be Very Good condition	14 Priority taxa recorded	No significant vegetation recorded	20 introduced taxa recorded, none of which are WoNS or Declared Pests. Note *Portulaca oleracea* not considered by DBCA (2014) to be a weed in the Midwest region; removed from this list
Square Kilometre Array Ecological Assessment - November 2022 (AECOM, 2023)	Numerous small areas covering a total of 56.44 ha. Closest location approx. 3.9 km northeast of Survey Area (TN BP Road Construction Camp)	November 2022	Reconnaissance flora and vegetation survey. • 4 relevés • 8 mapping notes • Traverses on foot for significant flora taxa	• 41 taxa • 20 genera • 12 families	• 3 vegetation communities described and mapped • Vegetation mapped as being in 'Very Good' condition	3 Priority taxa recorded	No significant vegetation recorded	No introduced taxa recorded

5.1.2 Significant Vegetation

The interrogation of DBCA's TEC and PEC Database (DBCA, 2023c) did not return any listed TECs. Four PECs with DBCA-applied buffer polygons were identified within the Desktop Study Area, two of which relate to invertebrate stygofauna communities and are not relevant to a flora and vegetation assessment ('Meeberrie calcrete groundwater assemblage type on Murchison palaeodrainage on Meeberrie Station' (P1) and 'Meka calcrete groundwater assemblage type on Murchison palaeodrainage on Meka Station' (P1)); therefore, these two PECs are not discussed further in a flora and vegetation context. The remaining two PECs relate to BIF vegetation communities, with DBCA-applied buffer polygons of 500 m. These communities are listed in **Table 5.2**. Neither of these PECs have buffer polygons that intersect the Survey Area (**Figure 5.1**).

A review of DBCA's TEC and PEC records spatial database (DBCA-038) (DBCA, 2017b) and current DBCA TEC and PEC lists (DBCA, 2023h, 2023i) did not identify any additional significant vegetation communities within, or having the potential to occur within, the Desktop Study Area. Similarly, interrogation of the DCCEEW SPRAT database with regard to MNES listed under the EPBC Act (DCCEEW, 2023d) did not identify any TECs as occurring or potentially occurring within the Desktop Study Area (full interrogation results presented in **Appendix B**). None of the previous flora and vegetation surveys discussed in **Section 5.1.1** have identified any TECs or PECs within or in the vicinity of the Survey Area, and review of DBCA's TEC and PEC lists (DBCA, 2023h, 2023i) did not identify any other significant vegetation communities that may occur in the Desktop Study Area.

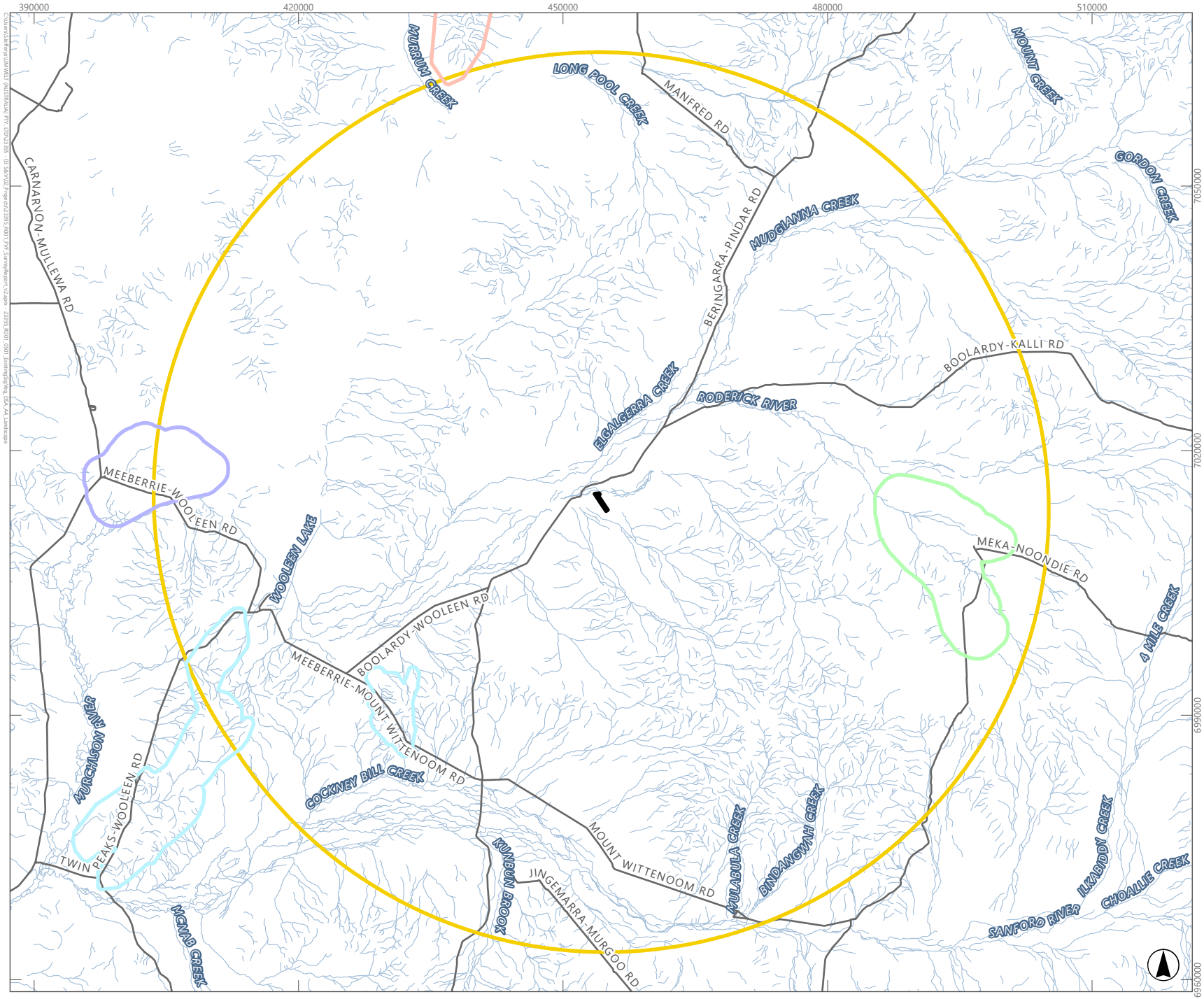
Table 5.2 Significant Vegetation Communities Returned from Desktop Assessment

Community	Status (WA)	Description*	Source	Distance to Survey Area^
New Forest (Including Twin Peaks and Barloweerie Range) vegetation complexes (banded ironstone formation)	PEC (P1)	None available	• DBCA TEC/PEC Database (2023c)	28 km southwest
Mount Dugel/Mount Nairn vegetation complexes (banded ironstone formation)	PEC (P1)	None available	• DBCA TEC/PEC Database (2023c)	49 km north-northwest

** Source: DBCA PEC list (DBCA, 2023h).*
^ Source: DBCA TEC and PEC Database interrogation spatial data (DBCA, 2023c).

FIGURE 5.1

Existing Significant Vegetation Records of the Desktop Study Area



Legend

- Desktop Study Area
- Survey Area
- Road

Significant Vegetation (DBCA, 2023c)

- Meeberrie calcrete groundwater assemblage type on Murchison palaeodrainage on Meeberrie Station
- Meka calcrete groundwater assemblage type on Murchison palaeodrainage on Meka Station
- Mount Dugel/Mount Nairn vegetation complexes (banded ironstone formation)
- New Forest (Including Twin Peaks and Barloweerie Range) vegetation complexes (banded ironstone formation)

0 12 24

Kilometres

Scale 1:600,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), DBCA (2023c)

5.1.3 Significant Flora Taxa

The interrogation of the DBCA WA Herbarium specimen database and TPFL databases (DBCA, 2023e) returned a total of 21 listed significant flora taxa that have records within the Desktop Study Area. No Threatened flora taxa were identified.

The interrogations of the DCCEEW SPRAT database with regard to MNES listed under the EPBC (DCCEEW, 2023d) did not identify any flora taxa listed as Threatened under the EPBC Act as occurring or potentially occurring within the Desktop Study Area (full interrogation results presented in **Appendix B**).

Table 5.3 presents a summary of listed significant flora taxa known to occur or potentially occurring within the Desktop Study Area. This list has been compiled from the results of searches of DBCA's TPFL and WA Herbarium databases (DBCA, 2023e) and the results of local surveys (**Section 5.1.1**). **Table 5.3** also presents the known flowering period and habitat for each taxon, according to data from specimens lodged at the WA Herbarium (1998-).

A total of 24 listed significant flora taxa have previous records in the Desktop Study Area (**Table 5.3**). All taxa are DBCA-classified Priority flora. The locations of these taxa are presented in **Figure 5.2** (subject to the availability of spatial data in the case of records from previous local surveys). There are no existing records of significant flora taxa within the Survey Area, but there are DBCA records of *Angianthus microcephalus* (P2) approximately 192 m north of the Survey Area, and *Eremophila simulans* subsp. *megacalyx* (P3) approximately 730 m northwest.

Table 5.3 Significant Flora Taxa Returned from Desktop Assessment

Taxon	Status (WA)	Source^	Flowering Time*	Habitat*
Angianthus microcephalus	P2	• NM • WAHerb	May, August - December	Saline clay plans, salt flats.
***Baeckea* sp. Mount Barloweerie (J.Z. Weber 5079)**	P1	• NM • TPFL • WAHerb	August	Banded ironstone slopes, chert outcrops, breakaways.
Balladonia aervoides	P3	• 360	August - October	Limestone, sand dunes.
Calandrinia butcherensis	P1	• 360 • NM • WAHerb	August - October	Red sandy loam or sand, undulating plains.
***Calandrinia* sp. Boolardy Station (P. Jayasekara 719-JHR-01)**	P1	• NM • WAHerb	Unknown	Red orange sand/clay. Flats or low plains.
Dicrastylis linearifolia	P3	• WAHerb	October - December	Flats and plains, slopes, ridges and hills. Red or yellow sand, clay loam.
Eremophila muelleriana	P3	• 360 • AECOM • NM • WAHerb	August - October	Granitic soil, red-brown clayey sand.
Eremophila simulans* subsp. *megacalyx	P3	• 360 • AECOM • NM • WAHerb	August - September	Plains with sand, rocky slopes, laterite banded ironstone.
Frankenia confusa	P4	• 360 • AECOM • NM • TPFL • WAHerb	August - November	Riparian zones, saline flats.
Gunniopsis divisa	P3	• AECOM • NM • TPFL • WAHerb	September - November	Slopes with banded ironstone and chert, sandy clay loam soil.
Hemigenia tysonii	P3	• 360 • AECOM • NM • WAHerb	August - January	Brown sandy clay or sand, hills and slopes; banded ironstone, laterite and chert.
Hibiscus krichauffianus	P3	• 360	April, October - November	Stony plains, slopes with sandy loam.

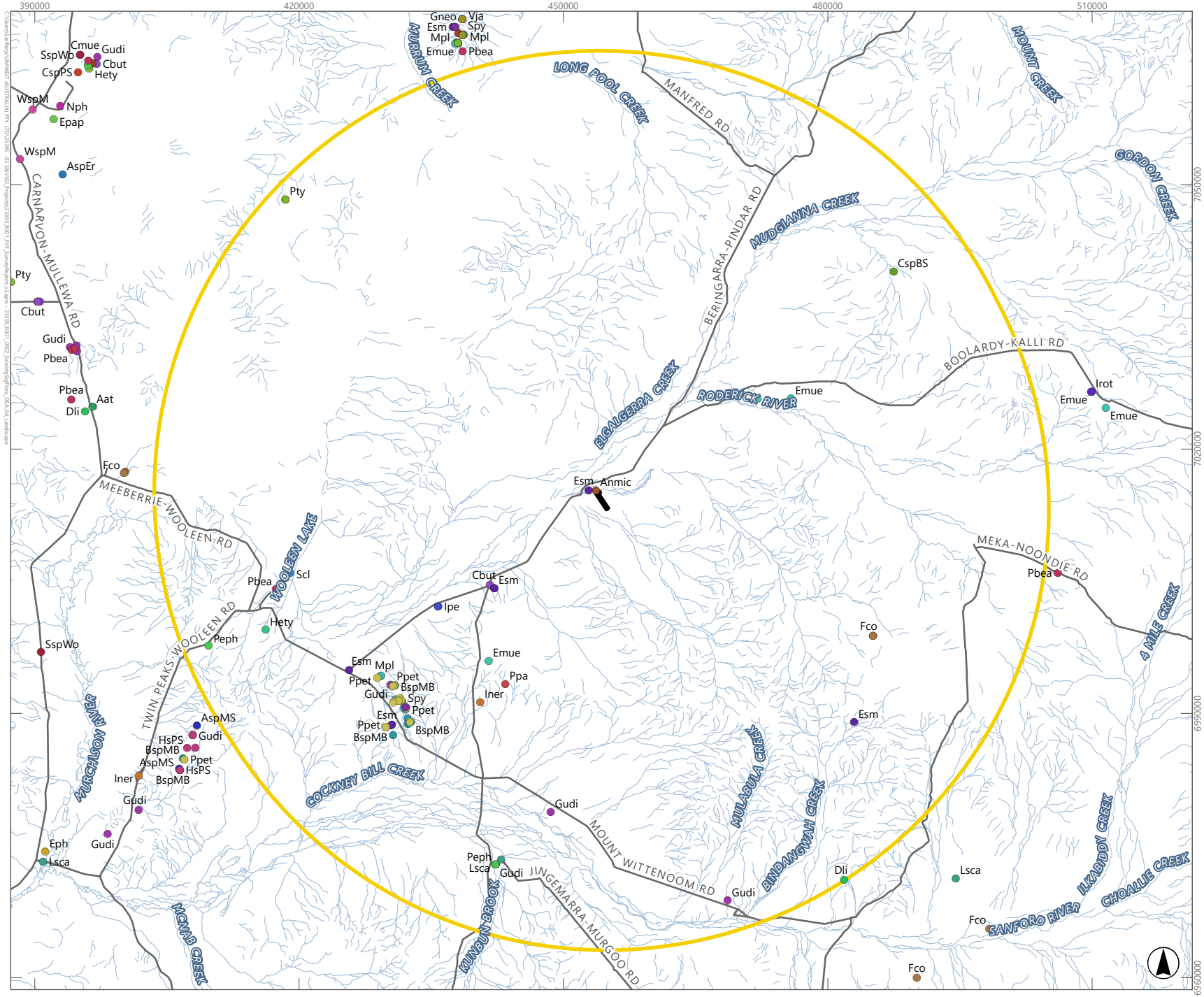
Taxon	Status (WA)	Source^	Flowering Time*	Habitat*
Indigofera eriophylla	P1	• 360 • NM • WAHerb	June - September	Granite outcrops, red sandy clay.
Isotropis petrensis	P1	• NM • WAHerb	July - August	Granite outcrops or sheets, brown loam.
Lepidium scandens	P3	• 360 • NM • WAHerb	August - September	Saline areas, river banks, low lying damp areas, plains.
Micromyrtus placoides	P3	• NM • TPFL • WAHerb	April, August - September	Banded ironstone slopes, laterite. Orange-brown sandy loam.
Petrophile pauciflora	P3	• 360 • NM • TPFL • WAHerb	August - September	Breakaways with granite or laterite; Flats or slopes with loam and clay.
Prostanthera petrophila	P3	• NM • TPFL • WAHerb	March, August - September	Slopes with banded ironstone, flats with basalt and haematite. Red soil.
Prostanthera tysoniana	P3	• NM • WAHerb	June - September	Rocky ridges, flats with red loam clay.
Psammomoya ephedroides	P3	• NM • WAHerb	August - October	Rocky breakaways or flats, red clay loam.
Ptilotus beardii	P3	• AECOM • NM • WAHerb	August - November	Flats, lower slopes of breakaways, red clay loam. Flood plains.
Ptilotus lazaridis	P3	• 360	September - October	Flow lines and flood plains.
Solanum pycnotrichum	P2	• NM • WAHerb	August	Rocky hillsides, gullies, drainage lines. Banded ironstone outcrop.
Stackhousia clementii	P3	• NM • WAHerb	April - September	Floodplains and flats. Clay loam, sometimes saline or with calcrete.

^ Sources are:
360: Murchison SKA Road Upgrade Flora and Vegetation Assessment (360 Environmental, 2017).
AECOM: Square Kilometre Array Ecological Assessment (AECOM, 2014, 2023).
NM: DBCA NatureMap interrogation (DBCA, 2023g).
TPFL: DBCA TPFL Database interrogation (DBCA, 2023e).
WAHerb: DBCA WA Herbarium Specimen Database interrogation (DBCA, 2023e).

** Source: WA Herbarium lodged specimen records data, accessed via Florabase (WA Herbarium, 1998-), except where stated otherwise.*

FIGURE 5.2

Existing Significant Flora Records of the Desktop Study Area



Legend

- Desktop Study Area
- Survey Area
- Road
- Watercourse

0 12 24

Kilometres

Scale 1:600,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), DBCA (2023e)

FIGURE 5.2

LEGEND: Existing Significant Flora Records of the Desktop Study Area

Legend

Label

Aat	*Acacia atopa* (P3)
AspMS	*Acacia* sp. Muggon Station (S. Patrick & D. Edinger SP 3235) (P2)
AspEr	*Anacampseros* sp. Eremaean (F. Hort, J. Hort & J. Shanks 3248) (P1)
Anmic	*Angianthus microcephalus* (P2)
BspMB	*Baeckea* sp. Mount Barloweerie (J.Z. Weber 5079) (P1)
Cbut	*Calandrinia butcherensis* (P1)
CspBS	*Calandrinia* sp. Boolardy Station (P. Jayasekara 719-JHR-01) (P1)
CspPS	*Calotis* sp. Perrinvale Station (R.J. Cranfield 7096) (P3)
Cmue	*Chthonocephalus muellerianus* (P2)
Dli	*Dicrastylis linearifolia* (P3)
Epap	*Eleocharis papillosa* (P3)
Emue	*Eremophila muelleriana* (P3)
Eph	*Eremophila physocalyx* (P3)
Esm	*Eremophila simulans* subsp. *megacalyx* (P3)
Fco	*Frankenia confusa* (P4)
Gneo	*Goodenia neogoodenia* (P4)
Gudi	*Gunniopsis divisa* (P3)
Hety	*Hemigenia tysonii* (P3)
HsPS	*Hibiscus* sp. Perrinvale Station (J. Warden & E. Ager WB 10581) (P1)
Iner	*Indigofera eriophylla* (P1)
Irot	*Indigofera rotula* (P3)
Ipe	*Isotropis petrensis* (P1)
Lsca	*Lepidium scandens* (P3)
Mamu	*Maireana murrayana* (P3)
Mpl	*Micromyrtus placoides* (P3)
Nph	*Neotysonia phyllostegia* (P1)
Ppa	*Petrophile pauciflora* (P3)
Pci	*Philotheca citrina* (P1)
Ppet	*Prostanthera petrophila* (P3)
Pty	*Prostanthera tysoniana* (P3)
Peph	*Psammomoya ephedroides* (P3)
Pbea	*Ptilotus beardii* (P3)
SspWo	*Sauropus* sp. Woolgorong (M. Officer s.n. 10/8/94) (P3)
Spy	*Solanum pycnotrichum* (P2)
Scl	*Stackhousia clementii* (P3)
Vja	*Verticordia jamiesonii* (P3)
WspM	*Wurmbea* sp. Muggon (T.D. Macfarlane & R. Davis TDM 3336) (P1)

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), DBCA (2023e)

5.1.4 Introduced Flora Taxa

Table 5.4 presents a summary of introduced flora taxa that have been previously recorded by local surveys within the Desktop Study Area (**Section 5.1.1**). Also presented in **Table 5.4** are comments regarding the significance of each taxon, including ecological impact and invasiveness ratings as per *Ecological Impact and Invasiveness Ratings from the Department of Parks and Wildlife for the Midwest Region* (DBCA, 2014).

A total of 23 introduced flora taxa have previous records in the Desktop Study Area. None of these taxa are Declared Pests or WoNS (CISS, 2023; DPIRD, 2023).

Table 5.4 Introduced Flora Taxa with Records in the Desktop Study Area

Taxon	Common Name	Source^	Ecological Impact*	Invasiveness*
Asphodelus fistulosus	Onion Weed	• 360	Moderate	Rapid
Avellinia michelii	Avellinia	• 360	High	Rapid
Brassica tournefortii	Wild Turnip	• AECOM	High	Rapid
Cenchrus ciliaris	Buffel Grass	• 360	High	Rapid
Citrullus amarus	Watermelon	• 360	Low	Rapid
Cenchrus setiger	Birdwood Grass	• 360	High	Rapid
Cleretum papulosum		• 360	Unknown	Rapid
Cynodon dactylon	Couch	• 360	High	Rapid
Emex australis	Double Gee	• 360	Low	Rapid
Erodium aureum		• AECOM	Low	Rapid
Hypochaeris glabra	Smooth Catsear	• 360	Low	Rapid
Lolium multiflorum	Italian Ryegrass	• 360	Unknown	Rapid
Lupinus cosentinii	Sandplain Lupin	• 360	Medium	Moderate
Lysimachia arvensis	Pimpernel	• AECOM	Low	Rapid
Mesembryanthemum nodiflorum	Slender Ice Plant	• 360	High	Rapid
Pentameris airoides subsp. airoides	False Hairgrass	• 360	Unknown	Rapid
Polycarpon tetraphyllum	Allseed	• 360	Low	Moderate
Polypogon monspeliensis	Annual Barbgrass	• 360	Moderate	Moderate
Rostraria pumila	Rough Cat's Tail	• 360	Unknown	Unknown
Rumex acetosella	Sorrel	• 360	Unknown	Unknown
Rumex vesicarius		• 360	Unknown	Unknown
Sonchus oleraceus	Common Sowthistle	• 360 • AECOM	Unknown	Rapid
Spergula pentandra	Five Ather Spurrey	• 360	Low	Rapid

^ Sources are:
360: Murchison SKA Road Upgrade Flora and Vegetation Assessment (360 Environmental, 2017).
AECOM: Square Kilometre Array Ecological Assessment (AECOM, 2014).

** Source: Ecological Impact and Invasiveness Ratings from the Department of Parks and Wildlife for the Midwest Region (DBCA, 2014).*

5.2 Field Survey Results

5.2.1 Flora Census

A total of 45 discrete vascular flora taxa and one formally named hybrid (as per WA Herbarium (1998-)) were recorded in the Survey Area by the 2023 survey, 11 of which are annuals and 35 being perennials. The taxa and hybrid represent 16 families and 26 genera. The most well-represented families were Fabaceae (11 discrete taxa and one formal hybrid) and Chenopodiaceae (8 taxa). Note that as discussed in **Section 1.3**, this was a Reconnaissance assessment and therefore a full census of all vascular flora taxa that occur in the Survey Area was not undertaken. However, opportunistic sampling of flora taxa not previously recorded elsewhere was undertaken while traversing the Survey Area.

No Declared Pests or WoNS were observed in the Survey Area.

A full list of flora taxa recorded by the 2023 survey in the Survey Area is presented in **Appendix C**. Raw relevé data and parameters from sites assessed in the Survey Area are presented in **Appendix D**.

5.2.2 Significant Flora Taxa

Two significant flora taxa were recorded in the Survey Area by the 2023 survey, being *Gunniopsis divisa* (P3) and *Hemigenia tysonii* (P3). **Table 5.5** presents a summary of location and abundance data of these taxa as recorded by the 2023 survey, with these locations presented in **Figure 5.3**. A detailed description and summary of information for these taxa are provided in the subsequent sections, and coordinates are presented in **Appendix E**.

Both significant flora taxa recorded by the 2023 survey were recorded by previous surveys in the vicinity of the Survey Area (360 Environmental, 2017; AECOM, 2014) (**Section 5.1.1**).

Table 5.5 presents the number of locations recorded for each significant flora taxon, the VTs within which they were recorded (refer to **Section 5.2.4** for VT descriptions).

Table 5.5 Summary of Significant Flora Taxa of the Survey Area

Taxon	Status (WA)	No. of Locations	No. of Individuals	VTs*
Gunniopsis divisa	P3	2	3	1
Hemigenia tysonii	P3	2	NA~	1

** Refer to **Section 5.2.4** for VT descriptions.*
~ Number of individuals not recorded for taxon.

5.2.2.1 *Gunniopsis divisa* (P3)

Gunniopsis divisa (P3) is a succulent, prostrate annual herb with large white flowers (**Photo 5.1**) that generally occurs in slightly saline clay soils on flats and plains (WA Herbarium, 1998-). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (2022c).

Gunniopsis divisa (P3) is endemic to the Midwest region of WA (ALA, 2023), occurring over a distribution of approximately 340 km, from east-northeast of Meekatharra near Mount Gould in the north to near the Karara mine site in the south (WA Herbarium, 1998-). According to specimens lodged at the WA Herbarium, there are 29 known records of this taxon, potentially representing approximately 23 regional populations, seven of which occur within UCL proposed for conservation (ex-Dalgaranga/Noongal, ex-Karara and ex-Woolgorong Stations) (WA Herbarium, 1998-).

Gunniopsis divisa (P3) was recorded at three locations in the southern part of the Survey Area; one within/adjacent to relevé KK02, and the other as an opportunistic location. The locations occur within VT 1; representative of a level plain with red-brown sandy clay loam.

Photo 5.1 *Gunniopsis divisa* (P3) (photos: Umwelt)

5.2.2.2 *Hemigenia tysonii* (P3)

Hemigenia tysonii (P3) is a low rounded shrub growing to 0.8 m high, and occurs on a range of habitats, including hills and slopes with BIF, laterite or chert, or sand dunes or flats, typically on brown sandy clay or sand (WA Herbarium, 1998-). This taxon is not listed under the EPBC Act or BC Act, but is classified as P3 by DBCA (2022c).

Hemigenia tysonii (P3) is currently known to occur in the Carnarvon, Gascoyne and Murchison IBRA regions over a range of approximately 800 km, from south of Collier Range National Park in the northeast, to Coodardy Station in the south, and west to near Toolonga Nature Reserve (WA Herbarium, 1998-). According to specimens lodged at the WA Herbarium, there are 22 known records of this taxon, potentially representing approximately 18 regional populations, one of which occurs within UCL proposed for conservation (ex-Muggon Station) (WA Herbarium, 1998-).

The records of *Hemigenia tysonii* (P3) made by the 2023 survey within the Survey Area fill a slight locality hole in the known range of the taxon, with the nearest known record located approximately 33 km to the southwest (WA Herbarium, 1998-).

Hemigenia tysonii (P3) was recorded during the 2023 survey from two relevés within VT 1 (KK02 and KK04), in the southern part of the Survey Area.

Photo 5.2 *Hemigenia tysonii* (P3) (left: WA Herbarium scanned specimens; right: close up of flower)

FIGURE 5.3

Significant Flora Taxa of the Survey Area

Legend

- Survey Area
- Road
- Watercourse

Significant Flora (Umwelt, 2023)

- Gudi *Gunniopsis divisa* (P3)
- Hety *Hemigenia tysonii* (P3)

0 250 500

Metres

Scale 1:12,500 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

5.2.3 Likelihood of Occurrence of Further Significant Flora Taxa

As discussed in **Section 5.1.3**, a total of 24 significant flora taxa were identified as occurring (or potentially occurring) within the Desktop Study Area prior to the 2023 survey, all of which are DBCA-classified Priority flora. Two of these taxa were recorded within the Survey Area by the 2023 survey.

Table 5.6 presents an assessment of the likelihood of the remaining 22 taxa still occurring in the Survey Area. This assessment considered whether a taxon was theoretically identifiable at the time of survey, the known range of the taxon, proximity of known records to the Survey Area, and the potential presence of appropriate habitat within the Survey Area, when determining the potential for a taxon to occur. It is worthy of note that suitable habitat has been determined using details recorded at known locations, according to the WA Herbarium (1998-). However, for many of the taxa known from the general vicinity of the Survey Area, suitable habitat is difficult to define, as available habitat information is often vague or very broad and difficult to interpret; for example an area described as a plain with red-brown clay loam could feasibly occur almost anywhere in WA. Therefore, a precautionary approach has been adopted when assessing whether suitable habitat for a species is present in the Survey Area.

It is considered that all 22 significant flora taxa theoretically would have been identifiable during the 2023 survey, either because the survey period coincides with the taxon's flowering period, or the taxon can be identified reliably when in fruit or sterile. This includes *Calandrina* sp. Boolardy Station (P. Jayasekara 719-JHR-01) (P1) that is known from only a single record according to Florabase (WA Herbarium, 1998-). While the lodgement information associated with this record (PERTH 08152217) does not indicate whether the plant was flowering at the time of collection, it is presumed that this is the case given it is an annual taxon, and was considered sufficiently taxonomically unique to raise a phrase name for the entity (as reproductive material is typically required for determination of taxonomic status and affinities). This collection was made in mid-October, while AECOM (2023) reported that the taxon was in flower in September. Therefore, it is likely that the 2023 survey (undertaken in mid-September) coincides with the flowering period of the taxon. However, there is a slight limitation of the assessment due to the below-average rainfall experienced in the region in the months leading up to survey (**Section 2.1**).

Two significant flora taxa have records within the immediate vicinity of the Survey Area. *Angianthus microcephalus* (P2) has a known record (PERTH00414107; collected in 1953), within 200 m of the Survey Area; there is little contextual information available for this record. However, the habitat of this taxon is primarily saline areas including salt flats and clay pans (WA Herbarium, 1998-), and consequently it is assumed that the known location is influenced by the ephemeral creekline area present to the north of the Survey Area. Therefore, it is considered that habitat for this taxon does not occur in the Survey Area (**Table 5.6**). No individuals of this taxon were recorded during the targeted survey, despite the survey being undertaken in the appropriate season for this taxon. *Eremophila simulans* subsp. *megacalyx* (P3) has a historical record of occurrence within 1 km of the Survey Area; this record is from a collection taken in 1960 (PERTH08316813), again with limited contextual information. The habitat at the collection location was noted as being 'plain with sandy surface' (WA Herbarium, 1998-); although the landform of the Survey Area as not particularly sandy, it is likely that similar habitat occurs in the Survey Area. However, no plants of this species were recorded despite systematic searching of the Survey Area during the targeted survey, and therefore it is considered unlikely to occur in the Survey Area (**Table 5.6**).

It is considered that all of the remaining 22 significant flora taxa that were identified by the desktop assessment but not recorded by the 2023 survey, are considered unlikely to occur in the Survey Area; in most cases, no suitable habitat is considered to be present (**Table 5.6**).

Table 5.6 Likelihood of Occurrence of Further Significant Flora Taxa in the Survey Area

Taxon	Status (WA)	Flowering Time*	Habitat*	Identifiable During Survey?	Min. Distance to Survey Area^	Likelihood of Occurrence in Survey Area
Angianthus microcephalus	P2	May, August - December	Saline clay plans, salt flats.	Y	0.2 km N	**Unlikely:** Habitat not considered to be present. Although the known record is in close proximity to the Survey Area, it occurs closer to the ephemeral creekline system located to the north, which would be influenced by increased saline conditions.
***Baeckea* sp. Mount Barloweerie (J.Z. Weber 5079)**	P1	August	Banded ironstone slopes, chert outcrops, breakaways.	Y	31.2 km SW	**Unlikely:** Habitat not considered to be present.
Balladonia aervoides	P3	August - October	Limestone, sand dunes.	Y	102 km SSW	**Unlikely:** Habitat not considered to be present, nearest known location represents eastern extent of distribution.
Calandrinia butcherensis	P1	August - October	Red sandy loam or sand, undulating plains.	Y	15.7 km SW	**Unlikely:** Habitat possibly present however taxon not recorded in Survey Area by targeted searching.
***Calandrinia* sp. Boolardy Station (P. Jayasekara 719-JHR-01)**	P1	Unknown: potentially September - October	Red orange sand/clay. Flats or low plains.	Possible – annual taxon known from a single specimen collected in mid-October (WA Herbarium, 1998-); flowering specimen recorded in	41.6 km NE	**Unlikely:** Habitat possibly present, however nearest known location represents only known record of taxon, and taxon not recorded in Survey Area by targeted searching.

Taxon	Status (WA)	Flowering Time*	Habitat*	Identifiable During Survey?	Min. Distance to Survey Area^	Likelihood of Occurrence in Survey Area
				September by AECOM (2023)		
Dicrastylis linearifolia	P3	October - December	Flats and plains, slopes, ridges and hills. Red or yellow sand, clay loam.	Y	49.9 km SE	**Unlikely:** Habitat possibly present however taxon not recorded in Survey Area by targeted searching.
Eremophila muelleriana	P3	August - October	Granitic soil, red-brown clayey sand.	Y	20.8 km NE	**Unlikely:** Habitat possibly present however taxon not recorded in Survey Area by targeted searching.
Eremophila simulans* subsp. *megacalyx	P3	August - September	Plains with sand, rocky slopes, laterite banded ironstone.	Y	0.7 km NW	**Unlikely:** Habitat possibly present however taxon not recorded in Survey Area by targeted searching.
Frankenia confusa	P4	August - November	Riparian zones, saline flats.	Y	33.3 km SE	**Unlikely:** Habitat not considered to be present.
Hibiscus krichauffianus	P3	April, October - November	Stony plains, slopes with sandy loam.	Y	112 km SSE	**Unlikely:** Nearest known location represents western extent of distribution.
Indigofera eriophylla	P1	June - September	Granite outcrops, red sandy clay.	Y	26.1 km SW	**Unlikely:** Habitat not considered to be present.
Isotropis petrensis	P1	July - August	Granite outcrops or sheets, brown loam.	Y	22.0 km SW	**Unlikely:** Habitat not considered to be present.

Taxon	Status (WA)	Flowering Time*	Habitat*	Identifiable During Survey?	Min. Distance to Survey Area^	Likelihood of Occurrence in Survey Area
Lepidium scandens	P3	August - September	Saline areas, river banks, low lying damp areas, plains.	Y	41.5 km SSW	**Unlikely:** Habitat not considered to be present.
Micromyrtus placoides	P3	April, August - September	Banded ironstone slopes, laterite. Orange-brown sandy loam.	Y	31.2 km SW	**Unlikely:** Habitat not considered to be present.
Petrophile pauciflora	P3	August - September	Breakaways with granite or laterite; Flats or slopes with loam and clay.	Y	22.8 km SW	**Unlikely:** Habitat not considered to be present.
Prostanthera petrophila	P3	March, August - September	Slopes with banded ironstone, flats with basalt and haematite. Red soil.	Y	31.2 km SW	**Unlikely:** Habitat not considered to be present.
Prostanthera tysoniana	P3	June - September	Rocky ridges, flats with red loam clay.	Y	48.3 km NW	**Unlikely:** Habitat not considered to be present.
Psammomoya ephedroides	P3	August - October	Rocky breakaways or flats, red clay loam.	Y	42.2 km WSW	**Unlikely:** Habitat not considered to be present.
Ptilotus beardii	P3	August - November	Flats, lower slopes of breakaways, red clay loam. Flood plains.	Y	37.8 km WSW	**Unlikely:** Habitat possibly present however taxon not recorded in Survey Area by targeted searching.
Ptilotus lazaridis	P3	September - October	Flow lines and flood plains.	Y	113 km NNE	**Unlikely:** Habitat possibly present however nearest known location represents western extent of distribution.

Taxon	Status (WA)	Flowering Time*	Habitat*	Identifiable During Survey?	Min. Distance to Survey Area^	Likelihood of Occurrence in Survey Area
Solanum pycnotrichum	P2	August	Rocky hillsides, gullies, drainage lines. Banded ironstone outcrop.	Y	31.9 km SW	**Unlikely:** Habitat not considered to be present.
Stackhousia clementii	P3	April - September	Floodplains and flats. Clay loam, sometimes saline or with calcrete.	Y	35.7 km WSW	**Unlikely:** Habitat possibly present however taxon not recorded in Survey Area by targeted searching.

** Source: WA Herbarium (1998-).*
^ Source: DBCA databases (DBCA, 2022b).

5.2.4 Vegetation of the Survey Area

A critical review of floristic and structural data collected at relevés in the Survey Area indicated that one VT was present (i.e. VT 1). This is supported by the Pre-European vegetation and soil landscape mapping (**Section 2.2** and **Section 2.3**), with VT 1 corresponding to the Yanganoo soil landscape system and the Upper Murchison 29 VSA in the Survey Area. A summary of the characteristics of VT 1 is presented in **Table 4.5**.

Areas where natural vegetation has been completely and apparently permanently removed, with no (or very scattered) native taxa remaining, have been mapped as 'Cleared Land' (CL) (where discernible at 1:5,000 scale). This includes the airstrip in the centre of the Survey Area, as well as areas cleared for gardens, infrastructure, roads, tracks and laydown areas. A total of 17.5 ha of 'Cleared Land' was mapped, representing 28.4 % of the Survey Area.

VT mapping, including mapping of cleared areas in the Survey Area, is presented in **Figure 4.4**.

Table 5.7 Summary of Vegetation Described in the Survey Area

VT	Summary	Representative Photo
1	**Description:** Low open woodland to isolated trees of *Acacia pteraneura* and occasionally *Acacia caesaneura* (narrow phyllode variant), *Acacia incurvaneura* and *Acacia craspedocarpa*, over occasional tall sparse shrubland of mixed species including *Acacia tetragonophylla*, *Acacia ramulosa* var. *linophylla* and *Acacia cuthbertsonii* subsp. *cuthbertsonii*, over mid open to sparse shrubland of *Eremophila forrestii* subsp. *forrestii* and occasionally *Eremophila galeata* and *Acacia kempeana*, over low isolated shrubs of mixed species including *Solanum lasiophyllum*, *Senna artemisioides* subsp. *helmsii*, *Senna* sp. Meekatharra (E. Bailey 1-26), *Ptilotus obovatus* var. *obovatus* and *Eremophila spuria*, over occasional low sparse to isolated chenopod shrubs of mixed species including *Sclerolaena densiflora*, *Salsola australis*, *Maireana villosa* and *Sclerolaena gardneri*, over low isolated clumps of tussock grasses of mixed species including *Aristida contorta* and *Monachather paradoxus*, on red-brown sandy clay loam or clay loam on flat plains. **Location:** Mapped across the entirety of the Survey Area, excluding cleared land. **Area Mapped (Proportion of Survey Area):** 44.2 ha (71.6 %). **Sample Sites:** 7 relevés (KK01, KK02, KK03, KK04, KK05, KK06 and KK07). **Significant Taxa:** *Gunniopsis divisa* (P3) and *Hemigenia tysonii* (P3). **Variation:** The southern part of this VT as sampled by quadrats KK02 to KK04 had slightly greater diversity, density and cover of mid and low shrubs and tussock grasses. This likely reflects slightly higher sheet flow and availability of surface water during heavy rainfall events, as water flows from the watercourse south of the Survey Area, to Roderick River north of the Survey Area (evident as the darker vegetation patterning on aerial imagery to the south and west of the Survey Area).	 **Photo 5.3 VT 1 (Relevé KK03)**
CL	**Description:** Cleared land; areas where natural vegetation has been completely and apparently permanently removed, with no (or very scattered) native taxa remaining (where discernible at 1:5,000 scale). **Location:** Mapped along the airstrip, as well as areas cleared for gardens, infrastructure, roads, tracks and laydown areas. **Area Mapped (Proportion of Survey Area):** 17.5 ha (28.4 %).	

FIGURE 5.4

Vegetation of the Survey Area

Legend

- Survey Area
- Road
- Watercourse

Vegetation Type

- 1
- CL

0 250 500

Metres

Scale 1:12,500 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

5.2.5 Significant Vegetation

As discussed in **Section 5.1.2**, no TECs listed under the EPBC or BC Acts were identified as being known to occur or likely to occur within the Desktop Study Area. Two DBCA-classified PECs relating to BIF vegetation communities were returned by the desktop assessment. The 'New Forest (Including Twin Peaks and Barloweerie Range) vegetation complexes (banded ironstone formation)' PEC (P1) occurs approximately 28 km southwest of the Survey Area, and while little information is publicly available about this vegetation community, it is likely geographically restricted to the Twin Peaks and Barloweerie Range. Similarly, the 'Mount Dugel/Mount Nairn vegetation complexes (banded ironstone formation)' PEC (P1), located approximately 49 km northwest of the Survey Area, is likely geographically restricted to the Mount Dugel/Mount Nairn. BIF ranges in the region are often classified by DBCA as PECs due to their high plant endemism and unique restricted plant communities; however, no areas of BIF were observed in the Survey Area, and none of the soil landscape units in the Survey Area indicate the presence of BIF (**Section 2.2**). Given this, and that these two PECs are likely geographically restricted, it is considered that they are not present in the Survey Area.

The 2023 survey did not identify any other vegetation considered to represent any formally-listed TECs or any other PECs additional to those discussed above. In addition, VT 1 as described in the Survey Area by the current assessment is not considered to be significant under any of the categories outlined by EPA (2016b, 2016d) (**Section 1.1** and **Section 3.1.8**), or for any other reason. Based on field observations and aerial photography interpretation, VT 1 – which occurs on plains, a common landform in the region surrounding the Survey Area – is considered likely to extend outside the Survey Area to some extent.

As there is no available region-wide vegetation dataset defined at the same scale at which the Survey Area VT was defined, it is not possible to conclusively assess the significance of the VT in a regional context. However, based on the overall taxon composition of VT 1, it is considered that this vegetation is relatively widespread in the general region surrounding the Survey Area; additionally, the landforms and geology with which this VT is associated, are known to occur widely in the region (**Section 2.2**). This is reflected in a regional sense by the Pre-European and current extent of the Upper Murchison_29 VSA that is intersected by the Survey Area, with this VSA occurring over 1,815,000 ha within the Western Murchison IBRA subregion, and having more than 99 % of its pre-European extent remaining within the IBRA subregion (DBCA, 2019) (**Section 2.3**).

Further to this, it is considered that VT 1 as described by this assessment is equivalent to, or has similarities to, vegetation types described by other assessments within the wider area (**Section 5.1.1**). **Table 5.8** presents a summary of these vegetation types, including the extent mapped within the associated study area. None of these vegetation types were considered by the authors as being representative of TECs or PECs, or otherwise of local or regional significance. These results are considered to support the determination that the vegetation of the Survey Area is also present in the local and regional area, and is not of significance.

VT 1 is not considered to represent preferred habitat for any significant flora taxa that have especially restricted distributions.

Table 5.8 Vegetation Types from Local Flora and Vegetation Surveys with Similarities to VT 1

Project, Author, and Source	Survey Location	Vegetation Types with Similarities to VT 1	Mapped Extent in Study Area (ha)
Square Kilometre Array Ecological Assessment (AECOM, 2014)	Proposed configurations of SKA1-Survey and SKA1-Low, including outline of the Murchison Radio-astronomy Observatory area. Closest location approx. 9 km north of Survey Area	**ApAgEf:** *Acacia pteraneura* low woodland to open woodland over *Acacia grasbyi* and *Acacia tetragonophylla* tall sparse shrubland over *Eremophila forrestii* subsp. *forrestii*, *Senna artemisioides* subsp. *helmsii* and *Eremophila fraseri* subsp. *parva* mid shrubland, on undulating flat terrain with red-brown sandy loam soils	Areas not provided
Murchison SKA Road Upgrade Flora and Vegetation Assessment (360 Environmental, 2017)	Three continuous road sections, extending 100 m either side of the sections (Boolardy to Kalli Road, approx. 23 km length; Twin Peaks to Wooleen Road, approx. 51 km; Carnarvon to Mullewa Road, approx. 78 km), as well as eight borrow pits. Closest location approx. 10 km northeast of Survey Area (Boolardy to Kalli Road section)	**28F:** *Acacia pteraneura* low woodland over *Acacia craspedocarpa*, *Acacia tetragonophylla*, *Eremophila platycalyx* subsp. *platycalyx* tall open shrubland to tall shrubland over *Abutilon cryptopetalum* scattered low shrubs and mixed open herbland, on flow lines and flow areas	350.77
		28W: *Acacia pteraneura* low open woodland over *Acacia tetragonophylla*, (*Acacia ramulosa* var. *linophylla*) scattered tall shrubs over *Eremophila forrestii* subsp. *forrestii* scattered shrubs over (*Eremophila spuria* low open shrubland) with *Monachather paradoxus*, *Eriachne helmsii* scattered grasses to very open grassland and *Ptilotus polystachyus* scattered herbs, on 'wanderrie' plains	132.45
		28H: *Acacia pteraneura* low open woodland to low woodland over *Acacia grasbyi*, *Acacia tetragonophylla* scattered tall shrubs over *Senna* spp., *Eremophila forrestii* subsp. *forrestii* scattered shrubs, on hardpan plain/plains	1,036.20
Square Kilometre Array Ecological Assessment - November 2022 (AECOM, 2023)	Numerous small areas covering a total of 56.44 ha. Closest location approx. 3.9 km northeast of Survey Area (TN BP Road Construction Camp)	**ApAgEf:** *Acacia pteraneura* low woodland to open woodland over *Acacia grasbyi* and *Acacia tetragonophylla* tall sparse shrubland over *Eremophila forrestii* subsp. *forrestii*, *Senna artemisioides* subsp. *helmsii* and *Eremophila fraseri* subsp. *parva* mid shrubland, on undulating flat terrain with red-brown sandy loam soils	3.24

5.2.6 Groundwater and Surface Water Dependent Vegetation

Riparian vegetation is defined as plant communities occurring in association with watercourses, both ephemeral and permanent, and is therefore considered to be dependent on surface water flows and/or groundwater. None of the vegetation in the Survey Area is considered to represent riparian vegetation; however, the vegetation in association with Roderick River to the north of the Survey Area is representative of riparian vegetation.

Mulga communities have been documented to be dependent on the interception of sheet flow water runoff during heavy rainfall events (Dunkerley, 2002a, 2002b). These communities consequently form resource 'hotspots' due to their ability to capture, retain and cycle sediments, nutrients and water during periods of heavy rainfall (Maslin & Reid, 2009). Within the Survey Area, this community is considered to be represented by VT 1, which is mapped on relatively flat, plain areas potentially subject to sheet-flow; this VT is therefore considered to be surface water dependent.

No data is currently available regarding depth to groundwater across the Survey Area. However, based on the taxa recorded in VT 1, it appears unlikely that this VT is representative of groundwater dependent vegetation. Although there appears to be very little information published on groundwater usage by vegetation in the Murchison bioregions, in general, phreatophytic taxa in the Eremaean are large trees from either the genus *Eucalyptus* or *Melaleuca* (Loomes & Braimbridge, 2010). However, no *Eucalyptus* or *Melaleuca* taxa were recorded or observed in the Survey Area. Therefore, it is considered that no phreatophytic taxa are present, and consequently no groundwater dependent vegetation is considered to occur.

5.2.7 Vegetation Condition

Table 5.9 presents the area (ha) of VT 1 and the condition rating(s) (as per EPA (2016d); **Section 3.1.7**) that have been mapped in the Survey Area by the 2023 survey. The vegetation condition mapping is presented in **Figure 5.5**.

The majority of vegetation in the Survey Area was rated as being in 'Very Good' condition (78.6 %; **Table 5.9**); Boolardy station was stocked with cattle and sheep from 1876 until 2014, with the Survey Area displaying evidence of this historical grazing, including loss of biomass, and soil surface erosion and compaction. However, there was otherwise only relatively slight signs of impact to vegetation composition as a result of human activities. This condition rating was mapped in the southern part of the Survey Area (**Figure 5.5**).

The next most common vegetation condition rating was 'Good' (**Table 5.9**), which was mapped in the northwestern part of the Survey Area (**Figure 5.5**). This condition rating was due to moderate levels of historical animal activity, as well as human activity including minor tracks and clearing.

Small areas of vegetation in the northeastern part of the Survey Area were rated as being in 'Poor' condition (**Table 5.9**, **Figure 5.5**). This vegetation was generally fragmented into small, isolated patches by clearing for roads, tracks, laydown areas and infrastructure, with greater evidence of edge effects, dumping, minor weeds levels, and some historical clearing.

Note that while the majority of vegetation in the Survey Area was observed to have been affected by multiple seasons of low rainfall levels (with senescence of shrubs and very little presence of annual and ephemeral taxa), these areas were generally not mapped as being in poorer condition. It is anticipated that the vegetation would recover to baseline levels following sufficient rainfall.

Table 5.9 Vegetation Condition Ratings for VTs Described in the Survey Area

VT	Area Mapped (ha)						
	Excellent	Very Good	Good	Poor	Degraded	Completely Degraded	Total
1	-	34.7	7.8	1.7	-	-	**44.2**

FIGURE 5.5

Vegetation Condition of the Survey Area

Legend

- Survey Area
- Road
- Watercourse

Condition

- Very Good
- Good
- Poor
- Not Applicable

0 250 500

Metres

Scale 1:12,500 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

6.0 Results – Fauna

6.1 Desktop Assessment

6.1.1 Previous Fauna Surveys in the Region

The review of previous fauna surveys in the region was restricted to surveys within 50 km of the Survey Area, i.e. within the Desktop Study Area, in the Murchison region. Note that where fauna records from these surveys have been submitted to DBCA, they will also be returned by the interrogation of the DBCA Threatened and Priority Fauna database (DBCA, 2023d). A summary of the key results of these surveys is provided in **Table 6.1** where they relate to terrestrial vertebrate fauna.

Table 6.1 Summary of Results of Local Fauna Surveys

Project, Author, and Source	Survey Location	Survey Timing	Scope and Parameters of Survey (Fauna)	Significant Fauna Recorded
Oakajee Port and Rail Sanford River Paleochannel Level 1 Vegetation, Flora and Fauna Desktop Assessment (Astron, 2011)	Up to 130 ha of clearing within two footprints totalling 126,380 ha within the shires of Murchison, Yalgoo and Cue. Closest location approx. 32 km south of Survey Area.	May 2011	Desktop assessment	Desktop assessment only
Square Kilometre Array Ecological Assessment (AECOM, 2014)	Proposed configurations of SKA1-Survey and SKA1-Low, including outline of the Murchison Radio-astronomy Observatory area. Closest location approx. 9 km north of Survey Area	September 2014	Basic fauna survey: • Searching for conservation significant fauna • Opportunistic observations • Fauna habitat assessments	• Western Spiny-tailed Skink (*Egernia stokesii badia*) (Note: Suitable habitat and species evidence was recorded approximately 29 km from the current Survey Area)
Square Kilometre Array (SKA) Main Roads Upgrade Fauna Assessment (Bamford, 2016)	Project stage involved the widening of the existing road formation, minor realignments and a single lane seal over approximately 180km of road. Closest location approx. 2 km north of Survey Area.	October 2015	Basic fauna survey	• Malleefowl (*Leipoa ocellata*) • Peregrine falcon (*Falco peregrinus*) • Western Spiny-tailed Skink (*Egernia stokesii badia*) (Note: This species was recorded approximately 22 km from the current Survey Area adjacent to Wooleen-Boolardy Road)
Boolardy Aerodrome Upgrade Works Biological Assessment (GHD, 2018a)	Within Survey Area; clearing area of 7.3 ha.	November 2017	Reconnaissance fauna survey: • Habitat assessments • Opportunistic fauna searches	None recorded

Project, Author, and Source	Survey Location	Survey Timing	Scope and Parameters of Survey (Fauna)	Significant Fauna Recorded
Boolardy Material Pits Targeted Fauna Assessment (GHD, 2018b)	Two areas along Beringarra – Pindar Road within Boolardy Station. Closest location approx. 1 km north of Survey Area.	2018	Targeted fauna survey for: • Malleefowl • Western Spiny-tailed Skink • Shield-backed Trapdoor Spider • Migratory bird species	None recorded
Square Kilometre Array Ecological Assessment (AECOM, 2021)	Reconfigured footprint of the SKA1-Low survey area, focussed on corridors that deviated significantly from previous surveys conducted by AECOM in 2014. Closest location approx. 3 km north of Survey Area	November 2020	Basic fauna survey: • Searching for conservation significant fauna • Opportunistic observations • Fauna habitat assessments	• Western Spiny-tailed Skink (*Egernia stokesii badia*) (Note: Suitable habitat and species evidence was recorded approximately 30 km from the current Survey Area)

6.1.2 Desktop Vertebrate Fauna Assessment Results

Several searches were undertaken to compile an expected fauna species list for the Desktop Study Area. Note that this compiled list does not include marine non-aviary species given the Desktop Study Area is land locked. Where appropriate, nomenclature was updated, with duplicate species removed following nomenclature updates.

A total of 227 fauna species are expected to occur within the Desktop Study Area, 22 of which are conservation significant. A summary of the expected faunal assemblage is presented in **Table 6.2**. The full list of amphibians, reptiles, birds and mammals that were identified in the desktop assessment is presented in **Appendix F**.

Conservation significant fauna records returned from the DBCA Significant Fauna Database interrogation (DBCA, 2023d) are displayed in **Figure 6.1.** Note that the DBCA database interrogation returned a record from 2007 of Western Spiny-tailed Skink (*Egernia stokesii badia*), purportedly located approximately 280 m east of the Survey Area (**Figure 6.1**). However, this record is noted to have an accuracy of 10 km, and the location description states that it occurs at the CSIRO Murchison Radio-astronomy Observatory (approximately 30 km north-northeast of the Survey Area) (DBCA, 2023d); therefore, the coordinates of this record are considered to be erroneous, with the actual location likely occurring further northeast.

Results of the DCCEEW EPBC Act Protected Matters Search Tool are shown in **Appendix B**.

Table 6.2 Summary of Vertebrate Fauna Identified During the Desktop Assessment of the Survey Area

Taxon	Total Species	Introduced Species	Conservation Significant Species				
			Threatened	Migratory	Specially Protected	Priority	Locally Significant
Amphibians	2	0	-	-	-	-	-
Reptiles	28	0	1	-	-	-	-
Birds	174	1	5	14	1	-	-
Mammals	23	7	1	-	-	-	-
Total	**227**	**8**	**7**	**14**	**1**	**-**	**-**

6.1.2.1 Amphibians

There are two species of frog that have the potential to occur in the Desktop Study Area (**Appendix F**). In general, the frog species that occur in the Desktop Study Area are common and widely distributed in the Murchison region. Burrowing frogs, such as the Spencer's Burrowing Frog (*Platyplectrum spenceri*) require winter-wet areas to breed, but during the non-breeding season, they range away from water and can be found in terrestrial habitats where they forage and/or aestivate underground.

6.1.2.2 Reptiles

There are 28 species of reptile that have the potential to occur in the Desktop Study Area, one of which is Threatened, being the Western Spiny-tailed Skink (*Egernia stokesii badia*) (**Appendix F**).

6.1.2.3 Birds

There are a total of 174 species of bird that have the potential to occur in the Desktop Study Area. Of these 174 species, one species is both Threatened and Migratory, with an additional four Threatened, 13 Migratory and one Other Specially Protected species (**Table 6.5**, **Appendix F**).

Table 6.3 Conservation Significant Bird Species of the Desktop Study Area

Common Name	Scientific Name	Conservation Status
Curlew Sandpiper	*Calidris ferruginea*	CR/MI
Malleefowl	*Leipoa ocellata*	VU
Australian Painted Snipe	*Rostratula australis*	EN
Southern Whiteface	*Aphelocephala leucopsis*	VU
Night Parrot	*Pezoporus occidentalis*	EN
Common Sandpiper	*Actitis hypoleucos*	MI
Fork-tailed Swift	*Apus pacificus*	MI
Sharp-tailed Sandpiper	*Calidris acuminata*	MI
Pectoral Sandpiper	*Calidris melanotos*	MI
Red-necked Stint	*Calidris ruficollis*	MI
Long-toed Stint	*Calidris subminuta*	MI
White-winged Tern	*Chlidonias leucopterus*	MI
Grey Wagtail	*Motacilla cinerea*	MI
Night Parrot	*Pezoporus occidentalis*	EN
Glossy Ibis	*Plegadis falcinellus*	MI
Wood Sandpiper	*Tringa glareola*	MI
Common Greenshank	*Tringa nebularia*	MI
Peregrine Falcon	*Falco peregrinus*	OS

6.1.2.4 Mammals

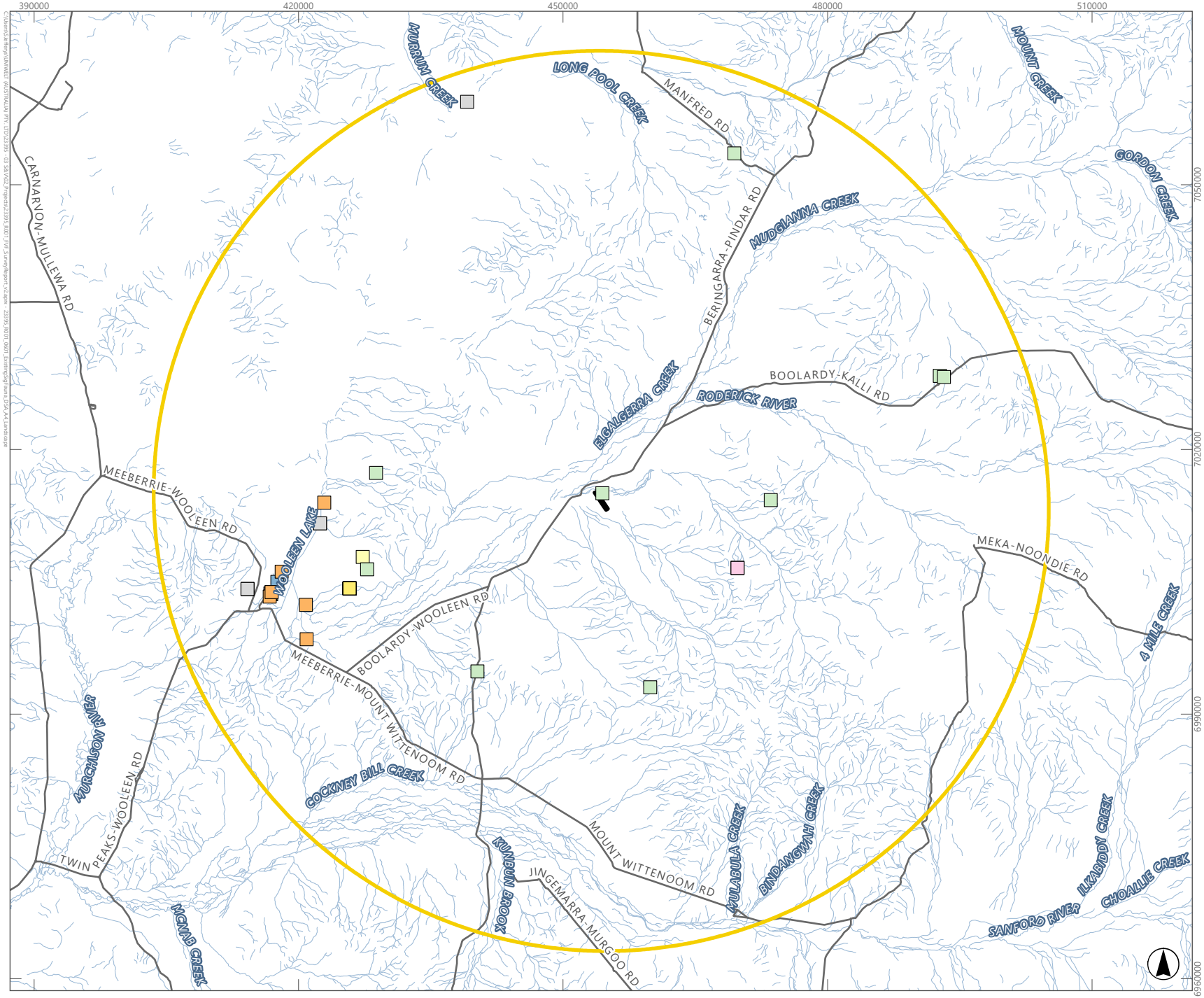
There are 23 species of mammal that have the potential to occur in the Desktop Study Area, of which 16 are native, one of these being Threatened, and seven introduced (**Appendix F**). Several of the mammals listed in **Appendix F** are insectivorous bats. Bats are likely to forage over the Survey Area at night, roosting in tree hollows or crevices by day.

Table 6.4 Conservation Significant and Introduced Mammals of the Desktop Study Area

Common Name	Scientific Name	Status
Black-flanked Rock-wallaby	*Petrogale lateralis* subsp. *lateralis*	EN
European Cattle	*Bos taurus**	Introduced
Goat	*Capra aegagrus hircus**	Introduced
Dingo/Dog	*Canis lupus familiaris**	Introduced
Cat	*Felis catus**	Introduced
European Rabbit	*Oryctolagus cuniculus**	Introduced
Sheep	*Ovis aries**	Introduced
European Fox	*Vulpes vulpes**	Introduced

FIGURE 6.1

Existing Conservation Significant Fauna Records of the Desktop Study Area



Legend

- Desktop Study Area
- Survey Area
- Road
- Watercourse

Significant Fauna (DBCA, 2023d)

- Australian painted snipe
- Black-flanked rock-wallaby, Black-footed rock-wallaby, Mooroorong
- Common greenshank
- Curlew sandpiper
- Glossy ibis
- Gull-billed tern
- Long-toed stint
- Northern shield-backed trapdoor spider
- Peregrine falcon
- Sharp-tailed sandpiper
- Western spiny-tailed skink
- Wood sandpiper

0 12 24

Kilometres

Scale 1:600,000 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023), DBCA (2023d)

6.2 Basic Fauna Survey

6.2.1 Fauna Recorded Within the Survey Area

A total of 58 fauna species were recorded during the Basic Fauna Survey, comprising 40 birds, 14 mammals and 4 reptiles (**Table 6.5**). This includes five introduced species (all mammals); Dog (*Canis lupus familiaris*), Goat (*Capra aegagrus hircus*), Rabbit (*Oryctolagus cuniculus*), Cat (*Felis catus*) and European cattle (*Bos taurus*). No amphibians were recorded during the field survey.

Three species were captured by motion camera (**Table 6.5**), with only two of the five deployed cameras capturing these species. Photos captured by the motion cameras are presented in **Appendix I**.

A total of six species of bat were recorded by ultrasonic recorders (**Table 6.5**).

Climactic conditions during and preceding the survey were generally consistent with long-term averages, although precipitation received at Boolardy Station in the six months preceding the start of the 2023 field survey (i.e. February to July 2023) was slightly below the long-term average for this period. Temperatures during the survey ranged between 13.5 - 32° C, and no rain was recorded immediately prior or during the survey (**Section 2.1**).

Table 6.5 Fauna Species Recorded in the Survey Area

Scientific Name	Common Name	Record Type
Reptiles		
Ctenophorus maculatus	Spotted Military Dragon	Opportunistic
Ctenophorus nuchalis	Central Netted Dragon	Opportunistic
Ctenophorus scutulatus	Lozenge-marked Dragon	Opportunistic
Varanus gouldii	Sand Monitor	Opportunistic
Mammals		
Antechinomys laniger	Kultarr	Opportunistic
Austronomus australis	White-striped Free-tailed Bat	Ultrasonic recorder
Chalinolobus gouldii	Gould's Wattled Bat	Ultrasonic recorder
Macropus fuliginosus	Western Grey Kangaroo	Opportunistic
Nyctophilus geoffroyi	Lesser Long-eared Bat	Ultrasonic recorder
Notomys alexis	Spinifex Hopping Mouse	Motion camera
Osphranter rufus	Red Kangaroo	Opportunistic, Motion camera
Scotorepens balstoni	Inland Broad-nosed bat	Ultrasonic recorder
Vespadelus baverstocki	Inland Forest Bat	Ultrasonic recorder
Vespadelus finlaysoni	Finlayson's Cave Bat	Ultrasonic recorder
Canis lupus familiaris*	Dog	Opportunistic
Capra aegagrus hircus*	Goat	Opportunistic
Oryctolagus cuniculus*	Rabbit	Opportunistic
Felis catus*	Cat	Opportunistic
Bos taurus*	European Cattle	Opportunistic

Scientific Name	Common Name	Record Type
Birds		
Acanthiza apicalis	Inland Thornbill	Opportunistic
Acanthiza uropygialis	Chestnut-rumped Thornbill	Opportunistic
Anthus novaeseelandiae	Australian Pipit	Opportunistic
Aphelocephala leucopsis	Southern Whiteface	Opportunistic
Aquila audax	Wedge-tailed Eagle	Opportunistic
Artamus cinereus	Black-faced Woodswallow	Opportunistic
Artamus cyanopterus	Dusky Woodswallow	Opportunistic
Cacatua sanguinea	Little Corella	Opportunistic
Cacomantis pallidus	Pallid Cuckoo	Opportunistic
Certhionyx variegatus	Pied Honeyeater	Opportunistic
Chlamydera guttata	Western Bowerbird	Opportunistic
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush	Opportunistic
Coracina novaehollandiae	Black-faced Cuckooshrike	Opportunistic
Corvus coronoides	Australian Raven	Opportunistic
Corvus orru	Torresian Crow	Opportunistic
Cracticus nigrogularis	Pied Butcherbird	Opportunistic
Cracticus torquatus	Grey Butcherbird	Opportunistic
Dromaius novaehollandiae	Emu	Opportunistic
Eolophus roseicapilla	Galah	Opportunistic
Grallina cyanoleuca	Magpie-lark	Opportunistic
Gymnorhina tibicen	Australian Magpie	Opportunistic, Motion camera
Haliastur sphenurus	Whistling Kite	Opportunistic
Hirundo neoxena	Welcome Swallow	Opportunistic
Lichenostomus virescens	Singing Honeyeater	Opportunistic
Malurus lamberti	Variegated fairywren	Opportunistic
Malurus leucopterus	White-winged Fairywren	Opportunistic
Manorina flavigula	Yellow-throated Miner	Opportunistic
Megalurus mathewsi	Rufous Songlark	Opportunistic
Melopsittacus undulatus	Budgerigar	Opportunistic
Ocyphaps lophotes	Crested Pigeon	Opportunistic
Oreoica gutturalis	Crested Bellbird	Opportunistic
Pachycephala rufiventris	Rufous Whistler	Opportunistic
Phylidonyris niger	White-cheeked Honeyeater	Opportunistic
Pomatostomus superciliosus	White-browed Babbler	Opportunistic
Pomatostomus temporalis	Grey-crowned Babbler	Opportunistic
Psephotus varius	Mulga Parrot	Opportunistic
Purnella albifrons	White-fronted Honeyeater	Opportunistic
Rhipidura leucophrys	Willie Wagtail	Opportunistic
Taeniopygia guttata	Zebra Finch	Opportunistic

6.2.2 Conservation Significant Fauna

The desktop assessment identified that a total of 22 vertebrate fauna of conservation significance may occur in the Desktop Study Area based on the data sources searched, comprising seven Threatened, 14 Migratory and one Specially Protected species (**Section 6.1.2**). The potential occurrence of each of these species has been assessed in the likelihood of occurrence assessment presented in **Appendix G**. This assessment also includes a description of each species' habitat requirements against known habitat elements recorded within the Survey Area. A summary of the results of the likelihood of occurrence assessment is provided in **Section 6.2.4**.

One conservation significant species, the Southern Whiteface (*Aphelocephala leucopsis*) (listed as Vulnerable under the EPBC Act), was recorded during the field survey via opportunistic observation. This taxon is discussed further below.

6.2.2.1 Southern Whiteface (Vulnerable)

Two individuals of Southern Whiteface (*Aphelocephala leucopsis*) (Vulnerable) were observed together moving through low shrubs while traversing the Survey Area. Southern Whitefaces prefer open woodlands or shrublands with an understorey of grasses, shrubs or both. They are often found within inland scrubs of mallee, mulga and saltbush, especially where fallen timber, logs and stumps are present. During periods of drought, they may range outside their normal range in search of wetter habitats (P. Higgins & Marchant, 1990).

These birds feed primarily on insects, spiders, and seeds, taken from the bare ground or leaf litter (Antos et al., 2008; Antos & Bennett, 2006; P. Higgins & Marchant, 1990). Although the species typically forages in small groups of 2 to 8 individuals, birds may congregate in larger flocks during the non-breeding season, with as many as 70 birds recorded in foraging parties in winter. They can often be spotted feeding in mixed flocks with other whiteface and thornbill species (P. Higgins & Marchant, 1990).

Southern Whiteface breed between July and October throughout most of the species' range; however, the timing of breeding can be affected by rainfall in arid regions. Breeding may take place outside their usual season following sufficient rainfall, or they may not breed at all during drought. A clutch size of 3 to 4 eggs is typical (P. Higgins & Marchant, 1990).

According to the Conservation Advice for *Aphelocephala leucopsis* (southern whiteface) (DCCEEW, 2023b), habitat critical to the survival of the Southern Whiteface includes areas of:

- relatively undisturbed open woodlands and shrublands with an understorey of grasses or shrubs, or both.
- habitat with low tree densities and a herbaceous understory litter cover which provides essential foraging habitat.
- living and dead trees with hollows and crevices which are essential for roosting and nesting.

It should be noted that no Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat for this species.

6.2.3 Fauna Habitats of the Survey Area

Fauna habitat types within the Survey Area were identified on the basis of broad vegetation descriptions, representative photographs, aerial photography and six fauna habitat assessment points assessed during the field survey. **Appendix H** presents the raw fauna habitat assessment data.

A total of two habitats were identified, including Low Open Woodland over Open Shrubland, and Cleared land. All habitat types showed signs of impacts from historic grazing, including loss of native understory. Each fauna habitat type, along with a description of the habitat, associated VTs and total area mapped within the Survey Area is presented in **Table 6.6**, while **Figure 6.2** presents the fauna habitat mapping.

Table 6.6 Fauna Habitat Types of the Survey Area

Habitat Type	Broad Vegetation Description	Important Habitat Elements	Associated VT*	Area (ha)
Low Open Woodland over Open Shrubland	Low open woodland to isolated trees of *Acacia pteraneura* and occasionally *Acacia caesaneura* (narrow phyllode variant), *Acacia incurvaneura* and *Acacia craspedocarpa* growing on sandy clay loam substrate. The ground layer of this habitat is sparse and includes bare ground and leaf litter that may provide foraging opportunities for some bird species. The habitat has signs of impacts from previous grazing activities, including reduced shrub and ground cover species. The habitat has the potential to provide a linkage to more structurally diverse habitat types within the local area. Therefore, providing connectivity in the landscape for some species of birds, reptiles and mammals. A drainage line lies just north of the Survey Area, which could act as a movement pathway and refuge for fauna.	Shrubs and tussock grasses as a refuge. Surface stones and soft sand for burrows.	VT 1	44.2 ha (71.6 %)
Cleared	Cleared land; areas where natural vegetation has been completely and apparently permanently removed, with no (or very scattered) native taxa remaining (where discernible at 1:5,000 scale). Cleared land may provide foraging opportunities for birds of prey. Location: Mapped along the airstrip, as well as areas cleared for gardens, infrastructure, roads, tracks and laydown areas.	Dispersal or potential foraging for certain species.	CL	17.5 ha (28.4 %)

** As per **Section 5.2.4**.*

FIGURE 6.2

Fauna Habitat Types of the Survey Area

Legend

- Survey Area
- Road
- Watercourse

Fauna Habitat Type

- Low open woodland to isolated trees of *Acacia pteraneura* and occasionally *Acacia caesaneura* (narrow phyllode variant), *Acacia incurvaneura* and *Acacia craspedocarpa*
- Cleared land

0 250 500

Metres

Scale 1:12,500 at A4
GDA2020 MGA Zone 50

Image Source: ESRI Basemap (2021) | **Data Source:** Landgate (2023), Umwelt (2023), Aurora (2023)

6.2.4 Likelihood of Occurrence of Further Significant Fauna Taxa

As discussed in **Section 6.1.2**, a total of 22 significant fauna taxa were identified as occurring (or having the potential to occur) within the Desktop Study Area prior to the 2023 survey, all of which are listed as Threatened, Migratory or Specially Protected. Of these 22 species, one Threatened species (Southern Whiteface, *Aphelocephala leucopsis*) was confirmed during the survey. An additional nine Threatened, Migratory or Specially Protected species were assessed as potentially occurring, as per the criteria outlined in **Table 3.6, Section 3.2.6**.

Table 6.7 and **Table 6.8** provide the summary of potentially occurring Threatened, Migratory or Specially Protected species within the Survey Area (i.e. those rated 'Low' or higher). The full likelihood of occurrence assessment is provided in **Appendix G**.

Table 6.7 Summary of the Likelihood of Occurrence Assessment of Threatened and Specially Protected Fauna

Species	Likelihood of Occurrence Rating
Peregrine Falcon (*Falco peregrinus*)	Low
Malleefowl (*Leipoa ocellata*)	Low
Australian Painted Snipe (*Rostratula australis*)	Low

Table 6.8 Summary of the Likelihood of Occurrence Assessment of Migratory Species

Species	Likelihood of Occurrence Rating
Fork-tailed Swift (*Apus pacificus*)	Moderate
Long-toed Stint (*Calidris subminuta*)	Low
Gull-billed Tern (*Gelochelidon nilotica*)	Low
Common Sandpiper (*Actitis hypoleucos*)	Low
Sharp-tailed Sandpiper (*Calidris acuminata*)	Low
Glossy Ibis (*Plegadis falcinellus*)	Low

7.0 Conclusions

7.1 Flora and Vegetation

Given the small size of the Survey Area and its low diversity of topographical and geological features, the Survey Area is considered to have low diversity of flora taxa and vegetation types. In the Murchison region, a much greater diversity of vegetation communities (and communities that support taxa with restricted ranges) would be expected where there are areas of relatively high or low topography, such as ironstone, BIF or greenstone ranges, or saline clay pans and lakes. Meanwhile, the Survey Area is dominated by alluvial Mulga plains of low relief and consistent underlying geology, corresponding to relatively uniform vegetation composition.

Systematic searching for all significant flora taxa considered to potentially occur within the Survey Area was undertaken across the entirety of the vegetated Survey Area. This survey was conducted within the flowering period of the majority of flora taxa in the botanical province (including the majority of significant flora taxa identified by the desktop assessment). This survey recorded two significant flora taxa, being *Gunniopsis divisa* (P3) and *Hemigenia tysonii* (P3). Both taxa have been recorded by previous surveys in the local area (**Section 5.1.1**). Both taxa were recorded in the southern part of the Survey Area, within the part of VT 1 that likely experiences higher sheet flow and availability of surface water during heavy rainfall events (this vegetation having slightly greater diversity, density and cover of mid and low shrubs and tussock grasses, evident as the darker vegetation patterning on aerial imagery to the south and west of the Survey Area).

A likelihood of occurrence assessment was undertaken for the 22 significant flora taxa identified by the desktop assessment but not recorded by the 2023 survey. It is considered that all 22 significant flora taxa theoretically would have been identifiable during the 2023 survey, but the taxa are unlikely to occur in the Survey Area. The primary reason for this determination was lack of suitable habitat for the majority of the significant taxa considered to be present. However, the below-average rainfall leading up the survey timing may potentially have had an impact on the visible presence of annual significant taxa in particular.

One VT was defined in the Survey Area using the structural vegetation classification technique. This VT represents a mulga community, and given mulga communities have been documented to be dependent on the interception of sheet flow water runoff during heavy rainfall events, this VT is consequently considered to be surface water dependent. However, it is not groundwater dependent. VT 1 is not considered to represent any formally listed TECs or PECs, or otherwise be of any local or regional significance.

The vegetation in the southern part of the Survey Area was rated and mapped as being in ‘Very Good’ condition due to evidence of historical grazing, including loss of biomass, and soil surface erosion and compaction. The northern part of the Survey Area was mapped as ‘Good’ to ‘Poor’ due to greater levels of animal and human activity, including clearing, edge effects, dumping and minor weeds levels.

There were no survey limitations that are considered to have significantly influenced the results of the flora and vegetation survey; however, the low rainfall levels received in the six months prior to the 2023 survey is considered to be a minor limitation of the assessment. While this assessment was not intended to provide a full census of the flora of the Survey Area, it is possible that some annual or ephemeral significant flora taxa that may occur in the Survey Area may not have been detectable.

7.2 Fauna

The Low Open Woodland over Open Shrubland habitat type comprises 71.6 % of the Survey Area. This habitat type represents the highest value to fauna. The remainder (28.4 %) of the Survey Area is comprised of cleared land, the majority of which is used as an airstrip for the nearby Boolardy Station. This land is highly disturbed and provides limited value to conservation significant fauna.

During the field survey, a total of 58 fauna species were recorded, comprising 40 birds, 14 mammals, and four reptiles. This included one species of conservation significance, the Southern Whiteface (*Aphelocephala leucopsis*), and five introduced mammal species.

While not recorded during the field survey, the Fork-tailed Swift (*Apus pacificus*) (Migratory) was considered to have a 'Moderate' likelihood of occurrence within and in proximity to the Survey Area, due to the Survey Area being within the likely distribution of these species, and suitable habitat (inland plains) potentially being present.

The Survey Area is in close proximity to remnant native vegetation including a drainage line and associated vegetation to the north. This habitat may provide refuge for fauna and act as a dispersal pathway through the landscape into the Survey Area.

There were no survey limitations that are considered to have significantly influenced the results of the fauna survey. It should be noted that the scope was a Basic Assessment; therefore, no fauna traps were deployed, and specific searches for conservation significant fauna were not conducted. As a result, not all species with the potential to occur in the Survey Area would be recorded by this type of survey. Cryptic species and those not readily identifiable are unlikely to be recorded during a Basic Assessment.

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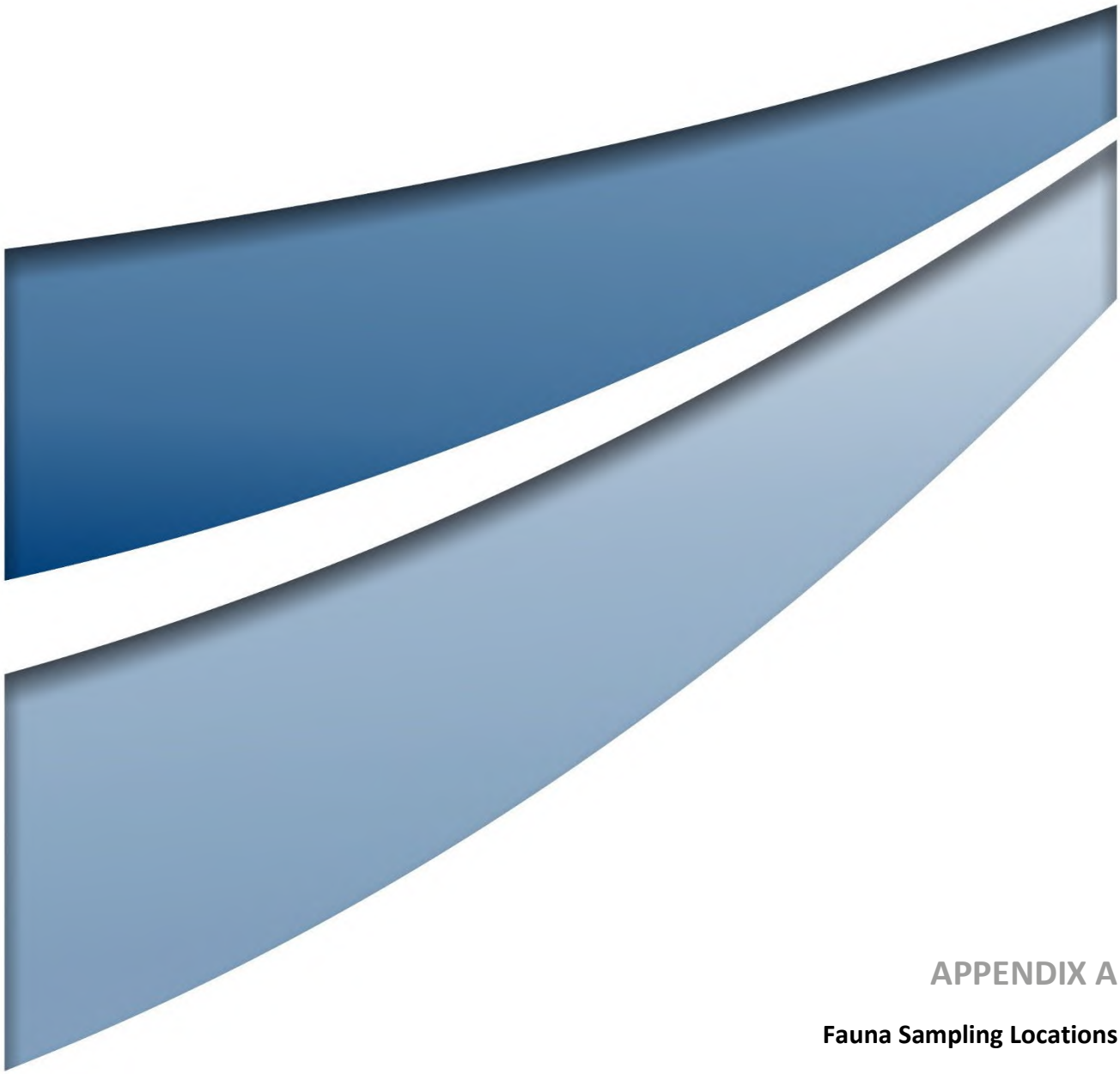


APPENDIX A

Fauna Sampling Locations

All locations are in GDA2020 Zone 50.

Table A.1 Fauna Habitat Assessment Points

Site	Date Surveyed	Habitat	Easting	Northing
Ha1	19/09/2023	Plain	454177	7014278
Ha2	19/09/2023	Mulga woodland	454579	7013593
Ha3	20/09/2023	Plain	454496	7013847
Ha4	20/09/2023	Plain	454774	7013563
Ha5	20/09/2023	Plain	454950	7013358
Ha6	20/09/2023	Plain	454033	7014491

Table A.2 Motion Cameras

Device	Deployed	Collected	Effort	Habitat	Comments	Easting	Northing
QC1	19/09/2023	20/09/2023	1 night	Plain	Next to fence line	454289	7014116
QC2	19/09/2023	20/09/2023	1 night	Plain	Sandy orange soil	454811	7013448
QC3	19/09/2023	20/09/2023	1 night	Plain	Next to airstrip/ camp	453893	7015033
QC4	19/09/2023	20/09/2023	1 night	Plain		454585	7013845
QC5	19/09/2023	20/09/2023	1 night	Clay loam plain	Rubbish surrounding	453815	7014788

Table A.3 Ultrasonic Bat Detectors

Device	Deployed	Collected	Effort	Habitat	Easting	Northing
S4U19188	19/09/2023	20/09/2023	1 night	Plain	454657	7013625
S4U19200	19/09/2023	20/09/2023	1 night	Clay loam plain	454051	7014472
S4U19203	19/09/2023	20/09/2023	1 night	Plain	454112	7015104

Motion Cameras Deployment Locations

QC1

QC2

QC3

QC4

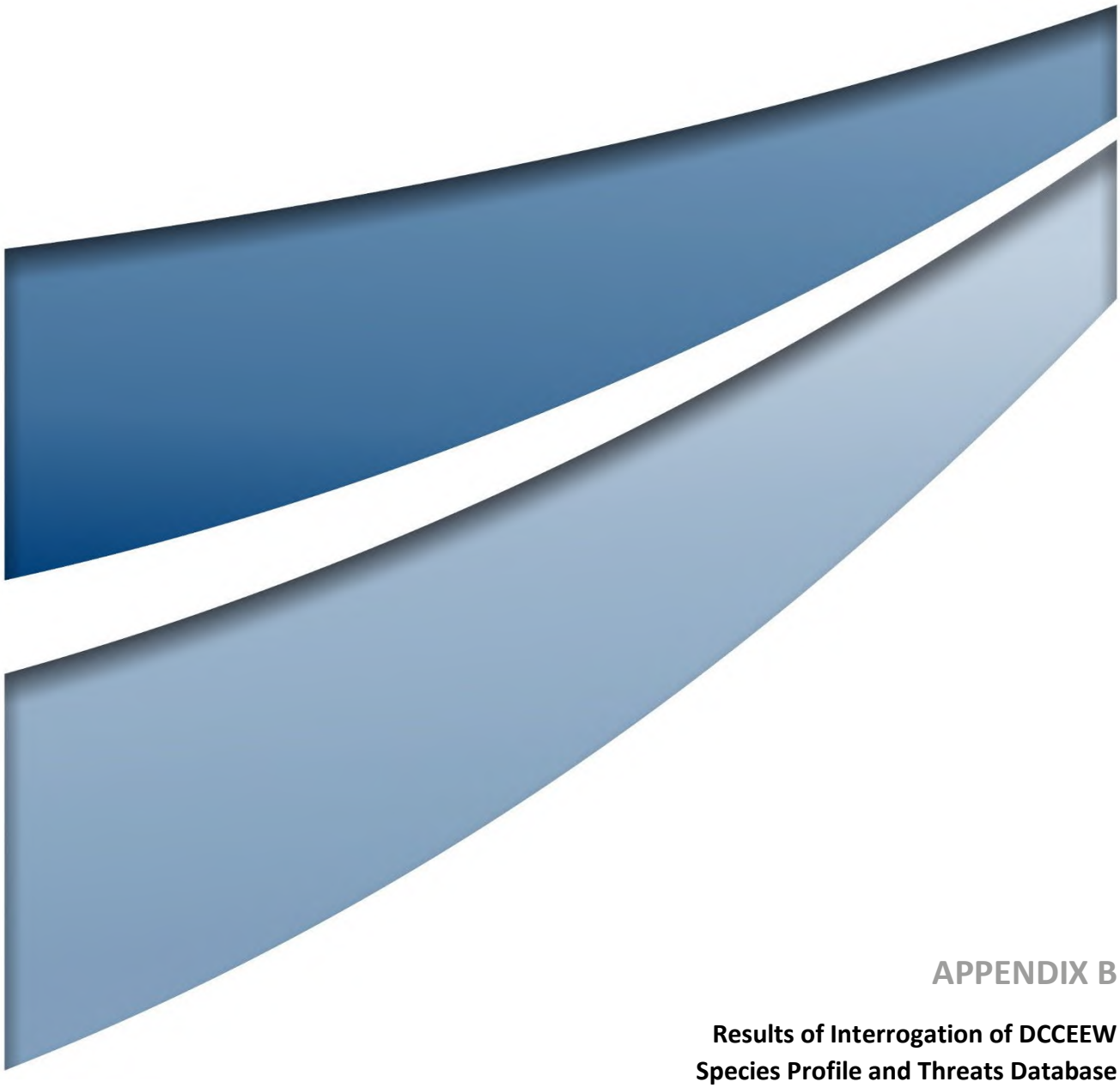
QC5

Ultrasonic Bat Detector Deployment Locations

S4U19188

S4U19200

S4U19203



APPENDIX B

Results of Interrogation of DCCEEW Species Profile and Threats Database (DCCEEW, 2023d)

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 23-Oct-2023

Summary

Matters of National Environment Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	7
Listed Migratory Species:	8

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	1
EPBC Act Referrals:	4
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species			[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.			
Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
REPTILE			
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat known to occur within area	In feature area
SPIDER			
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In buffer area only
Migratory Terrestrial Species			
Motacilla cinerea			
Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In buffer area only
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Tringa nebularia			
Common Greenshank, Greenshank [832]		Species or species habitat may occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In buffer area only
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In buffer area only
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Tringa nebularia			
Common Greenshank, Greenshank [832]		Species or species habitat may occur within area overfly marine area	In buffer area only

Extra Information

Nationally Important Wetlands		[Resource Information]
Wetland Name	State	Buffer Status
Wooleen Lake	WA	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Oakajee Rail Development	2010/5500	Controlled Action	Post-Approval	In buffer area only
Not controlled action				
Development of the Square Kilometre Array 1 radio telescope -Low Frequency Aperture Array, Boolardy	2017/7874	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
Australian Square Kilometre Array Pathfinder telescope & infrastructure	2009/4891	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

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

Threatened, migratory and marine species

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

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

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

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

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

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

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

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

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

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

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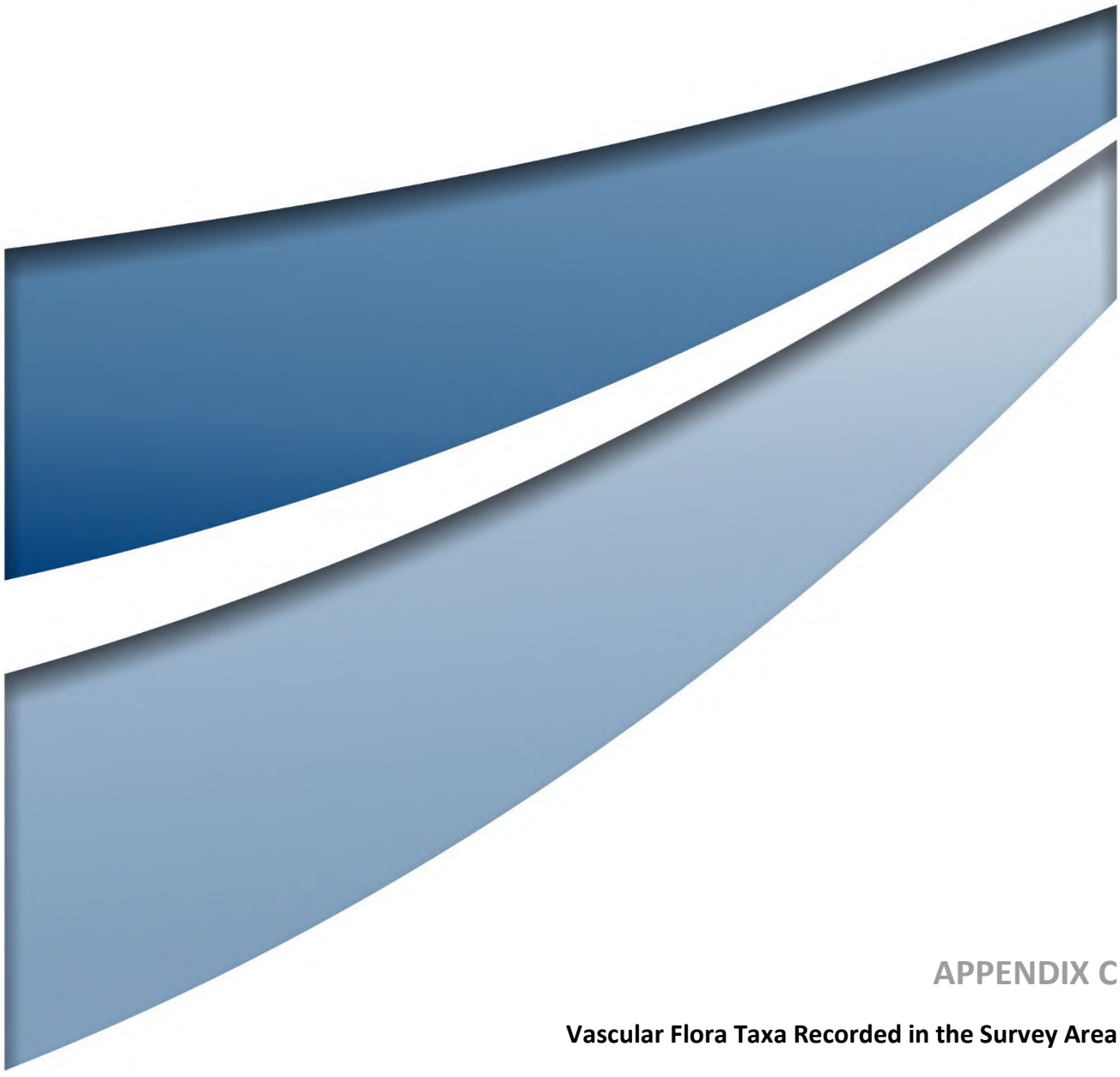
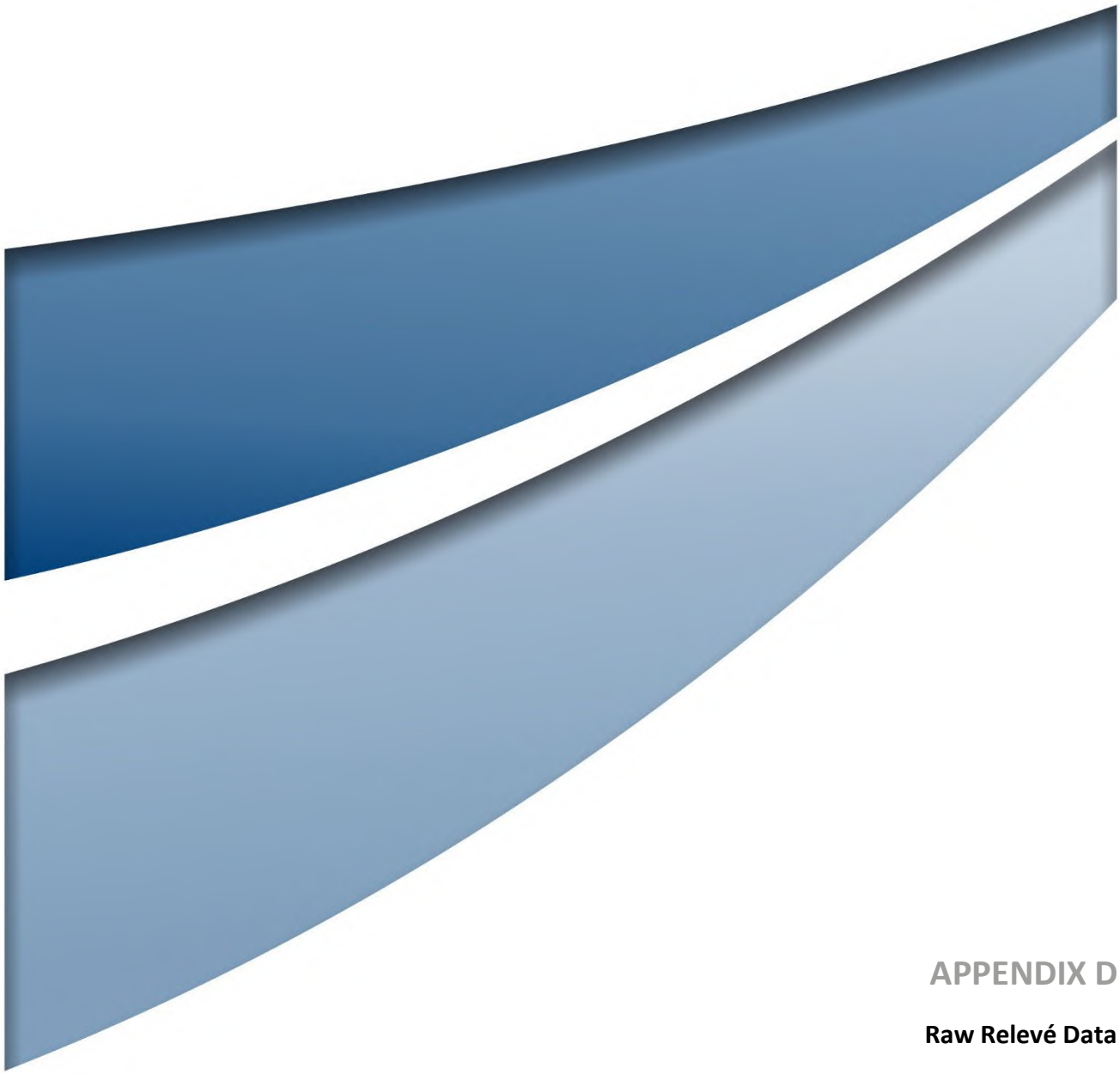


APPENDIX C

Vascular Flora Taxa Recorded in the Survey Area

Family	Taxon
Aizoaceae	*Gunniopsis divisa* (P3)
Amaranthaceae	*Ptilotus exaltatus*
	Ptilotus obovatus var. *obovatus*
Apocynaceae	*Leichhardtia australis*
Asteraceae	*Actinobole oldfieldianum*
	Gnephosis arachnoidea
Boraginaceae	*Trichodesma zeylanicum* var. *grandiflorum*
Brassicaceae	*Stenopetalum anfractum*
Chenopodiaceae	*Atriplex semilunaris*
	Maireana carnosa
	Maireana planifolia
	Maireana villosa
	Rhagodia eremaea
	Salsola australis
	Sclerolaena densiflora
	Sclerolaena gardneri
Euphorbiaceae	*Euphorbia porcata*
	Euphorbia tannensis subsp. *eremophila*
Fabaceae	*Acacia caesaneura* (narrow phyllode variant)
	Acacia craspedocarpa
	Acacia cuthbertsonii subsp. *cuthbertsonii*
	Acacia incurvaneura
	Acacia kempeana
	Acacia pteraneura
	Acacia ramulosa var. *linophylla*
	Acacia synchronicia
	Acacia tetragonophylla
	Senna artemisioides subsp. *helmsii*
	Senna artemisioides subsp. *x petiolaris*
	Senna sp. Meekatharra (E. Bailey 1-26)
Goodeniaceae	*Scaevola spinescens*
Lamiaceae	*Hemigenia tysonii* (P3)
Malvaceae	*Sida kingii*
	Sida ?sp. Pindar (A. Mitchell 3585)
Montiaceae	*Calandrinia creethae*
	Calandrinia polyandra
Poaceae	*Aristida contorta*
	Enneapogon polyphyllus
	Eragrostis eriopoda
	Eriachne helmsii

Family	Taxon
Poaceae cont.	*Monachather paradoxus*
Scrophulariaceae	*Eremophila forrestii* subsp. *forrestii*
	Eremophila galeata
	Eremophila latrobei subsp. *latrobei*
	Eremophila spuria
Solanaceae	*Solanum lasiophyllum*



APPENDIX D

Raw Relevé Data

GOVERNMENT AGENCY REFERENCE ONLY
NOT FOR PUBLIC DISSEMINATION
CONTAINS LOCATIONS OF SIGNIFICANT FLORA TAXA

Site Name:	KK01
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 454584.52E 7013847.69N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	VG - Very Good
Fire:	> 15 years
Habitat:	Scattered tall shrubs over scattered mid shrubs over low open shrubland.

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia craspedocarpa*, *Acacia pteraneura*
Mid Stratum 1:	*Eremophila forrestii* subsp. *forrestii*, *Eremophila galeata*, *Ptilotus obovatus* var. *obovatus*, *Senna artemisioides* subsp. *helmsii*, *Senna* sp. Meekatharra (E. Bailey 1-26), *Solanum lasiophyllum*
Lower Stratum 1:	*Sclerolaena densiflora*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia craspedocarpa	4	7
Acacia pteraneura	4	7
Aristida contorta	0.1	0.1
Calandrinia creethae	0.01	0.1
Eremophila forrestii subsp. *forrestii*	0.5	0.5
Eremophila galeata	1	0.5
Eremophila latrobei subsp. *latrobei*	0.3	0.1
Maireana carnosa	0.01	0.1
Maireana villosa	0.3	0.1
Ptilotus obovatus var. *obovatus*	0.5	0.5
Salsola australis	0.3	0.1
Sclerolaena densiflora	0.1	15
Senna artemisioides subsp. *helmsii*	0.8	0.3
Senna sp. Meekatharra (E. Bailey 1-26)	0.7	0.5
Solanum lasiophyllum	0.5	0.5

PHOTOS

Site Name:	KK02
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 454651.79E 7013629.29N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	VG - Very Good
Disturbance:	Grazing - Historical grazing
Fire:	> 15 years
Habitat:	Tall open shrubland over mid/tall open shrubland over scattered tussock grasses.

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia caesaneura* (narrow phyllode variant), *Acacia kempeana*, *Acacia pteraneura*, *Acacia ramulosa* var. *linophylla*, *Acacia tetragonophylla*
Mid Stratum 1:	*Eremophila forrestii* subsp. *forrestii*, *Senna artemisioides* subsp. *helmsii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia caesaneura (narrow phyllode variant)	5	6
Acacia kempeana	3	2
Acacia pteraneura	5	15
Acacia ramulosa var. *linophylla*	3	3
Acacia tetragonophylla	4	3
Aristida contorta	0.1	0.2
Eragrostis eriopoda	0.2	0.1
Eremophila forrestii subsp. *forrestii*	1.8	15
Gunniopsis divisa (P3)	0.01	0.01
Hemigenia tysonii (P3)	0.4	0.1
Maireana planifolia	0.4	0.1
Monachather paradoxus	0.3	0.3
Senna artemisioides subsp. *helmsii*	0.8	2
Senna artemisioides subsp. *x petiolaris*	0.8	0.5

PHOTOS

Site Name:	KK03
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 454803.53E 7013455.39N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	VG - Very Good
Disturbance:	Grazing - Historical grazing
Fire:	> 15 years
Habitat:	Tall open shrubland over mid open shrubland over scattered tussock grasses.
Comments:	

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia caesaneura* (narrow phyllode variant), *Acacia pteraneura*
Mid Stratum 1:	*Eremophila forrestii* subsp. *forrestii*
Lower Stratum 1:	*Aristida contorta*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia caesaneura (narrow phyllode variant)	5	15
Acacia pteraneura	4	8
Acacia synchronicia	5	1
Acacia tetragonophylla	1.8	2
Actinobole oldfieldianum	0.01	0.2
Aristida contorta	0.1	4
Calandrinia polyandra	0.01	0.1
Eremophila forrestii subsp. *forrestii*	1	15
Eremophila galeata	1	0.5
Eremophila spuria	0.7	1
Euphorbia tannensis subsp. *eremophila*	0.2	0.1
Leichhardtia australis		0.1
Maireana planifolia	0.2	0.2
Maireana villosa	0.3	0.1
Monachather paradoxus	0.3	0.3
Rhagodia eremaea	0.7	0.2
Solanum lasiophyllum	0.3	0.1

PHOTOS

Site Name:	KK04
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 454944.46E 7013362.52N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	VG - Very Good
Disturbance:	Grazing - Historical grazing
Fire:	> 15 years
Habitat:	Tall open shrubland over mid open shrubland over open tussock grassland.

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia incurvaneura*, *Acacia pteraneura*
Mid Stratum 1:	*Eremophila forrestii* subsp. *forrestii*, *Eremophila spuria*
Lower Stratum 1:	*Aristida contorta*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia incurvaneura	5	15
Acacia kempeana	0.5	0.2
Acacia pteraneura	6	15
Aristida contorta	0.1	3
Eragrostis eriopoda	0.2	0.2
Eremophila forrestii subsp. *forrestii*	1.2	17
Eremophila spuria	1	3
Eriachne helmsii	0.4	0.2
Hemigenia tysonii (P3)	0.5	0.2
Monachather paradoxus	0.2	0.2
Senna artemisioides subsp. *x petiolaris*	0.8	0.1
Senna sp. Meekatharra (E. Bailey 1-26)	1.2	0.2
Solanum lasiophyllum	0.3	0.2

PHOTOS

Site Name:	KK05
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 453812.3E 7014784.02N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	G - Good
Fire:	> 15 years
Habitat:	Scattered tall shrubs over scattered mid shrubs over low open shrubland.
Comments:	Poor condition until airstrip.

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia pteraneura*, *Acacia tetragonophylla*
Mid Stratum 1:	*Eremophila forrestii* subsp. *forrestii*, *Eremophila galeata*
Lower Stratum 1:	*Salsola australis*, *Sclerolaena densiflora*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia pteraneura	7	13
Acacia tetragonophylla	3	4
Actinobole oldfieldianum	0.01	0.1
Eremophila forrestii subsp. *forrestii*	0.8	1
Eremophila galeata	0.9	1
Sida ?sp. Pindar (A. Mitchell 3585)	0.1	0.1
Ptilotus obovatus var. *obovatus*	0.3	0.1
Salsola australis	0.2	3
Scaevola spinescens	2	1
Sclerolaena densiflora	0.2	10
Senna artemisioides subsp. *helmsii*	0.8	0.5

PHOTOS

Site Name:	KK06
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 454050.91E 7014469.89N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	VG - Very Good
Disturbance:	Grazing - Historical grazing, Animal Disturbance - Rabbits
Fire:	> 15 years
Habitat:	Scattered shrubs over scattered mid shrub over low grassland.

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia pteraneura	6	21
Actinobole oldfieldianum	0.01	0.1
Aristida contorta	0.1	0.1
Eremophila forrestii subsp. *forrestii*	1.2	7
Eremophila galeata	1.8	3
Gnephosis arachnoidea	0.1	0.1
Maireana villosa	0.3	3
Salsola australis	0.2	0.5
Sclerolaena densiflora	0.3	1.5
Solanum lasiophyllum	0.4	0.1
Stenopetalum anfractum	0.1	0.1

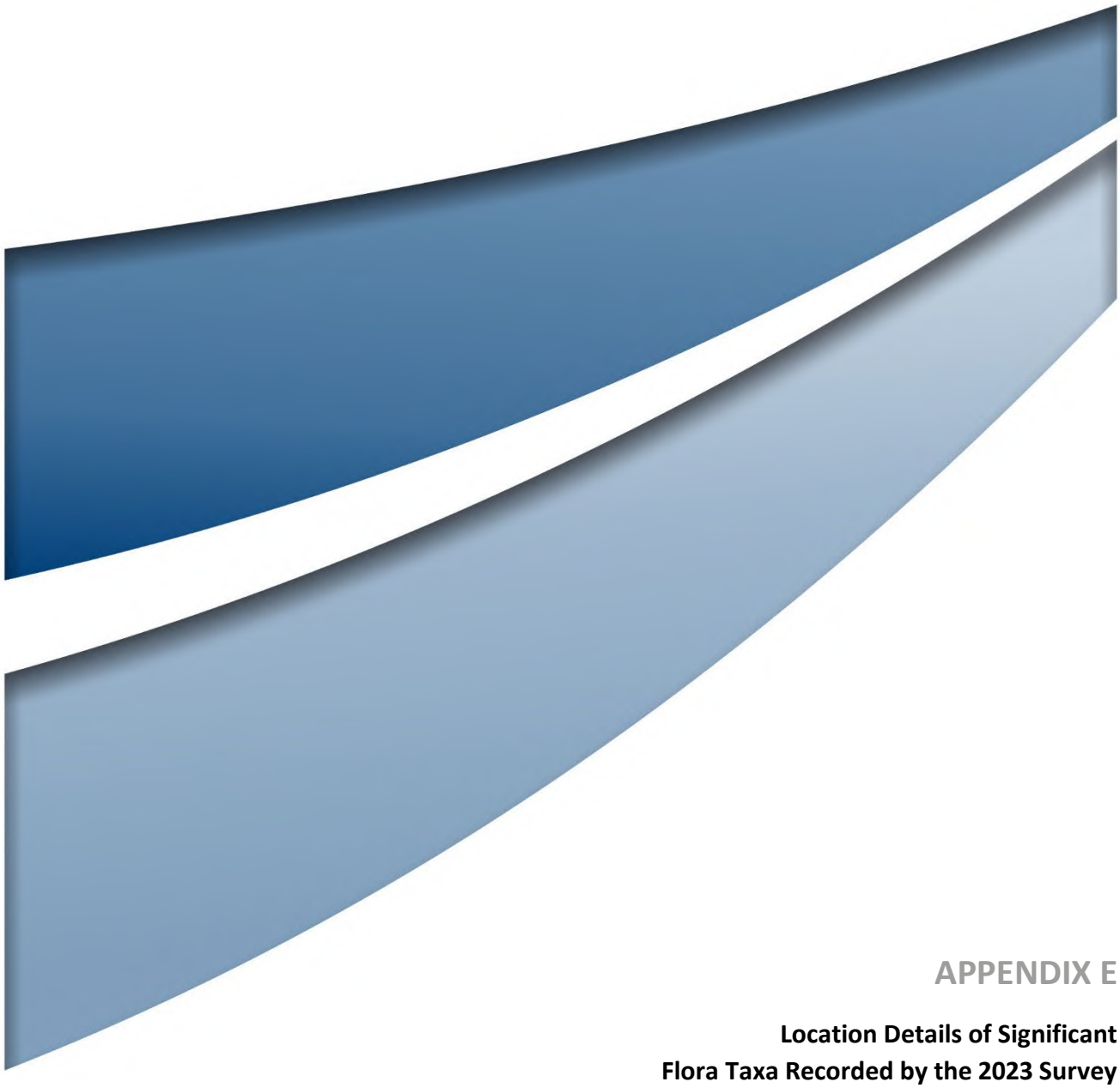
PHOTOS

Site Name:	KK07
Site Type:	RELEVE
Survey Date:	20/09/2023
GPS Location:	GDA94 Zone 50 453912.33E 7015024.08N
Vegetation Type:	1
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	P - Poor
Disturbance:	Grazing - Historical grazing, Limited Clearing - Tracks and other clearing, Exotic Weeds, Rubbish
Fire:	> 15 years
Habitat:	Isolated tall shrub over isolated mid-tall shrub over sparse open shrubland over sparse tussock grassland.

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia cuthbertsonii subsp. *cuthbertsonii*	2.5	3
Acacia pteraneura	6	11
Acacia tetragonophylla	2.25	3
Actinobole oldfieldianum	0.01	0.1
Aristida contorta	0.1	5
Atriplex semilunaris	0.4	1
Enneapogon polyphyllus	0.2	0.1
Eremophila forrestii subsp. *forrestii*	1.8	3
Euphorbia porcata	0.1	0.1
Euphorbia tannensis subsp. *eremophila*	0.2	0.1
Ptilotus exaltatus	0.3	0.1
Ptilotus obovatus var. *obovatus*	0.2	0.1
Salsola australis	0.3	3
Sclerolaena densiflora	0.1	0.1
Sclerolaena gardneri	0.1	3
Senna artemisioides subsp. *helmsii*	0.7	1
Senna sp. Meekatharra (E. Bailey 1-26)	0.8	1
Sida kingii	0.4	0.1
Solanum lasiophyllum	0.4	3

PHOTOS



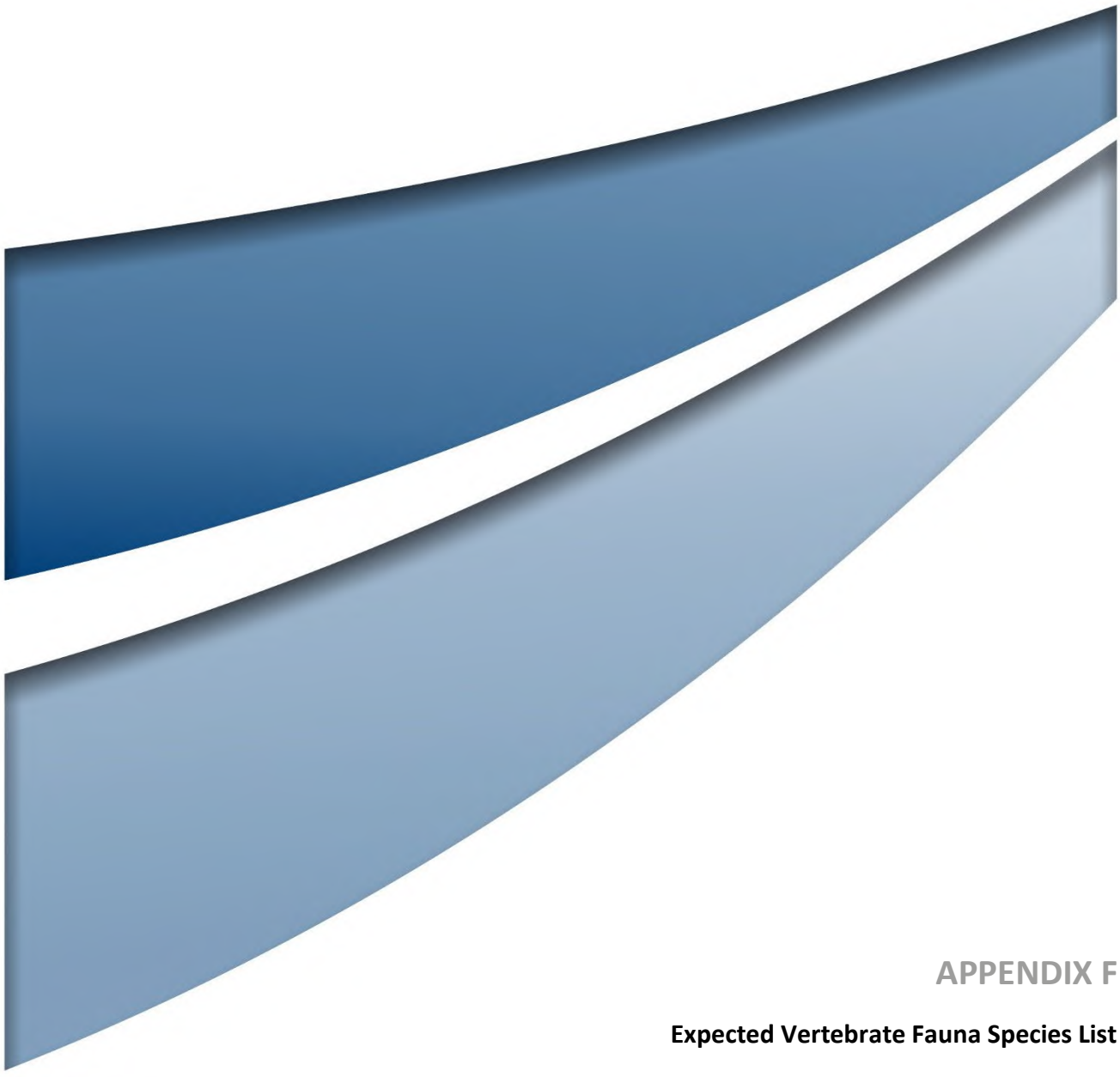
APPENDIX E

Location Details of Significant Flora Taxa Recorded by the 2023 Survey

GOVERNMENT AGENCY REFERENCE ONLY
NOT FOR PUBLIC DISSEMINATION
CONTAINS LOCATIONS OF SIGNIFICANT FLORA TAXA

All locations are in GDA2020 Zone 50.

Taxon	Status (WA)	Easting	Northing	Location	Abundance
Gunniopsis divisa	P3	454818	7013330		1
Gunniopsis divisa	P3	454664	7013631	Next to relevé KK02	2
Gunniopsis divisa	P3	454653	7013631	KK02	-
Hemigenia tysonii	P3	454653	7013631	KK02	-
Hemigenia tysonii	P3	454945	7013364	KK04	-



APPENDIX F

Expected Vertebrate Fauna Species List

Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
FROGS								
-	*Neobatrachus* sp.			X				
Spencer's Burrowing Frog	*Platyplectrum spenceri*			X				
REPTILES								
Pygmy Python	*Antaresia perthensis*			X	X			
Dinner-plate Turtle	*Chelodina steindachneri*			X	X			
Ring-tailed Dragon	*Ctenophorus caudicinctus* subsp. *caudicinctus*			X	X			
Ring-tailed Dragon	*Ctenophorus caudicinctus* subsp. *mensarum*			X				
Spotted Sand-dragon	*Ctenophorus maculatus*			X				
Central Netted Dragon	*Ctenophorus nuchalis*			X	X			
Ornate Ccrevice-dragon	*Ctenophorus ornatus*			X	X			
Western Netted dragon	*Ctenophorus reticulatus*		X	X	X			
Lozenge-marked Dragon	*Ctenophorus scutulatus*		X	X	X			
-	*Ctenophurus* sp.			X				
Clay-soil Ctenotus	*Ctenotus helenae*		X	X	X			
Leonhardi's Ctenotus	*Ctenotus leonhardii*			X	X			
Stern Ctenotus	*Ctenotus severus*			X	X			
Western Spiny-tailed Skink	*Egernia stokesii badia*	EN		X		X	X	X
Western Cryptic Gehyra	*Gehyra crypta*				X			
Large Spotted Midwest Rock Gehyra	*Gehyra polka*				X			
Spotted Dtella	*Gehyra punctata*			X	X			
Tree Dtella	*Gehyra variegata*			X	X			
Bynoe's Gecko	*Heteronotia binoei*			X	X			
Inland Broad-Blazed Slider	*Lerista nichollsi*			X	X			
Dwarf Burrowing Skink	*Lerista timida*			X	X			
Mottled Ground Gecko	*Lucasium squarrosum*				X			
Marbled Velvet Gecko	*Oedura marmorata*			X				
Gwardar	*Pseudonaja mengdeni*			X				
Western Beaked Gecko	*Rhynchoedura ornata*			X				
Jan's Banded Snake	*Simoselaps bertholdi*			X				
Stripe-tailed Goanna	*Varanus caudolineatus*			X				
Sand Monitor	*Varanus gouldii*							

Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
BIRDS								
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		X	X	X			
Inland Thornbill	*Acanthiza apicalis*		X	X	X			
Yellow-rumped Thornbill	*Acanthiza (Geobasileus) chrysorrhoa*		X	X				
Slaty-backed Thornbill	*Acanthiza robustirostris*			X				
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		X	X	X			
Collared Sparrowhawk	*Accipiter cirrocephalus*		X	X				
Brown Goshawk	*Accipiter fasciatus*			X				
Australian Owlet-nightjar	*Aegotheles cristatus*		X	X				
Common Sandpiper	*Actitis hypoleucos*	MI	X				X	X
Chestnut Teal	*Anas castanea*			X				
Grey Teal	*Anas gracilis*		X	X				
Australasian Shoveler	*Anas rhynchotis*			X				
Pacific Black Duck	*Anas superciliosa*		X	X				
Australasian Darter	*Anhinga novaehollandiae*			X				
Red Wattlebird	*Anthochaera carunculata*			X	X			
Australian Pipit	*Anthus novaeseelandiae*		X					
Southern Whiteface	*Aphelocephala leucopsis*	VU	X	X	X		X	X
Banded Whiteface	*Aphelocephala nigricincta*			X				
Fork-tailed Swift	*Apus pacificus*	MI					X	X
Wedge-tailed Eagle	*Aquila audax*		X	X	X			
Cattle Egret	*Ardea ibis*			X				
Intermediate Egret	*Ardea intermedia*			X				
Eastern Great Egret	*Ardea modesta*			X				
White-necked Heron	*Ardea pacifica*		X	X				
Australian Bustard	*Ardeotis australis*			X				
Black-faced Woodswallow	*Artamus cinereus*		X	X	X			
Dusky Woodswallow	*Artamus cyanopterus*			X	X			
Little Woodswallow	*Artamus minor*		X	X				
Masked Woodswallow	*Artamus personatus*		X	X	X			
Hardhead	*Aythya australis*			X				
Australian Ringneck	*Barnardius zonarius*		X	X	X			
Musk Duck	*Biziura lobata*			X				
Bush Stone-curlew	*Burhinus grallarius*			X				
Little Corella	*Cacatua sanguinea*		X	X				
Pallid Cuckoo	*Cacomantis pallidus*		X	X				

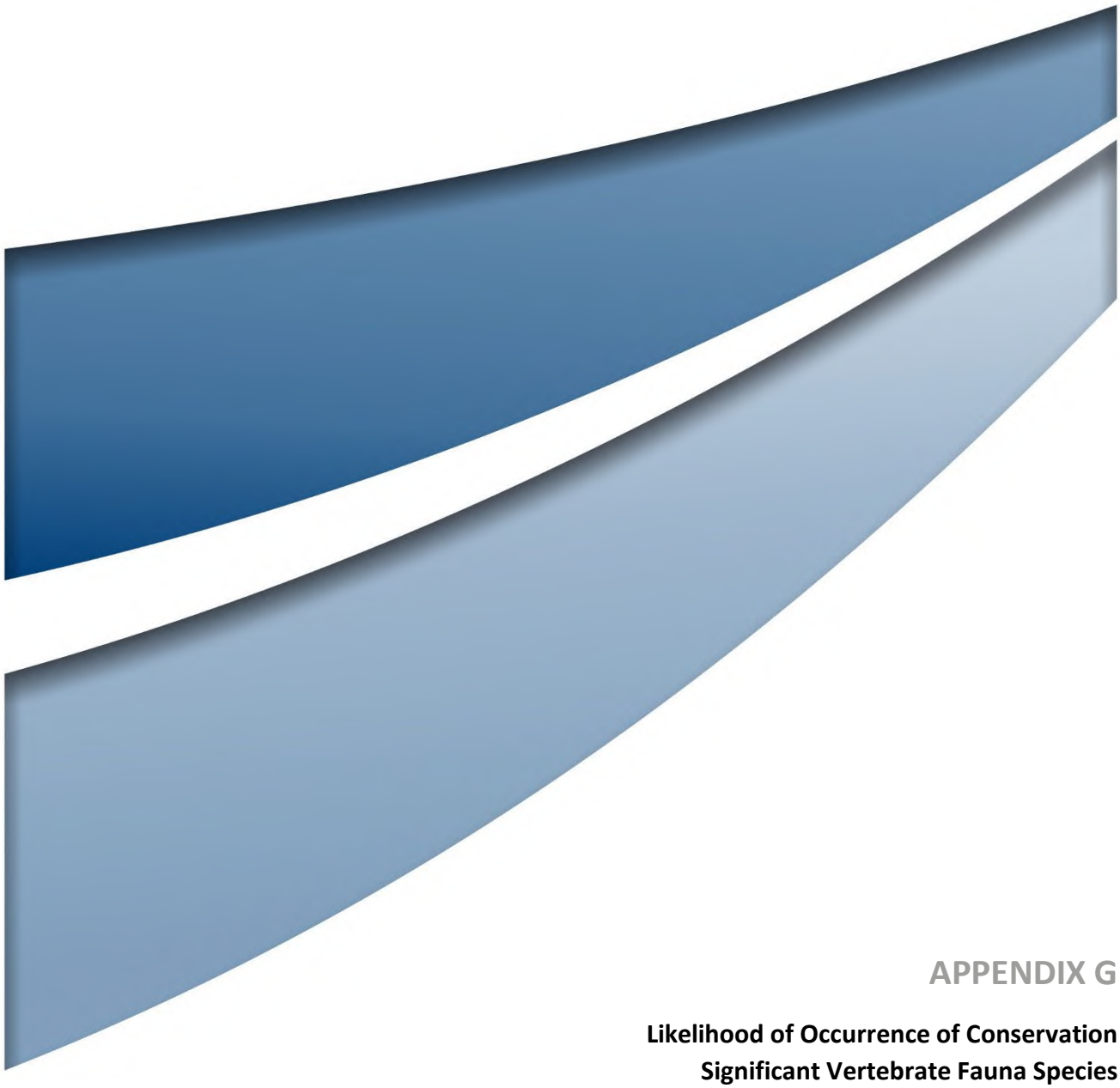
Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
Sharp-tailed Sandpiper	*Calidris acuminata*	MI		X		X	X	X
Curlew Sandpiper	*Calidris ferruginea*	CR/MI		X		X	X	X
Pectoral Sandpiper	*Calidris melanotos*	MI					X	X
Red-necked Stint	*Calidris ruficollis*	MI		X				X
Long-toed Stint	*Calidris subminuta*	MI		X		X		X
Red-tailed Black Cockatoo	*Calyptorhynchus banksii*			X				
Pied Honeyeater	*Certhionyx variegatus*			X				
Red-capped Plover	*Charadrius ruficapillus*		X	X				
Australian Wood duck	*Chenonetta jubata*		X	X				
White-backed Swallow	*Cheramoeca leucosterna*			X				
Western Bowerbird	*Chlamydera guttata*		X	X	X			
Spotted Bowerbird	*Chlamydera maculata*							
White-winged Tern	*Chlidonias leucopterus*	MI		X				X
Silver Gull	*Chroicocephalus novaehollandiae*			X				
Brown Songlark	Cincloramphus cruralis		X	X				
Rufous Songlark	*Cincloramphus mathewsi*		X	X		X		
Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*			X				
Western Quail-thrush	*Cinclosoma marginatum*		X	X				
Swamp Harrier	*Circus approximans*			X				
Spotted Harrier	*Circus assimilis*			X				
Banded Stilt	*Cladorhynchus leucocephalus*			X				
White-browed Treecreeper	*Climacteris affinis*			X				
Grey Shrikethrush	*Colluricincla harmonica*		X	X				
Ground Cuckooshrike	*Coracina maxima*			X				
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		X	X				
Little Crow	*Corvus bennetti*		X	X	X			
Australian Raven	*Corvus coronoides*			X				
Torresian Crow	*Corvus orru*		X	X				
Stubble Quail	*Coturnix pectoralis*			X				
Pied Butcherbird	*Cracticus nigrogularis*		X	X				
Australian Magpie	*Cracticus tibicen*			X				
Grey Butcherbird	*Cracticus torquatus*		X	X				
Black Swan	*Cygnus atratus*			X				
Blue-winged Kookaburra	*Dacelo leachii*			X				
Varied Sittella	*Daphoenositta chrysoptera*			X				

Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
Plumed Whistling Duck	*Dendrocygna eytoni*			X				
Mistletoebird	*Dicaeum hirundinaceum*		X	X				
Emu	*Dromaius novaehollandiae*		X	X	X			
Southern Scrub Robin	*Drymodes brunneopygia*			X				
Little Egret	*Egretta garzetta*			X				
White-faced Heron	*Egretta novaehollandiae*		X	X				
Black-shouldered Kite	*Elanus axillaris*		X	X				
Black-fronted Dotterel	*Elseyornis melanops*		X	X	X			
Galah	*Eolophus roseicapilla*		X	X				
White-fronted Chat	*Epthianura albifrons*			X				
Orange Chat	*Epthianura aurifrons*			X				
Crimson Chat	*Epthianura tricolor*		X	X				
Red-kneed Dotterel	*Erythrogonys cinctus*			X				
Spotted Nightjar	*Eurostopodus argus*			X				
Brown Falcon	*Falco (Ieracidea) berigora*			X	X			
Nankeen Kestrel	*Falco (Tinnunculus) cenchroides*		X	X				
Australian Hobby	*Falco longipennis*			X	X			
Peregrine Falcon	*Falco peregrinus*	OS		X		X		
Eurasian Coot	*Fulica atra*			X				
Gull-billed Tern	*Gelochelidon nilotica*	MI		X		X		X
Diamond Dove	*Geopelia cuneata*		X	X				
Bar-shouldered Dove	*Geopelia humeralis*			X				
Zebra Dove	*Geopelia striata*			X				
Western Gerygone	*Gerygone fusca* subsp. *fusca*			X	X			
Magpie-lark	*Grallina cyanoleuca*		X	X	X			
Australian Dagpie	*Gymnorhina tibicen*		X		X			
Whistling Kite	*Haliastur sphenurus*		X	X				
Black-breasted Buzzard	*Hamirostra melanosternon*			X				
Little Eagle	*Hieraaetus morphnoides*			X				
Black-winged Stilt	*Himantopus himantopus*			X				
Welcome Swallow	*Hirundo neoxena*		X	X				
Malleefowl	*Leipoa ocellata*	VU					X	X
Grey-fronted Honeyeater	*Lichenostomus plumulus*			X				
Singing Honeyeater	*Lichenostomus virescens*		X	X	X			
Brown Honeyeater	*Lichmera indistincta*		X	X				
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*			X				

Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
Pink-eared Duck	*Malacorhynchus membranaceus*			X				
Variegated Fairywren	*Malurus lamberti*		X	X				
Purple-backed Fairywren	*Malurus lamberti* subsp. *assimilis*		X	X				
White-winged Fairywren	*Malurus leucopterus*			X				
Splendid Fairy-wren	*Malurus splendens*		X	X	X			
Yellow-throated Miner	*Manorina flavigula*		X	X	X			
Little Grassbird	*Megalurus gramineus*			X				
Hooded Robin	*Melanodryas cucullata*		X	X				
Budgerigar	*Melopsittacus undulatus*		X	X				
Rainbow Bee-eater	*Merops ornatus*		X	X				
Little Pied Cormorant	*Microcarbo melanoleucos*			X				
Black Kite	*Milvus migrans*			X				
Grey Wagtail	*Motacilla cinerea*	MI					X	X
Yellow Wagtail	*Motacilla flava*	MI					X	X
Bourke's Parrot	*Neopsephotus bourkii*		X	X	X			
Morepork	*Ninox novaeseelandiae*			X				
Nankeen Night Heron	*Nycticorax caledonicus*			X				
Cockatiel	*Nymphicus hollandicus*		X	X				
Crested Pigeon	*Ocyphaps lophotes*		X	X				
Crested Bellbird	*Oreoica gutturalis*		X	X				
Rufous Whistler	*Pachycephala (Alisterornis) rufiventris*		X	X				
Red-browed Pardalote	*Pardalotus rubricatus*			X				
Striated Pardalote	*Pardalotus (Pardalotinus) striatus*			X				
Australian Pelican	*Pelecanus conspicillatus*			X				
Fairy Martin	*Petrochelidon ariel*		X	X				
Tree Martin	*Petrochelidon nigricans*		X	X				
Red-capped Robin	*Petroica (Petroica) goodenovii*		X	X				
Night Parrot	*Pezoporus occidentalis*	EN					X	X
Great Cormorant	*Phalacrocorax carbo*			X				
Little Black Cormorant	*Phalacrocorax sulcirostris*		X	X				
Australian Pied Cormorant	*Phalacrocorax varius*			X				
Common Bronzewing	*Phaps chalcoptera*		X	X				
White-cheeked Honeyeater	*Phylidonyris niger*							
Yellow-billed Spoonbill	*Platalea flavipes*			X				

Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
Western Rosella	*Platycercus varius*			X				
Glossy Ibis	*Plegadis falcinellus*	MI		X		X		X
Tawny Frogmouth	*Podargus strigoides*			X				
Western Tawny Frogmouth	*Podargus strigoides* subsp. *brachypterus*			X				
Hoary-headed Grebe	*Poliocephalus poliocephalus*			X				
White-browed Babbler	*Pomatostomus (Morganornis) superciliosus*			X				
Grey-crowned Babbler	*Pomatostomus temporalis*		X	X				
Australian Crake	*Porzana fluminea*			X				
Baillon's Crake	*Porzana pusilla*			X				
Spotless Crake	*Porzana tabuensis*			X				
Mulga Parrot	*Psephotellus (Psephotellus) varius*		X					
Chiming Wedgebill	*Psophodes occidentalis*			X				
White-plumed Honeyeater	*Ptilotula penicillata*		X	X				
White-fronted Honeyeater	*Purnella albifrons*			X				
Redthroat	*Pyrrholaemus brunneus*			X				
Grey Fantail	*Rhipidura albiscapa*			X				
New Zealand Fantail	*Rhipidura fuliginosa*			X				
Willie Wagtail	*Rhipidura (Sauloprocta) leucophrys*		X	X				
Australian Painted Snipe	*Rostratula australis*	EN		X		X	X	X
Weebill	*Smicrornis brevirostris*			X				
Laughing Dove	*Streptopelia senegalensis**			X				
Black Honeyeater	*Sugomel niger*			X				
Australasian Grebe	*Tachybaptus novaehollandiae*			X				
Australian Shelduck	*Tadorna tadornoides*			X				
Australian Zebra Finch	*Taeniopygia guttata*		X	X	X			
Australian White Ibis	*Threskiornis molucca*			X				
Straw-necked Ibis	*Threskiornis spinicollis*		X	X				
Red-backed Kingfisher	*Todiramphus pyrrhopygius*			X				
Sacred Kingfisher	*Todiramphus sanctus*			X				
Black-tailed Nativehen	*Tribonyx ventralis*		X	X				
Wood Sandpiper	*Tringa glareola*	MI				X		X
Common Greenshank	*Tringa nebularia*	MI	X	X		X	X	X
Little Buttonquail	*Turnix velox*			X				
Banded Lapwing	*Vanellus tricolor*		X	X				

Species		Status	Records					
			ALA	NatureMap	Dandjoo	DBCA	PMST	EPBC SPRAT
MAMMALS								
Kultarr	*Antechinomys laniger*			X	X			
White-striped Free-tailed Bat	*Austronomus australis*		X	X				
European Cattle	*Bos Taurus**							
Goat	*Capra aegagrus hircus**			X	X			
Dingo/Dog	*Canis lupus familiaris**							
Gould's Wattled Bat	*Chalinolobus gouldii*			X				
Cat	*Felis catus**							
Stick-nest Rat sp.	*Leporillus* sp.			X				
Western Grey Kangaroo	*Macropus fuliginosus*							
Red Kangaroo	*Osphranter rufus*							
Spinifex Hopping Mouse	*Notomys alexis*			X				
Lesser Long-eared Bat	*Nyctophilus geoffroyi*							
European Rabbit	*Oryctolagus cuniculus**							
Sheep	*Ovis aries**			X				
Black-flanked Rock-wallaby	*Petrogale lateralis* subsp. *lateralis*	EN		X		X		X
Woolley's False Antechinus	*Pseudantechinus woolleyae*			X				
Sandy Inland Mouse	*Pseudomys hermannsburgensis*			X				
Inland Broad-nosed Bat	*Scotorepens balstoni*			X				
Little Long-tailed Dunnart	*Sminthopsis dolichura*			X				
Hill's Sheath-tailed Bat	*Taphozous hilli*			X	X			
Inland Forest Bat	*Vespadelus baverstocki*							
Finlayson's Cave Bat	*Vespadelus finlaysoni*		X	X	X			
European Fox	*Vulpes vulpes**			X				



APPENDIX G

Likelihood of Occurrence of Conservation Significant Vertebrate Fauna Species

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Threatened Species					
Birds					
Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered, Migratory	Critically Endangered	The species mainly occurs on intertidal mudflats in sheltered coastal areas such as estuaries, bays, inlets and lagoons, and around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded less often inland, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand, occurring in both fresh and brackish waters (P. J. Higgins et al., 1996).	**Unlikely:** Two historic (1978) records approx. 29 km southwest of the Survey Area. The Survey Area does not contain suitable habitat.
Night Parrot	*Pezoporus occidentalis*	Endangered	Critically Endangered	The species occurs in areas of Spinifex grassland and/or chenopod shrubland in the arid and semi-arid zones, as well as *Acacia aneura* woodland, treeless areas and bare gibber plains. Roosting and nesting sites often consist of dense vegetation, primarily old and large Spinifex clumps (Garnett et al., 2011; Murphy & Night Parrot Recovery Team, 2015).	**Unlikely:** The species has not been recorded within the Survey Area. The nearest record of this species is from more than 500 km away from the edge of the Survey Area. No spinifex grasslands or suitable woodlands were observed in the Survey Area.

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Peregrine Falcon	*Falco peregrinus*	Other Specially Protected	Not listed	The species occurs in a variety of habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites and prefers coastal and inland cliffs or open woodlands near water (Australian Museum, 2019; Morcombe, 2000).	**Low:** Nearest record 30 km west of the Survey Area from 1998. The Survey Area is unlikely to contain suitable nesting habitat (cliffs) but may provide marginal foraging habitat.
Malleefowl	*Leipoa ocellata*	Vulnerable	Vulnerable	The species occurs in central and southern WA, as well as parts of SA, NSW, the Northern Territory and Victoria. They are found principally in the semi-arid to arid zone in shrublands and low woodlands dominated by mallee and associated habitats such as Broombush *Melaleuca uncinata* and Scrub Pine *Callitris verrucosa*. In WA, they are also found in some shrublands dominated by acacia, and occasionally in woodlands dominated by eucalypts such as Wandoo *E. wandoo*, Marri *Corymbia calophylla* and Mallet *E. astringens* (Benshemesh, 2007).	**Low:** There may be suitable habitat present within the Desktop Study Area (within 50 km of the Survey Area boundary), such as Eucalypt woodlands with Wandoo, Marri and Mallet. The Survey Area itself is unlikely to provide habitat for this species.

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Australian Painted Snipe	*Rostratula australis*	Endangered	Endangered	Shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*) (Marchant & Higgins, 1993).	**Low:** Recorded 38 km southwest of Survey Area in 2015. The Survey Area is unlikely to contain suitable habitat for this species as no wetlands are present.
Mammals					
Black-flanked Rock-wallaby	*Petrogale lateralis* subsp. *lateralis*	Endangered	Endangered	Rocky habitats, especially those with extensive development of caves, crevices and overhangs that allow the animals to escape extremes of weather and to hide from predators (Pearson, 2013).	**Unlikely:** One record 27 km southwest of the Survey Area, with no date attached. The Survey Area does not contain suitable habitat (rocky habitats) for this species.

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Reptiles					
Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink	*Egernia stokesii badia*	Endangered	Vulnerable	**Black form - Murchison region** During 2006–09 surveys by ecologia, all records of the black form of this species were on small, isolated stands of granite containing suitable habitat to larger, more extensive clusters of rock. Flat granite domes, with no boulders or crevices, do not support Western Spiny-tailed Skink (ecologia, 2010). This is distinct from the tree hollow habitat of the brown form (How et al., 2003).	**Unlikely:** This species has been recorded several times within 50 km of the Survey Area (most recently in 2013). The Survey Area lies within the likely distribution of this species; however, suitable habitat (granite outcrops) does not occur within the Survey Area, with the nearest potential habitat occurring approximately 8 km southeast (based on aerial imagery interpretation). This species relies on suitable habitat for refuge.
Migratory Species					
Fork-Tailed Swift	*Apus pacificus*	Migratory	Migratory	The species mostly occurs over inland plains, but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches, over dry or open habitats including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. The species is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground (P. Higgins, 1999).	**Moderate:** This species is known to occur within the region and may use the aerial space above patches of vegetation within the Survey Area to forage on invertebrates. Although this species generally transits south along the coast, individuals have been recorded inland and the Survey Area may provide suitable habitat, seasonally.
Red-necked Stint	*Calidris ruficollis*	Migratory	Migratory	In Australasia, this species is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores (P. J. Higgins et al., 1996).	**Unlikely:** The Survey Area is unlikely to support suitable habitat (coastal areas) for this species.

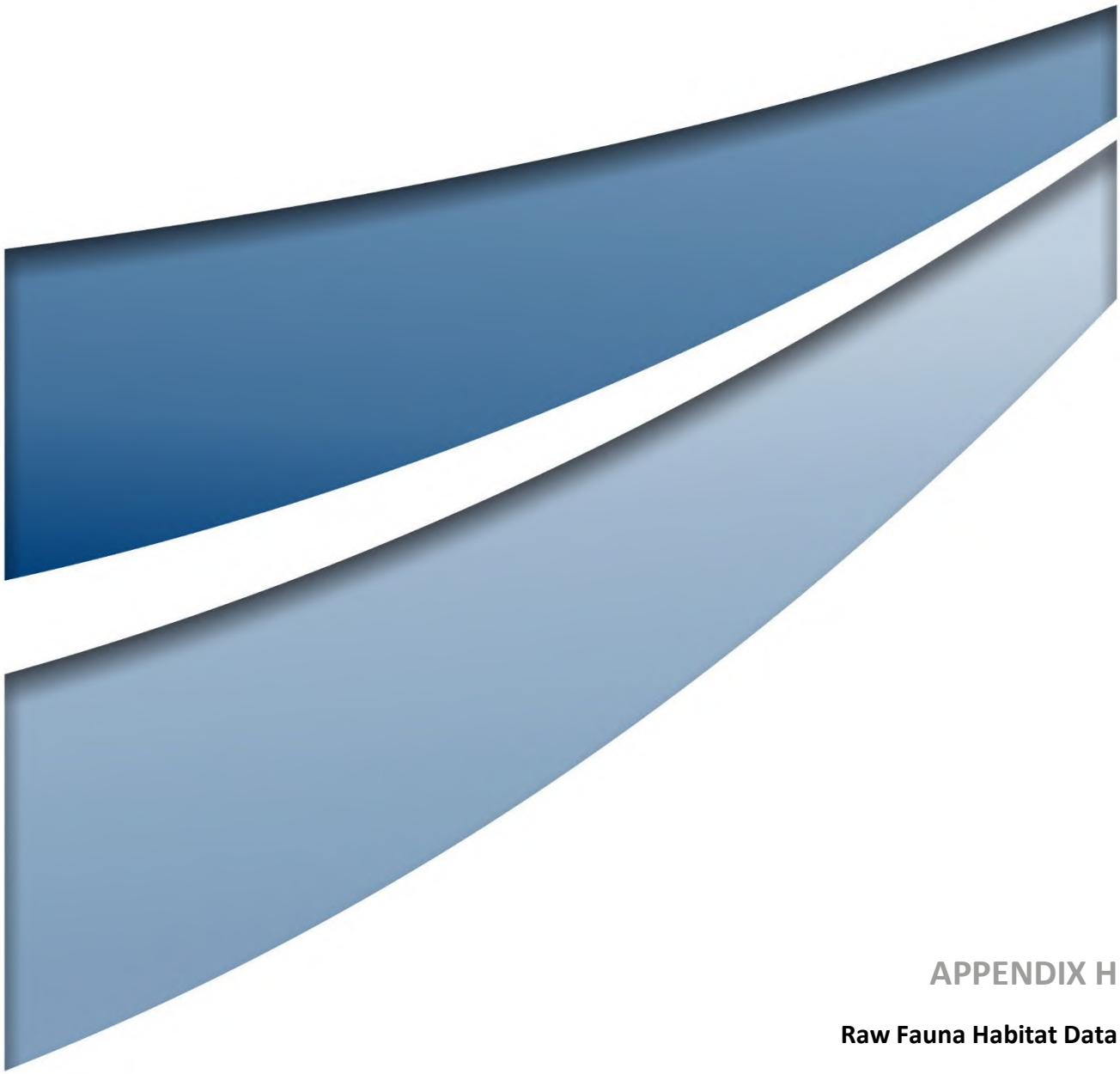
Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Long-toed Stint	*Calidris subminuta*	Migratory	Migratory	Shallow freshwater or brackish wetlands including lakes, swamps, river floodplains, streams, lagoons and sewage ponds. The species is also fond of areas of muddy shoreline, growths of short grass, weeds, sedges, low or floating aquatic vegetation, reeds, rushes and occasionally stunted samphire (P. J. Higgins et al., 1996).	**Low:** Two historic (1978) records 30 km southwest of the Survey Area. However, the Survey Area does not contain suitable habitat for this species due to the absence of wetlands etc.
White-winged Tern	*Chlidonias leucopterus*	Migratory	Migratory	Fresh, brackish or saline, and coastal or subcoastal wetlands. This species frequents tidal wetlands, such as harbours, bays, estuaries and lagoons, and their associated tidal sandflats and mudflats (Chan et al., 2008; Chan & Dening, 2007; Chatto, 2006).	**Unlikely:** The Survey Area does not support wetlands, tidal flats or mudlfats, and consequently does not provide habitat for this species.
Gull-billed Tern	*Gelochelidon nilotica*	Migratory	Migratory	Bare or sparsely vegetated islands, banks, flats, or spits of dry mud and sand including barrier beaches (shoals), dunes, saltmarshes, saltpans, freshwater lagoons, estuaries, deltas, inland lakes, rivers, marshes and swamps. On passage the species typically forages over saltpans, coastal lagoons, mudflats, marshes and wet fields, overwintering on estuaries, saltpans, lagoons and saltmarshes, or in more inland sites such as large rivers, lakes, rice-fields, sewage ponds, reservoirs, saltpans and irrigation canals (P. J. Higgins et al., 1996).	**Low:** Several records within 50 km of the Survey Area, most recently recorded in 2006. The Survey Area does not contain suitable habitat for this species. due to the absence of wetlands, estuaries etc.

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Grey Wagtail	*Motacilla cinerea*	Migratory	Migratory	This species is a scarce but regular visitor to northern Australia. In their normal breeding range, they are found across a variety of wetlands, especially water courses, but also on the banks of lakes and marshes, as well as artificial wetlands such as sewage farms, reservoirs and fishponds. This association with water extends into non-breeding habitats, with all confirmed Australian records being associated with water; especially creeks, rivers and waterfalls. On migration they may forage on rocky tidal flats (DoE, 2015)	**Unlikely:** The Survey Area does not contain suitable habitat for this species, as it does not contain wetlands, lakes etc.
Yellow Wagtail	*Motacilla flava*	Migratory	Migratory	This species occupies a range of damp or wet habitats with low vegetation, from damp meadows, marshes, waterside pastures, sewage farms and bogs to damp steppe and grassy tundra. In the north of its range it is also found in large forest clearings (BirdLife International, 2023; S. Tyler & Christie, 2012).	**Unlikely:** The Survey Area does not contain suitable habitat for this species which require damp, wet habitats.

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Common Sandpiper	*Actitis hypoleucos*	Migratory	Migratory	The species utilises a wide range of coastal wetlands and some inland wetlands with varying levels of salinity. The species is mostly found around muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, as well as on banks further upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties (Geering et al., 2007; P. J. Higgins et al., 1996).	**Low:** The Survey Area does not contain suitable habitat for this species such as wetlands, mudflats etc.
Sharp-tailed Sandpiper	*Calidris acuminata*	Migratory	Migratory	This species prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. They also occur in salt works and sewage farms (P. J. Higgins et al., 1996).	**Low:** One historic (1978) record 30 km southwest of the Survey Area. There may be limited suitable habitat present in the wider region (within 50 km of Survey Area boundary), only supporting artificial waterbodies and small farm dams lacking the required bank habitat that this species uses for cover.
Pectoral Sandpiper	*Calidris melanotos*	Migratory	Migratory	The species prefers shallow fresh to saline wetlands. It is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (P. J. Higgins et al., 1996).	**Unlikely:** The Survey Area is unlikely to support suitable habitat for this species such as wetlands and lagoons given its distance (250 km) from the coast.

Common Name	Scientific Name	EPBC Act Status^	WA Status	Habitat	Likelihood of Occurrence^
Wood sandpiper	*Tringa glareola*	Migratory	Migratory	Well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes (P. J. Higgins et al., 1996).	**Unlikely:** Two historic (1978) records 30 km southwest of the Survey Area. No suitable habitat exists within the Survey Area.
Glossy Ibis	*Plegadis falcinellus*	Migratory	Migratory	This species' preferred habitat for foraging and breeding are freshwater marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. The species is sometimes recorded in wooded swamps, artificial wetlands (such as irrigated fields), and in mangroves for breeding. Glossy Ibis roost in trees or shrubs usually near, but sometimes far, from water bodies (Brown et al., 1982; Marchant & Higgins, 1993).	**Low:** Multiple records within 40 km of the Survey Area, with the most recent from 2006. No suitable foraging or breeding habitat exists within the Survey Area.
Common Greenshank	*Tringa nebularia*	Migratory	Migratory	This species is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The species is known to forage at edges of wetlands, in soft mud on mudflats, in channels, or in shallows around the edges of water (P. J. Higgins et al., 1996).	**Unlikely:** One record (from 2004) 38 km southwest of the Survey Area**.** No suitable feeding or roosting habitat exists within the Survey Area.

^ Source: DBCA Significant Fauna Database (DBCA, 2023d).



APPENDIX H

Raw Fauna Habitat Data

Site	Tree Hollows	Woody Debris			Bark	Bedrock and Rocks	Water Features	Termitaria	Habitat Description	Soil	
	Presence	Coarse 5-10 cm	Logs 10-30 cm	Logs >30 cm	Presence	Presence	Presence	Terrestrial		Soil Type	Soil Colour
Ha1	N	Y			N	N	N	Y	Plain	Clay Loam	Orange
Ha2	N	Y			N	N	N	Y	Mulga woodland	Clay Loam	Orange
Ha3	N	Y			N	N	N	Y	Plain	Clay Loam	Orange
Ha4	N	Y			N	N	N	Y	Plain	Sandy Clay	Orange
Ha5	N	Y			N	N	N	Y	Plain	Sandy Clay	Orange
Ha6	N	Y			N	N	N	Y	Plain	Sandy Clay Loam	Orange

Site	Fire History	Grazing	Disturbance	Bare Soil (%)	Litter (%)	Canopy Cover (%)	Understory (%)
Ha1	10-20 Years	Cattle	Cattle	90	1	2	3
Ha2	10-20 Years	Cattle	Roads	90	2	5	4
Ha3		Cattle	Rubbish	90	2	1	10
Ha4		Cattle	Rubbish	90	2	1	6
Ha5	10-20 Years	Cattle	Rubbish and roads	85	2	1	8
Ha6	10-20 Years	Cattle, Goats	Airstrip	90	2	1	7

Ha01

Ha02

Ha03

Ha04

Ha05

Ha06

APPENDIX I

Images Captured from Motion Cameras

Camera number	Date	Species
QC02	20/9/23	Spinifex Hopping Mouse (*Notomys alexis*)

Camera number	Date	Species
QC03	19/9/23	Red Kangaroo (*Osphranter rufus*)

Camera number	Date	Species
QC03	20/9/23	Australian Magpie (*Gymnorhina tibicen*)

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