

Proposed land-swap. WA Bluemetal Mundijong Quarry.

A Fauna Assessment

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Jarrah forest at the WA Bluemetal quarry

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Introduction

At the request of WA Bluemetal, Western Wildlife undertook a fauna assessment of land at the WA Bluemetal Mundijong Quarry and nearby State Forest (Cockburn Sound Location 344 and M70/1240) to determine the fauna values of both, with a view to a possible land swap.

The aim of the site visit and desktop study was to identify the vertebrate fauna that has the potential to occur in the area, with a specific focus on species of conservation significance.

Methods

This report is classified as a Level 1 survey (a background research or ‘desk-top’ study with a site visit) according to the EPA Position Statement No. 3 and Guidance Statement No.56 (Environmental Protection Authority 2002, 2004). This was the level of assessment commissioned by the client. The site was visited on 3rd November 2005 by Dr Robert Davis (*BSc.Biol./Env.Sci., Hons.Biol., PhD. Zool.*) and Ms Jenny Wilcox (*BSc.Biol./Env.Sci., Hons.Biol.*) of Western Wildlife.

During the site visit, both areas were examined on foot. The purpose of the site inspection was to record any species of fauna present, assess the potential of habitats to support threatened fauna and to put fauna habitats into a regional context.

Sources of Information

Lists of fauna expected to occur in the study area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1990, 1999 and 2002), birds (Barrett *et al.* 2003; Johnstone and Storr 1998), and mammals (Menkhorst and Knight 2001; Strahan 1995). In addition, the databases listed below in Table 1 were searched for specimen or observational records.

These sources of information were used to create lists of species expected to occur in the study area. As far as possible, expected species are those that are likely to utilise the study area, or be affected by changes to the study area. The lists exclude species that have been recorded in the general region as vagrants or for which suitable habitat is absent.

Table 1. Databases used in the preparation of the fauna lists in Table 2 – 5.

Database	Type of records held on database	Area searched
Faunabase (WA Museum)	Records of specimens held in the WA Museum. Includes historical data.	32°15' to 32°20'S and 116°00' to 116°05'E
CALM's Threatened and Priority Fauna Database	Information and records on Threatened and Priority species in Western Australia	32°15' to 32°20'S and 116°00' to 116°05'E
EPBC Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species.	32°15' to 32°20'S and 116°00' to 116°05'E

Taxonomy and nomenclature for fauna species used in this report generally follow the WA Museum (2001) except for birds which is based on the taxonomy of Christidis and Boles (1994)

Assessment of conservation significance

The conservation significance of fauna species is assessed as being at one of three levels. At the highest level (Conservation Significance 1) are those species that are protected under State or Commonwealth legislation.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'matters of National Environmental Significance' that include threatened species and ecological communities and migratory species, among others. The threatened species are categorised as 'extinct', 'extinct in the wild', 'critically endangered', 'endangered', 'vulnerable' and 'conservation dependent', with all categories except 'extinct' and 'conservation dependent' listed as matters of National Environmental Significance. A list of migratory species is also maintained, containing mostly bird and marine species. The migratory species listed are those recognised under China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA) or species listed under the Bonn Convention for which Australia is a range state. Species listed in JAMBA are also protected under Schedule 3 of the *Western Australian Wildlife Conservation Act 1950*.

The *Western Australian Wildlife Conservation Act 1950* (WA Wildlife Conservation Act) is State legislation for fauna protection administered by the Department of Conservation and Land Management (CALM). The *WA Wildlife Conservation Act* lists species under a set of Schedules, where threatened species are listed as Schedule 1. Schedule 1 species are further categorised by CALM into 'extinct', 'extinct in the wild', 'critically endangered', 'endangered', 'vulnerable' and 'conservation

dependent' species. The schedules and categories are further described in Appendix 1.

At second-highest level of conservation significance (Conservation Significance 2) are species that are listed under publications on threatened species, or are listed as Priority species by CALM.

The Department of the Environment and Heritage (DEH, formerly Environment Australia) has supported the publication of reports on the conservation status of most vertebrate fauna species. Documents have been prepared on reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999). These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as this report pre-dates Mace and Stuart's review (1994).

In Western Australia, CALM has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the *WA Wildlife Conservation Act* but for which the Department feels there is cause for concern. Levels of Priority are described in Appendix One.

Fauna species included under conservation acts and/or agreements are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by CALM, or that are included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993) but not in State or Commonwealth Acts, are also of recognised conservation significance. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The WA Department of Environmental Protection (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan.

On the basis of the above comments, three levels of conservation significance are recognised in this report:

Conservation Significance 1: Species listed under State or Commonwealth Acts.

Conservation Significance 2: Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by CALM.

Conservation Significance 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

Site description

The two areas that were examined are situated to the east of the South Western Hwy near Mundijong and both are in the Darling Range.

1. Quarry Bushland (WA Bluemetal) Cockburn Sound Location 344

The area of bushland to the south of the existing quarry consisted of Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) forest with areas of outcropping granite, and a stream in the valley floor. The Jarrah forest varied in composition and included areas with dense Parrotbush (*Dryandra sessilis*) understorey, areas with Bull Banksia (*Banksia grandis*) and areas with a mixed shrub understorey. There were also a number of open and degraded areas characterised by introduced pasture grasses and other weeds. Such areas were only found as small patches to the south of the stream and around existing quarry operations. Bushland areas to the north and west of the stream were in very good condition as was the remainder of the lot.

The granite outcrops were vegetated by a floristically diverse heath. The stream was lined by a narrow band of low, dense vegetation with an over-storey of scattered Flooded Gums (*Eucalyptus rudis*).

2. State Forest (CALM) Location M70/1240

The State Forest area is situated to the north-east of the existing quarry area. This area mainly consisted of Jarrah forest with areas of large Marri, large areas of She-oak (*Allocasuarina fraseriana*) woodland, dense thickets of Parrotbush (*Dryandra sessilis*) and areas of low heath. There was evidence of dieback, past logging activities and past fires (with subsequent weed invasion) present throughout the site, as well as some human use of the area. The Jarrah trees were generally older and larger at this site. There were some creek-line areas present with dense stands of Karri Hazel.

Results

Lists of the vertebrate fauna expected to occur in the area are presented in Tables 2, 3, 4 and 5. Species recorded in the area on the WA Museum's Faunabase are indicated in the Tables. The results of the EPBC database search and the CALM Threatened and Priority Fauna Database search are presented in Appendices 2 and 3.

Amphibians

Although no frog species of conservation significance are to be found in the entire region (Table 2), the granite areas of the Quarry Bushland are more likely than the State Forest, to support populations of the Hooting Frog (*Heleioporus barycragus*). Although not a threatened species, the Hooting Frog is restricted to granite and clay soils of the Darling Range (Bush *et al.* 1995) and is patchily distributed and uncommon (pers. obs.).

Granite outcrop areas and rocky stream zones in the Quarry Bushland are likely to support a greater range and abundance of frog species than the State Forest including the Quacking Frog (*Crinia georgiana*), Bleating Frog (*Crinia pseudinisgnifera*) and Lea's Froglet (*Geocrinia leai*).

The State Forest is likely to support a range of burrowing species such as the Banjo Frog (*Limnodynastes dorsalis*) and Moaning Frog (*Heleioporus eyrei*) that utilise sandy upland habitat during the non-breeding season, migrating to wetlands to breed during autumn (Moaning Frog) and winter/spring (Banjo Frog). The smaller, more ephemeral drainages in the State Forest may support species such as the Quacking Frog and Bleating Frog

Reptiles

A range of reptile species is likely to be found at both sites, with 44 species listed as potentially occurring (Table 3). However, the presence of granite outcrop areas in the Quarry Bushland offers a habitat not found in the State Forest. Species that may favour granite outcrops include but are not limited to, the Ornate Crevice Dragon (*Ctenophorus ornatus*) and the Granite Worm-Lizard (*Aprasia pulchella*).

Four reptile species of conservation significance may be found in both the Quarry Bushland and the State Forest. Each species is listed and described below.

Conservation Significance 1

- **South-West Carpet Python** *Morelia spilota imbricata*
This snake is listed as Vulnerable according to Cogger *et al.* (1993), as Schedule 4 (Other Specially Protected Fauna) under the WA Wildlife Conservation Act and as Priority 4 by CALM.

The South-west Carpet Python has the potential to occur in both the Quarry Bushland and the State Forest. It shelters in hollow logs and rocks (Bush *et al.* 1995) and although is considered to be present in both areas, it may favour the Quarry Bushland due to the presence of granite outcrop areas which offer basking and shelter opportunities.

Conservation Significance 2

- **Southern Death Adder** *Acanthophis antarcticus*
This snake is listed as Priority 3 by CALM
- **Darling Range Ctenotus** *Ctenotus delli*
This skink is listed as Priority 4 by CALM and Rare or insufficiently known by to Cogger *et al.* (1993).

The Southern Death Adder is restricted to the Darling Scarp in the metropolitan part of its range and is found between Mt Helena and Jarrahdale (Bush *et al.* 1995). The Southern Death Adder has the potential to occur in both of the study sites. This species is rarely recorded from the Perth hills and is an ambush predator spending the day in dense leaf litter waiting to ambush prey (Bush *et al.* 1995).

The Darling Range Ctenotus is associated with Jarrah and Marri woodlands that have a shrub-dominated understorey on laterite, sand or clay soils of the Darling Range (Bush *et al.* 1995). This species is considered to be likely to occur at both sites.

Conservation Significance 3

• **Ornate Crevice Dragon**

Ctenophorus ornatus

The Ornate Crevice Dragon is a habitat specialist restricted to granite outcrops on the Darling Scarp as well as further north and east. If it is present in the area, it is only likely to be found in the Quarry Bushland where granite outcrop areas are present. The limiting factor for this species is exfoliating rock and granite boulders under which to shelter and it has been negatively impacted by the removal of rock on publicly accessible outcrops.

Birds

A total of 23 species were observed during the site visit with 92 species expected to occur (Table 4). Most bird species are likely to be found at both sites, however, the granite heaths and stream zones in the Quarry Bushland may offer habitat for a number of birds not likely to occur in the State Forest. These include most notably, the Red-winged Fairy-wren observed in the dense streamside vegetation during the site inspection, the Red-eared Firetail which also favours streamside vegetation and the Southern Emu-wren which may occur in the dense granite heaths. Although a small densely-vegetated drainage was noted in the State Forest this did not appear extensive or wet-enough to provide suitable habitat for these species.

There are several species of conservation significance that have the potential to occur in both the Quarry Bushland and the State Forest, and each is listed and described below.

Conservation Significance 1

• **Short-billed (Carnaby's) Black-Cockatoo**

Calyptorhynchus latirostris

This cockatoo is listed as endangered under the EPBC Act, the Wildlife Conservation Act and by Garnett and Crowley (2000).

• **Long-billed (Baudin's) Black-Cockatoo**

Calyptorhynchus baudinii

This cockatoo is listed as endangered under Wildlife Conservation Act, vulnerable under the EPBC Act and as 'near threatened' by Garnett and Crowley (2000).

• **Forest Red-tailed Black-Cockatoo**

Calyptorhynchus banksii naso

This cockatoo is listed as Vulnerable under the Wildlife Conservation Act.

• **Peregrine Falcon**

Falco peregrinus

This falcon is listed as 'other specially protected fauna' (Schedule 4) under the Wildlife Conservation Act.

• **Rainbow Bee-eater**

Merops ornatus

The Rainbow Bee-eater is classified as migratory under the JAMBA, CAMBA and Bonn Convention, and as such is protected under the EPBC Act. Its listing under JAMBA also means it is protected under the WA Wildlife Conservation Act.

• **Fork-tailed Swift**

Apus pacificus

This species is migratory under JAMBA, CAMBA and the Bonn Convention, and as such is protected under the EPBC Act. Its listing under JAMBA also ensures it is protected under the WA Wildlife Conservation Act.

Carnaby's Black-Cockatoo was recorded on the WA Museum Faunabase, EPBC Database and on CALM's Threatened Fauna Database for the area (Table 3, Appendices 2 and 3). This species has declined due to loss of breeding habitat in the wheatbelt and of non-breeding habitat along the west coast, partly due to urban expansion. The progressive loss of bushland areas is an ongoing concern for this species. Carnaby's Black-Cockatoo is likely to feed on Marri trees, Banksia's and other proteaceous vegetation in both study areas. This species is expanding its breeding range into the south-west and there have been records of this species breeding nearby at Serpentine National Park (Johnstone *et al.* 2005). Although this species prefers to breed in smooth-barked eucalypts, they have also been recorded breeding in Marri (Johnstone and Storr 1998). It is possible that this species breeds in the area or may breed in the area in the future. In addition, the loss of food sources for this species including Parrotbush, *Banksia grandis* and Marri may impact the local persistence of this species and reduce the capacity of the bushland to support feeding flocks.

Baudin's Black-Cockatoo is considered to be rare and declining in south-west WA primarily due to persecution by orchardists and loss of habitat due to wildfires and vegetation clearance in their range. This species was listed in the area on the EPBC database, CALM's Threatened Fauna database and the WA Museum Faunabase (Table 3, Appendices 2 and 3). Baudin's Black-Cockatoo is most common in the forested Darling Scarp and may be present in both study areas throughout the year. Loss of feeding habitat for this species may impact the capacity of the bushland in the local area to support this species. Baudin's Black-Cockatoo has been recorded breeding at Serpentine National Park (Johnstone *et al.* 2003), and may breed in large eucalypts in the study area.

The Forest Red-tailed Black-Cockatoo was recorded on both the CALM and WA Museum databases for the area (Table 1, Appendix 3) as well as being recorded at both sites during the site visit. The Forest Red-tailed Black-Cockatoo is generally restricted to the forest zone. Several large Jarrah trees present on both the Quarry Bushland and State Forest, may have suitable hollows for this species to nest in and this species may be resident in the area.

The Peregrine Falcon is a wide-ranging bird of prey that may be an occasional visitor to both sites. The sites would only be highly significant for this falcon if they were breeding in tall trees.

The Rainbow Bee-eater is a migratory species listed under the EPBC Act, migrating to south-west Australia to breed during summer. This species was recorded in the State Forest during the site visit (Table 4), but may also occur in the Quarry Bushland. The Rainbow Bee-eater nests in burrows dug into sandy ground or banks, including

fire-breaks and cleared land. There are no sandy areas available for nesting at either site and this species is therefore considered unlikely to nest at either site.

The Fork-tailed Swift is largely aerial and is unlikely to be affected by any proposed development.

Conservation Significance 2

- **Masked Owl** *Tyto novaehollandiae novaehollandiae*
This owl is listed as Priority 3 by CALM and as 'near threatened' by Garnett and Crowley (2000).
- **Barking Owl** *Ninox connivens*
This owl is listed as Priority 2 by CALM and as 'near threatened' by Garnett and Crowley (2000).
- **Crested Shrike-tit** *Falcunculus frontatus leucogaster*
This bird is listed as Priority 4 by CALM.

The Masked Owl and Barking Owl are both wide ranging and may be occasional visitors to both the Quarry Bushland and the State Forest. These owls rely on large hollows in eucalypts for breeding and potential breeding hollows may be present in the large jarrah trees that were observed.

The Crested Shrike-tit is generally associated with the Wandoo woodlands near Perth, where it forages on insects under peeling bark. There are records from the Jarrah forest but Jarrah is not considered to be primary habitat for this species.

Mammals

Both sites have the capacity to support a diverse assemblage of native mammal species, the majority of which are listed as being of conservation significance due to the many threats facing mammals in the south-west of WA, including feral cats and foxes, habitat loss and changed fire regimes.

Conservation Significance 1

- **Chuditch** *Dasyurus geoffroii*
The Chuditch is listed as Vulnerable by the EPBC Act, the Wildlife Conservation Act and Maxwell *et al.* (1996).
- **Quokka** *Setonix brachyurus*
The Quokka is listed as Vulnerable under the EPBC Act, the Wildlife Conservation Act and Maxwell *et al.* (1996).
- **Western Ringtail** *Pseudocheirus occidentalis*
The Western Ringtail Possum is listed as Vulnerable under the EPBC Act, the Wildlife Conservation Act and Maxwell *et al.* (1996).

The Chuditch is a wide-ranging carnivore that can disperse through well-connected landscapes. It is widespread throughout the hills of Perth and the south-west and is common in Jarrah and Wandoo forest where fox baiting has occurred. There are recent records from the area on CALM's Threatened Fauna database with an

individual sighted nearby in 1993. This species was also listed on the EPBC database as having the potential to occur on the site (Appendix 2).

It is considered likely that this species occurs on both the Quarry Bushland and the State Forest, at least as an occasional visitor, although only a trapping program will detect its presence and give some measure of abundance.

Although formerly common in the Darling Range near Perth, the Quokka is now largely extinct on the mainland except for parts of the south-west and south coast. However, small populations still persist in the Darling Range and the CALM Threatened Fauna Database contains a 1998 record for the greater region. This species is restricted to swampy areas and dense riparian habitats (CALM Threatened Fauna Database information) and although it is considered highly unlikely to occur due to noise and disturbance there is a small possibility that it may occur around the dense stream vegetation in the Quarry Bushland. Only an intensive trapping program would determine the presence of this species.

The Western Ringtail Possum has been recorded from the area as represented by a sighting record from 1991 on the CALM Threatened Fauna Database. Formerly widespread, this species is now rare this far north and confined to areas of Peppermint (*Agonis flexuosa*) woodland and jarrah forest. This species may occur in both the Quarry Bushland and the State Forest where it is likely to favour dense vegetation, but may be more likely to occur at the quarry site due to the dense riparian stream vegetation. In general, however, this species is extremely rare outside Peppermint forests and only intensive spotlighting surveys could detect its presence.

Conservation Significance 2

- **Quenda (Southern Brown Bandicoot)** *Isoodon obesulus*
The Quenda is listed as Priority 4 by CALM and as lower risk (near threatened) by Maxwell *et al.* (1996).
- **Brush-tailed Phascogale** *Phascogale tapoatafa*
The Brush-tailed Phascogale is listed as Priority 3 by CALM and as lower risk (near threatened) by Maxwell *et al.* (1996).
- **Brush Wallaby** *Macropus irma*
This wallaby is listed as Priority 4 by CALM and as lower risk (near threatened) by Maxwell *et al.* (1996).
- **Western False Pipistrelle** *Falsistrellus mackenziei*
This bat is listed as Priority 4 by CALM and as lower risk (near threatened) by Duncan *et al.* (1999).

The Quenda is widespread in south-west WA and there have been recent records from the area on CALM's threatened fauna database as well as on the WA Museum Faunabase (Table 5, Appendix 3). Interestingly, the obvious diggings of this species were not noted during the site inspection at the Quarry Bushland, but were noted in the State Forest in the dense southern area close to the quarry. It is considered highly likely that Quenda occurs at both sites. Quendas may be more common around the stream zones and associated riparian vegetation of the Quarry Bushland and the drainages of the State Forest.

The Brush-tailed Phascogale has been recorded from the area on the WA Museum Faunabase (Table 5). This species occurs in jarrah forest and may potentially occur at both sites.

The Brush Wallaby is still widespread in the forest zone of the south-west in suitable habitat and is likely to occur at both sites particularly in areas of dense understorey vegetation including heathlands and *Dryandra sessilis* thickets.

The Western False Pipistrelle could potentially occur anywhere on the site, roosting in hollows and crevices in mature trees. It may also roost under loose bark. This bat can be identified by its unique call (recorded using a bat detector) and captured in mist nets or harp traps.

A number of other mammal species such as the Western Pygmy Possum and Honey Possum are likely to occur and during the site inspection in State Forest, there was evidence of a well-worn path up a Marri that was likely to be from a Brush-tailed Possum.

Discussion

A number of threatened species of national conservation significance have the potential to occur at both the Quarry Bushland and the State Forest. Both sites may offer suitable habitat for these species and removal of vegetation at either site may constitute a controlled action for species listed under the EPBC Act.

Perhaps the most significant threat from proposed development relates to the three species of Black-Cockatoo that occur in the area. All of these species have the potential to breed at either site in tall Marri or Jarrah trees with suitable hollows and both Baudin's and Carnaby's Black-Cockatoos are known to breed at Serpentine (Johnstone *et al.* 2005). A number of potential nest trees were observed at both sites and the possibility of loss of breeding habitat from clearing, needs to be considered for these species. Even if individuals are not breeding on-site, the loss of feeding resources within close proximity to nesting sites can seriously affect breeding success and may also constitute a controlled action under the EPBC Act.

In general terms, both sites primarily comprise Jarrah forest, and have similar potential for containing nesting and roosting habitat for threatened species. The Quarry Bushland contains several areas of outcropping granite as well as densely vegetated streams, and may offer some habitats for species that are not available in the State Forest. The Quokka, Quenda and Western Ringtail, if present, are more likely to favour the perennial, denser streamside vegetation found in the Quarry Bushland. Other species such as the Chuditch and the Black-Cockatoo species are likely to be widespread throughout the region and have no specific reliance on stream systems or granite outcrops.

The granite heath communities present only in the Quarry Bushland, offer habitats not found in the State Forest. Although these habitats do not support any listed threatened species, they provide habitat for a number of reptile species not found elsewhere. These include the Ornate Crevice Dragon, the Granite Worm Lizard (*Aprasia*

pulchella) as well as a number of snakes, geckos and skinks that bask and shelter on granite outcrops. It should be noted that extensive areas of exfoliating rocks were not noted during the site inspection and the granite areas may therefore be of limited value for these species.

Without intensive trapping surveys and field studies, the presence, absence or abundance of many species cannot be determined for each site. This report has only detailed the potential of each site to support certain species.

It should be noted that the State Forest is larger in area than the Quarry Bushland and can therefore potentially support a greater diversity and abundance of species. It is also important to note that bushland needs to be well connected at a regional scale to support viable long-term populations of fauna. The landscape connectivity of bushland needs to be given high priority when planning development and land swaps.

Conclusions and Recommendations

The recommendations and conclusions arising from the site visit and desktop study are:

- The area of native vegetation to be cleared should be minimised as well as any disturbance during the development process. The loss of species and species diversity may be proportional to the amount of habitat cleared.
- The structure, size, shape and connectivity of bushland is crucial to the long-term survival of fauna populations and should be considered during the planning process. Larger well-connected areas of bushland preferable to small, isolated patches.
- As EPBC listed species are present, consideration will need to be given to any controlled actions that may arise under the EPBC Act and referral to DEH may be required.
- Further targeted surveys may be requested by the DEP/EPA or DEH to ascertain the presence of threatened fauna as listed in this report.

In conclusion, both sites represent quality habitat for fauna, and are likely to support a range of species, including species of conservation significance. However, the State Forest has been extensively logged and shows recent evidence of fire and both sites are degraded to some extent by weeds. The diversity and abundance of species is closely linked to the size of their habitat and any comparisons of the two sites must also take into account the larger area of the State Forest compared to the Quarry Bushland.

The diversity of habitats in the Quarry Bushland offers more opportunities for species that favour stream-side vegetation or granite outcrop habitats. This may include threatened species such as the Western Ringtail and Quokka (both, however, considered unlikely to occur) and the priority listed Quenda. Across the Darling Scarp, granite-heathlands are likely to be much more limited in extent of occurrence than Jarrah forest and represent an important habitat for fauna.

The land swap proposed by WA Bluemetals will involve exchanging the quarry bushland for CALM owned state forest.

Although a recommendation on the land swap is beyond the scope of the consultants engaged to undertake this survey, consideration of the impact on fauna should take into account the regionally more scarce fauna habitats contained in the quarry bushland and the lower degree of recent human impacts at this site. It should also be noted that the sites are different and both have the potential to support species of conservation significance. Any decisions on a land swap should be in conjunction with advice from the Department of Environment and Department of Conservation and Land Management with other advice on threatened species from the Department of Environment and Heritage.

Table 2. Amphibians expected to occur on the proposed quarry extension area. Species recorded from the Quarry Bushland are indicated by (+), species recorded by the WA Museum are indicated by (WAM). No species were recorded from the State Forest. Species of conservation significance and introduced species are indicated in the status column.

Species	Status	Recorded
Myobatrachidae (ground frogs)		
Quacking Frog <i>Crinia georgiana</i>		+ WAM
Glauert's Froglet <i>Crinia glauerti</i>		+ WAM
Granite Froglet <i>Crinia psuedinsignifera</i>		
Green-bellied Froglet <i>Geocrinia leai</i>		
Moaning Frog <i>Heleioporus eyrei</i>		WAM
Chocolate Frog <i>Heleioporus inornatus</i>		
Hooting Frog <i>Heleioporus barycragus</i>		
Marbled Frog <i>Heleioporus psammophilus</i>		
Banjo Frog <i>Limnodynastes dorsalis</i>		
Guenther's Toadlet <i>Pseudophryne guentheri</i>		WAM
Hylidae (tree frogs)		
Slender Tree-frog <i>Litoria adelaidensis</i>		+
Motorbike Frog <i>Litoria moorei</i>		
Number of species expected (observed):		12 (3)

Table 3. Reptiles that are expected to occur on the proposed quarry extension area. Species recorded in the Quarry Bushland are indicated by (+), species recorded in the State Forest are indicated by (*) and species recorded by the WA Museum are indicated by (WAM). Species of conservation significance and introduced species are indicated in the status column.

Species	Status	Recorded
Gekkonidae (geckoes)		
Clawless Gecko <i>Crenadactylus ocellatus</i>		
Wheatbelt Stone Gecko <i>Diplodactylus granariensis</i>		
Speckled Stone Gecko <i>Diplodactylus polyophthalmus</i>		
Southern Spiny-tailed Gecko <i>Strophurus spinigerus</i>		
Variegated Dtella <i>Gehyra variegata</i>		
Marbled Gecko <i>Christinus marmoratus</i>		
Barking Gecko <i>Underwoodisaurus milii</i>		
Pygopodidae (legless lizards)		
Granite Worm-lizard <i>Aprasia pulchella</i>		
Sandplain Worm-lizard <i>Aprasia repens</i>		WAM
Fraser's Legless Lizard <i>Delma fraseri</i>		
Gray's Legless Lizard <i>Delma grayii</i>		
Burton's Legless Lizard <i>Lialis burtonis</i>		
Common Scaleyfoot <i>Pygopus lepidopus</i>		

Table 3 (cont.).

Species	Status	Recorded
Agamidae (dragon lizards)		
Ornate Dragon <i>Ctenophorus ornatus</i>	CS3	
Western Bearded Dragon <i>Pogona minor</i>		WAM
Varanidae (monitors or goannas)		
Gould's Sand Goanna <i>Varanus gouldii</i>		
Rosenberg's Goanna <i>Varanus rosenbergi</i>		
Black-tailed Tree Goanna <i>Varanus tristis</i>		
Scincidae (skink lizards)		
South-western Cool Skink <i>Acritoscincus trilineatum</i>		WAM
Fence Skink <i>Cryptoblepharus plagiocephalus</i>		*
Darling Range Ctenotus <i>Ctenotus delli</i>	CS2	WAM
West Coast Ctenotus <i>Ctenotus fallens</i>		WAM
Odd-striped Ctenotus <i>Ctenotus impar</i>		WAM
Red-legged Ctenotus <i>Ctenotus labillardieri</i>		WAM
Western Limestone Ctenotus <i>Ctenotus australis</i>		
King's Skink <i>Egernia kingii</i>		WAM
Salmon-bellied Skink <i>Egernia napoleonis</i>		+
Five-toed Earless Skink <i>Hemiergis initialis</i>		+
Forest Four-toed Lerista <i>Lerista distinguenda</i>		WAM
Dwarf Skink <i>Menetia greyii</i>		WAM
		<i>Morethia lineoocellata</i>
Dusky Morethia <i>Morethia obscura</i>		WAM
Bobtail <i>Tiliqua rugosa</i>		+
Typhlopidae (blind snakes)		
Southern Blind Snake <i>Ramphotyphlops australis</i>		WAM
Fat Blind Snake <i>Ramphotyphlops pinguis</i>		
Beaked Blind Snake <i>Ramphotyphlops waitii</i>		
Boidae (pythons)		
South-West Carpet Python <i>Morelia spilota imbricata</i>	CS1	
Stimson's Python <i>Morelia stimsoni</i>		
Elapidae (front-fanged snakes)		
Southern Death Adder <i>Acanthophis antarcticus</i>	CS2	
Western Tiger Snake <i>Notechis scutatus</i>		WAM
Dugite <i>Pseudonaja affinis</i>		WAM
Gould's Hooded Snake <i>Parasuta gouldii</i>		
Black-backed Snake <i>Parasuta nigriceps</i>		WAM
Half-ringed Snake <i>Brachyuropsis semifasciata</i>		
Number of species expected (observed):		44 (4)

Table 4. Birds that are expected to occur on the proposed quarry extension area. Species observed in the Quarry Bushland are indicated by (+), those observed in State Forest are indicated by (*), species recorded by the WA Museum are indicated by (WAM). Species of conservation significance and introduced species (int.) are indicated in the status column.

Species	Status	Recorded
Casuariidae (cassowaries and emus)		
Emu <i>Dromaius novaehollandiae</i>		
Accipitridae (kites, hawks and eagles)		
Black-shouldered Kite <i>Elanus notatus</i>		
Whistling Kite <i>Haliastur sphenurus</i>		
Square-tailed Kite <i>Lophoictinia isura</i>		
Brown Goshawk <i>Accipiter fasciatus</i>		
Collared Sparrowhawk <i>Accipiter cirrhocephalus</i>		
Wedge-tailed Eagle <i>Aquila audax</i>		WAM
Little Eagle <i>Hieraaetus morphnoides</i>		
Falconidae (falcons)		
Peregrine Falcon <i>Falco peregrinus</i>	CS1	
Australian Hobby <i>Falco longipennis</i>		
Brown Falcon <i>Falco berigora</i>		
Nankeen Kestrel <i>Falco cenchroides</i>		
Turnicidae (button-quails)		
Painted Button-quail <i>Turnix varia</i>		
Columbidae (pigeons and doves)		
Spotted Turtle-Dove <i>Streptopelia chinensis</i>	int.	
Laughing Turtle-Dove <i>Streptopelia senegalensis</i>	int.	
Common Bronzewing <i>Phaps chalcoptera</i>		
Cacatuidae (cockatoos)		
Baudin's Black-Cockatoo <i>Calyptorhynchus baudinii</i>	CS1	WAM
Carnaby's Black-Cockatoo <i>Calyptorhynchus latirostris</i>	CS1	WAM
Forest Red-tailed Black-Cockatoo <i>Calyptorhynchus banksii</i>	CS1	+ * WAM
Galah <i>Cacatua roseicapilla</i>		*
Psittacidae (lorikeets and parrots)		
Purple-crowned Lorikeet <i>Glossopsitta porphyrocephala</i>		
Regent Parrot <i>Polytelis anthopeplus</i>		
Red-capped Parrot <i>Purpureicephalus spurius</i>		+ WAM
Western Rosella <i>Platycercus icterotis</i>		+ WAM
Australian Ringneck <i>Barnardius zonarius</i>		+ * WAM
Elegant Parrot <i>Neophema elegans</i>		
Cuculidae (cuckoos)		
Pallid Cuckoo <i>Cuculus pallidus</i>		
Fan-tailed Cuckoo <i>Cuculus pyrrhophanus</i>		
Horsfield's Bronze-Cuckoo <i>Chrysococcyx basalis</i>		
Shining Bronze-Cuckoo <i>Chrysococcyx lucidus</i>		

Table 4 (cont.).

Species		Status	Recorded	
Strigidae (hawk-owls)				
Southern Boobook Owl	<i>Ninox novaeseelandiae</i>			
Barking Owl	<i>Ninox connivens</i>	CS2		
Tytonidae (barn owls)				
Masked Owl	<i>Tyto novaehollandiae</i>	CS2		
Barn Owl	<i>Tyto alba</i>			
Podargidae (frogmouths)				
Tawny Frogmouth	<i>Podargus strigoides</i>			
Caprimulgidae (nightjars)				
Spotted Nightjar	<i>Eurostopodus argus</i>			
Aegothelidae (owlet-nightjars)				
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>			
Halcyonidae (forest kingfishers)				
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	Int.	+	WAM
Sacred Kingfisher	<i>Todiramphus sanctus</i>			
Meropidae (bee-eaters)				
Rainbow Bee-eater	<i>Merops ornatus</i>	CS1	*	
Climacteridae (treecreepers)				
Rufous Treecreeper	<i>Climacteris rufa</i>			
Maluridae (fairy-wrens)				
Splendid Fairy-wren	<i>Malurus splendens</i>		+	
Red-winged Fairy-wren	<i>Malurus elegans</i>		+	WAM
Southern Emu-wren	<i>Stipiturus malachurus</i>			
Pardalotidae (pardalotes)				
Spotted Pardalote	<i>Pardalotus punctatus</i>		+	*
Striated Pardalote	<i>Pardalotus striatus</i>			*
White-browed Scrubwren	<i>Sericornis frontalis</i>			
Weebill	<i>Smicronis brevirostris</i>			
Western Gerygone	<i>Gerygone fusca</i>		+	*
Inland Thornbill	<i>Acanthiza apicalis</i>		+	*
Western Thornbill	<i>Acanthiza inornata</i>		+	*
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>		+	
Meliphagidae (honeyeaters)				
Red Wattlebird	<i>Anthochaera carunculata</i>			
Western Wattlebird	<i>Anthochaera lunulata</i>			
Singing Honeyeater	<i>Lichenostomus virescens</i>			
White-naped Honeyeater	<i>Melithreptus lunatus</i>			
Brown Honeyeater	<i>Lichmera indistincta</i>		*	
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>			
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>			
Tawny-crowned Honeyeater	<i>Phylidonyris melanops</i>			
Western Spinebill	<i>Acanthorhynchus superciliosus</i>		*	
White-fronted Chat	<i>Epthianura albifrons</i>			

Table 4 (cont.).

Species	Status	Recorded
Petroicidae (Australian robins)		
Jacky Winter <i>Microeca fascinans</i>		
Scarlet Robin <i>Petroica multicolor</i>		+ *
Red-capped Robin <i>Petroica goodenovii</i>		
Hooded Robin <i>Melanodryas cucullata</i>		
White-breasted Robin <i>Eopsaltria georgiana</i>		
Western Yellow Robin <i>Eopsaltria griseogularis</i>		* WAM
Neosittidae (sittellas)		
Varied Sittella <i>Daphoenositta chrysoptera</i>		
Pachycephalidae (whistlers)		
Crested Shrike-tit <i>Falcunculus frontatus</i>	CS2	
Golden Whistler <i>Pachycephala pectoralis</i>		*
Rufous Whistler <i>Pachycephala rufiventris</i>		
Grey Shrike-thrush <i>Colluricincla harmonica</i>		*
Dicruridae (flycatchers)		
Restless Flycatcher <i>Myiagra inquieta</i>		
Magpie-lark <i>Grallina cyanoleuca</i>		
Grey Fantail <i>Rhipidura fuliginosa</i>		+
Willie Wagtail <i>Rhipidura leucophrys</i>		
Campephagidae (cuckoo-shrikes)		
Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i>		
White-winged Triller <i>Lalage sueurii</i>		
Artamidae (woodswallows)		
Black-faced Woodswallow <i>Artamus cinereus</i>		
Dusky Woodswallow <i>Artamus cyanopterus</i>		
Grey Butcherbird <i>Cracticus torquatus</i>		
Australian Magpie <i>Gymnorhina tibicen</i>		
Grey Currawong <i>Strepera versicolor</i>		
Corvidae (ravens and crows)		
Australian Raven <i>Corvus coronoides</i>		
Motacillidae (pipits and true wagtails)		
Australian Pipit <i>Anthus australis</i>		
Passeridae (finches and allies)		
Red-browed Firetail <i>Emblema temporalis</i>	Int.	
Red-eared Fire-tail <i>Stagonopleura oculata</i>		
Dicaeidae (flower-peckers)		
Mistletoebird <i>Dicaeum hirundinaceum</i>		
Hirundinidae (swallows)		
Welcome Swallow <i>Hirundo neoxena</i>		
Tree Martin <i>Hirundo nigricans</i>		
Zosteropidae (white-eyes)		
Silvereye <i>Zosterops lateralis</i>		+
Number of species expected (observed):		92 (23)

Table 5. Mammal species that are expected to occur on the proposed quarry extension area.). Species observed in the Quarry Bushland are indicated by (+), those observed in State Forest are indicated by (*), species recorded by the WA Museum are indicated by (WAM). Species of conservation significance and introduced species (int.) are indicated in the status column.

Species	Status	Recorded
Tachyglossidae (echidnas)		
Echidna <i>Tachyglossus aculeatus</i>		
Dasyuridae		
Mardo <i>Antechinus flavipes</i>		WAM
Chuditch <i>Dasyurus geoffroyi</i>	CS1	
Brush-tailed Phascogale <i>Phascogale tapoatafa</i>	CS2	WAM
Grey-bellied Dunnart <i>Sminthopsis griseoventer</i>		
Peramelidae (bandicoots)		
Quenda or Southern Brown Bandicoot <i>Isoodon obesulus</i>	CS2	* WAM
Tarsipedidae (honey possum)		
Honey Possum <i>Tarsipes rostratus</i>		WAM
Phalangeridae (possums)		
Brush-tailed Possum <i>Trichosurus vulpecula</i>		*
Burramyidae (pygmy possums)		
Western Pygmy Possum <i>Cercartetus concinnus</i>		
Macropodidae (kangaroos and wallabies)		
Western Grey Kangaroo <i>Macropus fuliginosus</i>		
Brush or Black-gloved Wallaby <i>Macropus irma</i>	CS2	
Mollosidae (mastiff bats)		
White-striped Bat <i>Tadarida australis</i>		
Western Freetail Bat <i>Mormopterus planiceps</i>		
Vespertilionidae (vesper bats)		
Gould's Wattled Bat <i>Chalinolobus gouldii</i>		
Chocolate Wattled Bat <i>Chalinolobus morio</i>		WAM
Western False Pipistrelle <i>Falsistrellus mackenziei</i>	CS2	
Little Brown Bat <i>Vespadelus regulus</i>		
Lesser Long-eared Bat <i>Nyctophilus geoffroyi</i>		
Gould's Long-eared Bat <i>Nyctophilus gouldi</i>		WAM
Greater Long-eared Bat <i>Nyctophilus timoriensis</i>		
Muridae (rats and mice)		
House Mouse <i>Mus musculus</i>	Int.	WAM
Black Rat <i>Rattus rattus</i>	Int.	WAM
Leporidae (rabbits and hares)		
Rabbit <i>Oryctolagus cuniculus</i>	Int.	
Canidae (foxes and dogs)		
European Red Fox <i>Vulpes vulpes</i>	Int.	
Felidae (cats)		
Feral Cat <i>Felis catus</i>	Int.	
Suidae (pigs)		
Feral Pig <i>Sus scrofa</i>	Int.	
Number of species expected (observed):		26 (2)

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Appendix 1. Categories used in the assessment of conservation status.**Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act** [categories from IUCN, based on review by Mace and Stuart (1994)].

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a very high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not Threatened.

WA Department of Conservation and Land Management Priority species (species not listed under the Conservation Act, but for which there is some concern).

Priority 1.	Taxa with few, poorly known populations on threatened lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2.	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3.	Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4.	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5.	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix 2. Species listed for the area 32°15' to 32°20'S and 116°00' to 116°05'E on the EPBC Protected Matters Search Tool, excluding marine species.

Species	Status
Baudin's Black-Cockatoo <i>Calyptorhynchus baudinii</i>	Vulnerable
Carnaby's Black-Cockatoo <i>Calyptorhynchus latirostris</i>	Endangered
Chuditch <i>Dasyurus geoffroii</i>	Vulnerable
Quokka <i>Setonix brachyurus</i>	Vulnerable
Red-tailed Phascogale <i>Phascogale calura</i>	Endangered
White-bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	Migratory

Appendix 3. Species listed for the area 32°15' to 32°20'S and 116°00' to 116°05'E on the CALM Threatened and Priority Fauna Database, excluding marine species.

Species	Status
Carnaby's Black-Cockatoo <i>Calyptorhynchus latirostris</i>	Schedule 1 Endangered
Baudin's Black-Cockatoo <i>Calyptorhynchus baudinii</i>	Schedule 1 Vulnerable
Forest Red-tailed Black-Cockatoo <i>Calyptorhynchus banksii naso</i>	Schedule 1
Quokka <i>Setonix brachyurus</i>	Schedule 1
Western Ringtail Possum <i>Pseudocheirus occidentalis</i>	Schedule 1
Chuditch <i>Dasyurus geoffroii</i>	Schedule 1
Quenda <i>Isodon obesulus</i>	Priority 5