10 May 2007



KOOLANOOKA / BLUE HILLS DSO MINING PROJECT

KOOLANOOKA BOREFIELD STYGOFAUNA ASSESSMENT

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STYGOFAUNA ASSESSMENT

Midwest Corporation Limited

10 May 2007

Document Status						
Rev No.	Author	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
1	M. White	J. D. Clark	03/05/2007			
2	M. White	J. D. Clark	10/05/2007	J.D. Clark	B. Mackenzie	11/05/2007

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Executive Summary

Midwest Corporation Limited (Midwest) is proposing to reopen and expand the previously mined ore bodies at Koolanooka and Blue Hills in the Murchison Region of Western Australia. Midwest intends to ship existing fine ore stockpiles from site and establish a shallow oxide open pit mining operation to the immediate south of the existing historical Koolanooka iron pit. Additionally, it is planned that some of the remnant detrital pisolitic scree ore on the western flanks of the existing pit will be mined in the late second or third year of the DSO Project. The DSO will be trucked to the proposed on-site crushing and screening plant via existing haul roads which will require minimal refurbishment.

In order to determine the potential impact to subterranean aquatic fauna (stygofauna), Midwest commissioned *ecologia* Environment to undertake a preliminary stygofauna survey in February 2007. Due to the relatively small scale of the project and the limited number of bores available at the time, the aim of the sampling assessment was to define the presence or absence of stygofauna in the project area. Midwest was aware that in the event that stygofauna species or communities were present within the project area, a more extensive sampling program would need to be developed and conducted at a later date.

The Koolanooka Springs Road borefield comprised eight bores suitable for stygofauna sampling. However four of these contain pumps which are used to supply water for exploration purposes. As such, four bores were sampled twice each at Koolanooka (February and April 2007).

Stygofauna sampling at the Koolanooka Borefield took place in three stages:

1. Description of the physical parameters of the bore;
2. Measurement of a number of physico-chemical parameters using a 90 FL multi-parameter meter from water bailed using sterile single use bailers; and
3. Stygofauna sampling following the methods recommended by the Department of Environment and Conservation (DEC).

Despite two rounds of appropriate stygofauna sampling, aquatic subterranean invertebrate fauna were not recorded at the Koolanooka borefield. Due to the absence of stygofauna, a more extensive survey program has not been developed and impacts to stygofauna from operation of the borefield are not expected.

Further, modelling of the haematite resource at Koolanooka suggests that mining will not take place below the water table and any dewatering activities are not expected to impact the water table (Rockwater 2004, 2006a). Thus stygofauna sampling associated with the Koolanooka and Blue Hills Stage 1 pits is not currently planned. However, should additional sources of processing water be required, further stygofauna surveys will need to be carried out by the proponent where the salt concentration of the aquifer under investigation is conducive of stygofauna presence.

1.0 INTRODUCTION

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 mine site is located approximately 160 km south east of Geraldton and 21 km east of Morawa. Blue Hills mine site is located 60 km to the east of Koolanooka (Figure 1.1). 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.

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).

The presence of stygofauna in Western Australia has been well documented, especially from regions such as the Pilbara and Kimberley, and less so in the Midwest and Southwestern regions of Western Australia (Cho *et al.* 2005; De Laurentiis *et al.* 2001; Eberhard 2004; Humphreys 2001; Karanovic 2004; Wilson and Keable 2002).

Stygofauna ("stygo" meaning adapted to living underground and referring to the River Styx in Greek and Roman mythology) are obligate, groundwater dwelling fauna known to be present in a variety of rock types including karst limestone, fissured rock (e.g. granite) and porous rock (e.g. alluvium)(Mamonier *et al.* 1993). They are typically adapted for the subterranean environment, with features such as lack of pigmentation, elongated appendages, filiform body shape (worm like) and reduced or absent eyes. Many of these fauna have other primitive features which link them to geological periods when vast areas of Australia were covered by tropical forests. They are, therefore, often regarded as 'relict' fauna which have survived in aquifers over geological timeframes (Danielopol and Stanford 1994; Humphreys 1993, 2001).

No mining below the water table is expected at either location, however water for ore processing will be required via abstraction of a suitable source in the vicinity of either Koolanooka or Blue Hills. In order to ascertain the presence or absence of stygofauna within the existing Koolanooka Borefield, Midwest commissioned *ecologia* Environment to undertake an initial baseline stygofauna survey. The aim of the sampling program was to determine the presence or absence of stygofauna in the project area. Midwest were aware that in the event that stygofauna were shown to be present in the Koolanooka borelfield, a more intensive and extensive sampling regime would need to be developed to meet EPA guidelines (EPA 2003) and expectations.

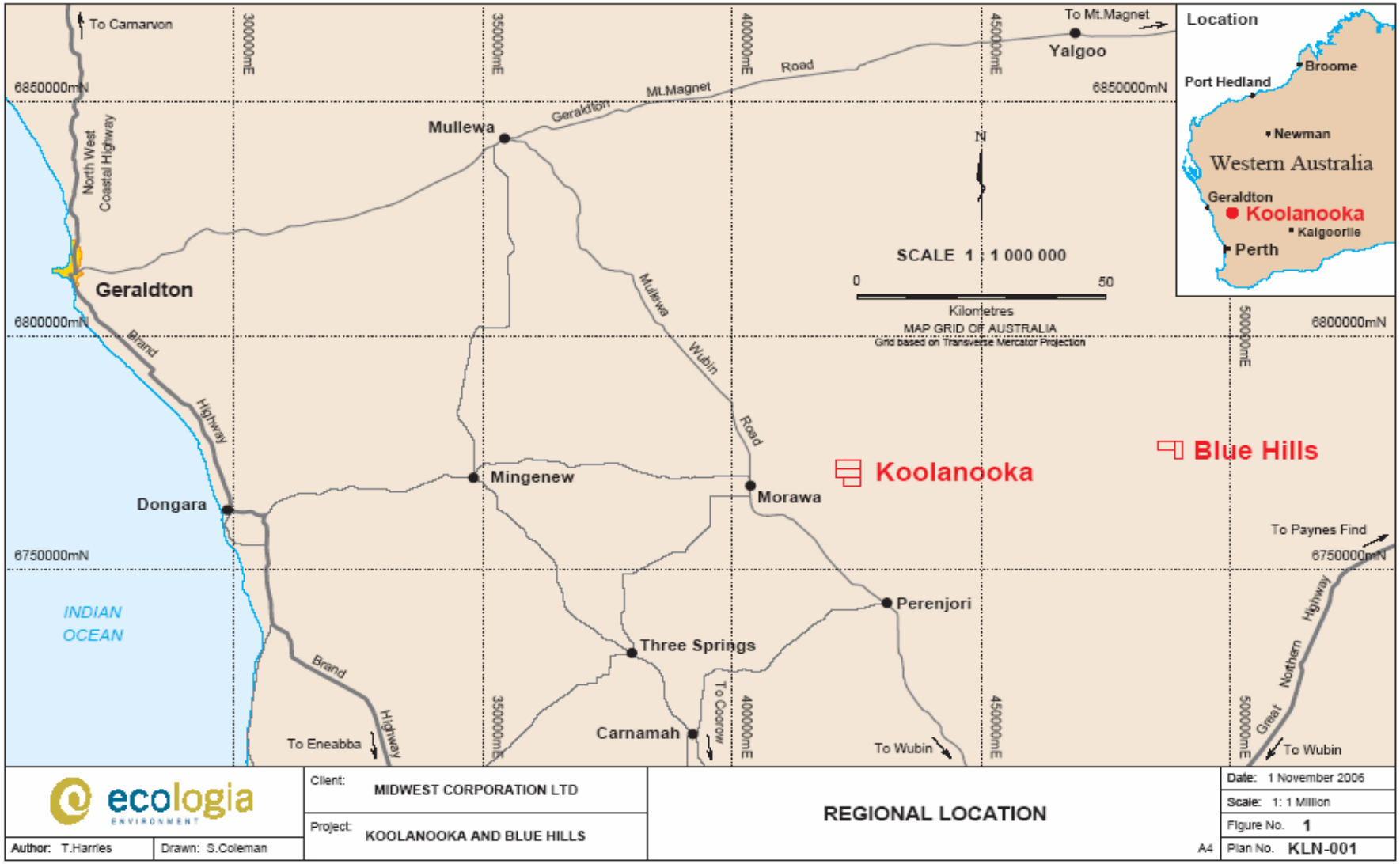

Figure 1.1 **Locality** Map showing the relative position of the Koolanooka and Blue Hills DSO Project.

1.1 LEGISLATIVE FRAMEWORK

The *Environmental Protection Act 1986* is "an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing." Section 4a of this Act outlines five principles that are required to be addressed to ensure that the objectives of the Act are addressed. Three of these principles are relevant to native fauna and flora:

- *The Precautionary Principle*

  Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- *The Principles of Intergenerational Equity*

  The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- *The Principle of the Conservation of Biological Diversity and Ecological Integrity*

  Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the EPA, in this case Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004), Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003), and principles outlined in the EPA's Position Statement No. 3 Terrestrial Biological Surveys as an element of Biodiversity Protection (EPA 2002).

Native fauna in Western Australia are protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a State level under the *Wildlife Conservation Act 1950* (WC Act).

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The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and ensures the conservation of migratory species. In addition to the principles outlined in Section 4a of the EP Act, Section 3a of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

The *WC Act* was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the *Government*

Gazette, declare a list of fauna taxa identified as likely to become extinct, or is rare, or otherwise in need of special protection. The current listing was gazetted on the 1 December 2006.

1.2 SURVEY OBJECTIVES

Midwest Corporation Ltd commissioned ecologia Environment (ecologia) to undertake an initial baseline biological survey of the stygofauna of the Koolanooka / Blue Hills DSO study area as part of the environmental impact assessment for the project.

The EPA's objectives with regards to fauna management are to:

- maintain the abundance, species diversity and geographical distribution of terrestrial fauna; and
- protect Specially Protected (Threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.*

Hence, the primary objective of this study was to provide sufficient information to the EPA to assess the impact of the project on the stygofauna of the area, thereby ensuring that these objectives will be upheld.

Specifically, the objectives this survey was to undertake a survey that satisfies the requirements documented in EPA's Guidance Statements 54 and 56, and Position Statement No. 3, thus providing:

- A review of background information;
- An inventory of stygofauna species occurring in the study area, incorporating recent published and unpublished records;
- A description of the characteristics of the faunal assemblage;
- An appraisal of the current knowledge base for the area, including a review of previous surveys conducted in the area which[5] are relevant to the current study;

However due to the relatively small size of the project and its accompanying borefield, which contains only eight bores, the primary aim of this survey was to ascertain the presence of absence of stygofauna on the project area.

2.0 BIOPHYSICAL ENVIRONMENT

2.1 CLIMATE

The climate in the Koolanooka / Blue Hills area is semi-arid with a mean annual rainfall of approximately 335mm. Annual evaporation is 2,315mm and far exceeds the annual rainfall. Monthly average rainfall and temperatures recorded at Morawa, 21 km to the west of the mine site are illustrated in Figure 2.1.

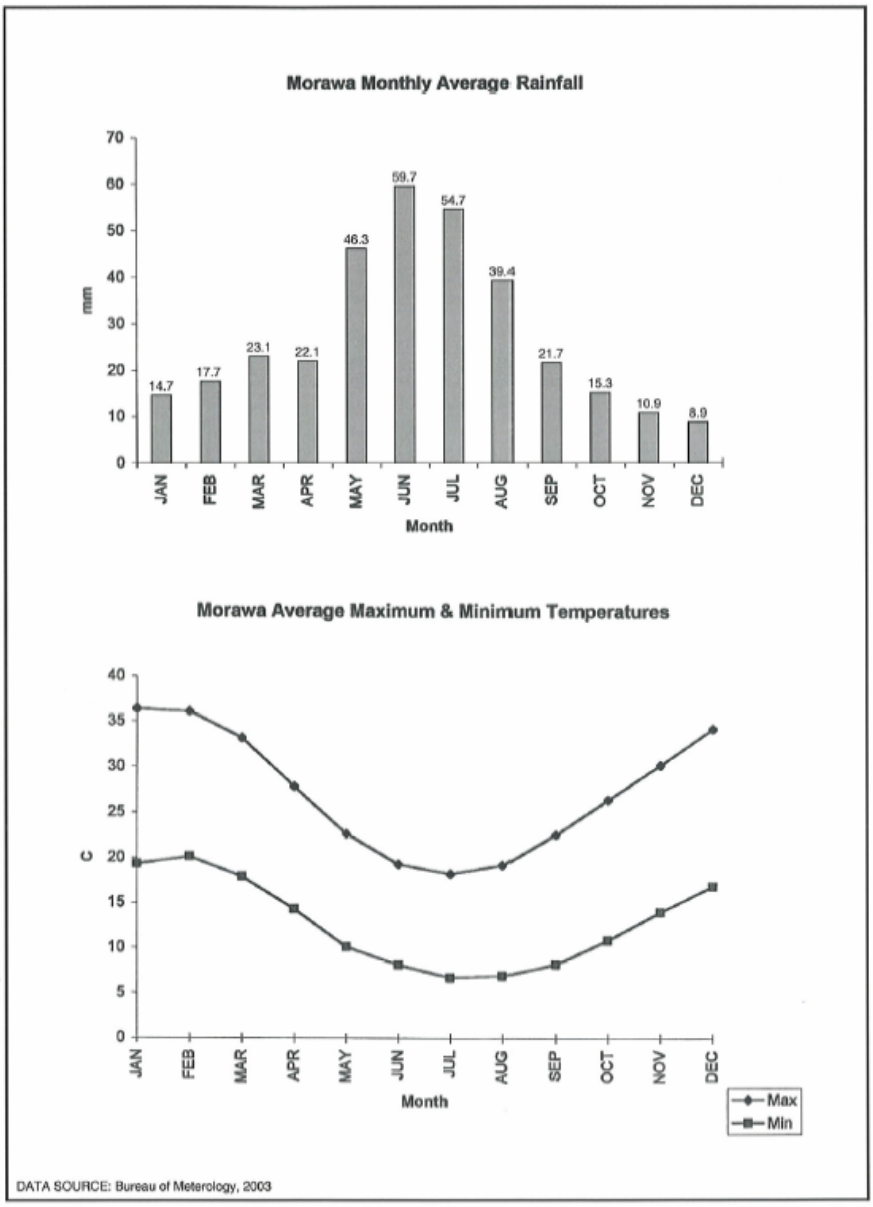

Figure 2.1 Rainfall and Temperature of the Morawa

2.2 Hydrology

The proposed mining of the South Fold and Pisolite orebodies will occur within existing disturbed areas whilst the shipping of the fine ore is a simple earthmoving operation. The South Fold orebody is effectively a cut-back situation to the south-east of the existing pit and the lowest level of the proposed pit will be approximately 95 metres above the free standing water table, thus aquifer dewatering will not be necessary at this stage. Similarly, the Pisolite ore body to the west of the existing pit is considerably higher than the regional water table and the mining of this orebody will not disturb either the ground or surface waters.

Water supply for site dust suppression and for watering of the haul roads is expected to come from the pumping of water out of the existing pit at Koolanooka, thus limited aquifer abstraction will be required for this purpose. No water will be pumped off site and in the second year of operation, water will be sourced locally for wet screening of the pisolite ore. Aquifer abstraction will be required however for ore processing. Groundwater exploration for this purpose by Rockwater (Rockwater 2004, 2006a) has revealed negligible results to date.

Should further groundwater exploration activities identify a suitable water source for ore processing, additional stygofauna surveys will be required, depending on the salinity levels of the aquifer under investigation. Many potentially sources investigated to date in the area have been shown to have salinities approaching that of seawater and thus, are unlikely to contain stygofauna.

2.2.1 Surface Waters

There are no permanent fresh water streams. Water courses which drain from the Koolanooka Hills to the south-west and north flow only during extended thunderstorm activity. Annual evaporation far exceeds rainfall and dams constructed to intersect these ephemeral flows are of limited use for water supply.

2.2.2 Groundwater

The regional ground water level generally occurs at around 255m AHD. Annual evaporation far exceeds annual rainfall although some minor subsurface recharge does occur during intense rainfall events. Groundwater in the bottom[7] of the existing pit is slightly saline but personal communication with ex WMC employees suggests inflowing groundwater during previous mining operations was relatively fresh.

Storage systems for ground water in the region may be broadly divided to three types.

- *Shallow Alluvial Sediments* - Limited volumes of ground water are stored in surficial sandy sediments associated with current drainages.
- *Fractured Bedrock* - Bedrock in the project area consists of Archaean supracrustal rocks enclosed in gneissic rocks and intruded by later granitoid rocks. The supracrustal sequence comprises a basal volcanic facies conformably overlain by clastic and chemical sedimentary rocks. The sedimentary sequence which is the focus of attention in this project consists of siltstone, feldspathic sandstone, pebbly sandstone and minor beds of quartz-pebble conglomerate overlain by, and interbedded with, banded iron-formation and well-laminated to massive, graded pelitic shale. It

has been observed from drill core that the sedimentary sequence is almost completely porous in the oxidised upper levels. Secondary permeability in the fresh deeper levels is less pronounced but may be enhanced by the presence of large strike slip faults that truncate the orebody.

- *Palaeodrainages* - Drainage during the Tertiary sub-era in the region was in an arcuate river system which flowed around the Koolanooka Hills to the west, north and east. This is now delineated by a series of salt lakes (Lake Nullewa to the north and Weelhamby Lake to the east) which flow periodically during intense rainfall events.

2.2.3 Potential Groundwater Sources for the Koolanooka and Blue Hills Project

Potential groundwater supplies were investigated by Rockwater (Rockwater 2004, 2006a) at both Koolanooka and Blue Hills. Five areas within the Koolanooka Project area were investigated. They included:

- Koolanooka Springs Road
- Koolanooka Pit
- Magazine Area
- Fault Zone
- Along Strike North of the Pit

None were shown to be able to supply water of a quantity required by the project. Four exploration bores drilled at Blue hills also failed to find a water source sufficient in quantity for this part of the project either.

2.3 Regional Context

Currently there is very little published or unpublished data concerning stygofauna in the Interim Biogeographic Regionalisation for Australia (IBRA) Yalgoo and Avon Wheatbelt (AW1) regions (CALM 2002). Recently however, to gain approval for the Mt Gibson Iron Ore and Infrastructure Project (~120km E/SE of Koolanooka), Mt Gibson Iron Ore committed to developing a Subterranean Fauna Management[8] Plan in relation to pit dewatering. Further, they have also committed to undertaking stygofauna sampling should additional water be required from either fractured rock aquifers or from palaeochannel aquifers in the area. Thus, although no data is available it can only be assumed that stygofauna are present in the range. This data will be sought from Mount Gibson Iron ore in the event that stygofauna are recorded at either Koolanooka or Blue Hills.

In the nearby Murchison region (western draining division) there are also a number of records that can be referred to. For example stygofauna are known from calcrete formations at Cue and the Big Bell minesite (Humphreys 2001). These include at least three genera and over 18 species of Dytiscid diving beetle (including one from Big Bell, *Nirridessus bigbellensis*, and two from Cue, *Tjirtudessus magnificus* and *Nirridessus cueensis*), a species of *Haloniscus* Isopod (aquatic slaters) an Ostracod (seed shrimps) Bathynellid Amphipods, Copepods and Oligochaetes (aquatic worms) (Humphreys 2001). Moving

further east, to the eastern draining section of the Murchison Region, far more calcretes, many associated with palaeochannels, have recorded many unique communities of stygofauna (e.g. at Paroo, Lake Violet, Lake Way, Hinkler Well and Windarra) (Humphreys 2001). However, stygofauna are not confined to calcrete aquifers and indeed have been recorded from many different geologies in Western Australia.

The regional summary of the different IBRA regions (CALM 2002), makes no mention of stygofauna in either the Yalgoo or Avon Wheatbelt (AW1) regions, in which the Blue Hills and Koolanooka project areas lie, respectively. However, in the Gascoyne regional summary, stygofauna are mentioned in reference to threats to habitats (calcretes) and also in terms of their knowledge, which is considered a major data gap for the Department of Environment and Conservation (formally CALM). Given the close proximity of the Koolanooka project to the Gascoyne Sub-Region boundary and in light of the ever increasing known distribution of stygofauna in the state, it is only reasonable to assume that there is a high chance of stygofauna being present in the Koolanooka or Blue Hills areas, should aquifers of a suitable porosity and salinity be identified.

2.4 STYGOFAUNA POTENTIALLY OCCURING IN STUDY AREA

All five groundwater explorations areas in the Koolanooka area recorded negligible to small groundwater yields of fresh to marginal quality. The salt content of the water obtained was certainly of a concentration suitable for stygofauna (EC < 60,000µs/cm), however the large proportion of clay, in conjunction with unfractured orthoquartzite and chert, which act to minimise the porosity of the underlying sediment, suggests that the chances of recording stygofauna in these areas is low.

Potential groundwater sources at Blue Hills were also investigated (Rockwater 2004, 2006a) and no suitable supplies were found. Again the salt content was suitable for stygofauna harbourage, but the large proportion of clays which restricts the porosity of the sediments, suggests that stygofauna are unlikely to be present in the areas investigated at Blue Hills so far.

Stygofauna have now been found in a range of very different geologies. These include (but are not limited to) calcretes aquifers associated with palaeochannels, haematite sandstone aquifers (e.g. Koolan Island), clay-sandstone aquifers on the Swan and Scott Coastal Plains (*ecologia* 1998, 2006a, b; Humphreys 2001; Rockwater 2006b), and porous aquifers, fractured-rock aquifers, springs and hyporheic habitats (Eberhard9*et al.* 2005). Recent experience west of Lake Way near Wiluna, has shown that palaeochannel aquifers with an EC of 60,000us/cm can harbour diverse and abundant stygal assemblages (ecologia 2006a).

3.0 SURVEY METHODS

3.1 SAMPLING METHODS

Four bores from a total of seven at Koolanooka Borefield described by Rockwater (2006) were sampled during this survey program. A description of the sampled bores is presented below in Table 3.1. Three of the original seven bores were not capped, so were not sampled.

Table 3.1 Summary of Koolanooka Bore Census Data (Table adapted from Rockwater 2006)

Bore	MGA Zone 50		Drilled Depth (mbgl)	Water Level (mbgl)	EC (µS/cm @ 25°C)	TDS (mg/L by EC)	pH
	Easting (m)	Northing (m)					
BH1	421860	6773756	54	20.43	1729	951	7.43
BH2	421853	6772729	42	21.00	1464	805	7.68
BH3	421822	6772620	48	22.50	1239	681	7.78
BH7	422119	6772917	54	14.97	2540	1397	7.37

Notes: KB= Koolanooka Borefield, mgbl= metres below ground level

Sampling of bores took place in three stages:

1. The physical parameters of the bore were described:
    - bore location, using a Global Positioning System (GPS);
    - the construction material of each bore (e.g. PVC, steel); and
    - the bore diameter (mm)
2. Water chemistry measurements were gathered using a 90 FL multi-parameter meter. The standing water level of each bore was obtained using a Solinst water level meter. All water samples for measurement were obtained using sterile one-use bailers.

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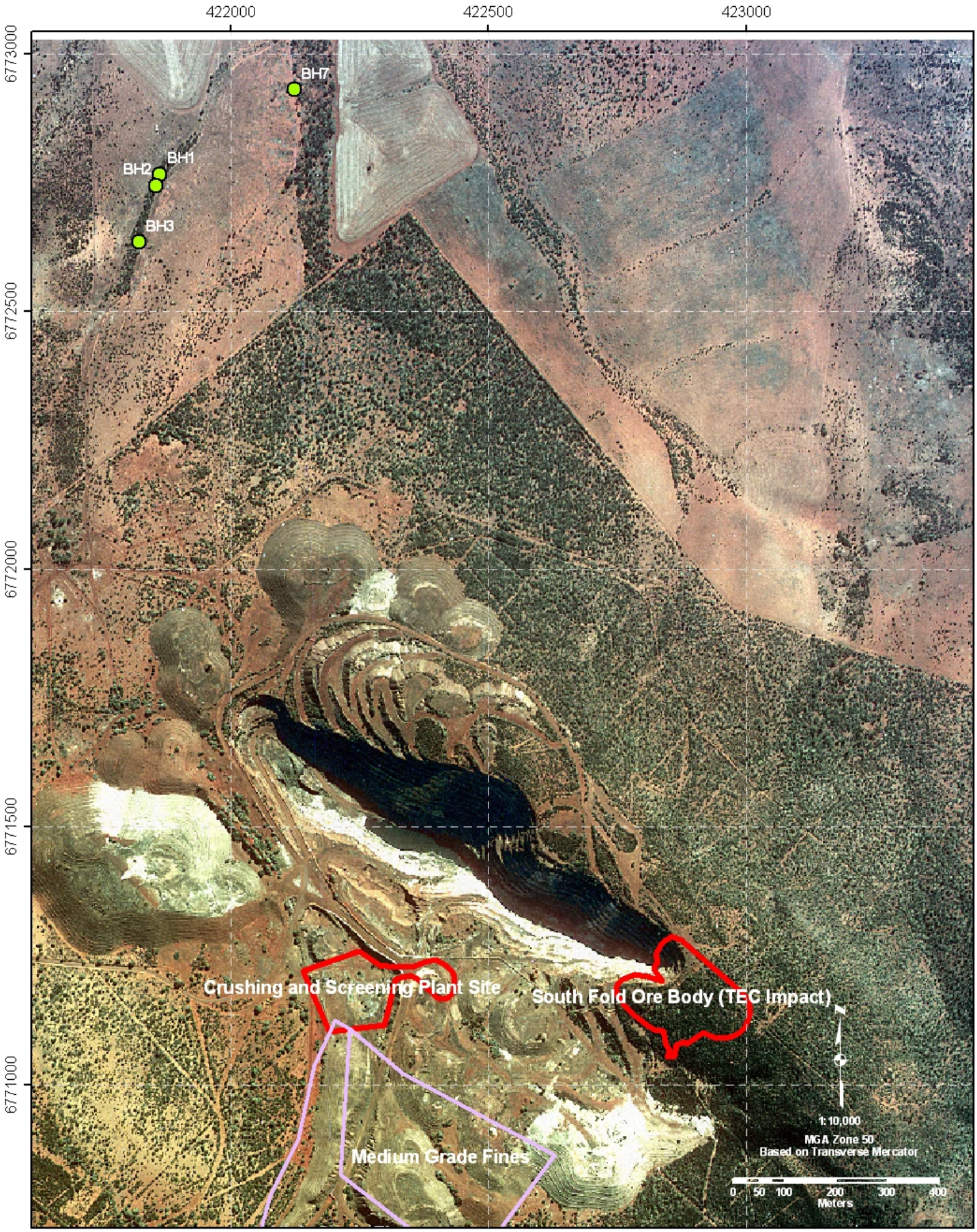
    The following parameters were measured in each of the bores from samples taken from approximately 30cm below the standing water level:
    - Water temperature [°C];
    - pH;
    - Conductivity [mS/cm];
    - Total Dissolved Salts (TDS) [ppK];
    - Oxygen Reduction Potential (ORP) [mV]; and
    - Dissolved Oxygen (DO) [ppM and % Saturation];
3. Stygofauna sampling followed those methods recommended by the Department of Environment and Conservation (DEC). The entire water column was dragged for

stygofauna a total of six times; three times using a 150 µm net was and a further three times using a 50 µm net. The specific methods were as following:

- an appropriate net diameter was chosen (most commonly 47 mm);
- the net was slowly lowered into the bore until it hit the bottom. Care was taken not to let the net free fall;
- once the net had reached the bottom of the bore, it was gently raised and lowered approximately 1 m, six times, to stir up the sediments at the bottom;
- the net was then slowly pulled up through the water column (<1 m/sec) in order to reduce the chance of animals avoiding capture by riding the bow wave at the top of the net;
- once the net was at the surface, it was immediately placed in a 50 µm Endicott sieve. The vial was removed from the net and all contents washed into the sieve using deionised water. The net was thoroughly rinsed over the sieve;
- the sieve contents were then washed into one corner and transferred into 120 mL preservation vials using absolute ethanol (100%);
- each vial was labelled with the date and bore name;
- after dragging the water column six times, all equipment was placed into a 25 L tub containing Decon90® for sterilisation to prevent cross-contamination of sites; and
- stygofauna samples were kept on ice in the field and in a dark location before transportation to Perth; once in Perth, they were stored out of direct sunlight. Sample sorting was completed by Magdalena Zofkova at *ecologia's* Perth laboratory.



ecologia ENVIRONMENT	Legend: Stygofauna; Fines; Disturbance Areas	Midwest Corporation Limited	Koolanooka Borefield Sampling Locations	Date: 2/5/2007
Author: BSM		Project: Koolanooka Stygofauna		Scale: 1:10,000
				Figure 3.1
				Project ID: 788

3.2 CURATION AND SPECIES IDENTIFICATION

All specimens were immediately placed in 100% absolute ethanol to enable genetic analysis if deemed necessary. All vials were labelled with the date, site, GPS coordinates, the name of the collector and the size of mesh aperture used to collect the animals. These details were written on the outside of the container and on waterproof paper placed in each vial.

All samples were processed by *ecologia* scientists at their Perth laboratory. Collected specimens are usually identified to the lowest taxonomic resolution possible by *ecologia* scientists. Subsequent identification and verification is often conducted by Dr Brenton Knott and Dr Danny Tang at the University of Western Australia.

3.3 IMPACT RISK ASSESSMENT

A risk assessment is normally undertaken to determine potential impacts arising from the development on stygofauna and the residual impacts following the implementation of management strategies identified in this document. Significance of the risks is classified as either "High" (site/issue specific management programmes required, advice/approval from regulators required), "Medium" (specific management and procedures must be specified) or "Low" (managed by routine procedures). However, as no stygofauna species or communities were recorded, from the bores sampled at Koolanooka borefield, a risk assessment has not been undertaken.

3.4 SURVEY TEAM

Name	Qualifications	Position
Jarrad D. Clark	BSc.(Environmental Management)	Project Manager / Senior Environmental Biologist
Magdalena Zofkova	PhD (Zoology)	Invertebrate Zoologist
Melissa White	BSc. (Mar. Biol/Zool) Hons	Environmental Biologist

4.0 STATUTORY FRAMEWORK

Fauna species that have been formally recognised as rare, threatened with extinction, or as having high conservation value are protected by law under Commonwealth and State legislation. At the national level, fauna are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Within WA, rare fauna are listed under the *Western Australian Wildlife Conservation Act 1950: Wildlife Conservation (Specially Protected Fauna) Notice 2005*. International Agreements include the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA).

Schedule 1 of the Commonwealth EPBC Act contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the wild and Conservation Dependent. Definitions of categories relevant to fauna occurring or potentially occurring in the project area are provided in Table 4.1.

Table 4.1 Definitions of relevant categories under the EPBC Act.

CATEGORY	DEFINITION
Endangered (EN)	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable (VU)	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Migratory (M)	Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention ((Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a range state; • The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA); or • The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA).

Classification of rare and endangered fauna under the WA Wildlife Conservation (Specially Protected Fauna) Notice 2005 of the *Wildlife Conservation Act 1950* recognises four distinct schedules, as listed in Table 4.2 below. In addition, the Department of Conservation and Land Management (CALM) maintains a Priority Fauna list which includes those removed from the Wildlife Conservation Act and other species known from only a few populations or in need of monitoring. Five Priority Codes are recognised, as detailed in Table 4.3.

Table 4.2 Definition of Schedules under the Wildlife Conservation Act 1950

SCHEDULE	DEFINITION
Schedule 1 (S1)	Fauna which are Rare or likely to become extinct, are declared to be fauna that is in need of special protection.
Schedule 2 (S2)	Fauna which are presumed to be extinct are declared to be fauna that is in need of special protection.
Schedule 3 (S3)	Birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction are declared to be fauna that are in need of special protection.
Schedule 4 (S4)	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned above.

Table 4.3 Definition of CALM Priority Codes

PRIORITY	DEFINITION
Priority One (P1)	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 Two (P2)	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 Three (P3)	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 Four (P4)	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 if present circumstances change. These taxa are usually represented on conservation lands.
Priority Five (P5)	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.

5.0 RESULTS

5.1 Biological

Sampling was conducted at four bores within the Koolanooka Borefield, with two samples taken from each bore (28th of February and 21st of April 2007). This preliminary survey effort yielded no stygofauna specimens. As stygofauna sampling has never been conducted at Koolanooka, Blue Hills or indeed nearby localities, it is unknown whether these results are typical for the area.

5.2 Water Chemistry

Six physico-chemical parameters (Temperature, pH, Conductivity, Total Dissolved Solids, Oxidation Reduction Potential and Dissolved Oxygen) were measured in the field from water bailed out of each of the four bores. The data is presented in Table 5.1. Stygofauna can be very sensitive to changes in their habitat (Masciopinto *et al.* 2006) and the physico-chemical features of groundwater habitats can be a limiting factor for them (Hahn 2006).

Water temperature is one of the most important water quality parameters as it can impact both water quality and the functions of any organisms present in it (Oberlin and Blinn 1997). The average water temperature recorded in the bores was 25.53 °C.

Dissolved oxygen (DO) is can directly impact an organisms reproduction, incubation and survival (Malard and Hervant 1999). The DO concentration of the four Koolanooka bores was typical of groundwaters throughout western Australia and elsewhere, where no photosynthetic plants are available to supply oxygen to the system.

Water pH can have a significant influence in determining invertebrate community structure (Rosemond *et al.* 1992). At the extreme end of the scale (4.0 or 13.0) physical damage to an organism can occur, however, the pH of the water sampled at the Koolanooka bores ranged between a very neutral 6.28-6.73.

Table 5.1 Summary of Koolanooka bores average water chemistry data

Bore	Total Depth (m)	Water level depth (m)	Oxygen Levels (ppm)	Conductivity (µS)	TDS (ppM)	pH	Electric Potential (mV)	Temperature (°C)
BH1	54	20.80	1.43	2158	1244	6.28	40	25.3
BH2	42	19.99	1.5	2030	1160	6.59	-94	25.3
BH3	48	22.22	3.52	1742	991	6.73	8	25.3
BH7	45	14.71	1.77	4000	2360	6.73	99	26.2
Mean	**47.25**	**19.25**	**2.055**	**2482.5**	**1438.75**	**6.59**	**13.25**	**25.53**
Standard deviation (±)	**2.56**	**1.60**	**0.49**	**513.26**	**311.56**	**0.11**	**40.41**	**0.23**

Note: Samples collected 27th February 2007.

6.0 DISCUSSION

Stygofauna species, communities and their habitats are generally threatened by two direct processes related to proposed or existing mining activities. Stygofauna may also be impacted upon via indirect pathways such as hydrocarbon or nutrient contamination, or via changes to aquifer dynamics due to the sealing of the ground above.

Firstly, stygofauna habitat may be impact upon by borefield operations which provide water for ore processing or potable supplies, or both. Where borefield operations drawdown the groundwater to below the geological unit supporting stygofauna, those species dwelling within may be lost.

Secondly, dewatering to allow pits to be safely dug and expanded may also act in the same way, to drawdown groundwater levels to below the geological unit supporting the species or communities.

No stygofauna species or communities were recorded during sampling of the Koolanooka borefield and therefore none of the above impact/disturbance pathways are considered likely to occur.

However, as stated above, this borefield is unlikely to be able to meet the total supply required in coming years at Koolanooka and Blue Hills and therefore additional stygofauna sampling is likely to be required when groundwater exploration activities identify a suitable water source for ore processing and potable supplies

7.0 MANAGEMENT RECOMMENDATIONS

As no stygofauna specimens were collected during the Koolanooka Blue Hills DSO Project stygofauna sampling program, conducted at Koolanooka borefield, water abstraction activities related to exploration and proposed mining activities will not impact any stygofauna species or communities. Additionally, specific management recommendations to ensure the survival of stygofauna communities are not necessary.

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