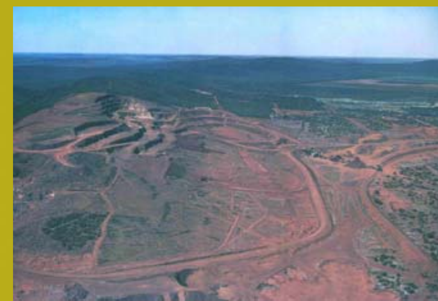
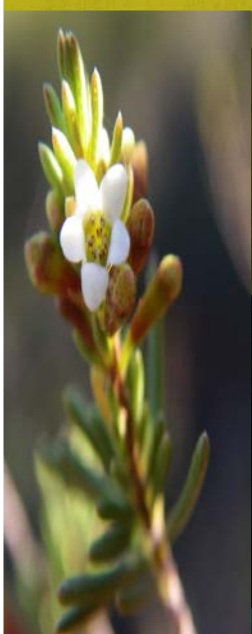
September 2008





KOOLANOOKA – BLUE HILLS DIRECT SHIPPING ORE (DSO) MINING PROJECT SHORT RANGE ENDEMIC LITERATURE

REVIEW AND RISK ASSESSMENT

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1.0 INTRODUCTION

1.1 BACKGROUND

Midwest Corporation Limited (Midwest) proposes to develop the Koolanooka/Blue Hills Direct Shipping Iron Ore (DSO) Mining Project to mine and process up to 2 mtpa of direct shipping grade iron ore for export, from a combination of three separate pits. The Koolanooka minesite is located approximately 160 km south east of Geraldton and 21 km east of Morawa, and the Blue Hills minesite is located 60 km to the east of Koolanooka (Figure 1). The mines were previously operated from 1966–1972 by WMC Resources Limited as part of the Geraldton Operations Joint Venture (GOJV) consisting of WMC Resources Ltd, Barrick Australia Limited and Australian Hanna Limited.

The Koolanooka/Blue Hills DSO Mining Project involves the recommencement of open pit mining activities from the existing open pit at the Koolanooka mine, development and mining of a shallow oxide pit as an extension to the south east of the existing open pit at Koolanooka, and mining and stockpiling of the pisolitic scree ore to the south and west of this same mine. Most work will be conducted in existing disturbed areas. Crushing and screening facilities for processing and blending varying ore types and grades of DSO will be constructed at the Koolanooka site again on sites that have been previously disturbed.

At Blue Hills depth extensions will occur into the existing East and West Mungada pits. These extensions will require small cutbacks to the existing pits. Run-of-mine ore from Blue Hills will be transported on the pre-existing Mt Karara / Mungada haul road by road-train to Koolanooka where it will be crushed and screened with ore from Koolanooka. The high grade Banded Iron Formation (BIF) ore from Blue Hills will be blended with the screened pisolite lump fraction to achieve an average DSO quality threshold of 58% Fe. Koolanooka oxide ore sourced from the South Fold pit will be crushed and screened to produce lump and fine products.

Ore will be transported by road to a rail siding at Morawa, then by rail to the Geraldton Port where it will be stockpiled in a covered storage facility then loaded for export (Figure 1). The DSO Mining Project is expected to run for a period of 3 to 5 years, with development scheduled to commence in mid 2007.

Midwest is currently exporting previously mined material from stockpiles at Koolanooka (Mining Proposal 4888, approved by the Department of Industry and Resources (DoIR) 21/12/2005) and site and port infrastructure is already permitted and in operation.

The Koolanooka/Blue Hills DSO Mining Project was referred to the EPA under Section 38 of the *Environmental Protection Act 1986* in September 2006 and June 2004. The EPA will formally assess the project on the basis of the potential environmental impacts of the project and has set the level of assessment as a Public Environmental Review (PER) (Current Assessment No 1653, previous Assessment No 1532). The public review period for this PER has been set at 6 weeks.

The Koolanooka DSO Mining Project was also referred to the Department of Environment and Heritage (DEH) and it was determined that the project was not considered to be a Controlled Action under the *Environmental Protection and Biodiversity Conservation Act 1999* (Referral No 2004/1886) (See Appendix A).

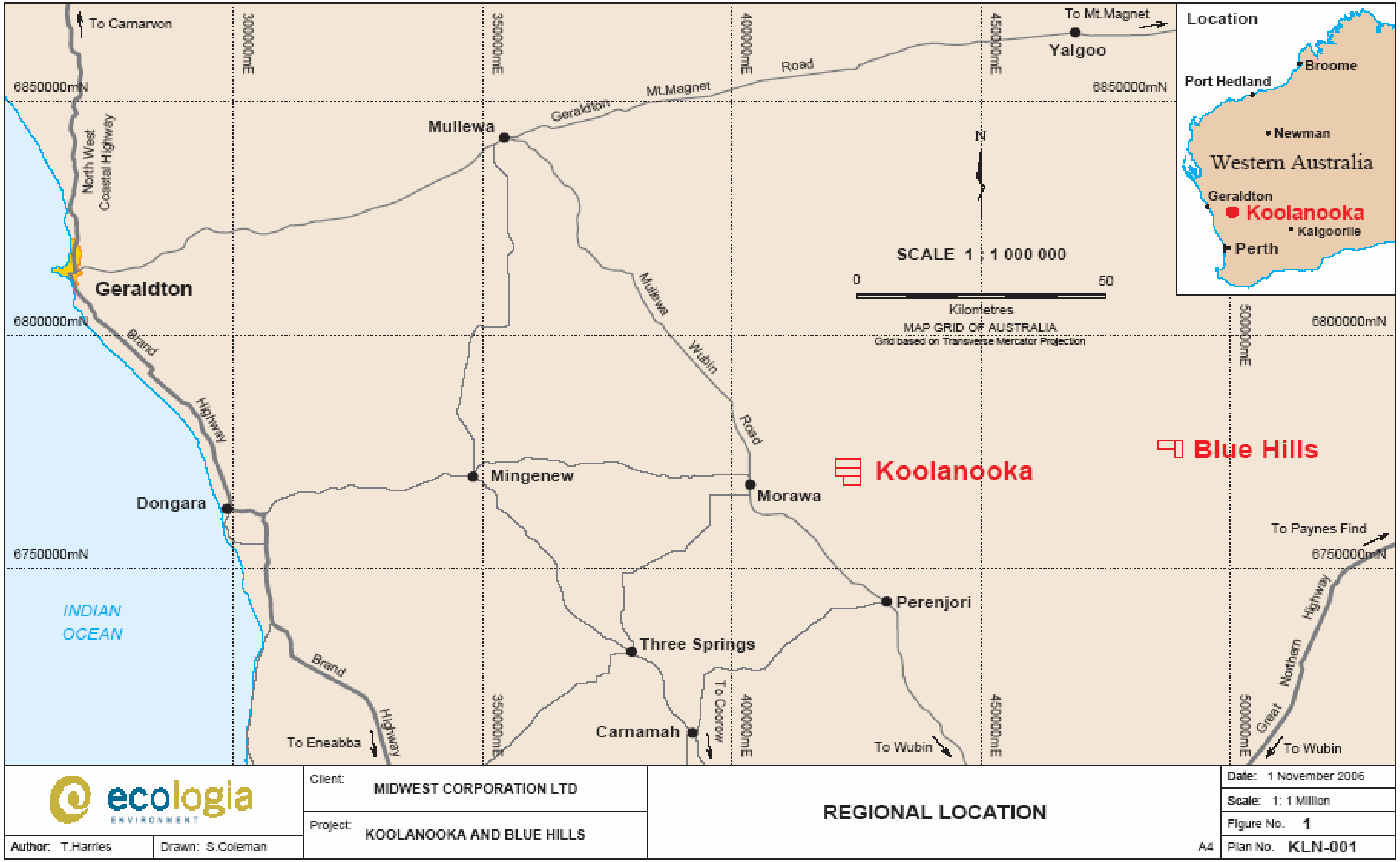

Figure 1.1: Map of the Geraldton, Koolanooka and Blue Hills Local Area

1.2 BIOREGIONS

The Koolanooka study area is located within the Avon-Wheatbelt Bioregion of Australia (Thackway and Cresswell, 1995), in relatively close proximity to the intersection of the South-Western and Eremaean Botanical Provinces of Western Australia. The study area is located within the Perenjori Botanical District (Beard, 1976).

The Blue Hills occurs on the boundary between the Austin Botanical District of the Eremaean Botanical Province and the Avon Botanical District of the Southwest Botanical Province (Beard, 1990), hence it is an interzone.

1.3 VEGETATION AND FLORA OVERVIEW

All ecologia site surveying has been scheduled for completion during early spring so as to survey during the period of the year where it is easiest to classify most species, due to the presence of inflorescence, and to supplement previously completed surveys which have not been carried out due this period.

1.3.1 Koolanooka

The Koolanooka study area is located within the Avon-Wheatbelt Bioregion (Thackaway and Cresswell, 1995), in relatively close proximity to the intersection of the South-Western and Eremaean Botanical Provinces of Western Australia. The study area is also situated within the Perenjori Botanical District (Beard, 1976). The study area is located within one of several vegetation systems associated with the Perenjori Botanical District, known as the Koolanooka System (Beard, 1976). This Koolanooka Vegetation System is naturally restricted to the two known existing occurrences at Koolanooka Hills and the nearby Perenjori Hills (south east of Koolanooka Hills) (CALM, 2003). The proposed mining area was cleared by Western Mining in the 1960's. The proposed new activities will be occurring in areas of recent regrowth. However the DSO Mining Project will impact on a total of 2.36ha of vegetation immediately abutting the existing pit, which is a part of the Koolanooka System Threatened Ecological Community.

The vegetation associated with the Koolanooka System is described as consisting of an Open Woodland of *Allocasuarina huegeliana*, *Eucalyptus ebbanoensis subsp. ebbanoensis, Acacia sp*. scrub with *Dodonaea inaequifolia* interspersed with thickets of *Allocasuarina campestris, Acacia acuminata, Grevillea stenostachya, Melaleuca cordata, Melaleuca nematophylla and Melaleuca radula.* York Gum (*Eucalyptus loxophleba*) Woodland interspersed with *Melaleuca sp*. scrub is prominent on the footslopes, while mixed Acacia spp. (*A. tetragonophylla, A. quadrimarginea and A. ramulosa*) scrub is supported on granite outcrops of the Koolanooka Hills (Beard, 1976).

A vegetation and flora survey of the Midwest lease area in the Koolanooka Hills was undertaken between 10 and 17 October 2003 (8 days in total) (Bennett Environmental Consulting, 2003). The flora and vegetation survey was conducted using the *EPA Guidance Statement No. 51: Guidance for the Assessment of Environmental Factors: Terrestrial flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2003) as a guide and the survey methodology produced quadrat based quantitative data.

A total of 220 taxa belonging to 117 genera and 43 families were recorded from the Koolanooka Hills study area. This included 207 native and 13 introduced or non-endemic species. The dominant families were Asteraceae (Daisy family – 26 taxa), Mimosaceae (Acacia family – 21 taxa), Myrtaceae (Eucalyptus family – 21 taxa) and Poaceae (Grass family – 19 taxa). These four dominant families represented approximately 39% of the total number of taxa recorded from the study area.

The prominent weed Ruby Dock (*Acetosa Vesicaria)*, is known to be present in the Midwest lease area in the Koolanooka Hills locality.

Significant Flora

Six species of conservation significance were recorded from within the Midwest mining leases during the 2003 vegetation and flora survey:- *Acacia acanthoclada subsp. glaucescens* (P3), *Persoonia pentasticha* (P2), *Frankenia glomerata* (P3) and *Baeckea sp.* Three Springs (P2), *Eremophila viscida* (R) and *Persoonia pentasticha* (P3) (Figure 10). Based on current data, no species of conservation significance will be impacted on by the mining associated with the DSO Mining Project.

Vegetation Types

A total of 31 different vegetation types were identified during the October 2003 vegetation and flora survey of the Midwest lease areas in the Koolanooka Hills (Bennett Environmental Consulting, 2003). An additional 20 vegetation types were identified during a vegetation survey of Midwest's lease areas in the Koolanooka Hills in March 2004 (ATA, 2004).

The vegetation types of the Midwest lease area and the Koolanooka Hills are shown in Figures 9 & 10.

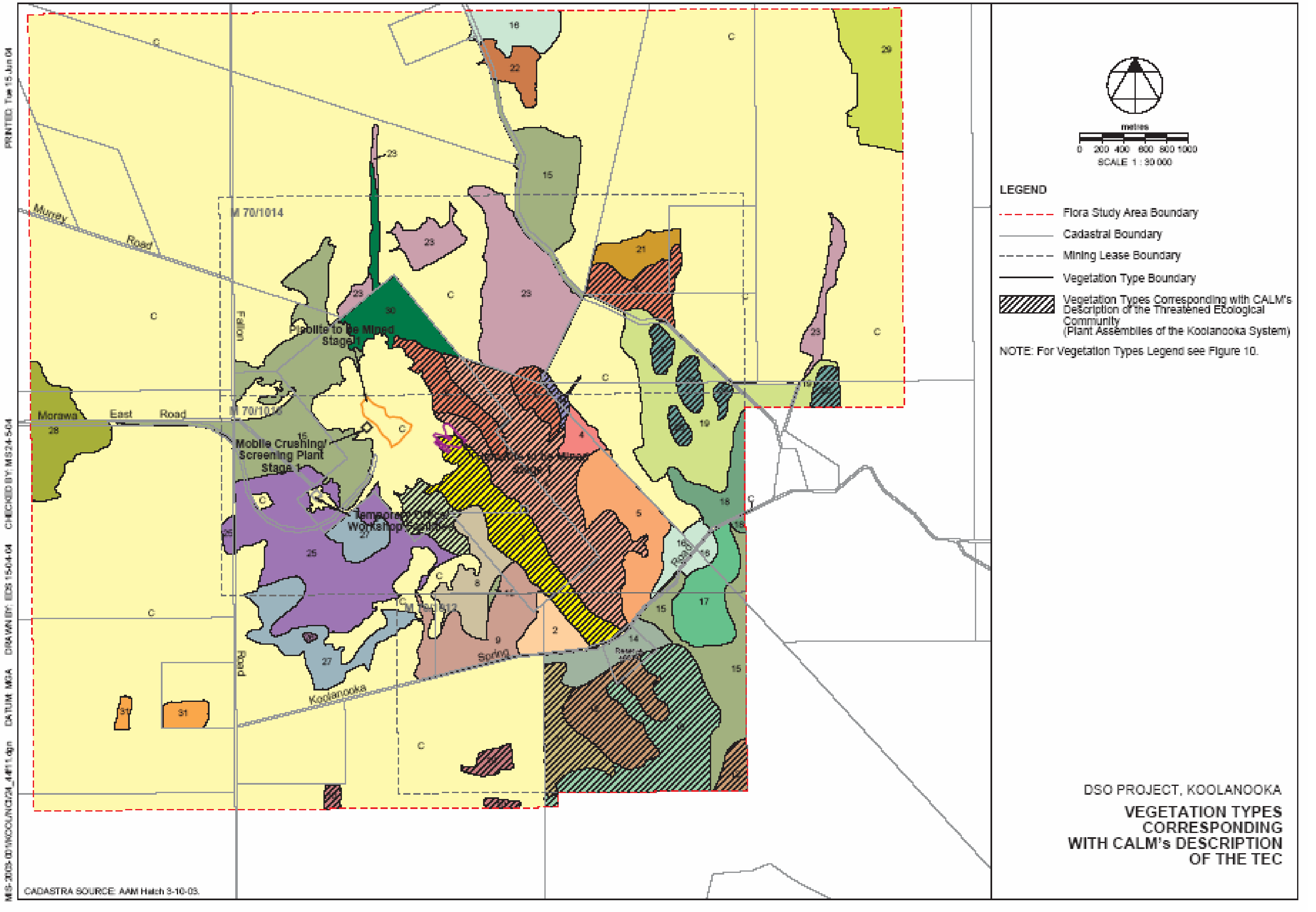
metres
0 200 400 600 800 1000
SCALE 1 : 30 000
LEGEND
Flora Study Area Boundary
Cadastral Boundary
Mining Lease Boundary
Vegetation Type Boundary
Vegetation Types Corresponding with CALM's Description of the Threatened Ecological Community (Plant Assemblies of the Koolanooka System)
NOTE: For Vegetation Types Legend see Figure 10.
DSO PROJECT, KOOLANOOKA
VEGETATION TYPES CORRESPONDING WITH CALM's DESCRIPTION OF THE TEC
M 70/1014
Pisolite to be Mined Stage 1
Mobile Crushing/ Screening Plant Stage 1
Temporary Office/ Workshop Facilities
Morawa East Road
Koolanooka Spring Road
CADASTRA SOURCE: AAM Hatch 3-10-03.

Figure 1.2 Conservation Vegetation Map at Koolanooka

2.0 LITERATURE REVIEW

Endemism refers to the restriction of species to a particular area, whether it be at the continental, national or local level (Allen *et al.*, 2002). Short range endemism refers to endemic species with restricted ranges, which in Western Australian is currently defined as less than 10,000 km^2 (100 km x 100 km). Such taxa are usually invertebrates, as they more likely to display poor dispersal abilities and a more defined or restrictive biology that promotes their isolation and eventual speciation. It is important to note that the potential SRE groups listed in this review are not exhaustive, and that invertebrates are historically understudied and in many cases lack formal descriptions. It is only relatively recently that extensive, reliable taxonomic evaluation of these species has begun and thus the availability of literature relevant to SREs is still scarce. It must also be stressed that the precautionary principle, as adopted by the EPA / DoE under Section 4a of the Environmental Protection Act 1986, is currently a guiding principle of this literature review.

2.1 PROCESSES PROMOTING SHORT RANGE ENDEMISM

Short-range endemism is influenced by numerous processes which generally contribute to the isolation of the species. A number of factors, including the ability and opportunity to disperse, life history, physiology, habitat requirements, habitat availability, biotic and abiotic interactions and historical conditions, influence not only the distribution of a taxon, but also the tendency for differentiation and speciation (Ponder and Colgan, 2002).

Isolated populations of both plants and animals tend to differentiate both morphologically and genetically as they are influenced by different selective pressures over time. Additionally, a combination of novel mutations and genetic drift promote the accumulation of genetic differences between isolated populations. Conversely, the maintenance of genetic similarity is promoted by a lack of isolation through migration between the populations, repeated mutation and balancing selection (Wright, 1943). The amount of differentiation and speciation between populations will be determined by the relative magnitude of these factors, with the amount of migration generally being the strongest determinant. Migration is hindered by poor dispersal ability of the taxon as well as geographical barriers to dispersal. Thus, those taxa that exhibit short-range endemism are generally characterised by poor dispersal, reliance on habitat types that are discontinuous, low growth rates and low fecundity (Harvey, 2002).

A number of habitats in Australia contain short-range endemics because they are surrounded by geographic barriers. Islands are a classic example, where terrestrial fauna are surrounded by a marine environment which impedes migration and thus gene flow. Similarly, habitats such as mountains, aquifers, lakes and caves are essentially islands exhibiting unique environmental conditions in comparison to the surrounding landscape. Areas in the Northern Yilgarn such as Jack Hills and Weld Range exemplify this, where Banded Ironstone Formations (BIF's) are separated by tens of kilometres of dissimilar Spinifex plain, preventing the flow of genes from one ridge to the next.

Harvey (2002) states that “freshwater habitats in Australia have a high proportion of short-range endemic species and many are restricted to individual river systems or drainage basins. Permanent freshwater ecosystems provide stable environments for a wide variety of taxa including many relictual lineages from Gondwanan periods.” The Koolanooka and Blue Hills project areas contain no permanent water bodies and thus taxa such as Phreatoicidea isopods, which are typically SREs, are almost certainly not going to be present.

The historical connections of habitats are also important in determining species distributions and often explain patterns that are otherwise inexplicable by current conditions. Many SREs are considered to be relictual taxa (organisms surviving as a remnant of an otherwise extinct species) and are confined to certain habitats, and in some cases, single geographic areas such as granite outcrops (Main, 1996). Relictual taxa include species dating back to Gondwanan periods that have a very restrictive biology.

In Western Australia, relictual taxa generally occur in fragmented populations, from lineages reaching back to historically wetter periods. For example, during the Miocene period (from 25 million to 13 million years ago), the aridification of Australia resulted in the contraction of many areas of moist habitat and the fragmentation of populations of fauna occurring in these areas (Hill, 1994). With the onset of progressively dryer and more seasonal climatic conditions since this time, suitable habitats have now become increasingly fragmented. Relictual species now generally persist in habitats characterised by permanent moisture and shade, with conditions provided by high rainfall (Main, 1996). Such conditions can be seen at sites adjacent to granite outcrops that drain water (Main, 1996), mountain summits, swampy headwaters of river systems and caves. Topography, proximity to the coast and directional orientation are also influential in determining relictual habitats. Due to the isolation of populations, many relictual species of cave fauna have very disjunct populations, indicating that their dispersal is limited (Clark and Spier, 2005).

2.2 CURRENT KNOWLEDGE OF SHORT RANGE ENDEMIC SPECIES IN THE MIDWEST OF WESTERN AUSTRALIA, WITH EMPHASIS ON THE STUDY AREA

Groups or organisms which display short range endemism include (but are not limited to) molluscs (e.g. Camaenid land snails), onychophorans (velvet worms), millipedes, some arachnids (scorpions, pseudoscorpions and schizomids) and some crustaceans (isopods) (Harvey, 2002).

Generally, however, the current state of knowledge on short range endemism of particular species in Australia, and indeed the Northern Yilgarn and Murchison Regions, is relatively poor . The paucity of targeted collections makes assessing the likely occurrence and the distribution of SRE fauna very difficult. There are currently SRE surveys underway at Jack Hills, Weld Range and also at Oakajee, all of which have recorded Mygalomorphae trap-door spiders, land snails, pseduscorpions and millipedes which are still being examined by taxonomic experts (or the survey is still going, i.e. Weld Range). Thus at this stage the conservation significance of these species can not be commented upon with certainty, but it can be said with a fair degree of confidence that the Mygalomorphae spiders from Jack Hills and Weld Range for example are new species'. And, that these species are restricted to southern facing slopes with their associated microclimatic conditions and have limited dispersal capabilities.

There are currently no references to SRE invertebrate fauna in the Yalgoo or Avon Wheatbelt IBRA sub-regions of Western Australia. However, a search of the DEC Threatedned and Prioirtity Fauna Database revealed the Shield-backed Trapdoor spider (*Idiosoma nigrum* Main 1952). This species is identified by the DEC as a Schedule 1 (Fauna that is rare or is likely to become extinct) species. The species is considered to be in decline in it patchy distribution through the northern and central wheatbelt and the coastal plain. The species is long-lived and very sensitive to disturbance. According to the database search the last record of the species was from Northampton in 1982, previously it had not been recorded since 1955.

2.3 TAXONOMIC GROUPS LIKELY TO SUPPORT SRE TAXA

2.3.1 Arachnids (Phylum: Athropoda, Sub Class: Arachnide)

Four orders of arachnids can exhibit short range endemism: Pseudoscorpiones (false scorpions), Scorpiones (true scorpions), Schizomida (whip spiders) and Araneae (Mygalomorph trap-door spiders). The vast majority of spider species in Australia are widely distributed due to their ability to 'balloon' (where spiders use silk to lift them off the ground and disperse via wind). However, some of the mygalomorph trap-door spider species are vulnerable to disturbance and exhibit short range endemism due to their inability to 'balloon', their extreme longevity and the long-term persistence of females in a single burrow (Raven, 1982). Mygalomorph spiders are largely considered 'old world' spiders and, as such, are generally adapted to past climatic regimes making them vulnerable to desiccation in semi/arid environments. They use a variety of behavioural techniques to avoid desiccation, the most obvious of which is their burrow, which in semi/arid areas may reach up to 70 cm in depth (Main, 1982). Mygalomorph groups are thus capable of surviving on the periphery of the great central desert region and minor habitats within the general arid regions of the continent. They are also quite common in the wheatbelt and in costal areas.

At least one new species was recorded by *ecologia* at Jack Hills and Weld Range respectively, and therefore it is reasonable to assume that new or restricted species might also be found at the Koolanooka and Blue Hills DSO project areas.

Further, a search of the DEC Threatened and Priority Fauna Database revealed the Shield-backed Trapdoor spider (*Idiosoma nigrum* Main 1952) to be present near the project area. This species is identified by the DEC as a Schedule 1 (Fauna that is rare or is likely to become extinct) species. The species is considered to be in decline in it patchy distribution through the northern and central wheatbelt and the coastal plain. The species is long-lived and very sensitive to disturbance. According to the database search the last record of the species was from Northampton in 1982, previously it had not been recorded since 1955. It is considered likely species such as this may be found in the relatiavely isolated Koolanooka and blue Hills project areas.

Another member of the arachnid class, the Schizomida, is comprised entirely of SREs, with most recorded from single localities (Harvey, 2002). Forty-six schizomid species have been described in northern Australia. Most are known to occur in the entrances to and inside caves, while the remainder occur in nearby habitats (Harvey, 2002). None are known to occur in the Midwest region of WA.

Scorpions (Scorpiones: Urodacus) and pseudoscorpions (Pseudoscorpiones) also exhibit high degrees of endemism (Harvey, 1996; Koch, 1981), some species of which display restricted ranges (Harvey, 1996); Mark Harvey pers. comm.). Although they are found in most climatic zones, scorpions are popularly thought of as desert animals. This may be a consequence of their larger size (a morphological adaptation to such environments) which makes them more visible.

Currently, there is little recently published distributional data regarding either of these orders in Western Australia, particularly in the study area (Harvey, 2002; Koch, 1977). However a review of the scorpion fauna of Western Australia is planned to commence early in 2007 which should substantially increase the knowledge of scorpions distribution and endemism in the near future.

2.3.2 Crustaceans (Phylum Athropoda, Subclass Crustacea)

Three families of the freshwater isopod suborder Phreatoicidea occur in Australia. Most are endemic and often allopatric, and all are constrained by their specific habitat requirements of permanent freshwater lakes, streams, mound springs and groundwater (see references within Harvey, 2002). Their dispersal ability is also thought to be poor as nearly all are restricted to areas that have been above sea level since the middle Cretaceous (Harvey, 2002). Phreatoicid isopods are renowned for their localised distributions (Harvey, 1996; Horwitz and Rogan, 2003; Koch, 1981) and numerous taxa occur in the north-west of Western Australia.

Eight described genera of Phreatoicidea isopod have been described from Western Australia. However, undescribed species-level diversity may be present in a number of genera (Wilson and Keable, 2002). As relictual aquifers and permanent waters become better known in Western Australia, additional taxa of Phreatoicideans are likely to be found (Wilson and Keable, 2002).

2.3.3 Millipedes and Centipedes (Phylum Athropoda, Class Myriapoda)

Despite the fact that millipedes can be highly abundant in soil and leaf litter, and highly diverse at the level of order (Harvey, 2002), they are inadequately studied and relatively little is known of their biogeography. One of the genera that have been studied is the Stygiochiropus (Humphreys and Shear 1993). This genus consists solely of four species that are found in the caves and subterranean cavities in the Cape Range Peninsula, three of which are restricted to single caves; *S. isolatus* Humphreys & Shear (1993), *S. sympatricus* Humphreys & Shear (1993) and *S. peculiaris* Shear &

Humphreys (1996). The fourth species, *S. communis*, occurs throughout the Peninsula, occurring sympatrically with *S. sympatricus*.

Centipedes (Chilopoda) are not listed by Harvey (2002) as SRE species; however they have been shown to be endemic to small areas on the east coast (Edgecombe *et al.*, 2002) and a recently described species has only been recorded from Albany (Jones, 1996). Examination of the distributions of species featured in the CSIRO centipede webpage also reveals disjunct and isolated occurrences of many species (Colloff *et al.*, 2005). A number of genera have Pangaean and Gondwanan affinities (Edgecombe *et al.*, 2002). In general, these animals have a relatively cryptic biology, preferring moist habitats in deep litter accumulations, under rocks and in rotting logs, and they have relatively poor dispersal abilities (Lewis, 1981). This suggests that they are potential candidate for designation as SREs.

2.3.4 Molluscs (Phylum: Mollusca)

Numerous species of freshwater and terrestrial molluscs belonging to many genera have been identified in Australia, with most being SREs (Harvey, 2002). Restricted ranges of the terrestrial molluscs of the drier northern and Western Australia were noted for a vast number of species (Solem, 1997). Among these were seven endemic species of Rhagada from the Dampier Archipelago, five of which were found to occur sympatrically on one island. However, in a recent genetic study conducted on the same species (Johnson *et al.*, 2004), allozyme analysis revealed little variation between taxa. Such a finding could indicate that there is merely high morphological diversity within one or a few species. It is also possible however, that there is a number of highly endemic species and morphological diversity has taken place rapidly with little genetic change (Johnson *et al.*, 2004).

2.3.5 Worms (Phylum: Annelida)

The taxonomic status of the earthworm family, Megascolecidae, in Western Australia was revised by Jamieson in 1971. As a result of this study, it was concluded that most of the earthworm genera are made up almost entirely of short-range endemics (Harvey, 2002). This is also the case with the Velvet worms (onychophorans). Due to several taxonomic revisions that have been conducted (see references within Harvey, 2002), the number of onychophoran species has expanded from six to over 70 species, and a number of species still remain undescribed (Harvey, 2002). Very few of these species exceed ranges of 200 km^2 and some are restricted to single localities and have high genetic differentiation, indicating very little mobility and dependence on their permanently moist habitats (Harvey, 2002).

2.4 THREATS TO SHORT RANGE ENDEMICS

Due to their restricted nature many SREs are vulnerable to loss of habitat. The primary threatening processes faced by SRE invertebrates in the Murchison are listed below (Yen and Butcher, 1997):

1. clearing of native vegetation;
2. habitat fragmentation;

3. inappropriate fire regimes;
4. mineral extraction; and
5. long term environmental changes.

The conservation significance of highly restricted, non-agile species (such as millipedes and land snails) is considered to be analogous to species that are restricted to caves or islands and therefore the threatening processes are the same. Many may be susceptible to land degradation and clearing, but definitive taxonomic and ecological studies are currently lacking to determine their full ranges or any threatening processes (Harvey and West, unpublished).

Short range endemics are especially vulnerable to the effects of anthropogenic activity due to their limited dispersal abilities and specific habitat requirements. Therefore, identifying SREs is essential in the conservation of biodiversity, not only because the possibility of their entire range being destroyed is greater, but also because their limited dispersal capabilities makes them even more vulnerable to the effects of habitat fragmentation and the problems of decreasing population numbers, inbreeding and the loss of genetic fitness that accompanies it. Thus, even if loss of habitat only occurs in parts of their range, local species extinction may still occur (due to their inability to exchange genes between fragments and recolonise those that die out due to stochastic events).

Unfortunately, there has been a lack of sampling and taxonomic studies of invertebrate species and many SRE may be unrecognised as a result of insufficient data (Harvey, 2002), placing them at an even greater risk (EPA, 2004). In order to recognise SREs, investigation of existing taxa, field studies and reliable taxonomic resolution is required (Ponder and Colgan, 2002).

2.5 POTENTIAL OCCURRENCES OF SHORT RANGE ENDEMICS IN THE STUDY AREA

The study area is located within one of several vegetation systems associated with the Perenjori Botanical District, known as the Koolanooka System (Beard, 1976). However the DSO Mining Project will impact on a total of 2.36ha of vegetation immediately abutting the existing pit, which is a part of the Koolanooka System Threatened Ecological Community.

Despite the majority of the proposal taking place on existing or previously disturbed areas, there are significant areas of potential SRE habitat. For example, granite outcrops, which generally are known to harbour restricted and endemic flora, fauna and invertebrates (Harvey, 2002; Hopper *et al.*, 1997; Johnson *et al.*, 2004; Main, 1997; Withers and Edward, 1997). According to symposium held in 1996 by the Royal Society of Western Australia (Hopper and Withers, 1996):

"Often, these rocky outcrops form inselbergs - ranges, ridges and isolated hills - that stand abruptly from the surrounding plains, like islands in a sea. Most commonly, granite outcrops appear as dome-shaped hills with bare rock exposed over most of

the surface. The water catchment so formed, combined with a diversity of microhabitats from rock pools to shallow desiccated soils and bare rock, make granite outcrops havens for biodiversity world-wide.

In Western Australia, granite outcrops form characteristic landforms across much of the State. They are of interest:

- *geologically, being among the world's oldest rocks*
- *hydrologically, as sources of water in a dry landscape*
- *biologically, being rich in endemic plants and animals,*
- *culturally vital for aboriginal, colonial and contemporary peoples alike.*"

In the Northern Agricultural Region (NAR) granite outcrops are an important biological resource. Due to their hard, rocky, upland nature granite outcrops were generally not cleared for agriculture and granite breakaways represent key vegetated islands in an otherwise cleared landscape (NACC, 2002).

Further, the open she-oak woodlands (*Allocasuarina huegeliana)* at Koolanooka are considered to have the potential to harbour SRE taxa. Similar habitat along the Oakajee River within the proposed Oakajee Industrial Area and Port for example, recently recorded eight trap door spider species including two undescribed *Aname* species of potentially restricted distribution (B.Main pers.comm.).

Specifically, the shield-backed spider, *Idiosoma nigrum* Main, is listed as a Schedule 1 species (fauna which are Rare or likely to become extinct, are declared to be fauna that is in need of special protection) under the *Western Australian Wildlife Conservtion Act 1950.* The species is in decline because of its patchy distribution through the northern and central wheatbelt and coastal plain, where land clearing has significantly reduced the quantity of available habitat. It is also a long-lived spcies which is very sensitive to disturbance.

Therefore, there are at least two habitats found at Koolanooka that appear to contain the characteristics that are likely to give rise the formation and maintenance of SRE taxa. Furthermore, the presence of TEC's at Koolanooka is another feature that lends weight to the need to conduct a targeted SRE survey. This is because invertebrates often show adaptation to particular plant communities and even individual plant species. Thus, a distinct vegetation community, such as a TEC, could be expected to harbour a distinct invertebrate community.

Below (Table 2.1) is an assessment of the likelihood of finding SRE taxa at Koolanooka Hills. The assessment was conducted in the same manner as a standard Risk Assessment, when considering the environmental impacts of a proposal. In conducting the assessment all eight groups currently known to include SRE taxa where assessed independently. In the majority of cases the 'risk' of SRE taxa being present was detemined to be moderate to highly likely.

Table 2.1 Potential SRE Taxa, Their Distribution and Likely Occurrence in the Koolanooka Hill and Blue Hills Areas of the Murchison Region.

Area/Subject				**Location**			
Presence of Short Range Endemic Fauna				Koolanooka Hills and Blue Hills			
Risk Identification and Analysis				**Current Information**	**Risk Rating**		
#	**Risk Issue (Source / Event)**	**Taxa**	**Suitable Habitat in Study Area**	**Data Sources**	**Propensity to form SRE's**	**Likelihood of SRE forming conditions**	**Risk Rating**
1	SMM Koolanooka Blue Hills Project results in adverse impact on 'unlisted' short range endemic fauna via land disturbance, introduction of exotic species (i.e. pests and weeds), increased noise and dust, changes in habitat (e.g. fire, drainage, contamination).	Mygalomorphae spiders: Ctenzidae rare; Dipluridae: Ischnothelinae: Cethegus; Hexathelidae sp.; Theraphosidae, especially *Selenocosmia stirlingi*; Actinopodidae: *Missulena* sp.; and *Idiosoma nigrum* (Shield-backed spider, Schedule 1).	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees and under leaf litter accumulations	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdotal evidence; New species of *Cethegus* recorded at Jack Hills and Weld Range.	4	5	20
		Scorpions	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdotal evidence.	3	3	9

			southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees and under leaf litter accumulations	Many specimens from Weld Range and Jack Hills of two Families presently being reviewed by WAM specialists.			
		Pseudoscorpions	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees and under leaf litter accumulations	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdotal evidence. Many specimens recorded using pitfall traps at Weld Range and Jack Hills	5	4	20
		Schizomida	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdotal evidence	5	1	5

			rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees and under leaf litter accumulations				
		Millipedes	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees.	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdota evidencel. Despite WAM predictions many specimens were recorded opportunistically at Weld Range.	5	4	20
		Centipedes	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris. May also be present in the Mulga	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdotal evidence. A number of specimens recorded at Jack Hills and Weld Range belong to undescribed	3	2	6

			Plains at base of Acacia and other tree.	species.			
		Mollusca: camaenid genus Rhagada, and others	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris. May also be present in the Mulga Plains at base of Acacia and other trees.	Desktop literature review, CALM/WAM Faunabase search, expert opinion, anecdotal evidence. Land snail specimens from Weld Range currently being reviewed by Wam experts.	5	5	25
		Annelids: Megascolecidae.	Deep leaf litter accumulations in the larger Koolanooka and Blue gullies, along southern facing slopes and under rocks and large debris.	Desktop literature review, CALM/WAM Faunabase search, expert opinion (Harvey, 2002), anecdotal evidence.	5	3	15

Risk Matrix:

Risk Assessment Rating		Likelihood of SRE forming conditions 5 ALMOST CERTAIN Habitats highly likely to lead to SREs Is expected to occur in most circumstance	4 LIKELY SREs will probably occur in most circumstance	3 POSSIBLE SREs Could occur	2 UNLIKELY SREs could occur but not expected	1 RARE SREs occur only in exceptional circumstances
Taxa Group Propensity to form SREs	5 - VERY HIGH	25	20	15	10	5
	4 - HIGH	20	16	12	8	4
	3 - MODERATE	15	12	9	6	3
	2 - MINOR	10	8	6	4	2
	1 - LOW	5	4	3	2	1

21 - 25	High risk of unrecorded SRE taxa, site specific survey required, senior management attention needed
16 - 20	Medium risk, management responsibility must be specified. Site specfic survey recommended
1 - 5	Low risk, managed by routine procedures. Site specific survey not required.

Figure 2.1 The Risk Matrix Used in the Determination of SRE Presence in the Koolanooka Hills Project Area

Likelihood of SRE forming conditions:		
Value	**Description**	**Criteria**
5	Almost Certain	SREs are expected to occur in most circumstance. Disjunct, microclimatic or relictual habitats are present: habitats highly likely to lead to the formation of SREs.
4	Likely	SREs will probably occur in most circumstance. Disjunct, microclimatic or relictual habitats are present or very little is known about the local environment and taxa present.
3	Possible	SREs Could occur. Disjunct, microclimatic or relictual habitats might be present but more importantly, very little is known about the local environment and taxa present.
2	Unlikely	SREs could occur but not expected. The majority habitat is homogenous regioanlly and locally. The taxa of the area are fairly well known. Disjunct, microclimatic or relictual habitats are absent or not previously known.
1	Rare	SREs occur only in exceptional circumstances. The majority habitat is homogenous regioanlly and locally. The habitats and resident taxa of the area are well known. New habitats such as permanent springs or caves would need to be discovered.

Propensity of Taxonomic Group to form SREs:		
Value	**Description**	**Criteria**
5	Very High	The group is known to display SRE taxon. They are relictual species known from past climatic regimes, they have poor powers of dispersal coupled with single sex-biased dispersal , highly specialised habitat requirements, low fecundity and male-biased dispersal.
4	High	The group is known to display SRE taxon. They inlcude relictual species known from past climatic regimes, have poor powers of dispersal which may be coupled with single sex-biased dispersal, moderately specialised habitat requirements, moderate fecundity and male-biased dispersal.
3	Moderate	The group is suspected or known to display SRE taxon. They might inlcude relictual species known from past climatic regimes, have poor-moderate powers of dispersal, moderately specialised habitat requirements and moderate fecundity.
2	Minor	They might inlcude relictual species known from past climatic regimes, have moderate powers of dispersal, fairly general habitat requirements and moderate-high fecundity.
1	Low	They are unlikely to inlcude relictual species, have moderate-high powers of dispersal, general habitat requirements and moderate-high fecundity.

Figure 2.2 The Definitions used in the determination of the SRE Presence Assessment at Koolanooka Hills.

2.6 CONSERVATION STATUS OF SHORT RANGE ENDEMICS IN THE STUDY AREA

A number of invertebrate species are listed under Federal (*Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999) and State (*Wildlife Conservation Act* (WC Act) *1950*) legislature and the Department of Environment and Conservation (DEC) Priority fauna listing.

As stated above, the Schedule 1 (WC Act 1950) Trap-door spider species *Idiosoma nigrum* is know from the region. A search of the DEC Threatened and Priority Fauna Database listed Yalgoo, Barnoong, Ajana, Galena and Northampton as locations where the species has been recorded, according to this database it has not been seen since 1982. Recent research my Barbara Main (Main, 2003) over ten years , suggests that the species is highly sensitive to environmental change and habitat degradation. In the remnant vegetation studied, rabbits, Gallahs and secondary salinisation were considered the primary processes causing the decline in the population of *I. nigrum*.

3.0 PROJECT RISK ASSESSMENT

Three risk issues were identified in the course of conducting the risk assessment for the Midwest Corporation Koolanooka and Blue Hills projects Figure 3.1. With respect to vegetation clearing four impacts were identified all of which were associated with the removal of SRE invertebrate fauna habitat. In all four cases with the implementation of the suggested controls, the residual risk was calculated to be low.

Similarly with the increased risk of dust arising from the proposal which could potentially result in damage to SRE fauna habitat via vegetation decline, the implementation of the suggested controls lowers the residual risk to low.

Lastly, the increased risk of fire resulting in degradation of SRE fauna habitat is considered low, once the suggested controls are implemented.

Biological Environmental Impact Risk Assessment											
Project: Midwest Corp. DSO PER		*Location: Koolanooka and Blue Hills*					*Date: 21* November 2006				
			Inherent Risk					**Residual Risk**			
Risk Issue	**Aspect (Event)**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Mine Site											
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Loss of local SRE invertebrate fauna communities	5	2	10	**Med**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	3	1	3	**Low**
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Adverse impact to ecological function	1	4	4	**Low**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	1	2	2	**Low**
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Habitat fragmentation	5	2	10	**Med**	Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical.	5	1	5	**Low**
Vegetation clearing	Removal of SRE invertebrate fauna habitat	Reduction in SRE invertebrate fauna populations	5	3	15	**High**	Clearing of riparian vegetation should be avoided. Clearing of southern facing ridge slopes would be avoided where possible	5	1	5	**Low**
Dust	Dust emissions arising from mining operations	Damage to vegetation resulting in loss of SRE invertebrate fauna habitat	4	3	12	**High**	Dust suppression measures should be implemented, including management of road speed on unsealed roads.	2	1	2	**Low**
Fire	Wildfire arising as a result of mining operations	Degradation of fauna habitat and populations	4	2	8	**Low**	A fire prevention strategy should be implemented. All vehicles should be fitted with fire extinguishers & all personnel trained in their use.	2	2	4	**Low**

Figure 3.1 The Koolanooka and Blue Hills Biological (SRE) Environmental Impact Risk Assessment.

Risk Matrix:

	Risk Assessment Rating	LIKELIHOOD: 5 ALMOST CERTAIN Is expected to occur in most circumstance	4 LIKELY Will probably occur in most circumstance	3 POSSIBLE Could occur	2 UNLIKELY Could occur but not expected	1 RARE Occurs in exceptional circumstances
CONSEQUENCES	5 - CATASTROPHIC Significant impact to fauna species of conservation significance or regional biodiversity	25	20	15	10	5
	4 - MAJOR Impact to fauna species of conservation significance in project area.	20	16	12	8	4
	3 - MODERATE Loss of fauna biodiversity in project area.	15	12	9	6	3
	2 - MINOR Short term or localised impact to fauna biodiversity.	10	8	6	4	2
	1 - INSIGNIFICANT No impact to fauna of conservation significance or biodiversity.	5	4	3	2	1

11-25	High risk, site/issue specific mangement programmes required, advice/approval from regulators required.
6 – 10	Medium risk, specific management and procedures must be specified.
1 – 5	Low risk, managed by routine procedures.

Figure 3.2 The Risk Assessment Matrix used in the Determination of the Biological Impact Risk Assessment

Likelihood:		
Value	**Description**	**Criteria**
5	Almost Certain	Environmental issue will occur, is currently a problem or is expected to occur in most circumstances.
4	Likely	Environmental issue has been a common problem in the past and there is a high probability that it will occur in most circumstances.
3	Possible	Environmental issue may have arisen in the past and there is a high probability that it could occur at some time.
2	Unlikely	Environmental issue may have occurred in the past and there is a moderate probability that it could occur at some time but not expected.
1	Rare	Environmental issue has not occurred in the past and there is a very low probability that it may occur in exceptional circumstances.

Consequence:		
Value	**Description**	**Criteria**
5	Catastrophic	Significant impact to fauna species of conservation significance or regional biodiversity
4	Major	Impact to fauna species of conservation significance in project area.
3	Moderate	Loss of fauna biodiversity in project area.
2	Minor	Short term or localised impact to fauna biodiversity.
1	Insignificant	No impact to fauna of conservation significance or biodiversity.

Figure 3.3 The Definitions used in the Determination of the Biological Impact Risk Assessment.

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