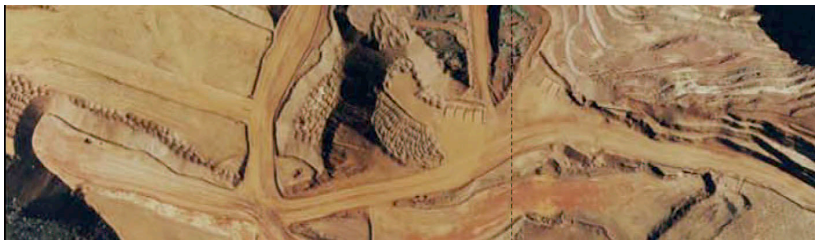
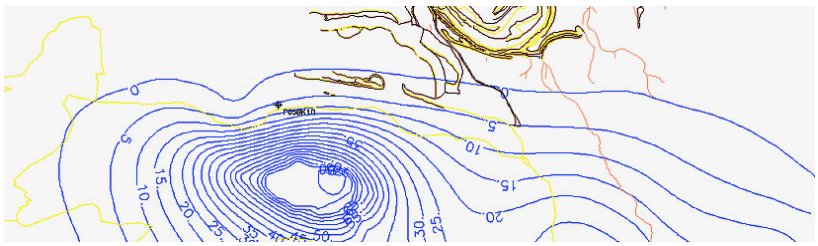
Biota Environmental Sciences

Brockman 2B Pit Deepening Stygofauna Assessment





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Prepared for Rio Tinto Iron Ore

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1.0 Introduction

1.1 Project Background

Rio Tinto Iron Ore (RTIO) has approval to operate the existing Brockman No. 2 (BS2) iron ore mine, approximately 45 km north-west of Tom Price in the Pilbara region of Western Australia (Figure 1.1). The current operational pit is approaching the limits of above-watertable mining and dewatering will shortly be required to access the remaining ore in the deposit. The areas of the mine under consideration comprise Pit 4, 4a and 6, the below water-table portions of which are collectively referred to as the BS2 'lower area'.

As part of approval for the deepening of the BS2 pit, RTIO will need to consider the factor of stygofauna. This groundwater-dwelling fauna occurs across the Pilbara bioregion in suitable groundwater habitats (see Section 1.3). The Pit 4 area of BS2 had a pre-mining watertable of approximately 618 m RL (RTIO 2009). RTIO has approval to dewater Pit 4 to 580m RL to facilitate mining, on the assumption that the watertable was not connected with the regional watertable within the Nammuldi valley to the immediate north (RTIO 2009).

1.2 Scope and Role of this Report

Due to historical mining activities within the pit areas, there are no groundwater bores remaining that are suitable for stygofauna sampling. This document therefore provides a desktop and habitat-based assessment of the risk that stygofauna would be present in the area and any related conservation values affected by the dewatering. This has been based on:

- site-specific geological and hydrogeological habitat data for the Brockman 2 pit;
- the outcomes of previous stygofauna surveys completed in ore body aquifers in the immediate vicinity of the Brockman 2 mine; and
- findings from stygofauna sampling in other hydrogeologically similar aquifers from elsewhere in the Pilbara bioregion.

As a desktop review, the conclusiveness of this document is limited to inferences drawn from these data sources. The use of desktop reviews is however provided for by EPA Guidance Statement 56a (EPA 2007), and it is suitable as an input to the environmental assessment process for the project.

1.3 General Background on Stygofauna

Stygofauna are those fauna that inhabit groundwater, sometimes occurring very close to the surface. They tend to be highly specialised to, and obligate dwellers of, subterranean groundwater habitats ('stygobites' Humphreys 2000). Stygofauna are known to be present in a variety of rock types including karst (limestones), fissured rock (e.g. granite) and porous rock (e.g. alluvium) (Marmonier et al. 1993). The types of animals that have become stygal (groundwater-inhabiting) in Western Australia include platyhelminthes, oligochaetes, crustaceans, water mites and water beetles, (Humphreys 1999, Watts and Humphreys 1999). Much attention has been directed to the crustacean fauna, which includes ostracods, copepods, bathynellid syncarids, isopods and amphipods (Humphreys 1999, Watts and Humphreys 1999, Biota unpublished data).

Subterranean food webs are typically almost entirely heterotrophic, with bioproduction primarily dependent on the transport of resources (biomass, detritus) from the surface (allotrophy; Gibert et al. 1994). There are few primary producers (chemolithotrophic bacteria; Danielopol et al. 1994). Groundwater microbes (i.e. bacteria, fungi and protozoans) are the primary consumers, with generally short direct trophic links to most meiofauna in the system.

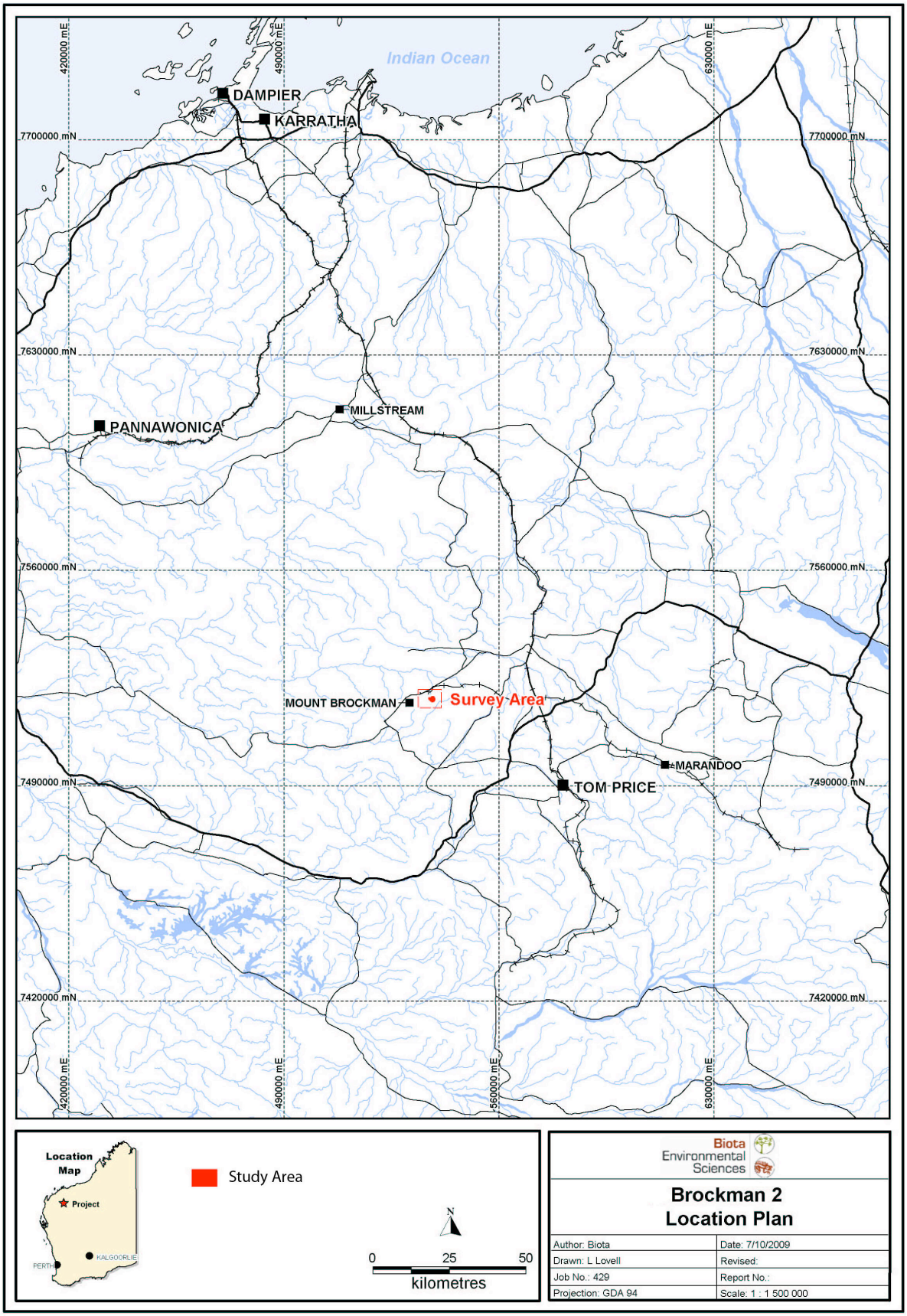

Figure 1.1: Locality map for the Brockman 2 mine.

2.0 Project Area and Proposed Dewatering

2.1 Geology

The BS2 deposit is located on the northern margin of the Brockman Syncline in steep topography and sits in a series of complex doubly plunging east south-east trending synclinal structures (Pilbara Iron 2005). The ore body comprises mineralised Brockman Iron Formation (BIF) and associated detrital deposits. The BS2 pits occur along the face of the syncline and comprise a series of above watertable cutbacks into the syncline wall (Pilbara Iron 2005).

The geology of the region comprises Proterozoic meta-sediments of the Hamersley Group and overlying Tertiary age regolith and valley fill sediments (Figure 2.1). The mineralised ore at BS2 occurs within the Dales Gorge Members of the Brockman Iron Formation. Iron-enriched detrital sediments have also been mined within the adjacent Nammuldi valley. The Nammuldi valley is filled with Tertiary sediments overlying the Wittenoom Formation which abuts the Marra Mamba Iron Formation and ridge to the north.

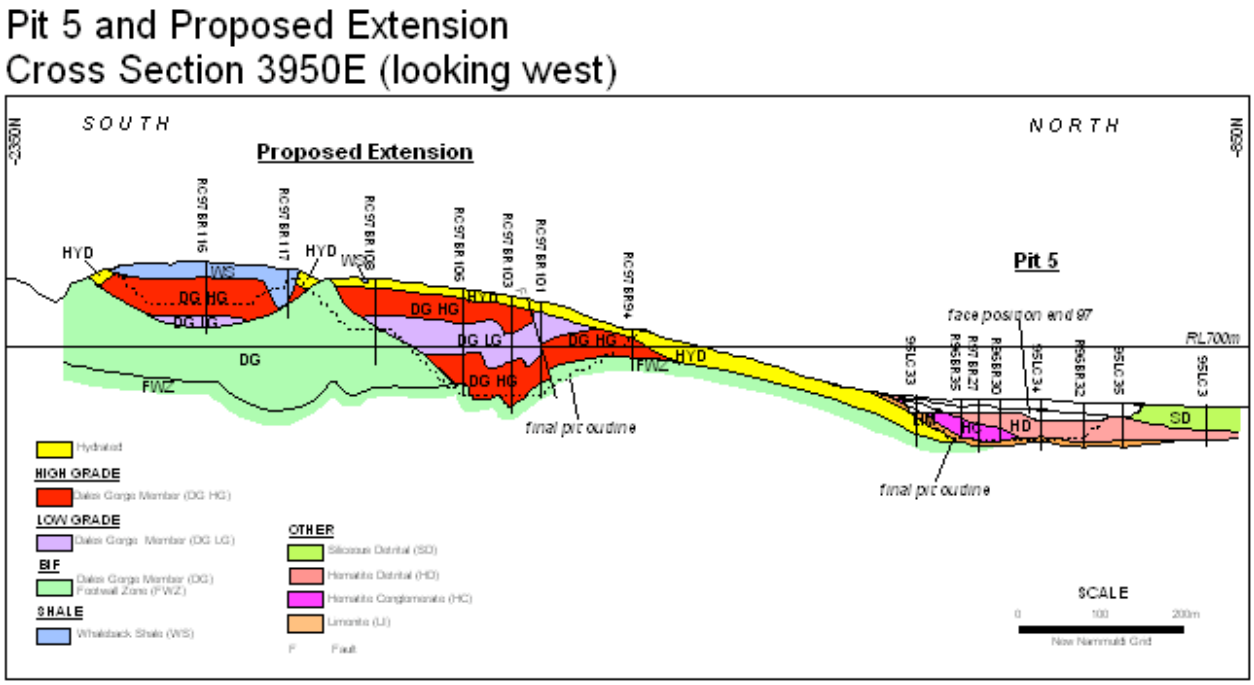

Figure 2.1: Brockman Syncline 2 geology section (source: Pilbara Iron 2005).

The BS2 deposit itself is divided into two pits separated by a steep valley. The deposit sits in a series of complex doubly plunging east – southeast trending synclinal structures (Pilbara Iron 2005). The valley and the original Pit 4 mark the centres of plunge for both synclines. Mineralisation occurs from the Mt McRae Shale (known locally as the Foot Wall Zone) through the Dales Gorge Member into the Whaleback Shale (Pilbara Iron 2005).

2.2 Hydrogeology

The target aquifer for dewatering is located within the mineralised Brockman Iron Formation, and is similar to those encountered in the pits at Tom Price and Paraburdoo. In the BS2 Lower area, an isolated unconfined aquifer occurs within the Brockman Iron Formation ore body (Pilbara Iron 2005 and 2009a). Available data suggest that the BS2 ore body aquifer is geologically bounded by unmineralised and relatively impermeable BIF and the Mt McRae Shale aquitard (Pilbara Iron 2005 and Rio Tinto 2009a).

Geological investigations indicate that there are no major structures providing conduits between this isolated ore body aquifer and the regional aquifer, with the regional water table being significantly lower (approximately 41 m) than the isolated aquifer targeted for dewatering. (Rio Tinto 2009a).

In regards to water quality in the ore body aquifer, the groundwater is fresh at generally less than 400mg/L Total Dissolved Solids (Rio Tinto 2009a). For the Pilbara, the groundwater is notably absent in bicarbonate and not very hard, indicating its recharge source is from rainfall, rather than groundwater inflow or other connection, and with minimal evaporative impact (Rio Tinto 2009a).

2.3 Dewatering

The existing B2 Pit4 has previously been mined to the 590RL. The Phase IIB deepening comprises extending the depth of mining beyond the 590RL down to 530RL to mine the lower area of BS2 (Rio Tinto 2009b). An updated groundwater model for the BS2 mine was prepared by Rio Tinto (2009a), with dewatering modelling and predictions then carried out by Rio Tinto (2009b) to assess the likely outcome of this pit deepening.

A key finding of that study was the influence of the relatively low permeability in the unmineralised BIF surrounding the ore body. This effectively limits the extent of groundwater drawdown to the north, west and east (Rio Tinto 2009b). The modelling therefore predicted negligible impact on groundwater levels within the regional watertable of the Nammuldi valley directly north of Pit 4a, and that drawdown will essentially be restricted to the ore body aquifer itself. The Rio Tinto (2009b) model was however open to the southeast, where the mineralised ore is yet to be closed out by resource drilling.

3.0 Likelihood of Stygofauna Occurrence

3.1 Subterranean Habitats

Currently available data indicate that the only aquifer habitat likely to be affected by the proposal to deepen the BS2 mine into the lower areas is the ore body aquifer itself (Section 2.0). Modelling indicates that other potential habitats for stygofauna to the north and in the wider region will not be affected by the proposed dewatering.

Therefore, for the purposes of this review, the habitat of interest in regards to potential stygofauna occurrence comprises:

- an isolated Brockman Iron Formation (BIF) ore body aquifer;
- surrounded by relatively impermeable unmineralised BIF and shales;
- relatively fresh water quality, but low calcium carbonate (Rio Tinto 2009a);
- most likely recharged by rainfall rather than regional inflow; and
- with a history of over-lying mining activity.

The largest abundance and diversity of stygofauna in the Pilbara bioregion often occur in aquifers associated with major fluvial systems, including calcrete aquifers, major alluvial and gravel aquifers and spring systems (Humphreys 1999, Eberhard et al. 2005, Biota 2006 and 2007). Hard rock systems, such as BIF aquifers, may also provide habitat to stygofauna, providing there is permeability or fracturing present (Humphreys 1999, Eberhard et al. 2005), and more often when in contact with other more core habitats such as saturated calcrete or alluvium. Therefore, while not a high-risk or recognised core habitat, it is possible that stygofauna could utilise the BIF ore body in the lower areas of BS2.

However, in most situations where stygofauna have been recorded from BIF aquifers, the formation has not been in the hydrologically isolated setting that the BS2 ore body is. Biota (2006) recorded stygofauna from two holes targeting BIF geology, but these were at Weeli Wolli Springs where the BIF was overlain by (and connected to) a thick sequence of saturated calcrete. None of the remaining 11 BIF holes on the Hope Downs deposit itself, which were not in contact with these core habitats, yielded any stygofauna in that study (Biota 2006). Similarly, EPA (2007) reports stygofauna from two bores targeting BIF during the Pilbara Biological Survey, but these were also from a similar setting at Millstream and presumably part of a far larger aquifer system.

The hydrogeological setting of the BIF aquifer, its small extent and its lack of connection to other regional groundwater systems, is therefore relevant to assessing the likelihood of stygofauna occurrence. The results of sampling from other nearby and/or similar systems are also informative (Section 3.2).

3.2 Previous Surveys of Nearby Systems

3.2.1 Nammuldi

An extensive programme of sampling for stygofauna was completed by Biota (2003) at the Nammuldi deposit, approximately 2 km to the north of the Brockman 2 mine. The survey work comprised sampling of a total of 22 boreholes on that ore body, with five phases of repeat sampling completed over a three year period (Biota 2003). Seventeen of the 22 boreholes never yielded stygofauna over the five phases of sampling. The only records were of four single specimens collected on separate occasions from single sample sites. Considering that this represented just four specimens from a total of 110 bore-sampling events over three years, Biota (2003) concluded that there was no indication of a stygal community of significance associated with the ore body aquifer. While Nammudi is a bedded Marra Mamba deposit rather than BIF, it

is still a relevant comparison data set from an ore body aquifer immediately adjacent to the Brockman 2 mine.

3.2.2 Brockman Syncline 4

Similar results were recorded during stygofauna sampling at Brockman Syncline 4, some 15 km to the south of the Brockman 2 mine (Biota 2005). The geology of this deposit is also similar to that of the Brockman 2 mine, being BIF-dominated (Biota 2005). Two phases of sampling were carried out at Brockman Syncline 4 at 27 locations: this total of 54 borehole-sampling events yielded just a single animal, and on 53 of the sampling events (98%) there were no stygofauna recorded. The single stygofauna record from that study was also from a bore that intersected alluvial strata in addition to the ore body itself (Biota 2005).

The conclusion from this sampling programme was again that there was little evidence of a stygal community associated with the groundwater of the Brockman Syncline 4 ore body (Biota 2005).

3.3 Previous Surveys of Similar Systems

3.3.1 West Angelas Deposit A

The West Angelas Deposit A aquifer, while comprised of Marra Mamba ore, is very analogous to the BS2 ore body in regards to its hydrology and setting. The Deposit A ore body had previously been mined above-watertable, and groundwater investigations indicated it contained a local ore body aquifer that was surrounded by lower permeability material and thereby disconnected from regional systems (Biota 2008). As with BS2, the dewatering influence was therefore predicted to be limited to the ore body itself.

A stygofauna survey was carried out at Deposit A by Biota (2008) to sample bores within and around the Deposit A mine pit area. Fifteen bores were successfully sampled and no stygofauna were recorded from any of the fifteen bores sampled in the ore body.

3.3.2 Orebody 18

Orebody 18 is a BHP Billiton Iron Ore (BHPBIO) deposit some 32 km to the east of Newman. The ore body is Brockman ore, cradled in the Shovellana Syncline (EPA 1996). Similar to BS2, the aquifer of that ore body is bounded by low permeability shales and unmineralised BIF, and forms a distinct aquifer unit (EPA 1996).

Orebody 18 was sampled for stygofauna over two phases by Biota (2007). Eleven bores were sampled during this study, and none of these yielded stygofauna.

4.0 Conclusions

On the basis of the review completed here, it appears unlikely that a stygobitic community of any significance would be present in the ore body aquifer of the lower areas of the Brockman 2 mine. This conclusions is reached after considering that:

- the ore body aquifer is hydrogeologically disconnected from regional groundwater systems (Section 2.2);
- geologically, it is comprised of BIF, which while providing habitat for stygofauna in some settings, is less likely to when isolated by impermeable shales and other formations (Section 2.2 and 3.1);
- sampling at two immediately adjacent ore body aquifers yielded very little evidence of stygal communities (Section 3.2); and
- sampling at other, similarly isolated ore body aquifers elsewhere in the region has also yielded no stygofauna (Section 3.3).

The only way to further confirm this finding would be to complete sampling of boreholes targeting the lower area BIF aquifer at BS2. The value of this is questionable however, considering the null result from of an identical exercise at West Angelas (Section 3.3.1), and that the geologically similar and proximal Brockman Syncline 4 deposit also yielded nothing of significance (Section 3.2.2). New boreholes would need to be drilled specifically for this purpose, and the time and effort of this, and the subsequent sampling programme itself, would all appear difficult to justify given the low risk.

Groundwater modelling indicates that the dewatering influence of the proposed pit deepening would also not extend beyond in the area of the BS2 mine itself. Other areas with known stygal communities (such as Homestead Creek to the north; Biota 2002), would remain unaffected. There therefore appears to be a low risk that any subterranean fauna conservation values would be compromised as a result of the deepening of the existing Brockman 2 mine.

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