



Bird in Hand Gold Project
Mining Lease Application
MC 4473

CHAPTER 18

FAUNA AND PEST SPECIES



BIRD IN HAND GOLD PROJECT

MINING LEASE PROPOSAL



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All maps presented in this chapter are in GDA94 / MGA zone 54 (EPSG: 28354) unless otherwise stated.

18 FAUNA

The proposed Mining Lease (ML) for the Bird in Hand Gold Project ('the Project' or 'BIHGP') was assessed for the presence of vegetation associations, flora and fauna species (including listed species) and key threatening processes (such as introduced plants and animals).

This chapter outlines the results from the Commonwealth Protected Matters Search Tool (PMST) and the South Australian Department of Environment and Water (DEW) Biological Databases of South Australia (BDBSA) desktop studies, as well as a Spring Break field survey conducted in October 2014 which recorded species throughout the proposed ML area.

The proposed area of disturbance within the ML is predominantly cleared agricultural land, used for beef cattle and dairy grazing over the preceding decades.

Broad-scale clearance has removed the vast majority of native vegetation within the proposed ML. There remains an isolated parcel of remnant native vegetation that is predominantly surrounded by agricultural land, which contains a 13.8 Ha protected with a Native Vegetation Heritage Agreement (NVHA), authorised in 2016.

This chapter describes the effects the mine may have on native fauna communities and associated habitats within the proposed ML and in adjacent areas where potential impacts exist. This chapter also describes the likely effects on pest animal species which have the potential to further impact both conservation significant and non-conservation significant species. It discusses specific design measures and management strategies to be implemented to minimise any potential impacts on native fauna. These include, minimising the design footprint of the project, creating buffer zones and vegetation corridors around the operational area during the design phase to mitigate edge effects as part of habitat and ecosystem health management and additionally, measures to reduce direct impacts to fauna, including no clearance of native vegetation or significant trees. As groundwater modelling undertaken for the project indicates (see Appendix H1) the potential for groundwater drawdown to occur in the vicinity of the NVHA, the ecological values and potential impacts to the habitat contained within was investigated, however, no impacts on habitat are expected as a result of the Project's construction, operation or closure. This chapter also assesses the effectiveness of all proposed measures and the residual impacts upon and risks to, native fauna species, with a focus on conservation-significant species listed under Commonwealth and State legislation.

COOE Pty Ltd (COOE) was engaged by Terramin to undertake studies to establish a baseline of flora and fauna data for the proposed BIH Project in October 2014. Reporting of their assessment is contained in Appendix Q1.

Both COOE and AC Environmental were engaged by Terramin to undertake both desktop and field survey reporting of stygofauna. Results of their assessments are located in Appendix Q2 and Q3.

Further Information relating to vegetation, conservation significant flora, and agroforestry harvesting is provided in Chapter 19.

18.1 APPLICABLE LEGISLATION AND STANDARDS

In addition to the primary approval and regulation of mining projects under the *Mining Act 1971* (SA) (Mining Act), there are a number of other South Australian and Commonwealth Acts, regulatory processes and planning frameworks that apply to activities associated with mining projects. Table 18-1

provides a preliminary examination of the legislation and planning framework that the construction and operation of the BIHGP may be considered against.

TABLE 18-1 | RELEVANT LEGISLATION AND PLANNING FRAMEWORK UNDER WHICH APPROVALS FOR BIH MAY BE REQUIRED, OR CONSIDERED AGAINST.

Legislation, Planning	Requirement, Purpose	Project Relevance
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act)	<p>Under the provisions of the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act), actions that have, or are likely to have, a significant impact on a matter of national environmental significance (MNES) require approval from the Australian Government Minister for the Environment. The nine MNES to which the EPBC Act applies are:</p> <ul style="list-style-type: none"> • World Heritage properties; • National Heritage places; • Ramsar wetlands of international importance; • Threatened species and ecological communities; • Migratory species; • Nuclear actions; • Commonwealth marine areas; • The Great Barrier Reef Marine Park; and • A water resource, in relation to coal seam gas development and large coal mining development. 	Where there is the potential for an action to have a significant impact on a matter of national environmental significance, an action must be referred to the Minister for a decision on whether assessment and approval is required under the EPBC Act.
<i>Mining Act 1971</i> (SA) (Mining Act)	Application for a ML requires supporting documentation in the form of a Mining Lease Proposal (MLP). The aim of the MLP is to identify the environmental and social risks associated with the project and set appropriate standards (outcomes) that are acceptable to stakeholders, and demonstrate a net public benefit if the MLP were to proceed. The MLP is placed on public exhibition and referred to relevant state government agencies for comment. In assessing and granting a ML, DEM considers the available information, including the application, the MLP and submissions in order to establish ML conditions.	It is expected that assessment of BIH will principally occur under the Mining Act, where the two-stage process for approval will require submission of a ML application, followed by a Program for Environment Protection and Rehabilitation (PEPR).
<i>Environment Protection Act 1993</i> (SA) (EP Act)	Imposes a duty on all persons undertaking an activity that pollutes, requiring them to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm.	The BIHGP will be assessed to ensure activities are undertaken in accordance with Terramin's general environmental duty.

Legislation, Planning	Requirement, Purpose	Project Relevance
	Defines a range of commercial or industrial activities (prescribed activities of environmental significance) for which a licence from the EPA is required.	The prescribed activities of environmental significance commonly associated with mining operations are: <ul style="list-style-type: none"> • mineral works; • chemical works; • fuel burning; • waste or recycling depots; • tailings from mineral processing; • sewage treatment; and • activities producing listed wastes.
	Under certain circumstances, environmental and development authorisations are required to control risks and reduce environmental impacts of activities.	Environmental authorisations in the form of works approvals and licences are required for various elements of mine operations.
	Sets-out the procedure for making, amending and revoking environment protection policies.	There are a number of environment protection policies relevant to mining operations and mineral processing. These include: <p>Environment Protection (Air Quality) Policy 2016 (SA)</p> <p>Environment Protection (Noise) Policy 2007 (SA)</p> <p>Environment Protection (Water Quality) Policy 2015 (SA)</p> <p>Environment Protection (National Pollutant Inventory) Policy 2008 (SA).</p>
<i>National Parks and Wildlife Act 1972 (SA) (NPW Act)</i>	Allows for the establishment and maintenance of a system of reserves, as well as the protection of threatened species of flora and fauna.	The BIHGP is not located within reserves or sanctuaries administered under the NPW Act.. <p>It is expected that threatened species will form part of flora and fauna management considerations for BIH.</p>
<i>Native Vegetation Act 1991 (SA)</i>	Regulates the clearance of native vegetation throughout South Australia.	Mining operations that involve the clearance of native vegetation must be undertaken in accordance with an approved native vegetation management plan (NVMP) that the NVC is confident will result in a significant environmental benefit (SEB). Provision of the SEB can involve an offset of native vegetation undertaken by Terramin, the offset of native vegetation elsewhere and/or a payment of money to the NVC (DWLBC 2005) or an accredited SEB provider.
<i>Natural Resources Management Act 2004 (SA)</i>	Permits are required for the construction of water harvesting/extracting facilities (such as wells) and water licences are required, along with any endorsed water allocation for water use from any prescribed water resource.	In October 2005, the water resources of the Western Mount Lofty Ranges were prescribed under the authority of the Minister and in accordance with the <i>Natural Resources Management Act 2004 (SA)</i> . The Bird-in-Hand Gold Project is located within the Western Mount Lofty Ranges prescribed water resources area for which the <i>Natural Resources Management Act 2004 (SA)</i> Water Allocation Plan for the Western Mount Lofty Ranges Prescribed Water Resources Area (AMLR NRMB 2013) exists.

Legislation, Planning	Requirement, Purpose	Project Relevance
	<p>Approximately 110 species are declared under the NRM Act, including weeds such as bridal creeper, salvation jane, wheel cactus, caltrop and African boxthorn (Biosecurity SA 2012). Landowners have the legal responsibility to control declared plants. The NRM Boards coordinate and enforce control programs for declared plants.</p>	<p>It is expected that declared species will form part of pest plant and animal management considerations for BIHGP.</p>
<p>South Australia's Strategic Plan</p>	<p>A Government-wide plan, built around interrelated objectives to improve South Australia economically, socially and environmentally.</p>	<p>The BIHGP is expected to contribute to South Australia's Strategic Plan's first key objective – Growing Prosperity and also (in accordance with relevant legislation) targets within Attaining Sustainability.</p>
<p>Adelaide Hills Council Development Plan</p>	<p>Outlines what types of development are envisaged for particular zones, and provides objectives, principles and policies related to development control.</p>	<p>Mining objectives and principles of development control have formed part of considerations in planning BIH.</p>
<p>Adelaide and Mount Lofty Ranges Natural Resources Management Plan (ALMRNRMP) – Strategic Plan</p>	<p>The BIHGP falls predominantly within the AMLR NRM region, but is also partially intersected by the SAMDB NRM region.</p> <p>Provides a strategic basis for improving the natural resources of the AMLR NRM region.</p>	<p>Terramin is committed to working towards the AMLRNRMP vision, goals and targets regarding ecological processes for life and livelihood, communities who are engaged and active, amenity culture and environment valued and knowledgeable decisions and action partners. BIHGP will be consistent with this plan.</p> <p>This is reflected in our decisions regarding project footprint, design and management strategies, our revegetation to date and planned in the future (10 Ha of planted revegetation), and our commitment to communities to maximise the benefits and minimise the impacts resulting from our activities.</p> <p>In specific, regional targets T2, T3, T7, T8, and T13.</p> <p>Revegetation plans include two landscape systems identified as priority – grassy ecosystems and closed shrublands.</p> <p>Terramin are committed to improving surface water quality, identified as a concern for the Onkaparinga River catchment, as well as protecting groundwater dependent ecosystems, and groundwater resources and increasing knowledge and participation in natural resource management/revegetation activities.</p>

Legislation, Planning	Requirement, Purpose	Project Relevance
South Australian Murray-Darling Basin Natural Resources Management Board Regional NRM Plan	Sets-out how the environment in the SAMDB NRM region should be managed to ensure balance is achieved between the collective need for resources and the needs of the environment.	Although the proposed ML includes very little of the SAMDBNRM area, BIHGP will be consistent with this plan. Terramin have designed a project with the three SAMDBNRM goals in consideration: People taking responsibility for natural resources and making informed decisions, sustainable management and productive use of land, water, air and sea and Improved condition and resilience of natural systems. This is reflected in our decisions regarding project footprint, design and management strategies, our revegetation to date and planned in the future (10 Ha of planted revegetation), and our commitment to communities to maximise the benefits and minimise the impacts resulting from our activities.

*Additional planning frameworks relevant to the BIHGP may include: Biodiversity Plan for the South Australian Murray-Darling Basin (DENR 2001); No Species Loss: A Nature Conservation Strategy for South Australia 2007-2017 (DEH 2007); Regional Recovery Plan for Threatened Species and Ecological Communities of Adelaide and the Mount Lofty Ranges, South Australia (Wilson and Bignall 2009); Strategic Infrastructure Plan for South Australia (DTEI 2005); Threatened species strategy 2015, Dept of the Environment and Energy, Australian Government.

18.2 ASSESSMENT METHOD

18.2.1 DESKTOP STUDY

A desktop study of the Project site and surrounds was undertaken by COOE (see Appendix Q1) to identify the nature and condition of the existing environment, including vegetation associations and habitat and to develop a list of flora and fauna species that may occur in the area, based on existing records. Literature reviews and database searches have been conducted, consisting of the following:

- The EPBC Act Protected Matters Search Tool – to determine if matters of national environmental significance have the potential to occur within the proposed project area;
- Species Profile and Threats Database – to gather information on the statutory, biological and ecological status of species protected under the EPBC Act;
- Biological Databases of South Australia – to access spatial datasets, including records of previous survey efforts and species observed within the area;
- NatureMaps and Data.SA (South Australian Government Data Directory) – Spatial datasets;
- Accessible published and unpublished literature, including the AMLR NRM Plan, associated recovery plans and previous survey assessments; and
- Aerial imagery and mapping.

The Commonwealth Department of the Environment’s Protected Matters Search Tool (PMST) was used to generate a Protected Matters Report (PMR), to help determine potential matters of national environmental significance (MNES) in the area of interest. The area nominated in the PMR was the aforementioned BIHGP proposed ML boundary. In 2014 the search was conducted based on the coordinates of the proposed ML, with a 10 km buffer. In 2017 the PMST search was updated (see Appendix R7).

A search of a wider area utilising the Biological Databases of South Australia (hereafter referred to as, 'BDBSA' or 'BioData') was also undertaken to collate flora and fauna records from within the Project site and surrounds. Upon request, BioData records were provided by the South Australian Department of Environment and Water (DEW). The records were utilised to indicate the likelihood of occurrence (unlikely, possible, likely or confirmed) of species listed under the EPBC Act and the NPW Act on the Project site. The likelihood assessment was based on proximity of the Project site to extant and historical records, habitat preferences and capacity for recruitment and increased distribution.

18.2.1.1 FAUNA SURVEY

The techniques adopted for the fauna survey were in accordance with the relevant Wildlife Ethics Committee policies for wildlife research, the Guidelines for Vertebrate Surveys in South Australia Using the Biological Survey of South Australia (Owens 2000) (hereafter referred to as, 'Vertebrate Survey Guidelines') and advice from the South Australian Museum. Pitfall traps, Elliott traps, cage traps, spotlighting and active searching were employed at selected sites to determine presence of fauna species. Opportunistic sightings of fauna not detected or captured by the abovementioned methods were also recorded if animals were seen whilst transiting between sites. Bats were surveyed using bat detectors (Anabat), harp nets and mist nets at selected sites. The survey was carried-out by COOE under:

- South Australian Wildlife Ethics Committee Approval of a Project Involving Animals (Project Number 35/2014);
- South Australian Department of Health Licence to Possess and Administer an S4 Drug (Licence Number 2013-81155);
- Permit to Undertake Scientific Research (Permit Number M26333-1);
- Licence to Use Animals for Teaching, Research or Experimental Purposes (Licence Number 278).

The Fauna Survey Report is located in Appendix Q1.

18.2.1.1.1 SITE SELECTION

Sites were selected within the proposed ML boundary to conduct ground-dwelling mammal, reptile and bat trapping and passive bat and bird surveys. Four sites were originally deemed suitable for trapping activities within the proposed ML, based on vegetation associations that represent a range of the habitats present in the area. That is, those sites assessed as having a higher likelihood of presence due to fauna refuge potential. Due to private land access constraints restricting allowable activities, Site 4 became an active search, spotlighting and passive bird survey site.

Active searching was conducted throughout the proposed ML, including potential habitat within the land parcel of proposed BIHGP activities – the project site. Placement of harp traps for the bat survey were targeted and dependent upon the particular features of the survey area, such as potential flight paths between trees or adjacent to trees with obvious hollows, the occurrence of dense corridors of vegetation and the presence of water sources. Please see Figure 18-1 for survey site locations.

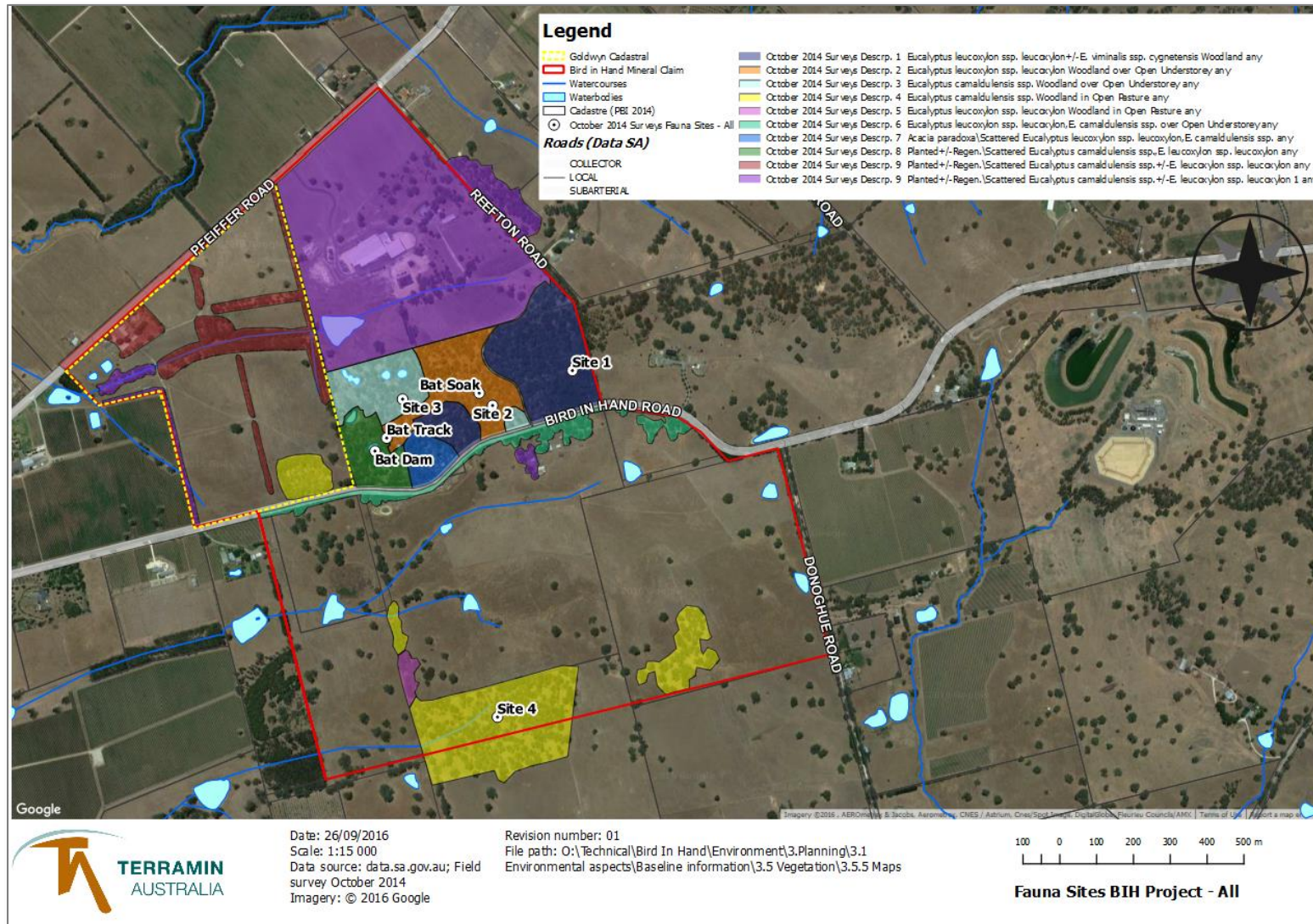


FIGURE 18-1 | LOCATION OF FAUNA OBSERVATION SITES

18.2.1.1.2 TRAPPING

As required in the Vertebrate Survey Guidelines' standard methodology for agricultural regions (Owens 2000), one trap-line was installed at each accessible site within the dominant habitat type. Survey effort was equal across the sites, with trap-lines consisting of one pit-line (six pitfall traps), one Elliott trap-line (15 Elliott traps) and two cage traps, maintained for four consecutive days and nights (Figure 18-2). All traps were checked twice each day, in the early morning and in the late afternoon.

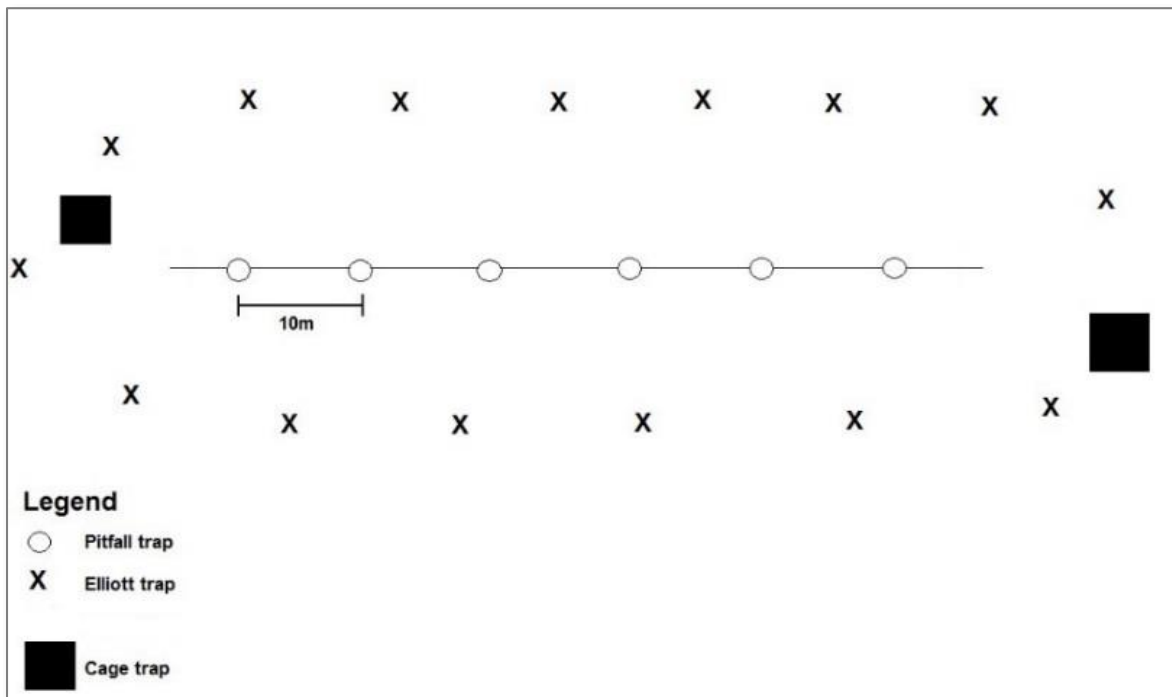


FIGURE 18-2 | SCHEMATIC LAYOUT OF TRAP-LINES USED IN THE SURVEY (NOT TO SCALE)

One standard pitfall-line consisted of six pitfall traps (287 mm diameter, 315 mm deep, with a metal fly-wire bottom measuring approximately 10 mm in diameter) placed in the ground, flush with the surface, at 10 m intervals. The six pitfall traps were connected by a continuous 60 m fly-wire fence measuring 300 mm in height (Figure 18-3). Approximately 75 mm of the fly-wire fence was buried to allow stability and to increase the chance of trap success by encouraging fauna to trail the fence and subsequently fall into the pits. Loose soil was spread at the bottom of each pitfall hole to form a soft, but level surface. Nesting material such as leaves and grass was also placed at the bottom of the trap to provide some protection.

Fifteen Elliott traps (type A, 330 mm long x 100 mm high x 90 mm wide) were distributed on either side (in a parallel manner) of each pitfall-line, approximately 10 m apart and 10 m from the pitfall-line. A small ball of peanut paste and oats was used as bait, placed in the Elliott trap opposite to the treadle mechanism end. All traps were placed under cover of vegetation or fallen timber to provide shaded cover and sufficiently marked with flagging tape to identify their location (Figure 18-3).

Two standard cage traps comprising a wire cage with a trip-plate release, measuring 220 mm wide x 220 mm in height x 550 mm long were placed at potentially advantageous points within the quadrat.

Cage traps were baited with the same mixture used for Elliott traps and covered by a hessian sack to provide shelter from the weather and placed under vegetation to provide additional cover.



(a) Pitfall trap with drift fence

(b) Elliott trap placement

FIGURE 18-3 | IMAGES OF (A) A PITFALL TRAP CONNECTED BY A FLY-WIRE FENCE AND (B) PLACEMENT OF AN ELLIOT TRAP

A total of 180 Elliott, 72 pitfall and 24 cage trap nights were conducted during the survey (Table 18-2). Survey effort was equal across the accessible three sites. Site 4, subject to concentrated active searching, spotlighting and passive bird observations due to survey activity restrictions, has been included in Table 18-2 for completeness.

TABLE 18-2 | TRAP EFFORT UNDERTAKEN DURING THE SURVEY.

Site	Nights	Elliott		Pitfall		Cage		TOTAL NIGHTS
		No.	Nights	No.	Nights	No.	Nights	
1	4	15	60	6	24	2	8	92
2	4	15	60	6	24	2	8	92
3	4	15	60	6	24	2	8	92
4	0	0	0	0	0	0	0	0
TOTAL		45	180	18	72	6	24	276

18.2.1.1.3 BAT SURVEYS

Harp Trapping and Mist Netting

The bat trapping survey was undertaken using harp traps and mist nets, with an additional three opportunistic sites selected to optimise results. Harp traps are a rectangular aluminium frame, with two banks of tightly stretched fine fishing line, leading into a catching bag (Austbat P/L, Bairnsdale, Victoria, modified from Tidemann and Woodside 1978) (Figure 18-4). Harp traps were set in potential flight paths between trees or adjacent to trees with obvious hollows. A total of 18 harp trap-nights were undertaken for the survey, as follows:

- Two harp traps were set for four nights (7–10 October 2014) along a faint walking track;
- Two traps were set for two nights (8–9 October 2014) at Site 2;
- Two traps were set for two nights (9–10 October 2014) at Site 3; and

- One trap was set at a small freshwater soak near Site 2 for two nights (10–11 October 2014).

Mist nets were also used during the survey, set next to a farm dam for one night (8 October 2014) and along a walking track at Site 3 for one night (9 October 2014) (Table 18-3).

TABLE 18-3 | BAT TRAPPING EFFORT.

Site	Additional Location (MGA Zone 54, GDA94)		Harp Nights	Harp		Mist Nights	Mist		TOTAL NIGHTS
	Eastings	Northing		No.	Nights		No.	Nights	
1	309363.00	6129955.00	0	0	0	0	0	0	0
2	309148.00	6129856.00	2	2	4	0	0	0	4
3	308903.00	6129868.00	2	2	4	1	1	1	5
4	309179.00	6129014.00	0	0	0	0	0	0	0
Track	308862.47	6129762.28	4	2	8	0	0	0	8
Soak	309110.96	6129888.73	2	1	2	0	0	0	2
Dam	308831.58	6129726.63	0	0	0	1	1	1	1
TOTAL			10	7	18	2	2	2	20

Trapped bats were identified, aged, sexed, weighed, measured and their reproductive condition assessed based on external appearance (Churchill 2008). Age was assessed by the degree of ossification of the finger joints, a characteristic that can only be used to recognise juveniles up to four months of age (Anthony 1988). Females were classified as pre-parous (not bred before), pregnant, lactating, or post-lactating (bred previously but not currently in breeding condition) (Racey 2009). To temporarily mark captured animals a small patch of fur on the rump was coloured with a black permanent marker. All bats were released at the capture site the following evening within two hours of sunset.



(a) Harp traps at Site 2 (b) Harp traps at Track site (c) Harp traps at Soak site

FIGURE 18-4 | HARP TRAPS SET AT (A) SITE 2, (B) TRACK SITE, AND (C) SMALL FRESHWATER SOAK LOCATED NEAR SITE 2

18.2.1.1.4 BAT DETECTORS

Echolocation calls were used to document diversity and activity patterns of insectivorous bats at four sites. Calls were recorded using AnaBat SD1 bat detectors (Titley Electronics, Lawnton, Queensland). Bat activity was recorded from sunset to sunrise for four consecutive nights (7–10 October 2014) at the four survey sites (one detector per site) (Table 18-4). Detectors were placed inside a plastic weatherproof box with the microphone angled upwards at approximately 45° (Figure 18-5 | Bat detectors in weatherproof plastic boxes attached to trees at (a) Site 1, (b) Site 2, and (c) Site 3

Prior to the survey, detectors were calibrated by adjusting their sensitivity levels against an ultrasound frequency generator (AnaBat Chirper 2, Titley Electronics) (Hayes 1997).



(a) Bat detector at Site 1



(b) Bat detector at Site 2



(c) Bat detector at Site 3



(d) Example of bat detector in close-range

FIGURE 18-5 | BAT DETECTORS IN WEATHERPROOF PLASTIC BOXES ATTACHED TO TREES AT (A) SITE 1, (B) SITE 2, AND (C) SITE 3

Echolocation call data were downloaded to a computer using CFCread version 4.3s, then analysed using AnlookW version 3.8m (C. Corben, www.hoarybat.com). Sonograms of recorded bat call sequences were sorted and identified by one observer (SG). A call sequence was defined as a file containing at least three echolocation pulses (frequency sweeps) identified as bat echolocation calls (Hourigan *et al.* 2008), and each call sequence separated by > 5 s was designated a unique file (Turbill 2008). During analysis, the number of call sequences was noted for each species (sometimes two or more species can occur in a single recording; in that case, one sequence was recorded for each species or species group).

Several taxa present in the Adelaide Hills region are difficult to distinguish, based solely on characteristics of echolocation calls. Therefore, some call sequences were assigned to a species group. For example, call sequences containing structural elements consistent with both Gould's Wattled Bats (*Chalinolobus gouldii*) and Southern Free-tailed Bats (*Mormopterus planiceps*) i.e. 26–30kHz without an alternating pulse, but not distinctly flattened, were recorded as the species group *C. gouldii*/*M. planiceps*. Similarly, calls with elements consistent with Large Forest Bats (*Vespadelus darlingotni*), Southern Forest Bats (*Vespadelus regulus*) and Little Forest Bats (*Vespadelus vulturinus*) were recorded as the species group *Vespadelus* spp. A conservative approach to species identification was taken and

any calls lacking adequate information for definitive identification were not identified. A description of the characteristics used to identify call sequences to species or species group level is provided in Appendix A.

TABLE 18-4 | BAT DETECTOR EFFORT.

Site	Additional Location (MGA Zone 54, GDA94)		Location Descrip.	Bat Detector Nights	Bat Detector		TOTAL NIGHTS
	Easting	Northing			No.	Nights	
1	309363.00	6129955.00	-	4	1	4	4
2	309148.00	6129856.00	-	4	1	4	4
3	308903.00	6129868.00	-	4	1	4	4
4	309179.00	6129014.00	-	0	0	0	0
Track	308862.47	6129762.28	Along walking track	4	1	4	4
Soak	309110.96	6129888.73	Small freshwater soak	0	0	0	0
Dam	308831.58	6129726.63	Next to farm dam	0	0	0	0
TOTAL				16	4	16	16

18.2.1.1.5 BIRD SURVEYS

The bird survey was conducted by a single observer over two days on 8 – 9 October 2014. Passive bird surveys were conducted throughout the entire proposed ML using the point-count method. Site data was collected for each of the four sites and opportunistic data was collected throughout the proposed ML. Weather conditions were considered optimal for bird observations, being calm and clear. Point-count surveys were carried-out in Sites 1 to 4, with most time spent in Sites 1 to 3, which still retain some undergrowth, providing valuable habitat and breeding locations for birds. Time was also spent observing birds in scattered trees in paddocks, planted woodlots and dams. Observation times were chosen to reflect times when birds are most active; for example early morning and late afternoon.

18.2.1.1.6 ACTIVE SEARCHING AND SPOTLIGHTING

Concentrated active searching and spotlighting was the primary method for locating fauna species within Site 4 and the land parcel of proposed BIH activities. The observations made in Site 4 using this methodology were recorded as specific site data. Throughout the remainder of the Project site and survey period, active day searches were frequently undertaken as an additional method of locating species.

Physical searches were conducted under shrubs, animal holes, and any natural or man-made debris to identify species and tracks, scats, owl pellets, scratchings, burrows and skulls. Concentrated active searching and spotlighting was conducted for between two and three hours, with search effort divided into multiple sessions to optimise searching conditions. All active searches were conducted on-foot and spotlighting was undertaken using a Led Lenser head torch (H7.2, 250 Lumen).

Spotlighting for three hours was undertaken in the Goldwyn creekline (Association 9) in February 2019.

18.2.1.1.7 OPPORTUNISTIC OBSERVATIONS

Fauna species not caught in traps, nor observed through active searching were recorded as opportunistic observations. Opportunistic observations, known as chance sightings of fauna by field surveyors whilst onsite, most commonly occurred when checking traps and travelling between trapping sites.

18.2.1.2 STYGOFAUNA

Previous groundwater studies indicate a baseline understanding of the hydrogeology in the project area including current groundwater quality, aquifer types and initial bore census. However, despite historic mining activities at BiH, there is limited quantitative data available to determine the extent of change over time to both groundwater quality and volume.

Datasets for stygofauna for the Woodside area are not available; the science of stygofauna is an emerging field, particularly in South Australia. However, a three year study (Leijs, R. 2008; Leijs, R. 2009) of stygofauna in South Australia indicated stygofauna were found in most spring habitats sampled in the Mount Lofty Ranges. Considering the existing data on the hydrogeology of the project area, such as presence of fractured rock aquifers with water qualities generally suitable for stygofauna, presence of a subsurface groundwater dependent ecosystems is possible.

Though the current legislation is not specific to stygofauna, certain provisions give rise to the protection and management of groundwater dependent habitats and thus indirectly to stygofauna. The locally relevant Water Allocation Plan, developed for the Western Mount Lofty Ranges Prescribed Area, states that it is not the aim to return water-dependent ecosystems to a pristine condition, but to keep them at an acceptable level of risk.

The Stygofauna Desktop Study is located in Appendix FF2.

18.3 EXISTING ENVIRONMENT

The following surveys, analysis and reports have been undertaken in order to gain a holistic understanding of all fauna within the ML:

- 2014 Commonwealth Protected Matters Search Tool (PMST) and the South Australian Department of Environment, Water and Natural Resources Biological Databases of South Australia (BDBSA) desktop study (Appendix Q1);
- 2014 Flora/Fauna field survey and report (Appendix Q1);
- Regular avifauna surveying within the riparian areas (Association 9) on the Terramin owned property (Goldwyn);
- Macroinvertebrate and Surface Water Report (descriptions of macroinvertebrates sampled in drainage lines within the ML) (Appendix I1);
- Stygofauna report – Desktop (Appendix Q2);
- Stygofauna Report – field survey and sample analysis (Appendix Q3);
- Bushland Condition Monitoring (sightings and observation of fauna included) (Appendix R1);
- 2017 Commonwealth Protected Matters Search Tool (PMST) (Appendix R7); and
- 2014 – 2019 opportunistic fauna observations.

18.3.1 FLORA, FAUNA AND KEY THREATENING PROCESSES ASSESSMENT

18.3.1.1 DESKTOP STUDY

The Commonwealth-listed threatened fauna species provided by the PMST and BDBSA in November 2017 comprised nine birds, two mammals, one frog and two fish. Fourteen Commonwealth-listed migratory birds were also identified. Thirty fauna species listed under the NPW Act were identified by the BDBSA, comprising 27 birds, two mammals and one amphibian species. The 2014 survey recorded four SA-listed species, comprising the Vulnerable Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) and Rare White-winged Chough (*Corcorax melanorhamphos*), Crested Shriketit (*Falcunculus frontatus*) and Common Brushtail Possum (*Trichosurus vulpecula*). Nine regionally-listed (AMLR) species were recorded, comprising the Rare Brown Tree Frog (*Litoria ewingii*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and seven bird species listed as Rare and higher. Locations of Listed Species from the PMST and BDBSA databases are shown in Figure 18-6.

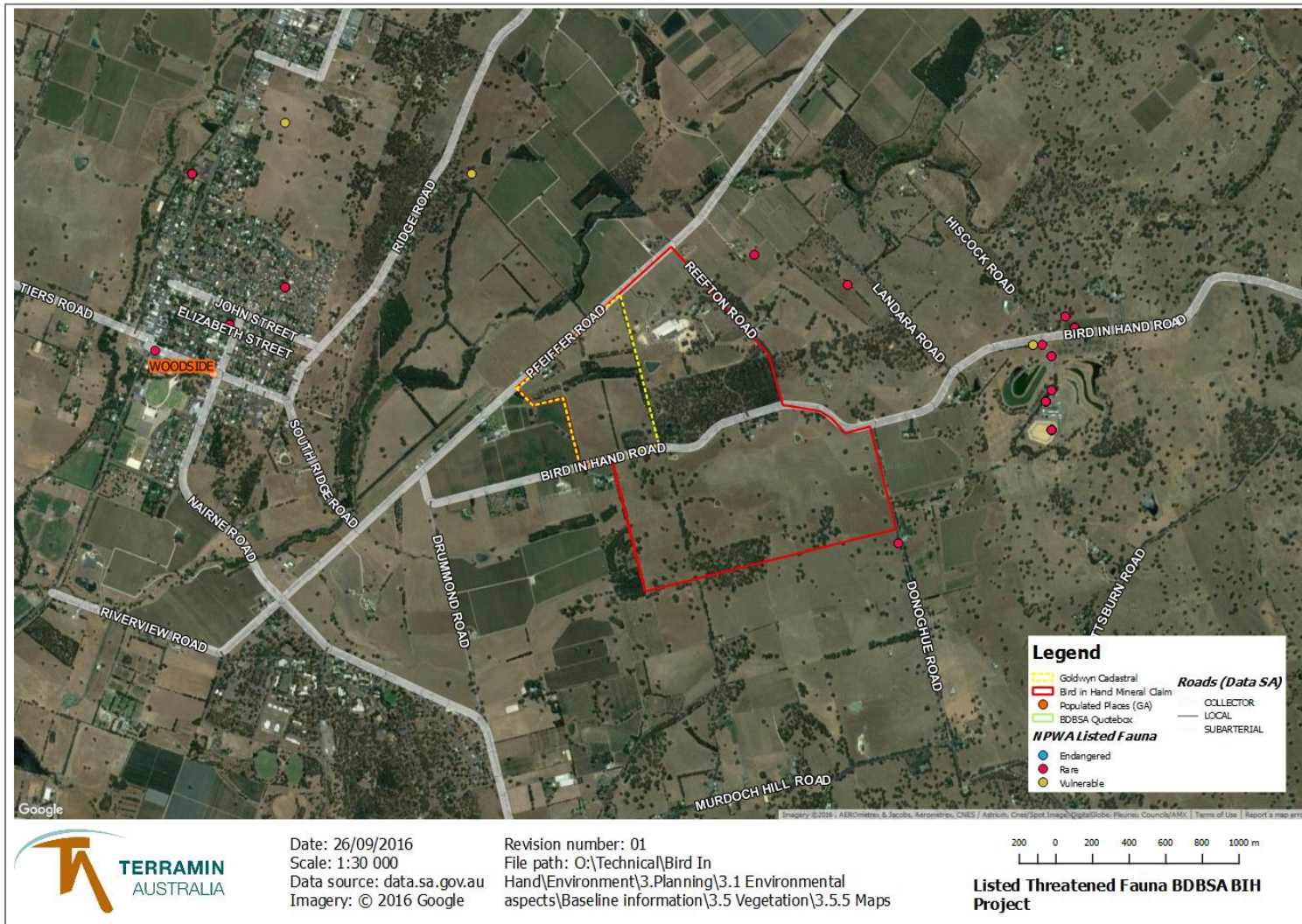


FIGURE 18-6 | LOCATIONS OF LISTED SPECIES FROM THE PMST AND BDBSA DATABASES

18.3.1.1.1 CONSERVATION SIGNIFICANT FAUNA

The PMST identified 33 Commonwealth-listed threatened species and two Commonwealth-listed threatened ecological communities as being potentially present within ten km of the Project site. Listed threatened species identified in the PMR comprise ten birds, three fish, one frog, one reptile, two mammal and 16 plant species.

The results of the EPBC Act Protected Matters Search are summarised in Table 18-5.

The BDBSA search provided a total of 1287 flora species records from 129 families distributed within and surrounding the Project site. A total of 250 fauna species records were provided by the BDBSA, comprising 29 mammal, 27 reptile, seven frog and 187 bird species.

TABLE 18-5 | SUMMARY OF THE RESULTS OF THE EPBC ACT PROTECTED MATTERS SEARCH (10 KM BUFFER)

Search Area (10 km buffer)	Matters of NES and Other Matters	Result
	World Heritage Properties	None
	National Heritage Properties	None
	Wetlands of International Importance	1
	Great Barrier Reef Marine Park	None
	Commonwealth Marine Areas	None
	Listed Threatened Ecological Communities	2
	Listed Threatened Species	33
	Listed Migratory Species	14
	Commonwealth Land	3
	Commonwealth Heritage Places	None
	Listed Marine Species	19
	Whales and other Cetaceans	None
	Critical Habitats	None
	Commonwealth Reserves Terrestrial	None
	Commonwealth Reserves Marine	None
	Places on the Register of the National Estate	7
	State and Territory Reserves	10
	Regional Forest Agreements	None
	Invasive Species	47
	Nationally Important Wetlands	None
Key Ecological Features (Marine)	None	

18.3.1.1.1.1 COMMONWEALTH-LISTED THREATENED FAUNA

The PMST provided eight Commonwealth-listed threatened fauna species, comprising ten birds, two mammals, one frog, one reptile and three fish (Table 18-6). Of the ten listed threatened bird species, two of them are also listed as migratory wetland. Four of the listed threatened migratory birds is also listed as a marine species under Other Matters Protected by the EPBC Act. BDBSA was also obtained and provided an additional five Commonwealth-listed threatened fauna species records, comprising two birds, two mammals and one reptile. Of all 13 Commonwealth-listed fauna species identified in the PMST and BDBSA, 10 of these species are also listed under the NPW Act.

18.3.1.1.1.2 COMMONWEALTH-LISTED MIGRATORY FAUNA

The PMST provided 14 Commonwealth-listed migratory species potentially occurring within a ten km radius of the Project site (Table 18-7). One marine bird, five terrestrial species (all birds) and eight wetlands species (all birds) were listed in the PMR. The *Pandion haliaetus* was identified in the PMR as a marine species only, but is listed as migratory and marine under the EPBC Act and has been given full consideration as a migratory marine bird in Table 18-7.

One terrestrial species and one wetlands species are also listed as threatened under the EPBC Act and have been assessed in Table 18-6. All 11 of the Commonwealth-listed marine species under Other Matters Protected by the EPBC Act are also provided in the list of migratory species and so have been covered in Table 18-7 in their entirety.

At the time of receiving BDBSA data, an additional three migratory marine bird records were provided, namely the Australian Reed Warbler (*Acrocephalus australis*), Common Sandpiper (*Actitis hypoleucos*) and Common Greenshank (*Tringa nebularia*), bringing the total number of migratory marine birds to five. However, as at 5 August 2014, *Acrocephalus australis* is no longer listed migratory for the purposes of the EPBC Act. The species is now marine only. This is particularly relevant, as this species was recorded during the October 2014 surveys. As such, the total number of listed migratory species considered in Table 18-7 is therefore 14.

18.3.1.1.1.3 SOUTH AUSTRALIAN-LISTED THREATENED FAUNA

A total of 38 fauna species listed under the NPW Act were identified by the PMR and BDBSA, comprising 35 birds, two mammals and one amphibian species (Table 18-8). Of the 38 species identified, seven were provided by the PMR only and the remaining 31 species were provided by the BDBSA only.

TABLE 18-6 | COMMONWEALTH-LISTED THREATENED FAUNA SPECIES PROVIDED IN THE PMR AND BDBSA AND THEIR LIKELIHOOD OF OCCURRENCE WITHIN THE BIRD-IN-HAND GOLD PROJECT SITE

No.	Species	Common	Listing			Source		No. BDBSA Records	Latest Record	Recorded within proposed ML (BDBSA 2014)	Distance from proposed ML (km) (BDBSA 2014)*	Recorded during Survey (2014) and Add. Inspections	Likelihood
			EPBC	NPW	AMLR	PMR	BDBSA						
Listed Threatened Under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)													
BIRDS													
1.	<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	E	RE	✘	✓		1900	N	10	N	Unlikely
2.	<i>Calidris ferruginea</i>	Curlew Sandpiper	CR	V	CR	✓	✘	-	-	-	-	N	Unlikely
3.	<i>Calyptorhynchus lathami halmaturinus</i>	Glossy Black-Cockatoo (Kangaroo Island) Glossy Black-Cockatoo (South Australia (64436)	EN	EN	-		✓					N	Unlikely
4.	<i>Calamanthus (Hylacola) pyrrhopygius parkeri</i>	Chestnut-rumped Heathwren (MLR ssp.)	EN	E	EN	✓	✘	-	-	-	-	N	Unlikely
5.	<i>Cincoloma punctatum anachoreta</i>	Spotted Quail-thrush (MLR ssp.)	CR	E	CR	✓	✓	3	1900	N	6 – 11	N	Unlikely
6.	<i>Grantiella picta</i>	Painted Honeyeater (470)	VU	RA			✓					N	Unlikely
7.	<i>Numenius madagascariensis</i>	eastern Curlew, Far Eastern curlew (847)	CE	-	-	✘	✓	1	1982	N	8	N	Unlikely
8.	<i>Leipoa ocellata</i>	Malleefowl	VU, Mi (T)	V	EN	✓	✘	-	-	-	-	N	Unlikely
9.	<i>Pedionomus torquatus</i>	Plains-wanderer	CE	EN	-		✓					N	Unlikely
10.	<i>Rostratula australis= Rostratula benghalensis (sensu lato)</i>	Australian Painted-snipe	EN, Mi (W), Ma	V	EN	✓	✘	-	-	-	-	N	Unlikely
11.	<i>Zoothra lunulata helmaturina</i>	Bassian Thrush	V	RA	V		✓					N	
MAMMALS													
12.	<i>Isodon obesulus obesulus</i>	Southern Brown Bandicoot (SA mainland and KI ssp.)	EN	V	EN	✓	✓	2	1992	N	9 – 11	N	Unlikely
13.	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	EN	R	RA	✘	✓	2	2011	N	7 – 9	N	Possible
REPTILES - NA													
1.	<i>Tiliqua adelaidensis</i>	Pygmy Blue-tongue	EN	EN		✓				N		N	unlikely
AMPHIBIANS													
2.	<i>Litoria raniformis</i>	Southern Bell Frog	VU	V	RE	✓	✓	2	1979	N	7 – 11	N	Unlikely
FISH													
3.	<i>Craterocephalus fluviatilis</i>	Murray Hardyhead (56791)	EN	-	CR		✓					N	Unlikely
4.	<i>Galaxias rostratus</i>	Flathead Galaxias	CE	-	-		✓					N	Unlikely
5.	<i>Maccullochella peelii peelii</i>	Murray Cod	VU	-	RE	✓	✘	-	-	-	-	N	Unlikely

Species nomenclature has been updated to reflect the DEWNR Vertebrates Biological Database of South Australia (2015). **ML:** Mining Lease. **Add.:** Additional. **Listing status:** EPBC (National – Australia): *Environment Protection and Biodiversity Conservation Act 1999* (Cth). NPW (State – South Australia): *National Parks and Wildlife Act 1972* (SA). AMLR (Regional – Adelaide and Mount Lofty Ranges Region): regional conservation status from DEWNR (2013). **Listing status codes:** CR: Critically Endangered. DD: Data Deficient. E: Endangered. E*: Extinct. EN: Endangered. EX: Extinct. LC: Least Concern. Ma: Marine. Mi: Migratory. Mi (Ma): Migratory Marine. Mi (T): Migratory Terrestrial. Mi (W): Migratory Wetlands. NE: Not Evaluated. NT: Near Threatened. V: Vulnerable. VU: Vulnerable. R: Rare. RA: Rare. RE: Regionally Extinct.

TABLE 18-7 | COMMONWEALTH-LISTED MIGRATORY SPECIES PROVIDED IN THE PMR AND BDBSA AND THEIR LIKELIHOOD OF OCCURRENCE WITHIN THE BIRD-IN-HAND GOLD PROJECT SITE

No.	Species	Common	Listing			Source		No. Records	BDBSA	Latest Record	Recorded within proposed ML (BDBSA 2014)	Distance from proposed ML (km) (BDBSA 2014)*	Recorded during Survey (2014) and Additional Inspections	Likelihood
			EPBC	NPW	AMLR	PMR	BDBSA							
Listed Migratory Under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)														
MIGRATORY MARINE SPECIES														
1.	<i>Actitis hypoleucos</i>	Common Sandpiper	Mi (Ma), Ma	R	EN	✘	✓	2		2001	N	12	N	Possible
2.	<i>Apus pacificus</i>	Pacific Swift (Fork-tailed Swift)	Mi (Ma), Ma	-	RA	✓	✘	-		-	-	-	N	Possible
3.	<i>Pandion haliaetus</i>	Osprey	Mi (Ma), Ma	E	VU	✓	✘	-		-	-	-	N	Unlikely
4.	<i>Tringa nebularia</i>	Common Greenshank	Mi (Ma), Ma	-	VU	✘	✓	1		2003	N	1	N	Possible
MIGRATORY TERRESTRIAL SPECIES														
5.	<i>Hirundapus caudacutus</i>	White-throated Needletail	Mi (T), Ma	-	CR	✓	✘	-		-	-	-	N	Possible
6.	<i>Motacilla cinerea</i>	Grey Wagtail	Mi (T)			✓	✘	-		-	-	-	N	Unlikely
7.	<i>Motacilla flava</i>	Yellow Wagtail	Mi(T),	-	VU	✓	✓	11		2012	N	5 – 10	N	Possible
8.	<i>Myiagra cyanoleuca</i>	Satin Flycatcher	Mi (T), Ma	E	-	✓	✘	-		-	-	-	N	Unlikely
9.	<i>Rhipidura rufifrons</i>	Rufous Fantail	Mi (T), Ma	-	-	✓	✘	-		-	-	-	N	Unlikely
MIGRATORY WETLANDS SPECIES														
10	<i>Actis hypoleucos</i>	Common sandpiper	Mi(W)	-		✓								
11	<i>Ardea alba</i>	Great Egret	Mi (W), Ma	-	VU	✓	✓	4		2001	N	4 – 10	N	Unlikely
12	<i>Ardea ibis</i>	Cattle Egret	Mi (W), Ma	R	VU	✓	✘	-		-	-	-	N	Unlikely
13	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Mi (W)			✓								
14	<i>Calidris ferruginea</i>	Curlew sandpiper	Mi(W), CE			✓								
15	<i>Calidris melanotos</i>	Pectoral Sandpiper	Mi (W)			✓								
16	<i>Gallinago hardwickii</i>	Latham's Snipe	Mi (W), Ma	R	EN	✓	✘	-		-	-	-	N	Unlikely
17	<i>Numenius madagascariensis</i>	Eastern Curlew	Mi (W), CE			✓								
18	<i>Pandion halliaetus</i>	Osprey	Mi (W)			✓								
19	<i>Tringa nebularia</i>	Common greenshank	MI (W)			✓								
20	<i>Rostratula australis = Rostratula benghalensis (sensu lato)</i>	Australian Painted-snipe = Painted Snipe	EN, Mi (W), Ma	V	EN	✓	✘	-		-	-	-	N	Unlikely

Species nomenclature has been updated to reflect the DEWNR Vertebrates Biological Database of South Australia (2015). **Listing status:** EPBC (National – Australia): *Environment Protection and Biodiversity Conservation Act 1999* (Cth). NPW (State – South Australia): *National Parks and Wildlife Act 1972* (SA). AMLR (Regional – Adelaide and Mount Lofty Ranges Region): regional conservation status from DEWNR (2013). **Listing status codes:** CR: Critically Endangered. DD: Data Deficient. E: Endangered. E*: Extinct. EN: Endangered. EX: Extinct. LC: Least Concern. Ma: Marine. Mi: Migratory. Mi (Ma): Migratory Marine. Mi (T): Migratory Terrestrial. Mi (W): Migratory Wetlands. NE: Not Evaluated. NT: Near Threatened. V: Vulnerable. VU: Vulnerable. R: Rare. RA: Rare. RE: Regionally Extinct.

TABLE 18-8 | SOUTH AUSTRALIAN-LISTED THREATENED FAUNA SPECIES PROVIDED IN THE PMR AND BDBSA AND THEIR LIKELIHOOD OF OCCURRENCE WITHIN THE BIRD-IN-HAND GOLD PROJECT SITE

No.	Species	Common	Listing			Source		No. BDBSA Records	Latest Record	Recorded within proposed ML (BDBSA 2014)	Distance from proposed ML (km) (BDBSA 2014)*	Recorded during Survey (2014) and Additional Inspections	Likelihood
			EPBC	NPW	AMLR	PMR	BDBSA						
Listed Threatened Under the <i>National Parks and Wildlife Act 1972 (SA)</i>													
BIRDS													
1.	<i>Accipiter novaehollandiae</i>	Grey Goshawk	-	E	-	✘	✓	1	1998	N	5	N	Unlikely
2.	<i>Actitis hypoleucos</i>	Common Sandpiper	Mi (Ma), Ma	R	EN	✘	✓	2	2001	N	12	N	Possible
3.	<i>Anas rhynchotis</i>	Australasian Shoveler	-	R	RA	✘	✓	78	2007	N	<1 – 12	N	Possible
4.	<i>Anhinga novaehollandiae</i>	Australasian Darter	-	R	VU	✘	✓	2	2003	N	9 – 12	N	Unlikely
5.	<i>Ardea ibis</i>	Cattle Egret	Mi (W), Ma	R	VU	✓	✘	-	-	-	-	N	Unlikely
6.	<i>Ardea intermedia</i>	Intermediate Egret	Ma	R	-	✘	✓	2	2001	N	10	N	Unlikely
7.	<i>Biziura lobata</i>	Musk Duck	Ma	R	VU	✘	✓	31	2007	N	1 – 12	N	Possible
8.	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black Cockatoo	-	V	VU	✘	✓	111	2012	N	35 – 360	Y	Confirmed
9.	<i>Cereopsis novaehollandiae</i>	Cape Barren Goose	Ma	R	RA	✘	✓	1	1994	N	8	N	Unlikely
10.	<i>Corcorax melanorhamphos</i>	White-winged Chough	-	R	RA	✘	✓	35	2012	N	2 – 14	Y	Confirmed
11.	<i>Coturnix ypsilophora</i>	Brown Quail	-	V	RA	✘	✓	1	1998	N	6	N	Possible
12.	<i>Falco peregrinus</i>	Peregrine Falcon	-	R	RA	✘	✓	10	2003	N	1 – 12	N	Likely
13.	<i>Falcunculus frontatus</i>	Crested Shrike-tit	-	R	EN	✘	✓	43	2004	N	<1 – 9	Y	Confirmed
14.	<i>Gallinago hardwickii</i>	Latham's Snipe	Mi (W), Ma	R	EN	✓	✘	-	-	-	-	N	Unlikely
15.	<i>Gerygone olivacea</i>	White-throated Gerygone	-	R	RA	✘	✓	6	1998	N	6 – 7	N	Possible
16.	<i>Glossopsitta pusilla</i>	Little Lorikeet	-	E	CR	✘	✓	2	1950	N	2 – 12	N	Unlikely
17.	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	Mi (T), Ma	E	EN	✓	✘	-	-	-	-	N	Unlikely
18.	<i>Leipoa ocellata</i>	Malleefowl	VU, Mi (T)	V	EN	✓	✘	-	-	-	-	N	Unlikely
19.	<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (south east ssp.)	-	V	CR	✘	✓	16	2009	N	5 – 10	N	Possible
20.	<i>Microeca fascinans fascinans</i>	Jacky Winter (south east ssp.)	-	R	CR	✘	✓	4	1999	N	6 – 12	N	Possible
21.	<i>Myiagra cyanoleuca</i>	Satin Flycatcher	Mi (T), Ma	E	-	✓	✘	-	-	-	-	N	Unlikely
22.	<i>Myiagra inquieta</i>	Restless Flycatcher	-	R	CR	✘	✓	12	1997	N	5 – 12	N	Possible
23.	<i>Neophema elegans</i>	Elegant Parrot	-	R	VU	✘	✓	2	2002	N	5 – 8	N	Possible
24.	<i>Oriolus sagittatus</i>	Olive-backed Oriole	-	R	RA	✘	✓	1	2002	N	12	N	Possible
25.	<i>Oxyura australis</i>	Blue-billed Duck	-	R	VU	✘	✓	15	2004	N	1 – 12	N	Possible
26.	<i>Pandion haliaetus</i>	Osprey	Mi (Ma), Ma	E	VU	✓	✘	-	-	-	-	N	Unlikely
27.	<i>Petroica boodang boodang</i>	Scarlet Robin (eastern ssp.)	-	R	VU	✘	✓	94	2007	N	5 – 12	N	Possible

No.	Species	Common	Listing			Source		No. BDBSA Records	Latest Record	Recorded within proposed ML (BDBSA 2014)	Distance from proposed ML (km) (BDBSA 2014)*	Recorded during Survey (2014) and Additional Inspections	Likelihood
			EPBC	NPW	AMLR	PMR	BDBSA						
28	<i>Petroica phoenicea</i>	Flame Robin	Ma	V	CR	✘	✓	5	2000	N	7 – 9	N	Possible
29	<i>Podiceps cristatus</i>	Great Crested Grebe	-	R	VU	✘	✓	2	2000	N	7 – 8	N	Unlikely
30	<i>Porzana tabuensis</i>	Spotless Crake	Ma	R	EN	✘	✓	4	2006	N	12	N	Unlikely
31	<i>Rostratula australis</i> = <i>Rostratula benghalensis (sensu lato)</i>	Australian Painted-snipe = Painted Snipe	EN, Mi (W), Ma	V	EN	✓	✘	-	-	-	-	N	Unlikely
32	<i>Stagonopleura guttata</i>	Diamond Firetail	-	V	EN	✘	✓	17	2002	N	5 – 12	N	Likely
33	<i>Stictonetta naevosa</i>	Freckled Duck	-	V	VU	✘	✓	7	2003	N	1 – 4	N	Possible
34	<i>Turnix varius</i>	Painted Buttonquail	-	R	VU	✘	✓	5	1977	N	1 – 5	N	Unlikely
35	<i>Zoothera lunulata</i>	Bassian Thrush	-	R	EN	✘	✓	10	2005	N	6 – 12	N	Possible
MAMMALS													
36	<i>Antechinus flavipes</i>	Yellow-footed Antechinus	-	V	RA	✘	✓	5	1999	N	7 – 13	N	Unlikely
37	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	-	R	RA	✘	✓	17	2002	N	5 – 12	Y	Confirmed
AMPHIBIANS													
38	<i>Pseudophryne bibronii</i>	Brown Toadlet	-	R	VU	✘	✓	2	2001	N	6 – 7	N	Possible

Species nomenclature has been updated to reflect the DEWNR Vertebrates Biological Database of South Australia (2015). **Listing status:** EPBC (National – Australia): *Environment Protection and Biodiversity Conservation Act 1999* (Cth). NPW (State – South Australia): *National Parks and Wildlife Act 1972* (SA). AMLR (Regional – Adelaide and Mount Lofty Ranges Region): regional conservation status from DEWNR (2013). **Listing status codes:** CR: Critically Endangered. DD: Data Deficient. E: Endangered. E*: Extinct. EN: Endangered. EX: Extinct. LC: Least Concern. Ma: Marine. Mi: Migratory. Mi (Ma): Migratory Marine. Mi (T): Migratory Terrestrial. Mi (W): Migratory Wetlands. NE: Not Evaluated. NT: Near Threatened. V: Vulnerable. VU: Vulnerable. R: Rare. RA: Rare. RE: Regionally Extinct.

18.3.1.1.2 STYGOFAUNA

The desktop stygofauna study undertaken by COOE reviewed:

- previous groundwater studies of the BiH project;
- groundwater dependent ecosystems and their relevance to stygofauna;
- the likelihood of stygofauna occurring within the BiH project footprint determined by summarising information relevant to stygofauna communities in South Australia;
- the historic and current activities of the BiH mine site with respect to groundwater, and;
- a review of legislation relevant to groundwater dependent ecosystems in South Australia.

Previous groundwater studies indicate a baseline understanding of the hydrogeology in the project area including current groundwater quality, aquifer types and initial bore census. However, despite historic mining activities at BiH, there is little quantitative data available to determine the extent of change over time to both groundwater quality and volume.

Datasets for stygofauna for the Woodside area are not available; the science of stygofauna is an emerging field, particularly in South Australia. However, a three year study (2008-2010) of stygofauna in South Australia indicated stygofauna were found in most spring habitats sampled in the Mount Lofty Ranges. Considering the existing data on the hydrogeology of the project area, such as presence of fractured rock aquifers with water qualities suitable for stygofauna, presence of a subsurface groundwater dependent ecosystems is was deemed likely.

Recommendations from this desktop study included a two-stage baseline stygofauna sampling survey which was undertaken by AC Environmental, and is described below in section 18.3.1.2.6.

18.3.1.2 FIELD SURVEY

Sites were selected within the proposed ML to conduct ground-dwelling mammal, reptile and bat trapping and passive bat and bird surveys (see Figure 18-1). Four sites were originally deemed suitable for trapping activities within the BIH proposed ML, based on vegetation associations that represent a range of the habitats present in the area. That is, those sites assessed as having a higher likelihood of presence due to fauna refuge potential. Due to private land access constraints restricting allowable activities, Site 4 became an active search, spotlighting and passive bird survey site only.

Active searching was conducted throughout the proposed ML, including potential habitat within the land parcel of proposed BIH activities (the “Project site”). Placement of harp traps for the bat survey were targeted and dependent upon the particular features of the survey area, such as potential flight paths between trees or adjacent to trees with obvious hollows, the occurrence of dense corridors of vegetation and the presence of water sources. Survey sites are shown in Figure 18-1.

A total of nine broad vegetation associations were identified across the Project site, predominantly comprising minor variations in *Eucalyptus leucoxylon ssp. leucoxylon* and *E. camaldulensis ssp. Woodland*. The Project site is considered to contain areas of high conservation value, with suitable habitat for listed flora and fauna species. In particular, listed flora species were recorded throughout the central parcel of native vegetation within the Project site (comprising five vegetation associations), while SA-listed bird species were recorded within the creekline of Goldwyn (Association 9).

The creekline of Goldwyn (Association 9) was not fauna surveyed in 2014 using trapping methods as this habitat was heavily impacted by cattle and horses and thus complete surveying was not considered by the consulting zoologists (COOE) as useful due to the presence of livestock.

The Project site was surveyed for mammals, reptiles, frogs and birds using a range of methodologies for four consecutive nights. A total of 1308 observations from 85 species within 46 families were recorded

during the fauna survey. Five bat species from two families were also identified from 2033 echolocation call sequences.

A total of 62 bird, 17 mammal, seven reptile and four amphibian species were recorded during the survey. Eight of the 17 mammal species comprised bats and of the nine ground-dwelling mammals, four were introduced species (all declared under the NRM Act). There were two introduced bird species observed from the 62 records.

No EPBC listed fauna was observed within the Project site.

The results of the fauna survey and methodology employed are located in Appendix Q1.

18.3.1.2.1 GROUND AND TREE-DWELLING MAMMALS

Sites 1 and 4 provided the highest total ground-dwelling mammal records and Sites 2 and 4 provided the greatest diversity. The most observed and ubiquitous native ground-dwelling mammal was the Western Grey Kangaroo (*Macropus fuliginosus*). The Common Brushtail Possum (*Trichosurus vulpecula*), listed as Rare under the NPW Act, was the second most observed species. Four of the nine species were introduced, including the European Brown Hare (*Lepus europaeus*), European Rabbit (*Oryctolagus cuniculus*) and Fox (*Vulpes vulpes*), all declared under the NRM Act.

Mammals identified by Terramin staff through 2014 to 2019 include Koalas (*Phascolarctos cinereus*), Eastern Grey Kangaroos (*Macropus giganteus*), Common Brushtail and Ringtail Possums (*Trichosurus vulpecula/Pseudocheirus peregrinus*), Bats (Lesser Long-eared (*Nyctophilus geoffroyi*) and the Little and Large Forest Bats (*Vespedalus vulturnus/Vespedalus darlingtoni*)).

Livestock within the proposed ML includes cattle within the southern domain. Two properties contain domestic animals, namely cats and chickens.

18.3.1.2.1.1 LISTED SPECIES

Of the three Commonwealth-listed and two SA-listed mammal species identified as potentially occurring within or surrounding the proposed ML, the October 2014 survey confirmed the presence of one SA-listed species, namely the Common Brushtail Possum (*Trichosurus vulpecula*). The regionally rare Common Ringtail Possum (*Pseudocheirus peregrinus*) was also recorded. It was identified as possible that the Grey-headed Flying-fox (*Pteropus poliocephalus*) may periodically utilise the proposed ML.

18.3.1.2.2 BIRDS

During the 2014 field survey a relatively high level of bird activity was observed, indicating relatively high bird diversity in consideration of the condition of some of the vegetation throughout the proposed ML. Site 1 provided the greatest abundance and diversity, with 30 species. This was closely followed-by Site 2, with Site 4 providing the lowest abundance and diversity. Birds from the Meliphagidae family were the most diverse group observed, with the New Holland Honeyeater (*Phylidonyris novaehollandiae*) the most recorded species. Two introduced species were recorded during the survey, namely the House Sparrow (*Passer domesticus*) and Common Blackbird (*Turdus merula*).

Additionally opportunistic surveying was undertaken from 2014 until the present day and avifauna surveying, using two observers, was undertaken within the Goldwyn creekline (Association 9) on 27 occasions between May and December 2018.

Additional species recorded either opportunistically or during the creekline surveying include the Tawny Frogmouth (*podargus strigoides*) and the Black-shouldered kite (*Elanus axillaris*).

No extra South Australian or EPBC listed avifauna species additional to what was recorded in the 2014 fauna survey have been observed.

A summary of Goldwyn creekline (Association 9) surveying in 2018 is below in Table 18-9.

TABLE 18-9 | AVIFAUNA SIGHTINGS RECORDED BETWEEN MAY AND DECEMBER 2018

Date	Common Name	Scientific name	Number of birds sighted
9/05/2018	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	2
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	21
	Australian Magpie	<i>Gymnorhina tibicen</i>	1
	BooBook Owl	<i>Ninox novaeseelandiae</i>	1
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	2
21/05/2018	Common Black Bird	<i>Turdus Merula</i>	2
	Australian Magpie	<i>Gymnorhina tibicen</i>	6
	Crimson Rosella	<i>Platycercus elegans</i>	5
23/05/2018	Black-shouldered Kite	<i>Elanus axillaris</i>	2
24/05/2018	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	1
31/05/2018	Australian Magpie	<i>Gymnorhina tibicen</i>	2
	Crimson Rosella	<i>Platycercus elegans</i>	11
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	2
	Yellow Thornbill	<i>Acanthiza nana</i>	15
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	20+
	White Fronted honeyeater	<i>Purnella albifrons</i>	15+
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	8
	Striped Honeyeater	<i>Plectorhyncha lanceolata</i>	5
	Australian Magpie	<i>Gymnorhina tibicen</i>	1
	Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	1
	Spiny cheeked Honeyeater	<i>Acanthageny rufogularis</i>	3
4/06/2018	Little Wattlebird	<i>Anthochaera chrysoptera</i>	10
	Australian Magpie	<i>Gymnorhina tibicen</i>	2
	Crimson Rosella	<i>Platycercus elegans</i>	9
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	2
	Yellow-rumped thornbill	<i>Acanthiza chrysorrhoa</i>	2
	Striped Honeyeater	<i>Plectorhyncha lanceolata</i>	8
	Grey Currawong	<i>Strepera versicolor</i>	1
	Brown thornbill	<i>Acanthiza pusilla</i>	2
	musk lorikeet	<i>Glossopsitta concinna</i>	30
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	2
15/06/2018	Little Wattlebird	<i>Anthochaera chrysoptera</i>	5
	Striped Honeyeater	<i>Plectorhyncha lanceolata</i>	5
	Crimson Rosella	<i>Platycercus elegans</i>	2
	Black-shouldered Kite	<i>Elanus axillaris</i>	1

Date	Common Name	Scientific name	Number of birds sighted
22/06/2018	Striped Honeyeater	<i>Plectorhyncha lanceolata</i>	17
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	7
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	9
	Crimson Rosella	<i>Platycercus elegans</i>	1
27/06/2018	Black-shouldered Kite	<i>Elanus axillaris</i>	1
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	7
	Striped Honeyeater	<i>Plectorhyncha lanceolata</i>	17
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	7
	Crimson Rosella	<i>Platycercus elegans</i>	8
3/07/2018	Superb Fairy-wren	<i>Malurus cyaneus</i>	2
	Little Raven	<i>Corvus mellori</i>	1
	Crimson Rosella	<i>Platycercus elegans</i>	12
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	10
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	9
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	8
	Silvereye	<i>Zosterops lateralis</i>	10
	Black-shouldered Kite	<i>Elanus axillaris</i>	1
	Silvereye	<i>Zosterops lateralis</i>	10
9/07/2018	Australian Magpie	<i>Cracticus tibicen</i>	13
	Little Raven	<i>Corvus mellori</i>	5
	Black-shouldered Kite	<i>Elanus axillaris</i>	1
	New Holland Honeyeater	<i>phylidonyris novaehollandiae</i>	10
	Crimson Rosella	<i>Platycercus elegans</i>	17
	Silvereye	<i>Zosterops lateralis</i>	7
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	15
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	5
	Musk lorikeet	<i>Glossopsitta concinna</i>	3
18/07/2018	Australian Magpie	<i>Cracticus tibicen</i>	9
	Crimson Rosella	<i>Platycercus elegans</i>	10
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	15
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	9
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	14
	Silvereye	<i>Zosterops lateralis</i>	17
	Crow	<i>Corvus splendens</i>	4
	Musk lorikeet	<i>Glossopsitta concinna</i>	2
25/07/2018	House Sparrow	<i>Passer domesticus</i>	2
	Red-Browed Finch	<i>Neochmia temporalis</i>	11
	Superb Fairy-wren	<i>Malurus cyaneus</i>	3
	Black Bird	<i>Turdus Merula</i>	6
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	3
	Australian Magpie	<i>Cracticus tibicen</i>	2
	New Holland Honeyeater	<i>phylidonyris novaehollandiae</i>	43
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	27
	Silvereye	<i>Zosterops lateralis</i>	16

Date	Common Name	Scientific name	Number of birds sighted
	Inland Thornbill	<i>Acanthiza apicalis</i>	1
	Crimson Rosella	<i>Platycercus elegans</i>	6
30/07/2018	Crow	<i>Covus splendens</i>	5
	Superb Fairy-wren	<i>Malurus cyaneus</i>	7
	Red-Browed Finch	<i>Neochmia temporalis</i>	9
	Australian Magpie	<i>Cracticus tibicen</i>	2
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	6
	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	2
	Crimson Rosella	<i>Platycercus elegans</i>	6
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	48
	Silvereye	<i>Zosterops lateralis</i>	22
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	14
8/08/2018	Kookaburra	<i>Dacelo novaeguineae</i>	3
	House Sparrow	<i>Passer domesticus</i>	1
	Crow	<i>Covus splendens</i>	1
	Australian Magpie	<i>Cracticus tibicen</i>	2
	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	1
	Superb Fairy-wren	<i>Malurus cyaneus</i>	4
	Crimson Rosella	<i>Platycercus elegans</i>	8
	Tawny frogmouth	<i>Podargus strigoides</i>	1
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	18
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	14
	Silvereye	<i>Zosterops lateralis</i>	10
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	3
17/08/2018	Crow	<i>Covus splendens</i>	2
	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	6
	Australian Magpie	<i>Cracticus tibicen</i>	3
	Red-Brown Finch	<i>Neochmia temporalis</i>	3
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	23
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	33
	Silvereye	<i>Zosterops lateralis</i>	60
	Tree Martin	<i>Petrochelidon nigricans</i>	30
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	3
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	4
	Crimson Rosella	<i>Platycercus elegans</i>	3
	Magpie-Lark	<i>Grallina cyanoleuca</i>	2
23/08/2018	Little Wattlebird	<i>Anthochaera chrysoptera</i>	13
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	6
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	14
	Silvereye	<i>Zosterops lateralis</i>	10
	Black-shouldered Kite	<i>Elanus axillaris</i>	1
	Australian Magpie	<i>Cracticus tibicen</i>	3
	Crimson rosella	<i>Platycercus elegans</i>	4
24/08/2018	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	1

Date	Common Name	Scientific name	Number of birds sighted
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	1
	Silvereye	<i>Zosterops lateralis</i>	7
	Superb Fairy-wren	<i>Malurus cyaneus</i>	1
	Red-Browed Finch	<i>Neochmia temporalis</i>	3
	Australian Magpie	<i>Cracticus tibicen</i>	1
	Black Bird	<i>Turdus Merula</i>	1
	House Sparrow	<i>Passer domesticus</i>	1
	Crow	<i>Covus splendens</i>	1
14/09/2018	Silvereye	<i>Zosterops lateralis</i>	12
	Little wattlebird	<i>Anthochaera chrysoptera</i>	11
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	8
	Kookaburra	<i>Dacelo novaeguineae</i>	2
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	4
	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	3
	Crimson Rosella	<i>Platycercus elegans</i>	5
	Australian Magpie	<i>Cracticus tibicen</i>	2
	Black Bird	<i>Turdus merula</i>	2
17/09/2018	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	5
	Black Bird	<i>Turdus merula</i>	2
	Crimson Rosella	<i>Platycercus elegans</i>	17
	Crow	<i>Covus splendens</i>	2
	Silvereye	<i>Zosterops lateralis</i>	12
	Little Wattlebird	<i>Anthochaera chrysoptera</i>	7
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	4
	Australian Magpie	<i>Cracticus tibicen</i>	2
5/10/2018	Little Wattlebird	<i>Anthochaera chrysoptera</i>	6
	Silvereye	<i>Zosterops lateralis</i>	8
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	10
	Australian Magpie	<i>Cracticus tibicen</i>	2
	Crimson Rosella	<i>Platycercus elegans</i>	2
12/10/2018	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	17
	Silvereye	<i>Zosterops lateralis</i>	19
	Australian Magpie	<i>Cracticus tibicen</i>	5
	Straited Thornbill	<i>Acanthiza lineata</i>	3
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	2
	House Sparrow	<i>Passer domesticus</i>	4
	Black Bird	<i>Turdus merula</i>	3
	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	2
	Common Bronzewing	<i>Phaps chalcoptera</i>	2
	Superb Fairy-wren	<i>Malurus cyaneus</i>	3
22/10/2018	Red-Browed Finch	<i>Neochmia temporalis</i>	3
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	3
	House Sparrow	<i>Passer domesticus</i>	2
	Black Bird	<i>Turdus merula</i>	3

Date	Common Name	Scientific name	Number of birds sighted
	Superb Fairy-wren	<i>Malurus cyaneus</i>	5
2/11/2018	Black Bird	<i>Turdus merula</i>	2
	Crow	<i>Covus splendens</i>	3
	Red-Browed Finch	<i>Neochmia temporalis</i>	3
	Galah	<i>Eolophus (Cacatus) roseicapilla</i>	1
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	12
	Superb Fairy-wren	<i>Malurus cyaneus</i>	5
7/11/2018	Little Wattle	<i>Anthochaera chrysoptera</i>	3
	Black Bird	<i>Turdus merula</i>	2
	Crow	<i>Covus splendens</i>	2
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	3
	Australian Magpie	<i>Cracticus tibicen</i>	1
	Common Bronzewing	<i>Phaps chalcoptera</i>	2
	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	2
15/11/2018	Common Bronzewing	<i>Phaps chalcoptera</i>	1
	Little Wattle	<i>Anthochaera chrysoptera</i>	3
	Black Bird	<i>Turdus merula</i>	2
	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	2
	Australian Magpie	<i>Cracticus tibicen</i>	1
	New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	4
18/12/2018	Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>	3
	Galah	<i>Eolophus roseicapilla</i>	4
	Black Bird	<i>Turdus merula</i>	2
	Superb Fairy-wren	<i>Malurus cyaneus</i>	2

18.3.1.2.2.1 LISTED SPECIES

Of the ten Commonwealth-listed threatened, 14 migratory and 35 SA-listed threatened bird species identified as potentially occurring within or surrounding the proposed ML, the October 2014 survey confirmed the presence of three SA-listed species. The vulnerable Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) and rare White-winged Chough (*Corcorax melanorhamphos*) and Crested Shrike-tit (*Falcunculus frontatus*) were recorded within the Project site. Of the five *C. funereus* records, three were identified within the creekline of the Project site (Association 9). All seven records of *C. melanorhamphos* were also located in the creekline of the Project site, in addition to two *C. melanorhamphos* nests in the same vicinity, indicating the habitat value provided by this area. In 2017 a body of a *C. melanorhamphos*, apparently killed by a cat, was observed in Association 9, subsequently this association was surveyed fortnightly throughout 2018 but no *C. melanorhamphos* have been observed subsequently.

18.3.1.2.3 INSECTIVOROUS BATS (MICROBATS)

The majority of microbat taxa regarded as resident in the Adelaide Hills region were identified by echolocation call sequences. However, the majority of call sequences (49.5%) could only be identified to the level of species group rather than species.

There was a relatively low capture success during the harp trapping, and no bats were captured during mist netting. The predominantly open canopy structure of the *Eucalypt* woodland across the survey area is likely to have influenced the low numbers of bats caught in harp traps. The abundance of permanent sources of standing water (e.g. farm dams) within the survey area, and on adjacent properties, is likely to have influenced the lack of capture success during mist netting. Conducting additional mist net surveys at water bodies during the hottest summer months may yield a greater capture rate and provide a more accurate representation of the diversity and abundance of microbat species present in the region.

18.3.1.2.4 REPTILES, FROGS AND FISH

Sites 1 and 2 provided the highest total reptile records, with Site 2 providing the greatest number of species. The most abundant species was the Garden Skink (*Lampropholis guichenoti*). All nine frog captures occurred at Site 3, with the remaining records occurring opportunistically. No reptile or frog species recorded during the October 2014 survey were listed under the EPBC Act or the NPW Act. The Brown Tree Frog (*Litoria ewingii*) was recorded during the survey and is listed as regionally rare within AMLR. In undertaking the threatened fauna assessment, the Eastern Tiger Snake (*Notechis scutatus*), listed as regionally endangered, that is in the Adelaide Mount Lofty Ranges region (AMLR) was identified as possibly occurring within the proposed ML. During the 2016 macroinvertebrate sampling survey in the Inverbrackie creek downstream of the Woodside-Nairne road bridge, at the 'Wicks' site, a Mountain Galaxias (*Galaxias olidus*), rated as vulnerable in AMLP was opportunistically sampled identified and released (Appendix I1). Reptiles and amphibians identified opportunistically between 2014 and 2019 thus far have been limited to a single Whip Snake (*Parasuta flagellum*), either a Red bellied black snake (*Pseudechis porphyriacus*) or an Eastern Tiger Snake (*Notechis scutatus*), Brown Snakes (*Pseudonaja textilis*), Eastern long necked turtles (*Chelodina longicollis*), Southern brown tree frog (*Litoria ewingii*) and Banjo Frogs (*Limnodynastes dumerilii*).

18.3.1.2.5 MACROINVERTEBRATES

Macroinvertebrate monitoring indicated that the community structure varied significantly between 2014 and 2016 sampling events. However comparisons between the sites within a sampling year showed that there was as much variability between the replicate samples from within each location as there was between the locations. Microcruscea, amphipods and midge larvae dominated the abundances at Polo Bridge and Wicks areas. In 2014 filter feeders were evident at Polo Bridge indicating significant flow. However in 2016 mosquito larvae dominated the abundances suggesting stagnant water.

Higher taxa richness was evident at the upstream site on both sampling occasions. Stream Invertebrate Grade Number – Average Level (SIGNAL) scores that are indices of stream health derived from the macroinvertebrate community structure indicated a downstream decline in health. A comparison of the data from this study with that obtained by the EPA in 2013 indicated a reduction in taxa richness and health of the stream. Since the sampling in 2013 where the EPA classified the creek as being highly disturbed and of poor quality, the health of the stream has been shown to decrease in health with each sampling year. Confounding this data is the timing of the sampling. As the creek is ephemeral taxa richness is expected to be higher after continued rainfall. Typically rainfall allows flushing, dilution of highly concentrated water quality parameters, particularly salinity, and also would provide increased habitat availability. Many mobile insects and particularly more pollution sensitive taxa, would colonise the creek, after periods of extended rainfall and warmer temperatures.

The macroinvertebrate investigation and report is located in Appendix I1.

18.3.1.2.6 STYGOFAUNA

The report assesses the recommendation by COOE (2014) for a two-stage baseline stygofauna sampling survey in conjunction with groundwater quality sampling, and thus has been undertaken between 2014 and 2017. Sampling locations are shown in Figure 18-7. AC Environmental was engaged by Terramin to undertake further stygofauna investigation and field work, obtaining samples from representative bores within the Project locality, as shown in Figure 18-7.

The projects objectives were to confirm the presence or absence of Stygofauna in seven groundwater samples; provide a report on search effort, GW water quality for sample, geological unit; and provide items of interest and proposed distance to underground operations. Water quality data collected during the survey indicated wide varying results within and between sites during the sampling process. pH was most acidic at 6628-8301 although the most acidic reading was recorded from 6628-8945. Dissolved Oxygen readings varied greatly and it is suggested that the sampling methodology would have influenced the recordings through artificial aeration. TDS were similar at all sites but with 6628-8301 appearing considerably higher than all other sites. Electrical Conductivity was also the highest at 6628-8301. 231086 was the only site to exhibit readings that were consistently below the previously reported favourable threshold of 1.5 mS/cm. High ions were recorded at 6628-8301, which is indicative of the high EC recorded from the site. Na⁺ and Cl⁻ dominated the ion concentration. High levels of Manganese were recorded at 231090, 231086 and 6628-8301. A high concentration of Total Nitrate was recorded at 6628-231087 with 1.0 mg/L and at 6628-8301 with 3.4 mg/L. All other readings were below drinking water trigger values. Examination of the stygofauna samples indicated no stygofauna were present in any of the samples. While some fauna were identified they were all of terrestrial origin. The conditions of the bores at BIHGP suggest that they not conducive to the presence of Stygofauna.

Stygofauna sampling was undertaken again in 2017 from IB bores 1, 2, and 5 and from two bores on the Goldwyn property, 6628-9156 and 6628-8942. No Stygofauna were found and the report completed in 2018 concluded that the water quality, conditions of the bores (depth to water and seasonal abstraction), and structure and connectivity of the groundwater bearing fractures suggest that the area is not conducive to the presence of Stygofauna.

The stygofauna investigation is located in Appendix Q3 (2016) and Q4 (2018).

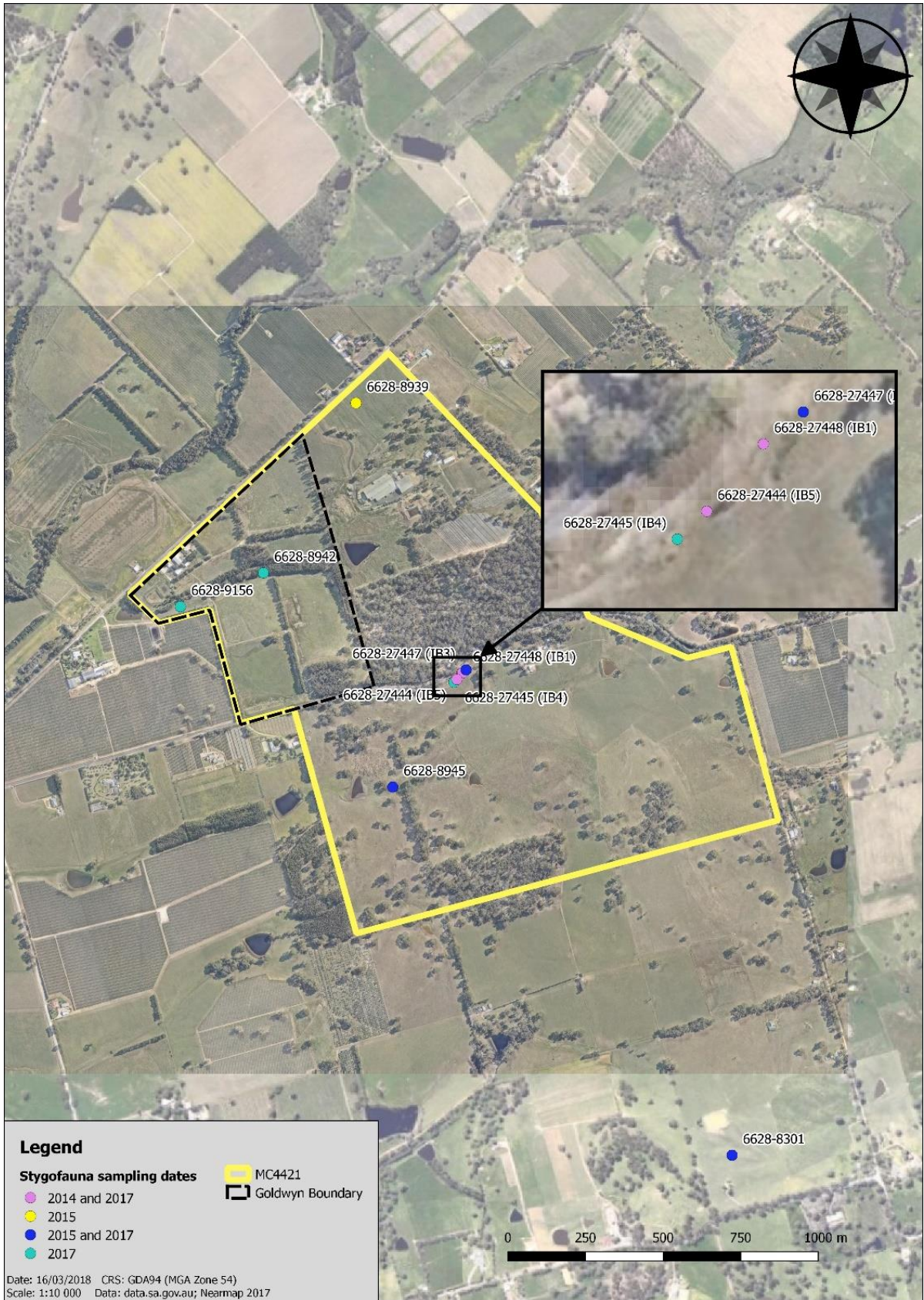


FIGURE 18-7 | STYGOFAUNA SAMPLE LOCATIONS

18.4 PESTS AND KEY THREATENING PROCESSES

There is significant evidence of fox, rabbit, hare, feral cat and European wasp occupation within the proposed ML. The PMST identified 22 invasive vertebrate species potentially occurring within a five kilometre radius of the Project site, comprising 11 birds and 11 mammals (Table 18-10). Table 18-1 identifies requirements from PIRSA's declared animals list and also the AMLR NRM Board's pest management hierarchy. The pest management hierarchy recommends management actions for target pest plants and animals.

Four of the nine ground and tree dwelling mammal species observed onsite were introduced, with the European Brown Hare (*Lepus europaeus*) and the European Rabbit (*Oryctolagus cuniculus*) equally the most observed species. Of the two Black Rat (*Rattus rattus*) observations, one was recorded as roadkill adjacent the proposed ML on Pfeiffer Road. Droppings at Site 2 indicated the presence of the Fox (*Vulpes vulpes*). All four introduced mammal species are declared under the NRM Act.

TABLE 18-10 | INVASIVE VERTEBRATE SPECIES IDENTIFIED IN PMR AND CORRESPONDING MANAGEMENT REQUIREMENTS IN SA

No.	Family	Scientific Name	Common Name	SA Manage. Reqs.		Recorded during Survey (2014)
				NRM Act	AMLR	
BIRDS						
	ALAUDIDAE	<i>Alauda arvensis</i>	Eurasian Skylark	C R	Manage Sites	N
	ANATIDAE	<i>Anas platyrhynchos</i>	Mallard (Northern Mallard)	C R	Manage Pests	N
	COLUMBIDAE	<i>Columba livia</i>	Feral Pigeon [Rock Dove]	C R	Manage Pests	N
	COLUMBIDAE	<i>Spilopelia chinensis</i>	Spotted Dove	C R	Contain	N
	FRINGILLIDAE	<i>Carduelis carduelis</i>	European Goldfinch	C R	-	N
	FRINGILLIDAE	<i>Chloris chloris</i>	European (Common) Greenfinch	C R	-	N
	PASSERIDAE	<i>Passer domesticus</i>	House Sparrow	C R	Manage Pests	Y
	PYCNONOTIDAE	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	-	-	N
	STURNIDAE	<i>Sturnus tristis</i>	Common (Indian) Mynah	-	-	N
	STURNIDAE	<i>Sturnus vulgaris</i>	Common Starling	M R	Manage Pests	N
	TURDIDAE	<i>Turdus merula</i>	Common Blackbird	C R	Manage Pests	Y
MAMMALS						
	BOVIDAE	<i>Bos taurus</i>	Cattle (European Cattle)	C R	-	N
	BOVIDAE	<i>Capra hircus</i>	Goat (Feral Goat)	Cp Np P R	Contain	N
	CANIDAE	<i>Canis lupus familiaris</i>	Feral Dog	C R	Protect Sites	N
	CANIDAE	<i>Vulpes vulpes</i>	Fox (Red Fox)	C M P R S	Protect Sites	Y
	FELIDAE	<i>Felis catus</i>	Domestic Cat (Feral Cat)	C R	Manage Pests	N
	LEPORIDAE	<i>Lepus europaeus</i>	European Brown Hare	C M P R S	Protect Sites	Y
	LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit (European Rabbit)	C M P R S	Destroy	Y
	MURIDAE	<i>Mus musculus</i>	House Mouse	P R	Protect Sites	N
	MURIDAE	<i>Rattus norvegicus</i>	Brown Rat (Sewer Rat, Norway Rat)	P R	Manage Pests	N
	MURIDAE	<i>Rattus rattus</i>	Black Rat (Ship Rat, Roof Rat)	P R	Manage Pests	Y
	SUIDAE	<i>Sus scrofa</i>	Pig (Feral Pig)	C R	Manage Pests	N

Species nomenclature has been updated to reflect the DEWNR Vertebrates Biological Database of South Australia (2015). **SA Manage. Reqs.:** **NRM Act** (State – South Australia): Natural Resources Management Act 2004 (SA). **AMLR** (Regional – Adelaide and Mount Lofty Ranges Region): Pest Prioritisation Management Actions (AMLR NRM Board 2009). **SA Manage. Reqs. codes:** **C:** Control required in whole of State. **Cn:** Control not required (but sale prohibited). **Cp:** Control required in part of State. **D:** Must be destroyed. **M:** Movement into control area prohibited. **N:** Notifiable throughout the State. **Np:** Notifiable in part of the State only. **P:** Possession prohibited. **R:** Release prohibited. **S:** Sale prohibited.

18.5 SENSITIVE RECEPTORS

Sensitive receptors include all kinds of native fauna including both conservation significant under the EPBC Act and/or the NPW Act. Even though, no conservation significant fauna listed in the EPBC Act have been identified through field surveys, nor is the site likely to encounter any, these species are still included as receptors to be conservative.

TABLE 18-11 | SENSITIVE RECEPTORS

Sensitive Receptor	Summary	Impact ID
Native fauna (conservation significant)	Includes conservation significant fauna listed under the EPBC Act and/or the NPW Act, as described in section 18.3.1.2. No conservation significant fauna listed in the EPBC Act have been identified through field surveys.	PIE_18_02 PIE_18_09 PIE_18_11
Native fauna (not conservation significant)	All other native Australian fauna understood to inhabit the area, as identified in section 18.3.1.2.	PIE_18_03 PIE_18_10 PIE_18_12
Native fauna (inclusive)	All native Australian fauna collectively (both conservation and not conservation significant).	PIE_18_01 PIE_18_04 PIE_18_05 PIE_18_06 PIE_18_07 PIE_18_08 PIE_18_13 PIE_18_14 PIE_18_15

18.6 POTENTIALLY IMPACTING EVENTS

The vast majority of potentially impacting events which could directly impact identified receptors (native fauna) is the clearance of vegetation within the ML.

Other identified potentially impacting events include the risk of a bushfire emanating from the site, and other indirect impacts which include the potential for disturbance of native fauna populations, from lighting, noise, air quality and vibration. Potential impacts to fauna from blasting, including vibration and air-overpressure, have been included in Chapter 17. Potential impacts to aquatic ecosystems have been included in Chapter 11.

Potentially impacting events through the operational phase of the project include the potential for vehicle strike onsite, as well as native fauna becoming attracted to putrescible waste, which then leads to increased interaction with humans, resulting in elevated levels of fauna mortality. The other potentially impacting event regarding waste includes the potential for an increase in pest species from

also being attracted to putrescible waste, which results in increased human interaction, which can lead to injury or death.

The other identified potentially impact event concerns the drawdown of groundwater in the vicinity of the NVHA area impacting health of the vegetation and habitat types, which has the potential to host conservation significant fauna species. An additional groundwater and ecological technical study was completed by Golder Associates Pty Ltd (Golder) based upon this premise (see Appendix R5), and further confirmed in 2018 during the drilling of a Managed Aquifer Recharge bore, which confirmed the depth to water being below where tree roots could source groundwater and hence the drawdown of any groundwater east of Reefton road will not impact ecosystem health.

Potentially impacting events through construction include the risk of fauna becoming trapped in excavations.

TABLE 18-12 | IDENTIFIED POTENTIALLY IMPACTING EVENTS

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Lighting at mine site results in altered behaviour patterns of fauna (e.g. bat species, possums)	Operation	Mine site lighting	Phototrophic behaviours, attraction of insectivorous species	Native fauna	Yes	PIE_18_01
Direct mortality or injury of conservation significant species as a result of vehicle strike	Construction, Operation, Closure	Moving vehicles	Vehicle collision with native fauna	Native fauna (conservation significant)	Uncertain	PIE_18_02
Direct mortality or injury of fauna (not conservation significant) as a result of vehicle strike	Construction, Operation, Closure	Moving vehicles	Vehicle collision with native fauna	Native fauna (not conservation significant)	Uncertain	PIE_18_03
Fauna captured in temporary open trenches and excavations resulting in injury/ mortality	Construction	Open trenches and excavations	Accidental capture of fauna	Native fauna	Yes	PIE_18_04

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Noise / vibration/ disturbance at mine site has the potential to alter the behaviour patterns of fauna	Construction, Operation, Closure	Noise and vibration generated from mining operations	Soundwave transmission	Native fauna	No	PIE_18_05
Mining operation activities have the potential to cause fires that result in injury or death of fauna and/or loss of habitat	Construction, Operation, Closure	Fire caused by mining operations	Consumption of habitat as fuel for uncontrolled fire	Native fauna	Yes	PIE_18_06
Native fauna attracted to putrescible waste leads to increased interaction with humans, resulting in elevated levels of fauna mortality	Construction, Operation, Closure	Putrescible waste materials	Interaction with humans and vehicle activity	Native fauna	Uncertain	PIE_18_07
Water stored in the water storage dam has the potential to impact on native fauna drinking or visiting the dam waters	Construction, Operation, Closure	Water storage dam	Physical contact or consumption of water	Native fauna	No	PIE_18_08
Clearance of vegetation results in reduction of habitat for conservation significant fauna	Construction, Operation	Vegetation clearance	Loss of habitat	Native fauna (conservation significant)	No	PIE_18_09
Clearance of vegetation results in reduction of habitat for fauna (not conservation significant)	Construction, Operation	Vegetation clearance	Loss of habitat	Native fauna (not conservation significant)	No	PIE_18_10

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Vegetation clearance results in direct mortality of native fauna (conservation significant)	Construction, Operation	Vegetation clearance	Physical impact of clearance machinery and falling trees	Native fauna (conservation significant)	No	PIE_18_11
Vegetation clearance results in direct mortality of native fauna (not conservation significant)	Construction, Operation	Vegetation clearance	Physical impact of clearance machinery and falling trees	Native fauna (not conservation significant)	Yes	PIE_18_12
Introduction and establishment of new invasive species has the potential to impact on native fauna and habitat	Construction, Operation, Closure	Invasive species	Introduced to site from offsite vehicle and human traffic movements	Native fauna	Yes	PIE_18_13
Increased populations of pest animal species as a result of mining operations (e.g. attracted to landfills, putrescible waste) results in increased competition with, or predation upon, native fauna	Construction, Operation, Closure	Pest animals attracted to putrescible waste materials	Competition or predation	Native fauna	Uncertain	PIE_18_14
Rehabilitation, landscaping and screening on the ML increases area of fauna habitat	Operation, Closure, Post-closure	Landscaping, screening and rehabilitation of disturbed land	Vegetation, soil and landforms	Native fauna	Yes - benefit	PIE_18_15

18.7 CONTROL MEASURES TO PROTECT ENVIRONMENT

18.7.1 DESIGN MEASURES

The site has been designed specifically to avoid clearing any significant trees, but also to reduce the clearance of the existing agroforestry vegetation on the Goldwyn property. No significant trees will be cleared in the construction of the creek crossing or any of the operational area.

The site contains agroforestry trees located alongside the primary drainage line located within the proposed site, as well as along primary fencelines, which were planted in 1992. Species include New South Wales Spotted Gums (*Corymbia maculata*), Tasmanian Blue Gums (*Eucalyptus leucoxylon ssp.*) and Victorian Casuarinas (*Allocasuarina ssp.*).

Terramin propose to harvest two small areas of these agroforestry trees, the proposed locations of which are shown in Figure 18-8. This includes an area of approximately 50m x 30m to allow the construction of a culvert to gain HV access to the site, and a single 150m line of New South Wales Spotted Gums (*Corymbia maculata*) to allow the water treatment area to be constructed.

Other design measures that have been incorporated into the site design in order to reduce the likelihood and potential severity of edge effects, including lighting, noise, air quality and vibration is the 30 metre buffer zones around the remnant vegetation block and the central riparian area, as shown in Figure 18-8, as well as the significant revegetation planning to increase available habitat.

Design measures specifically regarding noise, air quality, vibration, groundwater and surface water are located in the corresponding chapters (see Table 18-13).

TABLE 18-13 | LOCATION OF DESIGN MEASURES IN OTHER CHAPTERS

Aspect	Chapter
Noise	Chapter 16
Air Quality	Chapter 15
Air overpressure and Vibration	Chapter 17
Groundwater	Chapter 10
Surface Water	Chapter 11



FIGURE 18-8 | PROPOSED AGROFORESTRY CLEARANCE

TABLE 18-14 | DESIGN MEASURES: FAUNA

Design Measures	Impact ID
Site design includes buffer zones of endemic native vegetation of 30m around remnant vegetation (Vegetation Heritage Agreement Area)	PIE_18_01
Site design includes buffer zones of endemic native vegetation of 30m around riparian zones (excluding constructed culvert over drainage line)	PIE_18_01
No clearance of native vegetation including significant trees	PIE_18_09 PIE_18_10 PIE_18_11 PIE_18_12
Limited clearance of agroforestry trees	PIE_18_09 PIE_18_10 PIE_18_11 PIE_18_12
Fire access tracks and fire breaks incorporated into site design	PIE_18_06
Topsoil to be used on landscape and amenity bunding prior to revegetation	PIE_18_15
Topsoil to be used on rehabilitated landforms through the closure earthworks phase	PIE_18_15
Bunding and storage of hazardous chemicals as per AS standards	PIE_18_07
Topsoil stockpile height designed to limit compaction (3m)	PIE_18_15
Managed Aquifer Recharge system – maintain water levels in NVHA	PIE_18_09 PIE_18_10 PIE_18_11 PIE_18_12
Pre-Excavation Grouting – maintain water levels in NVHA	PIE_18_09 PIE_18_10 PIE_18_11 PIE_18_12
Endemic vegetation chosen which will grow in local soil types	PIE_18_15
Irrigation system on landscape bunding to establish vegetation if required	PIE_18_15
Revegetation hare fenced to guard against grazing pressure	PIE_18_15
Lighting has been designed to minimise light spill. Orange lighting reduces bugs, reduces birds/bats, and reduces possibility of vehicle strike. Low level fixed lighting. Use of reflectors along pathways, etc reduces need for lighting along pathways at night.	PIE_18_01
Operational areas and water storage dam will be fenced off, restricting access of ground-dwelling fauna	PIE_18_08

18.7.2 MANAGEMENT STRATEGIES

Management strategies relevant to protect, preserve and enhance the native habitat are listed below thematically around aspects including fire, soil, air quality, and weeds and plant pathogens. Primarily, Landscape Function Analysis (LFA) will be used as a tool to enable active, adaptive natural resource management planning and on-ground works based upon the prior year's results. LFA uses simple indicators to assess how well an ecosystem works as a biochemical system, and is able to identify deficiencies in revegetation, including erosion features, to allow alternative management practices to be implemented.

Management strategies specifically regarding noise, air quality, vibration, groundwater and surface water are located in the corresponding chapters (see Table 18-15).

TABLE 18-15 | LOCATION OF MANAGEMENT STRATEGIES IN OTHER CHAPTERS

Aspect	Chapter
Noise	Chapter 16
Air Quality	Chapter 15
Air overpressure and Vibration	Chapter 17
Groundwater	Chapter 10
Surface Water	Chapter 11

TABLE 18-16 | CONTROL AND MANAGEMENT STRATEGIES: FAUNA

Management Strategies	Impact ID
Landscape Function Analysis allows active adaptive management of vegetation	PIE_18_13 PIE_18_14
Bushland Condition Monitoring on control sites to track vegetation health	PIE_18_15 PIE_18_05
Biodiversity Management Plan (includes orchid propagation option)	PIE_18_15 PIE_18_05
Native Vegetation Heritage application for remnant vegetation implemented post-closure	PIE_18_15 PIE_18_05
Fire	
Equipment maintenance schedule to reduce fire risk associated with equipment	PIE_18_06
Fire suppression equipment located within all LVs and HVs and at points onsite	
Fire hydrants and tanks located onsite	
Dig/land disturbance permits to be signed off by Environment Superintendent	
Hot Work Permits to reduce bushfire risk	
Fuel reduction strategies included in the Biodiversity Management Plan	
Site based water truck for rapid response	
Training of personnel for emergency situations including bushfire	
Emergency Response Plan	
Soil	
Spray seeding of landscape and amenity bunds with native grass to reduce dust and erosion	PIE_18_15
Implementation of Soil Contamination Management Plan	PIE_18_15
Erosion control strategies (erosion logs and silt fencing through construction, establishment of WSUD swales through natural drainage lines)	PIE_18_15
Topsoil management plan to control topsoil placement and avoid compaction through operations. Includes annual testwork for anions and cations.	PIE_18_15
Seeding of stockpiles to reduce erosion and dust potential	PIE_18_05
Waste management plans including spill response plans, clean up kits, etc.	PIE_18_07
Air quality (dust)	
Air quality Management Plan (dust control) and TARP	PIE_18_05
Noise	
Noise Trigger, Action and Response Plan (TARP)	PIE_18_05
Weeds, pests and plant pathogens	
Weed and Pest Management Plan – prevent spread and/or increase of weeds and pests within the operational area of the ML (Goldwyn), based on active adaptive management of weeds and pests	PIE_18_13
Phytophthora and Phylloxera Management Plan	PIE_18_13
Waste	
Implementation of Waste Management Plan	PIE_18_14
Traffic	

Management Strategies	Impact ID
Onsite speed limit included in Traffic Management Plan to avoid collisions with native fauna	PIE_18_02 PIE_18_03
Construction works	
Ramps in excavations to allow fauna to escape	PIE_18_04
Inspection of trenches by environmental staff	PIE_18_04
Temporary fencing around construction works	PIE_18_04
Non-remnant vegetation will be checked for the presence of fauna immediately prior to clearing	PIE_18_09 PIE_18_10

18.8 IMPACT ASSESSMENT

This section describes the expected and identified potential impacts to fauna associated with the Project.

Terramin propose to harvest two small areas of these agroforestry trees, the proposed locations of which are shown in Figure 18-8. This includes an area of approximately 50m x 30m to allow the construction of a culvert to gain HV access to the site, and a single 150m line of New South Wales Spotted Gums (*Corymbia maculata*) to allow the water treatment area to be constructed.

The likelihood of the presence of threatened fauna in these areas is **very low to rare**. The property has had unfettered stock access and was grazed by cattle and horses in both of these areas for decades prior to Terramin acquiring the property in 2015. There is an evident resulting grazing line on all shrubbery and trees and all groundcover is limited to predominantly pasture grasses (phalaris) and introduced weeds, including thistles, wireweed and deadly nightshade. More information on the weeds present onsite has been included in Chapter 19. Pest species onsite are largely limited to hares, rabbits, cats and foxes as described in Section 18.4.

Terramin considered the risk of increasing pest numbers by having putrescible waste onsite, which can have a direct impact on the predation of native fauna, however, by ensuring a Waste Management Plan is appropriately developed, implemented, and reviewed annually. The Waste Management Plan will include covering all putrescible and non-putrescible waste disposal to significantly reduce the likelihood of an increase in pest fauna resulting from interactions with putrescible waste.

Impacts to soil quality and water quality post-closure which can impact potential habitat are managed by firstly eliminating the risk in the first instance. This has been done by establishing separate working areas and catchments for specific activities, such as the workshop and IML, of which both have stormwater runoff which drains to a sump and is pumped to the water treatment plant. All other areas of the Project are directed to swales onsite or directed to the stormwater retention dam, which allows sedimentation to naturally drop out. Water quality will be tested at this point, before exiting the dam via a swale and riprap spillway into the existing drainage line. This greatly reduces the likelihood of surface water contamination.

Specifically in regard to soil quality, a spills procedure is implemented as part of the management of hazardous chemicals and hydrocarbon spills. Spill response plans and clean up kits are currently in place onsite and will continue to be employed throughout the life of the Project.

Chemicals and hydrocarbons will be kept within designated storage areas bunded to prevent the accidental mobilisation of contaminants affecting soil and surface water quality. Final design of the bunding of hazardous materials storage area(s) will be designed to retain surface water flows during a 1 in 100 year flood event (as required by AS standards). A storm event exceeding the capacity of the

storage area could result in the contamination of surface water flows by contaminants, subsequently affecting soil and surface water quality.

LFA provides a useful monitoring tool to enable active, adaptive land management based upon the prior year's results. LFA uses simple indicators to assess how well an ecosystem works as a biochemical system, and is able to identify deficiencies in revegetation, including erosion features, to allow alternative management practices to be implemented. This vastly limits/prevents any long term impact to habitat and therefore potential for impact to native fauna, as trends are identified and able to be reversed early if required.

Terramin considered species listed as either migratory (JAMBA, CAMBA or ROKAMBA) or under the EPBC Act and provide notes below in Table 18-17 on their likelihood of occurrence within the disturbance footprint.

Note: To ensure their conservation the Australian Government has fostered international cooperation through a range of important agreements, including bilateral migratory bird agreements with Japan (JAMBA), China (CAMBA) and the Republic of Korea (ROKAMBA), the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), the Ramsar Convention on Wetlands, the Agreement on the Conservation of Albatrosses and Petrels (ACAP), and through the East Asian - Australasian Flyway Partnership.

TABLE 18-17 | EPBC LISTED AND MIGRATORY SPECIES IMPACT TABLE

Species	Notes
<i>Pteropus poliocephalus</i> - Grey-headed Flying-fox (Vulnerable)	The Flora and Fauna assessment (COOE 2016) identified the species as potentially occurring within the Project site. The species has complex migration traits in response to ephemeral and patchy food resources. Potential threats include noise, vibration and light disturbance, and reduction in foraging resources, namely Eucalyptus blossom. Agroforestry fenceline plantings of <i>E.maculata</i> and <i>E.leucoxylon</i> are present within the 'Goldwyn' site, including the operating area and could provide a blossom resource, however, these plantings are 25 years old and the trees are in poor condition experiencing a high blow over rate resulting in mortality and hence have a low foraging resource value. The Biodiversity Management Plan has revegetation as a mitigation strategy for visual amenity and strengthening biodiversity values, revegetation works will occur within the agroforestry's senescence areas as well as on all landscape bunding, boundary vegetation buffer zones and corridors, and in strategic sightlines. The site plan and mining operations have been designed around minimising disturbance to the local community, including minimising noise, visual and vibration disturbance. Potential impacts will be managed under BIHGP's Biodiversity Management Plan, Strategic Visual Assessment Plan, Noise Management and Monitoring Plan and Dust Management and Monitoring Plan.
<i>Isodon obesulus obesulus</i> - Southern Brown Bandicoot (eastern) (Endangered)	The Flora and Fauna assessment (COOE 2016) identified suitable habitat for the species within the Project site, outside of the development footprint. Potential threats include noise and vibration disturbance, and increased predation. The site plan and mining operations have been designed around minimising disturbance to the local community, including minimising noise and vibration disturbance. Potential pest impacts will be managed under BIHGP's Biodiversity Management Plan.
<i>Calidris ferruginea</i> - Curlew Sandpiper (Critically Endangered)	Preferred habitat is not present on the ML, hence the species is unlikely to occur within or near the lease. The species is uncommonly recorded inland around dams, waterholes and bore drains. Likelihood of occurrence is very low. Potential threats include alteration of the existing water sources. Management of stormwater onsite will involve a combination of swales, treatment devices (gross pollutant traps and oil and sediment separators), retention basins and ephemeral wetlands. The final, post mining design will provide an increase in surface water habitat.

Species	Notes
<i>Zoothera lunata halmaturina</i> - Bassian Thrush (South Australian) (Vulnerable)	Preferred habitat is not present on-site. Likelihood of occurrence is low. Potential threats include weed invasion and increased predation. Potential impacts will be managed under BIHGP's Biodiversity Management Plan
<i>Notechis scutatus</i> - Eastern Tiger Snake (formally Vulnerable) - included for completeness	Preferred habitat, riparian areas, is limited on site. There is one ephemeral creekline that is undergoing understory and mid story revegetation, the overstory is intact. Apart from a creek crossing no development will be undertaken in the riparian zone. Likelihood of occurrence is low as habitat has been overgrazed for a long period of time and is degraded. Potential threats are habitat loss or degradation, feral predation and low frog population numbers. Potential impacts will be managed under BIHGP's Biodiversity Management Plan
<i>Numenius madagascariensis</i> - Eastern Curlew, Far Eastern Curlew (Critically Endangered) Listed marine Listed migratory - CAMBA, JAMBA, ROKAMBA	The eastern curlew takes an annual migratory flight to Russia and north-eastern China to breed, arriving back home to Australia in August to feed on crabs and molluscs in intertidal mudflats. In South Australia, the species is scarce between the Victorian border and Cape Jaffa and patchily distributed from the Coorong north-west to the Streaky Bay area, and has previously been recorded in Lake Alexandrina and Lake Albert, South Australia. Therefore, the species is very unlikely to be found, if so a vagrant only, within or near the proposed mining lease as the habitat is not suitable.
<i>Grantiella picta</i> - Painted Honeyeater (vulnerable)	Species not recorded within the proposed ML. Preferred habitat is woodland, no clearance of native vegetation will occur on the mining lease and Terramin is planning to revegetate 10.5 hectares of the 36 hectare 'Goldwyn' farming property the project is based on, within the proposed mining lease area. The mining lease poses no credible impact to the species.
<i>Apus pacificus</i> - Fork-tailed swift <i>Hirundapus caudacutus</i> - White-throated Needletail Listed Marine Listed migratory - CAMBA, JAMBA, ROKAMBA	The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. The Fork-tailed Swift and the White-throated Needletail are non-breeding visitors to Australia (Higgins 1999). The mining lease poses no credible impact to the species as no large trees that may be potential roosting will be cleared.
<i>Motacilla cinerea</i> - Grey Wagtail <i>Motacilla flava</i> - Yellow Wagtail Listed migratory - CAMBA, JAMBA, ROKAMBA	The ML poses no credible impact to these species due to habitat not being suitable. Reference - Draft referral guideline for 14 birds listed as migratory species under the EPBC Act
<i>Actitis hypoleucos</i> - Common Sandpiper <i>Calidris acuminata</i> - Sharp-tailed Sandpiper <i>Calidris melanotos</i> - Common Greenshank <i>Pectoral Sandpiper</i> <i>Tringa nebularia</i> - Common Greenshank Listed migratory - Bonn, CAMBA, JAMBA, ROKAMBA	Common Sandpiper - This species is a migratory shorebird, the ML due to its inland location poses no credible impact to these species. Sharp-Tailed Sandpiper & Pectoral Sandpiper - preferred wetland habitat not present on or near the proposed mining lease area Common Greenshank - preferred habitat may be present near proposed mining lease boundary but riparian condition rated as 'poor' by the EPA, species not likely to be present but riparian habitat is being managed for biodiversity values so no impact by the mining operation is anticipated (Hansen, 2016).
<i>Pedionomus torquatus</i> - Plains-wanderer (Critically Endangered)	The plains wanderer is a highly unique, ground-dwelling bird that lives in the grasslands of Queensland, New South Wales, Victoria and South Australia. Preferred habitat is not present within the proposed ML, the existing land form is predominately cleared woodland with introduced cattle pastures. The mining lease poses no credible impact to this species.

Species	Notes
<i>Merops ornatus - Rainbow Bee-eater</i> <i>IUCN: Listed as Least Concern (Global Status: IUCN Red List of Threatened Species: 2017.1 list)</i> <i>NGO: Listed as Least Concern (The Action Plan for Australian Birds 2010 - non-threatened)</i>	The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999). The breeding season extends from August to January (Boland 2004a; Higgins 1999). The nest is located in an enlarged chamber at the end of long burrow or tunnel that is excavated, by both sexes, in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces. Nests of the Rainbow Bee-eater are presumably susceptible to predation, flooding and trampling because they are located on the ground and in banks, for example, of rivers and creeks. Potential impacts will be managed under BIHGP's Biodiversity Management Plan, buffer zones have been put in place around riparian and existing remnant vegetation hence trampling will be avoided.

18.8.1 NOISE

The effect of noise on wildlife can be similar to the effects observed in humans. Noise can adversely affect wildlife by interfering with communication, masking the sounds of predators and prey, cause stress or avoidance reactions and (in the extreme) result in temporary or permanent hearing damage. Experiments have shown that exposure to noise impulses throughout the night-time sleep period resulted in poorer daytime task performance by animals (Fletcher & Busnel, 1978).

The learning ability of many animal species, in regard to familiarisation, is discussed by Fletcher & Busnell. The animal's initial reaction to a new noise source is fright and avoidance but if other sensory systems are not stimulated (for instance optical or smell), the animal learns quite quickly to ignore the noise source, particularly when it exists in the presence of man.

Migratory birds have the potential to be influenced by noise from the project. Studies of birds (Larkin, 1996) have shown that they will habituate to loud noises that are not biologically meaningful for them. For example if the noise is associated with possible harm such as thunder on a cloudy day, birds will avoid it, but routine noises such as traffic will not disturb them. Examples are provided of sea-birds that voluntarily co-exist with relatively loud noise environments, such as around airports, and birds roosting on light-posts above busy motorways.

Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs may also help mitigate its effects on birds. Poole (Poole, 1982) and Algers et. al. (Algers, Ekesbo, & Stroemberg, 1978) shows that birds tend to adapt to steady state noise levels, even of a relatively high level (in the order of 70 dB(A)). Given the predicted steady noise levels around the BIHGP are expected to be much less than this level and largely within existing baseline noise values (section 16.4), noise impacts on birds surrounding the project is not considered a credible risk.

18.8.2 AIR-OVERPRESSURE AND VIBRATION

BHP's BMA coal operation in the Bowen Basin analysed data from 42 livestock herds. Animal installations were selected for observations on animal behaviour under sonic boom conditions. Numbers of animals observed in this study were about 10,000 commercial feedlot beef cattle, 100 horses, 150 sheep and 320 lactating dairy cattle. Sonic booms during the test period were scheduled at varying intervals during the morning hours Monday to Friday of each week. Results of the study showed that the reactions of the sheep and horses to sonic booms were slight. Dairy cattle were little affected by sonic booms (125 dB to 136 dB). Only 19 of 104 booms produced even a mild reaction, as evidenced by a temporary cessation of eating, rising of heads, or slight startle effects in a few of those being

milked. Milk production was not affected during the test period, as evidenced by total and individual milk yield. This analysis was included and approved by the Queensland Government as part of the project's Environmental Impact Statement (BHP BMA, 2009).

Terramin expect there to be no or **negligible** impact on livestock located within and surrounding the ML area.

18.8.3 GROUNDWATER RELATED IMPACTS

To mitigate against the groundwater related impacts to biodiversity and native fauna habitat values, the Project proposes to adopt a 'no net groundwater abstraction approach'. The mitigation involves engineering and management practices including; designing the mine declines to avoid fractures, grout ahead of mine development to limit groundwater inflows, followed by the reinjection of any groundwater inflows back into the aquifer via Managed Aquifer Recharge (MAR). This technique would maintain groundwater levels around the proposed mining area and ensure a 'no net groundwater abstraction' approach.

Terramin engaged Golder Associates to investigate the relationship between groundwater and the vegetation associations in the NVHA area.

The NVHA area Groundwater Study is located in Appendix R5.

18.8.3.1 GROUNDWATER ELEVATION

The drilling logs of investigation bores near the southern border of NVHA (detailed within AGT, 2017) revealed that the first groundwater cut in the FRA was typically encountered at depths of around 120 m bgl (325 m AHD), with moisture noted at 55 m bgl (390 m AHD) in one investigation bore. Above this depth, the overlying strata (fine grained Tarcowie Siltstone) was very 'tight' and exhibited very low primary and secondary porosity.

At all investigation bores, the groundwater elevation (piezometric head) was higher than the first water cut and was reported at an elevation of 410 m AHD or 40 m bgl (AGT, 2017). Hydrographs of two representative monitoring bores (BH37 and IB1) positioned near the NVHA area are shown in Figure 18-9.

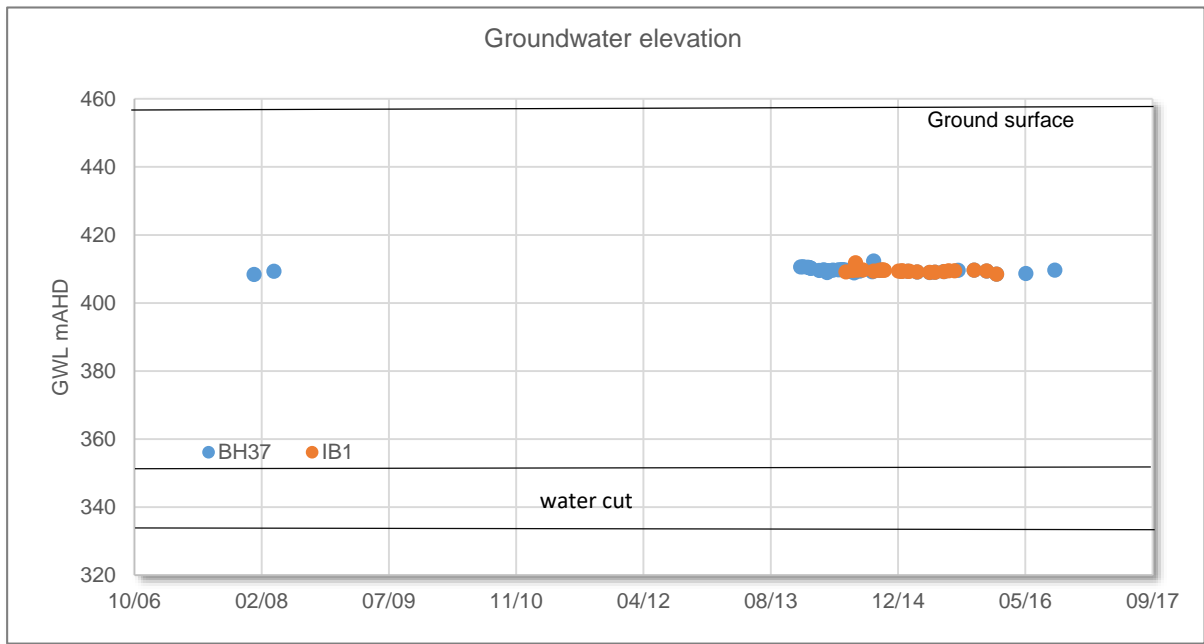


FIGURE 18-9 | HYDROGRAPH OF BH37 AND IB1 SHOWING PIEZOMETRIC HEAD

Contours showing current/pre-mining depth to groundwater are presented in Figure 18-10. This was produced by subtracting the groundwater elevation (410 m AHD) from ground surface elevation.

Figure 18-10 shows that approximately 90% of the NVHA area has a depth to water of 20 to 60 m bgl, and the remaining 10% of the area has a depth to water of about 15 m bgl. The area of shallowest depth to water (15 m bgl) is associated with a gully in the north-west corner of the NVHA area. A deep weathered (clay) zone underlies this area.

18.8.3.2 HISTORICAL GROUNDWATER ELEVATION

Historical evidence (See Appendix R5, Attachment B) suggest that groundwater levels were lowered by about 100 m bgl in the historic Bird in Hand Mine from mine dewatering that occurred during mining operations of the late 1880s and 1930s. Longer term groundwater abstraction from a bore placed in the Bird in Hand mine shaft to provide water to Inverbrackie Army barracks from the 1930s to 1967. Water abstracted was approximately 180 ML per annum and the measured ground water levels are found in Appendix R5, and ranged between 30m bgl and 124m bgl. Post 1935 the levels were between 34 and 48 m bgl. Despite this, the ongoing survival of Red Gums (*E. camaldulensis*) and Blue Gums (*E. leucoxylon*), indicate no apparent long term groundwater related impacts had arisen from historic mine dewatering or long term water supply abstraction activities.

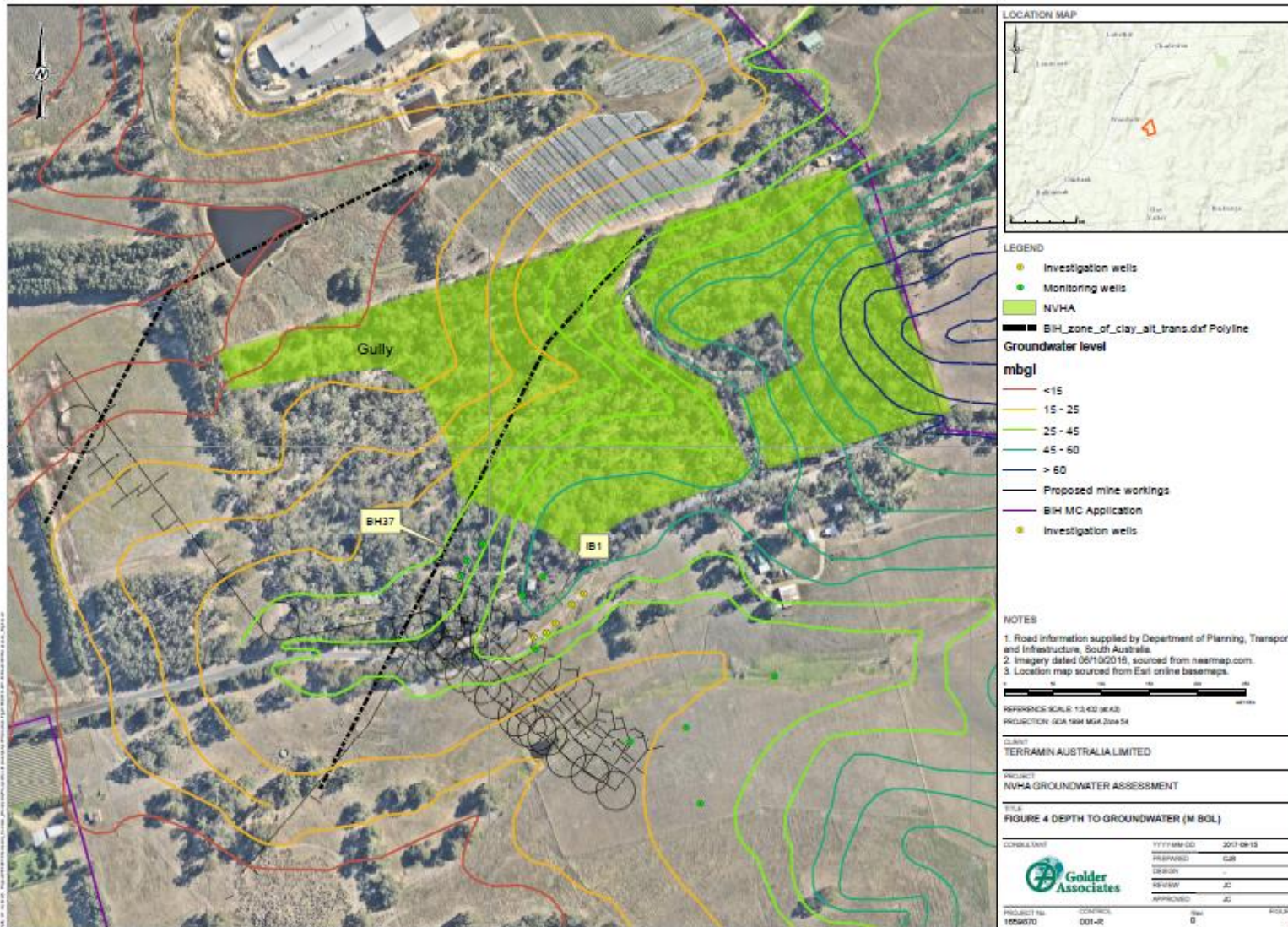


FIGURE 18-10 | GROUNDWATER ELEVATION - METERS BELOW GROUND LEVEL

18.8.3.3 NATIVE HERITAGE AGREEMENT AREA

Based on the depth to groundwater (15 to 81 m bgl), there is a low probability that vegetation within in the NVHA area can access or rely on groundwater supplies. One exploration hole revealed evidence of tree roots to a depth of 6 m (E. Whittaker, pers comm 2017). It is possible some of the trees on site may have deeper root systems or taproots, however this is an exception rather than the rule when it comes to tree root development (Australian Standard 4970-2009). A limiting factor for the growth of roots is gas exchange and therefore most plants are shallow rooted with the majority of roots occurring within the top 600 mm of the soil profile. Tree root systems are classed into three different parts: structural woody roots, second order roots and non-woody roots. Studies show that Blue gums (*E. leucoxylon*) are unlikely to access groundwater, particularly if clay layers are present (CSIRO, 2005). It is the non-woody roots that absorb water from the environment for plant function, and there is a low probability that these roots will occur at the depths required to access groundwater at the site because the depth to groundwater is greater than 15 m. Therefore, Golder have advised that any change in groundwater levels is unlikely to have a significant impact on the condition of vegetation and associated biodiversity values such as listed flora, including orchids, and avifauna in the project area. This is supported by the continued survival of the suite of sensitive flora and fauna despite the timber harvesting, grazing, development of a small settlement (Reefton heights), quarrying, mining and dewatering practices that have taken place over the preceding 137 years (See Attachment B in Appendix R5 for pictorial records from the SA Department of Mines).

Groundwater on site is shallowest within the ephemeral riparian gully, occurring 15 m below the natural ground level. If vegetation were able to access the groundwater, it is more likely to be in these areas. River Red Gum (*E. camaldulensis*) vegetation communities are commonly associated with watercourses, drainage lines or gullies across southern Australia, so is likely to be the main vegetation association in the lower lying parts of the gully on site, surveying confirms this (NVC 2012). River Red Gum (*E. camaldulensis*) communities are adapted for riparian environments, known for having a varying water supply and are tolerant to seasonal and drought related changes in water accessibility.

18.8.3.4 GROUNDWATER MODELLING OF PREDICTED DRAWDOWN

The process of mining reduces groundwater levels in the surrounding FRA. In FRA this is referred to as the zone of depressurisation (or drawdown) and the level of impact reduces with distance from the underground mine. Terramin propose to grout mine workings in order to reduce groundwater inflow and reinject remaining groundwater inflows back into the FRA in a radial pattern around the mine to constrain the extent of depressurisation.

Numerical groundwater modelling was undertaken by AGT (2017) to simulate the effects of the proposed underground mining operation on groundwater levels. Minor updates were made to the existing model in the area of the NVHA and an addition model simulation was undertaken by Golder (2017) to predict groundwater level response to mining beneath the NVHA area. Model updates included refinement of the extent of weathering beneath the NVHA, which was encountered during the latest geotechnical drilling program undertaken in 2016 by Terramin (see dashed lines on Figure 18-11).

The results of the model simulation are presented in Figure 18-11 (cone of drawdown at the end of the proposed mine life) and Figure 18-12 (predictive hydrograph near the gully area). Modelling results showed:

- The extent of the cone of drawdown is constrained by the location of individual MAR bores and the zone of weathering. Groundwater drawdowns of 10 to 20 m may occur beneath the topographic high / eastern portion of the NVHA area where current groundwater levels are deeper than 45 m bgl.
- During commissioning of the MAR system and associated monitoring piezometers, adjustment to reinjection bore locations and rate of injection will be made to ensure limited changes to water level due to mining occurs under the *Caladenia rigida* location to the eastern portion of the NVHA, on the eastern side of Reefton road, which runs through the centre of NVHA.
- Groundwater levels beneath the gully area are expected to remain stable owing to the presence of a clay aquitard which underlies this area and MAR (Figure 18-11).
- Overall, the lowering of groundwater levels outside of the gully area is unlikely to pose an adverse risk to the vegetation within the NHVA area as current groundwater levels (20 to 60 m bgl) are several meters (tens of meters) beyond the reach of the root system.

Groundwater Assessment for the NVHA Area is located in Appendix R5.

The drilling of a MAR investigation bore (BHMB03), in September 2018 in the Blue Gum and Manna Gum habitat to the East of Reefton road confirmed the modelling, and found the groundwater level to be ~81 metres below ground surface level. The subsequent piezometric level in that bore has been between 44 and 55 metres below ground level. These depths are well below where tree roots are expected to source groundwater and hence the drawdown of any groundwater east of Reefton road will not impact ecosystem health.

Detail regarding the drilling of the MAR bores during 2018 is included in Appendix H8.

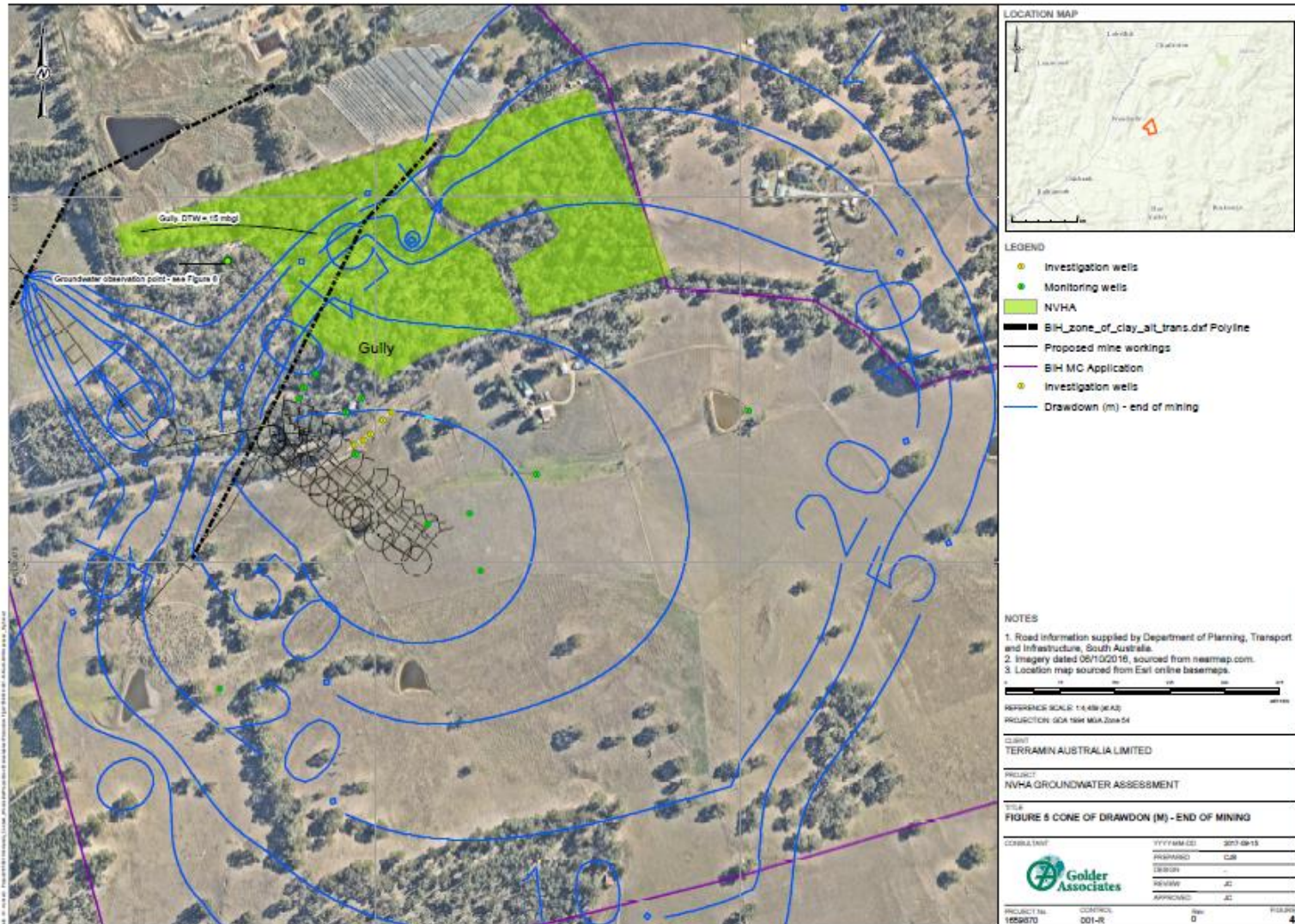


FIGURE 18-11 | GROUNDWATER DRAWDOWN (END OF MINE LIFE)

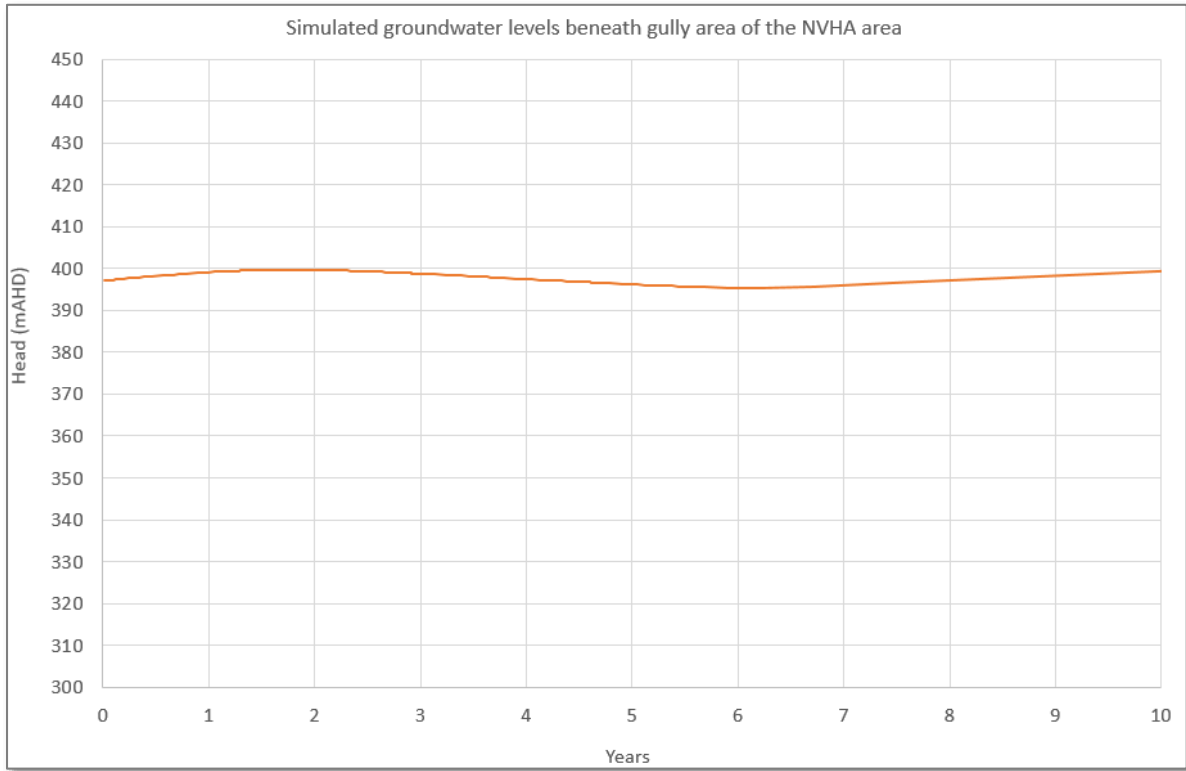


FIGURE 18-12 | PREDICTIVE HYDROGRAPH BENEATH THE GULLY AREA (MINE LIFE CORRESPONDS TO YEAR 0 TO 5.5)

18.9 DRAFT OUTCOME(S) AND MEASUREMENT CRITERIA

In accordance with the methodology presented in Chapter 6, an outcome has been developed for fauna and pest impact events with a confirmed link between a source, pathway and receptor (S-P-R linkage), see Table 18-18.

All outcomes are supported by draft measurement criteria which will be used to assess compliance against the draft outcomes during the relevant phases (construction, operation and closure), and where relevant draft leading indicator criteria. These measurement criteria and leading indicators are indicative only and will be developed further through the PEPR.

All Outcomes for the entire project are presented in Appendix D1.

TABLE 18-18 | DRAFT OUTCOMES AND MEASUREMENT CRITERIA

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
<p>No introduction of new species of declared weeds, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing declared weed or pest species on the mining lease caused by mining activities</p>	<p>Annual assessment until Lease surrender, or at a frequency as recommended by a suitably qualified and experienced independent party of fauna abundance and diversity measured through standardised fauna monitoring techniques (call recordings, active searching and/or bird surveys) at permanent fauna monitoring sites demonstrates:</p> <ul style="list-style-type: none"> no new declared pest species (including feral animals) have become established on the lease; and there has not been a statistically significant increase in abundance of existing declared pest species (including feral animals) on the lease area. <p>when compared to baseline avifauna surveys conducted prior to the commencement of operations and accounting for seasonal variation (regional trends) and mine/IML areas.</p>	<p>None proposed</p>
<p>No fauna injuries or deaths (excluding pests) caused by mining activities that could reasonably have been prevented, due to construction, operation and closure activities</p>	<p>Investigations of all native fauna deaths or injuries recorded on the lease demonstrate that the mine operator did not cause, or could not have reasonably prevented, the deaths or injuries occurring.</p>	<p>An incident register is to be maintained of all native fauna injuries or deaths identified by site personnel or the public. The register will be reviewed monthly and results will be presented in monthly site management reports prepared by the Mine Manager. The review will include the identification of any procedural changes required.</p>
	<p>Annual review of safety systems and maintenance of fire breaks shows that these were maintained and demonstrates that the mine operator did not cause, or could not have reasonably prevented, the deaths or injuries occurring.</p>	<p>None proposed</p>

18.10 FINDINGS AND CONCLUSIONS

Fauna impacts within the ML are not expected as part of the construction, operation and closure of the BIHGP, due to the operational area location in an area previously cleared for farming. This is largely due to no native endemic vegetation clearance, and the installation of 30 m buffer zones and landscape amenity bunding installed between the operational area and the remnant vegetation area which hosts the NVHA. Potential groundwater impacts are proposed to be managed through the operation of the grouting and MAR system, as the regional fractured rock aquifer system which underlies the NVHA area and surrounding catchment is at least 15 m bgl, with 90% of the NVHA area reporting groundwater levels of between 20 m and 80 m bgl. Based on the expected root depth of identified species within the



NVHA area (*E. leucoxyton* and *E. camaldulensis*), there is a low probability that vegetation within in the NVHA area accesses groundwater from the FRA system.

Direct risks to fauna onsite through interactions with humans will be minimised or prevented through the design measures and management strategies around aspects including noise, air quality, vibration, and surface water. The Weed and Pest Management Plan will reduce the potential for weeds to spread and impact habitat for native fauna, and the onsite waste management plan reduces potential for impacts associated with putrescible waste.

The largest risk considered to be able to impact conservation and non-conservation significant native fauna is the risk of bushfire originating from the project site, as it has the potential to reduce the habitat or impact a local population which may result in a long term decrease in abundance of state listed bird species.

The proposed design measures and management strategies which will be implemented to mitigate the level of impact and risk associated with fauna, such that it is considered all risks to be as low as reasonably practicable (ALARP).