



Golden Stallion Resources

Minjar Project

Stygofauna Pilot Study

September 2009

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Stygofauna Pilot Study, Minjar Project

Distribution:

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Document Control for Job Number: GMJ-SY-0709

Document Status	Author	Reviewer	Signature	Date of Issue
Final Report	Erin Thomas	Veronica Campagna	VC	7/09/09
		David Jasper	DJ	4/09/09

Executive Summary

In March 2009, Golden Stallion Resources (GSR) acquired Minjar with a sole focus on gold production. The Minjar Project is located 400 km north north-east of Perth with tenements that cover an area of 1,457 km^2 with additional rights over 403 km^2 of the prospective Yalgoo-Singleton Greenstone Belt (YSGB). The Minjar Project is considered highly prospective for gold, base metals, nickel, tungsten-molybdenum and iron-ore and the company is currently concentrating on existing low strip ratio resources with close proximity, or easy access to, the processing plant.

The Yilgarn region of Western Australia is considered to be a stygofauna hotspot by world standards. Reflecting this, the Environmental Protection Authority in Western Australia, has highlighted that stygofauna species may be threatened by a mining proposal where significant aquifer drawdown causes loss or reduction of habitat, or where there is contamination of the groundwater from project-related activities. To ensure adequate protection the proponent must demonstrate that, if stygofauna are present, they will not be placed at risk. For projects approved prior to the requirement of subterranean surveys, an expansion or changes to approved design require an assessment of risk.

With the proposed cut-back of several pits in the Minjar Project, a desktop study was conducted to assess the likelihood of stygofauna in the Project Area. Given the location of the project within the Murchison Province of the Yilgarn, a small pilot survey was also performed to identify the presence of stygofauna. Five bores and a pastoral well were sampled in July 2009, targeting the fractured rock aquifer associated with the ore body, and a shallow perched alluvial aquifer. Sampling followed the procedures set out in the EPA Guidance Statement 54A.

From the six sites, four bores yielded low numbers of invertebrates. Stygofauna taxa were only found in Minjar Bore, which intersected the perched alluvial aquifer. The deeper, fractured rock aquifer that would be dewatered with the pit expansion did not yield any stygofauna. These findings were found to be consistent with the few surveys previously conducted in the area. Taxa were typical for the region, consisting of syncarids, oligochaetes and copepods. All these stygal groups have been shown in other studies to prefer alluvial aquifers and have dispersal capabilities.

Previous hydrogeological studies found the alluvial aquifer was underlain by an impermeable clayey oxide subcrop and connection between the fractured rock aquifer and alluvial aquifer was unlikely. While stygofauna were identified within the Minjar Project Area, diversity and abundance were comparatively low compared to the calcrete and alluvial aquifers in the northern Yilgarn. Stygofauna were not present in the fractured rock aquifer that would be dewatered. As impact to the alluvial aquifer was considered negligible the risk to the stygofauna within the Minjar Project Area was considered to be very low to nil.

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1. INTRODUCTION

1.1 Project background

The Minjar Project is located 400 km north north-east of Perth. The project tenements cover an area of 1,457 km^2 with additional rights over 403 km^2 of the prospective Yalgoo-Singleton Greenstone Belt (YSGB). Also located within the YSGB are the Gossan Hill and Scuddles base metal deposits at Golden Grove and the Mt Gibson gold project. The Minjar Project is considered highly prospective for gold, base metals, nickel, tungsten-molybdenum and iron-ore.

Gindalbie Metals Ltd (formerly Gindalbie Gold NL) commenced gold production at Minjar in 2001. Over 122,000 ounces of gold and 105,000 ounces of silver were produced from open pits between 2001 and the cessation of operations in June 2004. The project was subsequently purchased by Monarch Gold in 2006. Golden Stallion Resources (GSR) acquired Minjar in March 2009 with a sole focus on gold production. The company is currently concentrating on existing low strip ratio resources with close proximity, or easy access to, the processing plant (Golden Stallion Resources 2009).

1.2 Physical environment

The climate is classified as arid to semi-arid warm Mediterranean; winters are mild, while the summers are hot and dry. Rainfall is low (mean annual rainfall of 200 - 250 mm (Pringle *et al.* 1994) and moderately variable, with patchy and irregular distribution. Most of the rainfall occurs in the winter months (62% of median annual rainfall), though irregular summer rainfall may occur. Depressions that are remnants of tropical summer cyclones bring summer downpours which may be locally restricted (Markey and Dillon 2008).

The Minjar Project is located within the Yalgoo IBRA subregion (Desmond and Chant 2002) which is nested within the Austin Botanical District of the Eremean Botanical Province (Beard 1990). Generally the vegetation communities consist of low mulga (*Acacia aneura*) woodlands on the sandy plains, *Acacia* scrublands on the hills and ranges and low hills with eucalypt or *Acacia* woodlands with halophytic understorey (Markey and Dillon 2008). Shifts in vegetation communities are strongly associated with changes in the topography and local geology.

The Yalgoo subregion lies within the Murchison Province (Bettenay 1983) and consists of an extensive plateau of low relief. The greenstone belts contain rounded low hills and rocky ridges with occasional lateritic breakaways and broad stony slopes, with some rugged ranges formed over the greenstone. While sandplains are not associated with the greenstone, hardpan wash plains and stony plains are commonly found downslope from the hills, comprised of very gently inclined alluvial surfaces that carry sheet flows (Tille 2006).

1.3 Geology

The Minjar Project tenements cover approximately 70% of the YSGB in the Southern Murchison Province of the Archaean Yilgarn Block of Western Australia. The YSGB extends 190 km in a north north-west direction from Mt Gibson in the south, to approximately 30 km north of Yalgoo. It comprises a typical Archaean supracrustal greenstone sequence of mafic and felsic volcanic rocks with associated sediments and intrusive mafic and ultramafic rocks (Golden Stallion Resources 2009) (**Figure 1**).

The supracrustral rocks of the greenstone sequences are divided into two groups; the Luke Creek Group and the overlying Mount Farmer Group (Watkins and Hickman 1990). The majority of the greenstone rocks in the Minjar area belong to the Gabanintha and Windaning formations of the Luke Creek Group. The Gabanintha formation consists of a bimodal succession of mafic and ultramafic rocks, felsic volcanic and volcanoclastic rocks, sediments and basalt. The overlying Windaning formation is the uppermost formation in the Luke Creek Group and comprises abundant banded iron formation (BIF) interlayered with felsic volcanics and volcanoclastic rocks and basalts (Golden Stallion Resources 2009).

The Mount Farmer Group overlies the Luke Creek Group and in the Minjar area, is predominantly represented by the Mougooderra Formation. The formation consists of epiclastic sediments confined to a shear-bounded basin extending along the length of the greenstone belt. The western margin of the Mougooderra sediments is formed by the Mougooderra Shear while the Chulaar Shear represents the eastern margin (Golden Stallion Resources 2009).

The Mougooderra Shear is considered to be the main structure controlling gold mineralisation in the area. It extends for 45 km through the primary Minjar tenement block, hosting substantial gold mineralisation over approximately 25 km. Deposits on this shear structure include Austin, Eastern Creek, Monaco, Bugeye, Phillip Island, M1 and Silverstone (Golden Stallion Resources 2009) (**Figure 2**).

1.4 Hydrogeology

Earlier studies by Coffey Geosciences (2000) found two major water yielding zones: the ore zone, dipping to the west and a zone extending across the footwall and hanging wall sequences, near the base of the rock weathering profile. Another aquifer was found perching on the clayey oxide subcrop (alluvial aquifer). The low permeability of the clayey soils underlying this aquifer indicated that hydraulic connection between the two was unlikely.

This lack of connectivity is supported by other studies in the mid-west region. For example, modelling for the Greater Karara Iron Ore Project (south of Minjar) suggests that the fractured rock aquifers associated with the Karara and Mungada Ridge BIF ranges have little to no hydraulic connectivity with the surrounding shallow alluvial aquifers (Ecologia Environment 2008a).

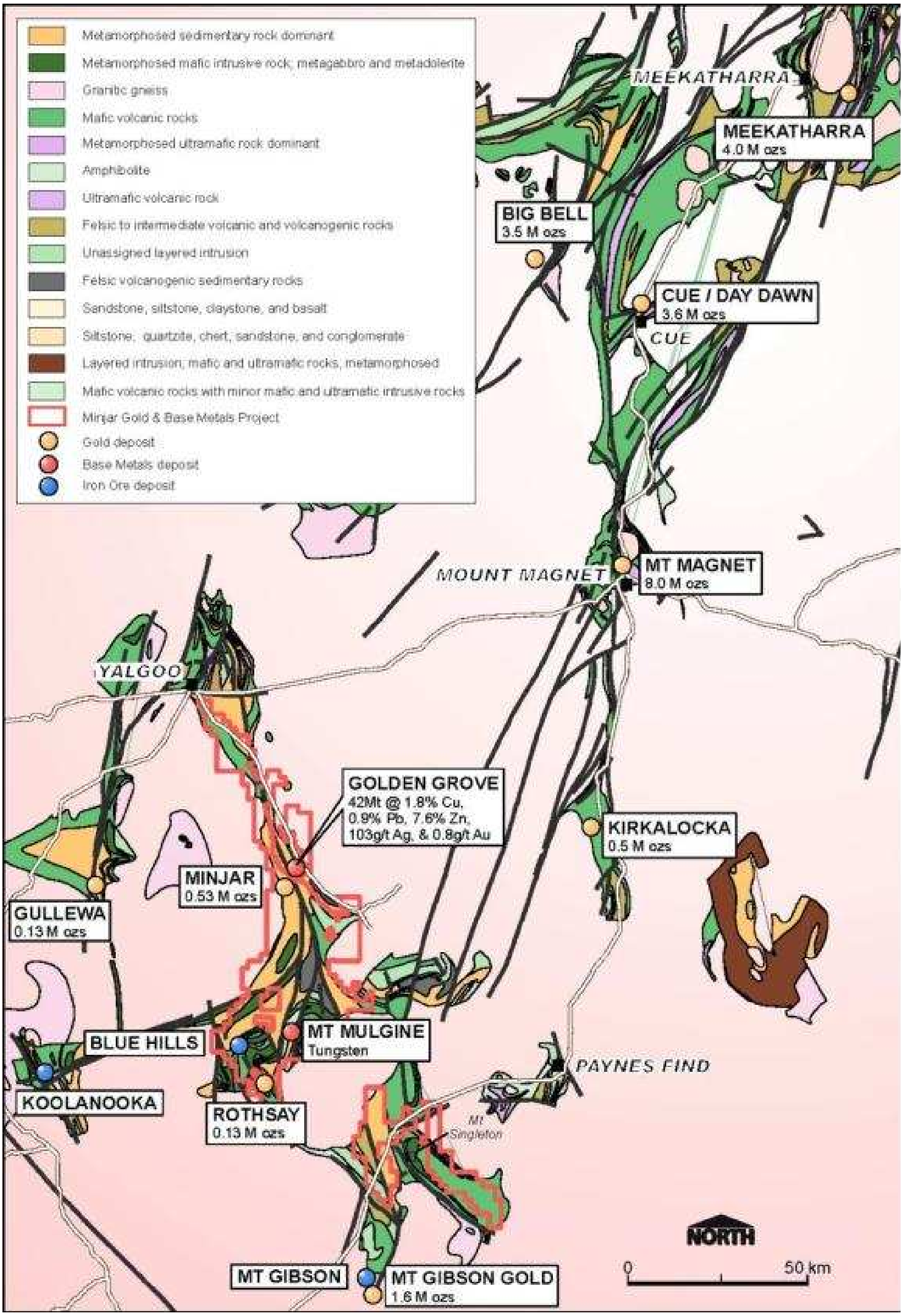

Figure 1: Murchison Province regional geology (Map courtesy of Golden Stallion Resources).

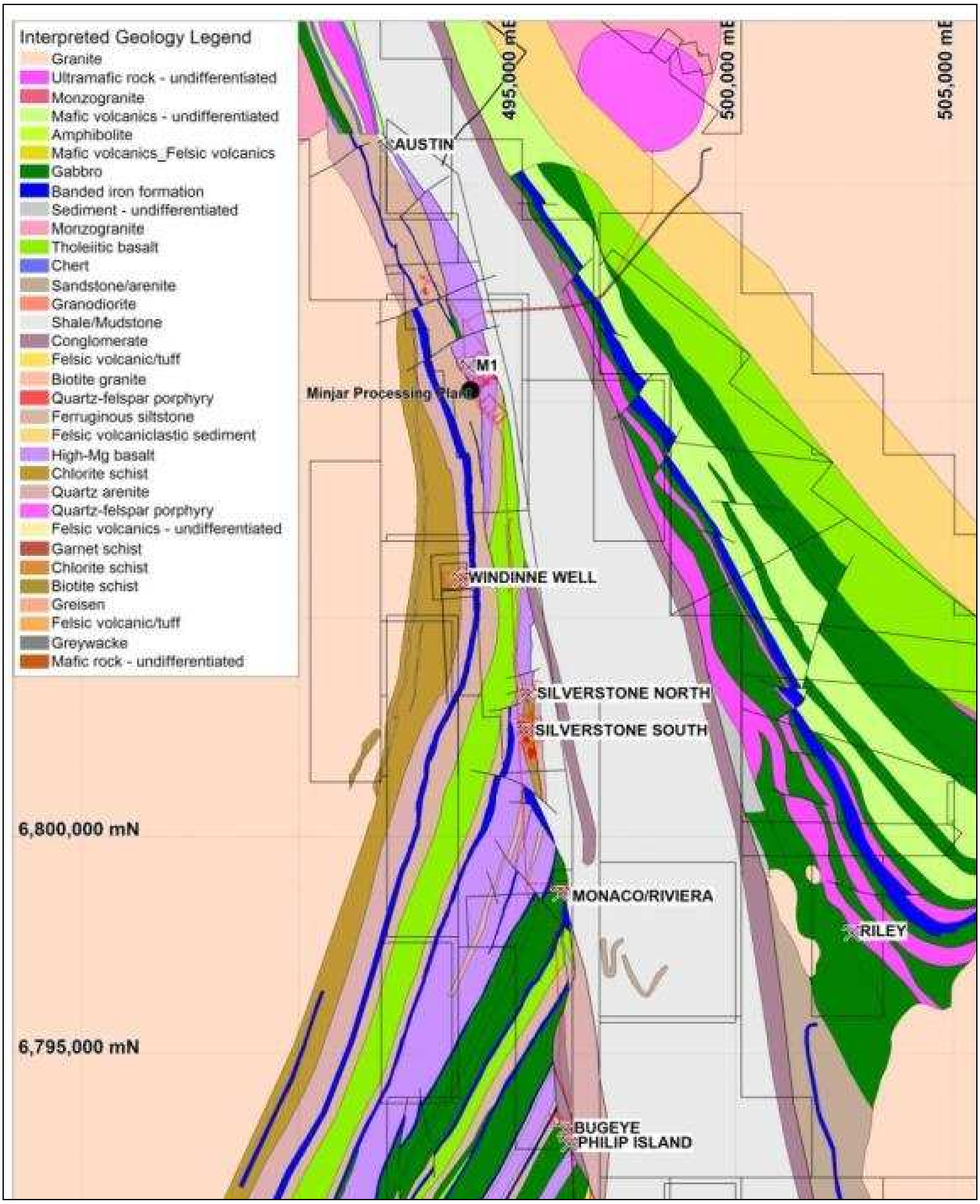

Figure 2: Minjar Project - North, interpreted geology with tenements in black and mine infrastructure in red (map courtesy of Golden Stallion Resources).

1.5 Stygofauna

Stygofauna are fauna that inhabit subterranean waters. These animals can be further divided according to their level of dependency on the subterranean environment. Animals that occur in groundwaters accidentally are referred to as stygoxenes while those that inhabit groundwaters on a permanent or temporary basis are called stygophiles. It is only animals that are obligate subterranean dwellers that are termed stygobites (Humphreys 2008). They display characteristics typical of a subterranean existence which include: a reduction or absence of pigmentation, absence or reduction of eyes, and the presence of extended locomotory and sensory appendages (Humphreys 2008).

Stygofauna occur in all types of aquifers that have voids of suitable size for a species' biological requirements, and include karst, fractured rock, calcretes, pisolites and alluvial aquifers (Humphreys 2009). Their distributions are primarily affected by hydrological stability, groundwater quality, available energy sources, dispersal routes and habitat space (Strayer 1994). The lack of abundant and/or stronger competitors and predators has also been identified as contributing to high stygobitic diversity (Humphreys 2009).

1.6 Stygofauna in the Murchison

Recent studies have shown that the arid and semi-arid zones of Western Australia contain stygofaunal communities in calcretes and alluvial aquifers that are rich by global standards on stygofauna (EPA 2003). The Pilbara, and to a lesser extent the Yilgarn, stand out as global hotspots for stygofauna diversity (EPA 2007). The Murchison region contain more species of subterranean beetles, many restricted to single calcrete aquifers, than are known from anywhere else in the world (Watts and Humphreys 2006). Diversity is also high for stygal amphipods (Cho *et al.* 2006) and copepods (Karanovic 2004) which inhabit the alluvial aquifers associated with the palaeorivers of the northern Yilgarn. While regionally endemic, they have a greater distribution than those stygal species found in the calcrete aquifers.

To date, few stygofauna surveys of the Yalgoo subregion have been conducted, compared to the numerous studies in the northern Goldfields, and are limited to environmental impact assessments for mining companies. A study for the Greater Karara Iron Ore Project, south of Minjar, identified several stygal groups, including syncarids, ostracods, copepods and oligochaetes. The stygofauna were collected from pastoral bores and wells which intersected the unconfined alluvial aquifers while the BIF aquifers failed to yield any stygofauna (Ecologia Environment 2008a).

A two phase stygofauna survey of the Koolanooka Project Area, east of Morawa in the Avon Wheat belt 1 subregion collected only two specimens of the stygobitic copepod *Microcyclops*. While one specimen was collected within the project area, the second was collected from a regional well approximately 70 km away from the project area (Ecologia Environment 2008b). Desktop studies of the Karara area by Biota (2007) suggested the area did not contain significant stygofauna habitats with the majority of the groundwater located in fractured rock aquifers.

1.7 Relevant legislation

Stygofauna are protected under the same legislation as that of terrestrial fauna, and are governed under three acts:

1. Wildlife Conservation Act (1950-1979) (WA) (WCA),
2. Environmental Protection Act (1986) (WA) (EP Act), and
3. Environment Protection and Biodiversity Conservation Act (1999) (Cth) (EPBC Act).

The Wildlife Conservation Act 1950 – 1979 provides protection for all native fauna species, and is administered by the DEC. Special provision is provided for fauna that are considered rare, threatened with extinction or of high conservation value. This includes some species of subterranean biota, which are currently considered to be Schedule 1 taxa (rare or likely to become extinct).

The Environmental Protection Act (1986) is administered by the Environmental Protection Authority (EPA) and includes guidelines for reviewing the aspects of proposals that might significantly impact environmental factors. Any operation that has the potential to significantly impact stygofauna habitat may be subject to formal Environmental Impact Assessment (EIA) under the EP Act. Guidance Statement No. 54A (EPA 2007) provides specific assessment and management requirements for subterranean fauna.

The Environment Protection and Biodiversity Conservation Act (1999) is administered by the Commonwealth Department of Environment, Water, Heritage and the Arts, to regulate protection of matters of national environmental significance. Any action (including projects, developments, undertakings, activity or series of activities) that is likely to have a significant impact on any matter included in Part 3 of the Act, must be referred to the Minister for decisions on whether the proposed action triggers the EPBC Act and requires assessment and approval under the Act. To date, the EPBC Act list of threatened fauna does not contain any invertebrate stygofauna.

1.8 Potential impacts of mining and scope of studies

According to the Draft EPA Guidance Statement No. 54A (EPA 2007) stygofauna species may be threatened by a proposal where significant aquifer drawdown causes loss or reduction of habitat, or where there is contamination of the groundwater from project-related activities. This Guidance Statement was prepared to assist mining companies in assessing if stygofauna surveys will be required as part of an EIA and thereby show whether or not a proposal is likely to pose a threat to the subterranean fauna.

In areas of low prospectivity a desktop assessment of the area can be used to demonstrate the project area is unlikely to have any significant value for subterranean fauna. In this assessment the characteristics of the subterranean fauna of the region (based on existing sampling results), geological, hydrogeological and other information suggesting the local habitat is unsuitable for stygofauna, and ways in which the local subterranean fauna population is likely to differ from the regional characteristics are to be addressed. In cases where the likelihood of stygofauna is low but a desktop survey does not provide convincing evidence a pilot study can be conducted to support this position.

1.9 Scope and objectives

The objective of this study was to determine the likelihood of stygofauna within the Minjar Project area and identify if there will be any risk to the stygofauna community, if present, from the proposal. To address this objective a desktop study was performed which included the collation of all available data on the geology and hydrogeology of the project and a literature review on the stygofauna of the region. Given the location of the project within the Yilgarn region, a pilot study was also performed to confirm the presence or absence of stygofauna in the groundwater of the project area.

2. METHODS

2.1 Sample sites

Six sampling sites were selected based on the availability of suitable bores or wells for sampling stygofauna. Selected bores met the requirements for stygofauna sampling as stated in the GS 54A and intersected the aquifer that would be impacted by the proposal. Two deposits were sampled; M1 and Silverstone, as well as sites outside the area of impact (**Figure 2**).

2.2 Groundwater quality

Basic groundwater physicochemical data was collected from each of the sampling sites and consisted of: pH, salinity, temperature and dissolved oxygen, as stated in EPA GS 54A. The standing water level (SWL) was measured using a Solinst 101 water level meter. Groundwater was then collected just below the SWL by lowering a disposable clear PVC bailer (42 mm x 900 mm) using a winch. A calibrated TPS 90 FLMV multi-parameter field instrument was used to measure the pH, temperature (temp), salinity as electrical conductivity (EC), and dissolved oxygen (DO) of the retrieved groundwater.

2.3 Stygofauna sampling

Sampling was consistent with the procedures outlined in the EPA Draft Guidance Statement No. 54a (EPA 2007). Haul nets which have been found to be the most efficient retrieval method (Allford *et al.* 2008) were used during the survey. The sampling method was as follows:

- Samples were collected using two weighted nets with mesh sizes of 150 µm and 50 µm. Each net was fitted with a glass vial with a base mesh of 50 µm.
- The 150 µm net was lowered first to near the bottom of the hole.
- Once at the bottom the net was gently raised up and down three times to agitate the bottom sediments.
- The net was then raised slowly to minimise the ‘bow wave’ effect that may result in the loss of specimens, filtering the stygofauna from the water column on retrieval.
- Once retrieved the collection vial was removed and all the contents emptied into a 120 ml polycarbonate vial and preserved with 100% undenatured ethanol in the field. Undenatured ethanol was used to allow for later allozyme electrophoresis and mitochondrial DNA sequencing, if required.
- This process was repeated up to ten times.
- The same procedure was then repeated using the 50 µm net.
- To prevent cross-contamination between sites, all sampling equipment was washed thoroughly with Decon 90 (detergent) and then rinsed with distilled water after sampling each drill hole.
- Samples were returned to Outback Ecology’s laboratory in Perth.

A Licence to Take Fauna for Scientific Purposes, Wildlife Conservation Act 1950, Regulation 17, was obtained from the DEC (Lic. No. SF006983). The report accompanying the licence has been submitted to the DEC. The field survey was undertaken by Dr Fiona Taukulis and Dr Erin Thomas, from Outback Ecology (Outback Ecology).

2.4 Identification of stygofauna

Preserved samples were sorted manually using a Leica MZ6 stereomicroscope following elutriation of the samples to separate larger sediment particles. Samples were sieved into fractions using 250, 90 and 53 µm mesh sizes, to improve sorting efficiency. Samples were sorted by Kimberley Moiler and basic identifications were undertaken by Kimberley Moiler, Dr Erin Thomas and Dr Nihara Gunawardene of Outback Ecology.

3. SAMPLING SITES

Five bores and one well were sampled during July 2009 and included bores WB1 and WB2 adjacent to the Silverstone Pit; WB3 and WB6 located adjacent to M1 Pit; and Metters Well and Minjar Bore, located outside the pit area (**Figure 3**). A description of each of the sites is presented in **Plate 1** and **Plate 2**. Photographs of the Silverstone and M1 Pits highlighting the geology of the area have been presented in **Plate 3**. Bore details are shown in **Table 1**.

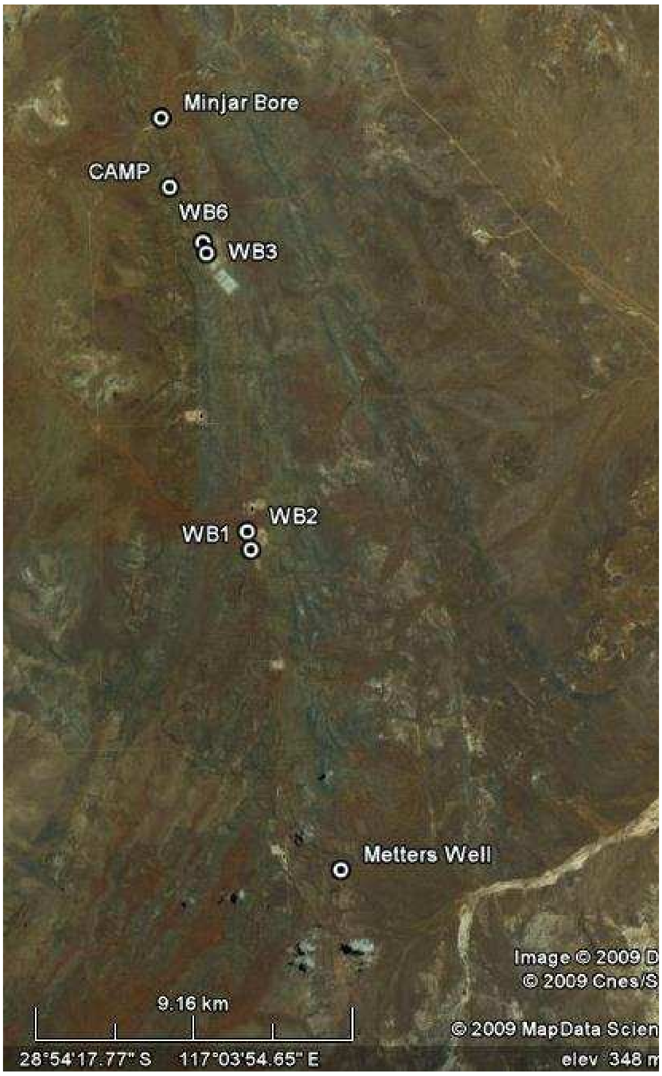

Figure 3: Location of the sampling bores within the Minjar Project Area. (Base map sourced from Google Earth)

WB1
Site description: Located at southern end of Silverstone Pit. Mulga scrub. Rabbit/goat scats are abundant. Major earthworks in area include pits, tracks and excavation.
Bore description: Rock capped production bore with steel collar.
Geology: Red sands, some calcrete at surface, 1 m caprock, 1.5 m topsoil, 12 m transported cover, white sediments and purple felsics. Gold shear not as obvious as M1 Pit. End of hole (EoH) should be approximately 80-90 m (same as WB2) however is approx. 61m. Possible siltation/sedimentation.

WB2
Site description: Northern end of Silverstone Pit. The site is located opposite pit lookout. Earthworks in area include pit, exploration and tracks. Mulga scrub.
Bore description: Brick capped production bore with steel collar.
Geology: Red sands, some calcrete at surface, 1 m caprock, 1.5 m topsoil, 12 m transported cover, white sediments and purple felsics. EoH deeper than WB1, white sediments at base of hole.

WB3
Site description: Southern end of M1 Pit – close to monitoring bores. Substantial earthworks in area from previous mining. Elevated compared to WB6. Mulga scrub.
Bore description: Steel capped production bore with concrete collar.
Geology: Red sands with gravel at surface, 1 m caprock, 1.5 m topsoil, 12 m transported cover, white sediments and purple felsics. Black shale at base of hole, anoxic, strong organic smell.

Plate 1: Sampling sites a) Bore WB1 (Silverstone Pit), b) WB2 (Silverstone Pit), c) WB3 (M1 Pit).

WB6
Site description: Northern edge of M1 Pit. Mulga scrub.
Bore description: Steel capped production bore with concrete collar.
Geology: Red sands with gravel at surface, 1 m caprock, 1.5 m topsoil and 12 m transported cover, white sediments and purple felsics. Black shale (sediments) at base of hole. Depth to end of hole (EoH) should be similar to WB3 however is shorter, suggesting possible siltation/sedimentation.

Metters Well
Site description: Possible old mine shaft turned pastoral well. Mulga/Eucalyptus scrub. The area is low-lying with a creekline nearby. Wet, swampy surrounds.
Bore description: Tin sheet and wooden log capped pastoral bore with no collar.
Geology: Surface red sands then arenaceous sediments- coarse equivalent of white sediments at Silverstone Pit.

Minjar Bore
Site description: 2 km north of Minjar Camp. Possibly the shallowest aquifer in the transported cover. Nearby infrastructure includes: tank, windmill, fenceline.
Bore description: Uncapped exploration bore.
Geology: Red sand/clay, transported cover, some calcrete/alluvium.

Plate 2: Sampling sites a) Bore WB6 (M1 Pit), b) Metters Well, c) Minjar Bore.

Silverstone Pit- Overview of pit facing south from WB2 bore. Showing geology consists of 1 m caprock, 1.5 m topsoil, 12 m transported cover, white sediments (shale) and purple felsics. The gold shear (Mougooderra Shear) is not as obvious as in the M1 pit. Groundwater levels have returned to pre-dewatering levels.

M1 Pit- Overview of pit facing south from WB6 bore. Showing geology consists of 1 m caprock, 1.5 m topsoil, 12 m transported cover, white sediments (shale) and purple/red felsics. The gold shear (Mougooderra Shear) is prominent. Groundwater levels have returned to pre-dewatering levels.

Plate 3: Overview of pits showing geological formations within the Minjar Project Area.

a) Silverstone Pit, b) M1 Pit.

4. RESULTS AND DISCUSSION

4.1 Groundwater quality

Stygofauna, like surface water fauna, are influenced by their immediate environment. Their distribution within an aquifer is controlled by the physicochemical characteristics of the groundwater (Strayer 1994). The collection of physicochemical data is therefore necessary to determine habitat tolerances and any factors which may limit the presence of stygofauna in the study area.

The groundwater levels (SWL) were found to vary slightly between the sampling areas (deposits). The SWL at Silverstone Pit was found to be shallower than at M1 with water levels measured at 27.8 mbgl at WB1 and 25.1 mbgl at WB2, compared to > 35 mbgl at the M1 bores (**Table 1**). Metters Well, south of Silverstone, had a SWL close to that of the Silverstone bores. The difference in SWL in the Silverstone area followed a similar finding in 2000, with the hydraulic gradient from south to north (Coffey Geosciences Pty Ltd 2000). In contrast, the SWL at Minjar Bore was very close to the surface (2.7 mbgl), indicating this bore intersected the alluvial aquifer rather than the fractured rock aquifer of M1 and Silverstone. Current groundwater levels in the Silverstone and M1 pits (which intersect the deeper fractured rock aquifers) are similar to the pre-dewatering levels (approximately 30 – 40 m) recorded seven years ago (C. Arthur, Chief Mine Geologist, GSR, pers. comm. 2009). This indicates that there has been aquifer recharge and subsequent replenishment of the aquifers.

The pH of the groundwater in the Minjar Project Area ranged from circumneutral (pH = 6.5 - 7.5) to slightly alkaline (pH > 7.5) (*sensu* Foged 1978) (**Table 1**), and was generally considered to be similar at all sites sampled. Variation was also observed in the groundwater salinity (measured as electrical conductivity). Half of the sites were classified as fresh (< 5 mS/cm) and the remaining sites, hyposaline (approximately 5-30 mS/cm) (Hammer 1986). The production bores WB3 and WB6, located at the southern and northern ends of the M1 Pit respectively and Minjar Bore were fresh. The highest salinity was recorded from WB2, located at the northern end of Silverstone Pit, followed by WB1 at the southern end of the Silverstone Pit with a slightly lower reading. Differences in salinity are often related to the residence time of the groundwater though this does not appear to be the case at Minjar with bores located within the same aquifer had different salinity readings. Studies by Coffey (2000) found the groundwater at Silverstone to be saline and pumping tests showed the salinity increased as the pumping continued. The groundwater at M1 was found to be fresh and remained consistently fresh, indicating a different geological origin.

Dissolved oxygen concentrations ranged from 0.98 ppm at WB2 to 4.86 ppm at WB1. A similar variation was observed at M1 with a difference of 3 ppm between the two bores. Generally levels below 2 ppm are considered inhospitable for aquatic fauna. However, stygobitic species are known to tolerate and recover from very low levels of oxygen (Strayer 1994) with many Australian stygobitic taxa been found in suboxic waters that have dissolved oxygen levels below 1 mg/L (= 1 ppm) (Humphreys 2008). This implies

Table 1: Bore details and groundwater quality parameters measured, Minjar Project, July 2009. IBD = internal bore diameter, SWL = approximate standing water level, EoH = approximate end of hole, EC = electrical conductivity, Temp. = temperature, DO = dissolved oxygen. ND – no datum.

Site Code	Location	GPS Coordinates	Bore Details					Water Quality Parameters				
			Use	Casing	IBD (mm)	EoH (mbgl)	SWL (mbgl)	pH	EC (mS/cm)	Salinity (ppt)	Temp. (℃)	DO (ppm)
WB1	Silverstone Deposit	50 J 0495231 6802134	Production	PVC	160	61.0	27.8	ND	8.4	5.1	25.0	4.9
WB2		50 J 0495122 6802656	Production	PVC	160	90.0	25.4	6.8	26.1	17.1	26.3	1.0
WB3	M1 Deposit	50 J 0493933 6810663	Production	PVC	160	85.0	40.7	7.3	1.0	1.0	28.5	1.1
WB6		50 J 0493829 6810977	Production	PVC	160	75.0	36.2	6.5	1.7	1.0	28.9	4.0
Minjar Bore	North of Camp	50 J 0492605 6814567	Exploration	PVC	60	12.0	2.7	7.2	3.5	2.1	29.0	2.3
Metters Well	South of Silverstone	50 J 0497829 6792920	Pastoral	Logs	2000	30.0	19.2	7.8	20.6	13.5	25.5	2.0

the dissolved oxygen concentrations of groundwaters in the Minjar Project are unlikely to preclude stygofauna.

4.2 Stygofauna

Four of the six sites yielded invertebrates and of these, Minjar Bore was the only site to contain stygal or potentially stygal specimens (all referred to as stygofauna) (**Table 2**). The stygofauna identified were from the crustacean orders Bathynellacea and Harpacticoida in conjunction with annelids (segmented worms) from the class Oligochaeta. Other invertebrate taxa collected during the pilot study included mites (Acarina), springtails (Collembola) and fly larvae (Diptera). The majority of these were classified as either terrestrial, in the case of the mites and springtails, or surface water inhabitants and have not been considered further in this study. A brief overview of the stygal and potentially-stygal groups collected from Minjar Bore is presented below.

4.2.1 Bathynellacea

Bathynellacea is a primitive stygobitic crustacean order (Guzik *et al.* 2008). Bathynellaceans are common in the calcrete aquifers of the Murchison region (Cho *et al.* 2006) and are also known from the groundwaters of the Pilbara region (Eberhard *et al.* 2004) and those of the Swan Coastal Plain (De Laurentiis *et al.* 2001). The interstitial spaces of alluvial aquifers are a preferred habitat for this group (Guzik *et al.* 2008) as was shown in this study by their presence in Minjar Bore, the only alluvial aquifer site sampled in the Minjar Project Area.

4.2.2 Harpacticoida

Copepods belonging to the order Harpacticoida inhabit both surface and groundwaters. A number of stygal species have now been described from subterranean waters in the arid region of Western Australia (Karanovic 2004, 2006). Similar to the bathynellaceans, the harpacticoids were only found at Minjar Bore. Even though identifications were basic, the pale pigmentation of these specimens suggests that they are stygofauna.

4.2.3 Oligochaeta

Oligochaetes are a diverse group which inhabit soils, and both surface and subterranean waters (Pinder 2008, Williams 1980). In Western Australia, these worms have been recorded from subterranean waters in the Pilbara, South Coast (Eberhard *et al.* 2004, Rockwater 2006) and Murchison regions (Outback Ecology unpublished data). The specimens collected from Minjar Bore lacked pigment and were therefore considered stygal.

Table 2: Invertebrate taxa collected from the groundwaters of the Minjar Project Area, July 2009.

Taxa		Sites					
Classification	**Identification**	**WB1**	**WB2**	**WB3**	**WB6**	**Minjar Bore**	**Metters Well**
Stygal & Potentially Stygal	Harpacticoida					4	
	Bathynellacea					8	
	Oligochaeta					2	
Non-Stygal	Acarina	1	5			18	
	Collembola		1				
	Diptera						1

4.3 Overview of stygofauna distribution in the Minjar Project Area

Overall, the findings of the pilot study conducted within the Minjar Project Area corresponded with the findings of other surveys in the area. Stygofauna surveys in the Greater Karara Iron Ore project near Minjar also had low to no stygofauna yields from fractured rock aquifers. Syncarids (the superorder to which Bathynellacea belongs), copepods and oligochaetes were instead collected from bores/wells that intersected the alluvial aquifers (Ecologia Environment 2008a). Other studies limited to desktop surveys concluded that the area was not considered a significant environment for stygofauna (Biota 2007).

4.4 Risk to stygofauna in the Minjar Project Area

Stygal or potentially stygal invertebrates were only collected from the alluvial perched aquifer intersected by Minjar Bore. This suggests that stygofauna in the area may be confined to shallow alluvial aquifers. The results of this study were supported by similar surveys in the region (Ecologia Environment 2008a). Given that there is considered to be no connectivity between the perched alluvial aquifer and the deeper fractured rock aquifer of the ore body, drawdown during the mining processes is not expected to impact the stygofauna community identified in the project area. As a result, the risk to the stygofauna posed by the Minjar Project appears to be very low.

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