Biota Environmental Sciences

Winu Project Noise and Vibration Impact Assessment

Prepared for Rio Tinto Winu Pty Ltd

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Winu Noise and Vibration EIA

Contents

Figures

Plates

Terminology

The following is an explanation of the terminology used throughout this report and is based in part on definitions provided in LGA (2025a):

Decibel (dB)

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting (A)

A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. In this document an A-weighted sound level is described as dB(A).

L_{A10}

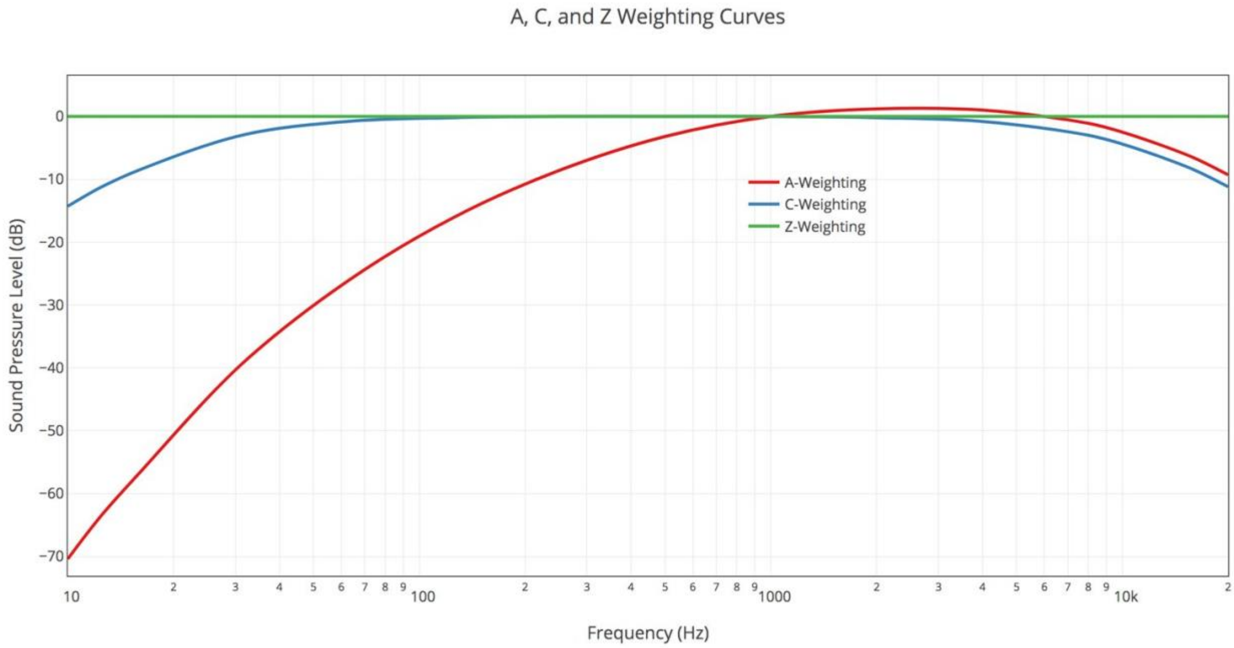
The L_{A10} level is the A-weighted noise level exceeded for 10 percent of the measurement period and is considered to represent the "intrusive" noise level. In this document, L_{A10} is the unit of measure used to present noise levels at the mine area and Wind Farm.

L_{Amax}

An L_{Amax} level is the maximum A-weighted noise level during a particular measurement. In this document, L_{Amax} is used to calculate and present noise levels at the Airfield.

Z-Weighting

Z-weighting represents a flat frequency response across a specific range (typically 10 Hz to 20 kHz), without any adjustments to account for the human ear's sensitivity. The difference between A and Z weighting noise levels is presented below.



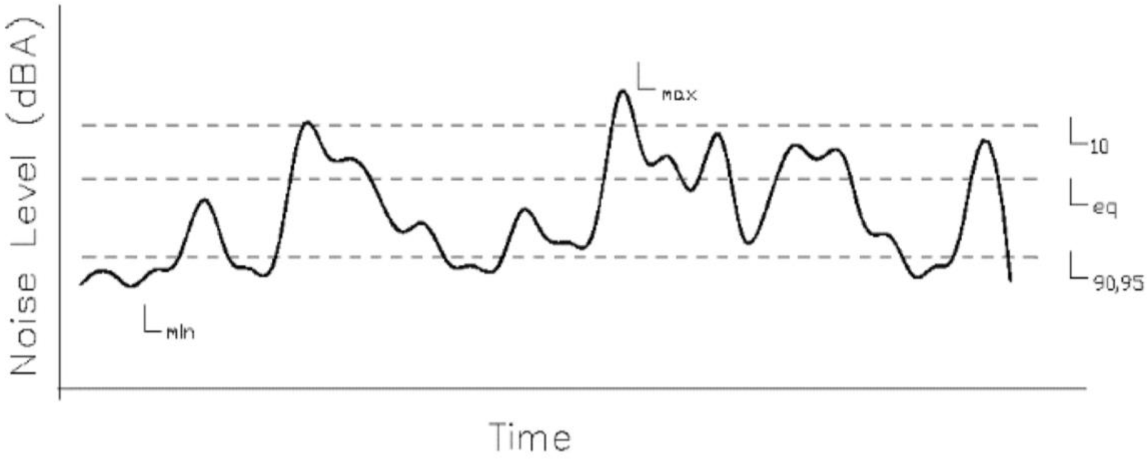
L_{Zpeak}

This is the greatest absolute instantaneous sound pressure level in decibels using the Z-frequency weighting. In this document, L_{Zpeak} has been used to describe air blast noise levels.

Peak Particle Velocity (PPV)

The maximum instantaneous velocity in millimeters per second (mm/s) of a particle at a point during a given time interval. Peak velocity is used to assess structural damage from vibration.

Chart of Noise Level Descriptors



1.0 Executive Summary

Rio Tinto Winu Pty Limited (RTW) plans to develop a copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Pilbara and Great Sandy Desert regions of Western Australia, within both the Nyangumarta and Martu Peoples' Native Title Determination Areas.

The Project will include noise and vibration emitting activities, including open pit mining using conventional drill and blast techniques, construction of waste rock landforms and a tailings storage facility, ore processing activities such as crushing, screening and stockpiling, and a processing plant, as well as an Airfield and Wind Farm.

Biota Environmental Sciences (Biota) was commissioned by RTW to undertake an impact assessment of the proposed noise and vibration emissions from the Project on significant fauna. Please refer to the Terminology section above the Executive Summary for an explanation of the acoustic terminology used throughout this report.

In the interests of a conservative assessment, a threshold of 50 dB(A) was adopted to identify any areas where a risk of behavioural impacts on significant fauna might arise due to predicted increases in ambient noise. While a small proportion (2.2%) of suitable habitat for some significant species is within areas where day-to-day operational noise emissions are predicted to be greater than 50 dB(A), a review of the literature indicated it is unlikely that any significant species known from or likely to occur in the Project area will be significantly impacted by noise. Although behavioural responses and masking effects are recorded in fauna where noise emissions exceed 50-60 dB(A), significant effects such as injury or hearing damage are only recorded at significantly higher levels (i.e. up to 140 dB(A) (Dooling and Popper 2007)), which exceed predicted day-to-day noise levels at the Project site.

This impact assessment has shown that, within key habitats for significant species (such as the Bilby), noise affected areas from Mine Operations represent a minor proportion of the total area of fauna habitat mapped across the project area:

- Shrub and Spinifex on Sandplain habitat supports a diversity of burrowing species associated with spinifex hummock grasslands, including in parts, areas associated with the Bilby, Brush-tailed Mulgara, Spectacled Hare-wallaby, and Dampierland Plain Slider. Excluding the indicative footprint, approximately 1.8% of this locally mapped habitat is within mine operational noise contours that exceed 50dB(A). Given the vast extent of this habitat across the region, the risk from indirect impacts to species within this habitat from the effects of noise is expected to be low.
- Inland Sand Dunes habitat can be associated with fossorial species and dune specialists, including the Fossorial Skink, Sand Slider, Northern Marsupial Mole, Bilby, and Dampierland Plain Slider. Excluding the indicative footprint, approximately 6.2% of this locally mapped habitat is within mine operational noise contours predicted to exceed 50dB(A). As with the previous habitat, Inland Sand Dune habitat is widely distributed across the Great Sandy Desert region, and the risk from indirect impacts to species within this habitat from the effects of noise is expected to be low.
- Gravelly Lateritic Rises habitat can be associated with species with a preference for rocky substrates such as the Western Pebble Mouse and the Spectacled Hare-wallaby. While none of this habitat is locally mapped within areas where mine operational noise contours exceed 50dB(A), some mapped areas (25%) are within the infrequent and short duration airfield noise impact areas. Given the distribution of this habitat within the Pilbara and Great Sandy Deserts, significant impact from noise within this habitat type is expected to be low.
- Clayey sand plain with Termitaria habitat can be associated with species that utilise termitaria as refugia or for foraging purposes, such as geckos (*Gehyra pilbara* and *Diplodactylus laevis) and* pythons (*Antaresia childreni* and *Aspidites melanocephalus),* none of which are listed as significant. While none of this habitat is locally mapped within areas where mine operational noise contours exceed 50dB(A), some mapped areas (20 hectares (ha), 15% of the locally mapped area) are within the infrequent and short duration airfield noise impact areas. Because the habitat is not exclusively used by significant species of the

Project area and the habitat is widely distributed throughout the Pilbara and Great Sandy Desert regions, the risk to species within this habitat from noise is low.

- Ephemeral Claypan habitat is potentially associated with Short-tailed Mouse and periodically with the Oriental Plover. None of this habitat is mapped within noise contours that exceed 50dB(A) and as such will not be impacted by noise emissions from the Project.

Another significant species recorded in the region is the Night Parrot. A small portion (15%) of potential Night Parrot habitat was mapped within the $50dBL_{Amax}$ associated with the infrequent and short duration airfield noise emissions, but no Night Parrot habitat was recorded in noise contours associated with the Mine Operations. No Night Parrot habitat was found within noise levels that exceeded approximately 75 dBL_{Amax}, which is still below levels that can cause significant impacts such as permanent or temporary hearing damage. Blasting impact was also assessed with worst-case blast scenarios produce 94 $dB_{Z\ Peak}$ and 0.1 mm/s at the nearest potential Night Parrot roosting habitat, a limit regularly exceeded by thunderstorms in the region (Martin 2018). Overall, the risks of significant noise-related impacts on Night Parrot arising from the Winu Project are low.

2.0 Introduction

Rio Tinto Winu Pty Limited (RTW) plans to develop a copper-gold mine, referred to as the Winu Project, approximately 320 km east of Port Hedland in the Pilbara region of Western Australia, within both the Nyangumarta and Martu Peoples' Native Title Determination Areas. (Figure 2.1).

The project includes noise and vibration emitting activities, including open pit mining, using conventional drill and blast techniques, construction of waste rock landforms and a tailings storage facility, ore processing activities such as crushing, screening and stockpiling, and a processing plant, as well as a proposed Airfield upgrade and Wind Farm.

Biota Environmental Sciences (Biota) was commissioned by RTW to undertake an impact assessment of the proposed noise and vibration emissions generated from the project and investigate the potential impact to significant fauna from these emissions.

2.1 Spatial Scope of the Project

The Winu Project area comprises the following spatial elements, as described throughout this document (Figure 2.1):

- The development envelope (DE) represents approximately 23,650 hectares (ha) area (as of 30 April 2025).
- The survey area represents the consolidated fauna habitat and vegetation survey extent across the broader Winu Project and covers approximately 44,478 ha. While not all survey areas are part of the DE, data collected within the DE and its surrounds are relevant to the Project and its impact assessment. A list of previous surveys relevant to this report are provided in Section 2.4.
- The noise study area represents the zone of predicted noise and vibration extent (modelled to the 25-30 decibel (dB) contour line, which represents background nature levels (LGA 2025a)), and occupies an area of approximately 38,111 ha surrounding and including the DE.

2.2 Study Objectives

The main objective of this study was to undertake an impact assessment of the proposed noise emissions on significant fauna, specifically to:

- Review terrestrial fauna surveys and technical studies completed for the Project, including the current noise and vibration modelling and assessment.
- Assess the presence of significant fauna species within predicted increased noise impact areas.
- Investigate key species (or groups) within noise impact areas, and review literature for any known responses to long-term noise impacts.
- Assess other potential impacts that may result from noise emissions, including changes to fauna behaviour, ecology and population dynamics.
- Quantify the potential impacts on fauna values potentially affected by noise emissions, as per EPA guidance.
- Summarise outcomes of the impact assessment.

2.3 Policy and Guidance

The review and impact assessment has also been undertaken with guidance from the Western Australian Environmental Protection Authority (EPA), Department of Water and Environmental Regulation (DWER), the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and others:

- EPA Statement of environmental principles, factors, objectives and aims of EIA (EPA 2023).

- EPA Instructions: How to prepare an environmental review document (EPA 2024).
- DWER Guideline – Assessment of Environmental Noise Emissions, Activities regulated under the: Environmental Protection Act 1986 Environmental Protection Regulations 1987 Environmental Protection (Noise) Regulations 1997. May 2021. Draft for consultation (DWER 2021a).
- DWER Noise Regulations fact sheet. Regulation 11: Blasting operations. June 2021 (DWER 2021b)
- EPA Environmental Factor Guideline – Social surroundings. November 2023 (EPA 2023b).
- EPA Environmental Factor Guideline – Human health. December 2016 (EPA 2016).
- Western Australian Planning Commission, Guidelines for Wind Farm Development, Western Australian Planning Bulletin Number 67 (WA Planning Commission 2004).
- Wind turbine sound limits: Current status and recommendations based on mitigating noise annoyance. Prepared with DCCEEW Independent Scientific Committee on Wind Turbines 2021 (2018-2021) (Davy et al. 2018).
- DCCEEW Independent Scientific Committee on Wind Turbines (2018-2021). https://www.dcceew.gov.au/energy/renewable/independent-scientific-committee-wind-turbines (DCCEEW 2022).

2.4 Previous Studies

The fauna and habitat data consolidated in this report were collated from multiple studies undertaken across the Winu Project. Key studies included:

- Winu Project Bilby Abundance Study (Biota 2020);
- Winu Project Fauna Assessment (Biota 2021a);
- Winu Project Area Extension Targeted Fauna Survey (Biota 2022);
- Winu Project Bilby Population Abundance Study (Biota 2023a);
- Winu Project Water Borefield Targeted Fauna Survey (Biota 2023b);
- Winu Project Native Vegetation Clearing Permit Fauna Clearance Survey (Biota 2023c);
- Winu Biological Gap Analysis (Biota 2023d);
- Winu Terrestrial Fauna Interim Consolidation Report (Biota 2023e);
- Winu Project Bilby Population Abundance Study (Biota 2024); and
- Winu Fauna Consolidation Report (Biota 2025a).
- Winu Targeted Night Parrot Survey (Biota 2025b)

Winu Project vegetation and flora data was also used to guide habitat assessment, and included:

- Paterson Flora, Vegetation and Fauna Habitat Survey (Astron 2018).
- Paterson Reconnaissance Flora, Vegetation and Fauna Survey (Astron 2019a).
- Paterson Road Corridor Reconnaissance Flora and Vegetation and Level 1 Fauna Survey (Astron 2019b).
- Winu Detailed Flora and Vegetation Survey Interim Report (Biota 2019).
- Winu Detailed Flora and Vegetation Survey (Biota 2021b).
- Winu Detailed Flora and Vegetation Assessment (Western Botanical 2023a).
- Winu Consolidated detailed flora and vegetation assessment (Western Botanical 2023b, 2025).

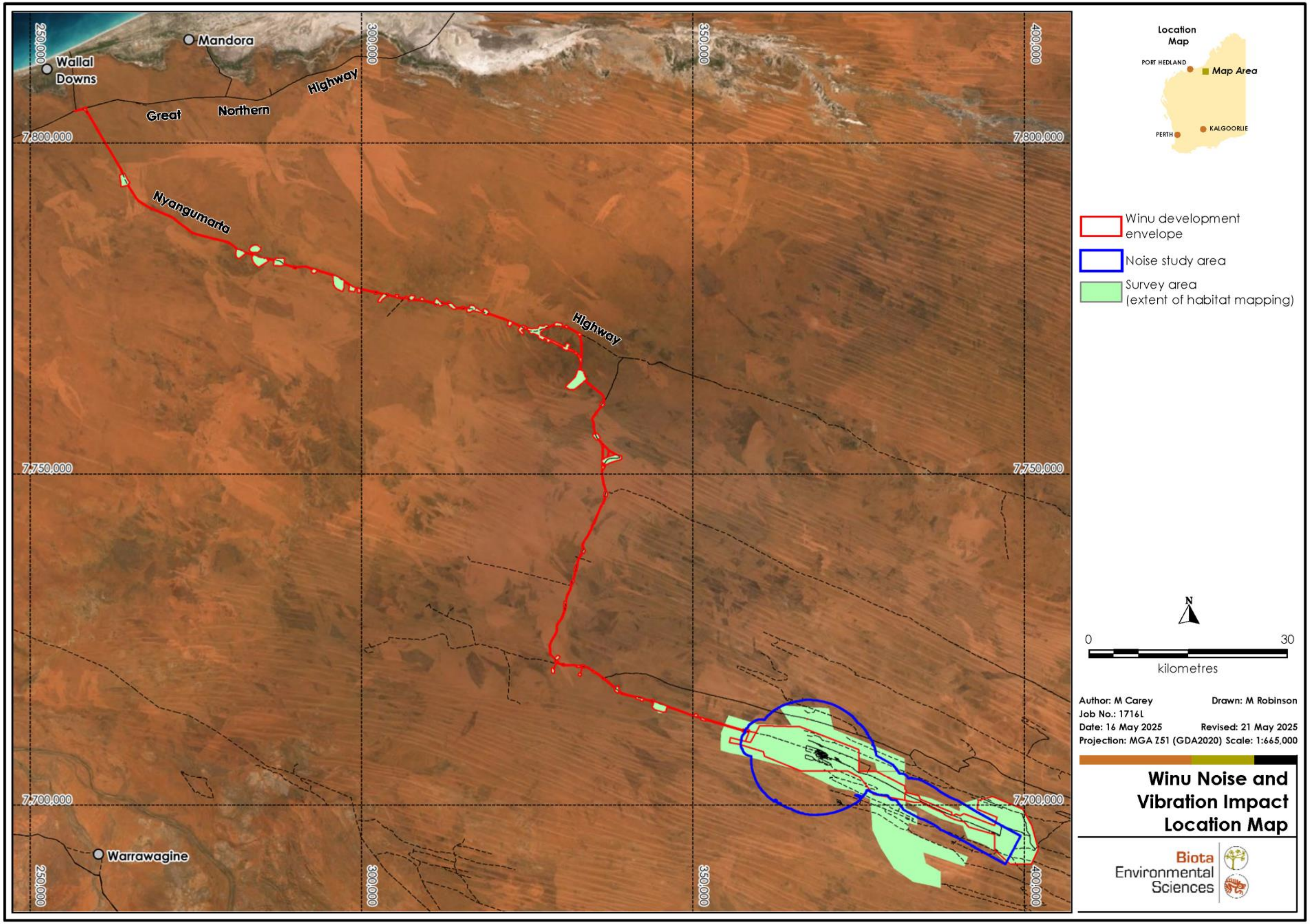


Figure 2.1: Location of the Project development envelope.

3.0 Existing Environment

3.1 Climate

3.1.1 Rainfall and Temperature

The noise study area is located within the Eremaean biogeographic region, Australia's arid biome (Beard 1990 and Ebach and Murphy 2020). The area experiences desert conditions, with 12 dry months a year, summer rainfall from tropical thunderstorms and extreme evaporation rates.

Mean monthly rainfall and mean maximum and minimum temperatures (2003-2023) (Telfer Aero No. 13030, located approximately 100 km south of Winu mine) are presented in Figure 3.1.

Average annual rainfall totals 365.8 mm, with most rain falling between November and March. Tropical thunderstorms occur one to four times a year and can bring up to 120 mm of rain in one event. Outside this summer wet season, rain is often minimal for several months. Summer months also record the highest temperatures, with each month between November and February recording 12-18 days over 40 °C (Grigg 2009).

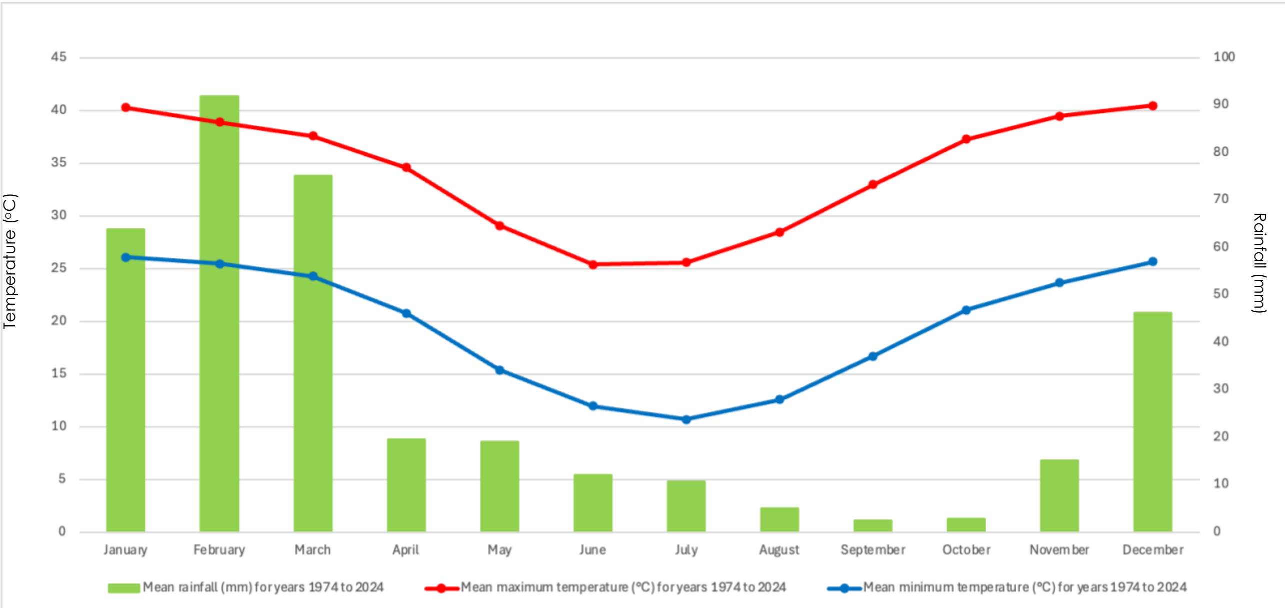


Figure 3.1: Mean monthly rainfall and max/min temperatures (Telfer Aero Weather Station, BoM 2024).

3.1.2 Wind Speed and Direction

Based on the nearest BOM weather station (Station No. 013030, Telfer Aero), the prevailing winds are from the southeast, with approximately 60% of all hourly wind direction coming from the east and south east (Figure 3.2). Winds from the prevailing east and southeast also generally recorded speeds of between 10-30 km/hr approximately 40% of the time, with stronger winds (>30km/hr) occurring approximately 15% of the time.

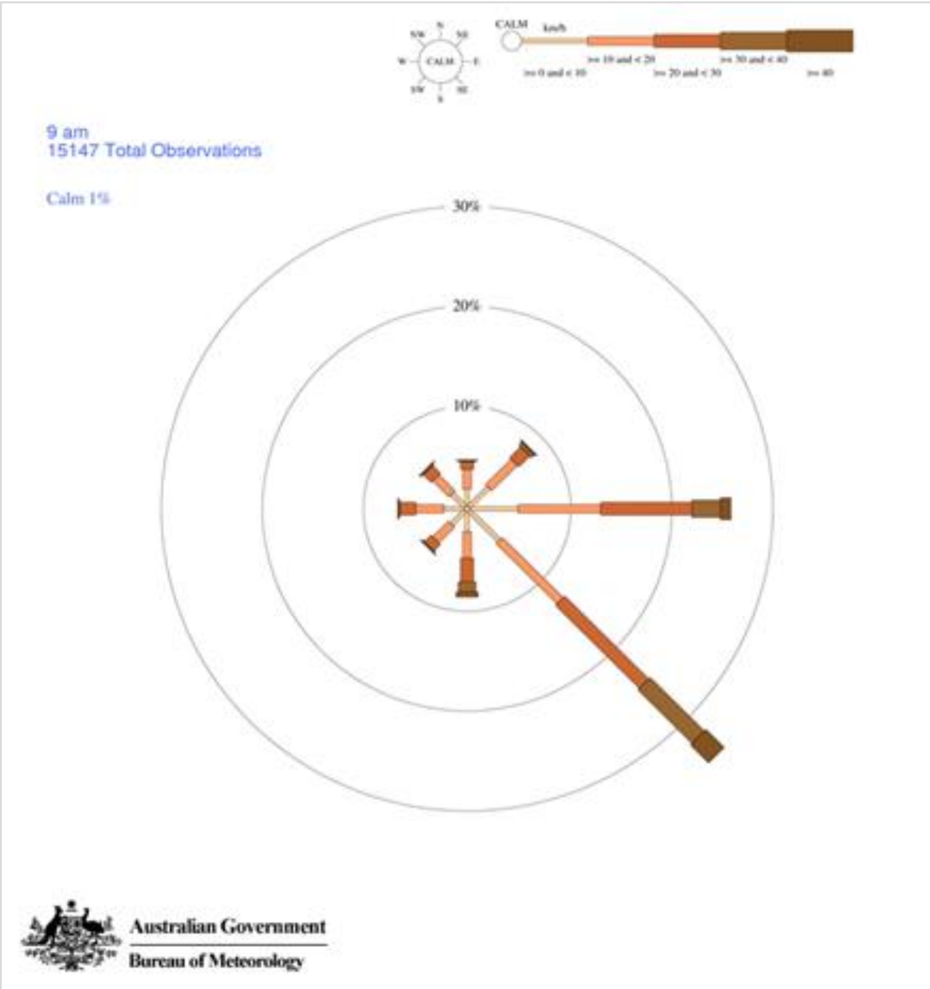


Figure 3.2: Wind Rose (Station No. 013030 – Telfer, BoM 2024).

3.2 Regional Vegetation Mapping

Broad-scale vegetation mapping for the locality has been prepared at the 1:1,000,000 scale based on the work of J.S. Beard for the Pilbara (Beard 1975) and Great Sandy Desert (Beard 1968). The broader Winu Project extends across five pre-European vegetation associations (Beard et al. 2013), one of which occurs within the noise study area, the 'Great Sandy Desert 134', as described below:

> "Great Sandy Desert (134) – Mosaic. Hummock grasslands, open low tree steppe; Desert Bloodwood and Feathertop Spinifex (*Triodia schinzii*) on sandhills / Hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills. Extent remaining 13,595,888 ha."

3.3 Fauna

As described in Section 2.4, multiple fauna and habitat studies have been undertaken in the DE and surrounds since 2018. A consolidation and integration of all relevant fauna data collected in previous surveys was undertaken by Biota (2025a), a summary of which is provided below.

Significant fauna recorded in the DE included:

- Bilby (*Macrotis lagotis*) – BC Act and EPBC Act Vulnerable;
- Grey Falcon (*Falco hypoleucos*) – BC Act and EPBC Act Vulnerable
- Brush-tailed Mulgara (*Dasycercus blythi*) – DBCA Priority 4;
- Northern Marsupial Mole (*Notoryctes caurinus*) – DBCA Priority 4;
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – DBCA Priority 4;
- Dampierland Plain Slider (*Lerista separanda*) – DBCA Priority 2;
- Oriental Plover (*Anarhynchus veredus*) – BC Act and EPBC Act Migratory;
- Oriental Pratincole (*Glareola maldivarum*) – BC Act and EPBC Act Migratory;
- Australian Tern (*Gelochelidon [nilotica] macrotarsa*) – BC Act and EPBC Act Migratory;
- Pacific Swift (*Apus pacificus*) – BC Act and EPBC Act Migratory; and
- Little Curlew (*Numenius minutus*) – BC Act and EPBC Act Migratory.

A further four significant species were recorded in proximity of the DE and are considered likely to occur:

- Northern Quoll (*Dasyurus hallucatus*);
- Spectacled Hare-wallaby (*Lagorchestes conspicillatus*);
- Black-footed Rock-wallaby (*Petrogale lateralis lateralis*); and
- Night Parrot (*Pezoporus occidentalis*).

While and an additional four species classified as may occur:

- Short-tailed Mouse (*Leggadina lakedownensis*);
- Peregrine Falcon (*Falco peregrinus*);
- Princess Parrot (*Polytelis alexandrae*); and
- Barn Swallow (*Hirundo rustica*).

Five rationalised fauna habitats were defined within the DE (Biota 2025a):

- Shrub and Spinifex on Sandplain;
- Inland Sand Dune;
- Gravelly Lateritic Rises;
- Clayey Sandplain with Termitaria;
- Ephemeral Claypan; and
- Disturbed/cleared.

Table 3.1 provides a summary of the significant species recorded on site or considered likely to, or may occur, and their preferred habitat. Figure 3.3 presents the recorded locations for significant fauna at the Project and its surrounds.

As described in Biota (2025a), each habitat type provides fauna values for a range of significant species:

- Shrub and Spinifex on Sandplain

  The dominant habitat of the DE, these broad plains comprised pink to red pindan soils of varied condition and fire history and supported occasional trees over open to moderately dense mixed shrublands, typically dominated by wattles (*Acacia* spp.), over hummock grasslands.

  This represents habitat for Bilby and Brush-tailed Mulgara, and supports a diversity of burrowing species and species with spinifex associations e.g. mammals that forage on seeds, or species that utilise shrubs and spinifex for cover and/or foraging.

- Inland Sand Dune

  Linear features lying perpendicular to the prevailing winds, the substrate of which consisted of red loose sand, with vegetation dominated by low woodlands and scattered trees over mixed acacia low open shrublands and open hummock grasslands.

  Species associated predominantly with this habitat include fossorial species and dune specialists. A fossorial skink, *Eremiascincus pallidus*, which inhabits the loose substrates of dunes, was only recorded from the dune sites. Similarly the sand slider *Lerista vermicularis*, endemic to the Great Sandy Desert where it inhabits crests of sand-ridges, was recorded only from the dune sites. Species such as the Northern Marsupial Mole (*Notoryctes caurinus*) also preferentially occupy this habitat type, particularly interconnected dunes that provide dispersal opportunity. Bilby were recorded on sand dunes where *Acacia monticola* was also present.

- Gravelly Lateritic Rises

  Low rises with a surface of lateritic gravel and pebbles, supporting open hummock grasslands of *Triodia epactia* with a low open shrubland of wattles (*Acacia* spp.), and sparse taller shrubs (e.g. *Grevillea* spp.).

  Species with a preference for rocky substrates, such as Ring-tailed Dragon (*Ctenophorus caudicinctus*) and Rock Ctenotus (*Ctenotus saxatilis*) occupied these areas.

- Clayey Sandplain with Termitaria

  The substrate of these plains comprised clayey sand to a loose depth of 2 cm, with *Acacia bivenosa* shrubland over *Triodia brizoides* open hummock grassland being the dominant vegetation type.

  The clayey sand substrate of this habitat type enabled construction of termitaria by mound-building termites (Isoptera). Vertebrate species that utilise termitaria, such as Pilbara Dtella (*Gehyra pilbara*), Desert Fat-tailed Gecko (*Diplodactylus laevis*), Children's Python (*Antaresia children*) and Black-headed Python (*Aspidites melanocephalus*) were associated with this habitat.

- Ephemeral Claypan

  These open areas are dominated by *Eragrostis* sp. grassland and become seasonally inundated.

  Open habitats such as these may be used occasionally by some migratory birds, such as Oriental Plover (*Charadrius veredus*).

Table 3.1: Significant species recorded, likely to or may occur within the project area (Biota 2025c).

Species Name	Common Name	State	C'wth	Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE**
Mammals						
Macrotis lagotis	Bilby, Dalgyte	VU	VU	*Acacia* shrubland, open tussock grassland.	✓	**Recorded:** Evidence of Bilby recorded throughout DE and in adjacent MIA extension areas, and Rimfire borefield.
Dasycercus blythi	Brush-tailed Mulgara, Ampurta	P4	-	Spinifex grasslands on sandplains and sandy swale between low dunes from south-western Queensland across the Simpson, Tanami, and Great Sandy Deserts of southern and central Northern Territory and central WA	✓	**Recorded:** Diggings, tracks and burrows recorded in MIA and RAC. Suitable vegetated sandplain habitats throughout the DE.
Notoryctes caurinus	Northern Marsupial Mole	P4	-	Vast sandy deserts of central Australia.	✓	**Recorded:** Mole holes observed within the RAC and MIA.
Pseudomys chapmani	Western Pebble-mound Mouse	P4	-	Stony hillsides with hummock grasslands in the central and eastern parts of the Pilbara.	✓	**Recorded:** Records from northwest section of the DE and additional mounds recorded south of there. Occurs in gravelly lateritic habitat within the area.
Dasyurus hallucatus	Northern Quoll	EN	EN	Rocky areas and tall open coastal eucalypt.	-	**Likely to occur:** Scats recorded near the central section of the RAC. Rockpiles provide suitable habitat though none are located within the DE. Likely a transitory visitor only.
Petrogale lateralis lateralis	Black-footed Rock-wallaby	EN	EN	Rockpiles and other rocky habitat providing shelter in the form of caves, cliffs and boulder screes during the day. Habitat critical to survival requires sufficient cave and crevice development to provide shelter from extremes of temperatures and predators.	-	**Likely to occur:** Records are concentrated in two areas outside of the DE in the northeast of the RAC near the diversion. Rockpiles are present near RAC section of the DE. Likely to occur in the DE as a transitory visitor only.
Lagorchestes conspicillatus	Spectacled Hare-wallaby	P4	-	Long unburnt spinifex on sandy or stony plains.	✓	**Likely to occur:** One record of tracks near the western end of the RAC section of the DE.

Species Name	Common Name	State	C'wth	Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE**
Leggadina lakedownensis	Short-tailed Mouse	P4	-	Cracking clay and adjacent habitats.	✓	**May occur:** Clay habitat available in MIA section of the DE and records from the locality.
Reptiles						
Lerista separanda	Dampierland Plain Slider	P2	-	Dune crests and sandy areas.	✓	**Recorded:** Records from RAC and in MIA, both representing a range extension for the species.
Birds						
Anarhynchus veredus	Oriental Plover	MI	MI	Open plains, bare, rolling country, muddy or sandy wastes near inland swamps or tidal mudflats, bare claypans, margins of coastal marshes, grassy airfields, sportsfields, lawns and coastal dune areas.	✓	**Recorded:** Records from RAC and MIA.
Gelochelidon [nilotica] macrotarsa	Australian Tern	MI	MI	Coastlines and estuaries, esp. with tidal flats, larger permanent and ephemeral wetlands inland, open plains (sometimes far from water).	✓	**Recorded**: One record from inside the DE in the MIA.
Glareola maldivarum	Oriental Pratincole	MI	MI	Lightly wooded and untimbered lowland plains that are crossed by major watercourses lined with taller trees or isolated manmade structures such as communications towers.	-	**Recorded:** Observations and audio recordings in RAC with two observations of flocks foraging near RAC.
Pezoporus occidentalis	Night Parrot	CR	EN	Roosting/nesting: widespread long unburnt spinifex with significant structural complexity. Foraging: Floristically diverse run-on areas providing a broad array of grasses and forbs, ranging from small depressions and gilgai formations to large floodplains.	-	**Likely to occur:** Recorded 4 km east of MIA/south of Rimfire. Potential roosting and foraging habitat mapped in close proximity to Rimfire pipeline corridor.
Numenius minutus	Little Curlew	MI	MI	Utilise a range of marine and freshwater, wetland habitats including tidal mudflats, beaches, estuaries, sewage ponds, dams, salt lakes, creeks and freshwater wetlands.	-	**Recorded**: Recorded on four acoustic recording units in the Rimfire borefield and south of Rimfire.
Falco hypoleucos	Grey Falcon	VU	VU	Diverse from rainforest to arid shrublands, from coastal heath to alpine, mainly about cliffs along coasts, rivers and ranges and about wooded watercourses and lakes.	✓	**Recorded:** A single Grey Falcon was observed during sampling for subterranean fauna (Biota 2021b). Suitable foraging habitat present.

Species Name	Common Name	State	C'wth	Preferred Habitat	Habitat in DE?	Likelihood of Occurrence in DE**
Falco peregrinus	Peregrine Falcon	OS	-	Short grassland habitats, including natural short grasslands or recently burnt grasslands, airfields and sports grounds.	✓	**May occur:** Records from the locality but no core habitat in the DE. May occur as a foraging visitor.
Apus pacificus	Pacific Swift	MI	MI	Thought to be almost exclusively aerial in Australia.	✓	**Recorded:** Recorded from within the RAC and the locality surrounding the DE during the AREH (Biota 2022b) survey.
Polytelis alexandrae	Princess Parrot	P4	VU	Sand dunes and sand flats in the arid zone.	✓	**May occur:** No records from the locality and only a small area of suitable habitat present.
Hirundo rustica	Barn Swallow	MI	MI	Open country with low vegetation, often near manmade structures.	✓	**May occur:** Suitable habitat present and some historical records within the locality.

* CR = Critically Endangered; EN = Endangered; VU = Vulnerable; MI = Migratory; P = Priority; CD = Conservation Dependent; OS = Other Specially Protected.
**DE = Development Envelope; RAC = Road Access Corridor; MIA = Mine Infrastructure Area.

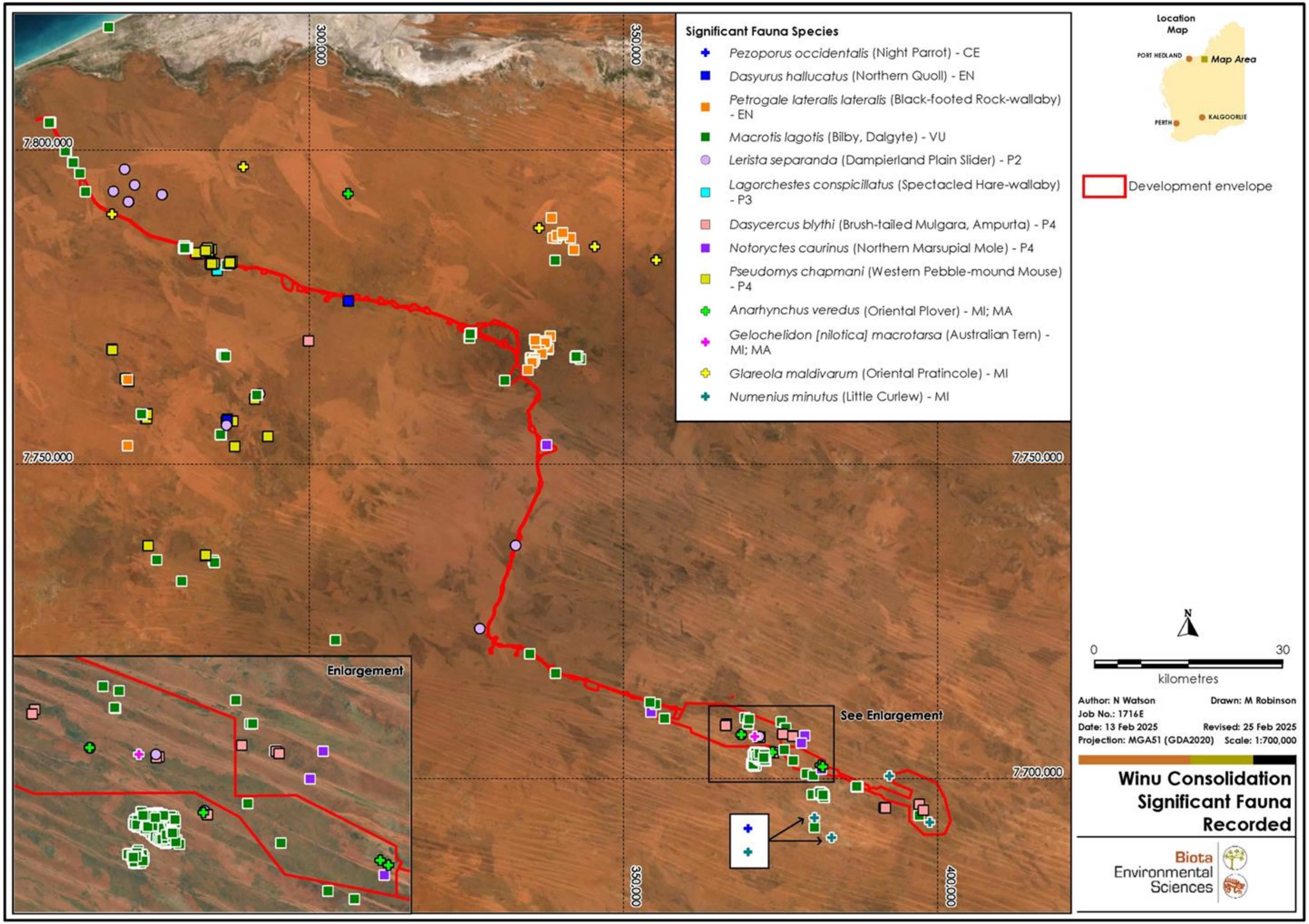


Figure 3.3: Recorded locations of significant fauna records from the development envelope and surrounding locality.

4.0 Predicted Noise Emissions

The Winu Project Referral Supporting document (RTW 2023) identified noise as a potential impact in its risk assessment of environmental and social values.

RTW (2023) noted that increased noise emissions have the potential to disturb fauna and cause an interruption in feeding and resting behaviour, reduced population densities, nest failure, abandonment of habitat area and roost sites and reduced hunting efficiency (Newport et al. 2014). RTW (2023) also noted that noise emissions may also impact on Nyangumarta and Martu amenity (enjoyment and use of Country) and cultural heritage values (e.g. cultural activities, beliefs and stories linked to animals).

4.1 Proposed Noise Emitting Activities

The Conceptual Footprint of the proposed Winu Project is presented in Figure 4.1. Primary noise emission sources for the Winu Project include:

- Operational and construction noise associated with mine activities:
  - All mobile mining fleet;
  - Blasting and excavation operations;
  - Equipment operating at the ROM and Process Plant; and
  - Power generation plant.
- Wind turbine noise associated with Winu Project Wind Farm.
- Operational aircraft noise, in accordance with AS2021:2015.

4.2 Noise and Vibration Assessment

Lloyd George Acoustics (LGA) was commissioned by RTW to assess the potential noise and vibration impacts from the Project, including aircraft and mining operations (LGA 2025a, 2025b). Concurrently, Wood (2025) undertook a noise assessment of the proposed Wind Farm. In all assessments, noise modelling software, SoundPlan Noise 9.0 was utilised to graphically represent the predicted noise levels under worst-case scenarios.

LGA (2025a) also undertook a cumulative noise impact review, incorporating the outcomes from Wood (2025) (RefRpt02-AU02408-Rev0-17 Feb 2025) within the predicted noise emissions from the Airfield and Mine Operations.

For context, the noise modelling considered nearby potential Night Parrot habitat as a sensitive receptor. LGA (2025a) note that as there is no legislated noise or vibration criteria for the Night Parrot, the predicted levels are provided for informative purposes only.

4.2.1 Source Sound Levels and Considerations

4.2.1.1 Mine Operations

Mining noise levels were predicted for the worst-case scenario to ensure a conservative approach to modelling. The source sound power levels for mining operations used in the modelling by LGA (2025a) are provided in Table 4.1.

The modelling scenario is based on all sources operating simultaneously and on RTW provided data and LGA measured database levels (LGA 2025a). Blasting noise and vibration calculations were undertaken using input blasting parameters provided by RTW.

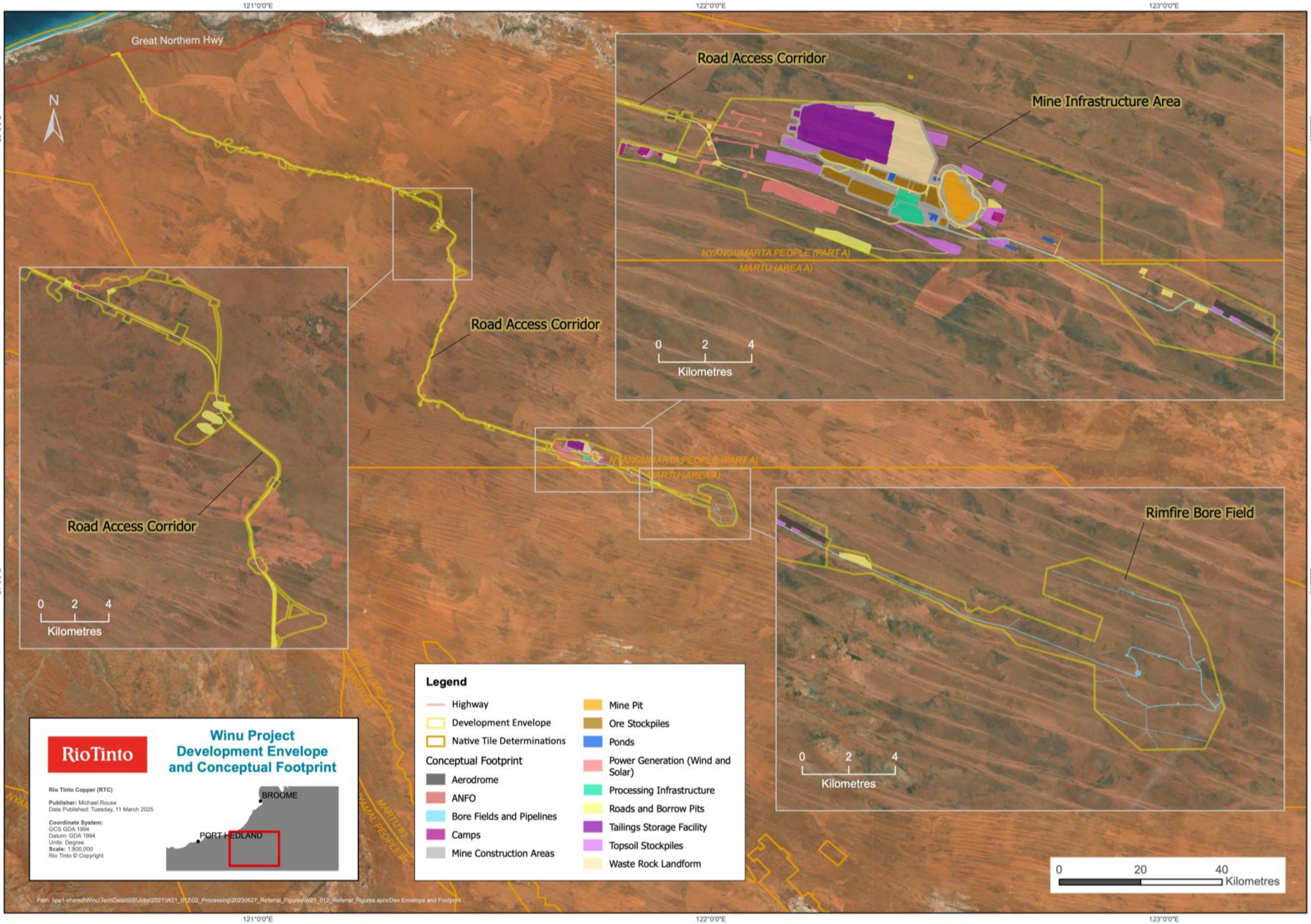


Figure 4.1: **Winu Project conceptual footprint layout.**

The modelling scenario consisted of:

- Mining Fleet (southern most pit area) – teams of pit mining fleet included: one haul truck; two drill rigs; one dozer; two excavators, as well as 21 haul trucks in transit between the pit teams and stockpile.
- Power Plant – 12 diesel generator enclosures at the power station (located adjacent to the process plant).
- Process Plant – The process plant is assumed to have a team of two front-end loaders, screening and crushing plant and a rock breaker.

The modelling scenario is based on all sources operating simultaneously (Table 4.1).

Table 4.1: Sound Source Power Levels, dB (A) (LGA 2025a).

Description	Overall dB(A)
Front End Loader	108
Komatsu 830E Haul Truck	116
CAT 16M Grader	113
Excavator Cat 6040	111
CAT D10 Tracked Dozer	112
Rock Breaker	116
Primary Crusher	113
Secondary Crusher	110
D65 Drilling Rig	116
SAG & BALL Mill	100
CAT Diesel Genset Enclosure	116

4.2.1.2 Airfield

Noise modelling software was used by LGA (2025a) to graphically represent the noise levels from worst-case aircraft projected noise along a 20 km centreline distance and 2.6 km sideline distance in each direction from the proposed Airfield. Departure noise is louder than arrival, therefore all modelling was undertaken assuming departures in either runway direction.

4.2.1.3 Wind Farm

The Wind Farm modelling prepared by Wood (2025) was reviewed and the noise levels from the 4 m/s wind speed scenario were considered appropriate for assessment in combination with other plant noise (LGA 2025a). Above this wind speed, the wind noise itself is likely to mask noise from operations. The following wind turbine configuration was considered as part of the noise modelling for the Wind Farm:

- Turbines: 11 x 7.2 MW;
- Tower Hub Height: 150 m;
- Diameter of Rotor: 172 m;
- Cut-in Wind Speed: 3 m/s;
- Cut-out Speed: 25 m/s; and
- Frequency: 50/60 Hz.

4.3 Noise Modelling Outcomes

4.3.1 Mine Operations

The results for the combined processing plant, power station and pit mining operations are provided in Table 4.2. A noise contour plot is also provided in Figure 4.2, showing noise levels from the Project.

The highest predicted level at the camp is 26 dB L_{A10} which is compliant with the 55 dB L_{A10} outside criteria level by a margin of 29 dB(A). Nearest Night Parrot habitats (roosting) are exposed to a worst-case noise level of 33 dB L_{A10}, with mobile fleet working in the southern areas of the pit and the power station contributing the most to noise levels of 21 dB L_{A10}.

Table 4.2: Mine Operations Overall Predicted Noise Levels, L_{10} dB(A) at sensitive receivers (LGA 2025a).

Receiver	Power Station	Haul Trucks	Mining Fleet*	Processing Plant	Overall
Nearest Night Parrot Habitat - Roosting	28	25	30	17	33
Nearest Night Parrot Habitat - Foraging	16	14	18	5	21
Winu Camp	23	17	21	14	26

*Mining Fleet description provided in Section 4.2.1.1

4.3.2 Airblast Noise and Vibration

Airblast noise and vibration levels have been predicted to the nearest Night Parrot habitat location and the Winu Camp, considered the closest sensitive receptors. The Winu Camp is 12.5 km from the pit and the nearest Night Parrot habitat is 5.6 km away from the pit. A worst-case blast of 265 kg mass would produce 94 dB $_{Z\ Peak}$ and 0.1 mm/s at the nearest potential Night Parrot roosting habitat. Although this habitat location is the closest point to the mine area, the patch is very small and isolated from the larger body of potential habitat to the east - where all confirmed detections have been recorded. The closest confirmed detection site is approximately 16 km from the mine pit. As discussed later in this document, hearing loss and permanent damage is recorded from noise levels exceeding 140 dB(A) for single impulse blasts (Section 5.5.2) and as such the worst-case noise levels predicted at the neared potential Night Parrot roosting habitat (94 dB $_{Z\ Peak}$) is significantly less than levels known to cause significant harm.

At the Winu Worker Camp, the blast would produce 85 dB $_{Z\ Peak}$ and 0.03mm/s, which is readily below compliance levels of 120 dB $_{Z\ Peak}$ (DWER 2021b, LGA 2025a).

4.3.3 Airfield

The aircraft used during mining operations will likely be a Fokker 100 or equivalent. Noise levels are projected up to 20 km along the runway centreline and 2.6 km either side of the centreline in each direction. Outside of these distances the noise contours, although they appear cropped, continue to decay (LGA 2025b, 2025a). Given departure noise is louder than arrival, all modelling was undertaken assuming departures in either runway direction.

The worst-case maximum noise level of a Fokker 100 departure at the nearest Night Parrot habitat (roosting and foraging) is up to 70 dB L_{Amax}. The Winu Camp falls outside of the contour areas, assuming a straight flight path, and therefore impact to the camp is expected to be minimal with a level of < 55 dB L_{Amax}.

The airfield noise will involve daytime only operations with exceptions for emergencies such as RFDS medical evacuations. The noise impacts will also occur infrequently and last a very short duration (10 – 15 seconds). The predicted aircraft movements per day are provided below for construction and operations demonstrating the infrequent nature of these impacts:

- Construction flight requirements are estimated at:
  - 2 flights per day am/pm (i.e. 4 plane movements) – 4 days per week – F100 capacity
  - 3 to 4 small planes (i.e. 8 movements) per week - 9 to 15 seats capacity
- Ongoing operational requirements:

- 3 flights per week (i.e. 6 plane movements) – F100 capacity
- 3 to 4 small planes (i.e. 8 movements) per week - 9 to 15 seats capacity

4.3.4 Wind Farm

Predicted noise levels for the Wind Farm are presented Table 4.3 and are based on wind speeds ranging from 3 m/s to 10 m/s. This assumes that the latter wind speed represents the minimal threshold where the maximum sound power level is applicable, thus maintaining consistent noise emissions for wind speeds beyond this.

As noted earlier, the LGA (2025a) review of the Wood (2025) Wind Farm modelling was based on noise levels from the 4 m/s wind speed scenario, as these were considered appropriate for assessment in combination with other plant noise and aircraft noise. Noise levels from the Wind Farm from 4 m/s wind speed did not exceed 21.5 dB(A) at any of the identified sensitive receptors.

Due to the very low risk of noise from the Wind Farm, impact assessment in later sections of this report (Section 6.0) have combined outcomes from the Wind Farm modelling with the Mine Operations noise assessment.

Table 4.3: Winu Project Wind Farm predicted noise levels at nearest sensitive receivers (Wood 2025).

Location	Noise Level L_{10} dB(A) at Hub Height Wind Speed m/s							
	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
Winu Camp East	19.4	21	22.8	24.6	26.4	28.3	30.1	31.9
Winu Camp North	15.3	16.9	18.6	20.5	22.3	24.1	26.0	27.7
Winu Camp SE	19.9	21.5	23.2	25.1	26.9	28.7	30.6	32.3
Winu Camp West	13.4	15	16.8	18.6	20.5	22.3	24.1	25.9

4.3.5 Project-wide

The cumulative scenario results are summarised in Table 4.4. A noise contour plot is also provided in Figure 4.2 showing noise levels in the vicinity of the Wind Farm and Winu Camp. Predicted noise contours for the Airfield are shown in Figure 4.3.

The results demonstrate that combined with the Wind Farm noise, overall levels at the camp are only likely to increase minimally. According to the Wood (2025) assessment, even at wind speeds of 10 m/s, the noise levels at the camp would not exceed 32 dB(A). It is therefore considered that overall noise levels are well within the compliance target of 55 dBL_{A10} (LGA 2025a).

Table 4.4: Cumulative predicted noise Levels, dB(A) at sensitive receivers (LGA 2025a).

Receiver	Mining Operations	Wind Farm Noise at 4/ms	Overall
Nearest Night Parrot Habitat	35	N/A	35
Winu Camp	26	22	27

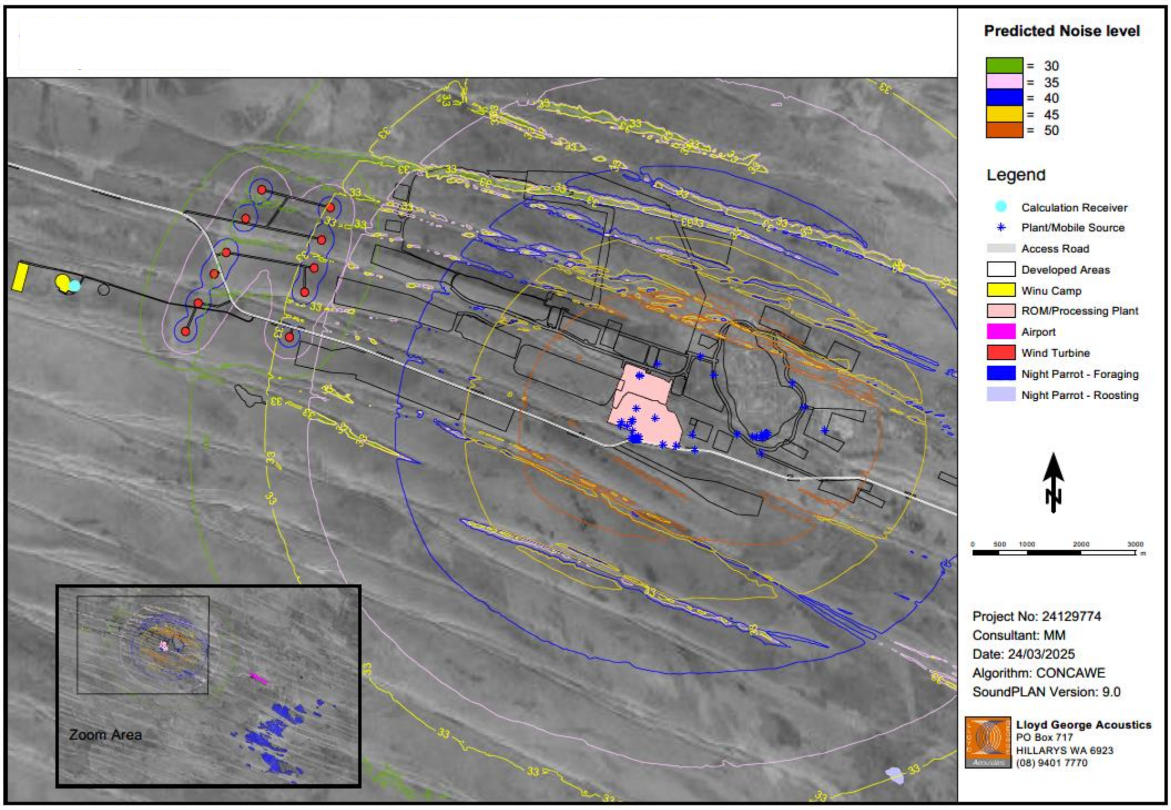


Figure 4.2: All mining operations and Wind Farm at 4 m/s dBL$_{A10}$ (Source: LGA 2025a).

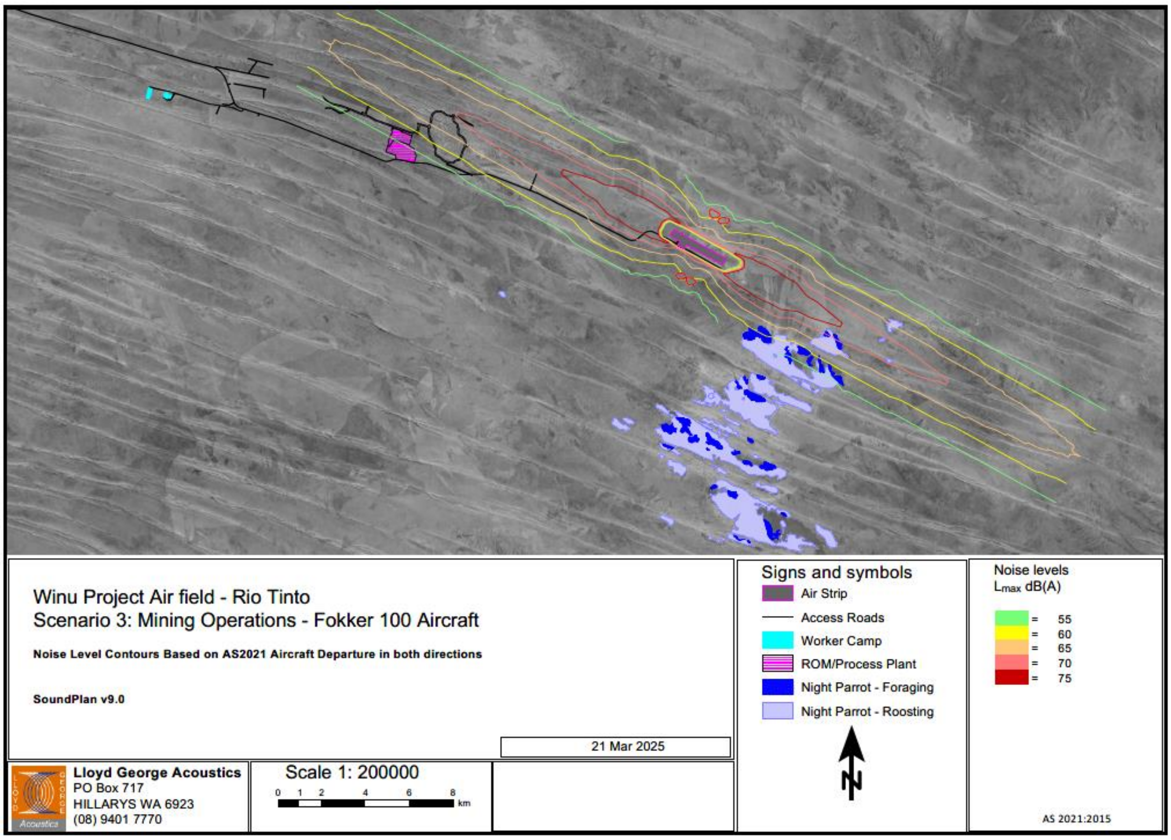


Figure 4.3: Winu Project Airfield noise (dBL$_{Amax}$) relative to Night Parrot habitat (Source: LGA 2025a).

5.0 Literature Review: Noise Impacts on Fauna

5.1 General Impacts

Many studies have investigated the effects of anthropogenic noise on fauna and biodiversity (including, but not limited to Dooling et al. 2000, Brumm 2004, Dooling and Popper 2007, Francis and Barber 2013, Newport et al. 2014, Blanchett et al. 2020, Carral-Murrieta et al. 2020, Sordello et al. 2020, Erbe and Thomas 2022, Arcangeli et al. 2023).

In one such meta-review, Sordello et al. (2020) screened almost 1,800 articles, finding overwhelmingly, that the majority of studies have concentrated on mammals and the effect of noise on behaviour (Table 5.1). Conversely, limited studies are available for certain species and taxonomic groups (amphibians, reptiles, invertebrates), types of noise (recreational, military, urban) and specific impact pathways (space use, reproduction, ecosystems).

Table 5.1: Taxonomic groups and types of impacts in studies in the literature (Source: Sordello et al. 2020).

Description	Behaviour	Bio Physiology	Communication	Ecosystem	Reproduction	Space Use
Mammals	355	181	95	68	18	42
Fishes	159	149	20	32	28	15
Birds	139	76	144	68	93	42
Crustaceans	23	24	-	6	3	2
Amphibians	15	18	27	10	15	3
Reptiles	15	8	-	6	1	1
Molluscs	13	19	-	5	0	2
Insects	11	8	10	5	7	-
Other vertebrates	3	-	-	-	-	-
Other invertebrates	2	6	-	3	-	2
Arachnids	1	0	1	1	-	0

The predominant conclusion of all previous studies is that exposure of fauna to noise can have negative repercussions, which vary in severity, depending on the species, individual traits (age, sex etc.) and the noise source. Field and laboratory research, as well as numerous systematic literature reviews, generally identify four main ways in which fauna are adversely affected by noise pollution:

- Injury (permanent and temporary hearing loss);
- Behaviour response (alternations in movements, foraging and reproduction etc.);
- Masking (inability to hear important environmental and animal signals); and
- Physiological stress response (increased heart rate, changes in breathing patterns etc.).

A generalised view of the potential negative effects of anthropogenic noise on fauna, with increasingly severe effects closer to the noise source, is presented in Figure 5.1.

At distance from the noise source, fauna may experience only mild, temporary annoyance, temporary avoidance of an area, or masking effects. Fauna closer to a significant noise source can experience injury and behavioural changes in the use of important feeding or breeding areas.

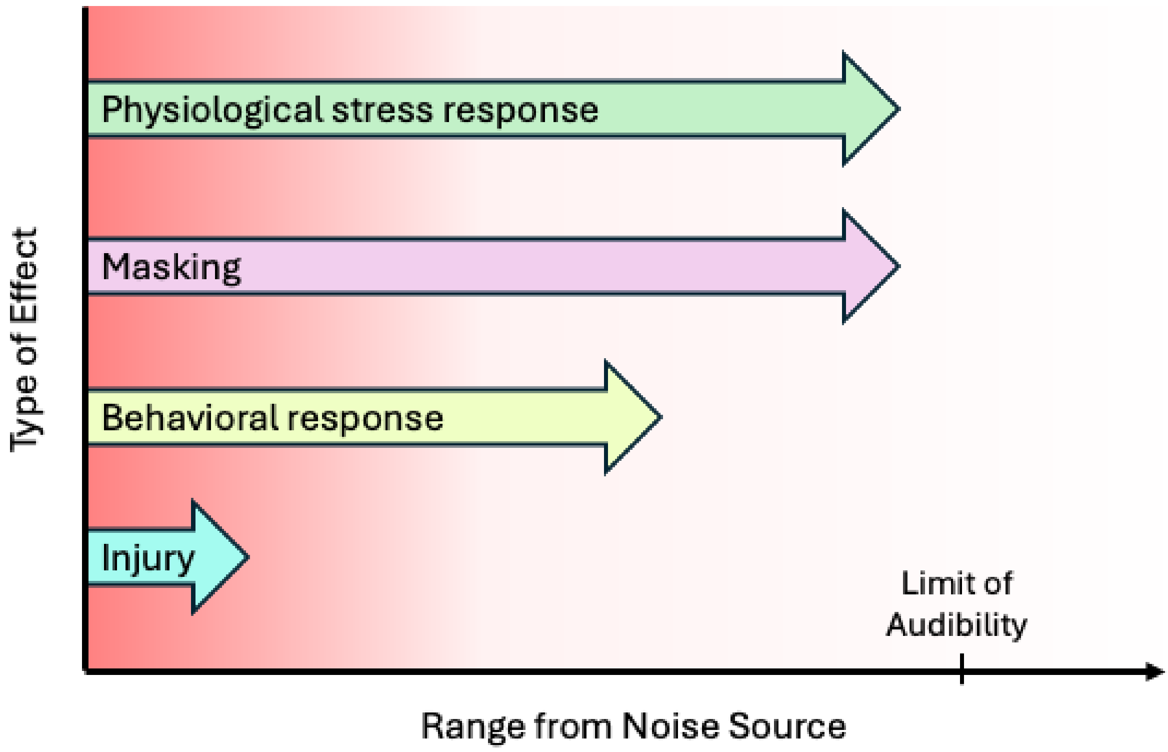


Figure 5.1: Generalised ranges from a noise source, at which different types of impact may occur (Source: Erbe and Thomas 2022).

5.1.1 Injury

For high levels of noise exposure, fauna may incur injury (acoustic trauma) to tissues and organs, such as damage to ear bones, lungs, kidney or gonads (Popper et al. 2014). Permanent or temporary hearing loss can also result from long-term exposure to a significant noise source (Dooling and Popper 2007, Francis and Barber 2013). Laboratory studies and field research have identified hearing loss, with noise levels of 85 Decibel or higher (Arcangeli et al. 2023).

5.1.2 Behaviour

Noise greatly influences behaviour, which in turn impacts survival and can lead to physiological stress that may compromise individual and population fitness (Francis and Barber 2013). Most noise-related impacts involve four behavioural responses, as further described below:

- changes in temporal patterns,
- alterations in spatial distributions or movements,
- decreases in foraging or provisioning efficiency coupled with increased vigilance and anti-predator behaviour, and
- changes in mate attraction and territorial defence.

5.1.2.1 Temporal Patterns

Changes in temporal patterns results in a disruption in normal behaviour routines (Francis and Barber 2013).

For example, animals in noisy environments are known to alter their feeding/foraging times to coincide with lower noise emissions, which can potentially influence foraging efficiency. Equally, changes in the calling times (for mate attraction) to periods when noise levels are lower can disrupt signaler–receiver coordination between singing males and responsive females, which may ultimately affect reproductive success.

5.1.2.2 Spatial Distribution

The most obvious response to noise is site avoidance or abandonment, resulting in a decrease in spatial abundance (Kok et al. 2023; Francis and Barber 2013). Social animals, where group living provides protection from predation, are more prone to site abandonment, with the loss of individuals increasing predation risk for the group and losing the benefit of safety in numbers. Depending on population structure and the scale at which individuals are displaced by noise, genetic diversity may also be reduced in local populations (Francis and Barber 2013)

Despite the known effects of noise on population sizes, there is still considerable evidence to suggest that animals may abandon areas where frequent or chronic noise stimuli interfere with cue detection or when more variable sounds are perceived as threats. Birds with low-frequency vocalisations experience more acoustic interference from chronic low-frequency anthropogenic noise, and therefore exhibit stronger negative responses to noise in their habitat use, than birds with high-frequency vocalisations that experience less acoustic interference (Francis and Barber 2013). For context, Night Parrot calls typically fall in the range of about 1.6 to 3.5 kHz, so would likely be higher frequency than typical low-frequency anthropogenic noise (*J. Graff pers comm, 8 May 2025*).

5.1.2.3 Foraging Efficiency and Vigilance

Francis and Barber (2013) found that noise can impair foraging and provisioning rates directly or indirectly because of increased vigilance and anti-predator behaviour. When noise is perceived as a threat, an organism may miss foraging opportunities while hiding or maintaining increased vigilance.

5.1.2.4 Mate Attraction and Territorial Defence

The most direct way in which noise may alter an individual's ability to attract mates or defend its territory is if potential receivers are simply unable to hear another individual's acoustic signals during important signalling windows. To adapt to noisy conditions, animals are known to change acoustic signals to successfully communicate (Francis and Barber 2013).

5.1.3 Masking

Masking communication signals occurs when the signal level received is below, or masked by, the ambient noise environment.

The ambient noise environment effectively increases the threshold of detection of a communication signal above the absolute threshold of hearing. This limits the distance over which communication between animals can take place. Masking caused by traffic noise may therefore potentially impact communication and behaviour.

In birds, a simple measure of the ability of the bird ear to detect a sound amongst background noise is the critical ratio. The critical ratio is determined by measuring the detection threshold of a pure tone in the presence of broadband ambient noise, and typically varies with frequency (Dooling et al. 2000). A higher critical ratio means that the pure tone must be of a higher level above the background noise to be detected.

Species with a high critical ratio are therefore more susceptible to auditory masking than species with a low critical ratio. Dooling et al. (2000) measure the critical ratios for fourteen bird species, including songbirds, non-songbirds, and nocturnal predators and compared the median critical ratio curve for these species with median critical ratio of humans (Figure 5.2). The critical ratio for the typical bird is about 6 dB greater than in humans in the bird communication range of 1 to 5 kHz (Dooling and Popper 2007).

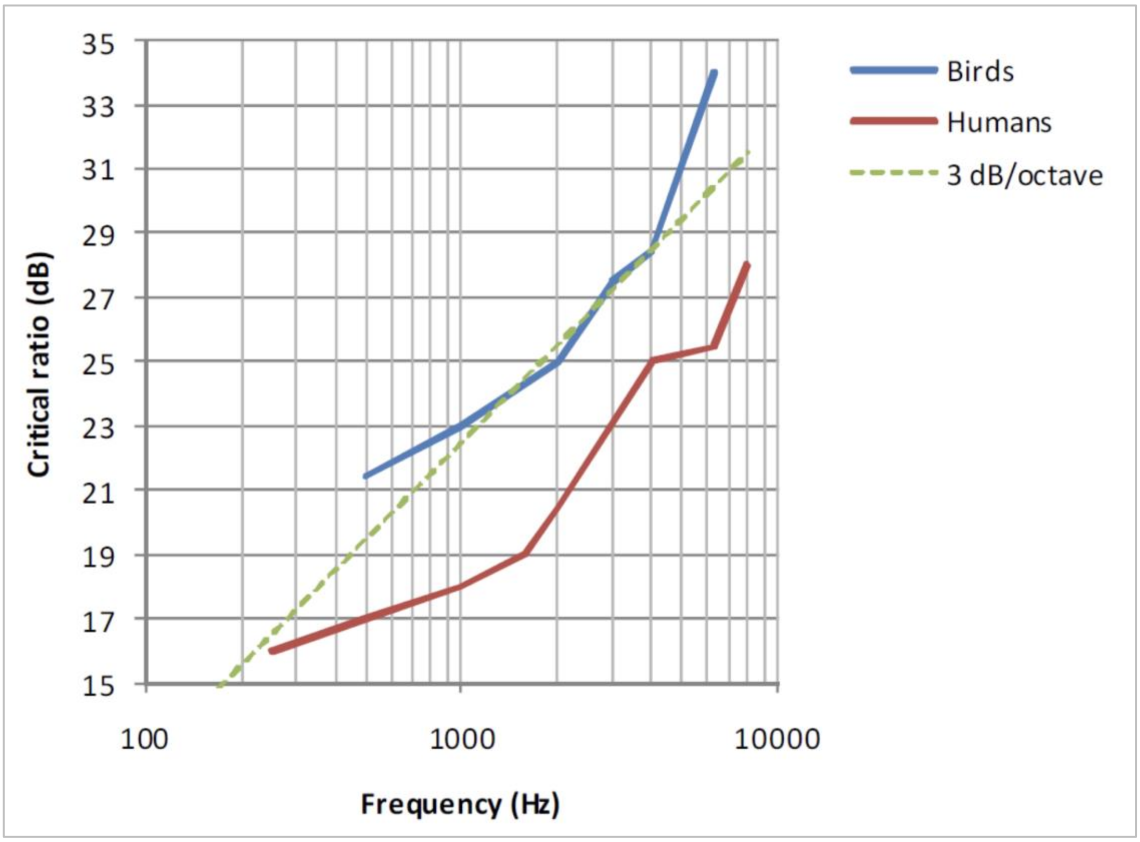


Figure 5.2: The median critical ratio for the typical bird based on data for 14 bird species compared to humans (Dooling and Popper 2007).

At a frequency of around 3 kHz, a bird communication signal needs to be about 27 dB higher than the spectrum level of the background noise to be detectable by another (typical) bird. For humans, the level of the pure tone must be about 21 dB higher to be detectable at this frequency. As a simple rule-of-thumb, the critical ratio in birds is about 6 dB higher than in humans in the vocalization range of birds. This fact has both positive and negative implications:

- Positive implication – humans hear noise from a heavily trafficked road at distances four times greater than birds. This is because noise from busy roads generally decreases by 3 dB as distance doubles.
- Negative implication – the distance over which communication between two birds can occur is halved in comparison to humans. Using a human listener to determine whether birds can hear a sound amongst background noise will therefore underestimate the masking effect of noise on bird communication.

5.1.3.1 Adaptation to Noise Masking

Dooling and Popper (2007) found that birds can adjust the characteristics of their vocalisations in response to temporary changes in background noise. Several species of birds have been shown to raise the level of their vocal output by as much as 10 dB in the presence of moderate background noise which is loud enough to affect the bird's perception of its own vocalizations (Osmanski and Dooling 2006). This demonstrates that birds have some short-term control over the pitch of their vocalizations and may use this ability to maximise information transfer in a noisy environment.

There is also evidence of birds using repetition to increase the efficiency of signal transmission (Lengagne et al. 1999). It is also well known that birds can adjust the timing of their vocalisations to avoid competition for acoustic space with other species or to coincide with low noise periods to prevent auditory masking (Cody and Brown 1969, Wasserman 1977, Popp and Ficken 1987, Evans 1991).

5.2 Population Scale Consequences

Whether the effect of noise is auditory, behavioural or physiological, individual animals respond in different ways to different noise ranges. Chronic and frequent noise interferes with an animals' abilities to detect important sounds, whereas intermittent and unpredictable noise is often perceived as a threat. Ultimately, these effects can lead to a reduction in animal fitness, which can have flow on consequences at a population and ecosystem level (Francis and Barber 2013, Newport et al. 2014).

To understand the link between noise exposure and population impacts, the National Research Council (2005) developed a population consequences of acoustic disturbance model (PCAD). The impact pathway is grouped into five stages and four transfer functions (Erbe and Thomas 2022) (Figure 5.3). The original model was further refined and restructured to clarify the linkages between behaviour and physiology and their multiple access points to acute and chronic effects, resulting in changes in the broader population dynamics (New et al. 2014) (Figure 5.4).

As the updated population consequences of disturbance model shows (Figure 5.4), longer-term impacts are measured by changes in the animals' health, which may eventually affect reproductive success and survival, which in turn may affect population status and trends.

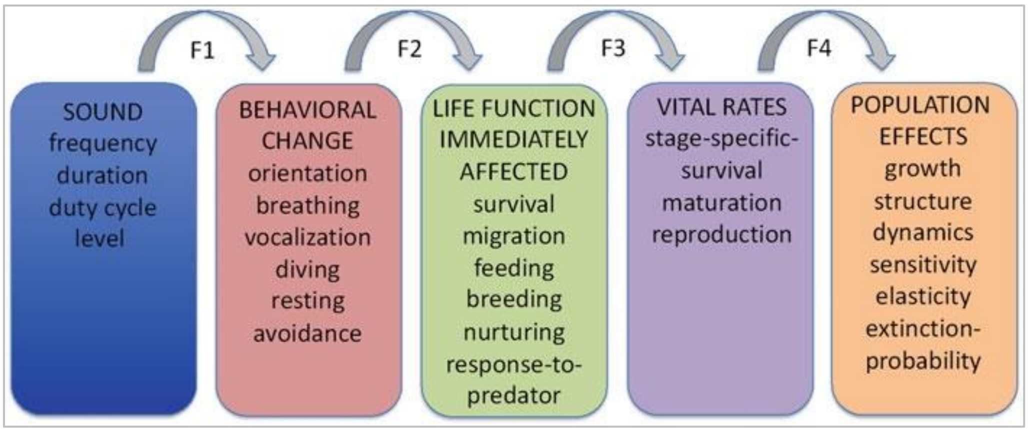


Figure 5.3: Population Consequences of Acoustic Disturbance (PCAD) model (National Research Council 2005), which links noise exposure from individual to population-level consequences via a series of stages, connected by transfer functions (Source: Erbe and Thomas 2022).

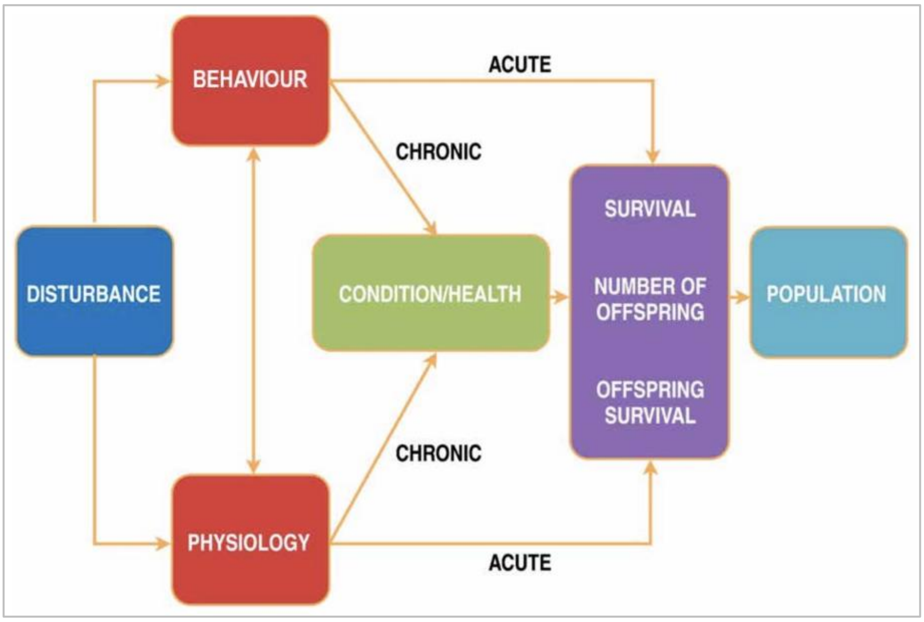


Figure 5.4: Updated Population Consequences of Disturbance model (Source: (New et al. 2014, Erbe and Thomas 2022).

5.3 Fauna Group Impacts

5.3.1 Terrestrial Invertebrates

Anthropogenic noise may impact insects in various ways. It can mask communication signals, increase stress, affect larval development, and ultimately decrease lifespan (reviewed by Raboin and Elias 2019, in Erbe and Thomas 2022).

Strong anthropogenic noise can result in hearing loss and stress. In a study described in Erbe and Thomas (2022), auditory receptors in the locust ear showed a decreased ability to encode sound after noise exposure. Erbe and Thomas (2022) also noted a series of experiments conducted to determine whether exposure to simulated road traffic noise induces increased heart rates, as an indicator of a stress response (Davis et al. 2018, in Erbe and Thomas 2022). Larvae of the monarch butterfly (*Danaus plexippus*) exposed for 2 hours to road traffic noise experienced a significant increase in heart rate, indicative of stress.

5.3.2 Reptiles

Little literature exists on the impacts of anthropogenic noise on terrestrial reptiles.

Not all reptiles produce sound for communication. Most reptiles can detect substrate-borne vibrations and low-frequency sound (Barnett et al. 1999; Christensen et al. 2012). The auditory anatomy of most reptile species includes a tympanic membrane near the rear of the head, a middle ear with a stapes, and a fluid-filled inner ear housing the lagena and its sound-sensing cells (Wever 1978). Brittan-Powell et al. (2010) indicated that reptile hearing is similar in frequency range to hearing in birds and amphibians. The most sensitive lizards have similar absolute sensitivities to birds.

5.3.3 Amphibians

Frogs rely heavily on acoustic communication for mating. Noise has been shown to alter both the production and perception of frog vocalisations. This can have serious implications for reproduction in these animals. Males that do not call as often will not attract females to their locations along a pond edge. Females that do not hear calls from the males will not be able to localise or approach them (Erbe and Thomas 2022).

Studies have been conducted in both the laboratory and the field to determine the effects of noise on acoustic communication in frogs, for both vocal production and auditory perception (Erbe and Thomas 2022). The amphibian inner ear contains two papillae, known as the amphibian papilla, which responds to lower frequencies, and the basilar papilla, which responds to higher frequencies. Audiograms show good sensitivity between 100 Hz and a few kHz (Megela-Simmons et al. 1985). Some species, however, exhibit sensitivity also to ultrasound (Narins et al. 2014), and others to infrasound (Lewis and Narins 1985).

5.3.4 Birds

Birds rely heavily on acoustic communication for numerous ecological behaviours such as warning others about predators, finding and assessing the quality of mates, defending territories, and discerning which hatchling to feed. When environmental noise levels are high, such behaviours become difficult or impossible, unless the birds can make temporary or permanent adjustments to their signal, posture or location.

Several studies have demonstrated that some birds are affected by low-frequency (<3 kHz) anthropogenic noise from roadways (reviewed by Reijnen and Foppen 2006, Goodwin and Shriver 2011).

Urban noise is known to affect reproduction and mating behaviours of birds in several ways. Urban noise can mask acoustic components of the lekking display by male greater sage grouse (*Centrocercus urophasianus*, Blickley and Patricelli 2012). It also disrupts female preference for low-frequency songs sung by male canaries (des Aunay et al. 2014) and great tits (Halfwerk et al. 2011).

Females of these (and other) species prefer males that sing lower-frequency songs over those that sing higher-frequency songs because the low-frequency songs are sung by males of higher quality (e.g. Gil and Gahr 2002). When low-frequency urban noise masks the low-frequency components of calls and songs, females either cannot detect or find the males that are singing or cannot discriminate between the high-quality males singing at low frequencies and the poorer-quality males singing at higher frequencies.

An extensive study conducted in the Netherlands found that 26 of 43 (60%) woodland bird species showed reduced numbers near roads (Reijnen et al. 1995). Another count of birds near and far from roads showed that even when habitats were similar, the number of birds in each area increased with increasing distance from the road (Polak et al. 2013).

One major advantage that birds possess, compared to humans, is the ability to regenerate auditory sensory cells lost during exposure to very loud sounds (Ryals and Rubel 1988), therefore birds experience no hearing loss over time from either aging or noisy environments. Birds do, however, experience stress from noise (Blickley et al. 2012; Strasser and Heath 2013).

Looking at noise levels in birds, Brumm (2004) found that, in songbirds, the level of environmental noise in a territory will contribute to its quality and thus considerably affect the behavioural ecology of singing males. Analysis of sound pressure levels revealed that males at noisier locations sang with higher sound levels than birds in territories less affected by background sounds. The study considered high background noise levels to be based on a median value of 57 dB(A) and low background noise levels as sites with a median value of 45 dB(A). The study also revealed that the songbirds themselves emit high noise values within short distances, with the male holding the territory that was least affected by environmental noise singing with a median sound level of 77 dB(A) (in 1 m distance). In contrast, the bird singing in the noisiest territory produced its songs on the average with more than 91 dB(A) to help maintain the distance in which other conspecific can perceive their songs (Brumm 2004). Furthermore, elevated noise in excess of 75 dB also tended to increase the frequency of flight (Wang et al. 2022).

In a similar study, Carral-Murrieta et al. (2020) conducted a point-count survey, measuring noise levels and bird surveys at each point. The survey of 82 bird species across a range of noise values (from 33 dB(A) to 97.6 dB(A)) found that bird detection probability decreases in sites exceeding approximately 45 dB(A).

Industry noise sources have also been assessed, with Habib et al. (2007) examining pairing success and age distribution of male ovenbirds (*Seiurus aurocapilla*) in the boreal forest in areas around noise-generating compressor stations compared with areas around habitat-disturbed, but noiseless, well pads. This study found a significant reduction in ovenbird pairing success at compressor sites (77%) compared with noiseless well pads (92%). These differences were apparent regardless of territory quality or individual male quality. The study concluded that noise interferes with a male's song, such that females may not hear the male's song at greater distances and/or females may perceive males to be of lower quality because of distortion of song characteristics.

In some studies, no effects from noise on birds were detected. In measuring noise levels at varying distances from the highway, at sites exposed to construction and traffic noise, Long et al. (2017) assessed acute behavioural responses to highway construction noises. The study found no differences in warbler territory placement, productivity, behaviour, or song characteristics that could be attributed to highway construction or traffic noise, with no evidence to suggest that highway construction or traffic noise had a negative effect on warblers. Mean noise levels were 54 dB(A) ± 8 SD in the construction site and 53 dB(A) ± 6 SD in the traffic noise site. Mean maximum noise levels were 67 dB(A) ± 8 SD in the construction site and 66 dB(A) ± 7 SD in the traffic noise site. However, the results of a playback study where birds were exposed to recordings of construction noise at ~80 dB(A) suggest that the noise would have to be close and much higher than levels typically recorded at construction sites (e.g. 90 dB(A)).

Dooling et al. (2000) conducted a review of the available studies on noise-induced hearing damage in birds. The review concluded that continuous noise levels between 93 and 110 dB(A) may cause temporary injury, with higher levels possibly resulting in permanent injury. For impulsive noise, such as piling or blasting noise, levels above 140 dB(A) for single pulses or 125 dB(A) for multiple pulses were estimated to cause hearing damage. Traffic noise levels near highways do not normally exceed the exposure criteria for noise-induced hearing damage in birds. As such, hearing damage is only a potential impact during the construction phase of a road project.

5.3.5 Mammals

In an experiment by Akefe et al. (2006), the exposure of rats to noise, induced significant neurobehavioural deficits and the appearance of oxidative stress. Manukyan et al. (2020) showed that mice exposed to noise over 90 dB for 60 days show higher levels of anxiety, alterations in orientation.

Increased activity at the level of the inferior colliculus was noted in pigs 4–12 hours after the administration of a strong acoustic stimulus (124 dB) in the cochlea (Mulders and Robertson 2013). This was also reported in mice exposed to over 110 dB for one hour (Longenecker and Galazyuk 2016), resulting in hyperactivity and agitation.

Disturbing acoustic stimuli can affect cognitive abilities, with Wieczerzak et al. (2021) finding that noise exposure impaired spatial learning, reference memory and stimulus–response habit learning, whereas cognitive flexibility tasks and reversal learning were unaffected.

Ghadirian et al. (2019) found that field surveys of the Persian gazelle showed that most populations responded to noise pollution by preserving distance from high-level noise (>40 dB) regions, indicating that high-level noise-affected habitats of Persian gazelle have been functionally lost.

Investigations into the consequences of bats experiencing exposure to noise from mining and exploration activities is limited. The grey literature from the Pilbara, documented in Bat Call WA (2021), suggests that Ghost Bats and other bat species may become accustomed to noise emissions, continuing to depart the roost and transit to foraging areas in a typical manner (for example, ongoing ghost bat presence nearby open cut mines such as Robe Valley Mesa A, Cattle Gorge, Mining Area C and Mt. Whaleback; author's unpublished observations, cited in Bat Call WA 2021). Bat Call WA (2021) note that very loud continuous noise more than 100 dB(A) may alter this result.

5.4 Vibration

Little data exists on the impact of vibration on fauna. North American hibernating bats are reported to be able to withstand vibration levels up to 5 mm/s without adverse effects (WVDoEP 2006). Sound and vibration have also been studied in various bats in the Pilbara (Bat Call WA 2010, Biota 2013, Bullen and Creese 2014).

During exploration drilling, Bullen and Creese (2014) found vibration levels up to 1 mm/s in combination with sound level of 70 dB(A) did not cause the Ghost Bats present to exit the cave and subsequent monitoring showed no adverse effects. Bullen (2013) also noted that no ill-effects on an Orange Leaf-nosed Bat colony from blasting where blast charge and distance from the colony remain below vibration levels of 10 mm/s.

5.5 General Threshold Guidance

Almost all terrestrial environments are not inherently silent, with noises of a geophysical nature (such as rain, wind, storm or cyclone events) and others of a biological nature (such as those produced by numerous animal species). Background of ambient noise, typical of a quiet suburban area would suggest noise guidelines in the range of 50-60 dB(A).

5.5.1 Noise Effects Guidelines (Dooling and Popper 2007)

Historical guidelines suggest that noise levels of about 60 dB(A) begin to affect behaviour. However, new data reviewed by Dooling and Popper (2007) suggests that a lower noise level guideline of 55 dB(A) is safer and more realistic. Dooling and Popper (2007) also suggest interim compliance guidelines (Table 5.2) using data from both the laboratory and the field, to address potential impacts of noise on bird species.

5.5.2 Noise Response Framework (Shannon et al. 2016)

Furthermore, Shannon et al. (2016) conducted a systematic review of scientific literature to identify the noise levels that elicit biological responses. This study aimed to integrate information on wildlife responses to noise into a common framework to assist with predicting potential outcomes of noise exposure and implementing meaningful thresholds and mitigation measures.

The framework developed was based on a subset of studies shortlisted by Shannon et al. (2016), which documented both a significant response to a noise stimulus and an associated acoustic value from that response. The studies spanned a wide range of species, noise responses and acoustic metrics. Noise levels from these studies were then sorted to produce a 'cumulative weight-of-evidence curve' as a function of the noise level at which a biological response was documented (Figure 5.5). Note, while it was not possible to adjust all values to a common acoustic metric across all studies, the various metrics used in each study were presented separately.

The study found that terrestrial wildlife, responses begin at noise levels of approximately 40 dBA, with 20% of papers documenting impacts below 50 dBA.

To provide insight into the relative effects of noise on wildlife compared to human tolerance, the cumulative curve was also compared against human responses to noise (ANSI, 2005). Despite the heterogeneity in the wildlife noise metrics and responses, the range of noise levels documented to induce annoyance in humans and responses in terrestrial wildlife are similar (40–100 dB).

Outcomes from the Shannon et al. (2016) review, summarising noise levels and biological responses are summarised in Table 5.3.

Table 5.2: Recommended interim guidelines for potential effects from different noise sources (Source: Table 3 of Dooling and Popper 2007).

Noise Source/Type	**Noise related impacts**			
	Hearing damage	**Temporary Threshold Shift**	**Masking**	**Behaviour/ physiological effects**
	Hearing loss due to permanent damage to the delicate inner ear sensory hair cells.	Temporary damage, with inner ear sensory hair cells able to regenerate	Interference with the detection of one sound by another, masking communication signals between individuals or groups.	Effects of noise on breeding biology, survival of eggs/ young, stress level effects, foraging behaviour, distribution patterns etc.
Single Impulse (e.g., blast)	140 dB(A)[1]	NA[3]	NA[7]	Any audible component of noise has the potential of causing behavioural and/or physiological effects independent of any direct effects on the auditory system or masking
Multiple Impulse (e.g., jackhammer, pile driver)	125 dB(A)[1]	NA[3]	ambient dB(A)[5]	
Non-Strike Continuous (e.g., construction noise)	None[2]	93 dB(A)[4]	ambient dB(A)[5]	
Highway Noise	None[2]	93 dB(A)[4]	ambient dB(A)[5]	
Alarms (97 dB/100 ft)	None[2]	NA[2]	NA[6]	

[1] Estimates based on bird data from Hashino et al.1988 and other impulse noise exposure studies in small mammals.
[2] Noise levels from these sources do not reach levels capable of causing auditory damage and/or permanent threshold shift based on empirical data on hearing loss in birds from the laboratory.
[3] No data available on TTS in birds caused by impulse noises.
[4] Estimates based on study of TTS by continuous noise in the budgerigar and similar studies in small mammals.
[5] Conservative estimates based on the addition of two uncorrelated noises. Above ambient noise levels, critical ratio data from 14 bird species, well documented short term behavioral adaptation strategies, and a background of ambient noise typical of a quiet suburban area would suggest noise guidelines in the range of **50—60 dB(A)**.
[6] Alarms are non-continuous and therefore unlikely to cause masking effects.
[7] Cannot have masking to a single impulse.

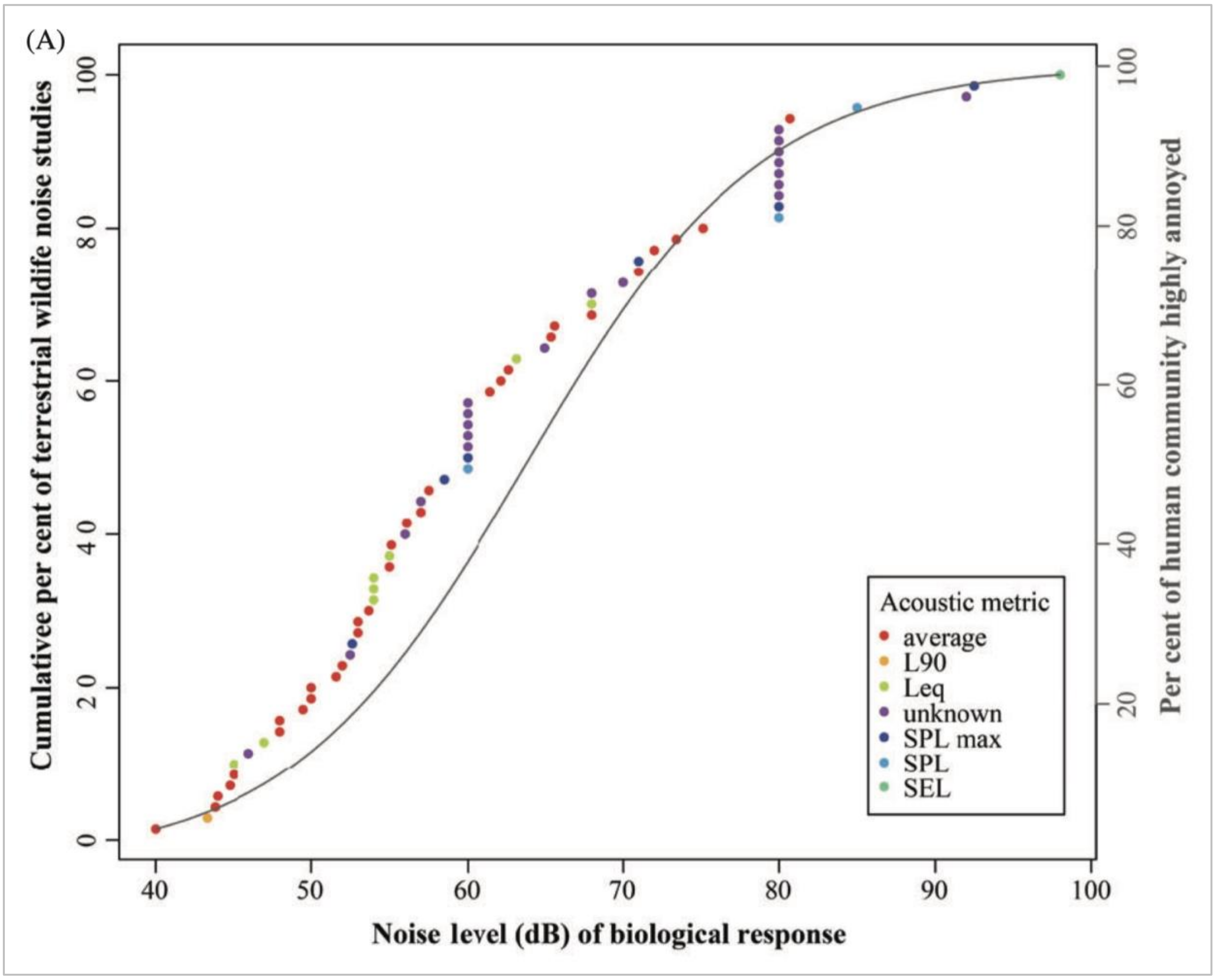


Figure 5.5: **Biological response to different noise source categories (Source: Table 3A of Shannon et al. (2016)).**

Table 5.3: Biological responses to different noise-source categories by terrestrial taxa. (Source: Table 5 of Shannon et al. (2016). Studies in this table are included in Figure 5.5.

Animal group	Environmental	Acoustic value	Transportation		Industrial		Military	
Birds	Changes in frequency components of vocalisations [1–22]	44–73 dBA # 54 dBA ** 60 dBA 59 dBA †* 53–80 dBA ?	Changes in frequency components of vocalisations [33–35]	60–65 dBA ? 50 dBA #	Changes in song frequency and length [53]	45 dBA **	Increase in vigilance and alert behaviour [64, 65]	63 dBA ** 80 dBA †
	Changes in call rate and duration [14–18]	60 dBA* 48 – 66 dBA # 57 dBA ?	Increase in amplitude of vocalisations [36]	57 dBA #	Increase in physiological stress levels [54]	52 dBA #		
	Shifts in timing of vocalisations [24]	63 dBA #	Preference for roosting in quieter areas [38]	47 dBA **	Decline in occupancy and abundance [56 – 58]	48 dBA # 55 dBA # 45 dBA #		
	Decreases in acoustic complexity of songbird community [25]	53 dBA †	Reduction in reproductive success in presence of road noise [39]	68 dBA ?	Changes in community and species interactions [59, 60]	60 dBC ? 50 dBC #		
	Decline in species diversity [26, 27]	40 dB $# 45 dBA *	Effects on physiology and development [40]	60 dBA †				
	Avoidance of noisy environments [28]	70 dBA ?	Changes in abundance, species richness, distribution and occupancy [41 – 43]	46 dBA ? 45 dBA # 55 dBA **				
	Decline in reproductive success [29, 30]	58 dBA * 43 dBA * **						
Mammals	Shifts in call frequency and amplitude for echolocating bats [31]	80 dB $	Disruption of foraging in gleaning bats [44, 45]	80 dBA	Increase in physiological stress from construction noise [61, 62]	52 dBL # 92 dBA ?	Short– term increase in heart rates and shifts in resting and movement behaviours of ungulates [66 – 68]	85 dB $* 98 dBA ‡ 92 dB $†
					Reduced reproductive efficiency of laboratory mammals exposed to construction noise [63]	68 dBA **		
Reptiles and amphibians	Shifts in energy distribution of cicada's songs towards higher frequency [32]	62 dBC #	Reduction in chorus tenure and duration by male anurans exposed to traffic noise [46 – 48]	72 dBA # 60–80 dBC ?	-		-	
			Difficulty locating mates [49]	75 dBC #				
			Increased minimum frequency of vocalisations [50]	60 dBA?				
			Change in calling time [51]	71 dBC †				
Invertebrates			Higher frequency components in courtship signal of grasshoppers [52]	81 dBA ?				

Symbols: * sound pressure level (SPL); ** equivalent continuous sound level (Leq or LAeq); † SPL max; ‡ sound exposure level (SEL); # average; ? unknown. $ indicates studies where it was unclear if a frequency weighting function was applied.

References below in Shannon et al. (2016):

[1] Pohl et al. (2012); [2] Seger-Fullam, Rodewald & Soha (2011); [3] Berm´udez-Cuamatzin et al. (2011); [4] Dowling, Luther & Marra (2012); [5] Berm´udez-Cuamatzin et al. (2009); [6] Mendes, Colino-Rabanal & Peris (2011); [7] Nemeth & Brumm (2010); [8] Hu & Cardoso (2010); [9] Proppe et al. (2012); [10] Slabbekoorn & Peet (2003); [11] Goodwin & Podos (2013); [12] Montague, Danek-Gontard & Kunc (2013); [13] Nemeth & Brumm (2009); [14] Mockford & Marshall (2009); [15] Halfwerk & Slabbekoorn (2009); [16] Ríos-Chel´en et al. (2013); [17] Potvin, Parris & Mulder (2011); [18] Gross, Pasinelli & Kunc, 2010); [19] Redondo, Barrantes & Sandoval (2013); [20] Pohl et al. (2009); [21] Nemeth et al. (2013); [22] Wood & Yezerinac (2006); [23] Lowry, Lill & Wong (2012); [24] Fuller et al. (2007); [25] Pieretti & Farina (2013); [26] Pat´on et al. (2012); [27] Proppe et al. (2013b); [28] McLaughlin & Kunc (2013); [29] Kight et al. (2012); [30] Gonz´alez-Oreja et al. (2012); [31] Hage et al. (2013); [32] Shieh et al. (2012); [33] Halfwerk et al. (2011b); [34] Potvin & Mulder (2013); [35] Verzijden et al. (2010); [36] Brumm (2004); [37] Arroyo-Solís et al. (2013); [38] Zhang et al. (2012); [39] Halfwerk et al. (2011a); [40] Crino et al. (2013); [41] Ar´evalo & Newhard (2011); [42] Goodwin & Shriver (2011); [43] McClure et al. (2013); [44] Schaub et al. (2008); [45] Siemers & Schaub (2011); [46] Lengagne (2008); [47] Sun & Narins (2005); [48] Kaiser et al. (2011); [49] Bee & Swanson (2007); [50] Cunnington & Fahrig (2010); [51] Lampe et al. (2012); [52] Vargas-Salinas & Am´ezquita (2013); [53] Francis, Ortega, & Cruz (2011a); [54] Blickley et al. (2012b); [55] Schroeder et al. (2012); [56] Bayne et al. (2008); [57] Blickley et al. (2012a); [58] Francis, Ortega, & Cruz (2011c); [59] Francis et al. (2009); [60] Francis et al. (2012); [61] Powell et al. (2006); [62] Westlund et al. (2012); [63] Rasmussen et al. (2009); [64] Conomy et al. (1998); [65] Goudie & Jones (2004); [66] Krausman et al. (1998); [67] Maier et al. (1998); [68] Weisenberger et al. (1996).

6.0 Noise Impact Assessment

6.1 Noise Thresholds for Impact Assessment

The outcomes from the literature review suggest that noise levels from approximately 50-60 dB(A) begin to affect animal behaviour (Dooling and Popper 2007, Shannon et al. 2016). As such this impact assessment has taken a conservative approach to noise thresholds and applied 50 dB(A) tolerance level as a guide for assessment of noise impacts within the Project. As Figure 6.1 demonstrates, values below 50 dB(A) are not considered to have a significant effect.

Although behavioural responses and masking effects are recorded in fauna where noise emissions exceed 50-60 dB(A), significant effects such as injury or hearing damage are only recorded at significantly higher levels (i.e. up to140 dB(A), (Dooling and Popper 2007)). Note, the highest predicted noise levels at the Project area were modelled at 75 dB L_{Amax} from aircraft departure (infrequent and short duration impact), with no day-to-day operating noise reaching this value. Furthermore, Airblast noise and vibration levels predicted for worse-case blast scenarios produce 94 dB $_{Z\ Peak}$ and 0.1 mm/s at the nearest potential night parrot roosting habitat, a noise limit regularly exceeded in the natural environment, from noise generated by thunderstorms in the region (Martin 2018).

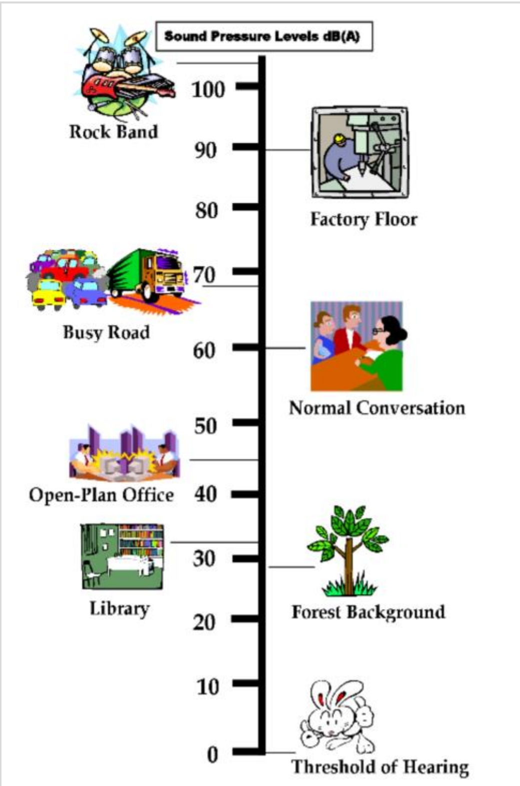


Figure 6.1: Typical noise levels (Source: LGA 2025a)

6.2 Noise Emissions Extent

The predicted extent of the noise emissions from the Project (i.e. the noise study area) is approximately 38,111 ha. This study area represents the furthest extent of the predicted noise model contours (including levels to 25 dB(A)), with a range of predicted noise level extents (Figure 6.2), including 958 ha where mine operational noise levels are > 50 dBL_{A10}.

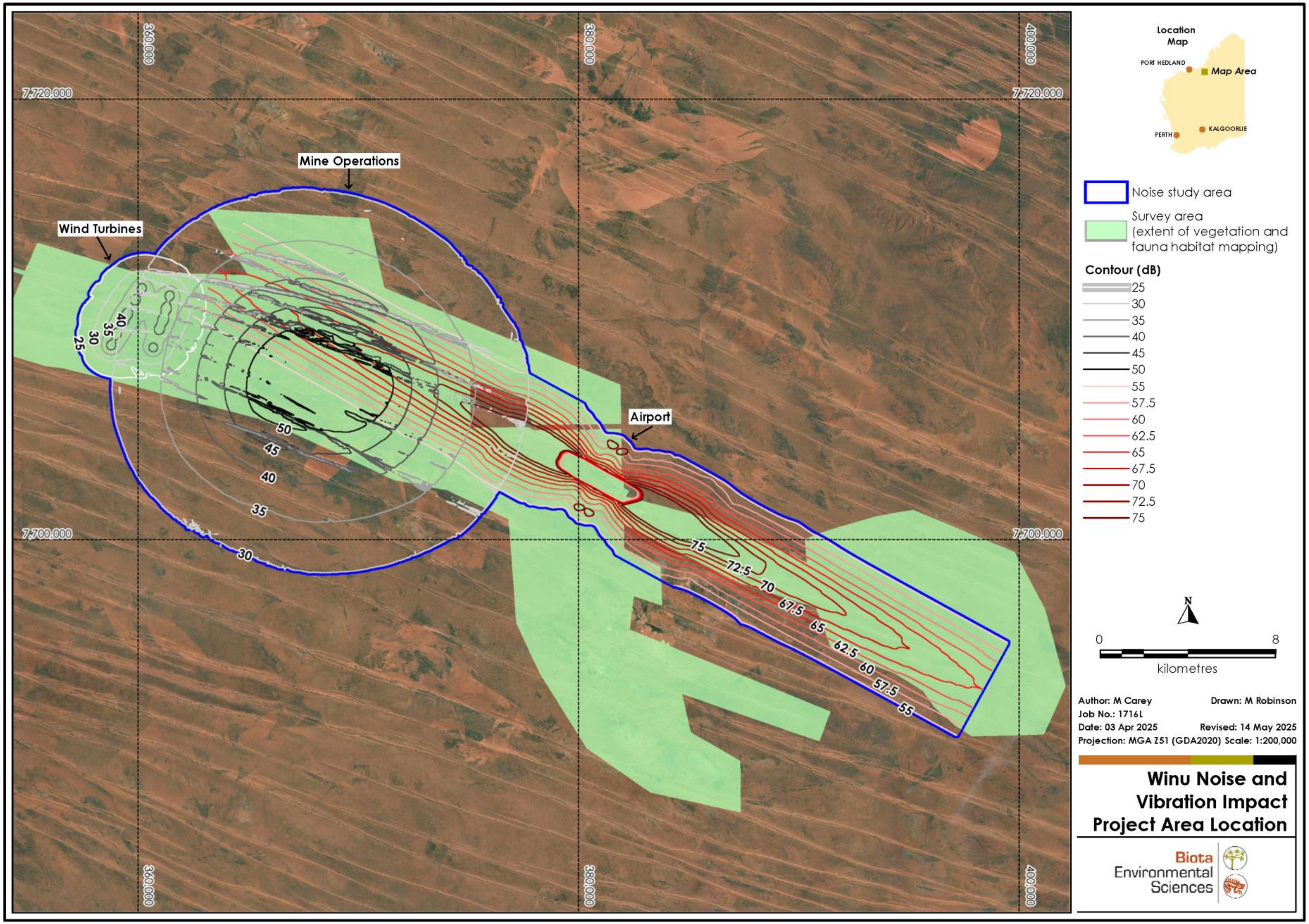


Figure 6.2: Project survey extent (habitat and vegetation) and predicted noise levels. Mining Operations and Wind Farm Noise (dB L_{A10}) and Airport Noise (dB L_{Amax}).

6.3 Fauna Habitat

As described earlier, the noise study area occurs within the Great Sandy Desert (Vegetation Associated 134) (Beard 1968), a vast mosaic of hummock grasslands, open low tree and shrub steppes, and spinifex sandhills, extending over 13,595,888 ha. The noise study area (area of predicted noise extent) represents approximately 0.3% of the Great Sandy Desert.

Of the five habitat types that occur within the DE, all were recorded within the noise study area and are all subject to clearing within the disturbance footprint (Table 6.1).

The habitat types that are within areas that exceed 50 dB(A) contour levels are presented in Table 6.2 and Figure 6.3 and Figure 6.4 for the Mine Operations and Wind Turbine noise levels (dBL_{A10}), and in Table 6.2 and Figure 6.5 for the Airfield noise levels (dBL_{Amax}). A summary of the impact assessment is provided in Table 6.3. Key species of significance from within these habitat types are discussed in Section 3.4 and later in this section.

Table 6.1: Fauna habitat within the total surveyed area, the DE, study area and disturbance footprint.

Fauna Habitat	Survey area (ha)	DE (ha)	Noise Study Area* (ha)	Disturbance footprint (ha)
Clayey sandplain with termitaria	130.4	124.7	130.4	39.3
Ephemeral claypan	479.0	49.3	-	-
Gravelly lateritic rises	3,632.1	3,116.2	935.3	237.9
Inland sand dune	5,558.0	3,105.5	4,142.1	815.4
Shrub and spinifex on sandplain	34,416.5	17,039.9	17,343.0	3,681.7
Disturbed/cleared [1]	262.6	215.1	118.8	102.4
Total	**44,478.6**	**23,650.8**	**22,669.6**	**4,876.7**

*Due to the size of the noise study area, fauna surveys do not cover the entire area.

Table 6.2: Habitat and noise levels in study area (excluding proposed indicative disturbance footprint).

Fauna Habitat	Area (ha) within Mine Operations and Wind Farm Noise Levels		Area (ha) within Airfield Noise Levels		Area (ha) within areas of Overlap (if any)	
	50-75 dB L_{A10}	>75 dB L_{A10}	50-75 dB L_{Amax}	>75 dB L_{Amax}	50-75 dB(A)	>75 dB(A)
Clayey sandplain with termitaria	-	-	19.3	1.3	-	-
Ephemeral claypan	-	-	-	-	-	-
Gravelly lateritic rises	-	-	883.2	38.3	-	-
Inland sand dune	346.8	-	1,611.6	92.3	87.8	-
Shrub and spinifex on sandplain	610.9	-	8,512.9	651.0	143.6	-
Disturbed/cleared [1]	2.0	-	36.0	1.3	2.0	-
Total	**957.7**	**-**	**11,027.0**	**782.8**	**231.4**	**-**

Table 6.3: Noise impact assessment in study area (excluding proposed indicative disturbance footprint).

Fauna Habitat	Mine Operations/Wind Farm, >50 dB L_{A10}		Airfield Noise, >50dB L_{Amax}	
	Total area (ha)	Proportion (%) of Survey Area	Total area (ha)	Proportion (%) of Survey Area
Clayey sandplain with termitaria	-	-	20.6	5.8
Ephemeral claypan	-	-	-	-
Gravelly lateritic rises	-	-	921.4	25.4
Inland sand dune	346.8	6.2	1,703.9	30.7
Shrub and spinifex on sandplain	610.9	1.8	9,163.9	26.6
Disturbed/cleared [1]	2.0	0.8	37.4	14.2
Total	**959.7**	**2.2**	**11,847.2**	**26.6**

[1] 'Disturbed/cleared' areas in Table 6.1 to Table 6.3, and in Figure 6.3 to Figure 6.5, represent areas of existing disturbance at the time of the surveys, and do not represent the indicative disturbance footprint proposed for the Winu Project.

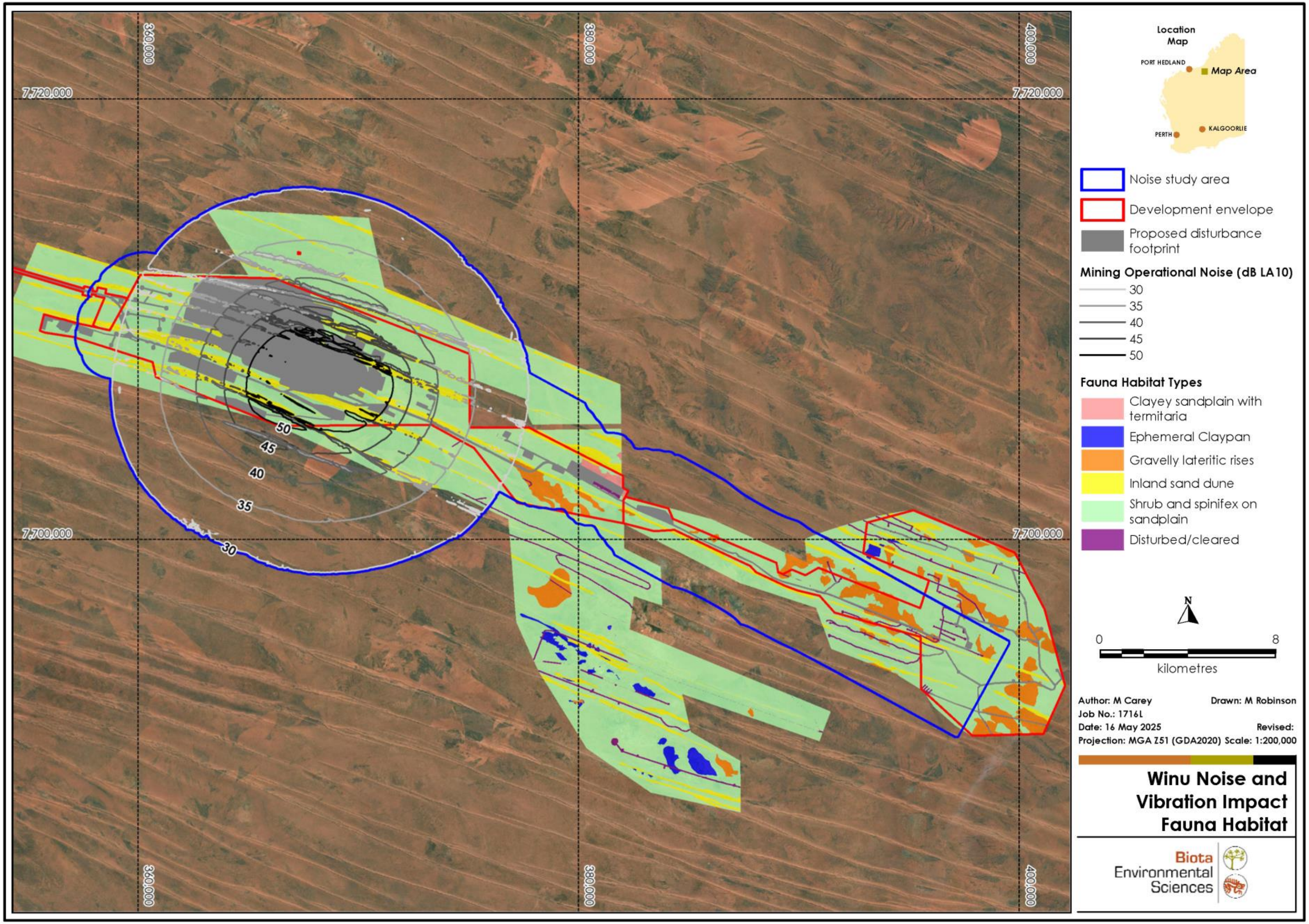


Figure 6.3: **Fauna habitats and predicted noise levels (Mine Area Noise Levels dBL_{A10}).**

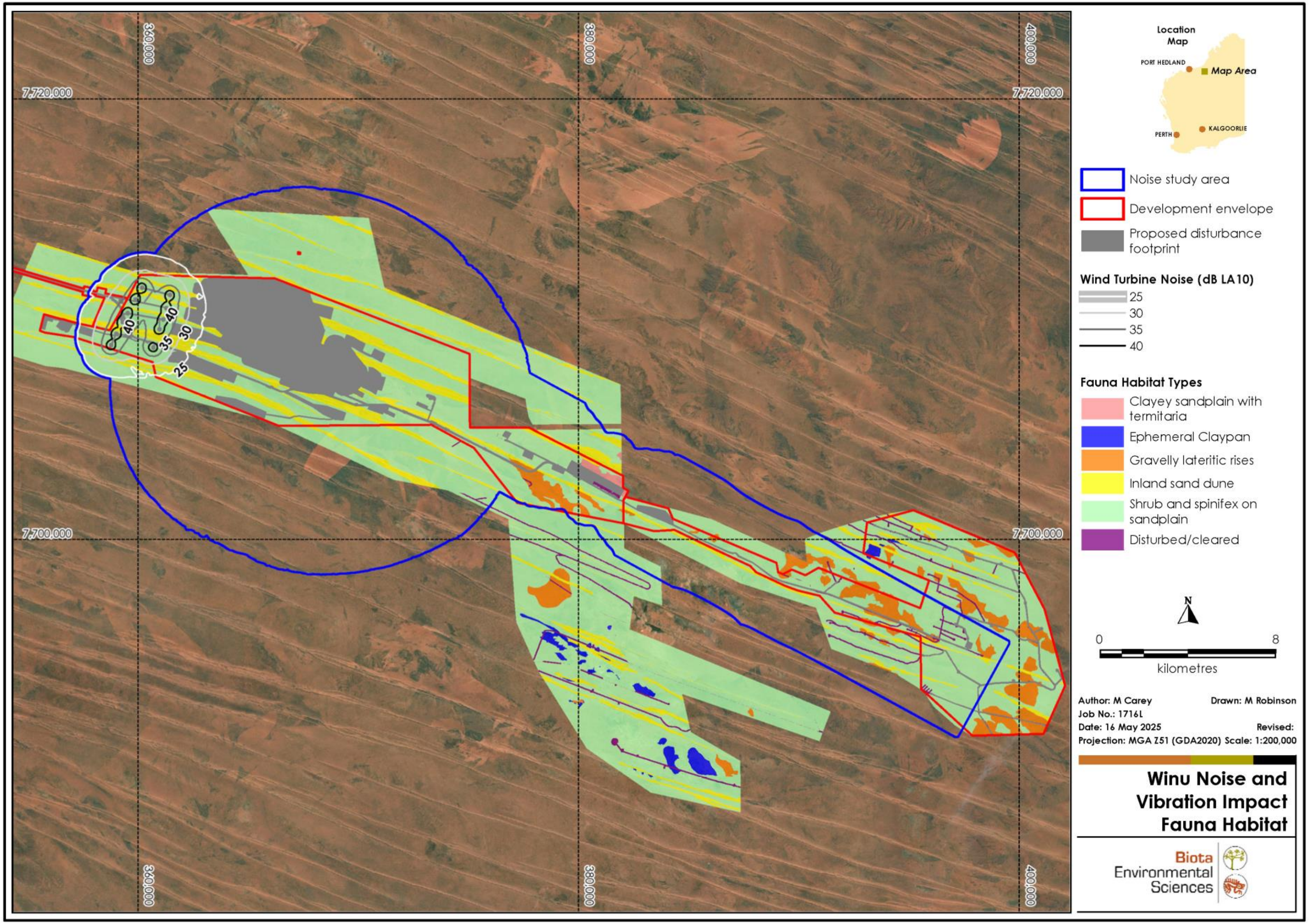


Figure 6.4: Fauna habitats and predicted noise levels (Wind Turbines Noise Levels dBL_{A10}).

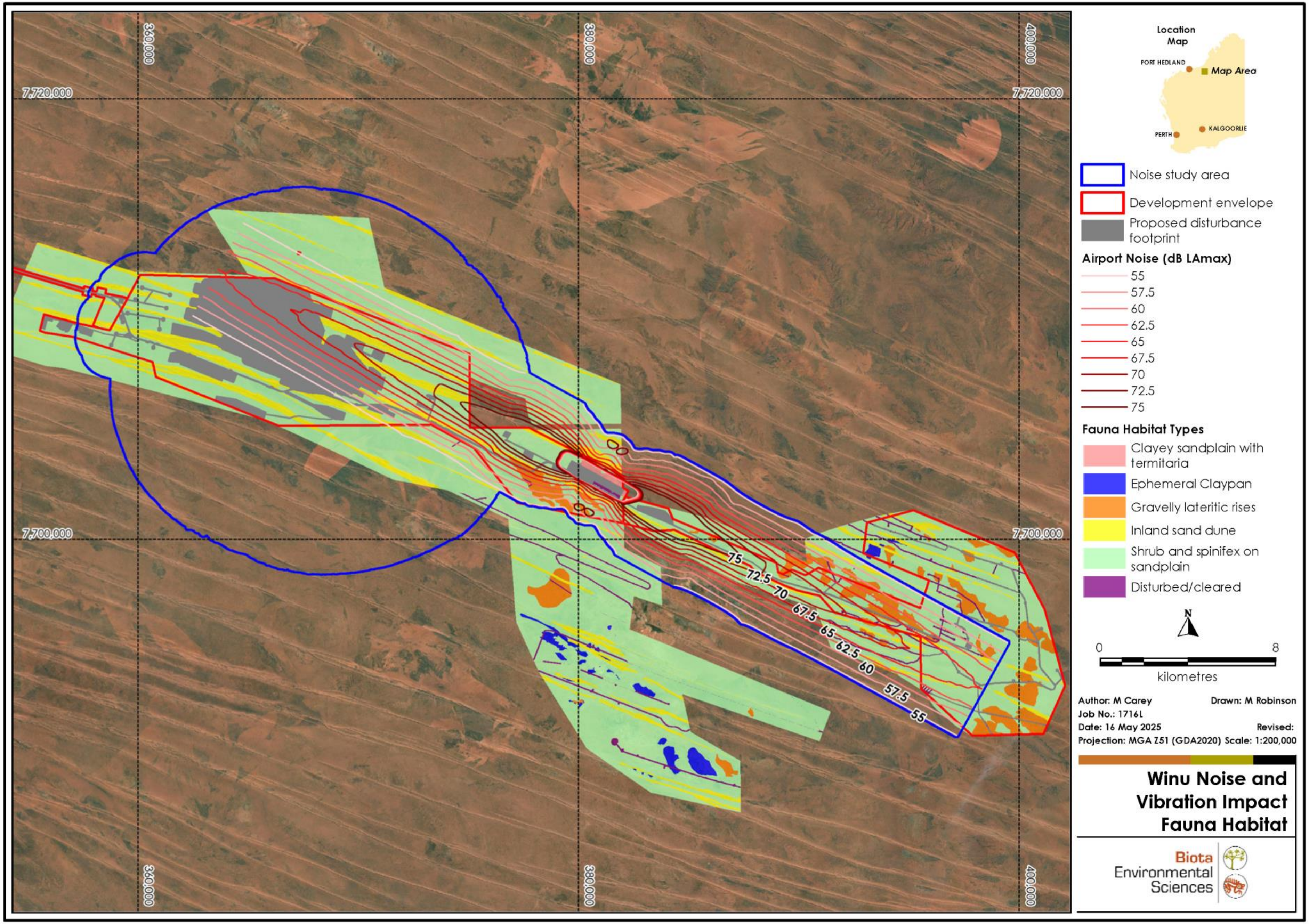


Figure 6.5: **Fauna habitats and predicted noise levels (Airfield Noise Levels dBL_{Amax}).**

The predicted Mine Operations noise extent for mapped habitats exceeding 50 dBL_{A10} is 958 ha, which represents 0.01% of the Great Sandy Desert region. The predicted infrequent and short duration Airfield noise extent for mapped habitats exceeding 50 dBL_{Amax} is 11,848 ha, which represents 0.09% of the Great Sandy Desert region. Key species of significance from within habitat types of the Project area are also presented in Table 3.1 and described below.

All five habitat types recorded within the DE, were recorded within predicted noise levels exceeding 50 dB(A), either associated with noise levels from the Mine Operations, Wind Turbines (dBL_{A10}) or the Airfield (dBL_{Amax}) (Table 6.2, Figure 6.3, Figure 6.4 and Figure 6.5). Figure 6.3, Figure 6.4 and Figure 6.5 also show that the higher noise levels are contained relatively close to the noise source and intersect areas that will already be directly impacted by the disturbance footprint through infrastructure establishment.

Of the five habitat types recorded, the two dominant habitats were Shrub and Spinifex on Sandplains habitat and Inland Sand Dunes habitat, typical images of which are provided on Plate 6.1 and Plate 6.2. Both habitats also provide areas that may be suitable for key significant species of the Great Sandy Desert region, such as the Bilby.

Shrub and Spinifex on Sandplain habitat represents the largest area of habitat within the predicted noise extent. Without the proposed disturbance footprint, 611 ha were recorded within >50 dBL_{A10} for the Mine Operations and 9,164 ha were recorded within >50 dBL_{Amax} for the Airfield. However, given the wide distribution of this habitat in the region, the area of Shrub and Spinifex on Sandplain habitat not within the disturbance footprint and mapped within noise levels >50 dB(A) represents just 1.8% (Mine Operations) and the 26% (Airfield) of the total mapped area of this habitat type locally. Regionally, this area represents a very small proportion (0.07%) of the Great Sandy Desert. As described in Biota (2025a), key species associated with this habitat include:

- Bilby, *Macrotis lagotis* (State and Commonwealth listed as Vulnerable); and
- Brush-tailed Mulgara, *Dasycercus blythi* (State listed Priority 4).

Inland Sand Dunes represent the second largest area of habitat within the predicted noise extent. Without the proposed disturbance footprint, 347 ha were recorded within >50 dBL_{A10} for the Mine Operations and 1,704 ha were recorded within >50 dBL_{Amax} for the Airfield. The area of Inland Sand Dunes habitat not within the disturbance footprint and mapped within noise levels >50 dB(A) represents just 6.2% (Mine Operations) and the 30% (Airfield) of the total mapped area of this habitat type locally. Regionally, this area represents a very small proportion (0.02%) of the Great Sandy Desert. As described in Biota (2025a), key species associated with this habitat include:

- Northern Marsupial Mole, *Notoryctes caurinus* (State listed Priority 4); and
- Bilby, *Macrotis lagotis* (State and Commonwealth listed as Vulnerable) (recorded when *Acacia monticola* is present).

Plate 6.1: Typical shrub and spinifex on sandplain habitat (Biota 2023e).

Plate 6.2: Typical Inland Sand Dunes habitat (Biota 2023e).

Neither the Gravelly Lateritic Rises Gravelly Lateritic Rises and Clayey Sandplain with Termitaria habitats were within the predicted noise extend of the Mine Operations, with only a portion of their mapped extent was recorded with areas associated with the infrequent and short duration Airfield noise. The area of Gravelly Lateritic Rises habitat not within the proposed disturbance footprint and potentially affected by Airfield noise >50 dBL$_{Amax}$ represented 25% of the total mapped area of this type locally. The area of Clayey Sandplain with Termitaria habitat not within the proposed disturbance footprint and potentially affected by noise >50 dBL$_{Amax}$ represents 15% of the total mapped area. Both habitat types are well represented across the Great Sandy Desert and Pilbara regions.

There are no areas of Ephemeral Claypans within the proposed disturbance footprint potentially affected by noise >50 dB(A). Besides occasional use of Ephemeral Claypans by migratory birds, these three habitat types also do not represent critical habitat for key significant species recorded at the Project and surrounds.

6.4 Night Parrot Habitat

Night Parrot habitat within noise level contours that exceed 50 dB (A) for Mine Operations (dBL$_{A10}$) and the Airfield (dBL$_{Amax}$) are summarised in Table 6.4, and presented in Figure 6.6, Figure 6.7, and Figure 6.8. Noise from the Mine Operations does not exceed 50 dBL$_{A10}$ for either roosting or foraging habitat, suggesting that noise-related impacts on Night Parrots arising from the day-to-day operations are low. As discussed in Section 4.3.2, worst-case blast scenarios produce 94 dB$_{Z\ Peak}$ and 0.1 mm/s at the nearest potential Night Parrot roosting habitat, a limit regularly exceeded by thunderstorms in the region (Martin 2018). Note, this nearest potential roosting habitat did not record Night Parrots, rather the nearest confirmed detections were recorded a significant distance from the mine pit, 16 km (Biota 2025b).

Noise associated with the Airfield did record some roosting and foraging habitat within contours that exceeded 50dBL$_{Amax}$, with approximately 254 ha of potential roosting habitat and approximately 117 ha of potential foraging habitat within noise extent of the infrequent and short duration (approximately 15-20 seconds) noise emissions at the Airfield. No Night Parrot habitat is within areas that recorded noise levels >75 dBL$_{Amax}$. Total areas of potential Night Parrot habitat not within the proposed disturbance footprint and potentially affected by noise >50 dBL$_{Amax}$ represent just 15% of the total area of locally mapped Night Parrot habitat.

Surveys further afield, more than 45 km south of the Project area near Lake Waukarlycarly, have also confirmed Night Parrot detections (Biota 2025b). These new detection sites at Lake Waukarlycarly represent another confirmed location for the species and provide important additional contextual information for the region, away from the Project area and unaffected by potential noise emission levels at the Project.

As noted in Section 5.5, significant noise related impacts such as temporary or permanent damage to inner ear sensory hair cells have been recorded from 93dB(A) of continuous noise (i.e. not impulse blast noise) (Dooling and Popper 2007), a value significantly higher than predicted noise levels at the Airfield.

Table 6.4: Night Parrot habitat and predicted noise contours within study area (excluding disturbance footprint).

Fauna Habitat	Total Mapped area	Area (ha) within Mine Operations and Wind Farm Noise Levels	Area (ha) within Airfield Noise Levels		Proportion (%) of Total Survey Area	
		>50dB L$_{A10}$	50-75dB L$_{Amax}$	>75 dB L$_{Amax}$	50-75 dB(A)	>75 dB(A)
Roosting	2,166.8	-	254.3	-	11.7	-
Foraging	307.1	-	116.9	-	38.1	-
Total	**2,473.9**	**-**	**371.2**		**15.0**	**-**

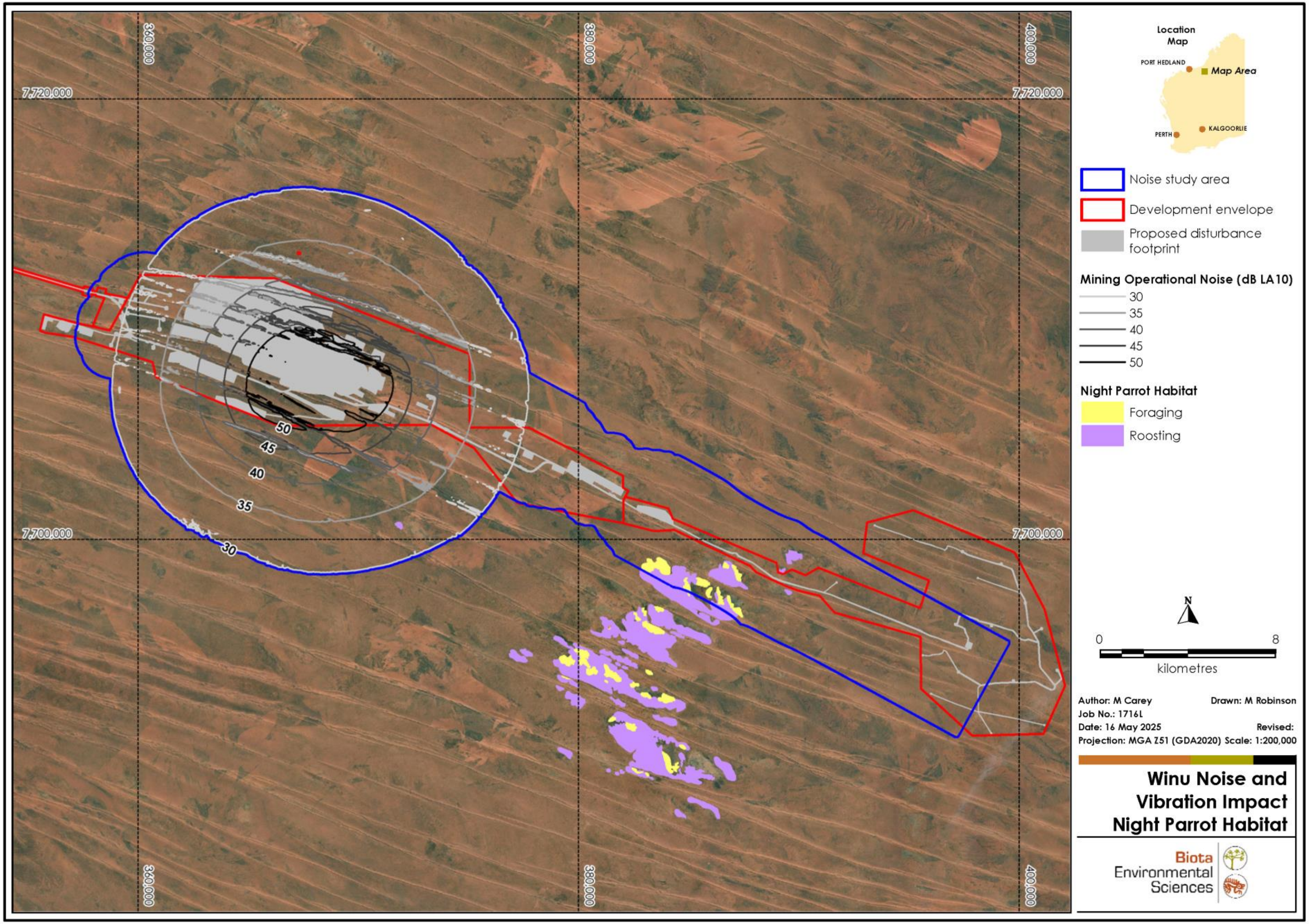


Figure 6.6: Night Parrot habitat and predicted noise levels at the Mine Area (Noise Levels dBL_{A10}).

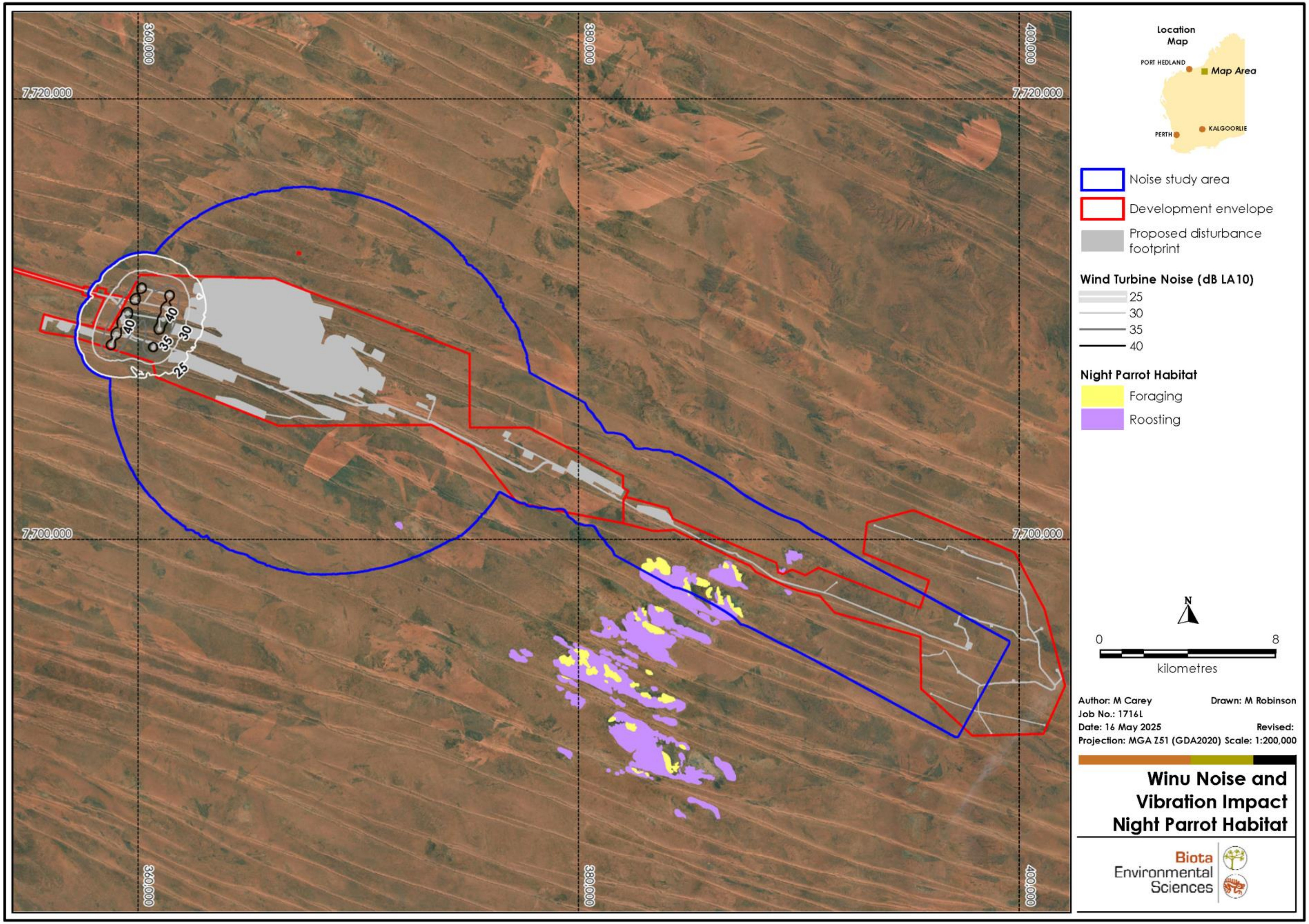


Figure 6.7: Night Parrot habitat and predicted noise levels at the Wind Farm (Noise Levels dBL_{A10}).

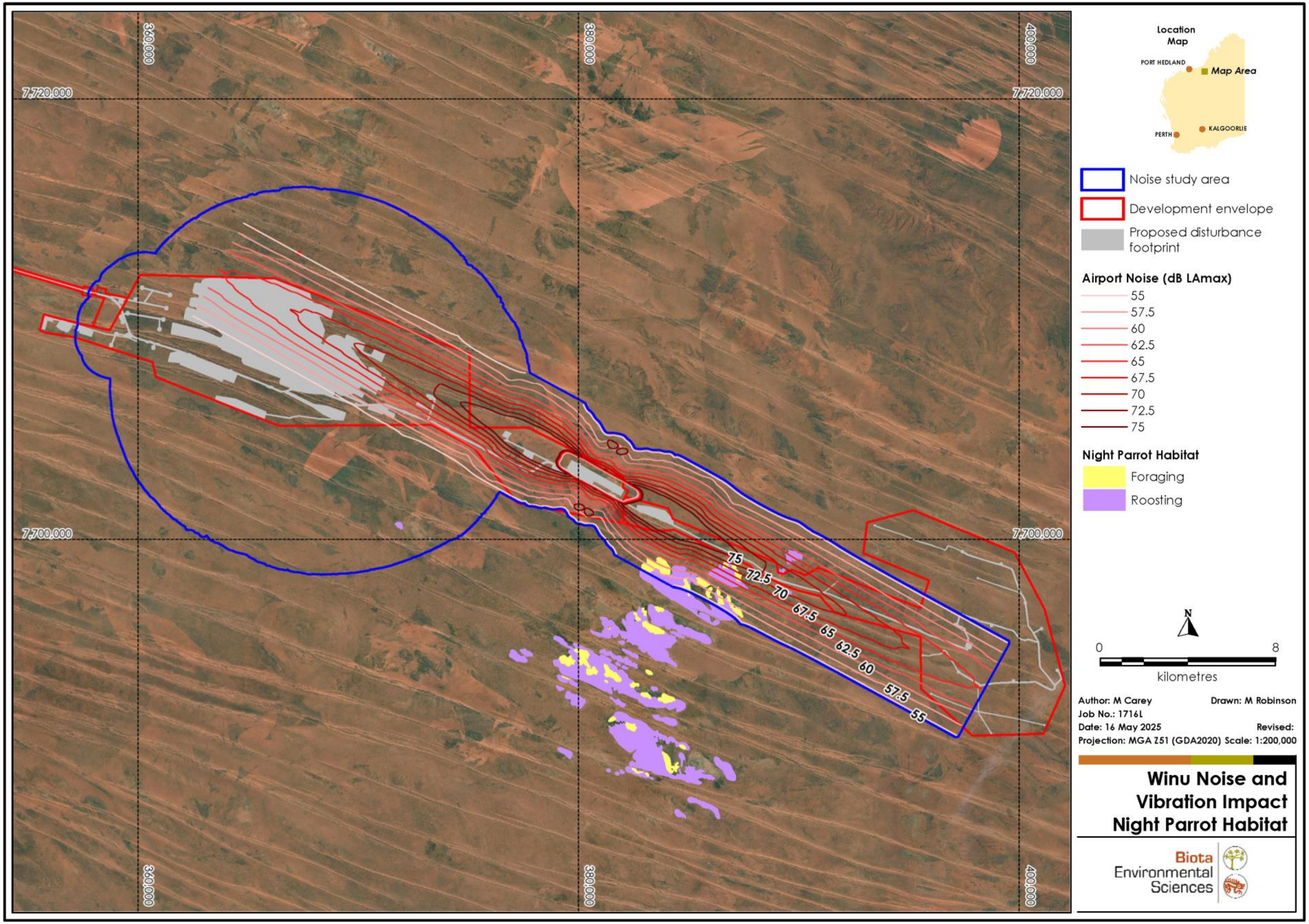


Figure 6.8: Night Parrot habitat and predicted noise levels at the Airfield (Noise Levels dBL_{Amax}).

7.0 Conclusion and Impact Summary

While a review of the literature indicated it is unlikely that any significant species known, or likely to occur in the Project area will be significantly impacted by noise, some habitat that may be suitable for significant species is within areas where noise emissions are predicted to exceed 50 dBL_{A10} during day-to-day Mining Operations and 50 dBL_{Amax} at the Airfield.

The impact assessment has found a small proportion (2.2%) of suitable habitat may be indirectly affected by day-to-day noise levels during Mine Operations, which is unlikely to impact significant species known, or likely to occur in the Project area. Indirect impacts to such small areas of potential habitat result in the risk of noise-related impacts on significant species from the Winu Project being low.

Although behavioural responses and masking effects are recorded in fauna where noise emissions exceed 50-60 dB(A), significant effects such as injury or hearing damage are only recorded at significantly higher levels (i.e. up to140 dB(A), (Dooling and Popper 2007)) than those predicted at the Winu Project.

In the interests of a conservative assessment, a threshold of 50 dB(A) (quieter than normal conversation) was adopted to identify any areas where a risk of behavioural impacts on significant fauna might arise due to predicted increases in ambient noise. The impact assessment has shown that, within the two key habitats noted as suitable for significant species (such as the Bilby), noise affected areas from Mine Operations represent a small proportion of the total area of fauna habitat mapped across the Project area:

- Shrub and Spinifex on Sandplain: Parts of this habitat may be associated with species including the Bilby, Brush-tailed Mulgara, Spectacled Hare-wallaby, and Dampierland Plain Slider. Excluding the indicative footprint, approximately 1.8% of this locally mapped habitat is within mine operational noise contours that exceed 50 dB(A), representing a low risk of indirect noise related impacts to species within this broader habitat from the Project.
- Inland Sand Dunes: Parts of this habitat may be associated with fossorial species and dune specialists, including the fossorial skink, sand slider Northern Marsupial Mole, the Bilby, and Dampierland Plain Slider. Excluding the indicative footprint, approximately 6.2% of this locally mapped habitat is within mine operational noise contours predicted to exceed 50 dB(A), also representing a low risk of indirect noise related impacts to species within this broader habitat from the Project.

Although both key habitats recorded high proportional mapped areas within noise contours from the Airfield (27% for Shrub and Spinifex on Sandplain habitat and 30% for Inland Sand Dune habitat), this noise source is infrequent and very short-lasting (approximately 15-20 second events), producing significantly less noise emissions than those recorded during natural events such as thunderstorms. Both habitat types extend far beyond the survey area boundaries of this study and are widely distributed throughout both the Pilbara and Great Sandy Desert regions.

No Night Parrot habitat was mapped in areas with a predicted noise level that exceeded 50 dBL_{A10} at the Mine Operations, however a small proportion (15%) of foraging and roosting habitat was mapped within the 50 dBL_{Amax} noise contours at the Airfield. No Night Parrot habitat was found within noise levels that exceeded 75 dBL_{Amax}, which is still well below levels that can cause significant impacts such as permanent or temporary hearing damage. Overall, the risks of noise-related impacts on Night Parrot arising from the Winu Project are low.

Airblast noise and vibration levels, with a worst-case blast of 265 kg mass, would produce 94 dB_{ZPeak} and 0.1 mm/s at the nearest potential Night Parrot roosting habitat (5.6 km), however all confirmed detections have been recorded more than 16 km from the mine pit, which further reduces potential noise emissions at these locations from blasting. As the literature review found, hearing loss and permanent damage is recorded from noise levels exceeding 140 dB(A) for single impulse blasts, a level not predicted at any potential Night Parrot habitat or detection sites within the Project area.

Overall, the day-to-day noise levels from the Project will result in minimal impacts to key habitat associated with significant species, with 6.2% of locally mapped Inland Sand Dune habitat within areas exceeding 50 dBL_{A10} and only 1.8% of locally mapped Shrub and Spinifex habitat within areas exceeding 50 dBL_{A10}. Higher noise emissions are predicated from the infrequent blast and airfield sources, however given these noise sources are associated with impulse emissions, much higher levels than those predicted at the Project area are required to have any significant hearing impacts.

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