Metals X Limited

Wingellina Nickel Project

Level 1 Terrestrial Fauna Assessment of the Wingellina Borefield and Borefield Pipeline Route

May 2012

METALS X LIMITED

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Executive Summary

Metals X Limited (Metals X) is currently evaluating the potential of developing the Southern Borefield and an associated pipeline route (the Project) as part of the proposed Wingellina Nickel Mine. The Project is located approximately 192 km east of Warburton in Western Australia, near the junction of the Western Australia, South Australia and Northern Territory borders.

As part of the initial scoping phase for the Project, Metals X commissioned Outback Ecology to undertake a Level 1 Terrestrial Fauna assessment for the Project. The area assessed (the Study Area) overlies tenement L69/12 and the Tjuntjuntjarra Track, and is located on the Ngaanyatjarra Aboriginal Lands. The Study Area extends 30 metres either side of an approximately 106 km long section of the Tjuntjuntjarra track, terminating at the Warburton-Blackstone road at the northern end and the bore OBW05 at the southern end. The assessment (This Study) involved a desktop study comprising database searches and a literature review, and a field survey, which was conducted in October 2011.

The purpose of This Study was to gather background biological information on the terrestrial fauna, faunal assemblages and fauna habitat within the Study Area, in order to support future permit and approval documentation for Metals X. The specific objectives of This Study were to:

- undertake a desktop study to develop an inventory of terrestrial vertebrate fauna species and terrestrial short-range endemic (SRE) invertebrate species previously recorded or likely to be present within the Study Area;
- provide a description of vertebrate fauna habitat, sensitive habitat and SRE invertebrate fauna habitat that occurs within the Project area;
- verify the results of the desktop study and map broad fauna habitats present within the Study Area via a field reconnaissance survey;
- assess desktop findings in a regional context by comparisons with available data from other localities within the bioregion; and
- identify the potential impacts of the Project on the terrestrial fauna assemblages and habitat in the Study Area.

A total of six broad fauna habitats was identified within the Study Area, comprising:

- Dense Mulga Woodland;
- Mulga over Hummock Grassland;
- Mulga over Tussock Grassland;
- Mulga-Mallee over Hummock Grassland;
- Drainage Line; and
- Scattered Eucalypts over Mixed Shrubland.

A total of 359 vertebrate fauna species was identified by the desktop study as potentially occurring in the Study Area., with 60 species recorded during this survey. This total comprises 14 species of

mammal (of which 10 are native), 31 species of bird and 15 species of reptile. No fish or amphibian species were recorded. The vertebrate fauna species richness was comparable with previous field surveys of similar size and scope within the locality of the Study Area. One species recorded during this survey, the Western Long-eared Bat (*Nyctophilus major tor*) was not recorded during database searches or previous surveys in the locality or the wider region.

During the field survey, three vertebrate species of conservation significance (ie species that are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 2002* (EPBC Act) and/or the Western Australian *Wildlife Conservation Act 1950* (WC Act), or are on the WA Department of Environment and Conservation (DEC) Priority Fauna list) were recorded:

- the Western Long-eared Bat (*Nyctophilus major tor*; DEC – Priority 4);
- the Australian Bustard (*Ardeotis australis*; DEC – Priority 4); and
- the Rainbow Bee-eater (*Merops ornatus*; EPBC – Migratory; WC Act – S3).

Of the invertebrates collected during the field survey, four of the species were considered potential SRE species based on current taxonomic and distribution knowledge. These were:

- the mygalomorph spiders *Synothele* sp., *Anidiops* sp. and *Aname* sp.; and
- the scorpion *Urodacus yaschenkoi*.

The desktop study also identified seven SRE mygalomorph spider species and two SRE pseudoscorpion species that have been collected in the area surrounding the Study Area. Although none of these species were collected within the Study Area, all have the potential to occur based on the land systems where they were collected and the distribution of these land systems within the Study Area.

The desktop study identified nine vertebrate species of conservation significance that were not recorded during the field survey component of This Study, but nevertheless are known to occur, are likely to occur or possibly occur within the Study Area. The likelihood of each of these species occurring was determined based on the habitat assessments performed during the field survey, reported data on species distributions and habitat from previous surveys in the wider region, and published knowledge on the biology of individual species. Briefly, these fauna consist of:

- seven species listed as Threatened under the EPBC Act and/or WC Act (including one also listed as Migratory under the EPBC Act, and two others also listed as Priority Fauna);
- three species listed by the DEC as being Priority Fauna (including two also listed as Threatened under the EPBC Act); and
- two species of bird listed as Migratory under the EPBC Act and/or WC Act (including one also listed as Threatened under the EPBC and WC Acts).

Habitat clearing represents the greatest potential direct impact of the Project on fauna and fauna habitats. Of the six broad fauna habitats, three were identified as significant within the Study Area. Dense Mulga Woodland, Mulga-Mallee over Hummock Grassland and Scattered Eucalypts over Mixed Shrubland are habitat types of particular value to vertebrate and invertebrate fauna within the

Study Area, and vegetation clearing and disturbance within these habitat types should be minimised where possible. In the Scattered Eucalypts over Mixed Shrubland habitat type, the clearing of large Marble Gums and other eucalypts should be avoided where possible. Other features of significance identified within the Study Area included a small rocky outcrop and areas containing large sand dunes. Efforts should be made to minimise clearing of and disturbance to these features. Of the potential indirect impacts of the Project, invasion by weeds is likely to be the most significant. Efforts should be made to ensure that vehicular traffic and other weed transport vectors are managed so as to reduce the risk of transporting invasive plants and their seeds.

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1.1. Project Background and Location

Metals X Limited (Metals X) is currently evaluating the potential of developing the Southern Borefield and an associated pipeline route (the Project) as part of the proposed Wingellina Nickel Mine. The Project is located approximately 192 km east of Warburton, near the junction of the Western Australia, South Australia and Northern Territory borders (**Figure 1**). As part of the initial scoping phase for the Project, Metals X commissioned Outback Ecology to undertake a Level 1 Terrestrial Fauna Assessment (This Study) for the Project. The area assessed (the Study Area) overlies tenement L69/12 and the Tjuntjuntjarra Track and is located on the Ngaanyatjarra Aboriginal Lands. The Study Area extends 30 metres either side of an approximately 106 km section of the Tjuntjuntjarra Track, terminating at the Warburton-Blackstone Road at the northern end and the bore OBW05 at the southern end. The Study Area contains exclusion zones, identified by the Ngaanyatjarra people as areas of cultural significance (**Figure 2**). Outback Ecology did not perform any field survey work within the exclusion zones.

1.2. Report Scope and Objectives

The purpose of This Study was to gather background biological information on the terrestrial fauna, faunal assemblages and fauna habitat within the Study Area, in order to support future permit and approval documentation for Metals X. The specific objectives of This Study were to:

- undertake a desktop study to develop an inventory of terrestrial vertebrate fauna species and terrestrial short-range endemic (SRE) invertebrate species previously recorded or likely to be present within the Study Area;
- provide descriptions of vertebrate fauna habitats, sensitive habitats and SRE invertebrate fauna habitats that occur within the Project area;
- verify the results of the desktop study and map broad fauna habitats present within the Study Area via a field reconnaissance survey;
- assess desktop findings in a regional context by comparisons with available data from other localities within the bioregion; and
- identify the potential impacts of the Project on the terrestrial fauna assemblages and habitat in the Study Area.

Whenever possible and relevant, the objectives and methods of This Study were aligned with:

- Department of Environment and Conservation (DEC) guidelines for the collection of vertebrate and invertebrate fauna for survey purposes (DEC 2009a, 2009b, c);
- Environmental Protection Authority (EPA) guidelines and position statements for conducting vertebrate fauna surveys (EPA and DEC 2010, EPA 2003, 2004); and
- EPA guidelines for conducting invertebrate fauna surveys (EPA 2009).

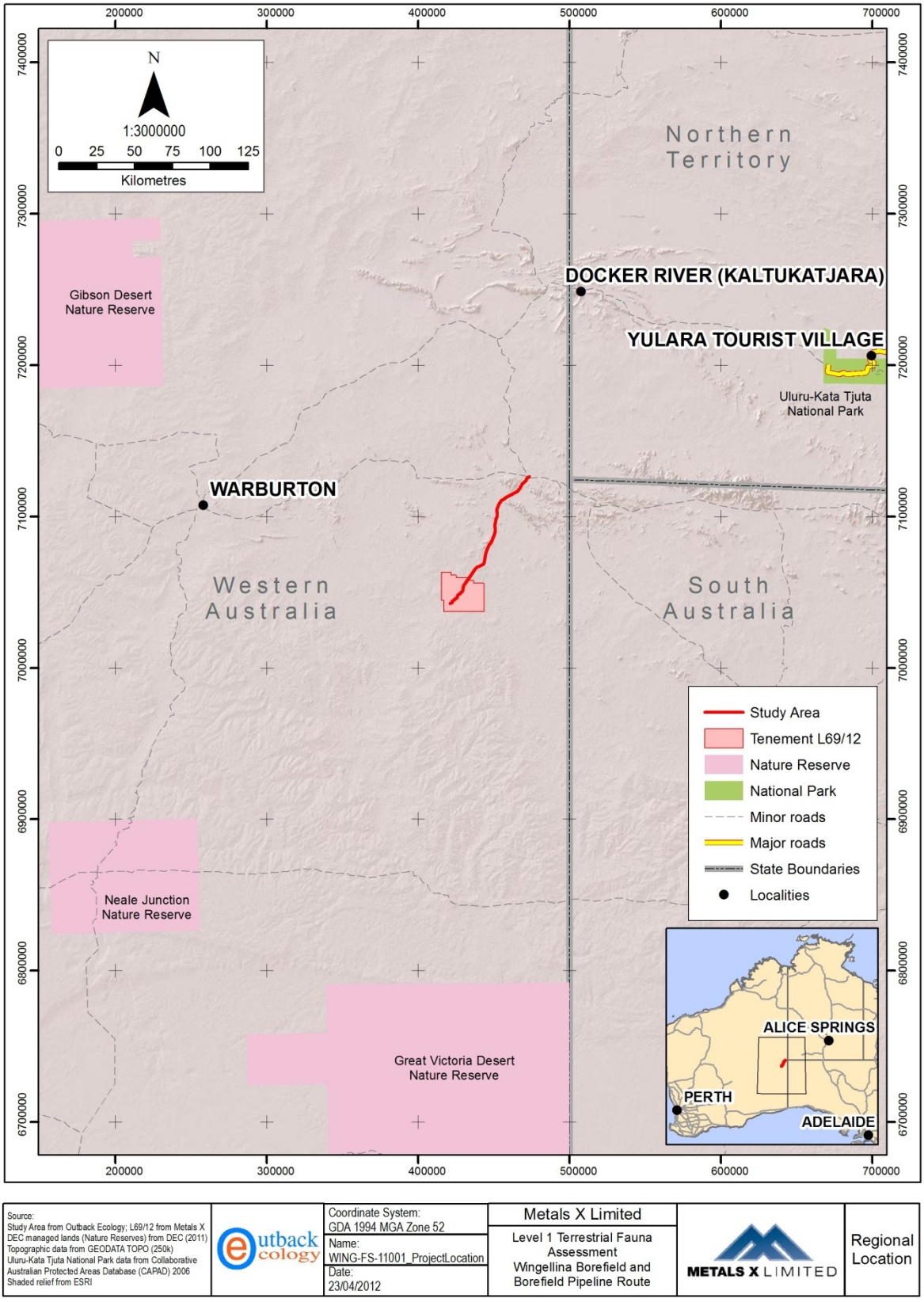

Figure 1: Regional location of the Study Area

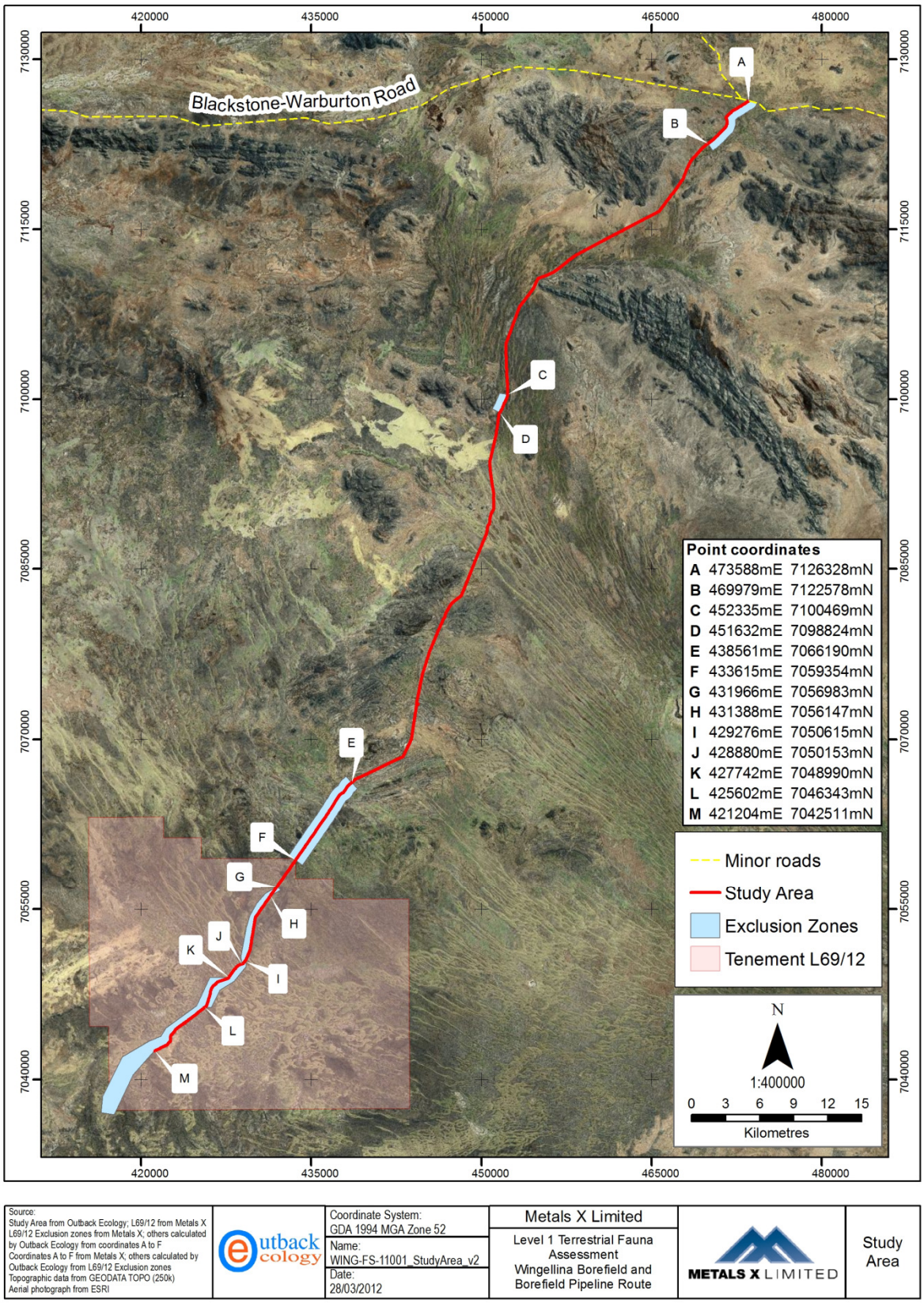

Figure 2: The Study Area and associated Exclusion Zones

(point coordinates refer to start and finish points of Exclusion Zones, along the Tjuntjuntjarra Track)

2. EXISTING ENVIRONMENT

2.1. Biogeographic Regions

The Study Area occurs within the Great Victoria Desert and Central Ranges bioregions, as defined by the Interim Bioregions of Australia (IBRA) classification system (McKenzie *et al.* 2003) (**Figure 3**). The Great Victoria Desert bioregion encompasses approximately 418,800 km^2 of land within Western Australia and South Australia, and is characterised by dunefields with playa lakes and lunettes (Australian Natural Resources Atlas 2009b). The bioregion is unsuitable for grazing as water is very limited and the climate is arid, with warm to extremely hot summers and mild to warm winters (Australian Natural Resources Atlas 2009b). A high proportion of the native mammal species of this bioregion are thought to have become locally extinct, including the Numbat (*Myrmecobius fasciatus*), Greater Bilby (*Macrotis lagotis*), Burrowing Bettong (*Bettongia lesueur*) and stick-nest rats (*Leporillus* spp.), and other species are thought to be in decline, including the Malleefowl (*Leipoa ocellata*) and Scarlet-chested Parrot (*Neophema splendida*). In contrast, invasive mammals have become well-established, and species such as the Rabbit (*Oryctolagus cuniculus*), House Mouse (*Mus musculus*), Camel (*Camelus dromedarius*), Fox (*Vulpes vulpes*) and Cat (*Felis catus*) are widespread (Australian Natural Resources Atlas 2009b).

The Central Ranges bioregion encompasses approximately 101,200 km^2 of land within Western Australia, the Northern Territory and South Australia, and is characterised by the east-west trending rocky ranges of the Petermann, Musgrave and Mann Ranges. The climate is arid, with hot to extremely hot summers during which daytime temperatures can exceed 50°C, but cool to cold winters (Australian Natural Resources Atlas 2009b). As with the Great Victoria Desert Bioregion, the Central Ranges bioregion has undergone declines in mammal fauna in concert with an increased presence of invasive species. For example, the Black-footed Rock Wallaby (*Petrogale lateralis*) and the Brushtail Possum (*Trichosurua vulpecula*) were commonly recorded in the Central Ranges bioregion during the 1930s but by the 1960s were nearly extinct (Australian Natural Resources Atlas 2009a). In addition to the invasive mammals seen in the Great Victoria Desert bioregion, the Central Ranges bioregion also hosts wild populations of Donkeys (*Equus asinus*) and Horses (*Equus caballus*).

Approximately 89% of the 106 km-long Study Area is within the Great Victoria Desert bioregion (**Figure 3**). The Great Victoria Desert bioregion contains six sub-bioregions, of which the Study Area traverses three. From the south, the Study Area begins in the Eastern sub-bioregion and continues northward within this sub-bioregion for approximately 37 km (**Figure 3**). The Eastern, or Maralinga sub-bioregion is underlain by the Devonian sediments of the Gunbarrel Basin, and has extensive sand plains of deep Quaternary aeolian sands (Barton and Cowan 2002b). The landforms consist of salt lakes and major valley floors with lake-derived dunes. The vegetation is primarily a tree steppe of mulga and *Eucalyptus* spp. over hummock grasslands on the aeolian sands, with *Acacia*, *Eremophila* and *Santalum* spp. dominating the colluvial soils and halophytic species confined to the edges of salt lakes and saline drainage systems (Barton and Cowan 2002b). Further north, the Study Area leaves

the Eastern sub-bioregion and continues northward for approximately 20 km within the Kintore sub-bioregion, before crossing into the Central sub-bioregion of the Great Victoria Desert bioregion (**Figure 3**).

The Central sub-bioregion of the Great Victoria Desert bioregion contains approximately 38 km of the Study Area (**Figure 3**). Approximately 126,260 km^2 in size, the Central sub-bioregion is the largest sub-bioregion in the Great Victoria Desert bioregion. The Central sub-bioregion is an arid, active sand-ridge desert with extensive dune fields of deep Quaternary aeolian sands overlying the Permian sediments of the Gunbarrel Basin (Barton and Cowan 2002a). The landforms and primary vegetation communities are similar to those of the Eastern sub-bioregion (Barton and Cowan 2002a, b).

The Study Area terminates in the Mann-Musgrave Block sub-bioregion of the Central Ranges bioregion, which contains a total of approximately 11 km of the Study Area toward its northern end (**Figure 3**). The Mann-Musgrave Block sub-bioregion of the Central Ranges bioregion is the largest sub-bioregion in the Central Ranges bioregion, with a size of approximately 91,734 km^2. In Western Australia, the Mann-Musgrave Block sub-bioregion is characterised by a high proportion of volcanic and quartzite Proterozoic ranges and derived soil plains, interspersed with red Quaternary sand plains with some Permian exposure (Barton and Cowan 2002a). The sand plains support low open woodlands of either Desert Oak (*Allocasuarina decaisneana*) or mulga over hummock grasslands, the ranges are often fringed by low open woodlands of *Acacia estrophiolata* and *Hakea* spp. over grasslands, and the ranges themselves typically support mixed *Acacia* spp. scrub or *Callitris glaucophylla* woodlands over grasslands (Barton and Cowan 2002a).

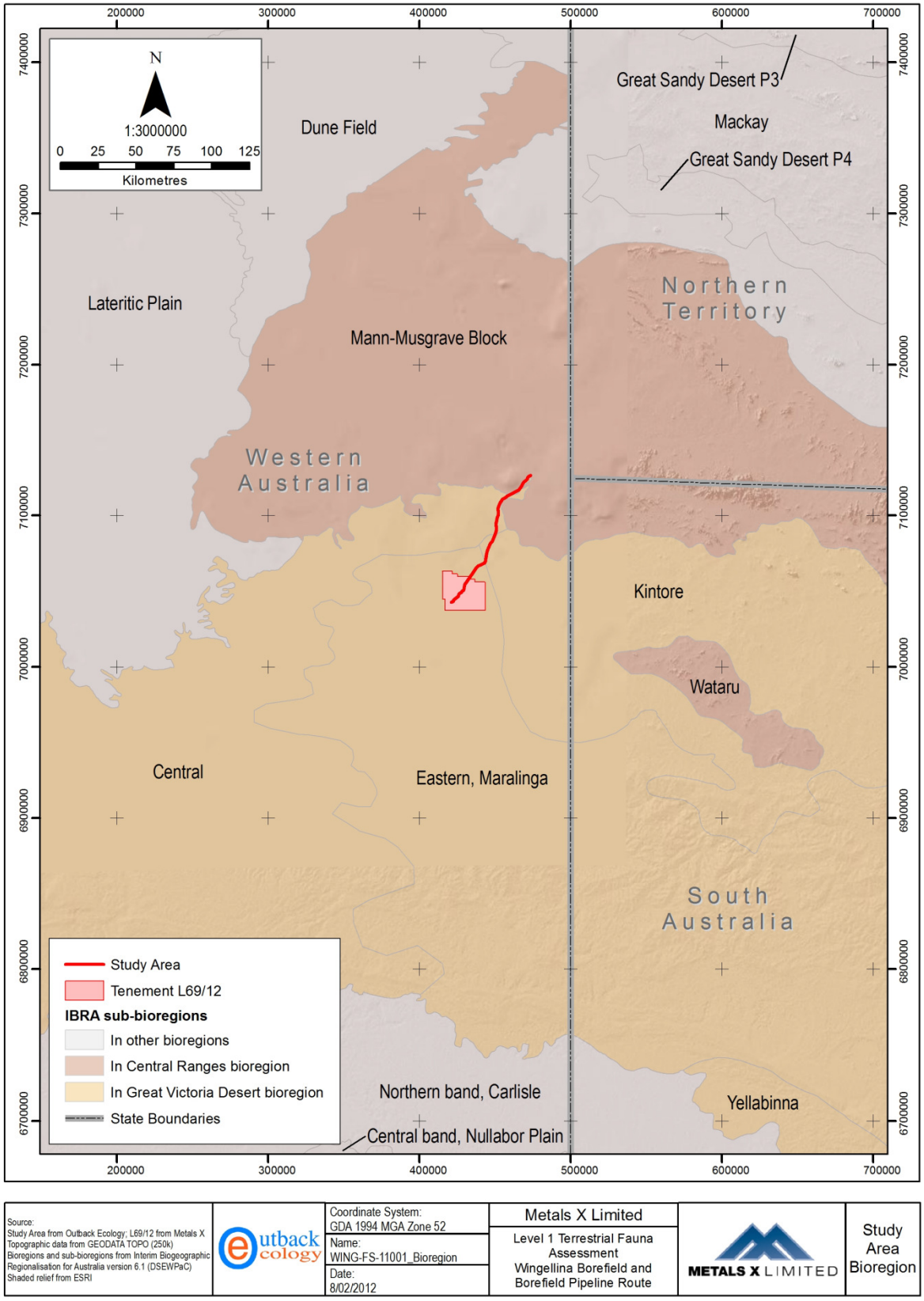

Figure 3: The Study Area with respect to IBRA bioregions and sub-bioregions

2.2. Climate

The Great Victoria Desert and Central Ranges bioregions are both characterised by having an arid climate, with low, variable rainfall (Australian Natural Resources Atlas 2009a, b). The Central Ranges bioregion is influenced by a northern tropical/summer climatic pattern, with the majority of rain falling during the summer months due to the movement of low-pressure troughs and tropical lows associated with monsoon troughs moving south in the region (Australian Natural Resources Atlas 2009b). In contrast, the Great Victoria Desert bioregion can receive rainfall during both summer and winter (Australian Natural Resources Atlas 2009b).

The closest Bureau of Meteorology (BOM) weather station to the Study Area is the Giles Meteorological Office, which is approximately 150 km to the north. The Giles Meteorological Office has a long term mean annual rainfall of approximately 289 mm, with the bulk of the rain falling between November and March (**Figure 4**). The Giles Meteorological Office experiences a mean of 32 rain days per annum (BOM 2012). The November to March period of maximum rainfall coincides with a period of peak temperatures, with mean maximum temperatures ranging from 20.0°C in July to 37.3°C in January, and mean minimum temperatures ranging from 6.9°C in July to 23.5°C in January (**Figure 4**).

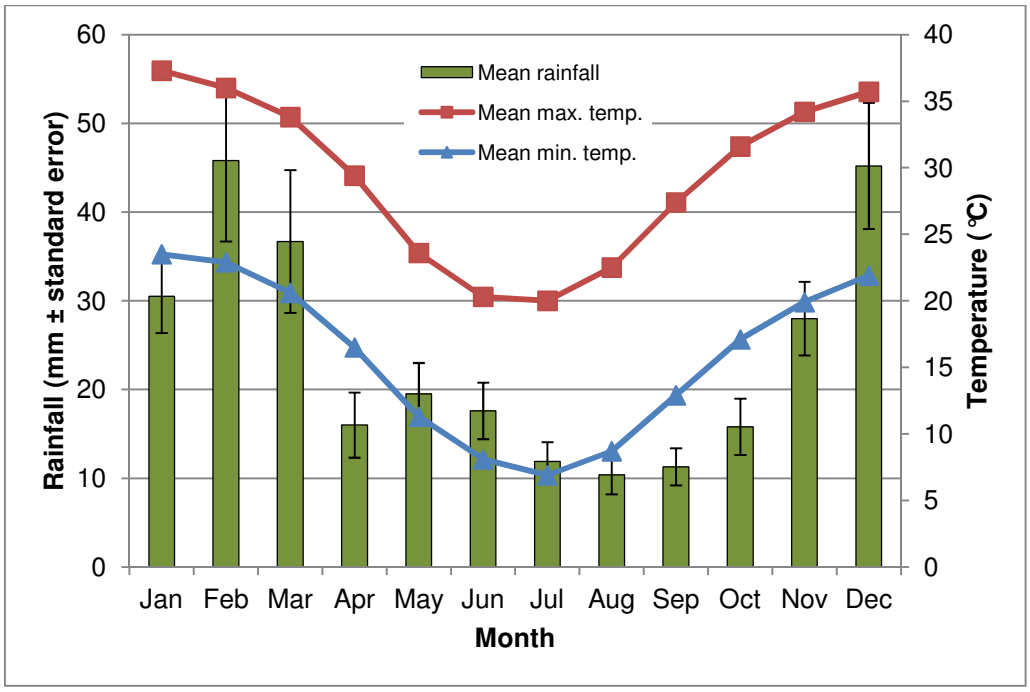

Figure 4: Climate data for Giles, 150 km north of the Study Area

Source data: BOM (2012), 1956 to 2012

2.3. Soil-landscapes of the Study Area

The most detailed and recent soil mapping for Western Australia's rangelands and arid interior was consolidated in 2006, into a hierarchy of soil-landscape mapping units Tille (2006). These data were then used to describe land systems for regions of Western Australia, based on landforms, soil, vegetation, geology and geomorphology (eg see Van Vreeswyk *et al.* 2004). For those parts of the arid interior that include the Study Area, the most recent data are the original field soil survey and aerial photography interpretations from the *Atlas of Australian Soils* (Northcote et al. 1960-1968); but, while the *Atlas* is presented as a soil map, it is in reality a soil-landscape map as the mapping units are associations of soil delineated by landscapes (Tille 2006). Thus, we treat these soil-landscape mapping units as analogous to land systems for the purposes of this report.

An assessment of these soil-landscapes can provide additional information on the occurrence and distribution of fauna habitats within and surrounding the Study Area. The Study Area traverses six soil-landscapes (**Table 1**). Of these, the majority of the Study Area (34.7% of its total length) traverses the AB64 mapping unit, but large portions of the Study Area also occur across the My112 (29.3%) and AB48 (25.8%) mapping units (**Figure 5**, **Table 1**).

Table 1: Summary of the land system characteristics for the Study Area

Soil-landscape	Brief description	Amount of Study Area	
		Length (km)	Proportion (%)
Mapping unit MM27	Outwash plains subjacent to ranges of basic igneous rocks; some low hills of basic rocks occur in the land system, as well as occasional dunes	0.8	0.7
Mapping unit Fa34	Steep hills and ranges on basic rocks; rock outcrops are common, and there are some gorges small pediments and plains	0.5	0.4
Mapping unit My112	Extensive plains with numerous dunes which are often short and of irregular shape and orientation	31.1	29.3
Mapping unit AB48	Very gently undulating plain traversed by longitudinal dunes	27.5	25.8
Mapping unit My109	Outwash plains and dissected fan and terrace formations, flanking ranges of sedimentary and some metamorphic, volcanic and granitic rocks	9.7	9.1
Mapping unit AB64	Plains with occasional short dunes, and hilly areas with rock outcrops	36.9	34.7
	Total	**106.5**	**100.0**

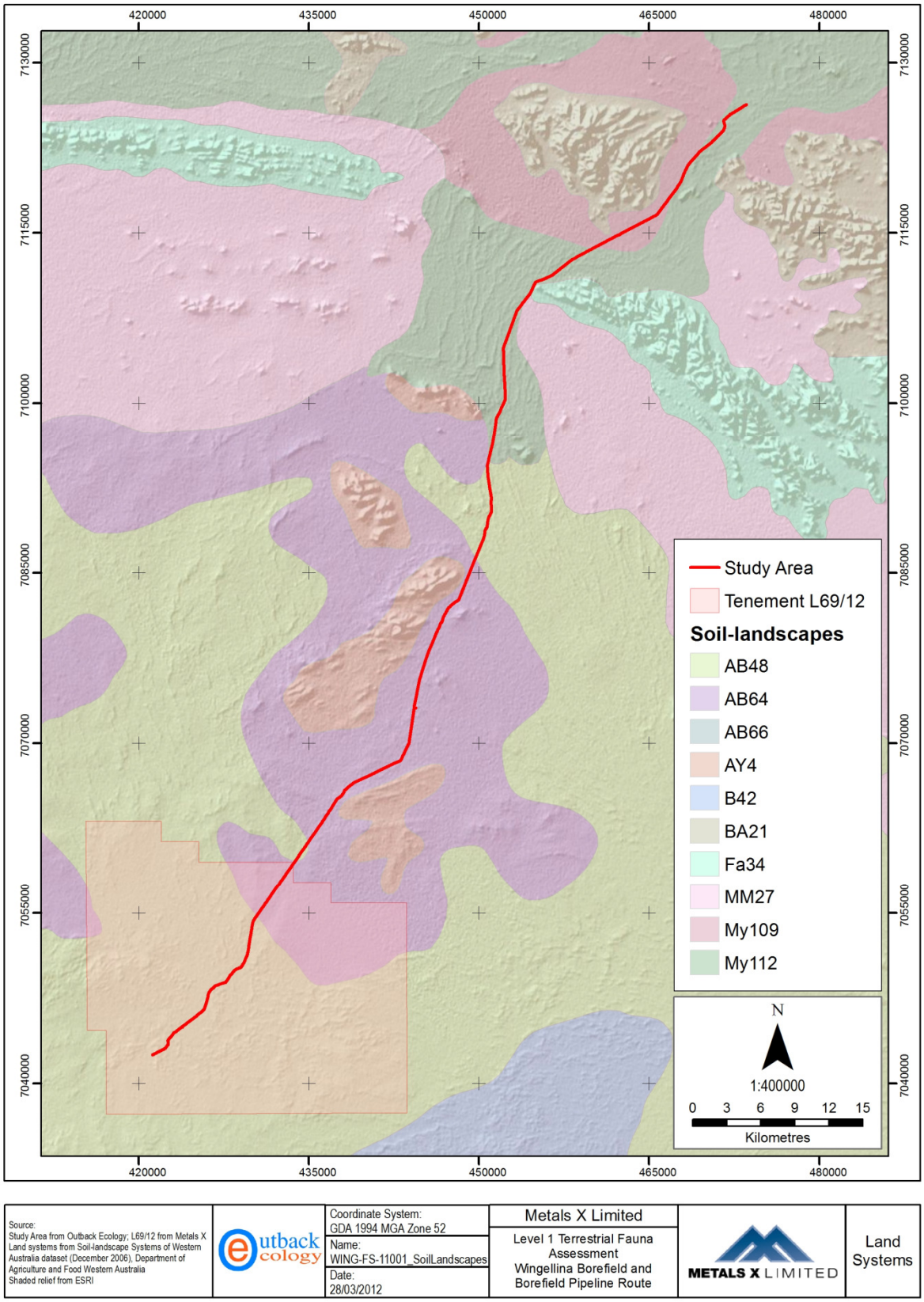

Figure 5: Soil-landscapes of the Study Area

(see **Table 1** for descriptions of individual land systems)

2.4. Land Use

Aboriginal Lands, including current and proposed indigenous protected areas, is the dominant land use category within the Central Ranges and Great Victoria Desert bioregions. Aboriginal Lands occupy the entirety of the Central Ranges bioregion and approximately 42% of the Great Victoria Desert bioregion. In the Great Victoria Desert bioregion, the largest aboriginal reserves are the Aṉangu Pitjantjatjara Lands and the Ngaanyatjarra Lands, with the Study Area located in the latter (**Figure 6**). The Ngaanyatjarra Lands have a high level of biodiversity and represent the traditional country of the Yarnangu people, who live on the Lands in 11 autonomous incorporated communities represented by the Ngaanyatjarra Council (DSEWPaC 2011). The Lands contain the Ngaanyatjarra Lands Indigenous Protected Area (IPA), declared in August 2002 under World Conservation Union *Category IV – Managed Resource Protected Area: Protected Area Managed Mainly for the Sustainable use of Natural Ecosystems* and currently the largest declared IPA in Australia (DSEWPaC 2011).

Conservation reserves are another major land use in the vicinity of the Study Area. The Gibson Desert, Neale Junction and Great Victoria Desert Nature Reserves, and the Mamungari Conservation Park, are all found in the Great Victoria Desert bioregion within 350 km of the Study Area (**Figure 6**). The Mamungari Conservation Park contains the Serpentine Lakes which are a significant wetland refuge (Australian Natural Resources Atlas 2009b). The Uluṟu-Kata Tjuṯa National Park, a federally-managed National Park listed under the World Heritage Convention for both natural and cultural values, is located approximately 280 km north-east of the Study Area.

The remainder of land in the vicinity of the Study Area is unallocated Crown land. Pastoral development and mineral exploration in the wider Great Victoria Desert bioregion have occurred, but pastoral development in the bioregion is confined to a few peripheral areas in the south and east, where water and feed are available in some years. The bioregion is otherwise unsuitable for grazing, as water is very limited and fodder plants are very sparsely distributed (Australian Natural Resources Atlas 2009b). Mineral exploration has been extensive since the 1970s, and seismic shot lines and survey lines exist; searches for uranium, coal and petroleum in the Eucla basin and exploration for gold and base metals within the Gawler Craton have been unsuccessful, however (Australian Natural Resources Atlas 2009b). Immediately to the north-east of the Study Area, the Wingellina Project lease area (E69/535) was opened for mineral exploration in the 1960s by Inco, and a number of abandoned chrysophase pits and drill holes are still present within the area. Metals X purchased the tenement from Acclaim Exploration in 2006 (Outback Ecology 2009).

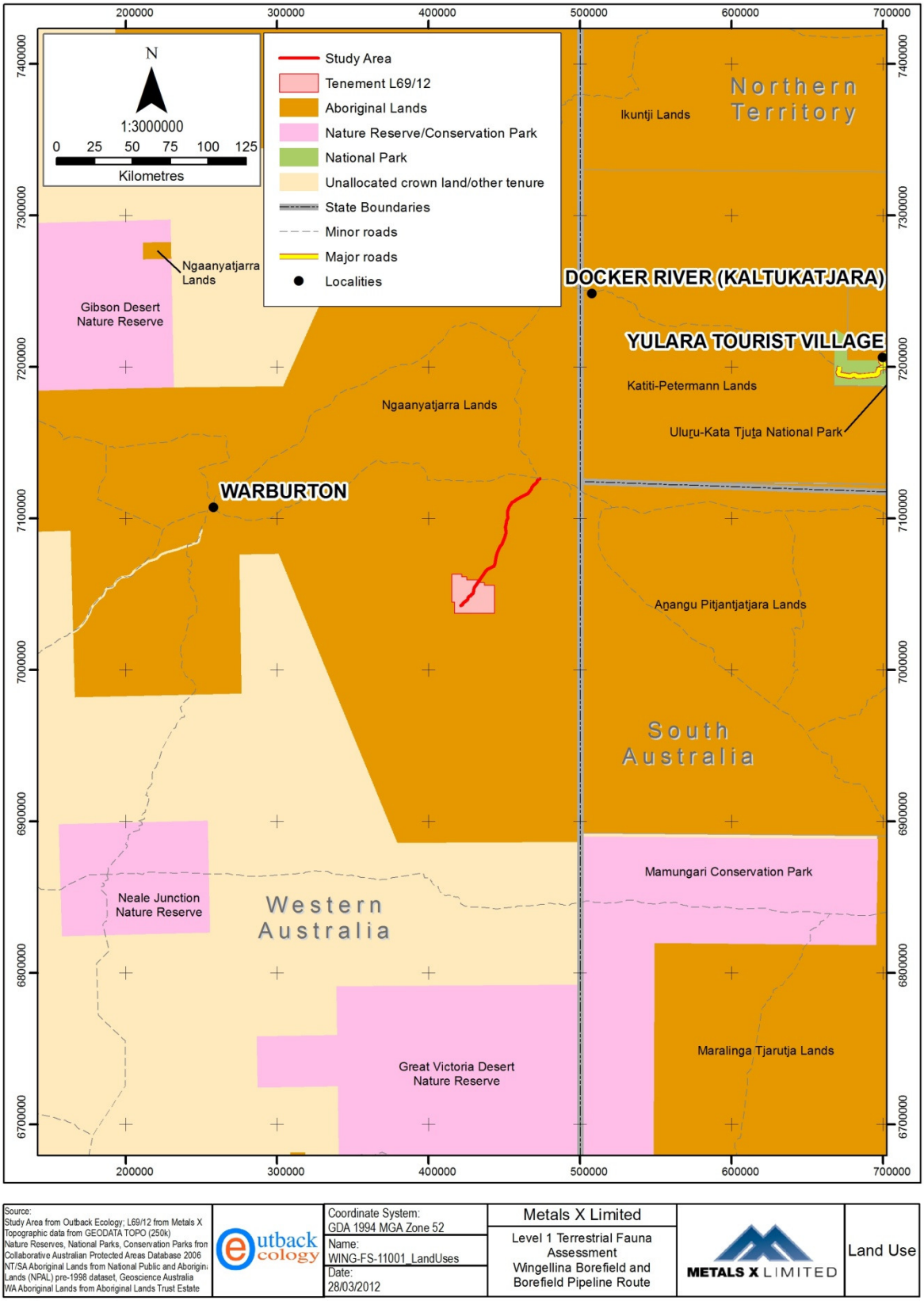

Figure 6: The Study Area and surrounding land uses

3. DESKTOP STUDY

Database searches and a literature review were undertaken prior to the fauna survey, to help identify the vertebrate and invertebrate fauna which potentially occur in the Study Area. The results of the database searches and literature review are presented in **Section 3.1** and **Section 3.2**, and for species of conservation significance the likelihood of their occurring in the Study Area is described in **Section 5.3**.

3.1. Database Searches

For the purpose of database searching, the Study Area was defined as a central point with coordinates 447003 mE 7081983 mN (WGS 1984, UTM 52J). The databases and search areas used were:

- the WA Department of Environment and Conservation's NatureMap database (DEC 2012a), with a search area consisting of the central point surrounded by a circular buffer zone of 40 km radius;
- the WA DEC's Threatened and Priority Fauna Database (DEC 2012b), with a search area consisting of the central point surrounded by a circular buffer zone of 135 km radius;
- the Birds Australia New Atlas 1998 to 2011 database (Birds Australia 2012), with a search area consisting of the central point surrounded by a circular buffer zone of 135 km radius;
- the Protected Matters Search Tool (DSEWPaC 2012a), with a search area consisting of a square box of side length 135 km – the box surrounded the central point and was delineated by the coordinates (clockwise, from the north-west corner) 312003 mE 7216983 mN, 582003 mE 7216983 mN, 582003 mE 6946983 mN and 312003 mE 6946983 mN; and
- the Western Australian Museum arachnid and diplopod collection database (WAM 2011), with a search area consisting of a square box of side length 200 km – the box surrounded the central point and was delineated by the coordinates (clockwise, from the north-west corner) 328931 mE 7146987 mN, 530106 mE 7148061 mN, 529635 mE 6948117 mN and 331607 mE 6946991 mN.

The database searches for the Study Area reported a total of 159 species of native, vertebrate fauna (**Table 2**, **Appendix A**), 22 of which are of conservation significance:

- the Crest-tailed Mulgara (*Dasycercus cristicauda*), Northern Marsupial Mole (*Notoryctes caurinus*), Central Marsupial Mole (*Notoryctes typhlops*) and Sandhill Dunnart (*Sminthopsis psammophila*), which are listed as Endangered (EPBC Act) and Schedule 1 (WC Act);
- the Malleefowl (*Leipoa ocellata*), Greater Bilby (*Macrotis lagotis*), Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*), Black-footed Rock-wallaby (MacDonnell Ranges race; *Petrogale lateralis* ANWC CM15314), Greater Stick-nest Rat (*Leporillus conditor*) and Great Desert Skink (*Liopholis kintorei*), which are listed as Vulnerable (EPBC Act) and Schedule 1 (WC Act);
- the Princess Parrot (*Polytelis alexandrae*), which is listed as Vulnerable (EPBC Act) and Priority 4 (DEC Priority Fauna List);

- the Slender-billed Thornbill (*Acanthiza iredalei iredalei*), which is listed as Vulnerable (EPBC Act);
- the Major Mitchell's Cockatoo (*Lophochroa leadbeateri*) and Peregrine Falcon (*Falco peregrinus*), which are listed as Schedule 4 (WC Act);
- the Bush Stone-curlew (*Burhinus grallarius*), Grey Falcon (*Falco hypoleucos*) and Australian Bustard (*Ardeotis australis*), which are listed as Priority 4 (DEC Priority Fauna List); and
- five species of migratory bird, which are listed as Migratory (EPBC Act) and/or Schedule 3 (WC Act) and are protected under international agreements (see **Appendix A** for full list).

Three species of short-range endemic invertebrate were also identified during the database search:

- a mygalomorph spider, *Aganippe* 'MYG190', recorded 24 km north-west of the Study Area;
- a mygalomorph spider, *Swolnpes morganensis*, recorded 28 km north-west of the Study Area; and
- a pseudoscorpion, *Synsphyronus gigas*, recorded 87 km south-west of the Study Area.

Table 2: Vertebrate species richness from database searches and previous studies

Fauna	Literature review							Database searches					Total
	A	B	C	D	E	G	Total	I	J	K	L	Total	
Native mammals	0	25	21	10	3	16	**35**	0	4	5	3	**9**	**40**
Introduced mammals	0	6	10	5	1	5	**10**	0	0	3	0	**3**	**10**
Native birds	51	176	130	23	54	72	**187**	138	4	8	39	**145**	**190**
Introduced birds	0	2	1	0	0	0	**3**	0	0	0	0	**0**	**3**
Reptiles	0	73	92	26	9	54	**109**	0	0	1	3	**4**	**109**
Amphibians	0	4	5	0	0	1	**7**	0	0	0	1	**1**	**7**
Total native fauna	51	278	248	59	66	143	**338**	138	8	14	46	**159**	**346**
Total fauna	51	286	259	64	67	148	**351**	138	8	17	46	**162**	**359**

For key to literature review study codes, see **Table 3**. For database searches, codes indicate: I, Birds Australia (2012); J, DEC (2012b); K, DSEWPaC (2012a); L, DEC (2012a). Species counts are combined over all survey methods.

3.2. Literature Review

The literature review identified six previous studies of relevance (**Table 3**, **Figure 7**). For the studies for which species lists were available, the results were collated to generate an inventory of the vertebrate fauna known to occur in the locality of the Study Area and within the surrounding wider region (**Table 2**, **Appendix A**).

Previous studies in the vicinity of the Study Area reported a total of 338 species of native, vertebrate fauna (**Table 2**, **Appendix A**), of which 28 are of conservation significance. Some of these species were previously identified during the database searches (**Section 3.1**), but 13 were not:

- the Brush-tailed Mulgara (*Dasycercus blythei*), which is listed as Vulnerable (EPBC Act) and Priority 4 (DEC Priority Fauna List);
- the Woma Python (*Aspidites ramsayi*), which is listed as Schedule 4 (WC Act);

- the Flock Bronzewing (*Phaps histrionica*), which is listed as Priority 4 (DEC Priority Fauna List); and
- ten species of migratory bird, which are listed as Migratory (EPBC Act) and/or Schedule 3 (WC Act) and are protected under international agreements (see **Appendix A** for full list).

Six species of invertebrate with potential to be short-range endemics were also identified during the literature review (**Table 3**):

- five species of mygalomorph spider (*Aganippe* sp. nov 'Wingellina' sp. 1, *Aganippe* sp. nov 'Wingellina' sp. 2, *Kwonkan* sp. 1 sp. nov, *Kwonkan* sp. 2 sp. nov and *Cethegus* sp.); and
- one species of pseudoscorpion (*Synsphyronus* sp. 'Wingellina').

Table 3: Key findings of relevant past studies

Code	Reference(s)	Survey details	Approx. proximity to Study Area†	Methods	Habitats defined or noted	Species of conservation significance	Comments
A	Gole (2002)	Project: Birds of the Wingellina Hills Client: Not applicable Study type: Casual survey Survey date: December 2001	Approximately 58 km north-east of the Study Area	• Avifauna census (standard Birds Australia Atlas surveys - see Barrett *et al.* 2003)	• Spinifex habitat • Sparse to moderately dense mallee and *Acacia* woodlands with patches of *Eremophila* spp. • Recent fire scars with green herbage • Older fire scars with tufty grasses below dead *Acacia* spp. • Thinly vegetated creek lines of limited extent	• None recorded	• The Wingellina Hills were noted to consist of a series of low, north-west to south-east trending ridges with a few higher and steeper hills • 31 Atlas surveys were performed over two weeks in a 20 km^2 area of the Hills • A species accumulation curve suggests that the survey recorded the bulk of the avifauna present in the area surveyed, but additional surveys at different times of year were recommended • The relatively low species count may reflect the relatively small area surveyed and the restricted habitats of the Hills themselves
B	Balding (1996) and Balding and Reid (1996)	Project: Compilation of vertebrate fauna checklists for Uluṟu-Kata Tjuṯa National Park Participant: Australian Government Director of National Parks Survey type: Desktop study Survey date: 1996	Approximately 270 km north-east of the Study Area	• Desktop studies only; no field methods used	• Rock outcrops, boulders, scree slopes and associated watercourses • Creeks (usually dry) and outwash plains • Low shrublands on alluvial fans, dominated by cassias • Claypans occasionally inundated with water • Shrublands on red loamy soil, usually dominated by mulga • Sandy country dominated by *Eucalyptus* mallee • Open habitat of soft grasses, often associated with mature mulga • Sand plain country which has been burnt in the last five years (approximately) • Sand plains and lower slopes of dunes, usually dominated by spinifex grass and/or desert oak • Sand dune crests and upper slopes • Stony plains and low hills with little vegetation	• Central Marsupial Mole (EPBC – VU; WA – S1) • Crest-tailed Mulgara (EPBC – EN, WA – S1) • Princess Parrot (EPBC – VU; WA – P4) • Great Desert Skink (EPBC – VU; WA – S1) • Major Mitchell's Cockatoo (WA – S4) • Peregrine Falcon (WA – S4) • Woma Python (WA – S4) • Australian Bustard (WA – P4) • Bush Stone-curlew (WA – P4) • Grey Falcon (WA – P4) • 14 species of bird listed as Migratory under the EPBC Act (see **Appendix A**)	• The animal checklist (Balding 1996) represents all non-avifauna species recorded in Uluṟu-Kata Tjuṯa National Park • The avifauna checklist (Balding and Reid 1996) represents all species of bird reliably recorded in the Park • Both checklists provide the Aṉangu names for the fauna encountered
C	Robinson *et al.* (2003)	Project: Aṉangu Pitjantjatjara Lands Biological Survey Participants: SA Department of Environment and Heritage, SA Museum, the Aṉangu people Survey type: Major biological survey Survey date: 1991 to 2001	This project surveyed a very large (102,650 km^2) amount of land. At its closest point the area surveyed is approximately 53 km east of the Study Area. The central point of the area surveyed is approximately 267 km south-east of the Study Area.	• Pitfall traps • Elliott traps • Cage traps • Avifauna census • Harp traps • Mist nets • Targeted searches • Spotlighting	19 vegetation communities, found within: • Drainage Lines • Sand plains and dunes • Plains • Mountain ranges and dissected tablelands	• Black-flanked Rock Wallaby (EPBC – VU; WA – S1) • Central Marsupial Mole (EPBC – VU; WA – S1) • Malleefowl (EPBC – VU, M; WA – S1) • Princess Parrot (EPBC – VU; WA – P4) • Great Desert Skink (EPBC – VU; WA – S1) • Major Mitchell's Cockatoo (WA – S4) • Peregrine Falcon (WA – S4) • Woma Python (WA – S4) • Australian Bustard (WA – P4) • Flock Bronzewing (WA – P4) • Grey Falcon (WA – P4) • Two species of bird listed as Migratory under the EPBC Act (see **Appendix A**)	• The survey added two new mammal, eight new bird and 33 new reptile species to the known fauna of the Aṉangu Pitjantjatjara Lands • The Great Desert Skink was thought to be extinct in SA until the discovery of several populations during this survey • The vegetation communities encountered were relatively intact, and low incidences of weeds were recorded • Pattern analyses were used to group faunal and floral communities • The report for this survey lists the Pitjantjatjara and Yankunytjatjara names for the fauna encountered

Code	Reference(s)	Survey details	Approx. proximity to Study Area†	Methods	Habitats defined or noted	Species of conservation significance	Comments
D	Outback Ecology (2009)	Project: Wingellina Nickel Project Terrestrial Fauna Assessment Client: Metals X Limited Survey type: Single-phase, Level 2 Survey date: April 2008	Approximately 60 km north-east of the Study Area	Vertebrates: • Pitfall traps • Elliott traps • Funnel traps • Cage traps • Targeted searching • Spotlighting • AnaBat recordings • Avifauna census Invertebrates: • Soil sieving • Pitfall trapping • Targeted searching	• Sparse mulga woodland/grasses • Open mulga woodland • Open mallee woodland • Rocky escarpment • Sparse mulga woodland/grasses • Open dead mulga woodland	Vertebrates: • Australian Bustard (WA – P4) Invertebrates with SRE potential: • five species of mygalomorph spider (*Aganippe* sp. nov 'Wingellina' sp. 1, *Aganippe* sp. nov 'Wingellina' sp. 2, *Kwonkan* sp. 1 sp. nov, *Kwonkan* sp. 2 sp. nov and *Cethegus* sp.) • one species of pseudoscorpion (*Synsphyronus* sp. 'Wingellina')	• Fauna habitats in the area surveyed were widely distributed in the surrounding region • Three of the six invertebrate taxa with SRE potential were recorded from rocky escarpment habitats, and it was considered likely that they have a limited geographic range, within this habitat type
E	HGM Maunsell (2002)	Project: Wingellina Baseline Biological Survey Client: Acclaim Exploration NL Survey type: Level 1 Survey date: April 2002	Approximately 60 km north-east of the Study Area	• Elliott traps • Avifauna census • Targeted searches • Spotlighting • Opportunistic recording	• Upland rocky ridges, hill slopes and boulders • Lower and mid-slope scree and low stony rises • Lowland grasses and forbs in valleys and on flats	• None recorded	• The area surveyed was found to be substantially disturbed as a result of mineral exploration, mining, altered fire regimes, vehicles and other human activities • Historical exploration issues and fire were identified as having had the largest impact on ecosystems within the area surveyed • There was minimal evidence of grazing in the area surveyed
F	Pearson *et al.* (2007)	Project: Ngaanyatjarra Lands Survey Participants: WA Museum, WA Department of Environment and Conservation, SA Museum, SA Department of Environment and Heritage, the Ngaanyatjarra people Study type: Single-phase, Level 2 Survey date: October 2006	First survey area: The general vicinity of the Rawlinson and Walter James Ranges, approximately 155 and 200 km north of the Study Area, respectively Second survey area: The general vicinity of the Morgan Range, approximately 57 km north of the Study Area	Vertebrates: • Pitfall traps • Elliott traps • Funnel traps • Tracking and hand-capture • Spotlighting • Opportunistic recording Invertebrates: • Aquatic dip-netting • Stygofauna sampling • Light-trapping • Spotlighting (including UV)	• Black dolerite ranges • Quartzite ranges • Sand dunes • Mulga • Isolated granite outcrops	• Unknown: species list not yet available	• Survey recorded 720 plant species, of which 37 were new records for the region or substantial range extensions • Range extensions were documented for several species of gecko • One hundred species of spider identified within the survey are thought to be undescribed • A new species of stygofauna was recorded, an aquatic beetle, most likely endemic to the Central Ranges • A new species of snake was recorded – the Central Ranges Taipan (*Oxyuranus temporalis*)

Code	Reference(s)	Survey details	Approx. proximity to Study Area†	Methods	Habitats defined or noted	Species of conservation significance	Comments
G	Brennan *et al.* (2012)	Project: Spinifex Native Title Determined Area surveys Participants: WA Department of Environment and Conservation, WA Herbarium, Museum Victoria, the Pila Nguru people Study type: Two-phase, Level 2 Survey date: May and October 2010	Approximately 240 km south-west of the Study Area	• Pitfall traps (standard and extra-deep) • Elliott traps • Funnel traps • Tracking and hand-capture • Motion-sensor cameras • Spotlighting • Opportunistic recording • Scat analysis • AnaBat recordings • Survey trenching	• Three different vegetation communities on sand dunes • Rocky rise with low open woodland • Sand plain with low woodland • Dune swale with low *Acacia* woodland • Gravelly rise with low *Acacia* and *Eucalyptus* woodland • Sand plain adjacent to rocky rise	• Central Marsupial Mole (EPBC – VU; WA – S1) • Malleefowl (EPBC – VU, M; WA – S1) • Princess Parrot (EPBC – VU; WA – P4) • Major Mitchell's Cockatoo (WA – S4) • Brush-tailed Mulgara (WA – P4) • Australian Bustard (WA – P4) • One species of bird listed as Migratory under the EPBC Act (see **Appendix A**)	• Extra deep (1 m deep) pitfall traps were used to maximise the chance of catching Mulgaras and Sandhill Dunnarts • Three new species of plant were identified, and only a single individual of one weed species was recorded during the habitat surveys • Damage to mulga habitat by camels was reported • The report for this survey lists the Pila Nguru names for many of the fauna encountered
H	Outback Ecology (2011b)	Project: Wingellina Nickel Project Proposed Borefield Drill Line Targeted Fauna Assessment Client: Metals X Limited Survey type: Targeted survey Survey date: October 2011	Immediately adjacent to the east side of the Study Area	• Targeted searching for burrows and tracks • Motion-sensor cameras • Opportunistic recording	Not applicable	• Brush-tailed Mulgara (WA – P4) • Rainbow Bee-eater (EPBC – M)	• This targeted survey was performed to detect the Bruch-tailed Mulgara and Great Desert Skink • Two records of live Brush-tailed Mulgara were obtained via motion-sensor camera, both immediately adjacent to the Study Area • No burrows of Mulgara or Great Desert Skink were recorded

†Distances are measured from a central point within the Study Area, as defined in **Section 3.1**.

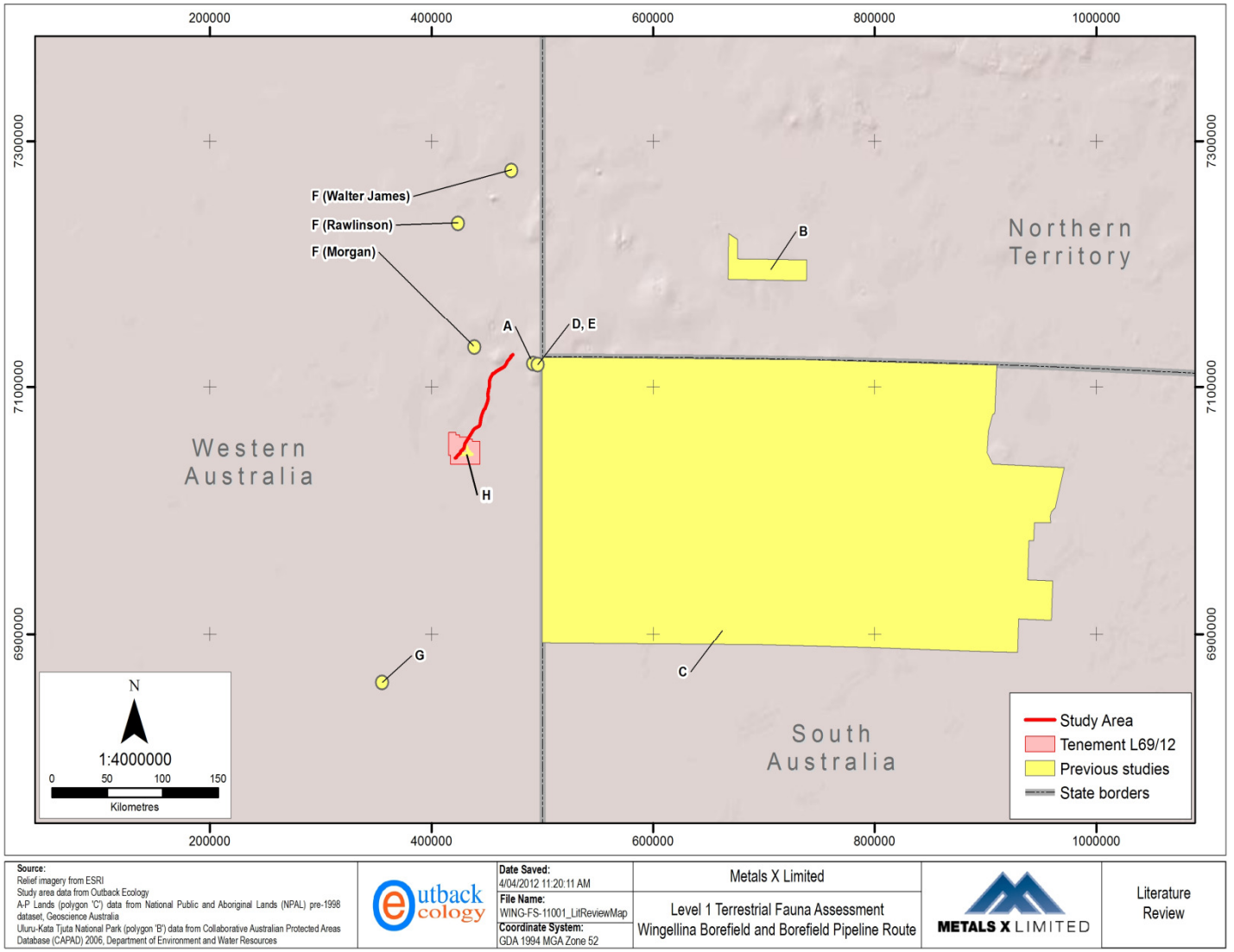

Figure 7: The Location of previous studies in the vicinity of the Study Area

(see **Table 3** for key to location codes)

4. FIELD SURVEY METHODOLOGY

4.1. Background Information

4.1.1. Survey Timing And Weather

The field survey ran from 2 October to 8 October 2011. The weather experienced was considered appropriate for a Level 1 survey. Maximum and minimum temperatures at Wingellina during the period were 32.7°C and 12.6°C, respectively, and mean maximum and minimum temperatures were 28.0°C and 14.8°C, respectively (**Table 4**). Total rainfall at Giles Meteorological Office in the six months prior to the survey was 49.4 mm, which is lower than the long-term average of 86.7 mm for this period (**Figure 8**). June and July 2011 received more rain than the average, but April, May, August and September received less (**Figure 8**); such variability is typical of rainfall patterns for the area (**Section 2.2**). The total rainfall at Wingellina during the survey period was 3.8 mm (**Table 3**).

Table 4: Daily weather observations at Wingellina, for the survey period

Date	Temperature (°C)		Rainfall (mm)	Relative humidity (%)	
	Min	Max		9.00 am	3.00 pm
2/10/2011	14.5	28.0	0.0	27	17
3/10/2011	16.3	29.1	3.8	34	21
4/10/2011	14.0	26.5	0.0	59	21
5/10/2011	12.6	25.2	0.0	66	30
6/10/2011	13.7	25.9	0.0	48	27
7/10/2011	16.2	28.5	0.0	52	21
8/10/2011	16.4	32.7	0.0	35	14

Source data: Metals X Wingellina weather station (M. Maczurad, pers comm)

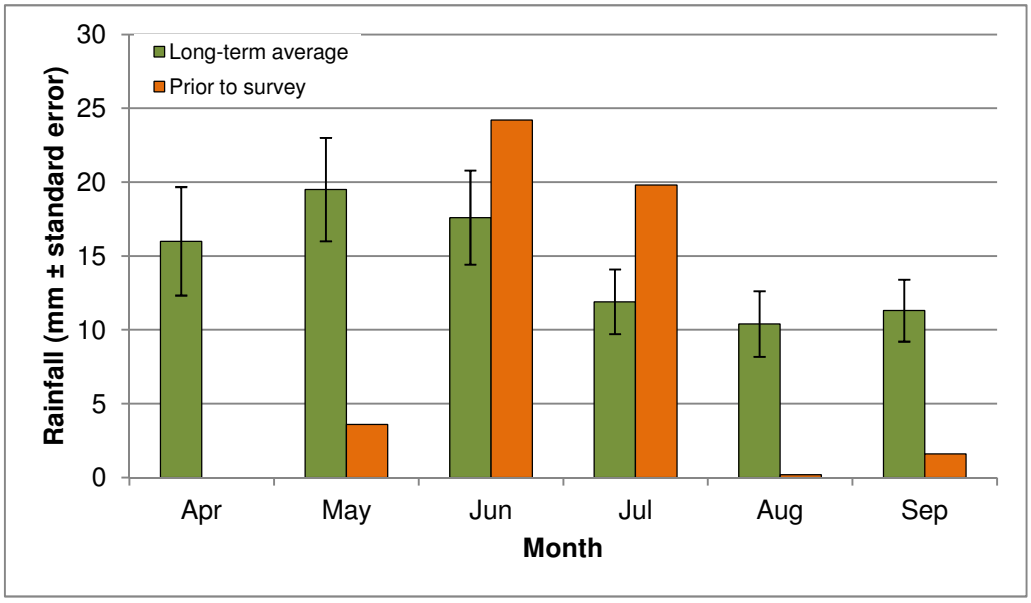

Figure 8: Long-term rainfall and rainfall for six months prior to the survey, at Giles

Source data: BOM (2012), 1956 to 2012

4.1.2. Study Team And Licensing

The field survey of the Study Area was conducted by Outback Ecology (**Table 5**). Permission to access the Study Area was granted by the Ngaanyatjarra Council (17614; Permission to Enter and Remain on Aboriginal Reserve). Bat echolocation recordings from SM2BATs were analysed by Bob Bullen, a bat specialist from Bat Call WA. The field survey was conducted under a Licence to Take Fauna for Scientific Purposes (DEC, Regulation 17 Licence) with details as follows:

- licence number SF008259;
- issue date 26 September 2011; and
- valid from 2 October to 1 December 2011.

Table 5: Study team for the field survey of the Wingellina Study Area

Person	Discipline	Qualifications	Position
Mike Young	Zoologist	BSc (Mar Sci) (Hons Zool) PhD (Evol Biol)	Outback Ecology Senior Environmental Scientist
Adrian Rakimov	Invertebrate Zoologist	BSc (Zool) (Hons Zool) PhD (Zool)	Outback Ecology Environmental Scientist

4.2. Habitat Assessment And Site Selection

Broad habitat types within the Study Area were identified in the field and representative areas were chosen for habitat assessments. The purpose of the habitat assessments was to characterise the quality and complexity of habitat provided for fauna, with a focus on species of conservation significance. The following parameters were considered:

- landscape and soil features;
- the presence or absence of logs or other habitat structures;
- vegetation cover, condition and species composition;
- estimate of leaf litter cover percentage and type;
- the presence or absence of water; and
- types of disturbance and levels of disturbance.

Each of the representative areas was given a rating of excellent, very good, good, moderate, degraded or completely degraded based on the overall condition of the habitat for fauna. Once the broad habitat types were identified, sites for targeted fauna searches were identified. Subsequent to the field survey, the habitat information was used in conjunction with aerial imagery and topographic maps to produce habitat maps for the Study Area.

4.3. Fauna Surveying

4.3.1. Systematic Searching

Based on habitat characteristics, ten locations were selected to conduct systematic searches for vertebrates and invertebrates and an additional site (TARGET-01) was selected to conduct a targeted

search for invertebrates only (**Figure 9**). Each search was performed by two people for 45 minutes, and the total systematic search effort for This Study was 15 person-hours. Each systematic search involved:

- observation and documentation of all vertebrate fauna seen or heard, or whose presence was inferred from tracks, scats or burrows;
- active hand-searching for cryptic species by overturning logs and stones, and searching beneath leaf litter and the bark of dead trees; and
- searches for invertebrate fauna, via digging scorpion and mygalomorph burrows and searching for invertebrates in the following microhabitats:
    - under logs, rocks and in crevices;
    - at the bases of shrubs, trees and spinifex; and
    - under bark and amongst leaf litter and debris.

4.3.2. Spotlighting

Spotlighting surveys were conducted by slowly driving sections of the Study Area at night, and by traversing suitable areas on foot using head torches and hand-held spotlights. Two spotlighting surveys were conducted (**Figure 9**), with a total search effort of 8.5 person-hours. Night searches were aimed at finding nocturnally active species such as owls, nightjars, frogs, geckos and scorpions.

4.3.3. Motion-Sensor Cameras

Based on habitat characteristics, six locations were chosen to deploy motion-sensor cameras (**Figure 9**). The cameras (Bushnell TrophyCam XLT Viewer) were baited using a mixture of rolled oats, peanut butter and sardines, and were intended to record the activities of macropods, small mammals such as dasyurids and rodents, and nocturnally active reptiles such as geckos. Depending on the performance of the each camera on its first night, some cameras were redeployed for a second night at the same location (**Table 6**). The total effort for camera trapping was nine trap-nights.

Table 6: Camera Trapping Effort

Trap location	Effort (trap nights)
CAMERA-01	2
CAMERA-02	1
CAMERA-03	1
CAMERA-04	2
CAMERA-05	1
CAMERA-06	2

4.3.4. Bat Echolocation Recording

A SongMeter 2 Bat Echolocation Recorder (SM2BAT; Wildlife Acoustics) was deployed in locations with habitats and features likely to support bat fauna. Each deployment was for a single night, and ten locations were chosen for deployment (**Figure 9**). Subsequent to the field survey, the recordings

were analysed by Bat Call WA, providing a species list for each deployment location. The total effort for bat echolocation recording was ten trap-nights.

4.3.5. Opportunistic Searching

Within the Study Area and survey period, vertebrate fauna that were observed outside of the systematic sampling and targeted search programmes were documented and the resulting records were classified as 'opportunistic'. Opportunistic records supplement those obtained during the systematic sampling and other search programmes, and may have been generated as a result of direct or indirect fauna observations made:

- before or after the fixed-time searches;
- while habitat mapping or travelling to and from search sites; and
- at any other time whilst working in or travelling within the Study Area.

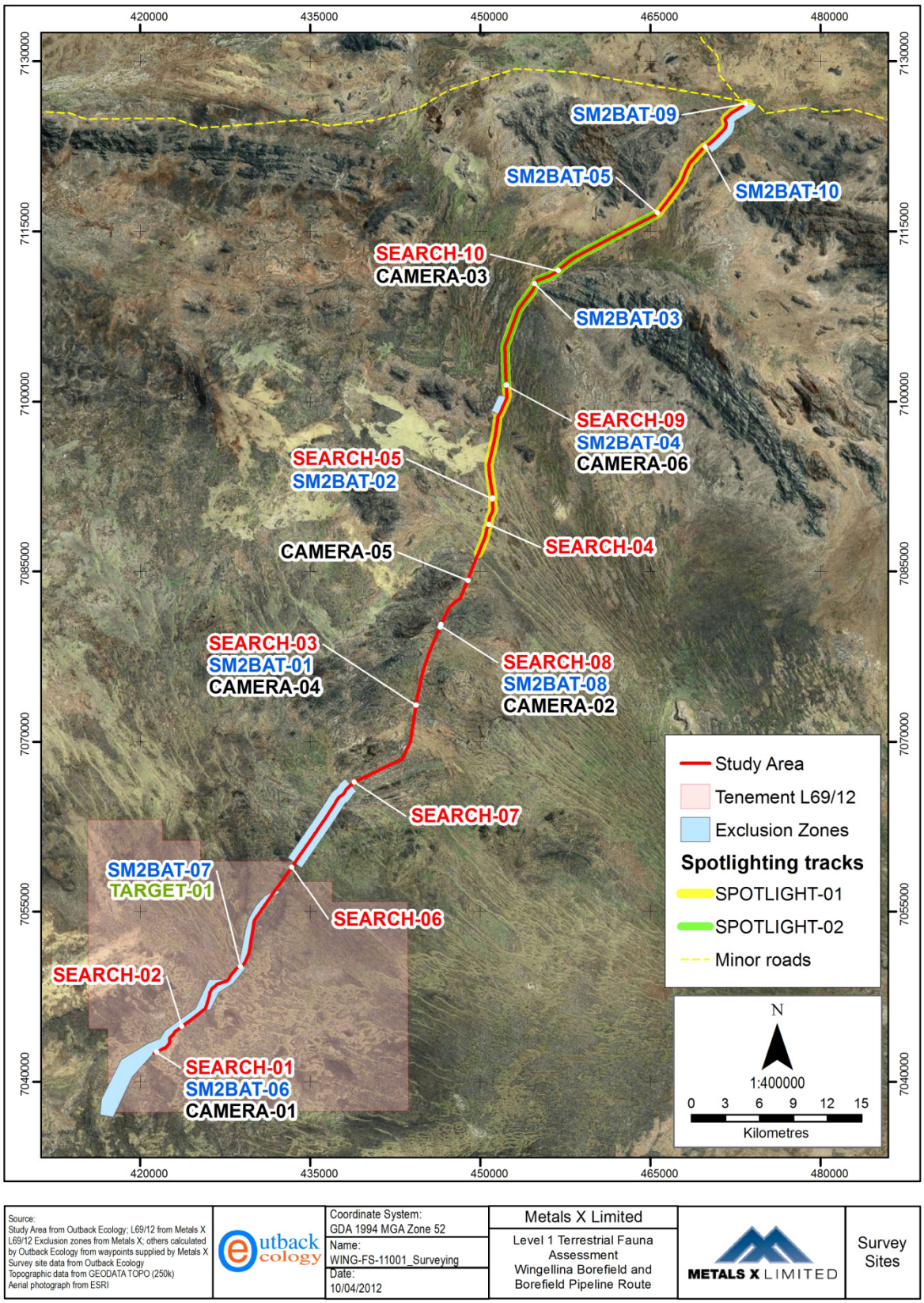

Figure 9: Location of survey activities within the Study Area

4.4. Taxonomy And Nomenclature

The nomenclature and taxonomy of all mammals, reptiles and amphibians in this report follow the *Checklist of the Vertebrates of Western Australia* (WAM 2010), and those of all birds follow the *Birds Australia Checklist of Australian Birds* (based on Christidis and Boles 2008). Relevant texts, from which information on more recent taxonomic updates and general patterns of distribution are available, were also considered for:

- non-volant mammals (Menkhorst and Knight 2004, Van Dyck and Strahan 2008);
- bats (Churchill 2008);
- birds (Johnstone and Storr 1998, 2004, Morcombe 2003, Pizzey and Knight 2007));
- reptiles (Cogger 2000, Storr *et al.* 1999, 2002, Wilson and Swan 2008, Wilson and Swan 2010); and
- amphibians (Cogger 2000, Tyler and Doughty 2009).

4.5. Limitations And Constraints

There are a number of possible limitations and constraints that can impinge on the adequacy of fauna surveys (EPA 2004). These are discussed below, with respect to the October 2011 survey of the Wingellina Project Study Area (**Table 7**). All fauna surveys are limited to some degree by time and seasonal factors, and ideally multiple surveys of an area would be undertaken over a number of years and within a number of different seasons.

Table 7: Discussion of the potential limitations and constraints of This Study

Factor	Constraint (Yes or No)	Comments
Competency and experience of consultants	No	Survey team members were fauna specialists employed by Outback Ecology. Both team members possessed relevant post-graduate qualifications and have had several years of experience undertaking fauna surveys of this nature in Western Australia
Scope	No	All terrestrial vertebrate fauna groups were surveyed using standardised and well-established techniques, and previous survey work local to and in the wider region of the Study Area was reviewed. Bat echolocation recordings were analysed by Bob Bullen of Bat Call WA
Proportion of fauna identified	No	The desktop component of This Study documented a combined total of 359 vertebrate species potentially occurring in the Study Area, and the field survey component recorded 59 (approximately 16%) of these. The field survey also recorded one additional species not previously recorded within the wider region. The total of 60 species found during the field survey is comparable to counts obtained during previous surveys in the vicinity of the Study Area, of a similar size and scope (HGM Maunsell 2002, Outback Ecology 2009). Although the database searches and some studies in the wider region recorded substantially more species, these were performed over larger areas with many more habitat types

Factor	Constraint (Yes or No)	Comments
Information sources (e.g. historic or recent)	Partial Constraint	The Study Area is located in a relatively poorly-surveyed region, and although the results of past surveys were included during the literature review these surveys were few in number and most were substantial distances from the Study Area.
Proportion of task achieved, and further work which might be needed	No	All planned survey works were conducted according to scope, and the conservation value of fauna in the Study Area has been demonstrated by this fauna assessment. Although it was not possible to perform spotlighting in the southern portion of the Study Area (for logistical reasons) it is unlikely that the outcomes of This Study would have been substantially different should this have occurred
Timing / weather / season / cycle	No	This report details the results of a spring survey
Disturbances	No	Although disturbances were present in the Study Area (tracks, bore holes and drill pads) these are unlikely to have affected the results of This Study
Intensity	No	The Study Area was sampled for a total of 19 trap nights (motion-sensor cameras and SM2BAT recorders), with a total of 23.5 person hours spent undertaking spotlighting and systematic searching. This level of field survey effort is appropriate for a Level 1 assessment
Completeness	No	The survey was complete. Search effort was distributed effectively among habitat types and with appropriate geographical spread (but see note under 'access problems', below)
Resources	No	Resources were adequate to carry out the survey satisfactorily, and the survey participants were competent in identification of species present
Remoteness / access problems	Partial constraint	Access to most of the Study Area was good and adequate survey coverage was achieved; however, survey activities were not performed within the Exclusion Zones (approximately 8.3% of the Study Area) and it is possible that these areas contain habitats or fauna not documented in this report
Availability of contextual information	No	Data were available for the Central Ranges and Great Victoria Desert bioregions from several sources (Australian Natural Resources Atlas 2009a, b, Birds Australia 2012, DEC 2012a, DEC 2012b, WAM 2011)

5. FIELD SURVEY RESULTS AND DISCUSSION

5.1. Fauna Habitats

5.1.1. Fauna Habitats Within The Study Area

Six broad fauna habitats were identified within the Study Area (**Table 8**):

- Dense Mulga Woodland;
- Mulga over Hummock Grassland;
- Mulga over Tussock Grassland;
- Mulga-Mallee over Hummock Grassland;
- Drainage Line; and
- Scattered Eucalypts over Mixed Shrubland.

With the exception of the Drainage Line and Scattered Eucalypts over Mixed Shrubland habitat types, which are of limited extent within the Study Area, the habitats present in the Study Area are relatively well-represented outside of the Study Area. Three habitat types, Scattered Eucalypts over Mixed Shrubland, Dense Mulga Woodland and Mulga-Mallee over Hummock Grassland were identified as significant fauna habitats (**Section 5.1.2**). Other features of significance identified within the Study Area were a small rocky outcrop and areas containing large sand dunes (**Section 5.1.3**).

Table 8: Habitat types within the Study Area

Fauna habitat	Survey effort	Reference	Vegetation features			Physical features	Other comments	Approx. extent[†]
			Upper stratum	Middle stratum	Lower stratum			
Dense Mulga Woodland	SEARCH-04 SEARCH-05 SEARCH-06 SM2BAT-05 SM2BAT-07 CAMERA-05 SPOTLIGHT-01 SPOTLIGHT-02 TARGET-01	**Plate 1** **Figure 10** **Figure 11** **Figure 13** **Figure 15**	Dense *Acacia* spp. (*aneura*-type) trees up to 5 m high, with up to 40% cover	*Acacia* spp. small trees and shrubs up to 1 m high, with up to 20% cover	Predominantly hummock (*Triodia* spp.) grasses up to 0.5 m high, with up to 30% cover. Some tussock grasses and herbaceous annuals (eg *Ptilotus* sp.) also present. Hummock grasses large and well-established	Red sandy soils, to white in colour when calcrete present, with good drainage. Land form typically flat to slightly undulating plain, but one instance where habitat type occurred amongst large sand dunes (see **Section 5.1.3**)	Some evidence of habitat damage by camels and habitat has been bisected by Tjuntjuntjarra Track, but otherwise habitat is in good condition. Habitat is somewhat discontinuous and promotes accumulation of relatively large amounts of leaf litter, thus may have good potential for hosting SRE invertebrates	Five instances Total of 19.3 km 18.2% of Study Area
Mulga over Hummock Grassland	SEARCH-10 SM2BAT-03 CAMERA-03 SPOTLIGHT-01 SPOTLIGHT-02	**Plate 2** **Figure 10** **Figure 12** to **Figure 15**	Openly to sparsely distributed *Acacia* spp. (*aneura*-type) and occasional *Eucalyptus* spp. (mallee form) trees up to 3 m high, with up to 20% cover	Predominantly *Acacia* spp. small trees and shrubs up to 1 m high, with up to 10% cover in middle stratum	Predominantly hummock (*Triodia* spp.) grasses up to 0.5 m high, with up to 50% cover. Some herbaceous annuals also present	Red sandy soils, to white in colour when calcrete present, with good drainage. Land form typically flat to slightly undulating, and in some instances habitat adjacent to or amongst small sand dunes	Evidence of past fire in some places, where hummock grasses are only of moderate size and not as well-established as in other parts of the Study Area. Evidence of camels present. Habitat has been bisected by the Tjuntjuntjarra Track and presence of bore holes in some places suggests potential for hydrological modification, but habitat is otherwise in very good condition	Four instances Total of 16.7 km 15.8% of Study Area
Mulga over Tussock Grassland	SEARCH-03 SEARCH-07 SM2BAT-01 SM2BAT-10 CAMERA-04 SPOTLIGHT-01 SPOTLIGHT-02	**Plate 3** **Figure 11** to **Figure 13** **Figure 15**	Openly to sparsely distributed *Acacia* spp. (*aneura*-type) and very occasional *Eucalyptus* spp. (mallee form) trees up to 3 m high, with 0 to 20% cover	Predominantly *Acacia* spp. small trees and shrubs up to 1.5 m high, with 5 to 20% cover	Predominantly tussock grasses up to 0.5 m high, with up to 50% cover. Herbaceous annuals abundant (eg Asteraceae spp., *Ptilotus* spp.)	Red sandy soils, to white in colour when calcrete present, with good drainage. Land form typically flat to slightly undulating	Evidence of past fire in some places, where remnants of burnt mulga exist. Evidence of large numbers (relative to the remainder of the Study Area) of camels present. Habitat has been bisected by the Tjuntjuntjarra Track and the weed species Ruby Dock (*Acetosa vesicaria*) is present along the verge in places. Habitat quality is moderate	Four instances Total of 26.0 km 24.5% of Study Area
Mulga-Mallee over Hummock Grassland	SEARCH-02 SEARCH-09 SM2BAT-04 SM2BAT-05 SM2BAT-09 CAMERA-06 SPOTLIGHT-01 SPOTLIGHT-02	**Plate 4** **Figure 10** **Figure 13** to **Figure 16**	Openly to sparsely distributed *Acacia* spp. (*aneura*-type) and common *Eucalyptus* spp. (mallee form) trees typically up to 3 m high but up to 10 m in parts, with up to 20% cover	Largely absent (but *Acacia* spp. shrubs present at up to 2m high and 30% cover in parts)	Predominantly hummock (*Triodia* spp.) grasses from 0.5 to 1 m high, with very high (up to 75%) cover. Few tussock grasses but herbaceous annuals common (eg Asteraceae spp., Solanaceae spp., *Ptilotus* spp., *Hibiscus* spp.)	Red sandy soils, to white in colour when calcrete present, with good drainage. Small stones sometimes common on soil surface. Land form typically flat to slightly undulating	Evidence of past fire in some places, but most areas appear long unburnt as hummock grassland is dense and more established than in other parts of the Study Area. Evidence of camels present. Habitat has been bisected by the Tjuntjuntjarra Track and presence of bore holes in some places suggests potential for hydrological modification, but habitat is otherwise in very good condition	Six instances Total of 32.7 km 30.8% of Study Area
Drainage Line	SEARCH-08 SM2BAT-08 CAMERA-02	**Plate 5** **Figure 13**	Almost entirely non-vegetated riverbed but large *Eucalyptus* spp. trees up to 10 m high on banks, with very low total cover due to discontinuous canopy	Largely absent	Predominantly tussock grasses up to 1 m high with almost continuous cover. Lower stratum dominated by Buffel Grass (*Cenchrus ciliaris*) on and immediately adjacent to banks, but other species also present in parts	Dry desert drainage channels resulting in linear strips of habitat perpendicular to the Study Area. Red to red-brown sandy soils, interspersed with slightly larger soil and stone particles, with good drainage. Rocks and pebbles almost entirely absent from soil surface	Evidence of camels present, and habitat has been bisected by the Tjuntjuntjarra Track. As the weed species Buffel Grass has modified the riparian zone of the habitat extensively, the habitat is considered degraded	One instance Total of 1.2 km 1.1% of Study Area
Scattered Eucalypts over Mixed Shrubland	SEARCH-01 SM2BAT-06 CAMERA-01	**Plate 6** **Figure 10**	Infrequently and irregularly distributed *Eucalyptus* spp. (eg *E. gongylocarpa*) up to 20 m high, with low (approximately 5%) total cover	*Acacia* spp. and *Eucalyptus* spp. (mallee form) small trees and large shrubs (eg *Grevillea stenobotrya*) up to 3 m high, with up to 40% cover	Hummock grasses up to 0.5 m high, with up to 40% cover. Seedlings and immature plants (most likely *Acacia* spp.) also present	Red sandy soils, with good drainage. Habitat occurs over large sand dunes (see **Section 5.1.3**)	Evidence of past fire in some places, where hummock grasses are only of moderate size relative to those in other parts of the Study Area. Evidence of camels present. Habitat has been bisected by the Tjuntjuntjarra Track, but is otherwise in good to very good condition	One instance Total of 1.3 km 1.2% of Study Area

[†] Habitat extents sum to 97.2 km (approximately 91.7% of Study Area). No data were gathered for the remainder of the Study Area due to the presence of Exclusion Zones on both sides of the Tjuntjuntjarra Track in three places (**Figure 10**, **Figure 11**).

Plate 1: Dense Mulga Woodland habitat type

Plate 2: Mulga over Hummock Grassland habitat type

Plate 3: Mulga over Tussock Grassland habitat type

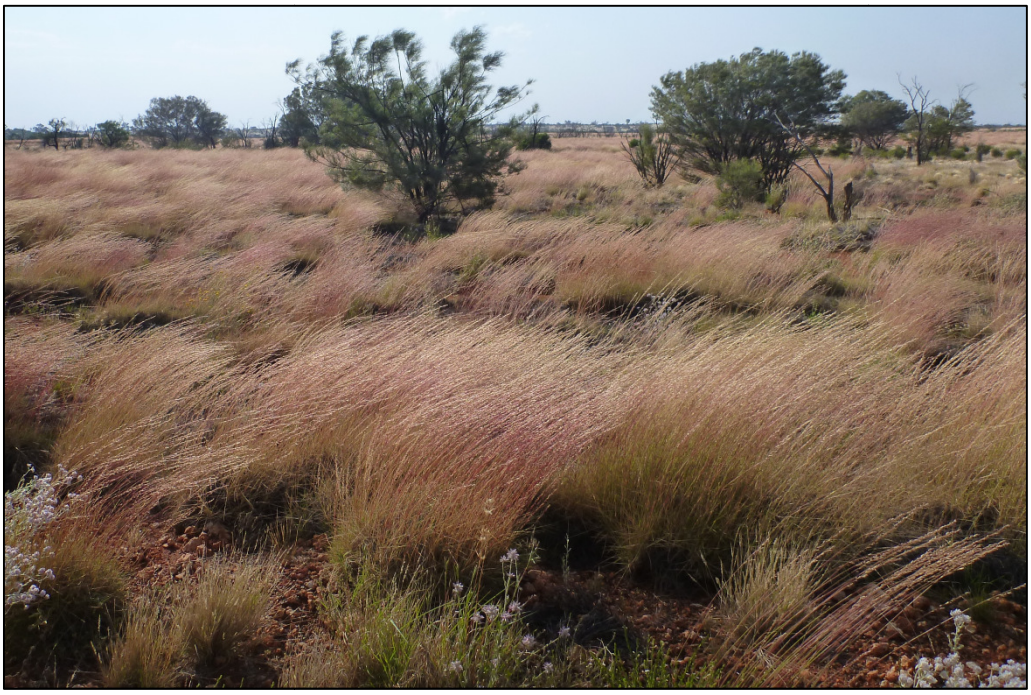

Plate 4: Mulga-Mallee over Hummock Grassland habitat type

Plate 5: Drainage Line habitat type

Plate 6: Scattered Eucalypts over Mixed Shrubland habitat type

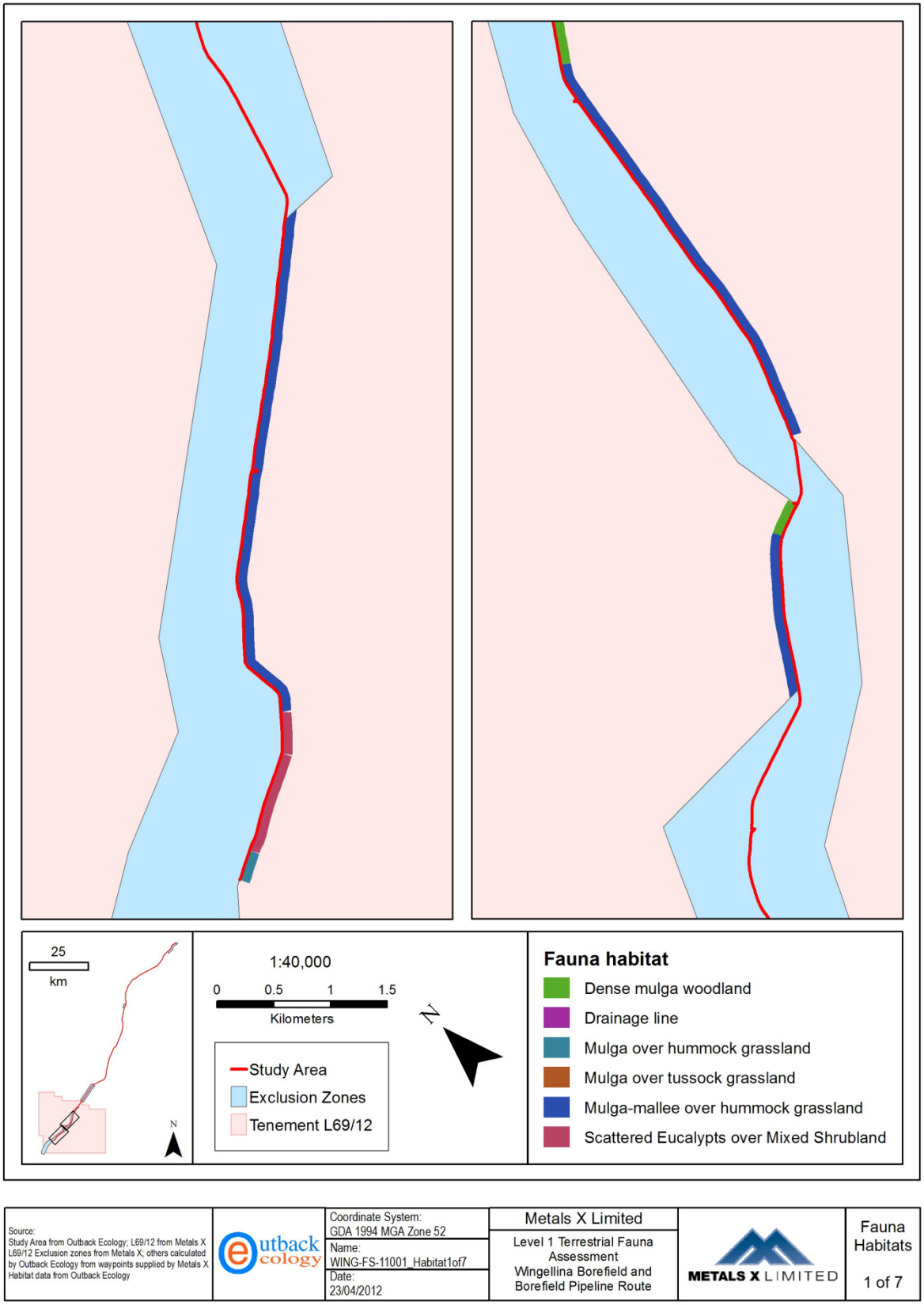

Figure 10: Fauna habitats in the Study Area - Map 1 of 7

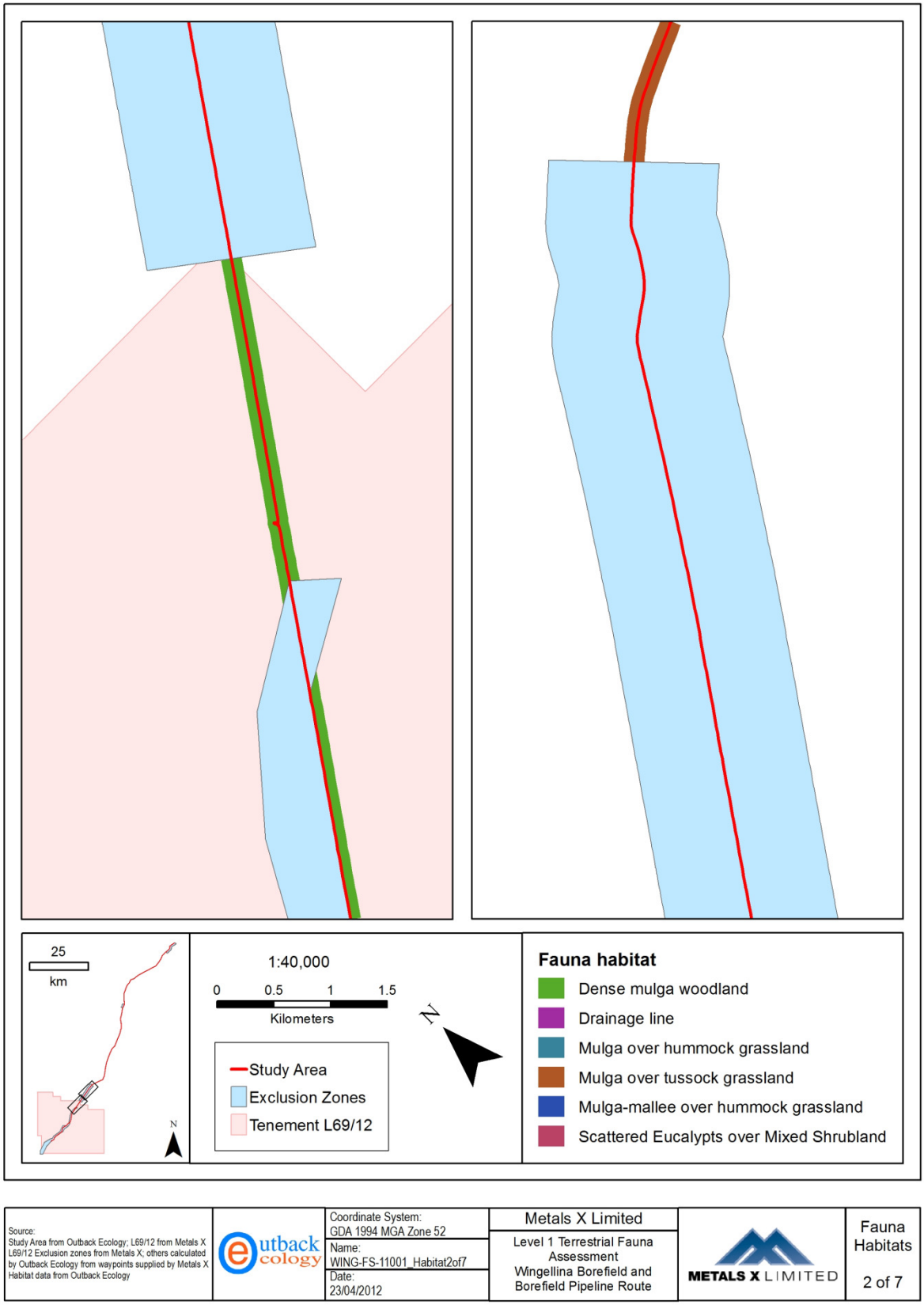

Figure 11: Fauna habitats in the Study Area - Map 2 of 7

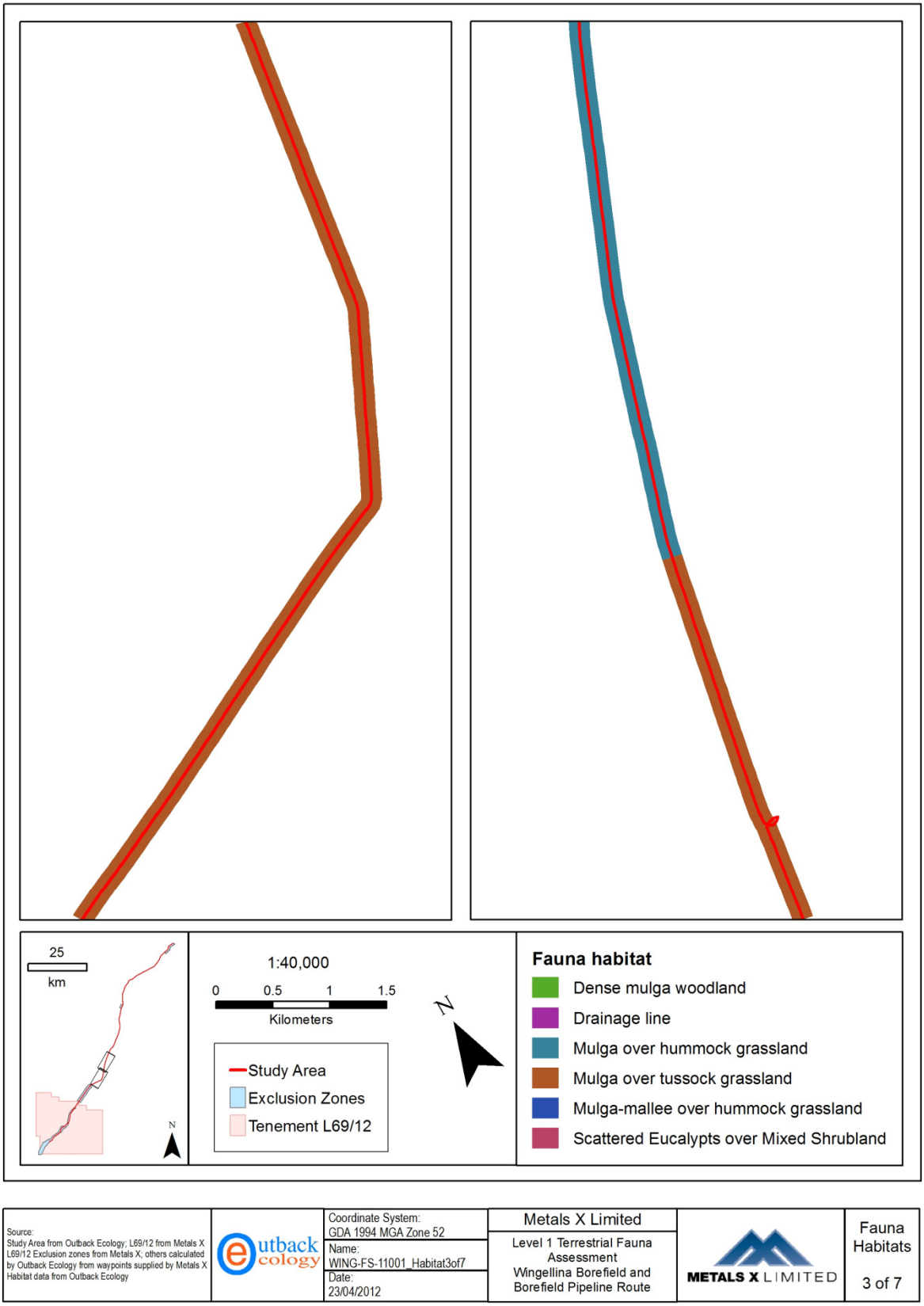

Figure 12: Fauna habitats in the Study Area - Map 3 of 7

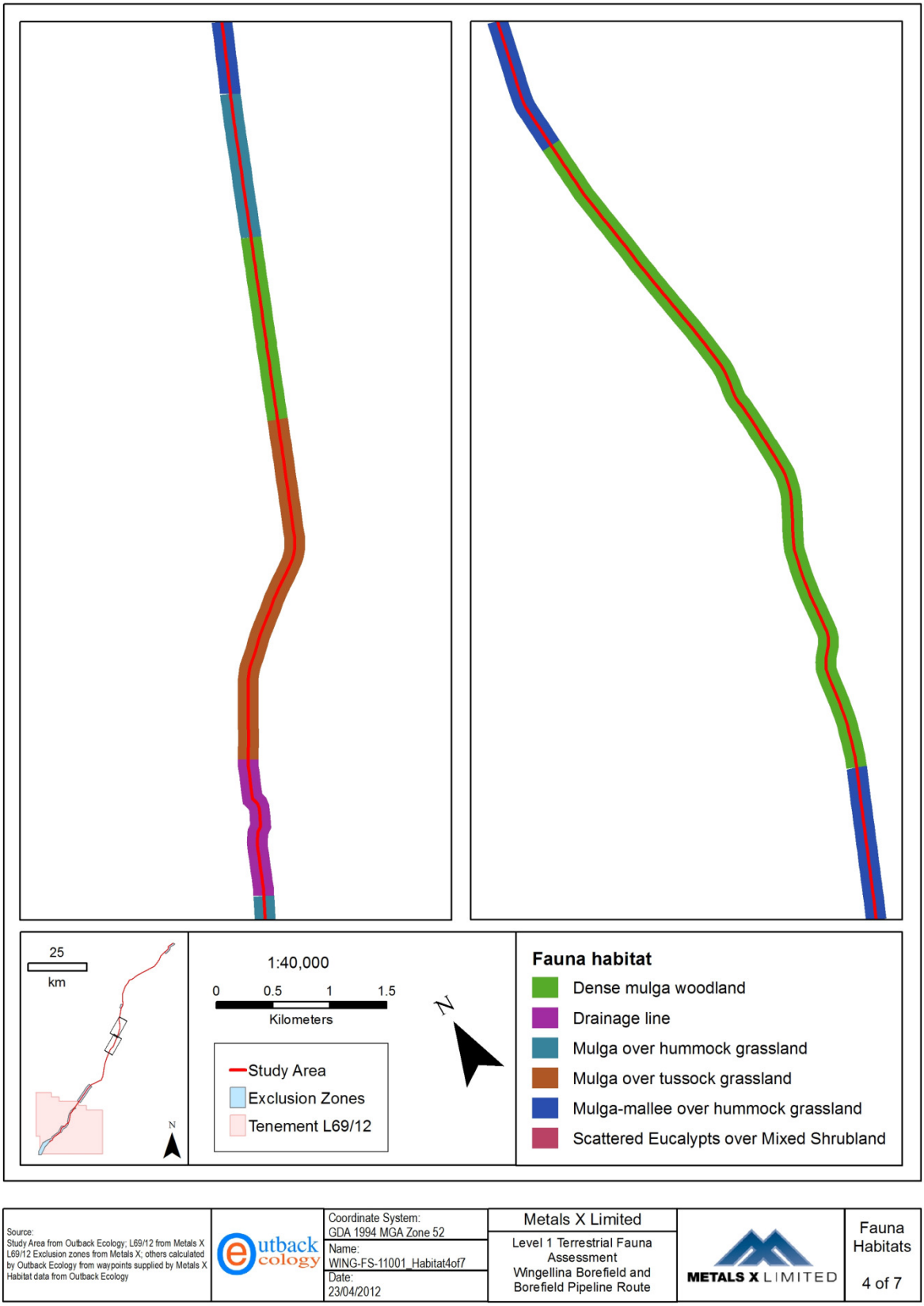

Figure 13: Fauna habitats in the Study Area - Map 4 of 7

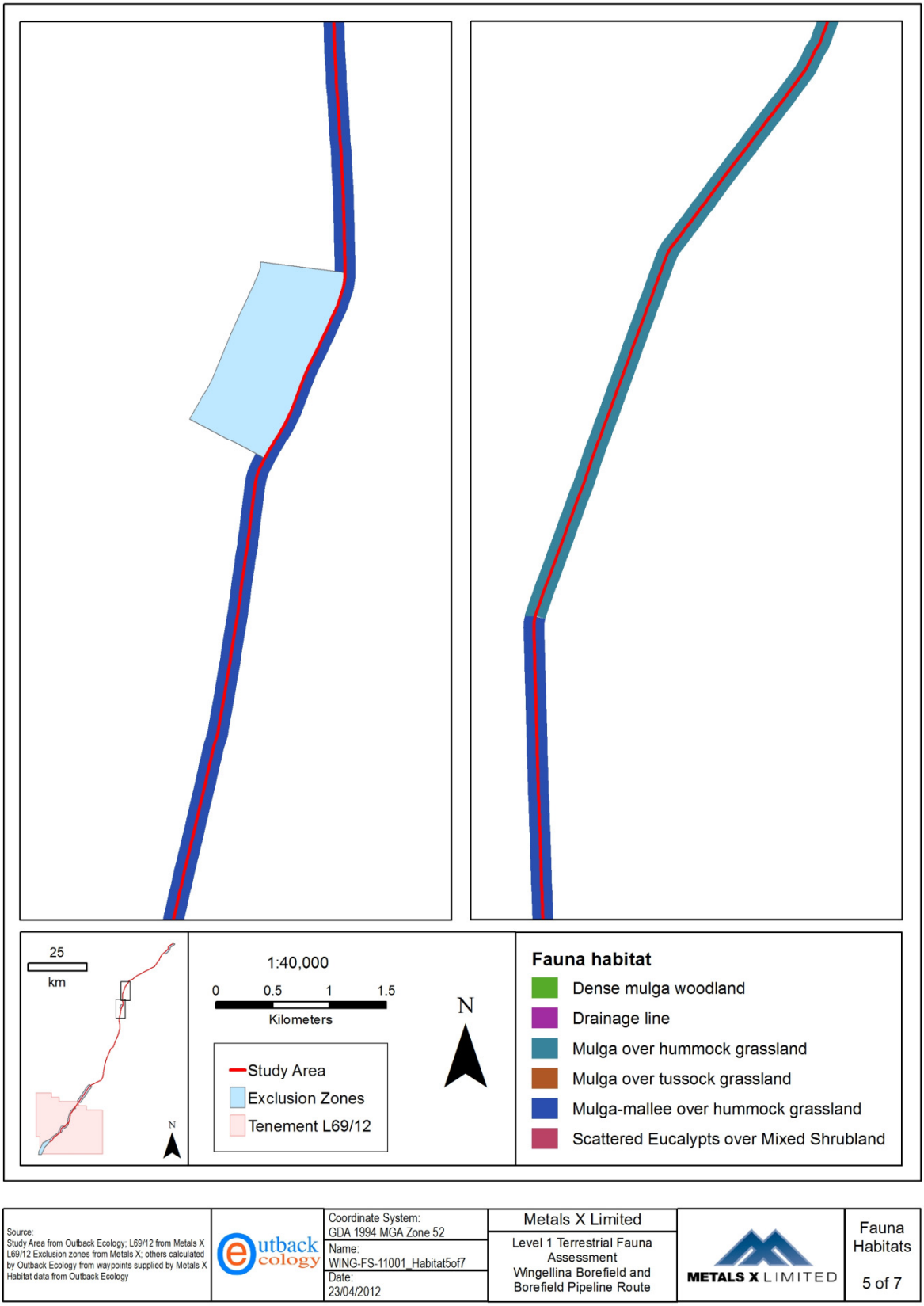

Figure 14: Fauna habitats in the Study Area - Map 5 of 7

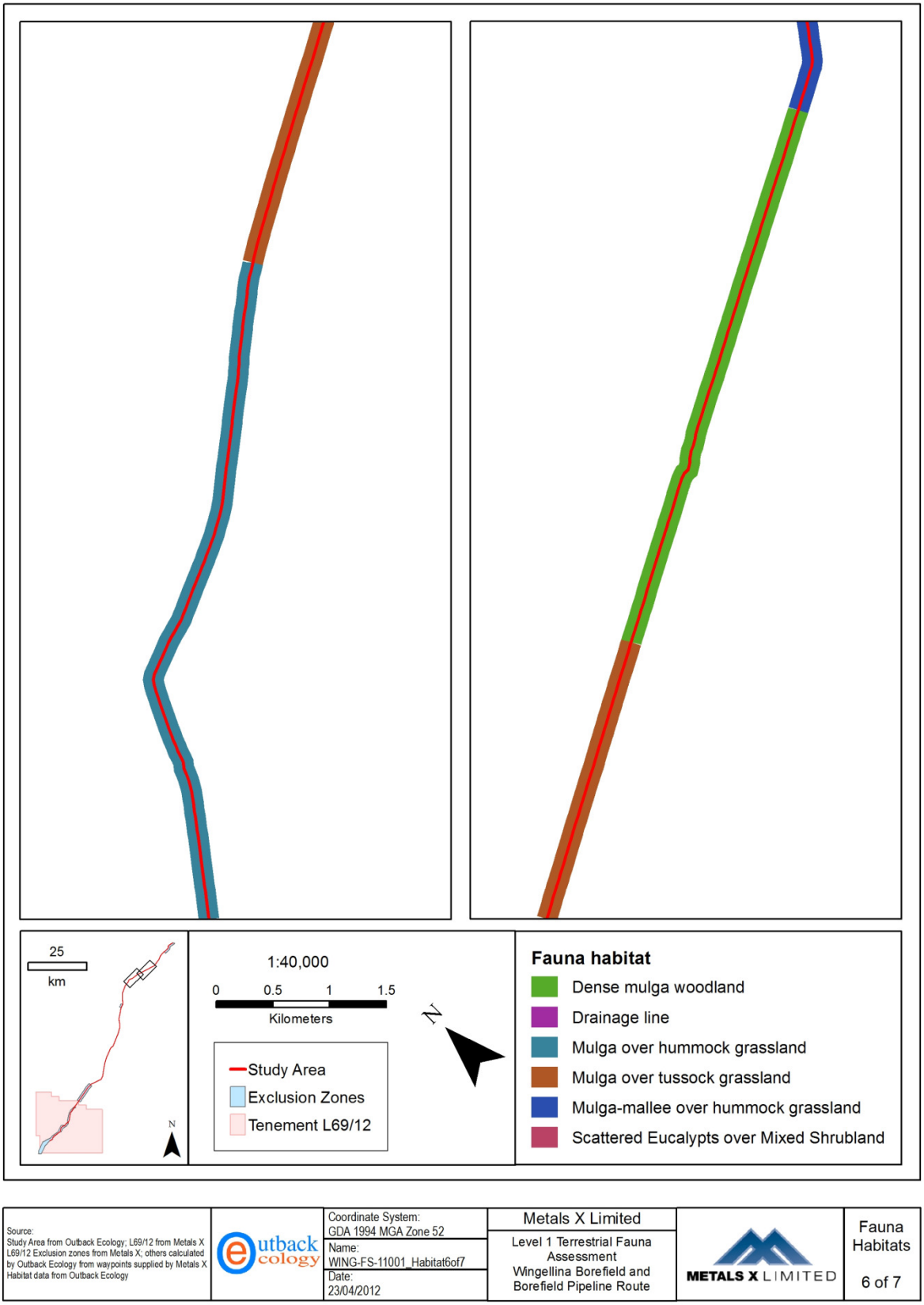

Figure 15: Fauna habitats in the Study Area - Map 6 of 7

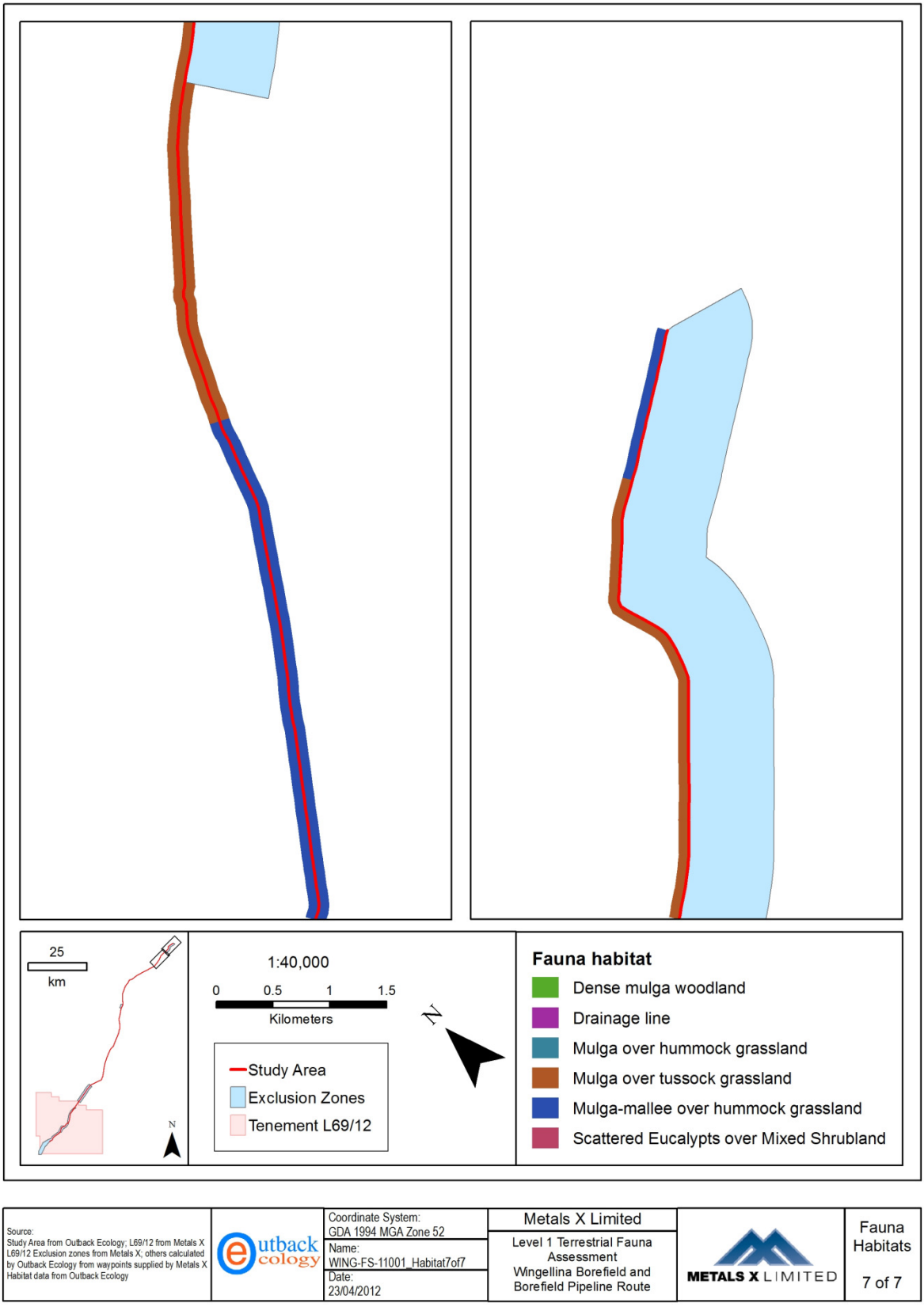

Figure 16: Fauna habitats in the Study Area - Map 7 of 7

5.1.2. Significant Fauna Habitats in the Study Area

Three significant fauna habitats were identified within the Study Area:

- Dense Mulga Woodland (**Table 8**, **Plate 1**, **Figure 10**, **Figure 11**, **Figure 13**, **Figure 15**)
- Scattered Eucalypts over Mixed Shrubland (**Table 8**, **Plate 6, Figure 10**); and
- Mulga-Mallee over Hummock Grassland (**Table 8**, **Plate 4**, **Figure 10**, **Figure 13** to **Figure 16**).

Dense Mulga Woodland is considered a significant habitat type due to it supporting a more favourable microclimate for fauna in comparison to other habitats in the Study Area. Dense stands of mulga provide substantial shade and often produce thick leaf litter; the resulting shelter makes the Dense Mulga Woodland habitat type more likely to support species of SRE invertebrate. Mygalomorph spiders and to a lesser extent scorpions, of which both groups contain taxa prone to short-range endemism, were common in Dense Mulga Woodland within the Study Area. In some areas of Dense Mulga Woodland, mygalomorph spider burrows that had been excavated by monitor lizards were numerous. Dense Mulga Woodland occupies 18.2% of the Study Area (**Table 8**).

Scattered Eucalypts over Mixed Shrubland is considered significant due to its relative scarcity (1.2% of the Study Area; **Table 8**, **Figure 10**) and because of the capacity of large eucalypts to provide tree hollows and substantial woody debris and leaf litter as shelter for vertebrate and invertebrate fauna. The Scattered Eucalypts over Mixed Shrubland habitat type occurred on large sand dunes and was adjacent to a sandy plain with extensive spinifex cover, making it potentially good foraging habitat for small mammals (including those of conservation significance, such as Mulgara). Most importantly, this habitat type provided the largest trees observed within the Study Area, and was one of only a few areas with large trees at all. These trees include the Marble Gum (*Eucalyptus gongylocarpa*), which occurs on sand plains, sand dunes and rises, and which was identified within this section of the current Study Area during a Level 1 flora and vegetation assessment of the Wingellina Borefield (Outback Ecology 2011a). The Princess Parrot, a bird of conservation significance, is frequently recorded in association with Marble Gums in central Australia (**Section 5.3**).

Mulga-Mallee over Hummock Grassland, which occupies 30.8% of the Study Area, is considered significant due to its heterogeneity and its consequent ability to support a variety of fauna assemblages. The ability of this habitat type to support fauna is closely related to its fire history; areas retaining a mosaic of fire ages are thought to provide the best habitat because newly burnt areas may be used for foraging, whereas long unburnt areas may be used for shelter and breeding (Parr and Andersen 2006, Southgate *et al.* 2007, Woinarski 1999). Spinifex provides important shelter given its ability to buffer temperatures in the face of harsh external conditions, while also providing a protective refuge for small native mammals (Van Dyck and Strahan 2008). Generally, this kind of habitat has potential to support populations of fauna of conservation significance, such as Mulgara (Körtner *et al.* 2007, Masters 2003). Within the Study Area, this habitat type differs from other hummock grassland habitats in that mallee eucalypts are more common, which promotes habitat heterogeneity by promoting an accumulation of leaf litter. Mulga-Mallee over Hummock

Grassland habitat could potentially support fauna of conservation significance within the Study Area, such as the Mulgara, Woma, Great Desert Skink and Australian Bustard (**Section 5.3**).

5.1.3. Other Significant Features in the Study Area

The Study Area contained two significant landscape features that were not separate habitat types, but which were considered important for providing habitat heterogeneity within the Study Area. The two significant features were:

- a small rocky outcrop; and
- areas of large sand dunes.

A small rocky outcrop was encountered in the Study Area, at location 444333 mE 7073205 mN (WGS 1984, UTM 52J; **Plate 7**). The rocky outcrop occurs in an area of Mulga over Tussock Grassland habitat and is noteworthy because it is the only rocky outcropping within the Study Area. It may therefore support and/or provide refuge for fauna not found elsewhere within the Study Area. For example, during This Study a motion-sensor camera provided two records for the Fat-tailed False Antechinus (*Pseudantechinus macdonnellensis*) at this location. This species is associated with sparsely vegetated rocky slopes and adjacent plains (Menkhorst and Knight 2010) and is unlikely to occur elsewhere within the Study Area. This location also yielded the only collections of pseudoscorpions within the Study Area, although these were not determined to be SREs.

Plate 7: A small rocky outcrop in the Study Area

Two areas with large sand dunes are present in the Study Area. The first coincides with the only occurrence of the Scattered Eucalypts over Mixed Shrubland habitat type (**Figure 10**), extending from 421447 mE 7042634 mN to 422500 mE 7043297 mN (WGS 1984, UTM 52J). The second coincides with an expanse of Dense Mulga Woodland habitat type; it extends from the junction of the Dense

Mulga Woodland and Mulga over Hummock Grassland habitat types at 449260 mE 7085210 mN (left-hand panel, **Figure 13**) to the southern end of the exclusion zone at 451518 mE 7098418 mN (left-hand panel, **Figure 14**). It is possible that these combinations of habitat type and topography are important for mammalian fauna, given that they offer close proximity of foraging habitat (amongst the mulga and eucalypts) to diurnal shelter (amongst the dune vegetation and associated hummock grasslands). Furthermore, it is thought that sand dune systems, specifically the crests and slopes within, are preferred habitat for the Central Marsupial Mole (*Notoryctes typhlops*), a species of conservation significance.

5.2. Vertebrate Fauna

A total of 359 vertebrate species – 50 mammals (including ten introduced), 193 birds (including three introduced), 109 reptiles and seven amphibians – was identified by the database searches and the literature review as potentially occurring in the Study Area (**Attachment A**). The previous surveys and database searches encompassed a wider range of habitat types than those present within the Study Area, and many of the previous surveys incorporated intensive sampling programmes; hence, lower species diversity was expected to be recorded during This Study. This Study recorded a total of 60 species.

Of the 60 species recorded during This Study, only one was not identified during the literature review and database searches as potentially occurring in the Study Area (**Attachment A**). The additional species, which is of conservation significance, is the Western Long-eared Bat (*Nyctophilus major tor*; see **Section 5.3**). This Study therefore recorded approximately 16% of the total number of species identified by the literature review and database searches as potentially occurring within the Study Area, and has expanded the potential species list for the Study Area from 359 species to 360.

5.2.1. Mammals

Fourteen species of mammal were recorded during the field survey; one dasyurid (carnivorous marsupial), one rodent, two macropods, six bats and four introduced species (**Table 9**). Only one of these species, the Western Long-eared Bat, is of conservation significance (see **Section 5.3** for more information on this record). Also of interest is the record of the Chocolate Wattled Bat (*Chalinolobus morio*); this record apparently represents the western-most extent of an isolated Central Ranges population of this species (**Appendix B**), although the species is not of conservation significance. Of the six bat species recorded, only Finlayson's Cave Bat (*Vespadelus finlaysoni*) is not known to roost in tree hollows or burrows; thus, while the Study Area may represent foraging habitat only for Finlayson's Cave Bat (which most likely roosts in cave systems outside of the Study Area), the other species recorded may have roost sites within the Study Area itself.

The total number of mammals recorded during This Study is comparable to counts obtained during previous surveys in the vicinity with of the Study Area of a similar size and scope (HGM Maunsell 2002, Outback Ecology 2009) (**Section 3.2**). All records were obtained by SM2BAT recordings,

interpretation of scats and tracks or motion-sensor cameras. No mammals were observed during spotlighting, and only the Camel (*Camelus dromedarius*) and the Dingo/Dog (*Canis lupus*) were directly sighted during daylight searches.

Table 9: Mammals recorded in the Study Area during the field survey

Common name	Species name	Conservation status	
		EPBC	WC
Gould's Wattled Bat	*Chalinolobus gouldii*		
Chocolate Wattled Bat	*Chalinolobus morio*		
Common Wallaroo	*Macropus robustus*		
Red Kangaroo	*Macropus rufus*		
Spinifex Hopping-mouse	*Notomys alexis*		
Lesser Long-eared Bat	*Nyctophilus geoffroyi*		
Western Long-eared Bat	*Nyctophilus major tor*		P4
Fat-tailed False Antechinus	*Pseudantechinus macdonnellensis*		
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*		
Inland Cave Bat	*Vespadelus finlaysoni*		
Camel	*Camelus dromedarius* *		
Dingo / Dog	*Canis lupus* *		
Cat	*Felis catus* *		
Rabbit	*Oryctolagus cuniculus* *		

*, introduced species; EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

5.2.2. Birds

A total of 31 species of bird was recorded during the field survey (**Table 10**). Only two of these species – the Australian Bustard (*Ardeotis australis*) and the Rainbow Bee-eater (*Merops ornatus*) – are of conservation significance (see **Section 5.3** for more information on these records). Introduced avifauna could potentially occur in the Study Area (**Appendix A**), but none was recorded during This Study. Small, granivorous species were abundant within the Study Area presumably due to the presence of substantial amounts of food resources (spinifex setting seed); the Budgerigar (*Melopsittacus undulates*), in particular, was seen in large flocks. Small, insectivorous species such as the Crimson Chat (*Epthianura tricolor*) were also numerous at most locations within the Study Area.

The total number of birds recorded during This Study is comparable to counts obtained during previous surveys in the vicinity of the Study Area, of a similar size and scope (Gole 2002, HGM Maunsell 2002, Outback Ecology 2009) (**Section 3.2**). Nearly all avifauna records were obtained during daytime searches, except for the Crested Bellbird (*Oreoica gutturalis*; seen using a motion-sensor camera), the Spotted Nightjar and the Eastern Barn Owl (*Eurostopodus argus* and *Tyto javanica*, respectively; seen during spotlighting).

Table 10: Birds recorded in the Study Area during the field survey

Common name	Species name	Conservation status	
		EPBC	WC
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		
Australian Bustard	*Ardeotis australis*		P4
Black-faced Woodswallow	*Artamus cinereus*		
Masked Woodswallow	*Artamus personatus*		
Australian Ringneck	*Barnardius zonarius*		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		
Torresian Crow	*Corvus orru*		
Stubble Quail	*Coturnix pectoralis*		
Pied Butcherbird	*Cracticus nigrogularis*		
Australian Magpie	*Cracticus tibicen*		
Galah	*Eolophus roseicapillus*		
Crimson Chat	*Epthianura tricolor*		
Spotted Nightjar	*Eurostopodus argus*		
Brown Falcon	*Falco berigora*		
Nankeen Kestrel	*Falco cenchroides*		
Diamond Dove	*Geopelia cuneata*		
Grey-headed Honeyeater	*Lichenostomus keartlandi*		
Yellow-throated Miner	*Manorina flavigula*		
Hooded Robin	*Melanodryas cucullata*		
Budgerigar	*Melopsittacus undulatus*		
Rainbow Bee-eater	*Merops ornatus*	M	
Crested Pigeon	*Ocyphaps lophotes*		
Crested Bellbird	*Oreoica gutturalis*		
Rufous Whistler	*Pachycephala rufiventris*		
Red-browed Pardalote	*Pardalotus rubricatus*		
Red-capped Robin	*Petroica goodenovii*		
Willie Wagtail	*Rhipidura leucophrys*		
Zebra Finch	*Taeniopygia guttata*		
Red-backed Kingfisher	*Todiramphus pyrrhopygius*		
Little Button-quail	*Turnix velox*		
Eastern Barn Owl	*Tyto javanica*		

*, introduced species; EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

5.2.3. Reptiles

A total of 15 species of reptile was recorded during the field survey; six skinks, four geckos, one dragon lizard, one elapid snake and three monitor lizards (**Table 11**). None of these species is of conservation significance. Gould's Goanna (*Varanus gouldii*) was the most frequently encountered

reptile in the Study Area, encountered six times during This Study. Most other species of reptile were represented by a single observation. The soils of the Study Area are capable of supporting burrowing herpetofauna; extensive varanid diggings were encountered throughout the Study Area, and burrowing species, such as the Pygmy Desert Monitor (*Varanus eremius*) and the Desert Skink (*Liopholis inornata*) were observed.

The total number of reptiles recorded during This Study is comparable to counts obtained by previous surveys in the vicinity of the Study Area, of a similar size and scope (HGM Maunsell 2002, Outback Ecology 2009; **Section 3.2**). Most species records were obtained by observation or hand capture during daytime searches, though the Smooth Knob-tail (*Nephrurus laevissimus*) and the Monk Snake (*Parasuta monachus*), were captured during spotlighting.

Table 11: Reptiles recorded in the Study Area during the field survey

Common name	Species name	Conservation status	
		EPBC	WC
Ariadna's Ctenotus	*Ctenotus ariadnae*		
Blue-tailed Finesnout Ctenotus	*Ctenotus calurus*		
Spotted-necked Ctenotus	*Ctenotus greeri*		
Clay-soil Ctenotus	*Ctenotus helenae*		
Fourteen-lined Ctenotus	*Ctenotus quattuordecimlineatus*		
Fat-tailed Diplodactylus	*Diplodactylus conspicillatus*		
Tree Dtella	*Gehyra variegata*		
Desert Skink	*Liopholis inornata*		
Thorny Devil	*Moloch horridus*		
Smooth Knob-tail	*Nephrurus laevissimus*		
Monk Snake	*Parasuta monachus*		
Beaked Gecko	*Rhynchoedura ornata*		
Pygmy Desert Monitor	*Varanus eremius*		
Perentie	*Varanus giganteus*		
Gould's Goanna	*Varanus gouldii*		

*, introduced species; EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

5.3. Fauna Of Conservation Significance

Three species of conservation significance were encountered during This Study: the Western Long-eared Bat (*Nyctophilus major tor*), the Australian Bustard (*Ardeotis australis*) and the Rainbow Bee-eater (*Merops ornatus*) (**Table 12**). The calls of the Western Long-eared Bat (*Nyctophilus major tor*) were detected during SM2BAT echolocation recording at site SM2BAT-04 (**Figure 17**). Australian Bustards (*Ardeotis australis*) were observed at two locations, as were Rainbow Bee-eaters (*Merops ornatus*) (**Figure 17**). The Australian Bustards were seen opportunistically, as were two of the Rainbow Bee-eaters. The record of the single Rainbow Bee-eater was obtained during SEARCH-10.

Table 12: Vertebrate fauna of conservation significance recorded during This Study

Common name	Species name	Conservation status		Number seen	WGS1984 UTM 52J	
		EPBC	WC		Easting	Northing
Western Long-eared Bat	*Nyctophilus major tor*†		P4	n/a	451056	7091360
Australian Bustard	*Ardeotis australis*		P4	2	433491	7059172
				1	444058	7071503
Rainbow Bee-eater	*Merops ornatus*	M		2	456845	7111580
				1	470862	7123329

†currently listed under a previous name – *Nyctophilus timoriensis* (central form)
EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

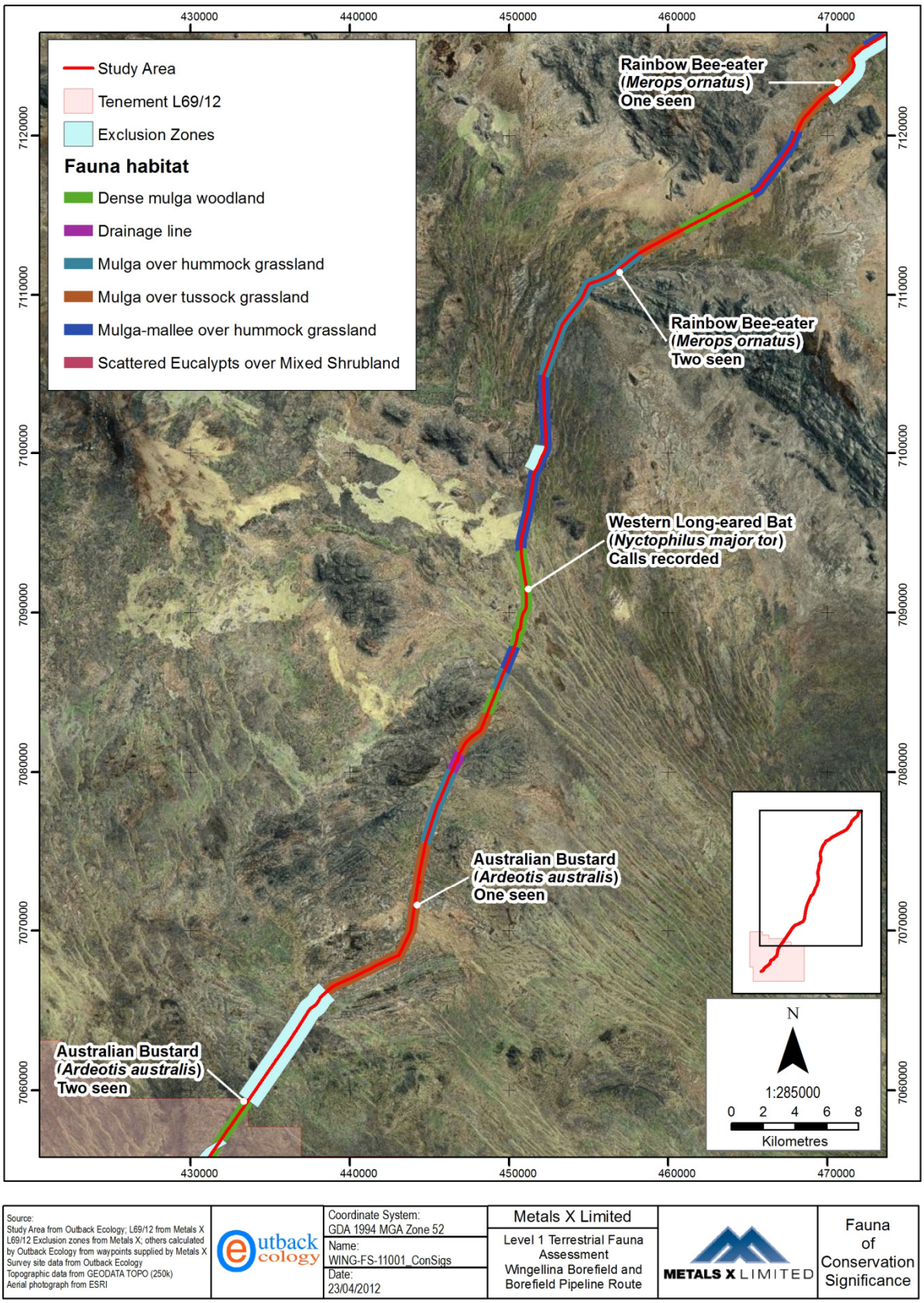

Figure 17: Locations of vertebrate fauna of conservation significance recorded in This Study

The literature review and database searches identified 35 species of conservation significance which potentially occur in the Study Area (**Attachment A**). Of these:

- 16 species are listed as Threatened under the EPBC Act and/or the WC Act (**Section 0**);
- seven species, including two species also listed under the EPBC Act, are recognised by DEC as Priority Fauna, (**Section 5.3.2**); and
- 15 species, including one species also listed as Threatened under the EPBC and WC Acts, are birds listed as Migratory under the EPBC Act, due to their being subject to international agreements such as the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals) (**Section 5.3.3**).

In **Section 5.3.1** to **Section 5.3.3**, the likelihood of each of these species of conservation significance occurring in the Study Area has been assessed and ranked. The rankings were assigned using the following definitions:

Confirmed – the presence of the species in the Study Area has been recorded unambiguously during the last ten years (ie during recent surveys of the Study Area or from recent records obtained via database searches);

Very likely – the Study Area lies within the known distribution of the species and contains suitable habitat(s), plus the species generally occurs in suitable habitat and has been recorded nearby within the last 20 years;

Likely – the Study Area lies within the known distribution of the species and the species has been recorded nearby within the last 20 years; however, either:

a. the Study Area contains only a small area of suitable habitat, or habitat that is only marginally suitable; or
b. the species is generally rare and patchily distributed in suitable habitat;

Possible – there is an outside chance of occurrence, because:

a. the Study Area is just outside the known distribution of the species, but it does contain suitable and sufficient habitat (the species may be common, rare, or patchily distributed); or
b. the Study Area lies within the known distribution of the species, but the species is very rare and/or patchily distributed; or
c. the Study Area lies on the edge of, or within, the known distribution and has suitable habitat, but the species has not been recorded in the area for over 20 years; or

Unlikely – the Study Area lies outside the known distribution of the species, the Study Area does not contain suitable habitat, and the species has not been recorded in the area for over 20 years.

5.3.1. Threatened Fauna

Legislation has been developed at a Commonwealth (EPBC Act) and State (WC Act) level to protect fauna species that have been formally recognised as rare, threatened with extinction or having high conservation value. For the full definitions of conservation significance under these Acts, see **Appendix C**. The database and literature searches identified 16 threatened species that could potentially occur within the Study Area (**Attachment A**), two of which were recorded during this survey (**Table 15**).

Table 13: Threatened fauna potentially occurring in the Study Area

Common name (species name)	Conservation status		Number of		Likelihood of occurrence
	EPBC	WC	Surveys	Databases	
Sandhill Dunnart (*Sminthopsis psammophila*)	EN	S1	0	1	Unlikely
Northern Marsupial Mole (*Notoryctes caurinus*)	EN	S1	0	1	Unlikely
Central Marsupial Mole (*Notoryctes typhlops*)	EN	S1	3	1	Likely
Crest-tailed / Brush-tailed Mulgara (*Dasycercus cristicauda* / *blythi*)	EN / VU	VU / P4	1 / 2	1 / 0	Unlikely / confirmed
Malleefowl (*Leipoa ocellata*)	VU, M	VU	2	3	Possible
Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*)	VU	S1	1	1	Unlikely
MacDonnell Ranges Black-footed Rock-wallaby (*Petrogale lateralis* ssp. ANWC CM15314)	VU	S1	0	3	Unlikely
Greater Stick-nest Rat (*Leporillus conditor*)	VU	S1	0	1	Unlikely
Greater Bilby (*Macrotis lagotis*)	VU	S1	0	2	Unlikely
Great Desert Skink (*Liopholis kintorei*)	VU	S1	2	1	Possible
Princess Parrot (*Polytelis alexandrae*)	VU	P4	3	2	Possible
Slender-billed Thornbill (Western Race) (*Acanthiza iredalei iredalei*)	VU		0	1	Unlikely
Woma (*Aspidites ramsayi*)		S4	2	0	Likely
Major Mitchell's Cockatoo (*Lophochroa leadbeateri*)		S4	3	1	Unlikely
Peregrine Falcon (*Falco peregrinus*)		S4	2	2	Possible

EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

- **Sandhill Dunnart (*Sminthopsis psammophila*)**

The Sandhill Dunnart is a little-known, small marsupial carnivore weighing less than 40 g. Its habitat requirements are not well understood, but it is thought to utilise a range of *Triodia* spp. and open xeric woodland habitats growing on sandy substrates. The Sandhill Dunnart may have an association with

areas of long-unburnt vegetation, and suitable habitat for the Sandhill Dunnart may exist in the Study Area. However, considering the lack of collection records in the wider region for the past 100 years and its absence from recent surveys near the Study Area, the presence of the species in the Study Area is considered to be unlikely.

- **Northern Marsupial Mole (*Notoryctes caurinus*)**

The Northern Marsupial Mole is an extremely poorly-known, small carnivorous marsupial. The current distribution of the species is thought to be largely confined to north-western WA, where suitable habitat exists, such as in the Tanami, Gibson and Great Sandy Deserts (DSEWPaC 2012b). The Northern Marsupial Mole is extremely specialised for burrowing through sand, and has an unmistakeable mole-like tubular body with a cone-shaped head, short limbs and no functional eyes (Menkhorst and Knight 2010). Its preferred habitat is thought to be sandy desert country, including dune fields and river flats, where it tunnels through soft sand and creates deep burrow systems (Menkhorst and Knight 2010).

The Northern Marsupial Mole was not recorded during This Study and has not been recorded in previous surveys of the wider region, and although one database search suggested the species may occur in the vicinity of the Study Area there are no specific collection records associated. Currently, the available data suggest that the distribution of the Northern Marsupial Mole is to the north-west of the Study Area. Given this, it is considered unlikely that this species occurs in the Study Area.

- **Central Marsupial Mole (*Notoryctes typhlops*)**

The Central Marsupial Mole, like its congener the Northern Marsupial Mole, is a small carnivorous marsupial highly adapted to life burrowing amongst sand dunes and sandy plains (Menkhorst and Knight 2010, Van Dyck and Strahan 2008). The Central Marsupial Mole, however, has been recorded slightly more often and consequently more is known about its ecology. The species tunnels through lightly cemented sand, and backfills as it proceeds; the tunnels are not thought to be re-used, and may persist in the soil profile for lengthy amounts of time (Van Dyck and Strahan 2008). The Central Marsupial Mole feeds on a range of subterranean prey, including termites and insect larvae (Menkhorst and Knight 2010), but is also known to be capable of taking arthropods and small vertebrates such as geckos (Van Dyck and Strahan 2008).

The Study Area is well within the currently accepted distribution of the Central Marsupial Mole (Van Dyck and Strahan 2008), and the sandy habitats within the Study Area – particularly those associated with extensive dune systems (**Section 5.1.3**) – are capable of supporting this species. One of the database searches and three of the previous surveys in the vicinity of the Study Area have recorded this species (**Appendix A**), and it has also been suggested that this species is more widespread and common than previously thought (Van Dyck and Strahan 2008). It is therefore considered likely that the Central Marsupial Mole occurs within the Study Area.

- **Crest-tailed Mulgara (*Dasycercus cristicauda*) / Brush-tailed Mulgara (*Dasycercus blythi*)**

Until recently the Brush-tailed Mulgara (*Dasycercus blythi*) was considered the same species as the Crest-tailed Mulgara (*Dasycercus cristicauda*; see Van Dyck and Strahan (2008). The Crest-tailed Mulgara is currently listed under the EPBC Act as Endangered using a now defunct taxonomic pseudonym *Dasycercus hillieri*, and as Schedule 1 under the WC Act using the current name *Dasycercus cristicauda.* The Brush-tailed Mulgara is currently listed under the EPBC Act as Vulnerable using the old name for this species *Dasycercus cristicauda*, and as Priority 4 by the DEC using the current name *Dasycercus blythi* (**Table 13**).

The current distribution of both species of Mulgara is uncertain and can only be confirmed following the correct identification and analysis of museum specimens (Pavey *et al.* 2012). Current knowledge suggests that the vast majority of Mulgara captured in Western Australia are the Brush-tailed Mulgara, *Dasycercus blythi*, and not the Crest-tailed Mulgara (Ric How, WA Museum, pers comm), though it is possible that Crest-tailed Mulgara still occur in WA (Pavey *et al.* 2012).

Introduced grazers, namely cattle and rabbits, altered fire regimes and predation by cats and foxes have contributed to the population declines of both species of Mulgara (Maxwell *et al.* 1996, Van Dyck and Strahan 2008). The Study Area is located inside the estimated range of the Brush-tailed Mulgara, but not that of the Crest-tailed Mulgara, and the Study Area contains ample habitat suitable for the Brush-tailed Mulgara. Despite the Mulgara not being encountered during This Study, an image of a Mulgara was captured using a motion-sensor camera within the current Study Area, during a targeted survey performed one week after This Study (Outback Ecology 2011b). It is therefore confirmed that the Mulgara, most likely the Brush-tailed Mulgara, occurs within the Study Area.

- **Malleefowl (*Leipoa ocellata*)**

The Malleefowl is a ground-dwelling bird that builds large and distinctive mounds of soil and litter, which it uses to incubate its eggs. The distribution of Malleefowl is fragmented and scattered through semi-arid rangelands across southern Australia. Their primary habitat consists of Mallee and semi-arid shrublands, with sandy or gravel soils (Garnett and Crowley 2000). Malleefowl sparsely populate the Watarru Indigenous Protected Area, which is in the Aṉangu Pitjantjatjara Lands to the east of the Study Area adjacent to the South Australia-Western Australia border (Benshemesh 2007, Robinson *et al.* 2003). Habitat apparently similar to that utilised by Malleefowl on the Watarru IPA occurs within the Study Area. The Study Area is just outside of the known distribution of the species, but given that suitable habitat is present it is considered possible that the Malleefowl occurs within the Study Area.

- **Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*)**

The Black-flanked Rock-wallaby is a small, agile rock-wallaby that specialises in arid and semi-arid range, gorge and cliff environments. *P. l. lateralis* is the western subspecies of the *P. lateralis* complex. Its habitat is steep rocky areas with caves or rocks in which it shelters during the day, and it feeds nocturnally on vegetation at the foot of cliffs, in gorges and on ridge tops. The Black-flanked Rock-wallaby is very sedentary, and its range has contracted dramatically during the last century; the species is now not considered to occur in modern times in the wider vicinity of the Study Area (Van

Dyck and Strahan 2008). Furthermore, suitable habitat does not occur in the Study Area. It is therefore considered unlikely that the Black-flanked Rock-wallaby occurs within the Study Area.

- **MacDonnell Ranges Black-footed Rock-wallaby (*Petrogale lateralis* ssp ANWC CM15314)**

The MacDonnell Ranges Black-footed Rock-wallaby is an un-described central Australian subspecies within the *P. lateralis* complex. Its habitat preferences and behaviour are similar to those of the Black-flanked Rock-wallaby (see above). The range of the Black-footed Rock-wallaby has contracted significantly during the last century, and today few populations remain outside of the Northern Territory (Van Dyck and Strahan 2008). The nearest known population to the Study Area is approximately 40 km away, but suitable habitat does not occur within the Study Area itself. It is therefore considered unlikely that the Black-footed Rock-wallaby occurs within the Study Area.

- **Greater Stick-nest Rat (*Leporillus conditor*)**

The Greater Stick-nest Rat is a herbivorous, medium-sized native rodent weighing approximately 350 g. The species is known for its habit of building complex communal lodges from woody material, which can measure up to 2 m tall and 3 m across. Preferred habitat of the Greater Stick-nest Rat is xeric woodland, possibly in association with long-unburnt or fire-shadow vegetation. Central Australia is thought to have been at the northern edge of the distribution of this species, but the Greater Stick-nest Rat is believed to have become extinct on mainland Australia sometime between 1940 and 1960 (Van Dyck and Strahan 2008). It is therefore considered unlikely to occur within the Study Area.

- **Greater Bilby (*Macrotis lagotis*)**

The Greater Bilby was formerly associated with a variety of inland habitats, including desert sandplains, dune fields with hummock grasslands, and massive red earths and *Acacia* shrublands (Maxwell *et al.* 1996). The species has undergone a widespread population decline, however, as a result of altered fire regimes, grazing pressure from introduced herbivores and livestock, and predation by the European Red Fox (*Vulpes vulpes*) and the Feral Cat (*Felis catus*). Bilbies are not reliant on surface water and receive most of their water requirements from food sources. Their diet consists of insects, larvae, seeds, bulbs, fruit and fungi (Van Dyck and Strahan 2008).

Bilbies dig large burrows in sandy substrates, which can reach up to 3 m long and 1.8 m deep (Van Dyck and Strahan 2008). Although the Greater Bilby was reported by two database searches as potentially occurring within the Study Area (**Table 13**), the only record within 135 km of the Study Area is from 1966 and it was not recorded during any of the previous surveys in the vicinity. Therefore, despite suitable habitat being present it is considered unlikely that the Greater Bilby occurs within the Study Area.

- **Great Desert Skink (*Liopholis kintorei*)**

The Great Desert Skink is a large, smooth bodied lizard that measures, on average, 200 mm long and up to 350 g in body mass (Pavey 2006). The species lives communally in warren systems with multiple entrances, dug amongst spinifex grasslands in sandy soils (Moseby *et al.* 2009). The Great Desert Skink is thought to forage nocturnally (Wilson and Swan 2010), consuming a wide variety of

invertebrates and small vertebrates, as well as the leaves, flowers and fruits of plants (Pavey 2006). This species is known to occur amongst Spinifex hummocks over arid red sand flats or loamy clay soils (Wilson and Swan 2010).

The current distribution of the Great Desert Skink is thought to consist of seven isolated populations in Australia (DSEWPaC 2012b). Three of these populations occur in the eastern interior of Western Australia in the Gibson and Great Sandy Desert at Patjarr, Lake Mackay and Rudall River National Park. In the Northern Territory, populations persist in the Tanami Desert, Uluṟu-Kata Tjuṯa National Park and the Yulara lease lands, while in South Australia one population is known to exist at Watarru on the Aṉangu Pitjantjatjara Lands. The habitats within the Study Area are capable of supporting the Great Desert Skink, and two previous surveys and one database search in the wider region of the Study Area have recorded this species (**Table 13**). It is therefore considered possible that the Great Desert Skink occurs in the Study Area.

- **Princess Parrot (*Polytelis alexandrae*)**

The Princess Parrot is a granivorous, tree hollow-nesting arid zone parrot with both nomadic and irruptive habits. The species is poorly known but is thought to be heavily dependent on the presence of mature eucalypts, especially Marble Gum (*Eucalyptus gongylocarpa*), for breeding habitat. The stronghold of the species is believed to be a few sites in the Great Sandy Desert, but they are irregular visitors to other sites in their range at intervals of up to 20 years. These irruptive movements are linked to rainfall events (Garnett and Crowley 2000). The Princess Parrot was not seen during This Study but it was recorded by three surveys in the wider region and appeared in two of the databases searches. Records for this species occur to the west and east of the Study Area from recent years, albeit at distances of over 100 km. Mature Marble Gums do occur within the Study Area (**Section 5.1.2**); this, combined with the bird's irruptive and nomadic nature, makes the presence of Princess Parrots in the Study Area possible.

- **Slender-billed Thornbill (Western Race) (*Acanthiza iredalei iredalei*)**

The Slender-billed Thornbill (Western Race) is a poorly-known, small insectivorous passerine bird. This species has a patchy distribution in arid and semi-arid regions of southern Australia, where suitable habitat exists. This species appears to have a specialised, narrow habitat requirement, as it is found feeding and breeding in chenopod shrubland – often near salt pans or ephemeral swamps (Garnett and Crowley 2000). The Western Race of the Slender-billed Thornbill was not observed during This Study and has not been recorded in previous survey of the wider region, and although one database search suggested the species may occur in the vicinity of the Study Area there are no specific collection records associated. Given that no suitable habitat is present within the Study Area and the species has not been recorded by fauna surveys in the wider region, its occurrence in the Study Area is considered to be unlikely.

- **Woma (*Aspidites ramsayi*)**

The Woma occurs in arid zones of Western Australia. Although the species itself is of conservation significance, it is the south-western (Wheatbelt) population which appears to be threatened, as

opposed to the northern populations (Storr *et al.* 2002). The DEC Priority Fauna List does not make this distinction. The species is patchily distributed, and occurs in woodland habitats, heathland and shrubland habitats often containing spinifex, and shelters mainly in abandoned burrows and soil cracks (Wilson and Swan 2010). The species is thought to prey upon both mammals and reptiles, and consume them within the confines of the burrows and crevices in which it shelters (Bush and Maryan 2011).

With the exception of the Dense Mulga Woodland and Drainage Line habitat types, the habitats observed within the Study Area are largely suitable for this species, and it has been recorded in the wider region of the Study Area in Uluṟu-Kata Tjuṯa National Park and surveys of the Aṉangu Pitjantjatjara Lands (**Appendix A**). Consequently, it is considered likely that the Woma occurs within the Study Area.

- **Major Mitchell's Cockatoo (*Lophochroa leadbeateri*)**

Major Mitchell's Cockatoo is a conspicuous, seed-eating cockatoo which is unevenly distributed across arid Australia. The species has sedentary habits but may be locally nomadic at times, and nests in hollows of mature Eucalypts within ephemeral riverine habitats. Major Mitchell's Cockatoo feeds in open *Acacia* woodlands and shrublands, and mixed woodlands. Its presence is recorded in three past surveys of the wider region and multiple records for it appear in one of the database searches, albeit at sites all over 100 km from the Study Area (Birds Australia 2012). Despite suitable feeding habitat for Major Mitchell's Cockatoo occuring in the Study Area, it was not observed during This Study and there are no records of this species occurring in the locality of the Study Area. It is therefore considered unlikely to be present in the Study Area.

- **Peregrine Falcon (*Falcon peregrinus*)**

The Peregrine Falcon is an aerial carnivore, which in the Australian arid zone nests on cliffs and steep-sided rocky outcrops. In central Australia, Peregrine Falcons are sparsely distributed and closely associated with waterholes, range and gorge environments, although they do range widely over riverine and *Acacia* woodland habitats when hunting (Aumann 2001, Garnett and Crowley 2000). This species was not recorded during This Study, but was found during two surveys in the wider vicinity of the Study Area, and was reported by two database searches as occurring. Potential habitat for Peregrine Falcons occurs within 10 km of some parts of the Study Area, and much of the Study Area contains habitat suitable for foraging; therefore; it is considered possible that this species occurs in the Study Area.

5.3.2. Priority Fauna

The WA DEC recognises several species that are not listed under the WC Act or the EPBC Act but for which there is some conservation concern, and has produced a supplementary list of Priority Fauna. For the full definitions of Priority Fauna rankings, see **Appendix C**. The database and literature searches identified seven species of Priority Fauna that potentially occur within the Study Area (**Appendix A**), one of which was recorded during This Study (**Table 14**).

The Brush-tailed Mulgara (*Dasycercus blythi*) and Princess Parrot are Priority species, but as they are also listed under the EPBC Act these were discussed in **Section 5.3.1**.

Table 14: Priority fauna potentially occurring in the Study Area

Common name (species name)	Conservation status		Number of		Likelihood of occurrence
	EPBC	WC	Surveys	Databases	
Princess Parrot (*Polytelis alexandrae*)	VU	P4	3	2	Possible
Brush-tailed Mulgara (*Dasycercus blythi*)	VU	P4	2	0	Confirmed
Western Long-eared Bat (*Nyctophilus major tor*)		P4			Confirmed
Bush Stone-curlew (*Burhinus grallarius*)		P4	1	1	Unlikely
Flock Bronzewing (*Phaps histrionica*)		P4	1	0	Unlikely
Grey Falcon (*Falco hypoleucos*)		P4	2	1	Possible
Australian Bustard (*Ardeotis australis*)		P4	5	2	Confirmed

†currently listed under a previous name – *Nyctophilus timoriensis* (central form)
EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

- **Western Long-eared Bat (*Nyctophilus major tor*)**

The Western Long-eared Bat is the newly re-described southern subspecies of the Long-eared Bat (*Nyctophilus major*), which itself is a newly re-described species resulting from a recent revision of the Greater Long-eared Bat (*N. timoriensis*) species group (Parnaby 2009). Thus, any records of the Western Long-eared Bat (*N. major tor*) from central Australia should be considered as equivalent to records of the central form of the Greater Long-eared Bat (*N. timoriensis* 'Central Form'), which is listed as Priority 4 Fauna (**Appendix B**). The Western Long-eared Bat can be found in a range of dry woodland and shrubland communities in arid and semi-arid areas, and is known from the goldfields and the woodlands in the areas north of the Nullarbor Plain (Parnaby 2009). *Nyctophilus major tor* forages low amongst the canopy and shrub layers to take arthropods from foliage, ground and in flight, predominantly roosting in tree hollows (Menkhorst and Knight 2004). Echolocation recordings of *Nyctophilus major tor*, at low activity levels, were made in the Dense Mulga Woodland habitat type within the Study Area (**Table 12**, **Table 14**, **Figure 17**). The detection of the Western Long-eared Bat within the Study Area probably represents the northern-most extent of its range in Western Australia (**Appendix B**).

- **Bush Stone-curlew (*Burhinus grallarius*)**

The Bush Stone-curlew is found in open woodland and forest, particularly near water courses and swampy areas (Geering *et al.* 2007). The species is active at night, when it calls with a distinctive, eerie whistle. In arid environments it is associated with significant ephemeral drainage courses with unburnt, marginal scrub to provide roosting cover. The nocturnal and cryptic habits of the Bush Stone-curlew make it difficult to locate, particularly in arid environments where the birds are sparsely distributed (Pizzey and Knight 2007). The only database and survey records for this species are

located 100 and 200 km away from the Study Area, respectively. Given this, and as no suitable habitat for Bush Stone-curlew occurs in the Study Area, its occurrence in the Study Area is considered unlikely.

- **Flock Bronzewing (*Phaps histrionica*)**

A long-winged, flock-forming granivorous pigeon, the Flock Bronzewing has irruptive and nomadic habits. The core range of this species encompasses the semi-arid, grassed plains of northern Australia, but during years of favourable climatic conditions this extends to the northern edges of the Simpson Desert or the western end of the Tanami Desert. Destination habitats during these times are wide areas of thick native pastoral grasses in treeless plains, with open water nearby for drinking; however, other marginal habitats such as open *Acacia* woodland with tussock grass understorey may be used during passage (Johnstone and Storr 1998). The Flock Bronzewing was not observed during This Study, and none of the database searches indicated it has been found in the wider vicinity of the Study Area. There is a single record of this species at a site approximately 400 km from the Study Area (Robinson *et al.* 2003). Given the paucity of observations in the wider region and the lack of suitable habitat within the Study Area, it is considered unlikely that the Flock Bronzewing occurs within the Study Area.

- **Grey Falcon (*Falco hypoleucos*)**

The Grey Falcon is a tree-nesting, predatory bird which principally takes aerial prey. It mainly occurs around inland ephemeral and permanent drainage systems where annual rainfall is less than 500 mm (Garnett and Crowley 2000). The Grey Falcon inhabits lightly wooded countryside, especially stony plains and *Acacia* scrublands (Morcombe 2003). This species can be rare, resident or nomadic but is distributed throughout most of the semi-arid interior of Western Australia. The Grey Falcon was not recorded during this survey but was recorded in two previous surveys from the wider region (**Appendix A**). It was also recorded in one of the database searches as occurring within the region (**Appendix A**). Given the wide distribution of the species, its nomadic nature, and that Mulga over Hummock Grassland and Mulga-Mallee over Hummock Grassland (and, to a lesser extent, Drainage Line habitat) within the Study Area represent suitable habitat, it is considered possible that the Grey Falcon occurs within the Study Area.

- **Australian Bustard (*Ardeotis australis*)**

The Australian Bustard has a wide distribution across Australia. The species is primarily insectivorous, and its abundance may vary considerably depending on the availability of food resources such as grasshoppers (Johnstone and Storr 1998). The Australian Bustard is a ground nesting bird, laying its eggs on bare ground. It predominantly inhabits open dry mulga woodlands, arid scrublands and hummock/tussock grasslands (Johnstone and Storr 1998, Morcombe 2003). The Australian Bustard was recorded during five of the seven previous surveys in the wider region, and was identified by two of the four database searches as potentially occurring in the region (**Table 14**) The presence of the Australian Bustard within the Study Area was confirmed during this survey (**Table**

12, **Table 14**, **Figure 17**). Two birds were seen on the edge of the Dense Mulga Woodland habitat type, and another bird was seen in the Mulga over Tussock Grassland habitat type.

5.3.3. Migratory Birds

Many species of migratory bird are listed under the EPBC Act, the WC Act and international agreements including the Japan-Australia Migratory Bird Agreement, the China-Australia Migratory Bird Agreement, Republic of Korea Australia Migratory Bird Agreement and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals).

The database searches and literature review identified 15 listed migratory species that have the potential to occur in the Study Area and its surrounds, one of which was recorded during This Study (**Table 15**). Of the 15 species, those that possibly occur are discussed briefly below. Those considered unlikely to occur within the Study Area are excluded from further consideration (but see **Table 15** for justification of their likelihood of occurrence within the Study Area). Broadly speaking, the occurrence of migratory waterbirds in arid Australia is highly sporadic and many species are only likely to be present in favourable seasons when water is plentiful (Halse *et al.* 1998, Kingsford and Norman 2002, Kingsford *et al.* 2010). As no major wetlands or substantial, natural water bodies occur within the Study Area, the occurrence of most migratory waterbirds would be occasional only, and these are unlikely to be dependent on the habitats present. The Malleefowl (*Leipoa ocellata*) is listed as Migratory under the EPBC Act, but was discussed in **Section 5.3.1** and is not considered further here.

Table 15: Migratory birds potentially occurring in the Study Area

Common name (species name)	Conservation status		Number of		Likelihood of occurrence	Reasons for likelihood
	EPBC	WC	Surveys	Databases		
Malleefowl (*Leipoa ocellata*)	VU, M	S1	2	3	Possible	
Red-necked Stint (*Calidris ruficollis*)	M		1		Unlikely	Wading bird. Small numbers overwinter in Central Australia. No suitable habitat in Study Area. Literature review report is from Uluṟu-Kata Tjuṯa National Park (UKNTP), 200 km away with suitable habitat.
Common Greenshank (*Tringa nebularia*)	M		1		Unlikely	Wading bird. Small numbers overwinter in Central Australia. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat.
Wood Sandpiper (*Tringa glareola*)	M		1		Unlikely	Wading bird. Moderate numbers overwinter in Central Australia. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat.
Broad-billed Sandpiper (*Limicola falcinellus*)	M		1		Unlikely	Coastal wading bird. Rare in Central Australia. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat.
Great Knot (*Calidris tenuirostris*)	M		1		Unlikely	Coastal wading bird. Vagrant in Central Australia. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat.
Oriental Pratincole (*Glareola maldivarum*)	M		1	1	Unlikely	Wading bird with terrestrial habits (savannah/steppe, saltpans or coasts). Overwintering migrant. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat.
Marsh Sandpiper (*Tringa stagnatilis*)	M		1		Unlikely	Wading bird. Moderate numbers overwinter in Central Australia. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat.

Common name (species name)	Conservation status		Number of		Likelihood of occurrence	Reasons for likelihood
	EPBC	WC	Surveys	Databases		
Common Sandpiper (*Actitis hypoleucos*)	M		1	1	Unlikely	Wading bird. Moderate numbers overwinter in Central Australia. No suitable habitat in Study Area. Literature review report is from UKTNP, 200 km away with suitable habitat. Database report is a single BirdData record from Warburton sewage ponds, 170 km away.
Rainbow Bee-eater (*Merops ornatus*)	M		5	2	Confirmed	
Glossy Ibis (*Plegadis falcinellus*)	M		1		Unlikely	Wetland ibis species. Small numbers overwinter in Central Australia. No suitable habitat in study area. Literature review report is from UKTNP, 200 km away with suitable habitat.
White-winged Black Tern (*Chlidonias leucopterus*)	M		1		Unlikely	Wetland tern species. Small numbers overwinter in Central Australia. No suitable habitat in study area. Literature review report is from UKTNP, 200 km away with suitable habitat.
Sharp-tailed Sandpiper (*Calidris acuminata*)	M		2		Unlikely	Wading bird. Moderate numbers overwinter in Central Australia. No suitable habitat in study area. One literature review report is from UKTNP, 200 km away with suitable habitat. The other was from the Aṉangu Pitjantjatjara Lands, where the species was opportunistically recorded, most likely from sewage ponds.
Oriental Plover (*Charadrius veredus*)	M		1	1	Unlikely	Wading bird with terrestrial habits (savannah/steppe specialist). Overwintering migrant. No suitable habitat in study area. Literature review report is from UKTNP, 200 km away with suitable habitat
Fork-tailed Swift (*Apus pacificus*)	M		1	1	Possible	

EPBC, status under EPBC Act; WC, status under WC Act or DEC Priority List

- **Rainbow Bee-eater (*Merops ornatus*)**

The Rainbow Bee-eater occupies numerous habitats, including open woodlands, sandpits, riverbanks, road cuttings, beaches, cliffs, mangroves and rain forests (Pizzey and Knight 2007). In Central Australia the Rainbow Bee-eater is a breeding migrant and passage migrant (Pizzey and Knight 2007), and nests in burrows dug at a slight angle in sandy banks and margins of drainage lines, roads and tracks, as well as in flat ground (Johnstone and Storr 1998). The Rainbow Bee-eater is known to be common and widespread across much of Australia. It was recorded during four previous surveys in the wider region of the Study Area (**Appendix A**), and was identified by two of the four database searches as potentially occurring within the Study Area. The presence of the Rainbow Bee-eater within the Study Area was confirmed during this survey (**Table 12**, **Table 15**, **Figure 17**). Two Rainbow Bee-eaters were seen in the Mulga over Hummock Grassland habitat type, and another was seen in the Mulga over Tussock Grassland habitat type.

- **Fork-tailed Swift (*Apus pacificus*)**

The Fork-tailed Swift is a nomadic species that may be seen before and after storm fronts or tropical cyclonic events that are associated with an increase in volant insect activity, and hence with greater food availability (Johnstone and Storr 1998). It is almost entirely aerial, and can be seen over any open country within Australia (Pizzey and Knight 2007). Despite not being recorded during This Study, it has been recorded at Uluru-Kata Tjuta National Park and appears in the Protected Matters database as potentially occurring within the Study Area. It is therefore considered possible that the Fork-tailed Swift occurs within the Study Area (during conducive weather events). The nature of its behaviour means that it may fly over the Study Area without alighting within, but the species may still derive benefit from the Study Area as a source of volant insects.

5.4. Short-Range Endemic Invertebrate Fauna

Database and literature review results are presented in **Section 5.4.1** and the SRE specimens yielded by the terrestrial SRE invertebrate fauna surveys are discussed in **Section 5.4.2**.

5.4.1. Database Search and Literature Review Results

The database search and literature review did not yield any collection records located inside the Study Area, but did yield collection records for the wider region. The database search identified three potential SREs that have been collected in the vicinity of the Study Area, whereas the literature review identified six potential SREs. All of these potential SRE species have the potential to occur within the Study Area based on the land systems where they were collected and the distribution of these land systems within the Study Area (**Table 16**, **Figure 18**).

Table 16: SRE invertebrate fauna records from the desktop study

Group	Species	Occurs in Land System	Land System present in Study Area?	Distance from Study Area	Source
Mygalomorph spider	*Aganippe* sp. 'MYG190'	My112	Yes	24 km NW	WAM (2011)
	Swolnpes morganensis	My112	Yes	28 km NW	WAM (2011)
	Aganippe sp nov 'Wingellina' sp. 1	BA21	Yes	28 km E	Outback Ecology (2009)
	Aganippe sp. nov 'Wingellina' sp. 2	BA21	Yes	28 km E	Outback Ecology (2009)
	Kwonkan sp. 2	BA21	Yes	28km E	Outback Ecology (2009)
	Kwonkan sp. 1	My109	Yes	32 km E	Outback Ecology (2009)
	Cethegus sp.	My109	Yes	32 km E	Outback Ecology (2009)
Pseudoscorpion	*Synsphyronus gigas*	AB48	Yes	87 km SW	WAM (2011)
	Synsphyronus sp. 'Wingellina'	My109	Yes	32 km E	Outback Ecology (2009)

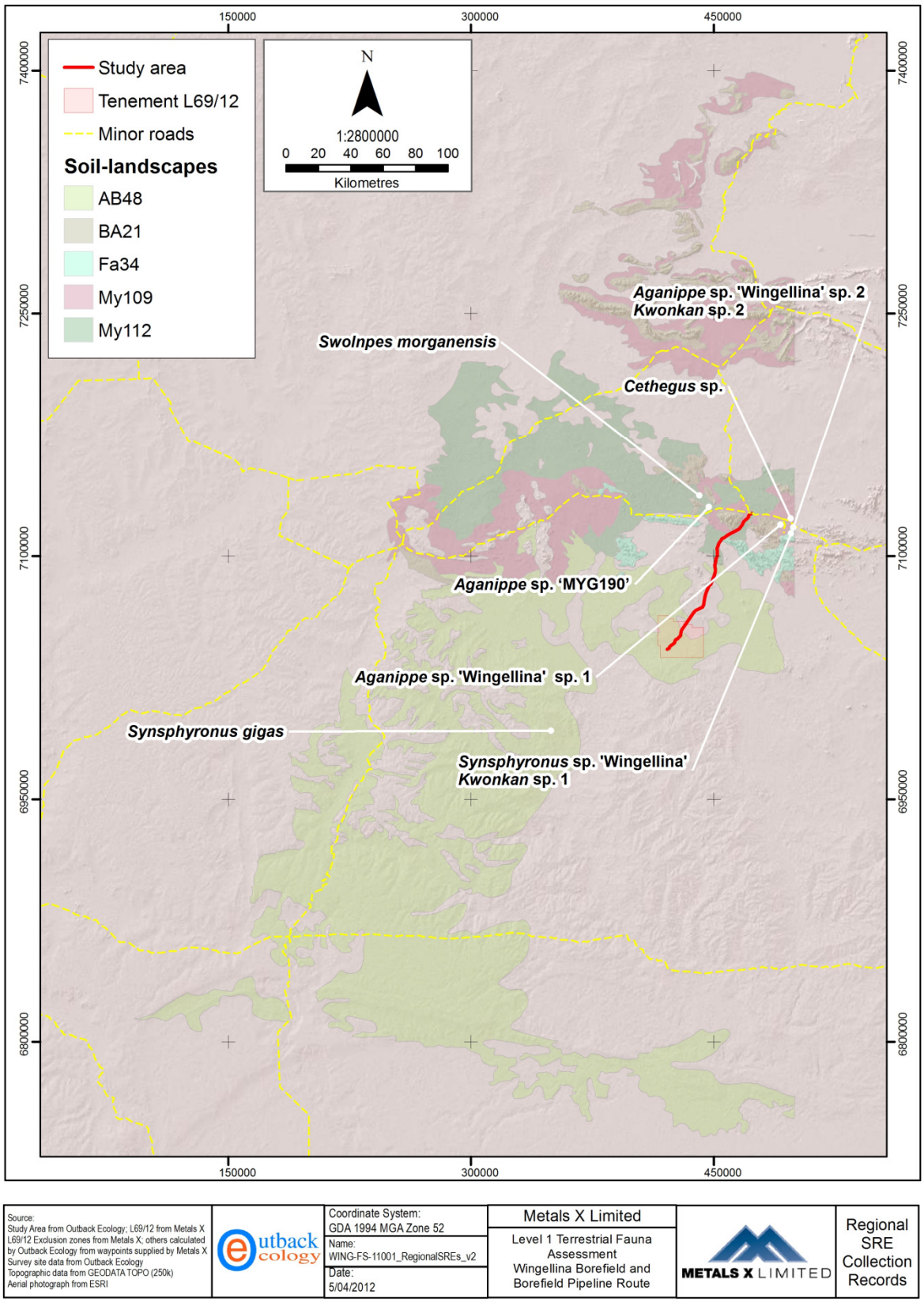

Figure 18: Locations of SRE invertebrate fauna records from the desktop study

5.4.2. Terrestrial SRE Invertebrate Fauna Collected from the Study Area

The field survey of the Study Area yielded 21 invertebrate specimens from eight species and morphospecies from taxa prone to short-range endemism. None of the species identified from the database search and literature review (**Section 5.4.1**) was collected during This Study. For brevity, in the remainder of this section the term 'species' will be used to refer to both species and morphospecies. A summary of the number of specimens and species collected from each of the invertebrate groups targeted in the survey are presented in **Table 17**.

Table 17: A summary of the invertebrates from SRE taxa collected during This Study

Target group	Number of specimens	Number of species
Mygalomorph spiders	4	4
Pseudoscorpions	4	1
Scorpions	7	2
Millipedes	6	1
TOTAL	21	8

For a variety of reasons, the identification of invertebrate species is often problematic. For example, identification can be difficult if little taxonomic work has been done on a taxonomic group, and identification may be impossible if a specimen is of the inappropriate sex or life stage. It can be difficult to attribute a SRE status to a specimen when there is taxonomic uncertainty, so for the purposes of This Study, the SRE status of the species collected during the field survey is reported using the criteria listed in **Table 18**.

Based on current taxonomic and distribution knowledge of the invertebrates collected during this study, four of the species were considered potential SREs (**Table 19**, **Figure 19**):

- the mygalomorph spider *Synothele* sp.;
- the mygalomorph spider *Anidiops* sp.;
- the mygalomorph spider *Aname* sp.; and
- the scorpion *Urodacus yaschenkoi*.

Table 18: Criteria for SRE status classification of the species collected during This Study

SRE Status	Criteria	Example
Confirmed SRE	Certain or almost certain to be a SRE; high levels of endemism present in group; conclusive morphological identification of specimens is possible; taxonomy of the group is well known; group is well represent in collections preferably from the region in question.	*Antichiropus* spp. millipedes
Likely SRE	Conclusive morphological identification of specimens is possible; however, the species belongs to a group with poor taxonomic resolution or where there is a lack of specimens in reference collections (and thus distribution is unknown). Likely SRE species may exhibit morphology indicative of habitat specialisation.	*Cethegus* spp. mygalomorph spiders
Potential SRE	Conclusive morphological identification is not possible because specimens are of an inappropriate sex or life stage to allow comparisons with reference collections. They have potential to represent SRE species because they belong to groups that contain SRE species	Female or juvenile mygalomorph spiders

Table 19: The distribution of potential SREs and their habitat within the Study Area

Habitat	Site	Number of potential SRE specimens collected			
		***Synothele* sp.**	***Anidiops* sp.**	***Aname* sp.**	***Urodacus yaschenkoi***
Mulga over Tussock Grassland	SEARCH-07				
	SEARCH-03				
Dense Mulga Woodland	SEARCH-04				1
	SEARCH-05				
	SEARCH-06	1		1	2
	TARGET-01		1		
Drainage Line	SEARCH-08				
Mulga-Mallee over Hummock Grassland	SEARCH-09				
	SEARCH-02				
Mulga over Hummock Grassland	SEARCH-10				
Scattered Eucalypts over Mixed Shrubland	SEARCH-01				

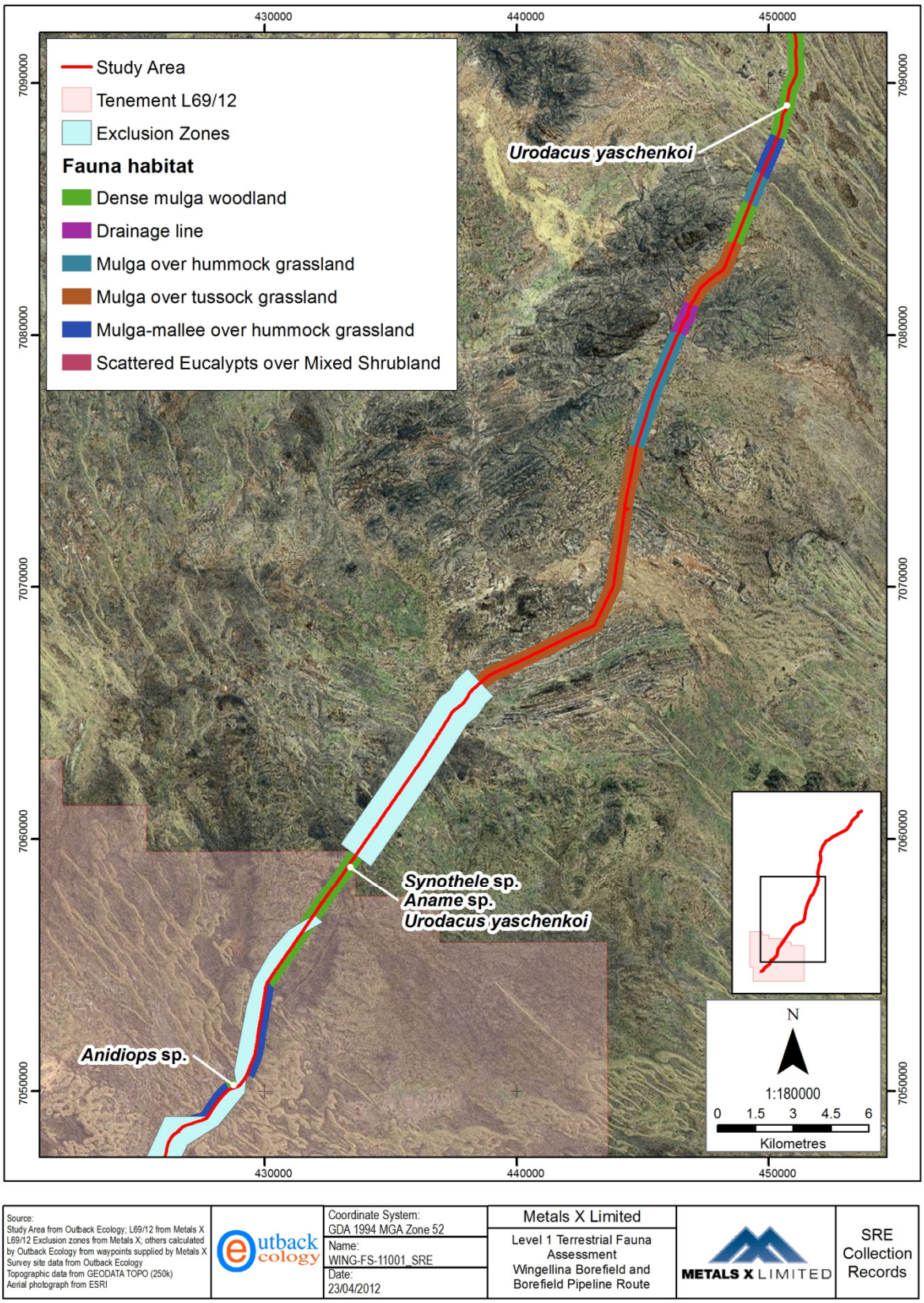

Figure 19: The collection records of SREs occurring within the Study Area

- ***Synothele* sp.**

A single *Synothele* sp. was collected from site SEARCH-06, which is located in the Dense Mulga Woodland habitat (**Figure 19**, **Appendix D**). The genus *Synothele* is presumably widespread throughout Western and Southern Australia and a number of species are currently described from Western Australia, some of them with restricted distributions (**Appendix D**). Despite that conclusive morphological identification was not possible, *Synothele* sp. is considered a potential SRE species as members of this genus are known to exhibit limited distributions (**Appendix D**).

- ***Anidiops* sp.**

A single *Anidiops* sp. was collected from site TARGET-01, which is located in the Dense Mulga Woodland habitat (**Figure 19**, **Appendix D**). The genus *Anidiops* is common throughout Western Australia, however only two species have currently been described (**Appendix D**). Some species within this genus have a limited distribution range and could be considered to be SRE (**Appendix D**). Despite that conclusive morphological identification was not possible, *Anidiops* sp. is considered a potential SRE species as members of this genus are known to exhibit limited distributions (**Appendix D**).

- ***Aname* sp.**

A single *Aname* sp. was collected from site SEARCH-06, which is located in the Dense Mulga Woodland habitat (**Figure 19**, **Appendix D**). The genus *Aname* is well represented in the Western Australian fauna by eight named and numerous unnamed species (**Appendix D**). The distribution and conservation status of many *Aname* are not well understood and detailed taxonomic work is required to understand the Western Australian fauna (**Appendix D**). Species within the genus are known to have a limited distribution and could be considered to be short-range endemics (**Appendix D**). Despite that conclusive morphological identification was not possible, *Aname* sp. is considered a potential SRE species as members of this genus are known to exhibit limited distributions (**Appendix D**).

- ***Urodacus yaschenkoi***

Two specimens of *Urodacus yaschenkoi* were collected from site SEARCH-06 and a single specimen was collected from site SEARCH-04, both of which occur in the Dense Mulga Woodland habitat (**Figure 19**, **Appendix E**). *Urodacus yaschenkoi* appears to be widespread in Australia; however, it represents a species complex comprising approximately six species (**Appendix E**). The distribution of the species within this complex is uncertain and some species could have restricted distributions (**Appendix E**). *Urodacus yaschenkoi* belongs to a poorly resolved species complex where there is limited knowledge about the species distributions within the complex, it is therefore considered a potential SRE species (**Appendix E**).

6. POTENTIAL IMPACTS

The primary objectives of this section are to describe the relevant threatening processes associated with the proposed Project (**Section 6.1**), and to examine the likely impact of these threatening processes on fauna habitat (**Section 6.1.6**) and fauna assemblages (**Section 6.3**).

6.1. Threatening Processes

Threatening processes relevant to the Great Victoria Desert and Central Ranges bioregions include feral predators and grazing and habitat damage by introduced herbivores, but otherwise the bioregions are relatively pristine due largely to their inaccessibility (Australian Natural Resources Atlas 2009a, b). Threatening processes specifically associated with Project activities within the Study Area are categorised as either direct or indirect impacts. Direct impacts of the Project may include habitat clearing/modification, ground disturbance, fire and collision with vehicles (**Section 6.1.1** to **Section 6.1.4**), while indirect impacts of the project may include noise and vibration, light, dust, introduced flora and introduced fauna (**Section 0** to **Section 6.1.9**). These are discussed in further detail below.

6.1.1. Habitat Clearing / Modification

The development of the Project will result in the removal of habitat via land clearance and also by the construction of pipeline infrastructure. Land clearing is a necessary part of the Project development, and represents the most direct impact on habitats and fauna assemblages present within the Study area. Land clearance will result in increased edge effects, habitat contraction and potentially fragmentation of habitat within the Study area. The Mulga-Mallee over Hummock Grassland, Dense Mulga Woodland and Scattered Eucalypts over Mixed Shrubland habitat types described during This Study have been identified as significant within the Study Area, and efforts to minimise clearing within these habitat types should be made. In the Scattered Eucalypts over Mixed Shrubland habitat type, large eucalypt trees should be preserved wherever possible. Removal of such trees, if they contain tree hollows, may equate to removal of potential habitat for the Princess Parrot, a species of conservation significance which possibly occurs in the Study Area.

For vertebrate fauna, clearing of vegetation can sometimes be conducted in a manner that minimises impact by considering the timing of clearance activities, progressively clearing over time to allow animals to disperse to other suitable areas, and also by retaining corridors or linkages so that individuals can move between remaining habitat patches. SRE invertebrate fauna, however, typically have poor powers of dispersal and are therefore unable to emigrate from land as it is being cleared. Land clearing is likely to result in the loss of SRE species populations that occur within the Project disturbance area. Clearing of the Dense Mulga Woodland habitat type, which has the greatest potential to support SRE species, should be minimised where practicable.

6.1.2. Ground Disturbance

Excavation and trenching works, if the proposed borefield pipeline is to be partially or completely buried, may directly trap vertebrate and invertebrate fauna. Depending on season and weather conditions, invertebrate fauna and small vertebrate fauna may become trapped in exposed trenches. Any such exposed trenches should be constructed to not have sheer sides or plastic sheeting, wherever possible. The length of time that trenches and pits are left open or unsealed should be minimised. If trenches are to be dug it may be advantageous to examine trench walls for evidence of Central Marsupial Mole burrows, so as to provide additional data pertaining to the likelihood of this species occurring within the Study Area.

6.1.3. Fire

The development and operation of the Project may alter the fire regime of the Study Area, through the introduction of unplanned fire as a result of vehicle movements and/or as a result of Project activities (eg welding). Fire may impact vertebrate and invertebrate fauna via direct contact between fire and small vertebrates or SRE invertebrates, or indirectly by long-term habitat modification brought about by inappropriate fire frequency and intensity. The value of many habitats to fauna lies in the mosaic of ages since fire that exist in those habitats as a result of traditional land management practices and/or natural fire regimes (Parr and Andersen 2006, Southgate *et al.* 2007, Woinarski 1999). Introduction of too frequent, hot or extensive fires can eliminate this mosaic, and reduce the capacity of these habitats to support diverse vertebrate and invertebrate fauna. The impact of inappropriate fire regimes may be reduced through the implementation of an appropriate fire management plan.

6.1.4. Collision With Vehicles

Vehicle collisions can have a considerable impact on some fauna assemblages. Although incidents typically only involve individuals, the cumulative effect they may have on populations can be considerable. The proposed Project would dissect relatively open habitats such as Mulga over Hummock Grassland, Mulga over Tussock Grassland, Mulga-Mallee over Hummock Grassland and Scattererd Eucalypts over Mixed Shrubland. Species that typically forage at night within these habitats (including, but not limited to, species of conservation significance such as the Brush-tailed Mulgara and the Woma) may be at risk when following or crossing any transport routes. Furthermore, a variety of avifauna may be at risk from vehicle collision during the hours surrounding dawn and dusk (including, but not limited to, species of conservation significance such as the Princess Parrot and the Australian Bustard).

Should it be necessary for vehicles to travel along transport and infrastructure corridors, collisions can be directly addressed by reducing the speed at which vehicles travel and restricting the times during which it is permissible to do so. Any collisions or incidents that result in the injury or death of species of conservation significance should be reported to the DEC and specimens should be retained (ie stored in a freezer) for further examination by DEC or the Western Australian Museum.

6.1.5. Noise And Vibration

During construction, development of the Project is likely to generate noise and vibration due to the general operation of machinery and vehicles, as well as the general presence of people. This may impact on vertebrate fauna, although after construction the nature of the Project means that ongoing noise and vibration impacts may be negligible in most parts of the Study Area. The adverse effects of noise on vertebrate fauna have been well studied, although responses vary depending on the species and on the age and sex of the individual animal (for comprehensive summaries, see Larkin *et al.* 1996, Radle 2007). General responses to noise across a wide variety of vertebrate species range from interruptions in feeding and resting behaviour to complete abandonment of an area. Noise may lead to reduced population densities in small mammals, nest failure and decreased population densities in birds (Slabbekoorn and Ripmeester 2008), and abandoning of roost sites and a reduced hunting efficiency in bats due to disturbance of their echolocation system. Constant levels of noise also affect species communication via acoustic interference (Parris and Schneider 2009).

Information on the potential effects of noise and vibration on SRE invertebrate fauna is limited. A trial that tested the effect of exploration drilling on the SRE Shield-backed Trapdoor Spider (*Idiosoma nigrum*) was conducted at Jack Hills in the Murchison, by Crosslands Resources (DMP 2010). In this trial, spiders were observed in their burrows while vibration simulating drilling was produced. Preliminary results suggest that the effects of vibration on spiders may be limited. Conversely, it has also been suggested that vibrations created by mining activities and heavy earthmoving equipment may actually attract spiders and other arachnids, which subsequently places these individuals at risk of direct contact with operations (Raven 2008). Without further research, it is not possible to predict and quantify the potential noise and vibration impacts of the Project on SRE invertebrate fauna.

6.1.6. Light

During construction, development of the Project is likely to result in an increase in exposure of fauna to artificial light. This may impact on vertebrate fauna, although after construction the nature of the Project means that ongoing exposure of fauna to artificial light may be negligible in most parts of the Study Area. Artificial light from Project activities may have detrimental effects on resident vertebrate and invertebrate fauna species as it may interfere with biological and behavioural activities that are governed by the length of day or photoperiod. Such activities include reproduction, dormancy, foraging and migration (eg Bradshaw and Holzapfel 2007, Le Corre *et al.* 2002). For example, nocturnal mice exposed to artificial light have been observed to exploit fewer food patches compared to mice exposed to areas of less light (Bird *et al.* 2004), while nocturnal frogs exposed to artificial light have been known to suspend normal feeding and reproductive behaviour (Harder 2002). Light pollution has also been shown to interfere with timing of songbird choruses, potentially leading to reduction in breeding success or survival (Miller 2006). It is likely that excessive light can also alter the natural foraging behaviour of bats.

To reduce the impact of artificial light on faunal communities, particularly during night-time hours, lights should be designed to illuminate designated areas such as pathways and roads, rather than inadvertently illuminating the night sky or the surrounding landscape. Further, it is recommended that lighting only be used in areas required for operations and/or security, that operational areas are served by directional lighting with low vertical aiming angle, and that light shields are installed where required.

6.1.7. Dust

During construction, the Project may result in an increase in dust pollution as a consequence of excavation and earthworks, the general traffic activities of light and heavy vehicles, the general use of equipment on site and the clearing of covering vegetation. Dust pollution may interfere with plant metabolic processes and high levels may reduce plant growth, resulting in the degradation of the overall ecosystem and the increased risk of disease in plants. In turn, this may impact the quality of fauna habitats and both vertebrate and invertebrate faunal assemblages within the Project area due to reduction in food resource and shelter availability. During construction, and following construction if necessary, adequate dust suppression measures should be implemented to reduce the effects of dust on vegetation and hence fauna habitats and assemblages.

6.1.8. Introduced Flora

Weeds may be brought in by mobile mining and construction equipment. Weed invasion is widely recognised as having a negative impact on vertebrate fauna species as it can fundamentally alter the composition and structure of native vegetation communities (Cowie and Werner 1993, Gordon 1998). Invasion by non-native species typically results in declines in native plant species richness, but the response of fauna may be more complicated with individual invasions potentially resulting in increase, decrease or no-change scenarios for different assemblages (Grice 2006). For example, even at low densities, Buffel Grass (*Cenchrus ciliaris*) has been seen to affect the composition of ground vegetation, birds and ant fauna, leading to declines in some species (Binks *et al.* 2005, Smyth *et al.* 2009). The invasion of weeds may have a negative impact on SRE invertebrate fauna (EPA 2009).

Currently, the Study Area is largely pristine and weed-free (Outback Ecology 2011a). It is therefore important to implement management strategies to reduce the occurrence and spread of weeds as a result of Project operations. In particular, the potential spread of Buffel Grass has been identified as a significant threat to vegetation in the Project area (Outback Ecology 2011a), and management priorities should be adjusted to recognise this.

6.1.9. Introduced Fauna

Introduced fauna (both herbivorous and predatory) cause fundamental changes to ecosystems, and have led to the decline and extinction of many species in Australia (Abbott 2002, Burbidge and McKenzie 1989, Ford *et al.* 2001, Short and Smith 1994). Predation by the Red Fox and predation by the Feral Cat are listed as key threatening processes to native fauna, under the EPBC Act.

Introduced herbivores have been responsible for the widespread degradation of much of semi-arid Australia due to overgrazing (Morton 1990). Such habitat degradation can potentially impact both vertebrate and invertebrate fauna.

Development of the Project may provide additional resources or habitat that attract and support a greater abundance of feral animals in the area, which in turn may adversely impact on populations of native fauna. It is suggested that monitoring and control of feral animals be conducted, in participation with surrounding land managers. Management measures to prevent the increase of feral species numbers and control the attraction of any new feral species include proper hygiene practices, appropriate disposal of wastes and control programs.

6.2. Impacts On Fauna Habitats

Vertebrate fauna habitat loss as a direct result of land clearing and excavation for the development of the Project is considered the primary impact on terrestrial vertebrate and SRE invertebrate fauna. Further, loss of habitat is listed as a key threatening process under the EPBC Act, although it is recognised as a necessary component of developing a resources project. It is likely that sedentary fauna currently residing within areas to be cleared would be lost and more mobile fauna would be displaced.

In the absence of project disturbance footprints, it is recommended that where possible, clearing should be minimised within the Mulga-Mallee over Hummock Grassland, Dense Mulga Woodland, and Scattered Eucalypts over Mixed Shrubland habitat types. In the latter, removal of large eucalypt trees – especially Marble Gums – should be avoided wherever possible. Clearing within areas of sand dunes should also be minimised where possible, and it is also recommended that the proposed borefield pipeline avoid the small rocky outcrop present within the Study Area. The significance of each of these habitat types and habitat features was discussed in **Section 5.1.2** and **Section 5.1.3**.

6.3. Impacts On Fauna Assemblages

Land clearance is likely to result in the direct loss of individuals during initial clearance activities. Faunal assemblages most likely to be impacted by the Project are those dependent on specific habitats or those with restricted ranges. As most of the habitats within the Study Area are represented outside of the Study Area, however, land clearance is not likely to have substantial impacts on fauna populations at a regional scale. The exception to this is the Scattered Eucalypts over Mixed Shrubland habitat type, which appears to be of limited extent and is the only habitat type with mature Marble Gums, which are associated with breeding populations of the Princess Parrot, a bird of conservation significance. In recognition of this, removal of large eucalypts within this habitat type should be avoided wherever possible. More generally, impacts to fauna assemblages may be reduced by considering the timing of land clearing activities and other developmental proposed works.

7. CONCLUSIONS

The inventory of fauna recorded during This Study is consistent with those obtained in previous surveys of similar scope in the locality of the Study Area. Although the desktop study suggested that more species potentially occur in the Study Area (359, versus 60 observed in This Study), these records were obtained from large search areas with greater diversity of habitats and thus include some species unlikely to occur in the Study Area. Further survey work in the specific habitats of the Study Area, including intensive trapping, would refine the known and potential species lists.

The Project will impact on vertebrate faunal assemblages on a local scale through direct loss of fauna during land clearing, loss of habitat and indirect impacts. Of the indirect impacts, the spread of invasive weed species is possibly the most likely to alter the faunal assemblages of the Study Area. The sheer length of the proposed pipeline route and the volume of vehicular traffic necessary for development of the Project will impose high risk of transport of invasive weeds and their seeds. Given that vegetation communities in the Study Area are largely in pristine condition, measures should be taken to limit the spread of weeds. Of the direct impacts of the Project, direct loss of fauna habitat via clearing of native vegetation is likely to have the greatest impact on fauna habitats and assemblages. If possible, use of the existing Tjuntjuntjarra Track as an access corridor should be promoted and further clearing of vegetation for vehicular access should be minimised.

Most habitats found in the Study Area were consistent with habitats known to occur elsewhere in the Central Ranges and Great Victoria Desert bioregions. The Scattered Eucalypts over Mixed Shrubland habitat type was of limited extent within the Study Area, however, and likely to be less represented in the surrounding landscape. Disturbance to this habitat type should be minimised where possible. Of the vertebrate fauna of conservation significance that may occur in the Study Area, only the Princess Parrot is likely to be tightly bound to a specific habitat type. If this species is present in the Study Area, Marble Gums present in the Scattered Eucalypts over Mixed Shrubland habitat are likely to be its only source of breeding habitat within the Study Area and these should be preserved wherever possible. Other vertebrate fauna of conservation significance are not likely to be bound tightly to particular habitat patches within the Study Area, and the regional impacts of the Project on species of conservation significance are likely to be small. Depending on the future requirements of the Project, it may be advantageous to better define the status of local populations of the Brush-tailed Mulgara in the Study Area. Targeted trapping may identify areas more densely inhabited by this species, and where it is therefore more at risk from traffic and general operations in the Project area.

Two other habitat types, Mulga-Mallee over Hummock Grassland and Dense Mulga Woodland are also significant habitat types within the Study Area and care should be taken to minimise their disturbance. Both of these habitat types are more widespread regionally and clearing within these areas is less likely to influence vertebrate fauna at a regional scale. Individuals of the potential SRE species that occur within Dense Mulga Woodland habitat are likely to be lost as a result of disturbance to this habitat. However, the occurrence of this habitat outside the Study Area suggests that impacts to these species are likely to be limited as a result of the Project.

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Appendix A

Vertebrate Fauna Recorded in the Wingellina Project Study Area and/or Surrounds

Legend

Abbreviations and symbols:

* Introduced species.

• Recorded during a field survey, or as part of a database or regional information search.

EPBC Entries in this column indicate the status of each species under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act): CR, Critically Endangered; E, Endangered; VU, Vulnerable; and M, Migratory. If a cell is empty, the species is not listed as Threatened under the EPBC Act.

WC Entries in this column indicate the status of each species in Western Australia. If a species is listed as Threatened under Schedule 1, 3 or 4 of the *Wildlife Conservation Act 1950* (WA) (WC Act), the Schedule on which it is listed is provided: S1, Schedule 1, Fauna that is rare or is likely to become extinct; S3, Schedule 3, Migratory birds protected under an international agreement; and S4, Schedule 4, Other specially protected fauna. Species not listed under the WC Act may be listed on the Department of Environment and Conservation's list of Priority Fauna. In these cases, their rankings are provided: P1, Priority 1; P2, Priority 2; P3, Priority 3; and P4, Priority 4.

Surveys considered in literature review

A Birds of the Wingellina Hills – Gole (2002)
B Compilation of Uluṟu-Kata Tjuṯa National Park Vertebrate Fauna Checklists - Balding (1996), Balding and Reid (1996)
C Aṉangu Pitjantjatjara Lands Biological Survey - Robinson *et al.* (2003)
D Wingellina Nickel Project Terrestrial Fauna Assessment - Outback Ecology (2009)
E Wingellina Baseline Biological Survey - HGM Maunsell (2002)
G Spinifex Native Title Determined Area Surveys - Brennan *et al.* (2012)
H Wingellina Nickel Project Proposed Borefield Drill Line Targeted Fauna Assessment - Outback Ecology (2011b)

Database searches

I Birddata: Custom Atlas Bird List - Birds Australia (2012)
J Threatened and Priority Fauna Database - DEC (2012b)
K Protected Matters Search Tool - DSEWPaC (2012a)
L NatureMap Database - DEC (2012a)

Vertebrate fauna recorded in the Wingellina Project Study Area and/or Surrounds

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Mammals															
BOVIDAE															
*Bos taurus**	European Cattle						•								
*Capra hircus**	Goat						•								
CAMELIDAE															
*Camelus dromedarius**	Camel			•		•	•	•		•					
CANIDAE															
*Canis lupus**	Dingo			•		•	•	•		•					
*Vulpes vulpes**	Fox					•	•			•				•	
DASYURIDAE															
Dasycercus blythei	Brush-tailed Mulgara		P4							•	•				
Dasycercus cristicauda	Crest-tailed Mulgara	EN	S1			•								•	
Ningaui ridei	Wongai Ningaui					•	•			•					
Planigale tenuirostris	Narrow-nosed Planigale						•								
Pseudantechinus macdonnellensis	Fat-tailed False Antechinus			•		•	•	•							
Sminthopsis crassicaudata	Fat-tailed Dunnart						•	•							
Sminthopsis dolichura	Little Long-tailed Dunnart									•					
Sminthopsis hirtipes	Hairy-footed Dunnart					•	•			•					
Sminthopsis macroura	Stripe-faced Dunnart					•	•	•							
Sminthopsis ooldea	Ooldea Dunnart					•	•			•					
Sminthopsis psammophila	Sandhill Dunnart	EN	EN											•	
Sminthopsis youngsoni	Lesser hairy-footed Dunnart					•									
EMBALLONURIDAE															
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat			•		•									
Taphozous hilli	Hill's Sheathtail-bat					•		•							
EQUIDAE															
*Equus asinus**	Donkey						•								
*Equus caballus**	Horse						•								
FELIDAE															
*Felis catus**	Cat			•		•	•	•		•	•			•	
LEPORIDAE															
*Oryctolagus cuniculus**	Rabbit			•		•	•	•		•				•	
MACROPODIDAE															
Macropus fuliginosus	Western Grey Kangaroo									•					
Macropus robustus	Common Wallaroo			•		•	•	•	•	•					
Macropus rufus	Red Kangaroo			•		•	•			•					
Petrogale lateralis lateralis	Black-flanked rock-wallaby	VU	S1				•						•		
Petrogale lateralis ssp. (ANWC CM15314)	Black-footed Rock-wallaby (MacDonnell Ranges Race)	VU	S1										•	•	•
MOLOSSIDAE															
Mormopterus planiceps	Little Mastiff-bat					•									
Tadarida australis atratus						•			•	•					
MURIDAE															
Leggadina forresti	Forrest's Mouse						•								•
Leporillus conditor	Greater Stick-nest Rat	VU	S1										•		
*Mus musculus**	House Mouse					•	•	•	•						
Notomys alexis	Spinifex Hopping-mouse			•		•	•	•	•	•	•				
Pseudomys desertor	Desert Mouse					•	•								
Pseudomys hermannsburgensis	Sandy Inland Mouse					•	•			•					
Rattus villosissimus	Long-haired Rat					•									

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
NOTORYCTIDAE															
Notoryctes caurinus	Northern Marsupial Mole	EN	S1											•	
Notoryctes typhlops	Central Marsupial Mole	EN	S1			•	•			•				•	
PHALANGERIDAE															
Trichosurus vulpecula vulpecula	Common Brushtail possum						•								
TACHYGLOSSIDAE															
Tachyglossus aculeatus	Short-beaked Echidna					•	•			•					
THYLACOMYIDAE															
Macrotis lagotis	Greater Bilby	VU	S1										•		•
VESPERTILIONIDAE															
Chalinolobus gouldii	Gould's Wattled Bat			•		•	•	•		•					
Chalinolobus morio	Chocolate Wattled Bat			•		•	•								
Nyctophilus geoffroyi	Lesser Long-eared Bat			•		•	•	•							
Nyctophilus major	Western Long-eared Bat		P4	•											
Scotorepens balstoni	Inland Broad-nosed Bat							•		•					
Scotorepens greyii	Little Broad-nosed Bat					•									
Vespadelus baverstocki	Inland Forest Bat					•									
Vespadelus finlaysoni	Inland Cave Bat			•		•	•	•							
Vespadelus regulus	Southern Forest Bat									•					
Birds															
ACANTHIZIDAE															
Acanthiza apicalis	Inland Thornbill					•	•			•		•			
Acanthiza chrysorrhoa	Yellow-rumped Thornbill					•	•		•			•			•
Acanthiza iredalei iredalei	Slender-billed Thornbill (western)	VU												•	
Acanthiza robustirostris	Slaty-backed Thornbill					•	•			•		•			•
Acanthiza uropygialis	Chestnut-rumped Thornbill					•	•		•	•		•			
Aphelocephala leucopsis	Southern Whiteface				•	•	•	•	•			•			•
Aphelocephala nigricincta	Banded Whiteface					•	•					•			
Aphelocephala pectoralis	Chestnut-breasted Whiteface						•								
Gerygone fusca	Western Gerygone					•	•					•			
Pyrrholaemus brunneus	Redthroat					•	•			•		•			
Smicrornis brevirostris	Weebill					•	•		•	•		•			
ACCIPITRIDAE															
Accipiter cirrocephalus	Collared Sparrowhawk					•	•		•			•			
Accipiter fasciatus	Brown Goshawk				•	•	•		•	•		•			•
Aquila audax	Wedge-tailed Eagle					•	•	•	•	•		•			•
Circus approximans	Swamp Harrier						•								
Circus assimilis	Spotted Harrier				•	•	•					•			
Elanus axillaris	Black-shouldered Kite				•	•	•		•			•			•
Elanus scriptus	Letter-winged Kite					•									
Haliastur sphenurus	Whistling Kite					•	•			•		•			
Hamirostra melanosternon	Black-breasted Buzzard					•	•			•		•			
Hieraaetus morphnoides	Little Eagle					•	•			•		•			
Lophoictinia isura	Square-tailed Kite					•									
Milvus migrans	Black Kite					•	•	•	•			•			
AEGOTHELIDAE															
Aegotheles cristatus	Australian Owlet-nightjar				•	•	•			•		•			
ANATIDAE															
Anas gracilis	Grey Teal					•	•					•			
Anas superciliosa	Pacific Black Duck					•						•			

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Aythya australis	Hardhead					•						•			
Chenonetta jubata	Australian Wood Duck					•	•					•			
Cygnus atratus	Black Swan					•						•			
Dendrocygna eytoni	Plumed Whistling-Duck					•						•			
Malacorhynchus membranaceus	Pink-eared Duck					•	•					•			
Tadorna tadornoides	Australian Shelduck				•										
ANHINGIDAE															
Anhinga novaehollandiae	Australasian Darter					•						•			
APODIDAE															
Apus pacificus	Fork-tailed Swift	M	S3			•								•	
ARDEIDAE															
Ardea modesta	Eastern Great Egret					•								•	
Ardea pacifica	White-necked Heron					•	•					•			
Egretta garzetta	Little Egret					•									
Egretta novaehollandiae	White-faced Heron					•	•					•			
Ixobrychus flavicollis	Black Bittern					•									
Nycticorax caledonicus	Nankeen Night Heron					•						•			
ARTAMIDAE															
Artamus cinereus	Black-faced Woodswallow			•	•	•	•	•	•	•		•			•
Artamus leucorynchus	White-breasted Woodswallow					•									•
Artamus minor	Little Woodswallow					•	•					•			
Artamus personatus	Masked Woodswallow			•	•	•	•		•			•			•
Artamus superciliosus	White-browed Woodswallow					•	•					•			
Cracticus nigrogularis	Pied Butcherbird			•	•	•	•	•	•	•		•			•
Cracticus tibicen	Australian Magpie			•	•	•	•	•	•	•		•			•
Cracticus torquatus	Grey Butcherbird				•	•	•		•	•		•			
BURHINIDAE															
Burhinus grallarius	Bush Stone-curlew		P4			•						•			
CACATUIDAE															
Cacatua sanguinea	Little Corella					•	•					•			
Calyptorhynchus banksii	Red-tailed Black-Cockatoo					•									
Eolophus roseicapillus	Galah			•		•	•		•	•		•			•
Lophochroa leadbeateri	Major Mitchell's Cockatoo		S4			•	•			•		•			
Nymphicus hollandicus	Cockatiel				•	•	•			•		•			
CAMPEPHAGIDAE															
Coracina maxima	Ground Cuckoo-shrike				•	•	•		•	•		•			
Coracina novaehollandiae	Black-faced Cuckoo-shrike			•	•	•	•		•	•		•			•
Lalage sueurii	White-winged Triller				•	•	•			•		•			
CASUARIIDAE															
Dromaius novaehollandiae	Emu					•	•			•		•			
CHARADRIIDAE															
Charadrius australis	Inland Dotterel					•	•								
Charadrius ruficapillus	Red-capped Plover					•									
Charadrius veredus	Oriental Plover	M	S3			•								•	
Elseyornis melanops	Black-fronted Dotterel					•	•					•			
Erythrogonys cinctus	Red-kneed Dotterel					•						•			
Vanellus miles	Masked Lapwing					•	•								
Vanellus tricolor	Banded Lapwing					•	•			•					
CICONIIDAE															
Ephippiorhynchus asiaticus	Black-necked Stork					•									

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
CLIMACTERIDAE															
Climacteris affinis	White-browed Treecreeper					•	•					•			
Climacteris rufa	Rufous Treecreeper											•			
COLUMBIDAE															
*Columba livia**	Rock Dove					•									
Geopelia cuneata	Diamond Dove			•	•	•	•		•			•			•
Geopelia striata	Peaceful Dove					•									
Geophaps plumifera	Spinifex Pigeon					•	•					•			
Ocyphaps lophotes	Crested Pigeon			•	•	•	•		•			•			•
Phaps chalcoptera	Common Bronzewing				•	•	•			•		•			
Phaps histrionica	Flock Bronzewing		P4				•								
CORACIIDAE															
Eurystomus orientalis	Dollarbird					•									
CORVIDAE															
Corvus bennetti	Little Crow				•	•	•		•	•		•			•
Corvus coronoides	Australian Raven						•								
Corvus orru	Torresian Crow			•	•	•	•	•	•	•		•			•
CUCULIDAE															
Cacomantis pallidus	Pallid Cuckoo				•	•	•	•	•	•		•			
Chalcites basalis	Horsfield's Bronze-Cuckoo					•	•			•		•			
Chalcites osculans	Black-eared Cuckoo					•	•			•		•			
Scythrops novaehollandiae	Channel-billed Cuckoo					•									
ESTRILDIDAE															
Emblema pictum	Painted Finch					•	•					•			•
Taeniopygia guttata	Zebra Finch			•	•	•	•	•	•	•		•			•
EUROSTOPODIDAE															
Eurostopodus argus	Spotted Nightjar			•		•	•	•	•	•		•			
FALCONIDAE															
Falco berigora	Brown Falcon			•	•	•	•	•	•	•		•			•
Falco cenchroides	Nankeen Kestrel			•	•	•	•		•	•		•			•
Falco hypoleucos	Grey Falcon		P4			•	•						•		
Falco longipennis	Australian Hobby				•	•	•		•	•		•			
Falco peregrinus	Peregrine Falcon		S4			•	•					•	•		
Falco subniger	Black Falcon					•	•					•			
FRINGILLIDAE															
*Carduelis carduelis**	European Goldfinch					•									
GLAREOLIDAE															
Glareola maldivarum	Oriental Pratincole	M	S3			•								•	
Stiltia isabella	Australian Pratincole					•				•					
HALCYONIDAE															
Todiramphus pyrrhopygius	Red-backed Kingfisher			•	•	•	•			•		•			
Todiramphus sanctus	Sacred Kingfisher					•	•								
HIRUNDINIDAE															
Cheramoeca leucosterna	White-backed Swallow				•	•	•		•	•		•			
Hirundo neoxena	Welcome Swallow					•	•								
Petrochelidon ariel	Fairy Martin					•	•					•			
Petrochelidon nigricans	Tree Martin				•	•	•					•			
LARIDAE															
Chlidonias hybrida	Whiskered Tern					•						•			
Chlidonias leucopterus	White-winged Black Tern	M	S3			•									

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Chroicocephalus novaehollandiae	Silver Gull					•									
Gelochelidon nilotica	Gull-billed Tern											•			
MALURIDAE															
Amytornis purnelli	Dusky Grasswren				•	•	•		•			•			
Amytornis striatus	Striated Grasswren					•	•			•		•			
Malurus lamberti	Variegated Fairy-wren				•	•	•		•	•		•			
Malurus leucopterus	White-winged Fairy-wren					•	•		•			•			
Malurus splendens	Splendid Fairy-wren					•	•			•		•			
Stipiturus ruficeps	Rufous-crowned Emu-wren					•			•			•			
MEGALURIDAE															
Cincloramphus cruralis	Brown Songlark				•	•	•					•			•
Cincloramphus mathewsi	Rufous Songlark				•	•	•		•			•			•
Eremiornis carteri	Spinifexbird						•					•			
Megalurus gramineus	Little Grassbird					•									
Leipoa ocellata	Malleefowl	VU, M	S1				•			•		•	•	•	
MELIPHAGIDAE															
Acanthagenys rufogularis	Spiny-cheeked Honeyeater			•	•	•	•	•	•	•		•			•
Certhionyx variegatus	Pied Honeyeater					•	•			•		•			
Conopophila whitei	Grey Honeyeater					•				•		•			
Epthianura aurifrons	Orange Chat					•	•					•			•
Epthianura tricolor	Crimson Chat			•	•	•	•		•	•		•			•
Lichenostomus keartlandi	Grey-headed Honeyeater			•		•	•	•				•			
Lichenostomus penicillatus	White-plumed Honeyeater					•	•		•			•			
Lichenostomus plumulus	Grey-fronted Honeyeater				•	•	•		•	•		•			
Lichenostomus virescens	Singing Honeyeater				•	•	•	•	•	•		•			•
Lichmera indistincta	Brown Honeyeater					•	•					•			
Manorina flavigula	Yellow-throated Miner			•	•	•	•	•	•	•		•			•
Purnella albifrons	White-fronted Honeyeater					•	•		•	•		•			•
Sugomel niger	Black Honeyeater					•						•			
MEROPIDAE															
Merops ornatus	Rainbow Bee-eater	M	S3	•		•	•			•	•	•		•	
MONARCHIDAE															
Grallina cyanoleuca	Magpie-lark					•	•		•			•			
MOTACILLIDAE															
Anthus novaeseelandiae	Australasian Pipit				•	•	•	•	•			•			•
NECTARINIIDAE															
Dicaeum hirundinaceum	Mistletoebird					•	•		•			•			
NEOSITTIDAE															
Daphoenositta chrysoptera	Varied Sittella					•	•			•		•			
OTIDIDAE															
Ardeotis australis	Australian Bustard		P4	•		•	•	•		•		•	•		
PACHYCEPHALIDAE															
Colluricincla harmonica	Grey Shrike-thrush				•	•	•	•	•	•		•			•
Oreoica gutturalis	Crested Bellbird			•	•	•	•	•	•	•		•			•
Pachycephala inornata	Gilbert's Whistler									•					
Pachycephala rufiventris	Rufous Whistler			•	•	•	•		•	•		•			
PARDALOTIDAE															
Pardalotus rubricatus	Red-browed Pardalote			•		•	•		•			•			
Pardalotus striatus	Striated Pardalote					•	•			•		•			
PELECANIDAE															

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Pelecanus conspicillatus	Australian Pelican					•	•								
PETROICIDAE															
Melanodryas cucullata	Hooded Robin			•	•	•	•		•	•		•			•
Microeca fascinans	Jacky Winter				•	•	•	•		•		•			
Petroica goodenovii	Red-capped Robin			•		•	•			•		•			
PHALACROCORACIDAE															
Microcarbo melanoleucos	Little Pied Cormorant					•						•			
Phalacrocorax carbo	Great Cormorant					•									
Phalacrocorax sulcirostris	Little Black Cormorant					•				•		•			
Phalacrocorax varius	Pied Cormorant					•									
PHASIANIDAE															
Coturnix pectoralis	Stubble Quail			•			•					•			
Coturnix ypsilophora	Brown Quail						•					•			
PODARGIDAE															
Podargus strigoides	Tawny Frogmouth					•	•			•		•			
PODICIPEDIDAE															
Podiceps cristatus	Great Crested Grebe					•									
Poliocephalus poliocephalus	Hoary-headed Grebe				•	•	•					•			
Tachybaptus novaehollandiae	Australasian Grebe					•	•					•			
POMATOSTOMIDAE															
Pomatostomus superciliosus	White-browed Babbler				•	•	•		•	•		•			•
PSITTACIDAE															
Barnardius zonarius	Australian Ringneck			•	•	•	•		•	•		•			•
Melopsittacus undulatus	Budgerigar			•	•	•	•	•	•	•		•			•
Neophema splendida	Scarlet-chested Parrot					•	•			•		•			
Neopsephotus bourkii	Bourke's Parrot				•	•	•	•				•			
Polytelis alexandrae	Princess Parrot	VU	P4			•	•			•		•		•	
Psephotus varius	Mulga Parrot				•	•	•		•	•		•			•
Psitteuteles versicolor	Varied Lorikeet					•									
PSOPHODIDAE															
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush					•						•			
Cinclosoma castanotum	Chestnut Quail-thrush					•	•					•			
Psophodes occidentalis	Chiming Wedgebill					•	•			•		•			•
PTILONORHYNCHIDAE															
Ptilonorhynchus guttatus	Western Bowerbird					•			•			•			
Ptilonorhynchus maculatus	Spotted Bowerbird						•								
RALLIDAE															
Fulica atra	Eurasian Coot					•						•			
Porphyrio porphyrio	Purple Swamphen					•									
Tribonyx ventralis	Black-tailed Native-hen					•	•								
RECURVIROSTRIDAE															
Cladorhynchus leucocephalus	Banded Stilt					•									
Himantopus himantopus	Black-winged Stilt					•	•					•			
Recurvirostra novaehollandiae	Red-necked Avocet					•	•					•			
RHIPIDURIDAE															
Rhipidura albiscapa	Grey Fantail					•						•			
Rhipidura leucophrys	Willie Wagtail			•	•	•	•	•	•	•		•			•
SCOLOPACIDAE															
Actitis hypoleucos	Common Sandpiper	M	S3			•						•			
Calidris acuminata	Sharp-tailed Sandpiper	M	S3			•	•								

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Calidris ruficollis	Red-necked Stint	M	S3			•									
Calidris tenuirostris	Great Knot	M	S3			•									
Limicola falcinellus	Broad-billed Sandpiper	M	S3			•									
Tringa glareola	Wood Sandpiper	M	S3			•									
Tringa nebularia	Common Greenshank	M	S3			•									
Tringa stagnatilis	Marsh Sandpiper	M	S3			•									
STRIGIDAE															
Ninox novaeseelandiae	Southern Boobook Owl					•	•			•		•			
STURNIDAE															
*Sturnus vulgaris**	Common Starling						•								
THRESKIORNITHIDAE															
Platalea flavipes	Yellow-billed Spoonbill					•									
Platalea regia	Royal Spoonbill					•									
Plegadis falcinellus	Glossy Ibis	M	S3			•									
Threskiornis molucca	Australian White Ibis					•									
Threskiornis spinicollis	Straw-necked Ibis					•						•			
TURNICIDAE															
Turnix velox	Little Button-quail			•	•	•	•				•	•			
TYTONIDAE															
Tyto javanica	Eastern Barn Owl			•		•	•			•		•			
Reptiles															
AGAMIDAE															
Amphibolurus longirostris	Long-nosed Dragon					•	•	•		•					
Ctenophorus clayi	Black-collared Dragon					•	•	•		•					
Ctenophorus cristatus	Crested Dragon						•			•					
Ctenophorus isolepis	Central Military Dragon					•	•	•		•					
Ctenophorus nuchalis	Central Netted Dragon					•	•	•		•					
Ctenophorus pictus	Painted Dragon									•					
Ctenophorus reticulatus	Western Netted Dragon						•								
Ctenophorus rufescens	Rusty Dragon						•								
Ctenophorus tjantjalka							•								
Diporiphora winneckei	Canegrass Dragon					•	•								
Moloch horridus	Thorny Devil			•		•	•			•					
Pogona minor minor	Dwarf Bearded Dragon					•	•			•					
Pogona vitticeps	Central Bearded Dragon						•								
Tympanocryptis centralis	Centralian Earless Dragon						•	•							
Tympanocryptis cephalus	Pebble Dragon							•							
Tympanocryptis lineata	Lined Earless Dragon					•									
Tympanocryptis tetraporophora	Eyrean Earless Dragon						•								
ELAPIDAE															
Brachyurophis fasciolatus	Narrow-banded Snake					•	•			•					
Brachyurophis semifasciatus	Southern Shovel-nosed Snake					•	•								
Demansia psammophis	Yellow-faced Whip Snake					•				•					
Demansia reticulata	Desert Whipsnake						•								
Oxyuranus temporalis	Central Ranges Taipan									•					
Parasuta monachus	Monk Snake			•		•	•			•					
Pseudechis australis	King Brown Snake					•	•			•					
Pseudonaja modesta	Ringed Brown Snake					•	•			•					
Pseudonaja nuchalis	Western Brown Snake					•	•								
Simoselaps anomalus	Desert Banded Snake					•	•			•					

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Simoselaps bertholdi	Jan's Banded Snake						•								
GEKKONIDAE															
Crenadactylus ocellatus	Clawless Gecko						•								
Diplodactylus conspicillatus	Fat-tailed Diplodactylus			•		•	•	•		•					
Diplodactylus tessellatus	Tessellated Gecko						•								
Diplodactylus wiru										•					
Gehyra montium	Centralian Dtella					•	•								
Gehyra purpurascens	Purplish Dtella					•	•	•		•					
Gehyra variegata	Tree Dtella			•		•	•	•	•	•					
Heteronotia binoei	Bynoe's Gecko					•	•	•	•	•					•
Lucasium damaeum	Beaded Gecko						•			•					
Lucasium stenodactylum	Crowned Gecko					•	•	•							
Nephrurus laevissimus	Smooth Knob-tail			•		•	•			•					
Nephrurus levis	Three-lined Knob-tail					•	•	•		•					
Rhynchoedura ornata	Beaked Gecko			•		•	•			•					
Strophurus ciliaris	Spiny-tailed Gecko					•	•	•							
Strophurus elderi	Jewelled Gecko					•	•	•		•					
Strophurus strophurus	Western Spiny-tailed Gecko									•					
Underwoodisaurus milii	Thick-tailed Gecko						•			•					
PYGOPODIDAE															
Delma australis	Marble-faced Delma						•								
Delma borea	Rusty-topped Delma					•	•								
Delma butleri	Unbanded Delma					•	•			•					
Delma nasuta	Sharp-snouted Delma					•	•	•	•	•					
Delma pax	Peace Delma					•									
Delma tincta	Excitable Delma						•								
Lialis burtonis	Burton's Snake-lizard					•	•	•	•	•					
Pygopus nigriceps	Hooded Scaly-foot					•	•			•					
PYTHONIDAE															
Antaresia stimsoni	Stimson's Python					•	•								
Aspidites ramsayi	Woma		S4			•	•								
SCINCIDAE															
Carlia triacantha	Desert Rainbow-skink					•	•								
Cryptoblepharus plagiocephalus	Callose-palmed Shinning-skink					•	•	•							
Ctenotus ariadnae	Ariadna's Ctenotus			•			•								
Ctenotus atlas	Southern Mallee Ctenotus									•					
Ctenotus brooksi	Wedgesnout Ctenotus					•	•			•					
Ctenotus calurus	Blue-tailed Finesnout Ctenotus			•		•	•			•					
Ctenotus colletti	Buff-tailed Finesnout Ctenotus					•									
Ctenotus dux	Fine Side-lined Ctenotus					•	•			•					
Ctenotus grandis	Grand Ctenotus					•	•								
Ctenotus greeri	Spotted-necked Ctenotus			•			•			•					
Ctenotus helenae	Clay-soil Ctenotus			•		•				•					
Ctenotus leae	Orange-tailed Finesnout Ctenotus					•	•								
Ctenotus leonhardii	Leonhardi's Ctenotus					•	•	•	•	•					
Ctenotus pantherinus	Leopard Ctenotus					•	•	•		•					
Ctenotus piankai	Coarse Sands Ctenotus					•	•								
Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus			•		•	•			•					
Ctenotus regius	Pale-rumped Ctenotus						•			•					
Ctenotus saxatilis	Stony-soil Ctenotus						•								

Species name	Common name	Conservation status		This study	Literature review							Database searches			
		EPBC	WC		A	B	C	D	E	G	H	I	J	K	L
Ctenotus schomburgkii	Barred Wedgesnout Ctenotus					•	•			•	•				
Ctenotus septenarius	Massive-gibber Ctenotus					•	•								
Cyclodomorphus melanops	Spinifex Slender Blue-tongue					•	•	•	•	•					
Eremiascincus fasciolatus	Narrow-banded Sand-swimmer					•	•								
Eremiascincus richardsonii	Broad-banded Sand-swimmer						•	•							
Lerista bipes	North-western Sandslider					•	•	•		•					
Lerista desertorum	Central Deserts Robust Slider					•	•			•					•
Lerista elongata	Wide-striped Mulch Slider						•								
Lerista labialis	Southern Sandslider					•	•								
Lerista muelleri	Wood Mulch-slider						•	•							
Lerista taeniata	Ribbon Slider						•								
Lerista xanthura	Yellow-tailed Plain Slider					•									
Liopholis inornata	Desert Skink			•		•	•			•					
Liopholis kintorei	Great Desert Skink	VU	S1			•	•							•	
Liopholis margaretae	Centralian Ranges Rock-skink						•								
Liopholis striata	Nocturnal Desert-skink					•	•			•					
Menetia greyii	Common Dwarf Skink					•	•								
Morethia adelaidensis	Saltbush Morethia Skink									•					
Morethia boulengeri	South-eastern Morethia Skink						•								
Morethia butleri	Woodland Morethia Skink						•			•					
Morethia ruficauda	Lined Firetail Skink					•	•		•						
Notoscincus ornatus	Ornate Soil-crevice Skink					•									
Proablepharus tenuis	Northern Soil-crevice Skink							•							
Tiliqua multifasciata	Centralian Blue-tongue					•	•								
Tiliqua occipitalis	Western Blue-tongue					•	•								
Tiliqua scincoides	Eastern Blue-tongue						•								
TYPHLOPIDAE															
Ramphotyphlops bituberculatus	Prong-snouted Blind Snake					•									
Ramphotyphlops endoterus	Interior Blind Snake					•	•			•					
Ramphotyphlops grypus	Long-beaked Blind Snake					•									
Ramphotyphlops waitii	Beaked Blind Snake						•								
VARANIDAE															
Varanus brevicauda	Short-tailed Pygmy Monitor					•	•								
Varanus eremius	Pygmy Desert Monitor			•		•	•			•					
Varanus giganteus	Perentie			•		•	•		•						
Varanus gilleni	Pygmy Mulga Monitor					•	•	•		•					•
Varanus gouldii	Gould's Goanna			•		•	•	•	•	•					
Varanus tristis	Black-headed Monitor					•	•			•					
Amphibians															
HYLIDAE															
Cyclorana maini	Main's Frog					•	•								
LIMNODYNASTIDAE															
Neobatrachus centralis	Trilling Frog					•	•								
Neobatrachus sudelli	Sudell's Frog									•					
Neobatrachus sutor	Shoemaker Frog					•	•								
Notaden nichollsi	Desert Spadefoot Toad					•									
Platyplectrum spenceri	Spencer's Burrowing Frog						•								
MYOBATRACHIDAE															
Pseudophryne occidentalis	Orange-crowned Toadlet						•								•
Total species per survey or database search				60	51	286	259	64	67	148	6	138	8	17	46
Combined total of actual and potential species recorded over This Study, all previous studies and all database searches															360

Appendix B

Bat Call WA Bat Identification Report: October 2011

The attached report presents a detailed analysis of SM2BAT echolocation data obtained during the October 2011 survey of the Wingellina Project Study Area. The analysis was performed by Bob Bullen of Bat Call WA, and the report was provided to Outback Ecology on 12 January 2012.

Wingellina WA,
October 2011

Echolocation Survey of Bat Activity.

Prepared for Outback Ecology

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Issue 1
Prepared by: R. D. Bullen – Bat Call WA
12 January 2011

Background

Chiroptera species presence, with an estimate of activity level, is presented for a study area near Wingellina in the Great Victoria Desert, WA. Outback Ecology carried out an echolocation based survey using full spectrum Songmeter SM2 bat detectors during October 2011. Bat Call WA has reviewed the recordings made and provided species lists for the bats present.

Habitats

The sites for the Chiroptera survey were chosen by Outback Ecology. Nine were thin woodland or shrubland sites with rocky ridges or dune systems close by. One was an ephemeral creek bed. Recordings from one night at each site were collected and analysed.

Site specific details are presented in Table 1.

Bat Fauna

A microbat list of six insectivorous species was confirmed as present by their echolocation calls. Characteristics of the calls recorded are presented in Table 2. Results are presented in Table 3. Four of the species are common in the area. Two, *Chalinolobus morio* and *Nyctophilus major tor* are known from the region but are considered uncommon.

An isolated population of *Chalinolobus morio* is known from the Central Ranges spanning Surveyor General's Corner and the ranges to the east (Reardon and Flavel 1987). The results of this study probably indicate the western most extent of that population.

The detection of *Nyctophilus major tor* also probably represents the northern most extent of its range in Western Australia. It is known from the goldfields and the woodlands in the region north of the Nullarbor Plain (Parnaby 2009, Figure 11). Until 2009 this species was known as *Nyctophilus timoriensis* (central form). Under the latter name, this species is listed as Priority 4 (a taxa in need of monitoring) by the Western Australian Department of Environment and Conservation listing of Priority Fauna but is not listed federally or in South Australia.

Survey Timing, Moon Phase and Weather

The echolocation survey was conducted between the 3rd and 7th October 2011. The survey was conducted in a warm and dry period. Sampling evenings were fine and clear. Minimum overnight temperatures were cool with temperatures around 15 deg C. The moon in this period was between first quarter and full. These conditions would typically result in lower than average bat activity and echolocation call detections.

Survey Team

The bat sampling work was conducted by staff of Outback Ecology. No activities were conducted that directly impacted upon the bat fauna present.

R.D. Bullen of Bat Call WA completed analysis of echolocation recordings.

Systematic Sampling

The six overnight recordings analysed were made with SM2BAT detectors (Wildlife Acoustics, USA). The jumper and audio settings used for the SM2BAT followed the manufacturers recommendations for bat detection contained in the user manual (Wildlife Acoustics 2010), Table 4. Selectable filters and triggers were also set using the manufacturers recommendations.

For all recordings, once reformatted as .wav files, COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.) was used to display each "continuous call" sequence (EPA and DEC 2010) for identification. Only good quality call sequences were used. Details of calls analysed are provided in Table 2 as recommended by Australasian Bat Society (ABS 2006). Reference data for the species identified are available in Bullen and McKenzie 2002, McKenzie and Bullen 2003 and McKenzie and Bullen 2009.

Bat activity was then characterised as "Low", "Medium" or "High" based on the rate of call sequences recorded.

- Low species activity is referred when a species is recorded with call spacing less often than ten minutes,
- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a significant time period followed by sporadic records for the remainder of the session.
- High species activity refers to call recording more often than two minutes apart for significant periods followed by reasonably regular records for the remainder of the session.

Further details of the calls analysed including graphical presentations are available from Bat Call WA on request.

Survey Limitations

The sites surveyed were accessible on foot and the recorders were set at ground level with the antenna horizontal. The omni antenna fitted to the SM2 detector will successfully record all bats that pass within range under these conditions. Bat sound recordings began at sunset and continued until sunrise.

Bat species density is impossible to estimate from echolocation records. Bat activity is therefore substituted as an approximate guide to the relative numbers of each species using the study area.

References

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Reardon, T.B. and Flavel, S.C. (1987). A Guide to the Bats of South Australia. South Australian Museum: Adelaide.

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Table 1 Site Specific details.

Location	Site description	Easting	Northing
SM2BAT-01	Thin woodland	421462	7042617
SM2BAT-02	Rocky Outcrop	444333	7073204
SM2BAT-03	Shrubland between dunes	428845	7050159
SM2BAT-04	Thin woodland adjacent to a dune	451056	7091360
SM2BAT-05	Open ephemeral creekbed	446460	7080108
SM2BAT-06	Shrubland plain	454763	7110393
SM2BAT-07	Shrubland plain	452285	7101466
SM2BAT-08	Shrubland between dunes	473415	7126266
SM2BAT-09	Shrubland plain adjacent to rocky hill	465642	7116628
SM2BAT-10	Shrubland between dunes	469845	7122449

Table 2: Summary of Echolocation call characteristics for microbat species present.

Genus species Authority	Common name	Typical F_{peakC} kHz	Ave. Q	Typical Duration msec	Typical Call Shape
Chalinolobus gouldii (Grey 1841)	Gould's wattled bat	32	10	7 - 11	FM
Chalinolobus morio (Gray 1841)	Chocolate wattled bat	50	10	7 - 8	FM
Nyctophilus major tor (Parnaby 2009)	Central greater long-eared bat	43	2.5	5	Steep FM
Nyctophilus geoffroyi Leach 1821	Lesser long-eared bat	47	2.5	5	Steep FM
Saccolaimus flaviventris (Peters 1867)	Yellow-bellied sheath-tailed bat	18	9	12 - 21	CF - FM
Vespadelus finlaysoni (Kitchener, Jones and Caputi 1987)	Inland cave bat	55	14	4 - 8	FM

Note: FpeakC and Q are defined in McKenzie and Bullen 2003, 2009.

Table 3. Microbat lists obtained

Date	**Site**	**Detector/Recorder**	***Chalinolobus gouldii***	***Chalinolobus morio***	*Nyctophilus major tor*	*Nyctophilus geoffroyi*	*Saccolaimus flaviventris*	***Vespadelus finlaysoni***
3 Oct	SM2BAT-01	Overnight recording using SM2BAT detector	Low				Low	
3 Oct Note 2.	SM2BAT-02	"						
4 Oct	SM2BAT-03	"	Low					
4 Oct	SM2BAT-04	"	Low		Low			
5 Oct	SM2BAT-05	"						Low
5 Oct	SM2BAT-06	"	Low	Low				Low

6 Oct	SM2BAT-07	"	Low		Low	Low
6 Oct	SM2BAT-08	"			Low	
7 Oct	SM2BAT-09	"	Low	Low	Low	Low
7 Oct	SM2BAT-10	"	Low			Low

Note 1: Low activity refers to call spacings that repeat less often than 10 minutes.
Med activity refers to call records that repeat more often than 10 minutes but less often than 2 minutes for significant periods of time then sporadically for the duration of the recording.
High activity refers to calls that repeat more often than 2 minutes for significant periods of time then periodically for the duration of the recording.

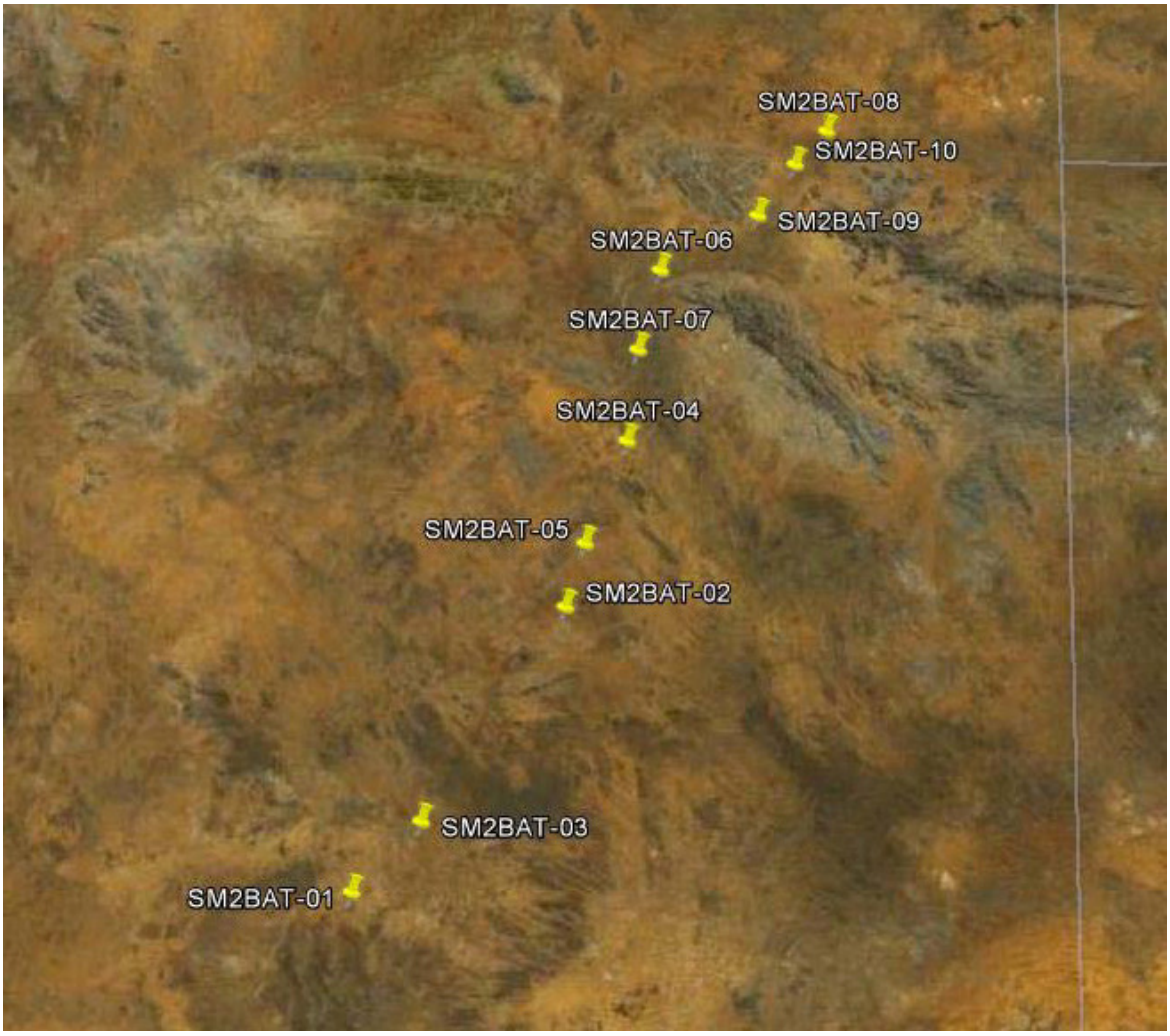
Note 2: No bats were recorded at this site.

Table 4 SM2 Audio settings used during survey.

Parameter	Setting
Sample rate	Fs = 384,000 kHz
Channel used	Left
Compression protocol	WAC4 (12 bit audio samples)
Gain - left channel	0.00
Digital high pass filter Left channel	Fs / 48
Digital low pass filter Left channel	Off
Triggering level Left channel	8SNR (adaptive +8 dB triggering)
Triggering window Left channel	2.0 sec.

Note: These settings are as recommended in Wildlife Acoustics (2010) except the high pass filter. This is set at 8 kHz to record any *Tadarida australis* that may be present

Figure 1. Location of study area sites in relation to local features



Appendix C

Definitions of Codes and Terms Used to Describe Conservation Significance

Fauna may be accorded legislative protection by being listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) and/or the *Wildlife Conservation Act 1950* (WA) (WC Act), or by being listed on the WA Department of Environment and Conservation's *Priority Species List*. This table presents a summary of the different rankings and listings used to describe conservation status. Some categories, such as 'extinct', 'extinct in the wild' and 'conservation dependent' (EPBC Act) are not presented here, as the table includes only the information needed to fully understand the codes presented in the preceding report. Refer to the relevant legislation for a full description of all codes in use, as well as their associated criteria.

Definitions of Codes and Terms Used to Describe Conservation Significance Status

Status	Code	Description
Categories used under the EPBC Act		
Critically Endangered	CR	Fauna that is considered to be facing an extremely high risk of extinction in the wild in the immediate future
Endangered	EN	Fauna that is considered to be facing a very high risk of extinction in the wild in the near future
Vulnerable	VU	Fauna that is considered to be facing a high risk of extinction in the wild in the medium-term future
Migratory	M	Species that migrate to, over and within Australia and its external territories.
Schedules used under the WC Act		
Schedule 1	S1	Fauna that is rare or likely to become extinct. Threatened fauna listed under Schedule 1 of the WC Act are further ranked by the DEC, according to the level of threat facing each species. The ranks are CR, EN and VU.
	CR	Critically endangered: considered to be facing an extremely high risk of extinction in the wild
	EN	Endangered: considered to be facing a very high risk of extinction in the wild
	VU	Vulnerable: considered to be facing a high risk of extinction in the wild
Schedule 2	S2	Fauna that is presumed to be extinct
Schedule 3	S3	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds
Schedule 4	S4	Fauna that is in need of special protection, other than for reasons mentioned above
DEC Priority Fauna Lists		
Priority 1	P1	Taxa with few, poorly known populations on threatened lands. These are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands. These are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands. These are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4	P4	Taxa in need of monitoring. These are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring. These are not considered threatened but are subject to a specific conservation programme, the cessation of which would result in the species becoming threatened within five years.

Appendix D

Arachnid and Diplopod Identification Report: December 2011

The attached report presents a summary of the identification of arachnids and diplopods obtained during the October 2011 survey of the Wingellina Project Study Area. The identifications were performed by the WA Museum.

Arachnids and Diplopods from Wingellina, Western Australia

Report to *Outback Ecology*

15 December 2011

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Summary

The samples submitted to the Western Australian Museum on the 1st December 2011 (accession no. A3988) included mygalomorph spiders from the families Barychelidae (Synothele), Idiopidae (Anidiops), Nemesiidae (Aname), and Theraphosidae: and pseudoscorpions from the family Olpiidae (*Indolpium*). The pseudoscorpions are not representatives of short-range endemic species. Considering the mygalomorph spiders are juveniles it is difficult to ascertain whether these specimens are short-range endemics.

Also included in the samples were millipedes from the family Pachybolidae. The millipede specimens are from the genus *Austrostrophus*. While species in this genus are widespread in WA, the samples collected in this survey are from a new locality which is >1100 km from the next known *Austrostrophus* and >450 km from an *Antichiropus* species. The genus *Austrostrophus* are not considered a short-range endemic. The identifications of the millipedes are listed in Appendix 1 for completion, but are not discussed further in this report.

Short-Range Endemism

The terrestrial invertebrate fauna of inland Australia contains a plethora of species, and just the arthropods were recently estimated to consist of more than 250,000 species (Yeates, Harvey et al. 2004; Chapman 2009). The vast majority of these are found within the Insecta and Arachnida, although significant numbers of millipedes are to be expected. For many years, the prospect of including invertebrates in assessments of biological systems subject to alteration proved daunting and were largely ignored as being too diverse and too difficult to comprehend to satisfy the rapid turn-around needed for environmental surveys.

In a recent publication, the issue of Short-Range Endemism in the Australian invertebrate fauna was examined (Harvey 2002), and series of major groups were nominated as having a very high proportion of individual species that satisfied a certain set of criteria. The main criterion nominated for inclusion as a Short-Range Endemic (SRE) was that the species had a naturally small range of less than 10,000 km^2. Harvey (2002) found that those species possessed a series of ecological and life-history traits, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal, only active during cooler, wetter periods; and
- low levels of fecundity.

The Western Australian fauna contains a number of SRE taxa, including millipedes, land snails, trap-door spiders, some pseudoscorpions, slaters, and onychophorans and these represent focal groups in Environmental Impact Assessment studies in the state (EPA 2009). The south coast region is relatively well known compared with other regions of the state (Framenau, Moir et al. 2008), but there are many poorly known species and gaps in our understanding of the distributions of many species.

Methods

Arachnids and diplopods collected by *Outback Ecology* from the Wingellina area were submitted to the Western Australian Museum on 1st December 2011. The specimens were examined at the WA museum using Leica dissecting microscopes (MZ6, MZ16). Scorpions were also included in the submission; these were passed on to an external expert Dr Erich Volschenk for identification and only the WAM registration numbers are supplied in this report.

ARACHNIDA

Infraorder Mygalomorphae (Trapdoor Spiders)

Mygalomorph ("trapdoor") spiders belong to one of the focal groups in surveys of short-range endemic taxa (Harvey 2002). Many mygalomorph spiders show low dispersal capabilities, may be restricted to relictual habitats, and have long life cycles with low fecundity. A number of mygalomorph spiders, e.g. *Aganippe castellum*, *Idiosoma nigrum*, *Kwonkan eboracum*, *Moggidgea tingle*, are listed on Schedule 1 ("Fauna that is rare or likely to become extinct" of the Wildlife Conservation (Specially Protected Fauna) Notice 2008 of the Western Australian Government. The Western Australian mygalomorph fauna is vast and, despite long-term and ongoing research by Drs Barbara Main (University of Western Australia) and Robert Raven (Queensland Museum), remains taxonomically poorly known for many families and genera (e.g. Barychelidae: *Idiommata*; Idiopidae: *Aganippe*; Nemesiidae: *Aname*, *Chenistonia*, *Kwonkan*).
The best taxonomic features to distinguish mygalomorph spiders are found within the genitalia of males. Females or juveniles may be indistinguishable, although burrow morphology may allow identification to species level in some cases (B.Y. Main, personal communication). The Western Australian Museum has recently initiated a reference collection of male mygalomorph morphospecies to facilitate an assessment of distribution patterns of these spiders. This collection is assembled in cooperation with Dr Barbara Main and will eventually be consolidated with her collection at the University of Western Australia. Mygalomorph morphospecies are consecutively numbered ("MYG001", "MYG002" etc.) to allow a comparison of taxa between different surveys.

Family Barychelidae

Members of the Barychelidae, the "Brush-footed Trapdoor Spiders" are cryptic spiders. Their burrow often lacks the firm and thick door of the Idiopidae or the extensive web of the Dipluridae (Raven 1994).

***Synothele* sp. (juveniles)**

The genus *Synothele* is presumably widespread throughout Western and South Australia and a number of species are currently described from Western Australia, some of them with narrow known distributions (Raven 1994). Some species within this genus have a limited distribution range and could be considered short-ranged endemics.

Family Idiopidae

The mygalomorph spider family Idiopidae includes a number of genera in Western Australia, including *Anidiops*, *Gaius*, *Arbanitis*, *Euoplos*, *Blakistonia*, *Cataxia*, *Eucyrtops*, *Idiosoma* and *Misgolas* (Main 1985; Raven and Wishart 2006). They comprise the 'typical' trap door spiders, i.e. those species that usually close the burrow with a hinged door. Spiders of this family are abundant, in particular in relatively stable habitats in temperate to tropical regions (Main 1985).

***Anidiops* sp. (juveniles)**

The genus *Anidiops* (including its current junior synonym *Gaius*) is common throughout Western Australia. Two species are currently described (*A. manstridgei* and *A. villosus*). Unpublished research by Barbara Main, University of Western Australia, suggests that both *Anidiops* and *Gaius* represent valid genera with *Anidiops* having generally a more northern distribution (B.Y. Main, personal communication). Some species within this genus have a limited distribution range and could be considered to be short-ranged endemics.

Family Nemesiidae

Members of the mygalomorph spider family Nemesiidae are represented in Western Australia by several genera, including *Aname*, *Chenistonia*, *Yilgarnia*, *Stanwellia*, *Teyl, Kwonkan* and *Swolnpes* (Main and Framenau 2009). They usually dig burrows in the soil, and do not cover their burrow entrances with lids.

***Aname* sp. (juveniles)**

The genus *Aname* is very well represented in the Western Australian fauna by eight named and numerous unnamed species. The Western Australian Museum has records from many different regions of the state, but only a small proportion of males in the collection have been incorporated in our reference database. Distribution and conservation status of many species are not well understood and detailed taxonomic work is needed to understand the Western Australian fauna. Some species within this genus have a limited distribution range and could be considered to be short-ranged endemics.

Family Theraphosidae

Members of the mygalomorph spider family Theraphosidae are represented in Western Australia. No species within the family are considered as potential short-ranged endemics

Order Pseudoscorpiones

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats. The material from this survey included 6 individuals from the family Olpiidae (Appendix 1).

Family Olpiidae

***Indolpium* sp. (family Olpiidae)**

One male, four females, and one juvenile specimen of *Indolpium* were collected during the survey (Appendix 1). Extremely similar specimens have been collected from other regions of Western Australia. Based on our current levels of knowledge it is unlikely that these specimens represent short-range endemic species.

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Appendix 1. Specimen data for arachnids and diplopods collected from Wingellina

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	M	F	JUV.	TOTAL
116692	Target 6-13	Arachnida	Araneae	Nemesiidae	*Aname*	sp.	26°35`25.2"S	128°19`45.4"E			1	1
116693	Opp 1-5	Arachnida	Araneae	Idiopidae	*Anidiops*	sp.	26°40`03.1"S	128°17`06.7"E			1	1
116694	Target 10-18	Arachnida	Araneae	Therphosidae		sp.	26°06`49.6"S	128°34`07.6"E			1	1
116695	Target 6-14	Arachnida	Araneae	Barchelidae	*Synothele*	sp.	26°35`25.2"S	128°19`45.4"E			1	1
116696	Target 3-8	Arachnida	Pseudoscorpiones	Olpiidae	*Indolpium*	sp.	26°27`37.4"S	128°26`30.1"E		3		3
116697	Target 3-2	Arachnida	Pseudoscorpiones	Olpiidae	*Indolpium*	sp.	26°27`37.4"S	128°26`30.1"E			1	1
116698	Target 3-4	Arachnida	Pseudoscorpiones	Olpiidae	*Indolpium*	sp.	26°27`37.4"S	128°26`30.1"E		1		1
116699	Target 3-3	Arachnida	Pseudoscorpiones	Olpiidae	*Indolpium*	sp.	26°27`37.4"S	128°26`30.1"E	1			1
116700	Target 2-7	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	sp.	26°42`53.6"S	128°14`00.0"E				5
116701	Target 1-1	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	sp.	26°44`07.8"S	128°12`36.9"E				1

Appendix E

WA Museum Scorpion Identification Report: February 2012

The attached report presents a summary of the identification of scorpions obtained during the October 2011 survey of the Wingellina Project Study Area. The identifications were performed by the ScorpionID.

ScorpionID

172D Odin Road, Innaloo, WA, 6018 | Ph: 0457 11 13 17 | email: evolschen@gmail.com

Scorpion Identification Report

Report ID: OE.Wi.201201
Prepared for: Outback Ecology
By Dr Erich S. Volschenk
Tuesday, 21 February 2012

Outback Ecology is undertaking a short-range endemic survey at Wingella, and has requested:
- Taxonomic identifications of scorpion from the survey; and
- SRE assessment of the species represented in the collection.

The collection is comprised of 7 samples.

FAMILY: Urodacidae Pocock, 1893

The family Urodacidae is endemic to Australia (Fet 2000; Prendini 2000; Prendini 2003; Volschenk *et al.* 2000) where it is represented by the genera *Urodacus* Peters, 1861 and *Aops* Volschenk and Prendini, 2008.

GENUS: *Urodacus* Peters, 1861

Urodacus has been considered a member of the family Scorpionoidea for many years, but in a revision of the superfamily Scorpionoidea Latreille, Prendini (Prendini 2000) placed *Urodacus* in its own family. Unlike the species designations for Buthidae, LE Koch's (Koch 1977) species' of *Urodacus* have been mostly supported by subsequent authors (Harvey & Volschenk 2002; Volschenk & Prendini 2008; Volschenk *et al.* 2000). The biggest issue confronting *Urodacus* taxonomy is the number of undescribed species being uncovered through current revisionary work (Volschenk unpublished data). Currently 22 species of *Urodacus* are described; however, this may represent as little as 20% of the real diversity of this genus in Australia. *Urodacus* appears to be most diverse in Western Australia and few species are recorded east of the Great Dividing Range in eastern Australia. *Urodacus* contains both widespread and SRE species. During a large-scale survey of the pilbara fauna, Volschenk, *et. al.* (Volschenk *et al.*) recorded nine undescribed species and only one formerly describes species were reported in that study.

Species: *Urodacus hoplurus* Pocock, 1898

SRE STATUS
Urodacus hoplurus is not an SRE.

TAXONOMIC RESOLUTION
Urodacus hoplurus is a well-defined and clearly recognised species.

DISTRIBUTION
Urodacus hoplurus has a wide distribution across southern arid Australia where it has been recorded from WA, SA, NT and Qld.

RECOMENDATIONS
Urodacus hoplurus is not an SRE and no management is recommended.

WAM Rego.	Client Rego.	♂	♀	Juv.	Location	Notes	Identified by
116686	Target 9-17	0	0	1	Wingellina, ~53 km WSW. of W.A./N.T./S.A. border	tentative DI, Subadult	Volschenk E.S.
116688	Target 9-16	0	0	1	Wingellina, ~53 km WSW. of W.A./N.T./S.A. border	tentative DI, Subadult	Volschenk E.S.
116690	Target 2-6	0	0	1	Wingellina, ~110 km SW. of W.A./N.T./S.A. border	tentative DI, Subadult	Volschenk E.S.
116691	Target 9-10	0	0	1	Wingellina, ~53 km WSW. of W.A./N.T./S.A. border	tentative DI, Subadult	Volschenk E.S.

Number of samples: 4

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Species: *Urodacus yaschenkoi* (Birula, 1903)

SRE STATUS

Urodacus yaschenkoi is a potential SRE.

TAXONOMIC RESOLUTION

Urodacus yaschenkoi is highly variable represents a species complex. Species boundaries are not yet established within the genus.

DISTRIBUTION

The *U. yaschenkoi* complex is widely distributed, from Northern WA to Western Queensland and New South Wales; however, this this complex is made up of at approximately six species. The distribution of the species within this complex is poorly resolved and some species may qualify as short range endemic.

RECOMMENDATIONS

Insufficient records are available to clearly guage this species as an SRE. If records of this species are restricted to areas proposed for development, then surveys should be undertaken to find viable populations of this species, there by demonstrating that this species will not be threatened by the proposed development.

While species delineation using morphology is still challenging, species delineations using barcoding approaches are possible and have been undertaken with scorpions. If follow-up surveys are deemed necessary, then I also recommend using genomic barcoding techniques to demonstrate conspecifics.

WAM Rego.	Client Rego.	♂	♀	Juv.	Location	Notes	Identified by
116685	Target 4-9	1	0	0	Wingellina, ~61 km SW. of W.A./N.T./S.A. border		Volschenk E.S.
116687	Target 6-12	1	0	0	Wingellina, ~94 km SW. of W.A./N.T./S.A. border		Volschenk E.S.
116689	Target 6-15	0	0	1	Wingellina, ~94 km SW. of W.A./N.T./S.A. border		Volschenk E.S.

Number of samples: 3

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