

10

Protected Matters under the EPBC Act

10. Protected Matters under the EPBC Act

10.1 Introduction

This chapter addresses matters specific to the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act), and in particular, potential impacts on Matters of National Environmental Significance (MNES).

Section 1.1 of the TOR for the preparation of an environmental impact assessment issued by the NT EPA for the Nolans Project has identified that the project '*... has the potential to have a significant impact on the following matters of national environmental significance that are protected under Part 3 of the EPBC Act:*

- Listed threatened species and communities (sections 18 & 18A) and
- Protection of the environment from nuclear actions (sections 21 and 22A).

This chapter provides an assessment of the threatened fauna species and/or populations listed under the EPBC Act that are present or considered likely to occur within the study area including:

- The quality and quantity of available habitat within the vicinity of the study area (identified and mapped)
- The regional and national significance of populations of threatened species
- The potential impact of the project on these species and their populations
- Proposing mitigation measures to reduce the risk of impacts that may be significant
- the residual risks to threatened species.

No listed, threatened flora species or threatened ecological communities are known and/or likely to occur in the vicinity of the Nolans site, therefore the focus in this Chapter is listed, threatened fauna species.

A detailed fauna assessment, including listed threatened species is available in Appendix N.

10.2 Environment Protection and Biodiversity Conservation Act (1999)

The EPBC Act focuses Australian Government interests on the protection of matters of national environmental significance, with the states and territories having responsibility for matters of state and local significance. The Act has been discussed in detail in Chapter 2 of this EIS

The delegate of the Commonwealth Minister has determined that the project is a controlled action that has the potential to significantly impact listed, threatened species and communities (under Sections 18 and 18A of the EPBC Act).

On 16 March 2015, the delegate of the Minister determined, based on an EPBC referral submitted by the Proponent, that the proposed action (the project) is a controlled action that has the potential to significantly impact on the on the following MNES:

- Listed threatened species and communities (sections 18 & 18A) and
- Protection of the environment from nuclear actions (sections 21 and 22A).

The proposed action will be assessed under the Bilateral Agreement between the NT and Commonwealth governments. The construction corridor for the project may coincide with habitat of EPBC-listed threatened species. This chapter addresses the EPBC-listed threatened species and communities.

10.3 Definitions

Listed threatened species and communities protected under the EPBC Act include species and communities that are considered to be either:

- extinct
- extinct in the wild
- critically endangered
- endangered
- vulnerable
- conservation dependent.

To determine if an action will have a significant impact, criteria have been developed for each of the abovementioned categories. The significant impact criteria are listed in the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance*, developed by the former Department of Environment (2013), and include:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline or
- Interfere with the recovery of the species.

Definitions for threatened species impacts

Assessment under the Significant Impact Guidelines 1.1 includes the use of three definitions in its description of impact criteria, namely, population, important population and habitat critical to the survival of a species or ecological community:

- A *population* of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:
 - A geographically distinct regional population, or collection of local populations or
 - A population, or collection of local populations, that occurs within a particular bioregion.
- An *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
 - Key source populations either for breeding or dispersal
 - Populations that are necessary for maintaining genetic diversity, and/or
 - Populations that are near the limit of the species range.

- *Habitat critical to the survival of a species or ecological community* refers to areas that are necessary:
 - For activities such as foraging, breeding, roosting, or dispersal
 - For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
 - To maintain genetic diversity and long-term evolutionary development, or for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

10.4 Existing environment

A detailed description of the existing environment at the Nolans site is included in Chapter 9 and Appendix M and N.

Fauna habitats across the study area have been subdivided into vegetation types that are technically different from each other botanically (see Appendix M for detailed information), but for fauna they can more broadly be grouped into six habitat types:

- Mulga woodland
- Spinifex grassland on sandplain
- Rocky rises
- Acacia and mallee shrubland/woodland
- Riparian woodland
- Non-spinifex grassland (occasionally with sparse open woodland).

These fauna habitats are described in more detail in Appendix M and N, including a description of their occurrence within the study area, their habitat attributes and their relationship to the different vegetation communities.

The existing environment as it relates specifically to listed, threatened species includes the following features:

- Predation, which is likely to be an important threat to some threatened species in the bioregion, including the Black-footed Rock-wallaby
- Changes to fire regimes, which are likely to be an important threat to some threatened species in the region
- Grazing by livestock and/or feral animals, which is likely to impact threatened species in the region including the Black-footed Rock-wallaby.

10.5 Methodology

10.5.1 Desktop review

The Commonwealth DotE Protected Matters Search Tool (PMST) was used to identify MNES potentially occurring within the study area. The PMST considers fauna species and communities listed under one or more provisions of the EPBC Act, and is based on predicted distributions of fauna species and communities and/or their habitat, rather than known records. Thus the PMST may predict the occurrence of a species or community in an area when there are no documented records from the area.

The DLRM Fauna Atlas database results were interrogated to identify actual records of all fauna species known to occur (rather than predicted to occur) within 10 km of the study area.

Scientific literature reviewed provided background information on the biology and conservation status of the threatened species. These species are often rare, cryptic and/or sparse, and require targeted and non-standard survey methods to maximise the chances of detection.

During the course of the fauna assessments for this project, the DoE made changes to the threatened species lists considered under the EPBC Act. Two of these changes concern species identified for this project; Brush-tailed Mulgara and Southern Marsupial Mole. Both species were assessed as EPBC listed, threatened species at the time of the field assessments, but neither is now listed as threatened under the EPBC Act, so both have been removed from this Chapter of the EIS. This is discussed in more detail in Appendix N.

10.5.2 Field assessment

Field surveys targeting the threatened species were undertaken at Nolans site between 2011 and 2015.

Table 10-1 provides a summary of the timing of surveys and level of effort applied.

Table 10-1 Targeted survey schedule and brief description

Timing	Team	Extent of survey	Brief description
8 – 9 December 2011	Two GHD zoologists	Diurnal surveys targeting Black-footed Rock-wallaby in and around the Nolans Bore mine site in areas of rocky habitat. Intensive spotlighting searches were undertaken in an effort to detect the Greater Bilby (<i>Macrotis lagotis</i>) in and around the Nolans Bore mine site.	Investigating areas of potential rock-wallaby habitat, collecting potential rock-wallaby scat, and photographing suitable rock-wallaby shelter habitat using a GPS camera.
21 – 23 July 2015	Three to five GHD ecologists/rangers including Dr Rachel Paltridge (Desert Wildlife Services)	Borefield area survey was undertaken to detect the presence of Great Desert Skink and Greater Bilby in the proposed access roads and water pipeline corridors (see Figure 10-1).	Daylight surveys walking along the transect corridor approximately 5-10 m apart scanning the ground for signs of the threatened species such as scat, burrows, diggings and/or latrines.
23 – 26 July 2015	Three GHD ecologists and Dr John Read (Ecological Horizons)	Targeted surveys for Black-footed Rock-wallaby over a 65,000 ha area in the eastern end of the Reynolds Range, Hann Range, Reaphook Hills and outcrops in between, targeting rocky outcrops, steep slopes, food plant areas(see Figure 10-2).	Surveys were conducted on foot in teams of two during daylight hours. Teams were dropped onto rocky outcrops by helicopter and surveyed sites for approximately one hour at each site.

10.5.3 Survey techniques

The following section describes the survey techniques that were utilised in targeted searches to detect presence of EPBC listed, threatened fauna species. Figure 10-1 illustrates the survey effort for the associated fauna species.

Borefield area survey

The borefield area surveys were primarily targeting the Great Desert Skink and Greater Bilby. A single Great Desert Skink burrow system was identified in the borefield area during baseline fauna survey.

Survey was conducted during daylight hours, with three to five ecologists and rangers on foot traversing the disturbance corridor, approximately 5-10 m apart and scanning the ground for signs of the threatened species such as scat, burrows, diggings and/or latrines. The total length of corridor surveyed was 37.4 km (see Table 10-1).

*Targeted surveys for Great Desert Skink (*Liopholis kintorei*)*

The surveying of burrow entrances may be more profitable in warmer months as the species is more active in the warmer weather. Watching burrows in cooler times of the year may involve setting up motion-sensing cameras to 'watch' for longer periods. McAlpin (2001b) reports the optimum time of year for monitoring burrows as late summer and early autumn, before the lizards enter hibernation, at which time the maximum number of individuals are likely to inhabit the burrow systems.

Burrows were observed during July 2015 which is a cooler time of the year and required setting up motion-sensing cameras to 'watch' for longer periods.

Additional searches were undertaken around the Great Desert Skink burrow previously recorded during the May 2015 baseline fauna survey. Four remote sensor cameras were set up, with the aim of obtaining images of the skinks when they become active again as the weather warms in September. Cameras were collected on the 22 October 2015 and contained images of Great Desert Skink.

*Targeted surveys for Greater Bilby (*Macrotis lagotis*)*

Spinifex-dominated habitats within the study area provide potential habitat, including areas with low shrub cover.

Recommended survey techniques include habitat assessments, searching for signs of activity, collection of predator scats and soil plot surveys (tracks). Spotlight or camera surveys at burrow entrances may be effective following detection of signs. Spotlight surveys from a vehicle allowing large distance to be covered through suitable habitat are also effective.

Extensive and intensive nocturnal (spotlighting) searches were undertaken on foot and from slow-moving vehicles to detect active individuals of this species in 2010/11 and again in 2015.

In 2015 diurnal searches of the borefield area were also undertaken to locate potentially suitable habitat and signs of potential activity, including burrows, tracks, scats and diggings.

Motion-sensing cameras were used in selected locations of suitable habitat and where possible Greater Bilby diggings/burrows were found.

*Targeted surveys for Black-footed Rock-wallaby (*Petrogale lateralis* MacDonnell Ranges race)*

Surveys concentrated on rocky outcrops, crevices, caves and boulder piles where rock-wallabies typically shelter, and vegetated parts of hills and escarpments, particularly grassy areas, where rock-wallabies potentially forage (see Figure 10-2).

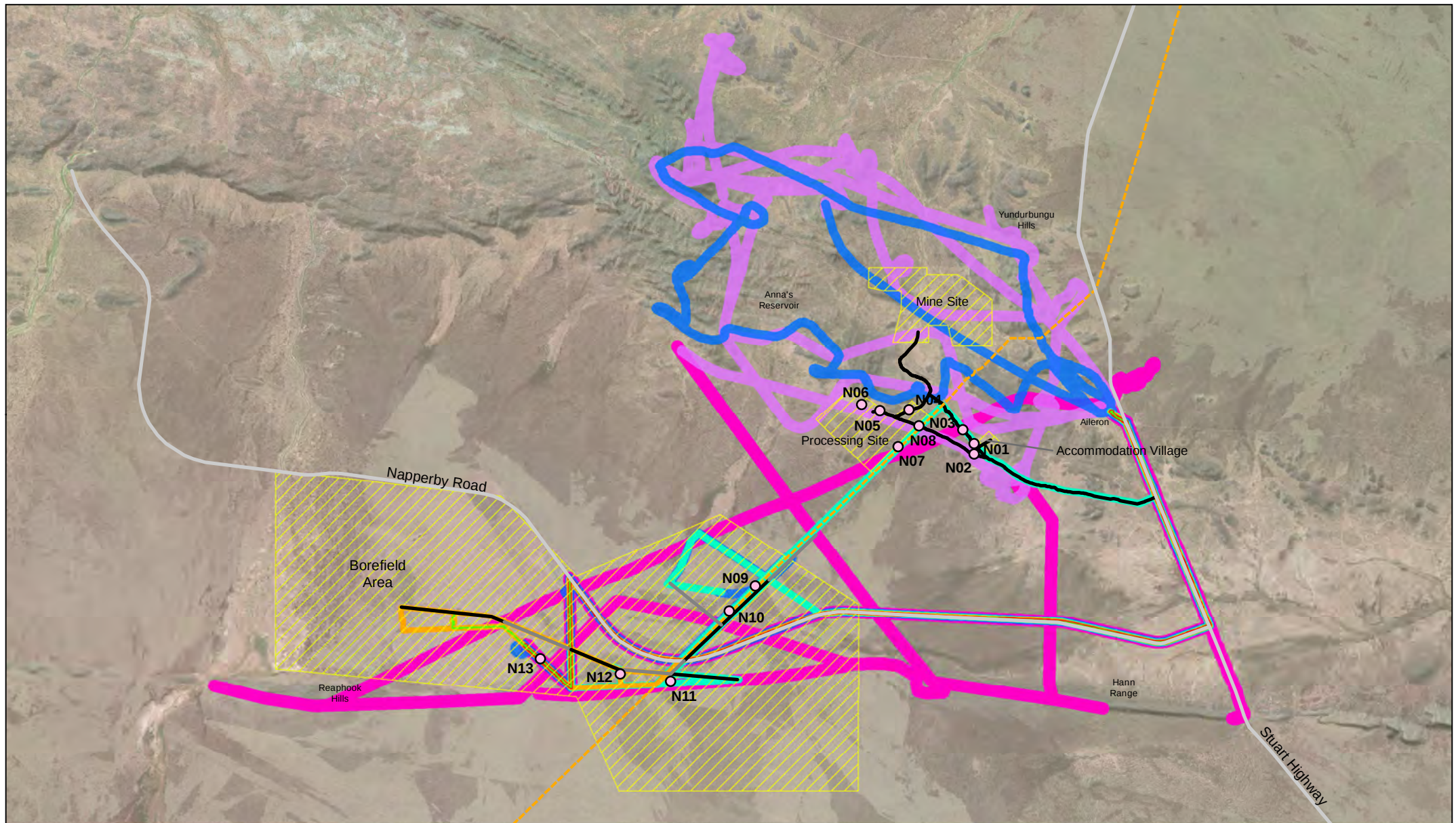
Low densities of Black-footed Rock-wallabies can be difficult to detect using ground-based diurnal or spotlighting surveys. Searching for scats is a reliable and repeatable technique for detecting populations. Macropod scats were collected for analysis.

During baseline fauna survey in September 2010, the survey team detected the Black-footed Rock-wallaby in the rocky habitats of the mine site area. In December 2011, diurnal surveys were undertaken by two ecologists over two days, in and around the mine site.

In July 2015, 65 survey sites were spread over a 650 km² area in the eastern end of the Reynolds Range, Hann Range, Reaphook Hills and many small outcrops in between.

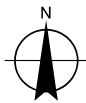
Surveys were conducted on foot, in teams of two, during daylight hours. Teams were dropped into sites by helicopter. A habitat assessment was completed at each site, including qualitative notes on presence/abundance, likely shelter/refuge sites (e.g. caves, crevasses or large boulder piles), proximity to forage and vegetative cover (especially figs, spearbush and grassy patches).

All scat identifications were verified by Dr John Read (Ecological Horizons) from the SA Warru Recovery Team. Scats collected were lodged with the Museum and Art Gallery of the Northern Territory.



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Grid: GDA 1994 MGA Zone 53



LEGEND

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| Fauna Sites | Study Area | Day 4 |
| Roads | Day 1 | Day 5 |
| Gas Pipeline | Day 2 | Day 6 |
| Access Roads | Day 3 | Day 7 |



Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Survey effort for 2015
targeted fauna surveys

Job Number	4322301
Revision	0
Date	13 Apr 2016

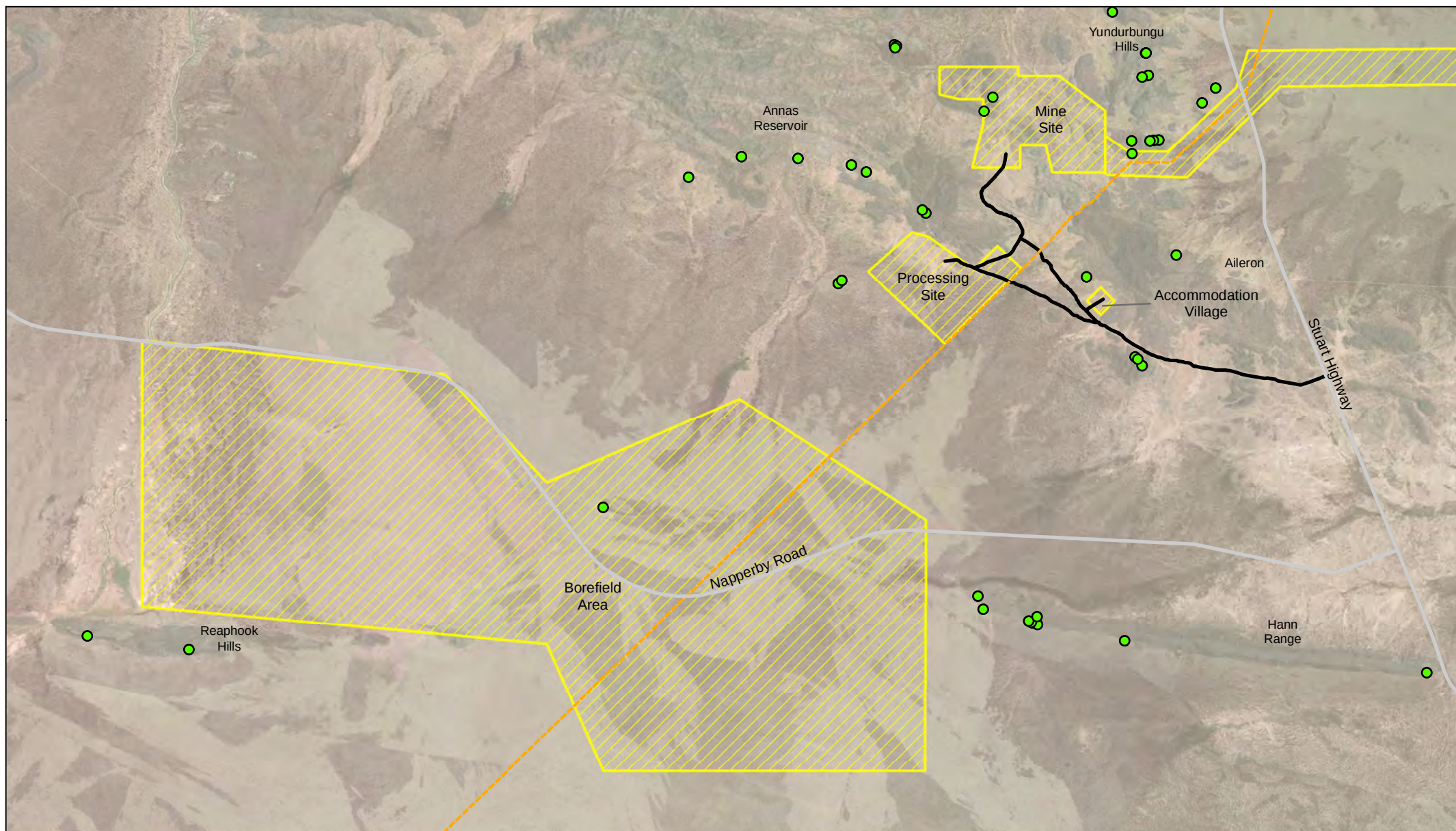
Figure 10-1

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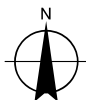
Data source: GA - Imagery (2008). Roads, Gas Pipeline (2015). GHD - Fauna Survey Sites, Proposed Mine Site, Proposed Treatment Plant, Proposed Accommodation Village, Borefield Area (2015). Created by: CM

Level 5 66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com



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Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53



LEGEND

- Black-footed Rock-wallaby Survey
- Access Roads
- Roads
- Gas Pipeline
- Study Area



Arafura Resources Limited
Nolans Project
Environmental Impact Statement

Job Number	4322301
Revision	0
Date	18 Mar 2016

**Black-footed Rock-wallaby
survey sites**

Figure 10-2

10.6 Results of targeted threatened species survey

10.6.1 Desktop assessment

Listed threatened fauna species are listed under one or more categories of threat (i.e. vulnerable, extinct, near threatened) under the EPBC Act.

Counts of EPBC listed fauna species identified for the Nolans site are presented in Table 10-2. Note that all species listed under the EPBC Act are also listed under the TPWC Act. Species which are listed under the TPWC Act and not the EPBC Act are discussed in Chapter 9 of this EIS.

More than half of the EPBC Act listed threatened species identified for the area are mammals (16 species), and of those, nearly half (seven species) are considered to be extinct in the Northern Territory or across the whole of Australia. The other threatened species are made up of birds (five species) and reptiles (one species). No frogs in the area are currently listed as threatened.

Table 10-2 Counts of fauna species (by group) identified for the study area that are listed in categories of threat

Threat category	Species group	Mammals	Birds	Reptiles	Frogs	Total
EPBC Act						
Extinct (EX)		7	0	0	0	7
Endangered (EN)		4	2	0	0	6
Vulnerable (VU)		5	3	1	0	9
Total (EPBC Act)		16	5	1	0	22

10.6.2 Threatened species – known and expected occurrence within study area

There are a range of terrestrial habitats in the study area, and each is mostly in good condition. Based on the typical habitat requirements and geographic distribution of the listed species, the study area is considered capable of providing at least some habitat for most of them.

The EPBC listed species are listed in Table 10-4 along with their conservation status and a summary of their potential use of the study area (likelihood of occurrence). Note that threatened species would be expected to use the Nolans site in varying ways, from breeding residents to occasional, frequent, seasonal, irregular, rare or vagrant visitors.

Table 10-3 EPBC listed species identified in the study area

Species	Mine site area	Accomm area	Processing site	access road to Stuart Hwy)	Utilities corridor (north)	Utilities corridor (south)	Borefield area
MAMMALS							
Greater Bilby (EPBC)	P	P	P	P	P	P	P
Black-footed Rock-wallaby (EPBC)	K		K				K
BIRDS							
Princess Parrot (EPBC)		P	P	P	P	P	P
REPTILES							
Great Desert Skink (EPBC)			P			P	K
Count (EPBC-listed species)	2	2	3	2	2	3	3

Key:

K – known to occur in this section of the study area;

P – occurrence possible in this section of the study area.

Blank grey cells indicate that a species is unlikely to occur in that section on the basis of dominant habitat in that section (but do not mean that species are absent).

Species listed under the EPBC Act are indicated as 'EPBC'.

For the utilities corridor, "north" and "south" refer to north and south of the processing site. Utilities corridor includes potable water and process water pipelines, powerlines and adjacent access track

10.6.3 Threatened fauna species most likely to be impacted by the Project

Four EPBC listed fauna species are given special attention based on the likelihood of occurrence assessment and are highlighted in Table 10-4 below.

If the Project results in significant residual impacts on any species listed as threatened under the EPBC Act, then compensatory offsets may be required under the EPBC Act, in accordance with DSEWPaC (2012). According to the EPBC Act website, offsets are 'measures that compensate for the residual impacts of an action on the environment, after avoidance and mitigation measures are taken.

Additional information for these species is provided in sections below.

Table 10-4 Threatened EPBC species within the survey area and likelihood of occurrence

Species	EPBC	Where detected? (GHD surveys)	Likely Extent of occurrence within the study area
MAMMALS			
Black-footed Rock-wallaby (MacDonnell Ranges race) <i>Petrogale lateralis</i>	VU	Mine site and borefield	Mine site and scattered outcrops in the borefield. Species restricted to steep rocky habitats, particularly the larger rock outcrops and ranges.
Greater Bilby (Bilby) <i>Macrotis lagotis</i>	VU	(Not detected)	Potentially suitable habitat occurs across much of the study area, but particularly in the southern areas that are dominated by sandplain.
BIRDS			
Princess Parrot <i>Polytelis alexandrae</i>	VU	(Not detected)	Potentially suitable habitat occurs across much of the study area, particularly in the southern areas that are dominated by sandplain.
REPTILES			
Great Desert Skink <i>Liopholis kintorei</i>	VU	Borefield area	Detected as burrow/latrine system, with identification of scats verified. May occur across much of the sandplain habitat in the south of the study area.

Key:

VU = vulnerable

Black-footed Rock-wallaby MacDonnell Ranges race (Petrogale lateralis)

Signs of Black-footed Rock-wallaby (Plate 10-1) were widespread across the broader study area, which indicates that this species is present, at least in small numbers. Based on observations of scat abundance and freshness, wallabies appear to favour some sites over others, and appear to have used some sites more recently than others. Evidence of juveniles at a small number of sites indicates that rock-wallabies are likely to be breeding in the area, or possibly dispersing through the area, but suggests that breeding/rearing does not occur in all areas, and may be limited to the most favourable habitat (e.g., abundance of food or safety from predators).

When assessed against vegetation, other fauna, fire history, distance to water and distance to higher quality habitat, patterns in rock-wallaby distribution were obscure and difficult to interpret. A larger and more comprehensive study of rock-wallaby ecology would be required to confidently explain the distribution of the species in the rocky hills that surround the mine site area.

However, most areas where Black-footed Rock-wallaby were recorded are not within the footprint of the mine or associated infrastructure corridors (although fresh scat and juvenile scat

was recorded within a distance of approximately 2 km from the mine site). Therefore, direct impacts on this species are expected to be minimal, although indirect impacts on the population may occur throughout the broader area through increases in the prevalence of wildfire and introduced predators, which may be a consequence of the Project. Mitigation measures will be put in place to minimise the effects of these impacts.



Plate 10-1 Black-footed Rock-wallaby (Photo taken at Finke Gorge National Park, NT)

Great Desert Skink (*Liopholis kintorei*)

One Great Desert Skink (*Liopholis kintorei*) burrow system was found during the 2015 baseline fauna survey (Table 10-3) in the borefield, with a possibility of occurrence in the southern utility corridor and processing site. It was in habitat that appeared not to have been burnt very recently, but had been burnt recently enough that the spinifex tussocks were large but not very large (perhaps burnt within the past 5-6 years).

The DLRM NT Fauna Atlas results (June 2015) indicate that the species has also previously been recorded in the borefield area in the vicinity of the Napperby Road but the record is undated. All parts of the study area that are spinifex-dominated sandplain provide potentially suitable habitat for this species, but areas that have larger and more established spinifex (perhaps as a result of less frequent fire) are most likely to support burrow systems.

Targeted surveys for Great Desert Skink burrows were completed during the 37.4 km of walking transects of the proposed alignments, and intensively within 200 m of the known Great Desert Skink burrow identified previously in 2015 and an historic record three kilometres north of the proposed alignment close to the Napperby Road. No signs of Great Desert Skink were detected along the proposed access roads and water pipeline corridor, or in the area surrounding the

historic record. No additional burrow systems were found in the area around the known Great Desert Skink burrow.

Four separate remote fauna cameras were established at the Great Desert Skink warren during the July 2015 survey and left *in situ* until they were collected in late October 2015. Great Desert Skinks first emerged from the burrows in mid-September (Plate 10-2) and remained active up until the cameras were collected in late October.



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Plate 10-2 Great Desert Skink image captured using remote sensor cameras collected on 22 Oct 2015

Greater Bilby (Macrotis lagotis)

Extensive and intensive spotlighting searches were undertaken in 2010/11 and in 2015 and walking transects along all linear infrastructure corridors (access roads, pipelines etc.) in 2015 in an effort to detect active individuals of this species. This species was not recorded during the 2010/11 or 2015 surveys, and no historical records exist for the study area. However, spinifex-dominated habitats within the study area provide potential habitat, including rocky areas and areas with a low shrub cover.

Surveys for Greater Bilby burrows were completed during the 37.4 km of walking transects of the proposed alignments, and from the air by helicopter when flying over areas of sandplain during rock-wallaby surveys. No signs of Greater Bilby were detected along the proposed access roads or service corridors.

This species was not recorded during the targeted surveys, and no historical records exist for the study area, however spinifex-dominated habitats in the borefield area provide potential habitat, including rocky areas and areas with a low shrub cover.

Princess Parrot (*Polytelis alexandrae*)

This species was not recorded during the 2010 or 2015 surveys, and no records exist for the study area. Suitable habitat is present within the study area, but the species is generally rare and highly mobile, and is considered to be, at most, an occasional visitor to the study area. Consequently, targeted surveys are not considered necessary for this species.

If the species is observed within the study area at any stage during the project, then that information should be made known to the NT DLRM and DotE.

10.6.4 Migratory species

Eight fauna species identified for the study area are listed as Migratory under the EPBC Act. These are listed in Table 10-5 with an evaluation of each species' likelihood of occurrence in the study area.

Two of the Migratory species (Fork-tailed Swift, *Apus pacificus* and Rainbow Bee-eater, *Merops ornatus*) are likely to occur within the study area, and one of those (Rainbow Bee-eater, *Merops ornatus*) was detected during the 2010 surveys.

Habitats within the study area are unlikely to be considered 'important habitat', and the birds that occur there are unlikely to be an 'ecologically significant population' (in accordance with the EPBC Act). The Project is not expected to impact on any listed migratory species.

Table 10-5 Fauna species identified for the study area and listed as Migratory under the EPBC Act

Species	Likelihood of occurrence within study area
Migratory Marine Birds	
Fork-tailed Swift <i>Apus pacificus</i>	Possible – All areas
Migratory Terrestrial Species	
Rainbow Bee-eater <i>Merops ornatus</i>	Present – all areas
Migratory Wetland Species	
Great Egret (White Egret) <i>Ardea alba (=modesta)</i>	Unlikely – All areas.
Cattle Egret <i>Ardea ibis</i>	Unlikely – All areas.
Oriental Plover, Oriental Dotterel <i>Charadrius veredus</i>	Unlikely – All areas.
Oriental Pratincole <i>Glareola maldivarum</i>	Unlikely – All areas.
Australian Painted Snipe <i>Rostratula benghalensis (australis)</i>	Unlikely – All areas.

Species	Likelihood of occurrence within study area
Glossy Ibis <i>Plegadis falcinellus</i>	Unlikely – All areas.

10.7 Potential impacts

The potential impact of the Project on MNES, specifically Black-footed Rock-wallaby (MacDonnell Ranges race) (vulnerable), Greater Bilby (vulnerable), Great Desert Skink (vulnerable) and Princess Parrot (vulnerable); has been assessed in Appendix N. The risk register for MNES (based on EPBC Significant Impacts Guidelines) has been developed separately from the whole of Project risk assessment, and is presented in Section 6.11 in Appendix N.

Evaluation of the significance of potential impacts are based on the Commonwealth's *Significant Impacts Guidelines 1.1 - Matters of National Environmental Significance* as applied to endangered and vulnerable species.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *Lead to a long-term decrease in the size of a population*
- *Reduce the area of occupancy of the species*
- *Fragment an existing population into two or more populations*
- *Adversely affect habitat critical to the survival of a species*
- *Disrupt the breeding cycle of a population*
- *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
- *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*
- *Introduce disease that may cause the species to decline*
- *Interfere with the recovery of the species.*

10.7.1 Assessment of the “real chance of probability” of an EPBC significant impact

An extensive risk assessment methodology has been developed to assess the potential risk of each impact against the significant impact criteria listed in the guidelines. The risk assessment methodology specific to MNES is discussed in the following sections.

A “real chance or probability” of a significant impact from a particular source is defined as there being an extreme or high risk of a population (or the fauna community) experiencing a significant consequence as defined in the guidelines e.g. reduce the diversity or modify the composition of plant or animal species.

The initial levels of risk, and determination of residual risk (after avoidance, mitigation and management actions have been applied) have been undertaken using standard qualitative risk assessment procedures consistent with AS/NZS ISO 31000:2009 'Risk Management – Principles and Guidelines', with the exception of economic risk which is not addressed in the Guidelines.

Assessment of risk has been conducted through consideration of the circumstances around risks, identifying necessary controls to address potential impacts and assuming effective implementation of planned and committed mitigation of potential impacts.

Avoidance, mitigation and management actions are proposed in an attempt to reduce residual risk (risk after actions) where possible to below “Extreme” or “High” risk outcomes to the extent reasonably practicable as part of reducing the overall Project risk.

The depth of focus on risk controls is linked to the level of risk and opportunity for reduction to meet organisational commitments and goals linked to an environmentally and socially responsible operation, and those requirements are part of the regulatory obligations and impact assessment guidelines.

Table 10-6 and Table 10-7 provide a summary of the qualitative risk matrix adopted and the levels of risk for the various consequence and likelihood combinations.

Table 10-6 Qualitative Risk Analysis Matrix

Likelihood	Consequence Level				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost Certain (5)	Medium	High	High	Extreme	Extreme
Likely (4)	Medium	Medium	High	High	Extreme
Possible (3)	Low	Medium	Medium	High	High
Unlikely (2)	Low	Low	Medium	Medium	High
Rare (1)	Low	Low	Low	Medium	Medium

Table 10-7 Definitions of levels of consequence

Levels of Consequence	Definitions
Catastrophic	Moderate or substantial regional decrease in size of population(s) of listed fauna species
Major	Substantial local decrease in size of population(s) of listed fauna species
Moderate	Moderate local decrease in size of population(s) of listed fauna species
Minor	Minor local decrease in size of population(s) of listed fauna species
Insignificant	No loss of individuals of listed fauna species

10.7.2 The fauna and populations of threatened species

Each of the species to be assessed can be regarded as having a “population” in the Nolans site area. The populations of each of the threatened species occupy specific areas in and around the study area as defined by the species’ preferred habitats and biology. Areas occupied/possibly occupied by the fauna and population of each species are unlikely to be related to boundaries imposed by the mine site/borefield boundaries or processing site.

This assessment is risk averse in that two of the species were not recorded during the study.

The areas occupied by the populations/the entire fauna are:

- Black-footed Rock-wallaby is known (from July 2015 targeted survey) to occur throughout the rocky habitats of the eastern parts of the Reynolds Range which incorporates the study area. Only transient populations appear to occur within the actual mine site footprint, however a viable population was found to occur in the immediate vicinity of the mine site with 20 sites found to contain fresh rock-wallaby scat and 25% of those sites containing juvenile scat (of 65 sites visited, 35 contained rock wallaby scat, 20 sites had fresh scat and 5 of the 20 had juvenile scat)
- The Great Desert Skink was only recorded on one occasion in the far south-west of the proposed borefield. Although only one active Great Desert Skink warren was recorded, despite extensive searches of the proposed borefield (i.e. 37.4 kms walking transect along proposed borefield pipeline network using a minimum of three ecologists), it is possible that this species could occur within any of the sandplain habitats of the study area (e.g. one other historic record for this species also exists in the borefield)
- The Greater Bilby was not recorded during the previous surveys (despite a distance of 37.4 km covered by three ecologists in addition to aerial surveys looking for burrows) and there are no historic records within the proposed Project footprint, however it is possible that this species could occur within any of the sandplain habitats of the study area
- The Princess Parrot was not recorded during the previous surveys and there are no historic records within the proposed Project footprint, however it is possible that this species could occur within any of the habitats within the proposed Project footprint apart from the rocky habitats.

The entire fauna is assumed to be broadly present within the Burt Plain Bioregion within their preferred habitats as described above. In reality the fauna and its threatened species extend much further than that considered in the assessments.

Sources of impact (events/activities/actions) arising from the proposed Project that have the potential to have a significant impact include:

- Clearing of breeding and/foraging habitat (includes harming or killing of animals directly)
- Dust generated by construction, mining and processing activities
- Noise generated by construction, mining and processing activities
- Wildfire that may result unintentionally from construction, mining and processing activities
- Introduction and/or spread of exotic plants and animals
- Poisoning of fauna from drinking water in the tailings and/or residue storage facilities
- Lowering or contamination of the water table
- Artificial light generated by mining and processing activities
- Injury and death of fauna from collisions with vehicles.

Each of these potential sources of impact is addressed in more detail below. Table 10-8 and Table 10-9 provide a summary of the level of residual risk associated with these potential sources of impact.

Table 10-8 Project Risk – Black-footed Rock-wallaby species present within the mine site and within the vicinity

Source of Impact	Likelihood	Consequence	Severity	Residual Risk (following additional implementation of mitigation measures)
Clearing – dispersal and foraging habitat	Unlikely	Minor	Low	Low
Dust	Unlikely	Insignificant	Low	Low
Noise	Unlikely	Insignificant	Low	Low
Light	Unlikely	Minor	Low	Low
Unplanned Wildfire	Possible	Major	High	Medium
Exotic plants and animals	Possible	Major	High	Low
Waste water	Rare	Insignificant	Low	Low
Lowering or contamination of water table	Rare	Insignificant	Low	Low
Traffic mortality	Rare	Insignificant	Low	Low

Table 10-9 Project Risk – Great Desert Skink, Greater Bilby, Princess Parrot species present within the borefield and adjacent access corridor

Source of Impact	Likelihood	Consequence	Severity	Residual Risk (following additional implementation of mitigation measures)
Clearing – dispersal and foraging habitat	Unlikely	Minor	Low	Low
Dust	Unlikely	Insignificant	Low	Low
Noise	Unlikely	Insignificant	Low	Low
Light	Unlikely	Minor	Low	Low
Unplanned Wildfire	Possible	Major	High	Medium
Exotic plants and animals	Possible	Major	High	Low
Waste water	Rare	Insignificant	Low	Low

Lowering or contamination of water table	Rare	Insignificant	Low	Low
Traffic mortality	Possible	Minor	Medium	Low

The following risk assessment tables associated with each of the aforementioned potential impacts are derived from the fauna report (Appendix N). Each table presents the risk assessment for

- the Black-footed Rock-wallaby, in areas within and around the mine site
- Great Desert Skink, Greater Bilby, Princess Parrot within the borefield and access corridor.

10.7.3 Clearing of breeding and/or foraging habitat

The figures provided below are highly conservative in that the total areas of clearing presented below indicate broad areas of habitat that may not completely represent preferred habitat (e.g. for rock-wallaby, the 266.23 ha of rocky habitat proposed for clearing is not all likely to be high quality habitat).

Black-footed Rock-wallaby

A total cumulative loss (all vegetation communities) of 266 ha of known foraging and dispersal habitat. This equates to broadly 0.41% of the 65,000 ha of potential habitat within the 150,000 ha search area from the July 2015 survey.

The habitat to be lost within the Project footprint appears to be foraging/dispersal habitat only (old scats present) compared to the foraging/breeding/dispersal habitat within the surrounding Reynolds Range in the vicinity of the proposed mine site survey.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-10 below.

Table 10-10 Risk assessment of the potential impact of clearing of breeding and/or foraging habitat on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- Develop and apply dedicated Biodiversity Management Plan (BMP) to minimise and mitigate clearing effects on the Black-footed Rock-wallaby - Monitor the impact that clearing has on the	Low
Reduce the area of occupancy of a population	1	2		Low
Fragment an existing important population into two or more populations	2	2		Low
Adversely affect habitat critical to the survival of a species	2	1		Low
Disrupt the breeding cycle of a population	2	1		Low

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	2	Black-footed Rock-wallaby population	Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	2	2		Low
Introduce disease that may cause the species to decline	1	1		Low
Interfere with the recovery of the species	2	2		Low

Great Desert Skink, Greater Bilby and Princess Parrot, species present within the borefield

The Great Desert Skink in the study area to lose:

- A total cumulative loss (all vegetation communities) of 122.25 ha of known foraging/breeding/dispersal habitat. This equates to broadly 0.29% of the approximately 41,568 ha of potential habitat within the sandplain habitats of Napperby and Aileron stations that encompass the Nolans Project.
- There is more extensive potential habitat in the Burt Plain Bioregion in addition to this area. A single Great Desert Skink active warren was recorded in the far south-west of the study area that is currently situated outside of the proposed development area for the borefield. It will be important to avoid this location during the construction and operation of the project.

The Greater Bilby in the study area to lose:

- A total cumulative loss (all vegetation communities) of 122.25 ha of possible foraging/breeding/dispersal habitat. This equates to broadly 0.29% of the approximately 41,568 ha of potential habitat within the sandplain habitats of Napperby and Aileron stations that encompass the Nolans Project. There is certainly much more extensive potential habitat in the Burt Plain Bioregion in addition to this area
- This species was not recorded during any of the previous surveys conducted within the study area (including aerial flyover of habitat looking for burrows). Despite not being detected, this species is mobile and could still occur in very low abundance (thus difficult to detect). Impacts would likely be low with the primary impacts being vehicle strike at night (low likelihood) and increased predation due to greater presence of people and their waste (i.e. increase in predator abundance).

The Princess Parrot in the study area to lose:

- A total cumulative loss (all vegetation communities) of 362.21 ha of possible foraging/dispersal habitat. This equates to broadly 0.87% of the approximately 41,568 ha (borefield). There is certainly much more extensive potential habitat in the Burt Plain

Bioregion in addition to this area. This species is highly nomadic and would be an occasional visitor to the study area at most.

- This species was not recorded during any recent or previous surveys in the study area. As mentioned, this species is highly nomadic and irruptive in response to rainfall and improved conditions. This species arrived at Newhaven Station in 2012 (approx. 180 km from the study area) following good rainfall in central Australia. It is possible that this species could visit the study area under similar conditions in the future.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-11 below.

Table 10-11 Risk assessment of the potential impact of clearing of breeding and/or foraging habitat on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- Importantly for species such as the Great Desert Skink, avoid the known active warren for this species, implement clearing during autumn when breeding has ended. For borefield fauna in general, avoid clearing during the winter/spring months when animals (particularly reptiles) are inactive in burrows or breeding. A qualified ecologist on-site during the clearing would capture and translocate animals encountered during the clearing process; - Develop and apply dedicated Biodiversity Management Plan (BMP) and ensure appropriate construction, weed, weed hygiene, fire and rehabilitation management aspects are covered in an attempt to minimize and mitigate clearing effects. - As part of BMP incorporate a monitoring program for threatened species (particularly Great Desert Skink) to monitor the impact that clearing has on local populations;	Low
Reduce the area of occupancy of an important population	4	1		Low
Fragment an existing population into two or more populations	2	2		Low
Adversely affect habitat critical to the survival of a species	2	2		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline				Low
Result in invasive species that are harmful to a vulnerable species becoming established in the	3	2		Low

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
vulnerable species' habitat				
Introduce disease that may cause the species to decline	1	1		Low
Interfere with the recovery of the species	2	2		Low

The areas to be cleared will form small islands of cleared habitat in a near continuous area of native vegetation. The area is bounded to the south by the Reaphook Hills and Hann Range and Stuart Highway to the east. The proposed mining will not cause any fragmentation of the habitat.

The proposed loss of habitat for these threatened species and the entire fauna are relatively small compared to the actual study area over which the faunal populations are distributed and potentially occur within the area assessed (approx. 150,000 ha by both vehicle and helicopter) and broader region which includes the eastern end of the Reynolds Range, Napperby and Aileron stations.

Clearing seems unlikely to have any significant direct impact on any of the threatened species and populations.

The fauna as a whole is similarly likely to experience no significant effects from the clearing itself with other impacts discussed below such as vehicle strike and the introduction of exotic predators likely to be more important for future management. Impacts from the clearing would likely be minimal, and not amenable to detection at the population level.

Specific mitigation measures would need to be implemented for species with very small known populations such as the Great Desert Skink active warren in the south-west of the study area. The active warren is not currently part of the proposed development and this would need to remain so, with protection of this location.

General mitigation measures

To minimise and mitigate clearing effects on threatened species populations, breeding habitat and foraging habitat the following actions have been considered:

- Subtle realignment and preliminary design and -siting of all infrastructure to minimise loss of key breeding and feeding habitat (particularly in the borefield to avoid the Great Desert Skink warren)
- Clearly marking areas of land to be cleared and areas to be retained (No-Go areas), so that impacts do not extend any further than necessary into important habitat
- Construction and clearing during non-breeding period (e.g. clearing to occur preferably in autumn when young animals are mobile and less dependent on parents and when reptiles are still active and have a chance to escape)

- Consider a cool, well managed fuel reduction burns of all habitats to be cleared to allow fauna to have the chance to escape prior to chaining of vegetation and bulldozing up into windrows. Details on this approach would be contained within a BMP
- Pre-clearing fauna surveys prior to construction of the mine with qualified ecologists on site to capture and translocate animals that are found during the clearing process
- Strict vehicle hygiene protocols to prevent new weed incursion and spread, including a vehicle wash down facility on site
- Strict fire prevention management protocols to prevent wildfire during clearing activities
- Possibly offsetting habitat at a higher quantum and condition, the habitat to be cleared, including actions to manage offset areas to decrease threatening processes, and increase threatened species populations. Details on this approach would be contained within a BMP
- Rehabilitation of edges (of clearing) abutting threatened species habitat to remove weed species, and maximise the presence of native plant regeneration
- Monitoring of habitat clearing to ensure compliance with areas marked as No-Go areas
- Use of already-disturbed areas (rather than undisturbed areas) wherever possible (e.g. set down areas for construction)
- Progressive and incremental clearing of land as needed, rather than large-scale clearing in advance
- Progressive rehabilitation/stabilisation of cleared land as activities are completed (which forms part of the Closure and Rehabilitation Plan)
- Ongoing pest animal control (e.g. control of cats and foxes in particular).

10.7.4 Dust generated by mining and processing activities

Dust is a potential problem for projects in regions that experience extended dry periods. Central Australia exhibits an arid and unpredictable climate that could extend for periods of months without rain.

Drilling, blasting, excavation, movement of vehicles and handling of materials results in dispersion of particulates and dust, particularly from the mine site, and consequent soil, surface/groundwater contamination.

Potential impacts of dust can include:

- Degradation/loss of fauna habitat from detrimental impacts of dust deposition on flora species and vegetation communities
- Degradation/loss of water source for fauna resulting from degradation of surface water quality due to dust deposition/sedimentation. Details of dust deposition can be found in air quality report contained in Appendix Q

Populations of Black-footed Rock-wallaby do occur within less than two kilometres of the mine site and could be subjected to levels of dust. Mitigation measures would need to be implemented to keep dust levels to a minimum.

The threatened species either do not or would not regularly occur in the vicinity of the mine site (Great Desert Skink, Greater Bilby, Princess Parrot) and hence would only ever be subjected to very low dust levels mainly from vehicles driving along gravel/dirt tracks.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-12 and Table 10-13 below.

Table 10-12 Risk assessment of the potential impact of dust on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- A Dust Management Plan (DMP) will be developed and implemented to minimise dust emissions - Produce and apply dedicated BMP and ensure appropriate dust controls are in place in an attempt to minimize and mitigate dust effects on the Black-footed Rock-wallaby population of the area - As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby to monitor the impact that dust has on the local population	Low
Reduce the area of occupancy of an important population	2	2		Low
Fragment an existing important population into two or more populations	2	2		Low
Adversely affect habitat critical to the survival of a species	2	2		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	2		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				n/a
Introduce disease that may cause the species to decline				n/a
Interfere with the recovery of the species	2	2		Low

Table 10-13 Risk assessment of the potential impact of dust on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- A Dust Management Plan (DMP) will be developed and implemented to minimise dust emissions - Produce and apply dedicated BMP and ensure appropriate dust controls are in place in	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	1	1		Low

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Disrupt the breeding cycle of a population	1	1	an attempt to minimize and mitigate dust effects on the threatened populations of the area - As part of BMP incorporate a monitoring program monitor the impact that dust has on the threatened populations	Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	1	1		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				n/a
Introduce disease that may cause the species to decline				n/a
Interfere with the recovery of the species	1	1		Low

General mitigation measures

To minimise and mitigate the effects of dust on threatened species populations, breeding habitat and foraging habitat the following actions are recommended:

- The minimisation of dust emission controls as defined in a Dust Management Plan that includes, but is not limited to
 - Crusher dust controls to industry standards, via watering, emission screens, road sealing, chemical applications, covering of exposed loads where practicable
 - Minimising mining, hauling and vehicle travel when prevailing winds and strength of winds reach a particular trigger level that would result in spatially extensive and heavy dust deposition in surrounding habitats where practicable.
- Dust monitoring to assess dust effects with distance from the mine or dust-generating activity as per GHD Air Quality report
- Reduced vehicle speeds for high-use areas/roads
- Progressive rehabilitation/stabilisation of cleared land as activities are completed (which forms part of the Closure and Rehabilitation Plan).

10.7.5 Noise generated by mining and processing activities

Disturbance to fauna associated with generation of unexpected and/or excessive noise from mining and processing activities and during construction can result in:

- Displacement of fauna
- Disruption to nesting/roosting/foraging behaviour.

Displacement of fauna into sub-optimal habitats could increase their susceptibility to predation and competition.

Decline in fauna populations associated with increased noise levels are subject to variation among years and the interaction with and between habitat quality and population density plays a significant role in determining the nature of a decline.

It is likely that faunal communities in the immediate vicinity of the mine site and mine operations would be most acutely affected by the proposal and could experience periodic periods of high noise levels that may encourage them to move to other nearby habitats.

The Black-footed Rock-wallaby does occur within less than two kilometres of the mine site and appears to occasionally pass through the actual mine site footprint (old scat recorded adjacent to Nolans Bore). It is quite likely that noise generated by the mine could preclude rock-wallaby movements through the mine site as has occurred previously, however particularly noisy activities would likely occur during diurnal periods when rock-wallabies are sheltering and noise would be somewhat buffered by their rocky, elevated habitat.

Particularly 'high noise' activities should be prevented from occurring during the rock-wallabies' nocturnal activity period when they could potentially be most disturbed

It is envisaged that the majority of the EPBC listed threatened species that are known or have the potential to occur within the study area (Great Desert Skink, Greater Bilby, Princess Parrot) occur some distance from the mine site (less than ten kilometres) and would unlikely be effected by mine site noise.

Increased vehicle noise in the borefield could have some localised and isolated low-level impacts however most of these species are nocturnal and their activity patterns would unlikely be adversely impacted by activity in the borefield at night. Vehicle passage in this area would be infrequent for maintenance purposes and may only occur on a weekly basis in daylight hours.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-14 and Table 10-15 below.

Table 10-14 Risk assessment of the potential impact of noise on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise at night when rock-wallabies are active - Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area;	Low
Reduce the area of occupancy of an important population	2	2		Low
Fragment an existing important population into two or more populations	2	2		Low
Adversely affect habitat critical to the survival of a species	2	2		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	2		Low
Result in invasive species that are harmful to a vulnerable species becoming				n/a

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
established in the vulnerable species' habitat			- As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby to monitor the impact that noise has on the local population.	
Introduce disease that may cause the species to decline				n/a
Interfere with the recovery of the species	2	2		Low

Table 10-15 Risk assessment of the potential impact of noise on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- The implementation of noise controls as defined in a Noise Management Plan – likely to include the avoidance of loud noise at night when rock-wallabies are active - Produce and apply dedicated BMP and ensure appropriate noise controls are in place in an attempt to minimize and mitigate noise effects on the Black-footed Rock-wallaby population of the area; - As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby to monitor the impact that noise has on the local population.	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	1	1		Low
Disrupt the breeding cycle of a population	1	1		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	1	1		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				n/a
Introduce disease that may cause the species to decline				n/a
Interfere with the recovery of the species	1	1		Low

General mitigation measures

Minimising impacts on fauna from noise will involve:

- Minimising noise wherever possible
- Limiting high-impact noise to daylight hours only (this will reduce the impact on nocturnal fauna, which includes most of the threatened species).

10.7.6 Artificial light generated by mining and processing activities

Light plays a critical role in ecology. It determines activity levels of diurnal and nocturnal fauna, it assists predators in their hunting success, and some light sources attract invertebrate fauna that attract and are then preyed on by other fauna. Localised disturbance to nocturnal fauna associated with generation of light in mining and processing areas can cause the following impacts on fauna:

- Local displacement of fauna (i.e. nocturnal fauna move away from brightly lit areas)
- Increased susceptibility of fauna to predation (e.g. prey species find it harder to remain concealed in brightly lit areas)
- Disruption to nesting/roosting behaviour (e.g. bright lights may awaken diurnal species).
- Disorientation of migrating birds (e.g. Longcore et al. 2008)
- Attraction and disorientation of amphibians (Buchanan 2006)
- Disorientation of bats (e.g. Stone et al., 2009; Polak 2011)
- Attraction of and enhanced mortality of insects (e.g. Yoon et al., 2010; Ferreira and Scheffrahn 2011; Fox 2012)
- Alteration of bird calling behaviour (e.g. Kepempenaers et al., 2010; Loncore 2010)
- Breeding behaviour of amphibians (e.g. Baker and Richardson 2005)
- Small mammal activity rhythms (e.g. Rotics et al., 2011).

It is envisaged that the majority of the EPBC listed threatened species that are known or have the potential to occur within the study area (Great Desert Skink, Greater Bilby, Princess Parrot) occur some distance from the mine site (less than ten kilometres) and would unlikely be affected by mine site light. Increased vehicle and infrastructure lighting in the borefield could have some localised and isolated low-level impacts however, it is unknown whether artificial lighting has any adverse impacts on these species.

The Black-footed Rock-wallaby does occur within less than two kilometres of the mine site and appears to occasionally pass through the actual mine site footprint (old scat recorded adjacent to Nolans Bore, see Figure 24). It is possible that light emitted specifically from the concentrator at the mine site could impact on the nocturnal movement of rock-wallabies in the immediate vicinity of the mine site (i.e. previous rock-wallaby activity in the mine site appears to have been transitory only. Nocturnal lighting could reduce these dispersal activities in the immediate mine site vicinity). Rock-wallabies occurring at distances greater than or equal to two kilometres from the mine site are unlikely to be adversely impacted by artificial lighting, provided that lights are not directed at their habitat. The distance and buffering by the elevation and rocky habitat would diminish the penetration of the 'brightness' of the majority of lights that would be used for illumination purposes.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-16 and Table 10-17.

Table 10-16 Risk assessment of the potential impact of lighting on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- Avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts; - Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the Black-footed Rock-wallaby population of the area.	Low
Reduce the area of occupancy of an important population	2	2		Low
Fragment an existing important population into two or more populations	2	2		Low
Adversely affect habitat critical to the survival of a species	2	1		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	1		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	1	1		Low
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	2	1		Low

Table 10-17 Risk assessment of the potential impact of lighting on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- Avoiding unnecessary lighting at night when rock-wallabies are active and keeping lighting low and directed at operations rather than surrounding habitat will assist greatly in mitigating impacts;	Low
Reduce the area of occupancy of an important population	2	2		Low
Fragment an existing important population into two or more populations	2	2		Low
Adversely affect habitat critical to the survival of a species	2	1		Low
Disrupt the breeding cycle of a population	2	2		Low

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	1	- Produce and apply dedicated BMP and ensure appropriate lighting controls are in place in an attempt to minimize and mitigate artificial light effects on the threatened	Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	2	1		Low

General mitigation measures

The potentially negative impacts of artificial light can be mitigated by:

- Limiting artificial light to areas where it is essential
- Turning off lights when not required
- Limiting the escape of light into surrounding areas of fauna habitat (i.e., using shields/deflectors)
- Ensuring that artificial lighting is not directed upwards or laterally (i.e. should be directed towards the ground)
- Using lower rather than higher lighting installations
- Using lower wavelengths of light wherever possible, i.e. red/yellow lights
- Using light intensities that are as low as possible without reducing safety or efficiency
- Avoiding painting large structures bright or reflective colours and minimise use of bright or reflective construction materials and finishes for large structures.

10.7.7 Unplanned bushfire

Bushfire has an influential role in arid zone ecology, and is a necessary ecological process in some habitats. Fire can benefit some disturbance-tolerant species, but can have detrimental impacts on other types of fauna and fauna habitat, if it occurs at the wrong time of year, or in habitats that don't respond well to fire, or with excessive heat.

This Project introduces a range of potential sources of fire. Vehicles, machinery, hot works, switchgear, transformers, HV power and personnel provide potential ignition sources that could lead to fire. Impacts of fire on fauna include:

- Killing/injuring fauna
- Displacement of fauna
- Disruption to nesting/roosting/foraging habitats and/or behaviour
- Reduction of area of fauna habitat locally and/or regionally

- Habitat fragmentation
- Subsequent erosion and sedimentation resulting from loss of vegetation
- Degradation of surface water quality due to erosion of soils and landforms.

The impacts of too frequent, hot and extensive fires are well documented in the arid zone of central Australia (Woinarski et al. 2007). A number of the threatened species recorded within the study area are adversely affected by too frequent and extensive fires. Large-scale, intense wildfires from a lack of patch burning can devastate or fragment local populations of Great Desert Skink (Woinarski et. al. 2007). Wildfire within Black-footed Rock-wallaby habitat is also a major impact on populations as it burns food plants such as Spearbush and fig rendering habitats unsuitable for periods of time (Dr J. Read pers. comm.).

It is expected that all of the threatened species either known or potentially occurring within the study area would be affected by fire (both positive and negative impacts).

Controlled and strategic cool patch burns of spinifex sandplain habitat could have positive outcomes for species such as Greater Bilby (promotes food plants). Extensive burns (not patchy) of Great Desert Skink and Black-footed Rock-wallaby habitat could be detrimental as the fire would remove important shelter and food resources.

Burning of rocky habitat is unlikely to be beneficial for many species and should be avoided as there are some excellent examples of long-unburnt rocky habitats supporting species such as pine and mulga that should continue to be protected. Continued persistence of the Black-footed Rock-wallaby in the area will depend on prevention of wildfire in the surrounding rocky habitats of the study area and surrounds.

As mentioned above, too frequent, hot and extensive wildfire is unlikely to benefit any of the threatened species in the study area and surrounds, whereas localised cool patch burns are likely to be beneficial.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-18 and Table 10-19.

Table 10-18 Risk assessment of the potential impact of unplanned wildfire on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- A separate Bushfire Management Plan will be required to manage this risk; - Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Black-footed Rock-wallaby population of the area;	Low
Reduce the area of occupancy of an important population				
Fragment an existing important population into two or more populations				
Adversely affect habitat critical to the survival of a species	2	1		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of	2	1		Low

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
habitat to the extent that the species is likely to decline			- As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby using the recent July 2015 survey as baseline data (see Section 10.5.2) to monitor possible impacts of fire (would include naturally occurring fire in addition).	
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				
Introduce disease that may cause the species to decline				
Interfere with the recovery of the species	2	1		Low

Table 10-19 Risk assessment of the potential impact of unplanned wildfire on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- A separate Bushfire Management Plan will be required to manage this risk; - Produce and apply dedicated BMP and ensure appropriate wildfire controls are in place in an attempt to minimize and mitigate the potential 'High' impacts on the Great Desert Skink population of the area; - As part of BMP incorporate a monitoring program for Great Desert Skink using the recent July 2015 survey as baseline data to monitor possible impacts of fire (would include naturally occurring fire in addition).	Low
Reduce the area of occupancy of an important population				
Fragment an existing important population into two or more populations				
Adversely affect habitat critical to the survival of a species	2	1		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	1		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				
Introduce disease that may cause the species to decline				
Interfere with the recovery of the species	2	1		Low

General mitigation measures

Minimising impacts on fauna from unplanned wildfire will involve:

- Planning of where high-risk activities can take place
- Maintenance of fire breaks around high-risk areas/activities
- Active fire management, and the use of cool-season control burns
- Development of a Fire Management Plan
- Erosion control in waterways, if fire should occur and kill vegetation that otherwise stabilises soil/sediments.

10.7.8 Introduction and/or spread of exotic plants and animals

Noxious weeds

The establishment or spread of weeds can alter the ecological balance of arid zone ecology. Weed dominated habitats are generally less favourable for fauna than weed-free habitats. In particular, Buffel Grass (*Cenchrus ciliaris*) is a serious ecological pest in central Australia and its spread into rocky habitats of the study area should be prevented.

Transport of materials, vehicle movements and inappropriate waste management allows for introduction of new weeds and spread of existing weeds during construction and operations. These can cause:

- Local decline in habitat quality
- Displacement of fauna from habitats as habitat quality deteriorates
- Invasion of fauna species that are attracted to the weed species (e.g., cattle with buffel grass)
- Impacts on conservation significant fauna (i.e., threatened species)
- Changes in fuel load, resulting in changes to fire frequency and intensity.

Non-native animals

Creation of new roads and tracks and inappropriate management of waste (garbage) allows for introduction or spread of pest animal species (and potentially in some cases native predators including the dingo). This can cause:

- Increased predation pressure (particularly on threatened species) by opening up of new areas to feral predators (e.g., Cat, Red Fox) and potentially native predators such as the dingo
- Increased competition (particularly on threatened species) by natural areas becoming invaded by aggressive and dominating pest species (e.g., House Mouse, Black Rat)
- Large-scale decline in habitat quality as natural areas are trampled and grazed increasingly by non-native species that have the potential to alter ecological processes (e.g., Cattle, Camel, Goat).

Feral (and native – e.g. dingo) predators appear to be common within the study area, with all transects walked in the borefield (approx. 36 km walked by a minimum of three people situated at least 5 m apart) recording a least one of fox, cat or dingo. Each of these species was also recorded on the mine site. It will be important that with an increase in people on-site waste products are contained within a predator-proof fence to prevent access (access to easily obtained food resources could allow predators to increase in abundance).

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-20 and Table 10-21.

Table 10-20 Risk assessment of the potential impact of exotic species on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste; - Produce and apply dedicated BMP and ensure appropriate controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Black-footed Rock-wallaby population of the area; - As part of BMP incorporate a monitoring program for Black-footed Rock-wallaby to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	Low
Reduce the area of occupancy of an important population				
Fragment an existing important population into two or more populations				
Adversely affect habitat critical to the survival of a species	2	1		Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	1		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				
Introduce disease that may cause the species to decline				
Interfere with the recovery of the species	2	1		Low

Table 10-21 Risk assessment of the potential impact of exotic species on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	2	2	- Various design aspects will need to be considered for the mine such as a predator-proof compound to contain food waste; - Produce and apply dedicated BMP and ensure appropriate	Low
Reduce the area of occupancy of an important population				
Fragment an existing important population into two or more populations				

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Adversely affect habitat critical to the survival of a species	2	1	controls are in place to minimize and mitigate the potential 'High' impacts of exotic plants and animals on the Great Desert Skink and other potential threatened species populations of the area; - As part of BMP incorporate a monitoring program for Great Desert Skink to monitor possible impacts of exotic plants and animals on the population. Part of this monitoring would include an assessment of the abundance of exotic/native predators.	Low
Disrupt the breeding cycle of a population	2	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	2	1		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat				
Introduce disease that may cause the species to decline				
Interfere with the recovery of the species	2	1		Low

General mitigation measures

Minimising impacts on fauna from the introduction or spread of weeds will involve:

- Development of a Weed Management Plan (likely to be part of broader Biodiversity Management Plan) to document mitigation measures to control existing exotic plants, and to stem the spread of others
- Cleaning vehicles (washdown) that are new to the site, to prevent the introduction of new weeds
- Washdown when moving from areas of high weed density to areas that are currently weed free
- Keeping vehicles to established tracks and roads, and limiting the use of vehicles off-road
- Annual weed monitoring and mapping
- Weed control activities in consultation/partnership with Aileron and Napperby station owners as necessary.

Minimising impacts on native fauna from the introduction or spread of non-native fauna (and in some cases native predators such as dingoes) will involve:

- Sound waste management (garbage) to limit invasion/colonisation by Black Rat (*Rattus rattus*). This will also be particularly important for the Black-footed Rock-wallaby population near the mine site as any on-site garbage waste will need to be held in a securely fenced (i.e. the fence will need to prevent the entry of cats, foxes and dingoes) compound to prevent the scavenging of waste material and potential population increases in both feral and native predators
- A Pest Animal Management Plan will need to be produced (as part of a broader Biodiversity Management Plan)

- Investigate innovative new passive baiting and trapping methods
- Pest eradication/control program, targeting foxes, cats and rabbits across the study area, and non-native rats and mice in mine site and accommodation village areas
- Monitoring of feral fauna species.

10.7.9 Radioactivity

Arafura has determined the radiological risks to flora and fauna using the internationally recognised ERICA assessment method. The assessment demonstrated that the radiological risks to species of flora and fauna are negligible. See Chapter 12 for more detail.

10.7.10 Poisoning of fauna from drinking contaminated water

The links between use of tailings dams and poisoning in waterfowl and other species of avifauna is well documented in the Australian literature (Ryan and Shanks 1996).

Effects can be immediate or cumulative. Consumption of contaminated water can cause:

- Death or harm
- Disruption to breeding success
- Knock-on effects, by attracting predators/scavengers to ill/dead fauna.

The Nolans Project TSF/RSFs will be quite small (approx. 244.03 ha) and will likely contain free-standing supernatant water. It is unlikely that the EPBC listed threatened species that are known or have the potential to occur with the study area (Black-footed Rock-wallaby, Great Desert Skink, Greater Bilby, Princess Parrot) would access liquid contained within these facilities. There would be an extremely low chance that passing Princess Parrots would stop for a drink at a tailings dam.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-22 and Table 10-23.

Table 10-22 Risk assessment of the potential impact of waste water on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams - Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	-	-		NA
Disrupt the breeding cycle of a population	-	-		NA

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	-	-	Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than rock-wallabies.	NA
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	-	-		NA

Table 10-23 Risk assessment of the potential impact of waste water on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- Avoid the possibility by maintaining WADCN levels below levels poisonous to wildlife, and prevent wildlife access to new tailings dams - Produce and apply a Water Quality Monitoring and Management Plan. A Tailings Dam Wildlife Monitoring Program would be incorporated into a BMP and would be more broadly directed at fauna in general rather than just specifically threatened species.	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	-	-		NA
Disrupt the breeding cycle of a population	-	-		NA
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	-	-		NA
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	-	-		NA

General mitigation measures

Impacts on native fauna from waste water can be reduced by:

- The reduction of impacts of TSF/RSFs on wildlife by following best practice guidelines currently recommended for the Northern Territory where practicable;
- The reduction of the attractiveness of the dam landscape for wildlife via design that includes, but is not limited to, the reduction of the dam surface area, removing dam bank vegetation, creating steep dam walls, providing alternative adjacent 'fauna friendly' water sources, and avoiding the creation of islands in the dam
- Looking into, where necessary, implementing appropriate bird-deterrent methods to keep waterbirds and birds of prey away.

10.7.11 Lowering or contamination of the water table

Changes to the water table can lead to changes in surface vegetation and habitat characteristics, particularly those communities reliant on surface water runoff and groundwater (e.g. riparian vegetation). Lowering or contamination of the water table has the potential to cause the following indirect impacts on fauna:

- Decline in availability of water resulting in loss of habitat for species relying on riparian habitat
- Shorter inundation period in waterbodies that may provide water for fauna.

After decommissioning, the mine void may act as a sink concentrating salts/contaminants which can seep to groundwater. This in turn can lead to:

- Impacts on vegetation that rely on groundwater or surface water flows, in turn leading to reduction in available habitat for fauna
- Unnatural inundation of fauna habitats.

In this Project, the water table (and therefore indirectly, fauna habitat) could be impacted by:

- Progressive water table drawdown from unsustainable groundwater extraction rates from the Southern basins borefield
- Mine void results in a long-term source of contaminated water with the potential to contaminate groundwater and surface water
- Embankment failure or overtopping of the TSF at the mine site and RSFs at the processing site, due to slope instability or extreme wet weather event (all of which could damage fauna habitat)
- Inappropriate storage and handling of hazardous substances on mine site or processing site resulting in uncontrolled release, spills or passive discharge.

Given the distance from these potential impacts and lack of reliance on Groundwater Dependent Ecosystems, none of the EPBC listed threatened species known or predicted to occur within the study area (Black-footed Rock-wallaby, Great Desert Skink, Greater Bilby, and Princess Parrot) are likely to be directly impacted by water table impacts. Residual and 'knock on' impacts could occur however, such as the very low chance that any of these species could consume contaminated water.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-24 and Table 10-25.

Table 10-24 Risk assessment of the potential impact of lowering or contamination of the water table on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- Adherence and implementation of the mitigation measures outlined in below	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	-	-		NA
Disrupt the breeding cycle of a population	-	-		NA
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	-	-		NA
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	-	-		NA

Table 10-25 Risk assessment of the potential impact of lowering or contamination of the water table on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- Adherence and implementation of the mitigation measures outlined in below	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	-	-		NA

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Disrupt the breeding cycle of a population	-	-		NA
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	-	-		NA
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	-	-		NA

General mitigation measures

Impacts on native fauna through changes to the water table can be reduced by:

- Constructing adequate bunds around the TSF/RSFs and other sources of potential contamination, to contain contaminated water in the event of heavy rainfall
- Monitor hydrogeological changes
- Undertake predictive groundwater flow modelling
- Development and implementation of groundwater and surface water management strategies
- Establish a Surface Water Plan for contaminated sites that serves to minimise the chance of contamination escaping into waterways.

10.7.12 Injury and death from collisions with vehicles

Creation and use of new roads and tracks through fauna habitats can lead to increased collisions with fauna, particularly at night, when nocturnal fauna can become dazed by a vehicle's bright lights. There can be both biotic and abiotic effects of roads on ecosystems (Coffin 2007) and these include:

- Injuring/killing fauna
- Breeding failure caused by loss of naïve young fauna, or adult fauna that have dependent offspring
- Changes to hydrology and water quality, both increases and decreases (Forman and Alexander 1998)
- Erosion and sediment transport (Jones et al. 2000)
- The introduction of chemical pollutants, including toxic contaminants (Forman 2003)
- Noise effects (Bayne et al. 2008)
- Direct mortality (Erritzoe et al. 2003)

- Barriers to movement (Shepard et al. 2008)
- The creation of new habitat types, especially in agricultural landscapes (Bellamy et al. 2000)
- The creation of corridors and conduits of species movement or invasion (von der Lippe and Kowarik 2008)
- Fragmentation and edge effects (Hawbaker et al. 2006).

It is possible that several of the species that occur within the borefield could occasionally be struck and killed by vehicles moving in the area (e.g. Great Desert Skink).

The majority of the threatened species that are known or have the potential to occur in the study area are nocturnal and would only be affected by vehicles travelling at night.

The overall risk of the potential impact has been assessed against the significant impact criteria in Table 10-26 and Table 10-27 below.

Table 10-26 Risk assessment of the potential impact of traffic mortality on the Black-footed Rock-wallaby

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	1	1	- Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP. - Implementation of speed limits and possibly the reduction in vehicle travel at night.	Low
Reduce the area of occupancy of an important population	1	1		Low
Fragment an existing important population into two or more populations	1	1		Low
Adversely affect habitat critical to the survival of a species	-	-		NA
Disrupt the breeding cycle of a population	-	-		NA
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	-	-		NA
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	-	-		NA

Table 10-27 Risk assessment of the potential impact of traffic mortality of the water table on the borefield species

Significant impact criteria	Likelihood	Consequence	Minimising, mitigation and management actions	Residual risk
Lead to a long-term decrease in the size of a population.	3	2	- Produce and apply a Traffic and Road Safety Management Plan, a Weed Hygiene Procedure and provision of on-site wash down facilities. Aspects of these will be incorporated into a BMP. - Implementation of speed limits and possibly the reduction in vehicle travel at night.	Low
Reduce the area of occupancy of an important population	3	2		Low
Fragment an existing important population into two or more populations	3	2		Low
Adversely affect habitat critical to the survival of a species	-	-		NA
Disrupt the breeding cycle of a population	3	2		Low
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	3	2		Low
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	-	-		NA
Introduce disease that may cause the species to decline	-	-		NA
Interfere with the recovery of the species	-	-		NA

General mitigation measures

To minimise and mitigate the effects of increased road traffic or increased road network on the threatened species populations the following actions are recommended:

- Keep the proposed road network to a minimum and upgrade and utilise existing vehicle tracks
- Reduce speed limits and install speed reduction infrastructure such as whoa-boys and speed humps
- Provide road safety and awareness training to all staff and contractors with respect to safe driving in areas where native wildlife occurs
- Implementing and enforcing speed restrictions in high-use areas
- Limiting the movement of vehicles at night (between the period of one hour before dusk to one hour after dawn)
- Monitoring roadkill for threatened species
- Documenting location and time of day of roadkill within the study area, to determine high-risk periods or locations (additional mitigation may be required)

- Fatigue management for vehicle operators
- Development and implementation of a Traffic Management Plan.

10.8 Summary of impacts for threatened fauna

10.8.1 Black-footed Rock-wallaby – MacDonnell Ranges Race (Vulnerable)

Population in the study area

Black-footed Rock-wallaby is known to occur throughout the rocky habitats of the eastern parts of the Reynolds Range which incorporates the study area. Transient populations only appear to occur within the actual mine site footprint, however a breeding population was found to occur in the immediate vicinity of the mine site.

Impacts

Clearing

The habitat to be lost within the project footprint appears to be foraging/dispersal habitat only compared to the foraging/breeding/dispersal habitat within the surrounding Reynolds Range within 2km of the proposed mine. Clearing of low quality habitat was rated as having an initial low risk to the rock-wallaby population that exists in the vicinity of the mine. For example, it is unlikely that the clearing and operation of the mine would lead to the fragmentation of the rock-wallaby population in the area as suitable habitat (foraging, breeding, shelter) will continue to persist in the rocky areas surrounding the mine site. Suitable habitat surrounds the mine site and exists on all sides of the proposal.

Dust

Populations of Black-footed Rock-wallaby occur within <2 km of the mine site and could be subjected to low levels of dust. Mitigation measures will need to be implemented to keep dust levels to a minimum, however it is unlikely that dust levels following mitigation would penetrate into surrounding rocky habitats in excess of 2km from the mine site to the extent that a significant impact would be expected on the rock-wallaby population. Dust was rated as having an initial low impact on the rock-wallaby population of the study area.

Noise

The Black-footed Rock-wallaby occurs within <2 km of the mine site and occasionally uses habitats within the mine site. It is possible that noise generated by the mine could minimise rock-wallaby movements through the mine site, however particularly noisy activities would likely occur during diurnal periods when rock-wallabies are sheltering and noise may be somewhat buffered by their rocky, elevated habitat. It will be necessary to restrict particularly loud activities (e.g. blasting) from occurring during rock-wallaby nocturnal activity period when they could potentially be disturbed. This will form part of the noise mitigation strategy. Noise was rated as having an initial low risk to the rock-wallaby population of the study area.

Light

As mentioned above, the Black-footed Rock-wallaby occurs within the rocky habitats that surround the mine site and also occasionally use the habitats of the mine site itself. It is possible that light emitted from the mine site could adversely impact on nocturnal movements of rock-wallabies in the immediate vicinity of the mine site. Rock-wallabies occurring at distances greater than or equal to 2 km from the mine site are unlikely to be adversely impacted by artificial lighting, provided that lights are not directed at their habitat. The distance and buffering by the elevation and rocky habitat may diminish the penetration of light used for illumination

purposes. Light was rated as a low initial impact for the rock-wallaby population of the study area, with the mitigation measures recommended it is expected to remain a very low risk.

Wildfire

Wildfire within Black-footed Rock-wallaby habitat is a major impact on populations as it burns food plants such as SpeARBush and fig rendering habitats unsuitable for periods of time. Extensive burning of Black-footed Rock-wallaby habitat could be detrimental to populations as the fire would remove important shelter and food resources. Wildfire was rated initially as a high risk to the rock-wallaby populations of the study area.

Continued persistence of the Black-footed Rock-wallaby in the area will depend on prevention of wildfire in the surrounding rocky habitats of the study area and surrounds. Rock-wallabies were not found within the study area where previous fire had occurred.

Implementing mitigation measures such as fire management plan would reduce the risk to medium, however this risk will require the most intensive management.

Introduction and/or spread of exotic plants and animals

The potential for exotic plants and animals as well as some native predators to increase in abundance due to the proposal is possible. The increase in food waste products has the potential to be used as a food resource by feral predators (fox, cat) and native predators (dingo), which in turn could lead to increases in the populations of these species. Increases in predator abundance could result in increased predation on threatened species such as the Black-footed Rock-wallaby. It will be an important mitigation measure that on-site waste products are contained within a predator-proof fence to prevent access. The impact of predators only increases when combined with wildfire as this removes important refuge allowing predators easier access to prey.

There is also potential for exotic plants such as Buffel Grass to increase in abundance as a result of seed brought into the site on vehicle tyres and other equipment. Buffel Grass is known to be flammable and has the ability to allow a fire to carry through rocky habitats. This could be a high risk for rock-wallaby habitats, opening them up to wildfire. Mitigation for exotic plants is likely to include vehicle hygiene protocols and monitoring for an increase in the incidence of Buffel Grass.

The spread of exotic plants and animals was rated as an initial high risk prior to mitigation. With mitigation it is possible that the risk posed by these threats can be managed down to a low risk.

Poisoning of fauna from drinking contaminated water

It is unlikely that Black-footed Rock-wallaby would access liquid contained within a tailings dam due to the location of such facilities away from their preferred rocky habitats. Tailings facilities proposed for this project occur predominantly within mulga woodland – it would highly unlikely for rock-wallabies to use this habitat. This rated as a low initial risk.

Lowering or contamination of the water table

Impacts to the water table have the potential to impact on Groundwater Dependent Ecosystems (GDEs) such as riparian River Red Gum communities. No GDEs occur within rock-wallaby habitats, therefore water table impacts to rock-wallaby are likely to be very low. This rated as a low initial risk.

Injury and death from collision with vehicles

The Black-footed Rock-wallaby is primarily nocturnal and would only be affected by vehicles travelling at night. There would be an extremely low likelihood that rock-wallabies would descend

from rocky habitats and cross the road in the vicinity of the mine site. On the very rare occasion that wallabies descend to flat ground to disperse, mitigation measures would be put in place to minimise the chance of a collision (which would be extremely low as the chance of encountering a rock-wallaby outside of rocky habitats would be very low). Mitigation would likely involve the implementation of speed limits and possibly a reduction in vehicle travel at night.

The initial risk rating that death from vehicle collision for the rock-wallaby population was low.

Highest risk sources of impact for the Black-footed Rock-wallaby

Potential impacts that pose the highest risk to the Black-footed Rock-wallaby are:

- Impacts of unplanned wildfire;
- Impacts associated with introduction and/or spread of exotic plants and animals, particularly predators.

10.8.2 Greater Bilby (Vulnerable)

Population in the study area

The Greater Bilby was not recorded during any of the previous surveys within the study area (including aerial flyover of habitat looking for burrows). Despite not being detected, this species is mobile and could still occur in very low abundance (thus difficult to detect). Impacts would likely be low with the primary impacts being vehicle strike at night (low likelihood) and increased predation due to greater presence of people and their food waste (leading to increase in predator abundance).

Impacts

Clearing

The small amount of clearing that will occur within potential Greater Bilby habitat is unlikely to have an impact on a population should it exist given the large area of similar habitat in the region (well in excess of 40,000 ha). Clearing of low quality habitat was rated as having an initial low risk to a Greater Bilby population should it exist.

Dust

A population of Greater Bilby either does not or would not regularly occur in the vicinity of the mine site (Greater Bilby populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low dust levels mainly from vehicles driving along gravel/dirt tracks. Dust was rated as having an initial low risk to a Greater Bilby population should it exist.

Noise

A population of Greater Bilby either does not or would not regularly occur in the vicinity of the mine site (Greater Bilby populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low noise levels mainly from vehicles driving along gravel/dirt tracks. Noise was rated as having an initial low risk to a Greater Bilby population should it exist.

Light

A population of Greater Bilby either does not or would not regularly occur in the vicinity of the mine site (Greater Bilby populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low light levels mainly from vehicles

driving along gravel/dirt tracks. Light was rated as having an initial low risk to a Greater Bilby population should it exist.

Wildfire

Controlled and strategic cool patch burns of spinifex sandplain habitat could have positive outcomes for species such as Greater Bilby (promotes food plants). Extensive burns (not patchy) would however be detrimental as the fire would remove shelter and open up bilbies to predation by exotic and native predators.

Implementing mitigation measures such as fire management plan would reduce the risk from high to medium, however this risk will require the most intensive management.

Introduction and/or spread of exotic plants and animals

The possible increase of exotic and native predators in response to food waste from the mine could have a high impact on a Greater Bilby population should it occur, especially if combined with wildfire.

Poisoning of fauna from drinking contaminated water

It is unlikely that Greater Bilby would access liquid contained within a tailings dam due to the location of such facilities away from their preferred sandplain habitats. Tailings facilities proposed for this project occur predominantly within mulga woodland – it would unlikely that Greater Bilby would occupy the location for the tailings dam/s. This rated as a low initial risk.

Lowering or contamination of the water table

Impacts to the water table have the potential to impact on Groundwater Dependent Ecosystems (GDEs) such as riparian River Red Gum communities. No GDEs occur within Greater Bilby habitats, therefore water table impacts to Greater Bilby are likely to be very low. This rated as a low initial risk.

Injury and death from collision with vehicles

It is possible that Greater Bilby, should they be present within the borefield could occasionally be struck and killed by vehicles moving in the area (there is a very low likelihood for this to occur). Given the Greater Bilby is primarily nocturnal, it would only be affected by vehicles travelling at night. Mitigation would likely involve the implementation of speed limits and possibly the reduction in vehicle travel at night.

The initial risk rating that death from vehicle collision for the Greater Bilby population was medium, with control in place this would be reduced to low.

Highest risk sources of impact for the Greater Bilby

Potential impacts that pose the highest risk to the Greater Bilby are:

- Impacts of unplanned wildfire;
- Impacts associated with introduction and/or spread of exotic plants and animals, particularly predators;
- Injury and death from collision with vehicles.

10.8.3 Great Desert Skink (Vulnerable)

Population in the study area

The Great Desert Skink was only recorded on one occasion in the far south-west of the proposed borefield. Although only one active Great Desert Skink warren was recorded despite extensive searches of the proposed borefield it is possible that this species could occur within any of the sandplain habitats of the study area. A single Great Desert Skink active warren was recorded in the far south-west of the study area that is currently situated outside of the proposed development area for the borefield. It will be important to avoid this location during the construction and operation of the project. Although only the one active warren was observed, several animals of different sizes were recorded using the warren on motion sensing cameras.

Impacts

Clearing

The small amount of clearing that will occur within potential Great Desert Skink habitat is unlikely to have an impact on a population should it exist given the large area of similar habitat in the region (well in excess of 40,000 ha). Clearing of low quality habitat was rated as having an initial low risk to the Great Desert Skink population.

Dust

A population of Great Desert Skink either does not or would not regularly occur in the vicinity of the mine site (Greater Desert Skink populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low dust levels mainly from vehicles driving along gravel/dirt tracks. Dust was rated as having an initial low risk to the Great Desert Skink population.

Noise

A population of Great Desert Skink either does not or would not regularly occur in the vicinity of the mine site (Great Desert Skink populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low noise levels mainly from vehicles driving along gravel/dirt tracks. Noise was rated as having an initial low risk to the Great Desert Skink population.

Light

A population of Great Desert Skink either does not or would not regularly occur in the vicinity of the mine site (Great Desert Skink populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low light levels mainly from vehicles driving along gravel/dirt tracks. Light was rated as having an initial low risk to the Great Desert Skink population.

Wildfire

Large-scale, intense wildfires from a lack of patch burning can devastate or fragment local populations of Great Desert Skink (Woinarski *et. al.* 2007). Extensive burns (not patchy) of Great Desert Skink habitat could be detrimental as the fire would remove important shelter and food resources.

Implementing mitigation measures such as fire management plan would reduce the risk from high to medium, however this risk will require the most intensive management as this risk is potentially the greatest to this species especially when combined with an increase in exotic and native predators.

Introduction and/or spread of exotic plants and animals

The possible increase of exotic and native predators in response to food waste from the mine could have a high impact on the Great Desert Skink population, especially if combined with wildfire.

Poisoning of fauna from drinking contaminated water

It is unlikely that Great Desert Skink would access liquid contained within a tailings dam due to the location of such facilities away from their preferred sandplain habitats. Tailings facilities proposed for this project occur predominantly within mulga woodland – it would highly unlikely that Great Desert Skink would occupy the location for the tailings dam/s or regularly access standing water. This rated as a low initial risk.

Lowering or contamination of the water table

Impacts to the water table have the potential to impact on Groundwater Dependent Ecosystems (GDEs) such as riparian River Red Gum communities. No GDEs occur within Great Desert Skink habitats, therefore water table impacts to Great Desert Skink are likely to be very low. This rated as a low initial risk.

Injury and death from collision with vehicles

It is possible that Great Desert Skink could occasionally be struck and killed by vehicles moving in the area (there is a very low likelihood for this to occur). Given the Great Desert Skink is primarily nocturnal, it would only be affected by vehicles travelling at night. Mitigation would likely involve the implementation of speed limits and possibly the reduction in vehicle travel at night.

The initial risk rating that death from vehicle collision for the Great Desert Skink population was medium, with control in place this would be reduced to low.

Highest risk sources of impact for the Great Desert Skink

Potential impacts that pose the highest risk to the Great Desert Skink are:

- Impacts of unplanned wildfire;
- Impacts associated with introduction and/or spread of exotic plants and animals, particularly predators;
- Injury and death from collision with vehicles.

10.8.4 Princess Parrot (Vulnerable)

Population in the study area

The Princess Parrot was not recorded during the previous surveys and there are no historic records within the proposed project footprint, however it is possible that this species could occur within any of the habitats within the proposed project footprint apart from the rocky habitats. However, there are many thousands of hectares of similar habitat in the region that this species could also use.

This species is highly nomadic and irruptive in response to rainfall and improved conditions. This species arrived at Newhaven Station in 2012 (approx. 180 km from the Nolans study area) following good rainfall in central Australia. It is possible that this species could visit the study area under similar conditions in the future.

Impacts

Clearing

The small amount of clearing that will occur within potential Princess Parrot habitat is unlikely to have an impact on a population should it exist given the large area of similar habitat in the region (well in excess of 40,000 ha). Clearing of low quality habitat was rated as having an initial low risk to the Princess Parrot population.

Dust

A population of Princess Parrot either does not or would not regularly occur in the vicinity of the mine site (Princess Parrot populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low dust levels mainly from vehicles driving along gravel/dirt tracks. Dust was rated as having an initial low risk to a potential Princess Parrot population.

Noise

A population of Princess Parrot either does not or would not regularly occur in the vicinity of the mine site (Princess Parrot populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low noise levels mainly from vehicles driving along gravel/dirt tracks. Noise was rated as having an initial low risk to a potential Princess Parrot population.

Light

A population of Princess Parrot either does not or would not regularly occur in the vicinity of the mine site (Princess Parrot populations would most likely occur in habitats >10km from the mine site) and hence would only ever be subjected to very low light levels mainly from vehicles driving along gravel/dirt tracks. Light was rated as having an initial low risk to potential Princess Parrot populations.

Wildfire

It is more difficult to determine the impacts of wildfire on a nomadic and highly mobile species such as the Princess Parrot. It is possibly safe to assume that various food plants and certainly hollow-bearing nest trees could be destroyed by fire.

Implementing mitigation measures such as fire management plan would reduce the risk from high to medium.

Introduction and/or spread of exotic plants and animals

The possible increase of exotic and native predators in response to food waste from the mine could have an adverse impact on the Princess Parrot, particularly as feral cats would likely prey on this species given the chance.

Poisoning of fauna from drinking contaminated water

There would be an extremely low chance that passing Princess Parrots would stop for a drink at a tailings dam and therefore be at risk of poisoning from such as facility. It is likely that this would be a low risk even before mitigation due the rare chance that Princess Parrot would be present within the study area to begin with.

Lowering or contamination of the water table

Impacts to the water table have the potential to impact on Groundwater Dependent Ecosystems (GDEs) such as riparian River Red Gum communities. No GDEs occur within Princess Parrot

habitats within the vicinity of the mine site, therefore water table impacts to Princess Parrot are likely to be very low. This rated as a low initial risk.

Injury and death from collision with vehicles

It is possible that Princess Parrot could very occasionally be struck and killed by vehicles moving in the project footprint (there is an extremely low likelihood for this to occur however as this species would be rare at best within the study area to begin with). Mitigation would likely involve the implementation of speed limits and possibly the reduction in vehicle travel at night.

The initial risk rating that death from vehicle collision for the Princess Parrot population was low.

Highest risk sources of impact for the Princess Parrot

Potential impacts that pose the highest risk to the Princess Parrot are:

- Impacts of unplanned wildfire;
- Impacts associated with introduction and/or spread of exotic plants and animals, particularly predators;
- Injury and death from collision with vehicles.

10.9 Mitigation and monitoring

Based on the identified sources of impact, the following mitigation measures are recommended below to reduce the level of impact to an acceptable level.

10.9.1 Mitigation

Source of impact	Mitigation Measure	Species
General		
	Site induction will include the following components for biodiversity management: • Summary of biodiversity at the Project including ecologically sensitive areas and threatened fauna; • Identification of potential impacts to biodiversity from the Project activities; • Requirement to enter and exit site through recognised vehicle access points, and to travel around site using existing/approved roads and tracks only; • Requirement for speed restrictions across the Project; and No work to be undertaken without an approved Ground Disturbance Permit.	All species
	No work undertaken within 200 m of the Great Desert Skink warren recorded within the Borefield.	Great Desert Skink
	Implement all aspects of the Environmental Management Plan including the following sub-plans: • Air and Dust Management Plan; • Erosion and Sediment Control Plan; • Fire Management Plan; • Weed Management Plan; • Mine Closure Plan; and • Non-mineralised Waste Management Plan.	All species

Source of impact	Mitigation Measure	Species
	Seal/cover open holes, pits, trenches (e.g. monitoring bores, production wells, exploration bores) when not manned to prevent ground-dwelling fauna from falling in.	All species
Clearing of vegetation		
	• Use previously disturbed areas before clearing vegetation from undisturbed areas. • Minimise ground disturbance at all locations and specifically at/near riparian zones. • Maximum clearing easements for haul roads and access roads will be complied with. • Qualified ecologist will be present during clearing of the Borefield where the Great Desert Skink is known, to capture/translocate animals unable to escape. • Clearly mark areas of land to be cleared and areas to be retained (No-Go areas), so that impacts do not extend any further than necessary into important habitat. • If possible, plan to clear vegetation progressively and incrementally as needed, rather than through large-scale clearing in advance. • Rehabilitate/stabilise cleared land progressively as activities are completed (which forms part of the Closure and Rehabilitation Plan).	All species
	Consider applying a cool, well-managed fuel-reduction burn to all habitats to be cleared (but not beyond), to encourage fauna to flee prior to clearing. The specifics of fuel-reduction burns to be determined in consultation with relevant stakeholders prior to fire being lit.	All species
Noise		
	Where possible, high-impact noise (e.g. blasting) will be limited to daylight hours.	All species
Light		
	Implement a light reduction strategy during the detailed design phase including: • Limit artificial light to areas where it is essential; • Turn off lights when not required; • Avoid the flood of light into natural habitats and limit the escape of light into surrounding areas of fauna habitat (i.e. using shields/deflectors); • Ensure that artificial lighting is not directed upwards or laterally (i.e. should be directed towards the ground); • Use lower (i.e. closer to the ground) rather than higher lighting installations; • Use lower wavelengths of light wherever possible i.e. red/yellow lights; • Use light intensities that are as low as possible without reducing safety or efficiency; and • Avoid painting large structures bright or reflective colours and minimise use of bright or reflective construction materials and finishes for large structures.	All species

Source of impact	Mitigation Measure	Species
Unplanned wildfire		
	- Carefully plan and identify where high-risk activities can take place. - Maintain adequate fire breaks around high-risk areas/activities. - Implement active fire management, using localised cool-season control burns within 100 m of mine activities and roads to reduce fuel loads.	All species
Pest animals		
	As part of the Waste Management Plan, implement sound waste (garbage) management to limit invasion/colonisation by Black Rat (<i>Rattus rattus</i>).	All species
	General site wastes will be managed to prevent/reduce interaction with fauna. Waste management includes: - Regular burning of the landfill; - Fencing installed surrounding the landfill to restrict interaction with fauna; - Waste storage outside of the landfill is to be situated in bins with lids secured; - Waste oils and/or hazardous substances will be kept in sealed containers and/or covered; and All domestic waste outside the landfill/waste-storage facility is to be stored in vermin-proof bins with lids secured.	- Black-footed Rock-wallaby - Great Desert Skink - Greater Bilby
	Implement a Pest Monitoring Plan to monitor feral cat and fox populations to determine if control measures are required. The plan is summarised in Table 10-28.	All species
Surface and groundwater		
	- Reduce attractiveness (to wildlife) of the Residue Storage Facility, Flotation Tailings Storage Facility, Sediment Basins and Process Water Ponds through the implementation of Best Practice Guidelines for Reducing Impacts of Tailings Storage Facilities on Avian Wildlife (DME, 1998). - Fence off tailings storage facilities to prevent ground-based fauna from accessing the water.	Princess Parrot
Vehicle collision		

Source of impact	Mitigation Measure	Species
	- Keep the proposed road network to a minimum and upgrade and utilise existing vehicle tracks. Ensure that all vehicles travel on these designated roads, and not on secondary or short-cut roads/tracks. - Implement and enforce speed restriction controls for all roads across the entire study site. - Implement slower speed limits for all vehicles moving at night in sensitive habitat areas, to reduce the likelihood of roadkill. - Upgrade high-use areas to be safer for vehicles and fauna (e.g. no blind curves, wider shrub-free verges). - If injured fauna is encountered, assess the situation and potential requirement to euthanize and/or contact Wild Care Alice Springs for advice: M: +61 419 221 128 E: wildcareasp@gmail.com - If dead animals are found on/beside roads, the Environmental Officer is to be notified immediately to remove the carcass a minimum of 20 m into adjacent land.	

10.9.2 Monitoring

Monitoring plans have been established to determine if mitigation measures at the Project are sufficient. The plans include:

- Pest Monitoring Plan – Cats, Foxes and Dingoes (Table 10-28);
- Register – Cats, Foxes and Dingoes (Table 10-29);
- Pest Animal Management Plan (Table 10-30);

Threatened Species Monitoring – Black-footed Rock-wallaby

- Table 10-31); and
- Threatened species monitoring – Sandplain habitats (Table 10-32).

Table 10-28 Pest Monitoring Plan

Program		Pest Monitoring Plan – Cats, Foxes and Dingoes
Objective		Establish baseline and subsequent comparative data on population sizes of feral predators and dingoes to inform control program.
Survey Effort	Survey	Establish baseline data by undertaking a motion-sensing camera survey prior to construction, using site occupancy as the measure of predator populations. Cameras to be deployed for a minimum of 28 nights.
	Operation	Establish 30 baited camera stations that can be repeatedly used including: 10 sites within 100 m of proposed mine activities (particularly around the landfill); 10 sites approximately 1 km from mine activities; and 10 sites more than 5 km from mine activities.
	Timing	Annual (during operation)
	Personnel	Qualified ecologists.

Trigger Points	Cats / Foxes	Acceptable level of change: No increase Any increase in population size is likely to be detrimental to biodiversity. Action required if >10% increase in numbers of individuals detected across two surveys.
	Dingoes	Acceptable level of change: Moderate change Dingoes are native predators and their presence is likely to limit the population size of other predators (cats and foxes). Therefore, dingo presence and increase in population is acceptable. However, over-abundance of dingoes is likely to be detrimental to threatened species. Action required if >50% increase in abundance across two surveys.
Contingency		Implement or increase predator control program as required. Increase cat/fox control efforts, through trapping, poisoning, shooting. Make sure predator control method does not result in the unintentional capture or death of threatened fauna species.

Table 10-29 Register

Program		Register – cats, foxes, rabbits and dingoes
Objective		Provide additional information on feral predator and pest animal populations, in conjunction with monitoring program.
Method	Survey	Predator and pest-animal sightings are to be recorded in the Fauna Sighting and fatality Register (Appendix A) to be established and maintained. Input will be opportunistic, however all personnel will be encouraged to report all sightings of cats (including colour and identifying markings, if possible), foxes, rabbits and dingoes.
	Timing	Continually.
	Personnel	All personnel.
Trigger Points	Cats / Foxes / Rabbits	Acceptable level of change: No increase Any increase in population size is likely to be detrimental to biodiversity. Additional mitigation action required if the Fauna Sighting and fatality Register (Appendix A) indicates an increase in sightings in a particular area (e.g. more often per week, larger numbers per night, more individuals in an area). Action required if >10% increase in numbers of individuals detected across a six month period.
	Dingoes	Acceptable level of change: n/a Fauna Sighting and fatality Register not to be used to guide response actions for dingoes.
Contingency		Implement or increase predator and pest-animal control program as required (e.g. if there is a notable increase in sightings of non-native predators in the study area). Increase cat/fox/rabbit control efforts, through trapping, poisoning, shooting, in consultation with DLRM and CLC. Make sure predator/pest control method does not result in the unintentional capture or death of threatened fauna species.

Table 10-30 Pest Animal Management Plan

Program		Pest Animal Management Plan (Bait and Trapping Plan)
Objective and approach		Implement a pest eradication/control program targeting foxes, cats and rabbits across the Project and non-native rats and mice at the mine site and accommodation village to minimise potential impacts of vermin and pest predators.
Target species		• Non-native rats/mice (e.g., <i>Rattus rattus</i>, <i>Mus musculus</i>); • European Rabbit; • Red Fox; • Feral Cat; and • Dingo (if overabundant).
Rats / Mice	Methods	Poisoned baits in and under buildings and within the confines (fences) of the landfill facility.
	Timing	All year.
	Location	Offices and accommodation areas across the Project and around the landfill facility.
Rabbits	Methods	Warren fumigation and/or ripping. Prior to control methods being used on a suspected rabbit warren, motion-sensing cameras must be deployed at warren entrances for at least 30 days during the warmer months (October to March) to make certain that the burrows aren't used by Great Desert Skinks, or any other threatened fauna species. If any burrow is found to support a native threatened species, then fumigation and warren ripping are not suitable. Other rabbit-control methods are to be established (e.g., trapping, shooting).
	Timing	All year, as required. The need for rabbit control will be informed by the Fauna Sighting and fatality Register (Appendix A), and the results of other fauna monitoring (e.g. use of motion-sensing cameras).
	Location	Across Study area, particularly in sandplain areas where the impact of rabbits on native threatened species has the potential to be greater.
Cats / Foxes	Methods	Range of methods to be trialled upon the outset of the Project to determine the most effective and efficient method. Possible methods include: • Poisoned baiting; • Trapping (e.g., cage trapping); • Shooting; and • Grooming traps (innovative new passive baiting and trapping methods that target cats (http://www.ecologicalhorizons.com/initiatives). Grooming Traps may provide a long-term tool to control trap- or bait-shy cats in areas of high conservation value (e.g. in areas of known Black-footed Rock-wallaby habitat).
	Timing	Annually, and more frequently if required on the basis of monitoring results.
	Location	Mine site and broader project area. Focus efforts initially in and around the mine site and landfill facility where non-native rats and mice are most expected to attract non-native predators. Expand area of control if any of the fauna monitoring or Fauna Sighting and fatality Register (Appendix A) data suggest that predator numbers have increased in areas away from the mine site.
Dingoes	Methods	Dingoes are native predators and are not expected to require regular or frequent active population control measures. However, if the mine activities promote an increase in non-native rats and mice, allowing dingo populations to get unnaturally large to the point where they threaten native fauna also, then control measures may be required. Possible methods include: • Poisoned baiting; or

		Shooting. Control of dingo populations, if required, is expected to involve removal of relatively small numbers of individuals, rather than broadscale population control and would be undertaken in consultation with regulatory authorities.
	Timing	As needed, on the basis of monitoring results.
	Location	Across mine site and broader project area, as required.
Personnel		Environmental Officer
Contingency		Implement or increase predator and pest-animal control program as required. Make sure predator and pest-animal control method does not result in the unintentional capture or death of threatened fauna species.

Table 10-31 Threatened Species Monitoring – Black-footed Rock-wallaby

Program		Threatened Species Monitoring – Black-footed Rock-wallaby
Objective		Assess the potential impact from the Project on Black-footed Rock-wallaby through: - Documenting the persistence of the local rock-wallaby population; - Understanding changes in habitat use near the mine site; - Evaluating the effectiveness of predator control measures; and - Evaluating the effectiveness of vehicle movement restrictions.
Method	Survey	Aerial and motion camera surveys.
	Locations	Marginally rocky habitat, rocky outcrops near the mine site and in surrounding rocky areas (landscape context).
	Timing	Annual.
	Personnel	Qualified ecologist.
Trigger Points		Acceptable level of change: moderate change Additional mitigation action required if: - Rock-wallabies are not detected in rocky outcrop near the mine site and in the preceding year rock-wallabies are killed on the roads in the study area; - Predator monitoring shows that numbers of predators in the study area over the preceding 12 months increased (cat and fox) or increased greatly (dingo); or - Wildfire in rocky areas during the preceding 12 months and no rock-wallabies are detected in nearby rocky areas.
Contingency		Mitigation measures include: - Increase cat/fox control efforts (trapping, poisoning, shooting) if predator numbers have increased; - Broaden fire breaks in high risk areas to prevent future fires, if fire may have been responsible, and - Reduce vehicle speeds or access in high-risk areas if roadkill may have been the cause.

Table 10-32 Threatened Species Monitoring – Sandplain Habitats

Program		Threatened species monitoring – Sandplain Habitats
Objective		To document the persistence of known threatened species in the vicinity of the mine, and to evaluate the effectiveness of predator control measures.

Method	Survey	Motion-sensing camera surveys within known threatened species habitat for Great Desert Skink including two cameras at known warrens. Transect surveys searching for warrens within known threatened species habitat for Great Desert Skink. Camera surveys will comprise five 400m camera transects, each comprising 5 cameras at 100m intervals and be left insitu for 28 nights during Great Desert Skink active season.
	Locations	Sandplain Habitat.
	Timing	Annual.
	Personnel	Qualified ecologists.
Trigger Points		Acceptable level of change: small change Additional mitigation action required if: • >20% decrease in numbers of Great Desert Skink and in the preceding year an incident of roadkill is recorded; • Predator monitoring shows that numbers of predators in the study area over the preceding 12 months increased (cat and fox) or increased greatly (dingo); or • Wildfire in the sandplain habitat during the preceding 12 months and no Great Desert Skink are detected.
Contingency		Mitigation measures include: • Increase cat/fox control efforts (trapping, poisoning, shooting) if predator numbers have increased; • Broaden fire breaks in high risk areas to prevent future fires, if fire may have been responsible, and • Reduce vehicle speeds or access in high-risk areas if roadkill may have been the cause.

10.10 Conclusion

Across the 2010 and 2015 surveys, 174 native terrestrial fauna species were recorded, including 25 mammals, 103 birds, 41 reptiles, three frogs. Five introduced fauna species (all mammals) were recorded overall. Four threatened species that do occur or could occur within the study area are listed as Vulnerable under the EPBC Act and are the focus of this chapter:

- **Four mammals** –
 - Black-footed Rock-wallaby, *Petrogale lateralis MacDonnell Ranges race* (Vulnerable)
 - Greater Bilby, *Macrotis lagotis* (Vulnerable)
- **One bird** - Princess Parrot, *Polytelis alexandrae* (Vulnerable)
- **One reptile** - Great Desert Skink, *Liopholis kintorei* (Vulnerable).

To minimise or avoid significant impacts, mitigation measures will need to be implemented during all construction and operations activities in habitats that are most likely to support these species.

One of these species (Black-footed Rock-wallaby) is typically restricted to rocky habitats, which occur mainly in the mine site area and in isolated outcrops in the borefield area (e.g. Reaphook Hills).

Another species (Great Desert Skink) is restricted to sandy habitats, which occur throughout the borefield area and along the southern extent of the proposed water supply pipelines.

Two species (Greater Bilby and Princess Parrot) are more general in their habitat use across arid Australia, and could occur in any part of the study area. That said, the Greater bilby (a

burrowing species) is probably more likely to use sandy habitats (rather than rocky habitats or habitats with heavier clay soils), which are more conducive to digging. Therefore, both the Greater bilby and also the Princess Parrot are more likely to occur within the sandy habitats of the borefield.

Minimising impacts on all these species and their habitats will serve to minimise impacts on most if not all other threatened and near threatened (i.e., as listed under the TPWC Act) species.

10.10.1 Recommendations

This assessment resulted in the detection of two EPBC Act-listed fauna species in the study area, and identified two others that could also occur there. Recommendations made here focus on those species. In particular, they focus on the mitigation and management of impacts to these species during the construction and operation of the Project.

The following are recommended:

- Prepare a Biodiversity Management Plan
- Construction and operation of the Project across the entire study area must be kept within the minimal possible area
- Undertake representative sampling/assessment in an effort to learn and contribute to the known information about these species in this region of the NT.

More information and recommendations are described in the Fauna report (Appendix N).

Key to Table:

EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

TPWC *Territory Parks and Wildlife Conservation Act 2006*

EX Extinct EW Extinct in the wild

EN Endangered DD Data deficient

CR Critically endangered

NT Lower risk - near threatened

VU Vulnerable

RX Regionally extinct

PMST Identified by the PMST search tool of the EPBC Act

GHD Detected during 2010/11 or 2015 survey

LRMDLRM Recorded on the DLRM list (within 20 km of study area)

BPB Recorded on the list for the Burt Plain Bioregion

Likelihood of occurrence of fauna is assessed on a 4-tier scale:

1: **Present** – observed during the 2010 or 2015 baseline fauna surveys;

2: **Possible** - suitable habitat occurs within the study area, and site is within species' normal range;

3: **Unlikely** - suitable habitat does not occur within the study area, or suitable habitat present but substantially modified or degraded;

4: **Highly unlikely** – no suitable habitat within the study area and site is outside species' normal range.

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
MAMMALS						
Black-footed Rock-wallaby (MacDonnell Ranges race) <i>Petrogale lateralis</i>	VU	NT	GHD, DLRM, PMST, BPB	2011 GHD 1987 DLRM	Present - Mine site Unlikely - all other areas	Results from scat samples collected in 2011 suggest that this species occasionally passes through the mine site and follow up surveys confirmed that a reproductive population exists in the vicinity of the mine site and surrounding ranges, extending down to outcrops in the southern borefield area (e.g. Reaphook Hills). Suitable habitat for this species is present within the rocky outcrops of the mine site, with habitat connectivity to other ranges nearby, suggesting that a larger population persists in the Reynolds Range area. Two waste rock dumps at the west of the mine site will directly impact a small area of likely habitat. Most of the habitat in the area surrounding the Mineral Lease will not be directly impacted by the Project.

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
Greater Bilby (Bilby) <i>Macrotis lagotis</i>	VU	VU	PMST, BPB	-	Possible – all areas, but particularly in sandplain areas in southern parts of study area	Not recorded during the 2010 or 2015 surveys, and no records exist for the study area, although suitable habitat is present. Spinifex-dominated habitats within the study area provide potential habitat, including rocky areas and areas with a low shrub cover. Species occupies vegetation types including open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate 1990b). In favourable conditions, populations can expand rapidly in abundance and occupied area (Woinarski et al. 2007). Species once widespread across NT, but populations declined dramatically following European settlement. The Greater Bilby is now generally reported from the western deserts region of NT, although other sightings occur occasionally. Species considered likely to still be present in this part of NT, albeit probably in small numbers. Species known from the Burt Plain Bioregion.
BIRDS						
Princess Parrot <i>Polytelis alexandrae</i>	VU	VU	PMST, BPB	-	Unlikely – Mine site Possible – all other areas	Not recorded during the surveys and no records exist for the study area, although suitable habitat is present. Species has patchy and irregular distribution in arid Australia. In NT, it occurs in the southern section of the Tanami Desert south to Angas Downs and Yulara and east to Alice Springs. The exact distribution within this range is not well understood. Few locations exist in the Northern Territory where the species is regularly seen, and even then there may be long intervals (up to 20 years) between records. Most records from the MacDonnell Ranges Bioregion are during dry periods (DLRM 2006). Species considered unlikely to use habitats within the mine site due to the absence of dune and swale habitats (although species has been recorded in riverine, woodland and shrubland habitat occasionally; Woinarski et al. 2007). Sandplain habitats in the borefield area provide potential foraging habitat for this species, with potential nesting sites also occurring in the sparse hollow-bearing trees. Possible occasional visitor.

Species	EPBC	TPWC	Source	Most recent record (DLRM or other)	Likelihood of occurrence within the study area	Comments
REPTILES						
Great Desert Skink <i>Liopholis kintorei</i>	VU	VU	GHD 2015; DLRM, PMST, BPB	2015 GHD; DLRM - no date	Present - Borefield area Possible - Processing site Unlikely - Mine site	Burrow/latrine system seen in borefield area during GHD 2015 survey. NT Fauna Atlas indicates one undated record, also in the borefield area (near Napperby Road). This species inhabits large complex burrows in a variety of desert habitats on sandy, clay and loamy soils (Cogger, 2000 cited in DotE 2015). It occurs on sand plains and on the flats between low sand dunes, preferring areas vegetated with spinifex clumps and scattered shrubs (Paltridge and McAlpin, 2002 cited in DotE 2015). Habitats for this species within the mine site are limited and this species is considered unlikely to occur there. However, sand plain habitats located in the borefield area and parts of the processing area support the preferred spinifex clumps with scattered shrubs occupied by this species in other areas.